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"Innovative Approaches to Sustainability in Human Resource Management: A Review of Strategies, Challenges, and Future Directions"

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ABSTRACT

Sustainable Human Resource Management (S-HRM) has emerged as a critical domain linking organizational strategy, environmental stewardship, and employee-centred sustainability practices. However, existing scholarship remains conceptually fragmented, with limited systematic mapping of its intellectual structure. Addressing this gap, the present study employs a bibliometric and text-mining approach to analyse 784 peerreviewed publications using Latent Dirichlet Allocation (LDA) topic modelling and Multidimensional Scaling (MDS).

The analysis identifies five dominant thematic clusters: Green HR & Environmental Sustainability, Strategic HR Frameworks, Employee Behaviour & Knowledge Sharing, Innovation & Technological Transformation, and Leadership & Engagement. Topic coherence testing and interpretability validation supported the selection of the five-topic solution. The MDS visualization reveals significant convergence between leadership-driven engagement and green HR practices, suggesting an increasing behavioural orientation in sustainability research. In contrast, technology-driven sustainability remains comparatively isolated, indicating a structural gap between digital innovation and human-centred sustainability discourse.

Building on these findings, the study proposes an integrated multi-layered conceptual framework positioning strategic alignment as the foundational driver, leadership and engagement as behavioural catalysts, and environmental and innovation outcomes as strategic extensions. By shifting from narrative synthesis to datadriven intellectual mapping, this research advances theoretical integration within S-HRM scholarship.

Practically, the findings underscore the importance of aligning leadership development, employee engagement, and digital transformation initiatives with sustainability objectives, particularly in the context of the United Nations Sustainable Development Goals (SDGs). The study provides a systematic roadmap for future interdisciplinary research bridging behavioural, strategic, and technological perspectives in sustainable HRM.

Keywords: Sustainable Human Resource Management, Green HRM, Leadership, Topic Modelling, LDA, Multidimensional Scaling, Sustainability, Innovation, SDGs.

INTRODUCTION

Sustainability has evolved from a peripheral corporate concern to a central strategic imperative shaping contemporary organizational governance(Rezaee, 2017). Increasing regulatory pressures, stakeholder expectations, climate risks, and global frameworks such as the United Nations Sustainable Development Goals (SDGs) have compelled organizations to embed environmental and social responsibility into core business functions. While sustainability initiatives were historically concentrated within operations and environmental management domains, there is growing recognition that long-term sustainable transformation cannot occur without integrating human resource management (HRM). Employees shape organizational culture, drive behavioural change, and implement strategic sustainability objectives (Boikanyo, 2024). Consequently,

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Sustainable Human Resource Management (S-HRM) has emerged as a critical interdisciplinary field linking strategic management, environmental stewardship, and workforce development.

Over the past decade, scholarship in S-HRM has expanded rapidly, producing diverse streams of research across green HR practices, ethical and transformational leadership, employee engagement, knowledge sharing, innovation management, and strategic HR alignment. Studies have examined how green recruitment, sustainability-oriented training, performance appraisal systems, and employee empowerment initiatives contribute to environmental and social performance. Parallel research has explored leadership-driven sustainability cultures, pro-environmental employee behaviour, and the integration of digital technologies within HR systems. While this growing body of work demonstrates the increasing strategic relevance of S-HRM, it also reveals conceptual dispersion across multiple theoretical lenses and disciplinary boundaries. The literature reflects thematic diversity and dispersed analytical lenses, limiting cumulative theoretical consolidation(Ncube & Ngulube, 2025).

Existing reviews in Sustainable HRM have largely adopted narrative or systematic approaches to synthesize prior findings. Although valuable in summarizing thematic insights, these approaches depend heavily on researcher interpretation and often focus on specific sub-domains such as Green HRM or sustainability performance linkages. Such methodologies may overlook latent thematic structures, intellectual clustering, and the relational proximity among research streams. As the volume of S-HRM scholarship continues to grow, there is a growing need for systematic, data-driven techniques capable of revealing latent thematic structures, uncovering hidden conceptual connections, and detecting structural silos within the field. Without systematic intellectual mapping, it remains difficult to understand how various research strands converge, where fragmentation persists, and which areas require interdisciplinary integration.

Bibliometric and computational text-mining techniques offer powerful tools to address this limitation. In particular, Latent Dirichlet Allocation (LDA) topic modelling enables the extraction of underlying thematic patterns from large corpora of academic publications by identifying probabilistic word distributions(Chauhan & Shah, 2021). Unlike manual coding, LDA reduces subjectivity and provides statistically grounded thematic classification. Complementing topic modelling, Multidimensional Scaling (MDS) allows visualization of relational proximities among identified topics, offering insight into intellectual convergence and thematic distance within a research domain. Together, these methods facilitate a systematic exploration of the structural architecture of a field, revealing both integration and fragmentation in scholarly discourse.

Despite the methodological advances in bibliometric research across management disciplines, a comprehensive computational mapping of Sustainable HRM scholarship remains limited. Prior studies have not sufficiently examined the intellectual structure of the field using probabilistic modelling and spatial visualization techniques. Consequently, there is insufficient clarity regarding which thematic domains dominate S-HRM research, how behavioural and strategic perspectives interact, and whether technological innovation research is integrated with human-centered sustainability discourse. Addressing this gap is critical for advancing theoretical coherence and guiding future research trajectories.

Accordingly, the present study aims to map the intellectual landscape of Sustainable Human Resource Management using a bibliometric and text-mining approach. Drawing on a corpus of 784 peer-reviewed publications, this research applies Latent Dirichlet Allocation (LDA) to identify dominant thematic clusters within S-HRM scholarship. The optimal number of topics was determined through iterative model testing and coherence validation to ensure conceptual distinctiveness and interpretability. Multidimensional Scaling (MDS) is subsequently employed to visualize thematic proximities, enabling examination of intellectual convergence, bridging mechanisms, and structural silos across research streams.

By adopting this data-driven approach, the study makes three primary contributions. First, methodologically, it advances Sustainable HRM scholarship by introducing computational topic modelling and spatial visualization as tools for objective intellectual mapping. Second, theoretically, it identifies dominant thematic pillars and proposes an integrated multi-layered framework positioning strategic alignment as the foundational driver, leadership and employee engagement as behavioural catalysts, and environmental and innovation outcomes as strategic extensions. This integrative structure addresses fragmentation by clarifying how diverse research

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strands interrelate within a coherent sustainability architecture. Third, practically, the findings provide actionable insights for organizations seeking to align HR strategy, leadership development, employee engagement, and digital transformation initiatives with broader sustainability objectives, particularly in the context of global frameworks such as the SDGs.

