Digitizing Talent, Intensifying Emissions: A Review of the Rebound Effect in AI-Driven Human Resource Management Systems

ESTHER DOMINIC PETER[1], CHIBUEZE UZOMA CHIBUNDU[2], SAMUEL IHEANYI AYOZIEUWA[3], ONYINYECHI HENRIETTA USOH[4], CHIDINMA GRACE EMMANUEL[5], IDARA OKOKON ASUQUO[6]

[1] College of Management Science and Engineering, Chengdu University of Technology, China.
[2] College of International Business, Chengdu University of Technology, China
[3] Department of History, College of Education, Imo State University, Owerri, Nigeria.
[4] College of Management Science and Engineering, Chengdu University of Technology, China.
[5] Department of Education Economics, University of Nigeria Nsukka, Nigeria.
[6] Department of French, Faculty of Art, University of Uyo, Nigeria.

Abstract- The integration of artificial intelligence into human resource management has been widely championed as a pathway to organizational efficiency and, increasingly, as a tool for advancing sustainability objectives through digital transformation. This review challenges the prevailing assumption that AI-enabled HR systems inherently reduce environmental impact by examining the phenomenon through the lens of the Jevons paradox. Synthesizing evidence from engineering informatics, energy economics, and strategic human resource management, we argue that efficiency gains in algorithmic HR processes generate rebound effects that may partially or fully offset anticipated resource savings. The review identifies three mechanisms through which digital HR intensifies resource consumption: the scaling effect, wherein reduced marginal costs drive increased transaction volumes; the complexity effect, wherein ever-expanding datasets and model architectures demand escalating computational resources; and the oversight effect, wherein algorithmic outputs generate new categories of human labor for validation and correction. We propose the Net-HR Carbon Account framework as a methodological response, integrating Life Cycle Assessment principles with HR process analytics. The review concludes that sustainable HR scholarship must move beyond surface-level digitization metrics toward a systemic accounting of the energy, water, and human costs embedded in AI-driven talent management.

Keywords: Jevons paradox; artificial intelligence; human resource management; rebound effect; sustainable innovation; green computing.

I. INTRODUCTION

The digitization of human resource management has accelerated dramatically over the past half-decade, with artificial intelligence now permeating recruitment, performance evaluation, workforce planning, and employee engagement functions (Erkutlu, H. V.; 2025, Khatoon, U. T., et al., 2025; Nwokoro, E. C et al., 2025). Concurrently, organizations face mounting pressure to demonstrate environmental, social, and governance performance, with HR functions increasingly expected to contribute to corporate sustainability agendas. The prevailing academic and practitioner literature conceptualizes AI-driven HRM as a linear progression from 'Organizational Enablers' (leadership, change management, data privacy) toward enhanced 'Outcomes' (business agility, employee experience). This framework, illustrated in Figure 1, implicitly treats digitalization as an inherently virtuous and frictionless process. Critically, however, this model suffers from a profound omission: it excludes the material, energetic, and environmental dimensions of the technological infrastructure that underpins these enablers. The framework assumes that digital processes exist in a dematerialized vacuum, a presumption that this review directly challenges. This convergence has produced a burgeoning literature on "Green HRM" and "Digital Green HRM," which positions AI as an enabler of sustainability through reduced paper consumption, optimized workforce scheduling, and enhanced environmental monitoring (Muhammad Hamza Khan, et al., 2024).