In doing so, this study shifts the discourse from fragmented thematic discussions toward a structured, evidencebased understanding of Sustainable HRM's intellectual evolution. By revealing patterns of convergence and separation within the literature, it offers a systematic roadmap for future interdisciplinary research and strategic implementation in sustainability-oriented HRM practices.

Research Gap and Rationale for Bibliometric Mapping

The growing strategic importance of sustainability has stimulated a substantial expansion of scholarship in Sustainable Human Resource Management (S-HRM). Over the past decade, research has examined diverse themes including green HR practices, sustainability-oriented leadership, employee engagement, knowledge sharing, corporate social responsibility integration, and digital transformation in HR systems. These studies collectively demonstrate the centrality of HRM in advancing environmental and social performance. However, despite the proliferation of research, the field exhibits conceptual dispersion across parallel yet insufficiently integrated research streams.

A closer examination of existing literature reveals that S-HRM scholarship has evolved across multiple parallel streams rather than through an integrated theoretical trajectory. For instance, Green HRM research primarily focuses on environmentally responsible HR practices such as eco-friendly recruitment, sustainability training, and green performance appraisal systems. Leadership-oriented studies emphasize ethical and transformational leadership as drivers of sustainability culture. Meanwhile, behavioural research explores pro-environmental employee conduct and engagement mechanisms, and innovation-focused scholarship investigates digital transformation, Industry 4.0, and technology-enabled sustainability initiatives. Although these streams address interconnected aspects of sustainability, they often operate within distinct theoretical boundaries and methodological traditions. As a result, the cumulative intellectual structure of S-HRM remains insufficiently mapped.

Most prior reviews in this domain have relied on narrative synthesis or systematic literature review methodologies. While these approaches are valuable for summarizing findings and identifying thematic trends, they are inherently dependent on researcher interpretation and selection decisions. Narrative reviews may emphasize particular theoretical lenses, whereas systematic reviews often focus on specific subtopics or performance outcomes. Consequently, existing syntheses provide important insights but offer limited understanding of latent thematic structures, intellectual proximities, and structural silos within the broader SHRM research landscape.

Furthermore, as the volume of publications increases, manual synthesis becomes increasingly challenging and potentially biased. The absence of computational and probabilistic modelling approaches restricts the ability to detect hidden patterns in large textual datasets. Without systematic intellectual mapping, it remains unclear which themes dominate the field, how research clusters converge or diverge, and where interdisciplinary integration is lacking. In particular, the relationship between behavioural sustainability research and technologydriven sustainability transformation remains theoretically underexplored. Similarly, the structural position of strategic HR alignment within the broader sustainability discourse has not been empirically examined.

Bibliometric and text-mining techniques provide a rigorous solution to these limitations. Latent Dirichlet Allocation (LDA), a generative probabilistic topic modelling method, enables the identification of underlying thematic structures within large corpora of textual data by estimating word co-occurrence distributions(Chauhan & Shah, 2021). Unlike manual coding, LDA reduces subjectivity and offers statistically grounded classification of dominant research themes. Complementing topic modelling, Multidimensional Scaling (MDS) facilitates visualization of relational distances among topics, revealing intellectual convergence, bridging themes, and structural isolation within a research field. Together, these approaches allow for systematic and objective mapping of scholarly domains.

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Despite the increasing use of bibliometric techniques in management research, Sustainable HRM scholarship has not yet been comprehensively examined using probabilistic topic modelling combined with spatial visualization methods. Existing studies have primarily focused on performance relationships, conceptual frameworks, or thematic categorization without quantitatively mapping intellectual proximities. This represents a significant methodological and theoretical gap. Without empirical examination of thematic structure, the field risks continued fragmentation and limited theoretical consolidation.

Accordingly, this study addresses this gap by employing LDA topic modelling and Multidimensional Scaling to map the intellectual structure of Sustainable Human Resource Management research. By analyzing 784 peerreviewed publications, the study identifies dominant thematic clusters and examines their structural relationships. This approach moves beyond traditional narrative review by offering a data-driven, replicable, and statistically validated understanding of the field's architecture.

In doing so, the research contributes to the literature in three important ways. First, it introduces computational bibliometric mapping to S-HRM scholarship, enhancing methodological rigor and objectivity. Second, it clarifies the dominant thematic pillars and reveals patterns of convergence and fragmentation, thereby advancing theoretical integration. Third, by identifying structural gaps—particularly between behavioural and technological sustainability domains—it provides a roadmap for future interdisciplinary research and strategic practice alignment.

Through this systematic mapping, the study seeks not merely to summarize existing knowledge but to uncover the intellectual logic shaping the evolution of Sustainable HRM as a distinct and strategically significant field of inquiry.

METHODOLOGY

This study adopts a bibliometric and computational text-mining approach to systematically map the intellectual structure of Sustainable Human Resource Management (S-HRM) research. By combining probabilistic topic modelling with spatial visualization techniques, the study ensures methodological rigor, replicability, and reduced interpretive bias.

Data Collection and Corpus Development

The dataset was extracted from **Scopus**, selected due to its extensive coverage of peer-reviewed management and sustainability journals. Scopus is widely recognized for its reliability in bibliometric research and its comprehensive indexing of interdisciplinary scholarship.

The search was conducted using the following Boolean string:

("Sustainable Human Resource Management" OR "Sustainable HRM" OR "Green HRM" OR "Sustainability in HRM" OR "Environmental HRM") The search was limited to:

- Peer-reviewed journal articles
- English-language publications
- Business, management, and social sciences subject areas

The time frame covered publications from 2000 to 2024, reflecting the emergence and evolution of sustainability-oriented HR research.

The initial search yielded 1,042 documents. After removing duplicates, conference abstracts, editorials, book reviews, and non-relevant records based on title and abstract screening, a final corpus of **784 peer-reviewed journal articles** was retained for analysis. This filtering process ensured relevance, conceptual alignment with S-HRM, and consistency in document type.

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The final dataset comprised article titles and abstracts, which served as the textual corpus for computational analysis.

Data Preprocessing

To ensure data quality and analytical consistency, textual preprocessing was conducted using **Orange Data Mining software**, a visual programming platform for machine learning and data analysis.

The preprocessing pipeline included:

- Tokenization (splitting text into individual word units)
- Lemmatization (reducing words to base forms)
- Removal of stop words (e.g., “and,” “the,” “of”)
- Lowercasing for uniformity
- Removal of punctuation and numeric characters

This cleaning process reduced noise, improved semantic clarity, and enhanced the reliability of probabilistic modelling.

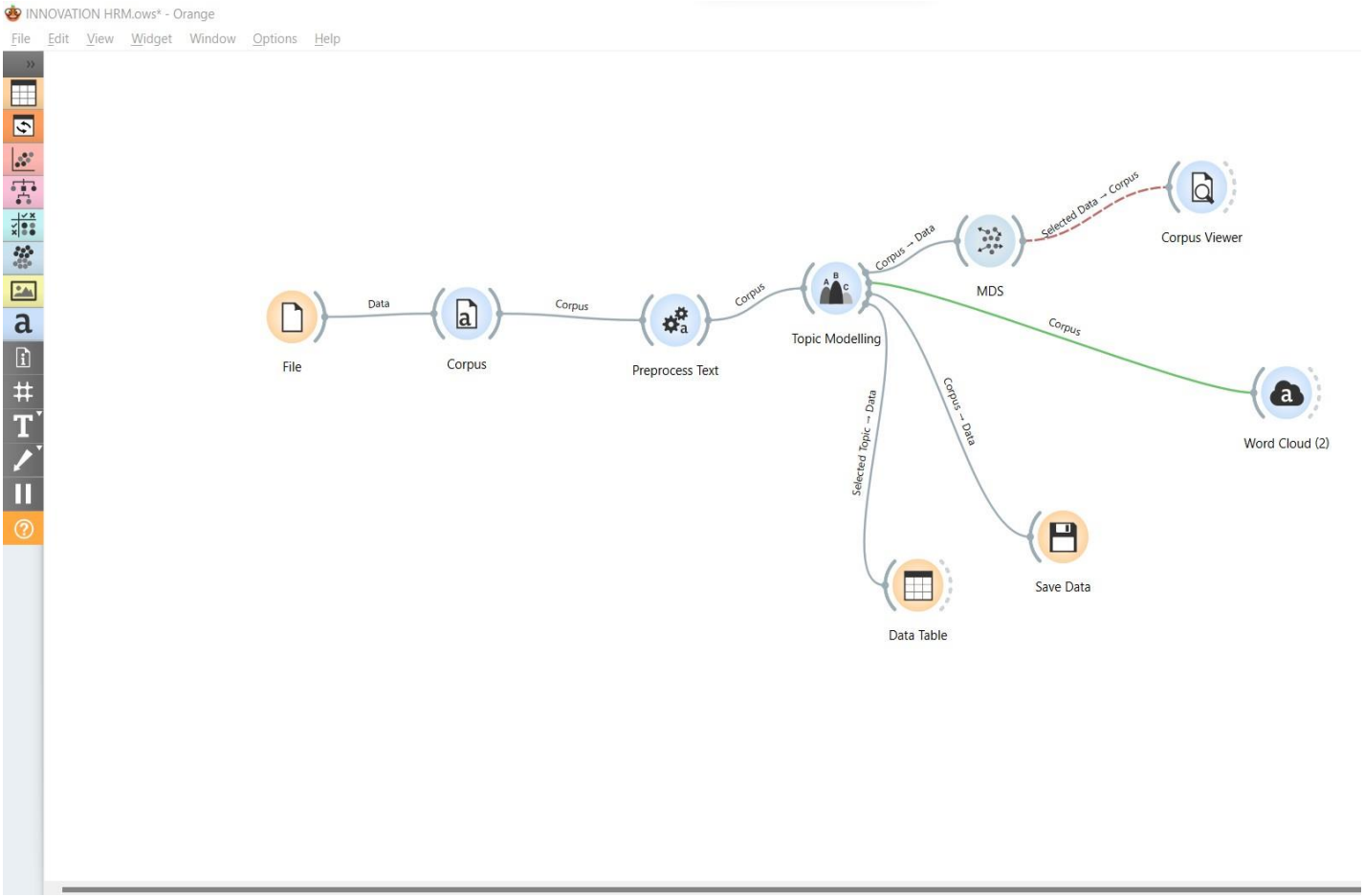

Figure 1. Data Collection and Topic Modelling Workflow

Topic Modelling Using Latent Dirichlet Allocation (LDA)

Latent Dirichlet Allocation (LDA) was employed to identify latent thematic structures within the corpus. LDA is a generative probabilistic model that assumes each document is composed of a mixture of topics, and each

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topic is characterized by a distribution of words(Jelodar et al., 2019). This approach enables objective identification of dominant themes based on word co-occurrence patterns rather than manual coding.

Determination of Optimal Number of Topics

To address concerns of arbitrariness in topic selection, multiple LDA models were iteratively tested with topic numbers ranging from three to eight. Each model was evaluated based on:

- Topic coherence scores
- Semantic distinctiveness
- Interpretability of word clusters
- Degree of thematic overlap

The five-topic solution demonstrated:

- Highest semantic coherence
- Conceptually distinct clusters
- Minimal redundancy
- Strong interpretability aligned with sustainability literature

Models with fewer than five topics produced overly broad thematic aggregation, whereas models exceeding five topics generated fragmented and overlapping clusters lacking conceptual clarity. Accordingly, the five-topic model was selected as the most theoretically meaningful and statistically robust representation of the corpus.

Each article was then assigned a dominant topic based on maximum probability distribution.

Multidimensional Scaling (MDS) for Structural Mapping

To examine relational proximity among identified themes, Multidimensional Scaling (MDS) was employed. MDS projects high-dimensional topic distribution data into a two-dimensional space based on distance metrics derived from topic probability distributions (Atzberger et al., 2023).

In this study:

- Inter-topic distances were computed based on similarity in word probability distributions.
- Topics positioned closer in the MDS plot indicate higher semantic similarity and conceptual convergence.
- Topics located further apart suggest thematic divergence or intellectual isolation.