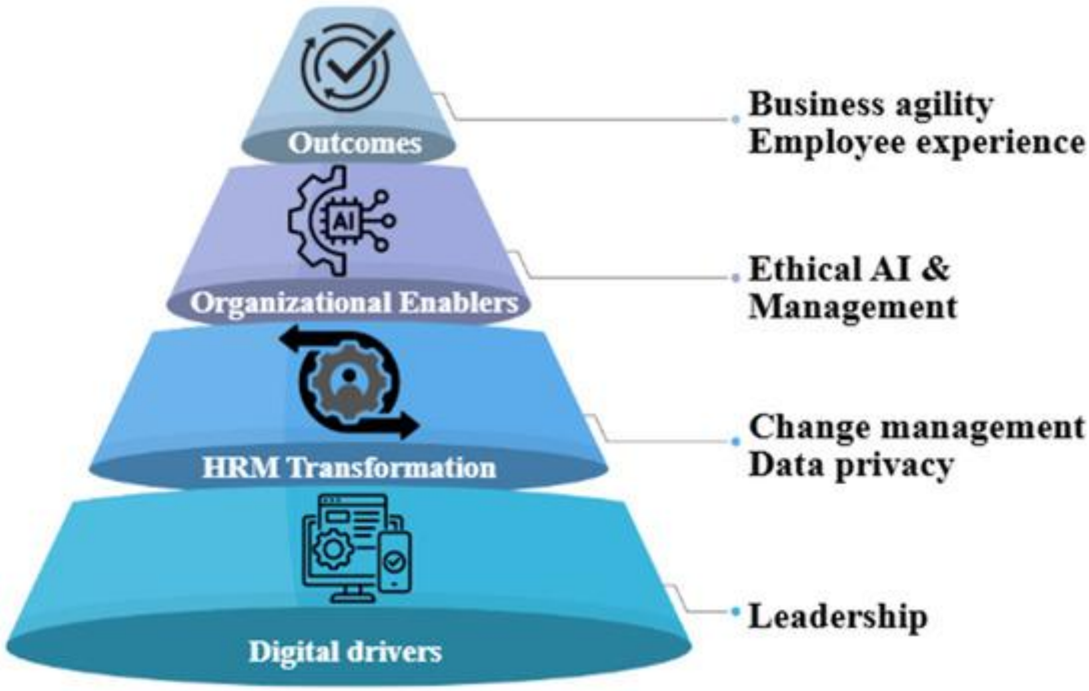


Figure 1. The dominant conceptual framework of AI-driven HRM transformation in contemporary literature (Khatoon, U. T., et al.,2025. https://doi.org/10.3390/admsci15110452)

Yet this optimistic narrative rests on a questionable assumption: that the substitution of digital processes for physical ones yields net environmental benefits. The engineering and energy economics literatures have long recognized that efficiency improvements do not necessarily reduce aggregate resource consumption, a phenomenon formalized by William Stanley Jevons in 1865, who observed that Watt's more efficient steam engine increased rather than decreased coal consumption (Hynes M et al., 2022). This review examines whether a similar paradox operates in the domain of AI-driven HRM, where algorithmic efficiency may paradoxically intensify the energy, water, and human resources required to manage talent.

The significance of this inquiry is underscored by recent empirical evidence. Google's emissions increased 48% since 2019, attributed primarily to its data center strategy and AI integration, while Microsoft's emissions rose 29% since 2020 due to data center construction for AI workloads. These corporate disclosures suggest that the environmental costs of AI infrastructure are substantial and growing. Yet the HR literature has largely treated digital transformation as an unqualified good, neglecting the material footprint of the technologies upon which digital HR depends.

This review addresses this gap by synthesizing insights from three disciplinary domains: (1) the Jevons paradox literature in ecological economics and engineering, (2) the energy informatics literature on computational resource consumption, and (3) the strategic HRM literature on digital transformation and sustainability. We ask: Under what conditions do AI-driven HR processes generate rebound effects that offset their efficiency gains? And how might organizations account for these effects in sustainability reporting and HR system design?