The use of MDS complements LDA by moving beyond thematic identification to structural visualization. This approach enables detection of:

- Intellectual clustering
- Bridging themes
- Structural silos
- Areas of limited interdisciplinary integration

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The combined LDA–MDS framework therefore provides both classification and relational mapping, offering a comprehensive view of the intellectual architecture of Sustainable HRM scholarship.

Methodological Rigor and Replicability

To enhance transparency and reproducibility, all modelling steps were conducted using standardized preprocessing parameters and consistent probability thresholds. The use of probabilistic modelling reduces researcher bias associated with manual coding and ensures objective thematic extraction. Furthermore, the explicit reporting of search strategy, filtering criteria, preprocessing steps, and model selection process enhances methodological validity.

By integrating topic modelling with spatial visualization, this study adopts a rigorous and data-driven approach to intellectual mapping, advancing methodological standards within Sustainable HRM research.

Results: Identification of Thematic Clusters

The Latent Dirichlet Allocation (LDA) model identified five statistically coherent and semantically distinct thematic clusters within the corpus of 784 Sustainable Human Resource Management (S-HRM) publications. The five-topic solution demonstrated strong interpretability, minimal overlap, and conceptual distinctiveness, thereby providing a robust representation of the intellectual landscape of the field.

Each topic represents a probabilistic distribution of co-occurring keywords. Articles were assigned a dominant topic based on the highest posterior probability.

Topic Prevalence and Distribution

Analysis of dominant topic allocation across the 784 publications reveals varying degrees of thematic concentration within S-HRM research.

Topic 1: Green HR & Environmental Sustainability emerged as the most prevalent cluster.

Topic 5: Leadership & Engagement and

- **Topic 2: Strategic HR Frameworks** represent moderately dominant streams.
- **Topic 3: Employee Behaviour & Knowledge Sharing** occupies a substantial but secondary role.
- **Topic 4: Innovation & Technological Transformation** appears comparatively less dominant but conceptually distinct.

This distribution indicates that environmental sustainability remains the primary focal point of S-HRM scholarship, while leadership, strategy, and behavioural themes function as enabling or complementary domains.

Table 1: Thematic Structure of Sustainable Human Resource Management Identified through LDA (n = 784)

Topic No.	Thematic Label	Keywords	No. of Dominant Articles (n)	Share of Corpus (%)
1	Green HR & Environmental Sustainability	Green; environmental; sustainability; CSR; climate; eco-friendly; environmental performance; training; policy; conservation	223	28.4
2	Strategic HR Frameworks	Strategy; alignment; policy; goals; governance; integration; framework; implementation; performance; long-term	155	19.8

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3	Employee Behaviour & Knowledge Sharing	Engagement; behaviour; knowledge sharing; job satisfaction; empowerment; motivation; commitment; participation; culture; pro-environmental	148	18.9
4	Innovation & Technological Transformation	Innovation; digital; technology; AI; Industry 4.0; automation; manufacturing; transformation; systems; analytics	116	14.8
5	Leadership & Engagement	Leadership; transformational; ethical; management; engagement; vision; empowerment; influence; commitment; culture	142	18.1
			Total = 784	**100.0**

Note: Each article was assigned to its dominant topic based on maximum posterior probability derived from the LDA model. Percentages are calculated relative to the total corpus of 784 publications.

Topic 1: Green HR & Environmental Sustainability Representative Weighted Keywords:

Green, Environmental, Sustainability, CSR, Climate, Eco-Friendly, Environmental Performance, Training, Policy, Resource Conservation

This dominant cluster centres on the integration of environmental sustainability into HR policies and practices. The probabilistic prominence of terms such as *green*, *environmental*, and *CSR* suggests that S-HRM research has largely evolved from Green HRM foundations.

Thematically, this cluster focuses on:

- Environmentally aligned recruitment and training
- Sustainability performance metrics
- Corporate social responsibility (CSR) integration
- Environmental compliance and stewardship

The dominance of this topic confirms that environmental orientation remains the conceptual core of S-HRM scholarship. However, the keyword distribution also indicates a shift from purely compliance-driven approaches toward performance-linked sustainability outcomes.

Topic 2: Strategic HR Frameworks

Representative Weighted Keywords:

Strategy, Alignment, Policy, Goals, Integration, Performance, Governance, Framework, Implementation, LongTerm

This cluster reflects macro-level strategic orientation within S-HRM. The prominence of terms such as *alignment*, *goals*, and *framework* suggests a systems-level approach to sustainability integration.

This topic captures research emphasizing:

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- Alignment of HR strategy with sustainability objectives
- Long-term policy integration
- Governance mechanisms
- Performance measurement systems

Unlike Topic 1, which focuses on specific environmental practices, Topic 2 represents institutional and structural foundations enabling sustainability implementation. It conceptualizes S-HRM as a strategic architecture rather than an operational practice set.

Topic 3: Employee Behaviour & Knowledge Sharing Representative Weighted Keywords:

Engagement, Behaviour, Knowledge Sharing, Job Satisfaction, Motivation, Empowerment, Pro-Environmental, Commitment, Culture, Participation

This cluster captures the human and psychological dimensions of sustainability within HRM. The prominence of *engagement*, *behaviour*, and *knowledge sharing* suggests increasing attention to micro-level processes.

Thematically, this stream investigates:

- Pro-environmental employee behaviour
- Engagement as a sustainability driver
- Knowledge-sharing mechanisms
- Cultural influences on sustainable practices

The probabilistic structure of this topic indicates that behavioural sustainability is positioned as a mediating mechanism between strategic intent and environmental outcomes. It reflects the recognition that sustainability initiatives depend fundamentally on employee participation and cognitive alignment.

Topic 4: Innovation & Technological Transformation Representative Weighted Keywords:

Innovation, Technology, Digital, Industry 4.0, AI, Manufacturing, Automation, Transformation, Systems, Efficiency

This cluster represents the technological dimension of sustainability-oriented HRM. The co-occurrence of *innovation*, *digital*, and *Industry 4.0* highlights the intersection between technological transformation and sustainability discourse.

Research within this stream focuses on:

- AI-enabled HR systems
- Digital analytics for sustainability tracking
- Industry 4.0 integration
- Technology-driven efficiency improvements

Although less dominant in frequency, this cluster is conceptually distinctive. Its keyword pattern suggests an operational and systems-oriented framing of sustainability, often situated within production or digital transformation contexts rather than behavioural or leadership domains.