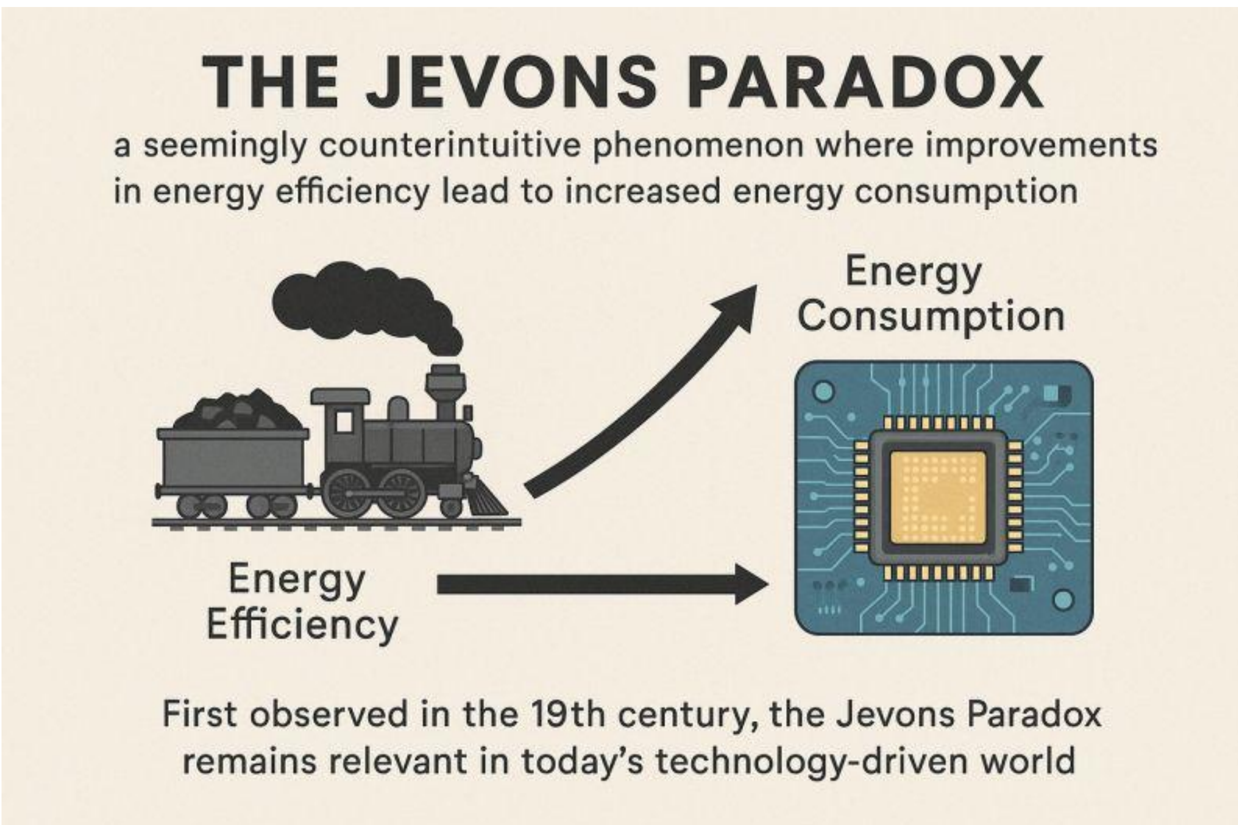
The review proceeds as follows. Section 2 develops the theoretical framework, integrating the Jevons paradox with the specific characteristics of HR information systems. Section 3 examines the mechanisms through which AI intensifies HR resource consumption. Section 4 proposes the Net-HR Carbon

Account framework as an analytical and practical response. Section 5 identifies research gaps and proposes an agenda for future inquiry. Section 6 concludes with implications for scholarship and practice.

II. THEORETICAL FOUNDATIONS: THE JEVONS PARADOX AND ITS APPLICABILITY TO HR SYSTEMS.

2.1 The Jevons Paradox in Historical and Contemporary Perspective

William Stanley Jevons's observation that technological efficiency increases rather than decreases resource consumption has proven remarkably durable across two centuries of technological change. The paradox operates through a simple mechanism: when efficiency reduces the cost of using a resource, demand for that resource expands. In the case of coal, more efficient steam engines reduced the cost of steam power, which expanded the applications for which steam power was economically viable, ultimately increasing coal consumption (Antoine Missemer. William Stanley Jevons'; 2012).