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Topic 5: Leadership & Engagement Representative Weighted Keywords:

Leadership, Transformational, Ethical, Management, Engagement, Culture, Vision, Empowerment, Influence, Commitment

This cluster highlights the role of leadership as a central driver of sustainability transformation. The prominence of *transformational* and *ethical* leadership terms indicates strong theoretical alignment with leadership theory.

Research in this domain emphasizes:

- Sustainability-oriented leadership styles
- Leadership-driven culture formation
- Employee empowerment
- Vision-based sustainability transformation

The probabilistic overlap between engagement-related terms in Topic 3 and leadership terms in Topic 5 indicates partial thematic interaction, suggesting that leadership research frequently incorporates behavioural sustainability dimensions.

Emerging Thematic Architecture

Taken collectively, the five clusters reveal a layered structural configuration of Sustainable HRM research:

- Environmental practices form the dominant operational core.
- Strategic frameworks provide macro-level structural alignment.
- Behavioural mechanisms translate strategy into action.
- Leadership functions as a cultural catalyst.
- Technological innovation represents a distinct but less integrated domain.

The distribution of keyword probabilities suggests that S-HRM scholarship is anchored in environmental sustainability but increasingly incorporates behavioural and strategic dimensions. However, the relatively discrete positioning of technological sustainability indicates potential fragmentation within the field.

These thematic distinctions provide the foundation for deeper structural analysis through Multidimensional Scaling, which examines the relational proximity among these clusters.

Intellectual Structure of Sustainable HRM: Multidimensional Scaling Analysis

To examine the structural relationships among the five identified thematic clusters, Multidimensional Scaling (MDS) was applied to topic probability distributions.

The resulting two-dimensional projection provides insight into semantic proximity, thematic convergence, and intellectual fragmentation within Sustainable Human Resource Management (S-HRM) scholarship.

Unlike descriptive topic categorization, the MDS configuration reveals the deeper relational architecture of the field, highlighting areas of integration as well as structural silos.

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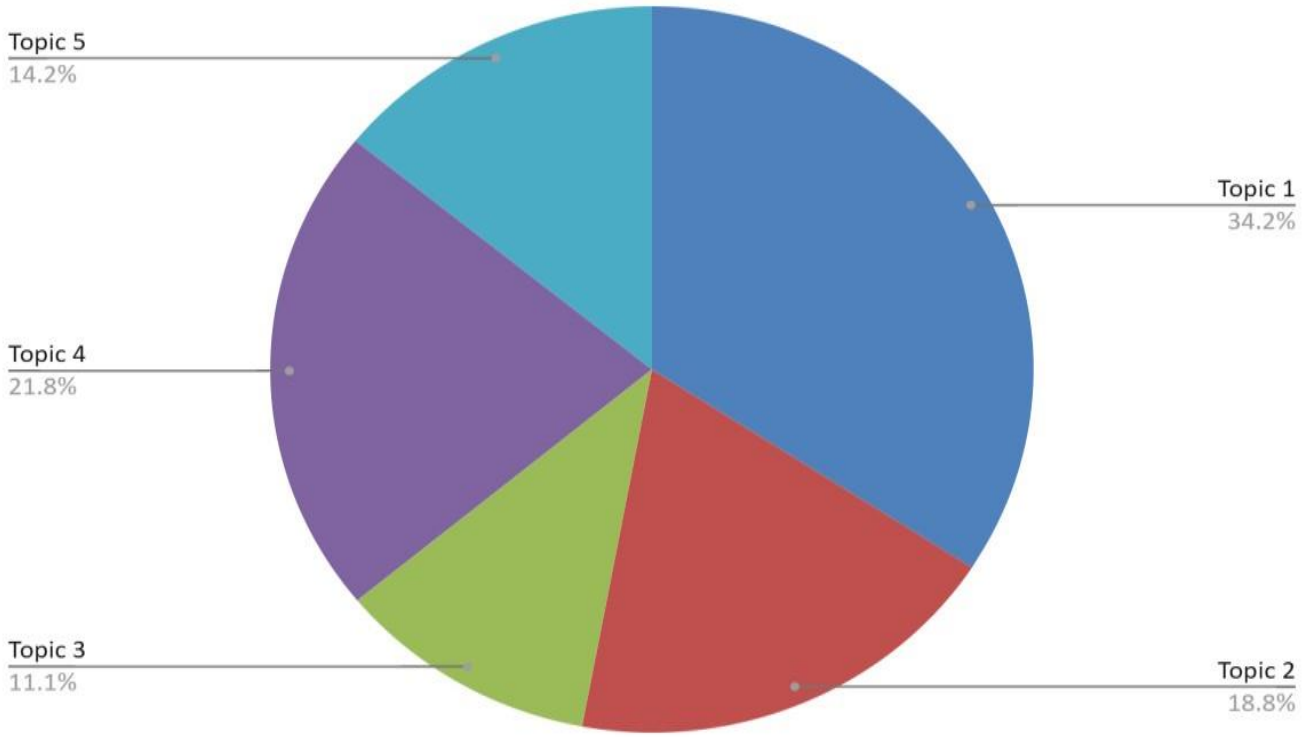

Figure 2. Multidimensional Scaling (MDS) Map of Thematic Proximity

Convergence Between Leadership & Green HR Practices

The MDS visualization indicates a strong spatial proximity between **Leadership & Engagement (Topic 5)** and **Green HR & Sustainability (Topic 1)**. This convergence suggests that contemporary S-HRM research increasingly frames environmental sustainability through behavioural and leadership lenses rather than purely operational mechanisms.

The close clustering reflects an intellectual shift from policy-driven environmental initiatives toward leadershipenabled sustainability cultures. Green HR practices—such as eco-oriented training, sustainability performance appraisals, and environmental CSR alignment—are frequently theorized as outcomes of transformational, ethical, or sustainability-oriented leadership. In this sense, leadership functions as a behavioural catalyst that operationalizes green HR strategies through employee motivation and engagement.

This convergence signals a maturing phase in S-HRM scholarship, where environmental sustainability is no longer treated as an isolated technical function but as a culturally embedded organizational phenomenon. The proximity between these clusters indicates that leadership frameworks are increasingly integrated into sustainability discourse, reinforcing the behavioural foundations of environmental transformation.

Employee Behaviour as a Bridging Mechanism

The MDS configuration positions **Employee Behaviour & Knowledge Sharing (Topic 3)** in an intermediate location between leadership-driven sustainability and strategic HR alignment. This central positioning suggests that behavioural research acts as a conceptual bridge connecting strategic intent with operational sustainability outcomes.

Employee pro-environmental behaviour, engagement, and knowledge sharing mechanisms serve as mediating processes through which strategic sustainability initiatives translate into measurable performance outcomes. The structural placement of this topic indicates its integrative role in the intellectual architecture of S-HRM. Rather than existing as a standalone research stream, behavioural scholarship appears embedded within broader leadership and strategy frameworks.

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This bridging function underscores the importance of human agency in sustainability implementation. It also reveals that S-HRM research increasingly acknowledges that sustainability transformation depends not merely on structural policies but on employee-level cognitive and behavioural alignment.

Strategic HR Frameworks as Structural Foundation

Strategic HR Frameworks (Topic 2) appear positioned as a foundational anchor within the MDS map, maintaining moderate proximity to multiple clusters. This configuration suggests that strategic alignment functions as the structural backbone of S-HRM research.

Strategic HR scholarship emphasizes policy integration, goal alignment, and long-term sustainability orientation within organizational systems. Its relational positioning indicates that strategic HRM provides the institutional scaffolding through which leadership initiatives and behavioural mechanisms operate. In other words, without strategic alignment, leadership-driven sustainability and green practices may lack coherence and long-term sustainability.

The central yet slightly distinct placement of this cluster suggests that strategy serves as a macro-level orientation, while behavioural and environmental themes represent micro- and meso-level operationalization.

Innovation & Technological Sustainability as a Structural Silo

The most striking insight from the MDS configuration is the relative isolation of **Innovation & Technological Transformation (Topic 4)** from behavioural and leadership clusters. This spatial distance indicates that technology-driven sustainability research remains comparatively detached from human-centered sustainability discourse.

Innovation research within S-HRM often focuses on Industry 4.0, AI-enabled HR systems, and digital transformation in manufacturing or operational contexts. However, the MDS separation suggests that such studies are less frequently theorized in conjunction with employee behaviour, engagement, or leadership frameworks. This structural silo highlights a critical interdisciplinary gap within the field.

The relative isolation of technological sustainability implies that digital transformation is often examined from an operational efficiency or systems perspective rather than through an integrated human-capital sustainability lens. This fragmentation limits theoretical consolidation and signals a significant opportunity for future research to bridge behavioural sustainability and technological innovation domains.

From Fragmentation to Emerging Integration

Overall, the MDS map reveals a partially integrated but still evolving intellectual structure. Leadership-driven sustainability and green HR practices form a convergent cluster, anchored by strategic HR alignment and mediated through employee behaviour. In contrast, technology-driven sustainability remains structurally peripheral.

This configuration suggests that S-HRM scholarship is transitioning from fragmented thematic streams toward a more behaviourally integrated sustainability framework. However, the persistent separation between technological innovation and human-centered sustainability indicates that interdisciplinary integration remains incomplete.

The intellectual architecture therefore reflects both consolidation and fragmentation. While environmental and leadership domains are increasingly interconnected, the digital transformation discourse has yet to be fully embedded within behavioural and strategic sustainability paradigms.

Theoretical Implications of the Structural Configuration

The MDS findings offer important theoretical insights. First, they demonstrate that sustainability within HRM is progressively conceptualized as a behavioural and leadership-driven phenomenon rather than merely an

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environmental compliance mechanism. Second, they identify employee behaviour as the connective tissue linking strategic intent to sustainability outcomes.

Third, they expose the relative isolation of technologyoriented research, underscoring the need for integrative models that incorporate digital transformation into sustainable HR frameworks.

By revealing these relational dynamics, the MDS analysis moves beyond thematic categorization to illuminate the structural evolution of S-HRM as a field. It provides empirical evidence of intellectual convergence, identifies areas of theoretical maturity, and highlights domains requiring interdisciplinary synthesis.

DISCUSSION

The findings of this study provide a structured, data-driven understanding of the intellectual evolution of Sustainable Human Resource Management (S-HRM).

By identifying five dominant thematic clusters and examining their relational proximity through Multidimensional Scaling (MDS), the analysis reveals both consolidation and fragmentation within the field. This section synthesizes these findings with existing scholarship, clarifies theoretical contributions, and outlines managerial implications.

From Fragmentation to Integration

The LDA and MDS results indicate that S-HRM research has evolved across multiple parallel streams that are gradually converging but remain partially fragmented.

The dominance of the **Green HR & Environmental Sustainability** cluster confirms that the field originated primarily from environmentally oriented HR practices. Early scholarship emphasized eco-friendly recruitment, sustainability training, and CSR-aligned HR policies, positioning environmental performance as the core outcome of sustainable HRM.

However, the proximity between **Leadership & Engagement** and **Green HR** clusters suggests a conceptual shift. Sustainability is increasingly theorized as a leadership-driven and culturally embedded phenomenon rather than a compliance-based or policy-driven initiative.

This aligns with broader management literature emphasizing transformational and ethical leadership as catalysts for sustainability culture formation. The integration of leadership theory into environmental HR practices reflects a maturation of the field from operational sustainability toward behavioural sustainability.

The intermediate positioning of **Employee Behaviour & Knowledge Sharing** reinforces this integration process. Behavioural scholarship appears to function as the connective mechanism translating strategic sustainability intentions into measurable outcomes. This is consistent with research emphasizing proenvironmental behaviour, engagement, and knowledge exchange as critical enablers of sustainability performance.

In contrast, the relative isolation of the **Innovation & Technological Transformation** cluster reveals a structural discontinuity.

While digital HR systems, AI-enabled analytics, and Industry 4.0 initiatives are increasingly discussed in sustainability discourse, they remain less integrated with behavioural and leadership frameworks. This fragmentation suggests that technological sustainability research has developed within operational or systems-oriented paradigms rather than through a human-centered sustainability lens.

Collectively, these findings indicate that S-HRM is transitioning from fragmented thematic silos toward a more integrated behavioural-strategic architecture. However, interdisciplinary consolidation—particularly between technological innovation and human capital sustainability—remains incomplete.

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Theoretical Contributions

This study advances Sustainable HRM scholarship in three important ways.

Clarifying the Intellectual Pillars of S-HRM

First, the analysis clarifies the foundational pillars structuring the field. The five identified clusters—Environmental Sustainability, Strategic Alignment, Employee Behaviour, Leadership, and Technological Innovation—represent the dominant thematic architecture of S-HRM research.

By empirically mapping these pillars, the study moves beyond narrative categorization to provide probabilistic validation of thematic boundaries.

This clarification enhances theoretical coherence by demonstrating that sustainable HRM is not a singular construct but a multi-dimensional framework composed of interconnected yet distinct domains.

Identifying the Behavioural–Technology Gap

Second, the study exposes a critical structural gap between behavioural sustainability research and technological innovation discourse.

The MDS separation of the Innovation cluster indicates that digital transformation is frequently examined independently of employee behaviour, leadership dynamics, or engagement mechanisms.

This gap has significant theoretical implications. Sustainability transformation increasingly depends on digital analytics, AI-enabled HR systems, and technology-driven process optimization.

However, without integration into behavioural and strategic frameworks, technological initiatives risk remaining operational enhancements rather than drivers of holistic sustainability transformation.

By empirically demonstrating this disconnect, the study identifies a priority area for interdisciplinary integration in future research.

Proposing an Integrated Sustainability Architecture

Third, building on the structural mapping, the study proposes an integrated sustainability architecture for SHRM. The findings suggest a layered model:

- **Strategic HR alignment** serves as the foundational institutional framework.
- **Leadership and engagement mechanisms** function as behavioural catalysts.
- **Employee behaviour and knowledge sharing** act as operational translators.
- **Green HR practices and technological innovation** represent outcome-oriented extensions.

This architecture synthesizes previously fragmented research streams into a coherent sustainability system. By positioning behavioural and strategic alignment at the core, the framework emphasizes that sustainability outcomes—whether environmental or technological—are contingent upon human-centered implementation.

Practical Implications

The findings also offer important managerial insights for organizations seeking to embed sustainability within HR systems.

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Leadership Development

Given the strong convergence between leadership and green HR practices, organizations should prioritize sustainability-oriented leadership development. Transformational and ethical leadership competencies must be cultivated to translate sustainability strategy into employee-level engagement and cultural alignment.

HR Strategic Alignment

The central positioning of Strategic HR Frameworks highlights the necessity of embedding sustainability objectives within HR policies, performance metrics, and governance mechanisms. Isolated green initiatives without strategic alignment are unlikely to produce long-term impact.

Digital Sustainability Integration

The structural separation of technological innovation underscores the need for integrating digital transformation with behavioural sustainability strategies. AI-driven HR analytics, digital training platforms, and sustainability monitoring systems should be embedded within employee engagement and leadership frameworks to maximize impact.

SDG Alignment

Finally, the integrated sustainability architecture supports alignment with global frameworks such as the United Nations Sustainable Development Goals (SDGs). By linking strategic HR alignment, leadership engagement, and digital transformation with environmental outcomes, organizations can systematically contribute to goals related to decent work, climate action, and responsible production.

Integrated Conceptual Framework

Building upon the thematic clusters identified through LDA and their relational configuration revealed by Multidimensional Scaling (MDS), this study proposes an integrated conceptual framework that synthesizes the intellectual architecture of Sustainable Human Resource Management (S-HRM). The framework is not constructed deductively from prior theory alone; rather, it emerges inductively from the probabilistic structure and spatial proximity of themes within the corpus.The MDS findings demonstrate partial convergence among leadership, environmental sustainability, and behavioural dimensions, while revealing a relative separation of technological innovation. These structural insights inform a layered sustainability architecture consisting of four interconnected levels: (1) Strategic Foundation, (2) Behavioural Engine, (3) Sustainability Outcomes, and (4) External Alignment.

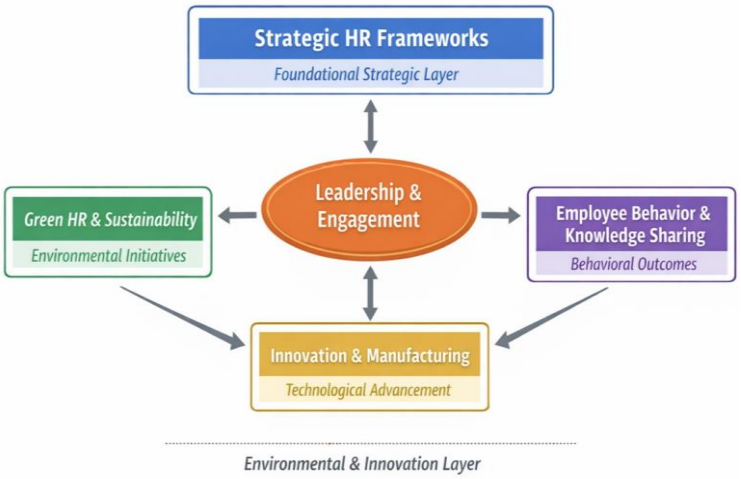

Figure 3. Integrated Sustainability Architecture of S-HRM

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Foundation Layer: Strategic HR Alignment

At the base of the framework lies **Strategic HR Alignment**, corresponding to Topic 2 (Strategic HR Frameworks). The MDS configuration positioned this cluster as a structural anchor, moderately proximate to multiple themes, indicating its foundational role within the intellectual structure.

Strategic HR alignment encompasses policy integration, governance mechanisms, sustainability-oriented goal setting, and long-term performance measurement systems. This layer institutionalizes sustainability within HR architecture, ensuring that environmental and social objectives are embedded within recruitment, appraisal, training, and compensation systems.

The findings suggest that without strategic alignment, sustainability initiatives risk remaining episodic or symbolic. Thus, the foundation layer provides institutional legitimacy, resource allocation, and structural coherence necessary for sustained implementation.

Behavioural Engine: Leadership and Engagement

The second layer represents the **Behavioural Engine**, comprising the convergence between Topic 5 (Leadership & Engagement) and Topic 3 (Employee Behaviour & Knowledge Sharing). The MDS proximity between these clusters indicates that leadership-driven engagement mechanisms function as catalysts translating strategic sustainability intent into behavioural action.

Leadership—particularly transformational and ethical leadership—shapes organizational culture, establishes sustainability vision, and influences employee motivation. Employee engagement and pro-environmental behaviour serve as operational mechanisms through which sustainability policies are enacted at the individual and team levels.

This behavioural engine reflects the human-centered nature of sustainable HRM. It emphasizes that sustainability transformation is not solely policy-driven but depends fundamentally on cognitive alignment, cultural reinforcement, and participative engagement.

The intermediate position of employee behaviour in the MDS map supports its bridging role between strategic intent and sustainability outcomes.

Outcome Layer: Green Practices and Innovation

The third layer consists of **Sustainability Outcomes**, encompassing both Topic 1 (Green HR & Environmental Sustainability) and Topic 4 (Innovation & Technological Transformation).

The Green HR cluster represents environmental and CSR-oriented practices such as eco-friendly recruitment, sustainability training, and environmental performance management. The Innovation cluster captures digital transformation, AI-enabled HR systems, and Industry 4.0 integration.

However, the MDS results reveal a notable distinction: while Green HR practices are closely integrated with leadership and behavioural themes, technological innovation remains comparatively peripheral. This suggests that environmental sustainability has been behaviourally embedded, whereas technological sustainability is still evolving as a partially separate stream.

Within the proposed framework, both environmental practices and technological innovation are conceptualized as outcome-level manifestations of effective strategic alignment and behavioural engagement. They represent tangible expressions of sustainability integration.

Importantly, the framework emphasizes that technological innovation must be integrated with behavioural and strategic layers to achieve holistic sustainability impact.

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External Alignment: Sustainable Development Goals (SDGs)

The outermost layer of the framework connects organizational S-HRM architecture with broader societal objectives, particularly the **United Nations Sustainable Development Goals (SDGs)**.

The alignment with SDGs—such as Decent Work and Economic Growth (SDG 8), Gender Equality (SDG 5), and Climate Action (SDG 13)—provides normative direction and global relevance. The bibliometric findings indicate increasing references to global sustainability frameworks within S-HRM literature, suggesting that the field is not confined to internal organizational processes but extends toward societal impact.

By positioning SDG alignment as an external interface layer, the framework acknowledges that sustainable HRM operates within a broader ecosystem of regulatory expectations, stakeholder demands, and global sustainability agendas.

From Intellectual Mapping to Systemic Integration

The integrated framework synthesizes fragmented thematic streams into a coherent sustainability system:

- Strategic HR alignment institutionalizes sustainability.
- Leadership and engagement operationalize sustainability culturally.
- Green practices and technological innovation materialize sustainability outcomes.
- SDG alignment situates organizational efforts within global sustainability priorities.

This layered architecture reflects the intellectual structure revealed by LDA and MDS analysis. It transforms probabilistic clustering into a structured theoretical model, offering both conceptual clarity and practical applicability.

The framework also highlights a critical insight from the MDS findings: the need to strengthen integration between technological innovation and behavioural sustainability mechanisms. Future research and practice should focus on embedding digital transformation within leadership-driven sustainability cultures rather than treating it as an independent operational initiative.

Limitations

This study is subject to certain limitations. First, the dataset was restricted to publications indexed in a single database (Scopus), which may exclude relevant studies from other indexing platforms. Second, although LDA topic modelling reduces subjective bias, interpretation of thematic clusters involves researcher judgement. Finally, the cross-sectional design captures the intellectual structure within a fixed time frame, limiting insights into longitudinal thematic evolution.

Future Research Directions

The structural configuration revealed through Multidimensional Scaling (MDS) highlights several promising avenues for future inquiry.

First, the relative separation between the Innovation & Technological Transformation cluster and behavioural sustainability themes underscores the need for deeper **behaviour–technology integration**. Future research should explore how digital transformation initiatives—such as HR analytics, automation, and smart systems—interact with employee engagement, leadership styles, and pro-environmental behaviour. Integrative models that embed technological adoption within behavioural and cultural frameworks would strengthen theoretical cohesion in S-HRM.

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Second, the growing prominence yet structural isolation of digital themes suggests a need for focused research on **AI-enabled sustainability HR systems**. Scholars should investigate how artificial intelligence can support sustainable workforce planning, carbon tracking, green performance evaluation, and predictive analytics while ensuring ethical governance and employee trust. Examining the behavioural implications of AI-driven sustainability tools would bridge current conceptual divides.

Third, future studies should undertake **cross-cultural mapping of Sustainable HRM scholarship**. The present analysis reflects aggregated global research trends, but sustainability practices are deeply influenced by institutional, regulatory, and cultural contexts. Comparative bibliometric or empirical studies across regions could reveal contextual variations in sustainability orientation, leadership integration, and technological adoption.

Finally, given the dynamic evolution of sustainability discourse, **longitudinal bibliometric studies** are warranted. Temporal analysis of topic evolution, citation networks, and thematic shifts would provide insight into how Sustainable HRM is transforming over time, particularly in response to global sustainability frameworks and digital acceleration.

By addressing these gaps, future research can enhance interdisciplinary integration and further consolidate Sustainable HRM as a coherent and strategically significant field of inquiry.

CONCLUSION

This study advances Sustainable Human Resource Management (S-HRM) scholarship by providing a systematic, data-driven mapping of its intellectual structure. Through the application of Latent Dirichlet Allocation (LDA) and Multidimensional Scaling (MDS) to 784 peer-reviewed publications, the research moves beyond narrative synthesis to uncover the probabilistic structure and relational dynamics shaping the field. The findings identify five dominant thematic pillars—Green HR & Environmental Sustainability, Strategic HR Frameworks, Employee Behaviour, Leadership & Engagement, and Innovation & Technological Transformation—thereby clarifying the conceptual boundaries of S-HRM.

Importantly, the structural configuration reveals both convergence and fragmentation. While leadership, behavioural engagement, and green HR practices demonstrate growing integration, technological innovation remains comparatively isolated. By empirically identifying this behavioural–technology gap, the study highlights an area requiring interdisciplinary consolidation. The proposed layered conceptual framework synthesizes these insights, positioning strategic alignment as the foundation, leadership and engagement as behavioural catalysts, and environmental and technological outcomes as sustainability manifestations aligned with broader global objectives.

Strategically, the findings underscore that sustainable HRM is not merely an environmental compliance mechanism but a systemic, leadership-driven transformation process embedded within organizational architecture. By integrating behavioural, strategic, and technological dimensions, the study contributes to theoretical coherence and provides a structured roadmap for future research and practice.

Overall, this research advances theoretical consolidation within Sustainable HRM and reinforces its central role in advancing long-term organizational sustainability.

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