The Jevons Paradox - A Foundational Framework for Understanding AI-Driven Rebound Effects; *Adapted from the classical formulation of Jevons (1865).*

Contemporary scholars have documented Jevons-type effects across multiple domains, including energy efficiency, computing, and transportation. Akpan and Adebayo's recent synthesis demonstrates that AI efficiency gains are associated with rising aggregate computational energy demand, as lower costs, broader adoption, and increasing model complexity offset efficiency improvements (Akpan & Adebayo, 2026).". The evidence indicates that this pattern holds across multiple AI applications, with resource consumption scaling with adoption rather than declining proportionally with efficiency gains.

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The paradox is particularly relevant to information and communication technologies because digital systems exhibit what some scholars term "hyper-datafication", the tendency to generate, store, and process ever-expanding volumes of data. The narrative that data has negligible cost obscures the material footprint of storage, processing, and transmission infrastructure. Data center energy consumption already accounts for approximately 4.4% of total U.S. electricity consumption, with annual growth rates of 12%. Water consumption for data center cooling exceeds 560 billion liters annually, with a quarter of existing facilities located in regions projected to experience water scarcity by 2050.

2.2 The Productivity Paradox and HR Technology

The Jevons paradox intersects with what the IBRS has termed the "productivity paradox" in information technology, the observation that successive waves of digital innovation have failed to produce commensurate gains in measured productivity . From mainframes to personal computers to mobile computing, each technological wave was predicted to deliver massive productivity improvements, yet Western productivity has remained remarkably flat (Alexandra Sasha Luccioni, et al, 2025). This pattern suggests that efficiency gains are often absorbed by increased task complexity, quality demands, or new categories of work rather than translating into reduced resource inputs.

This paradox has particular salience for HR technology. Predictive models for attrition, automated resume screening, sentiment analysis of employee communications, and AI-driven performance management all promise to reduce the time and effort required for HR functions. Yet each of these applications generates new demands: data preparation and labeling, model training and retraining, output validation and correction, and the management of algorithmic systems themselves.

2.3 The Applicability of the Jevons Framework to HR Processes

To apply the Jevons framework to AI-driven HRM, we must specify the "resource" whose consumption is at issue. Unlike coal or electricity, HR process efficiency gains are measured primarily in labor time and administrative cost. However, these efficiencies are achieved through computational processes that consume electricity, water, and hardware resources. The relevant question is whether the labor time saved by AI-driven HR processes exceeds the environmental cost of the computational infrastructure required to generate those savings, and whether total HR resource consumption (including both computational and human inputs) declines or increases (Rehaman Pasha, et al., 2025).

A recent systematic review of Digital Green HRM identified what the authors termed a "persistent digital sustainability paradox": while DGHRM enhances organizational sustainability performance through transparency and reporting, it simultaneously raises concerns about energy consumption (Syahrudin, M. (2026) . The review found that only 50 studies addressed this tension between 2020 and 2025, predominantly from Asian countries, with limited theoretical integration and methodological diversity. This suggests that the field is in early stages of grappling with the paradox.

III. MECHANISMS OF AI-INTENSIFIED RESOURCE CONSUMPTION IN HR SYSTEMS

Building on the theoretical framework, we identify three mechanisms through which AI-driven HR processes may generate rebound effects.

3.1 The Scaling Effect: Reduced Marginal Costs Drive Increased Transaction Volumes

The first mechanism operates through the classic Jevons mechanism: as the marginal cost of HR transactions declines, organizations increase transaction volumes. When algorithmic screening reduces the cost per resume reviewed, organizations may expand their applicant pools, run more recruitment cycles, or screen for more granular criteria. When automated performance monitoring reduces the cost per employee evaluation, organizations may increase evaluation frequency, expand the metrics tracked, or conduct analyses they previously forwent.

This scaling effect is not merely hypothetical. Laddha, Ogueda, and Seshaiyer's dynamic modeling of AI

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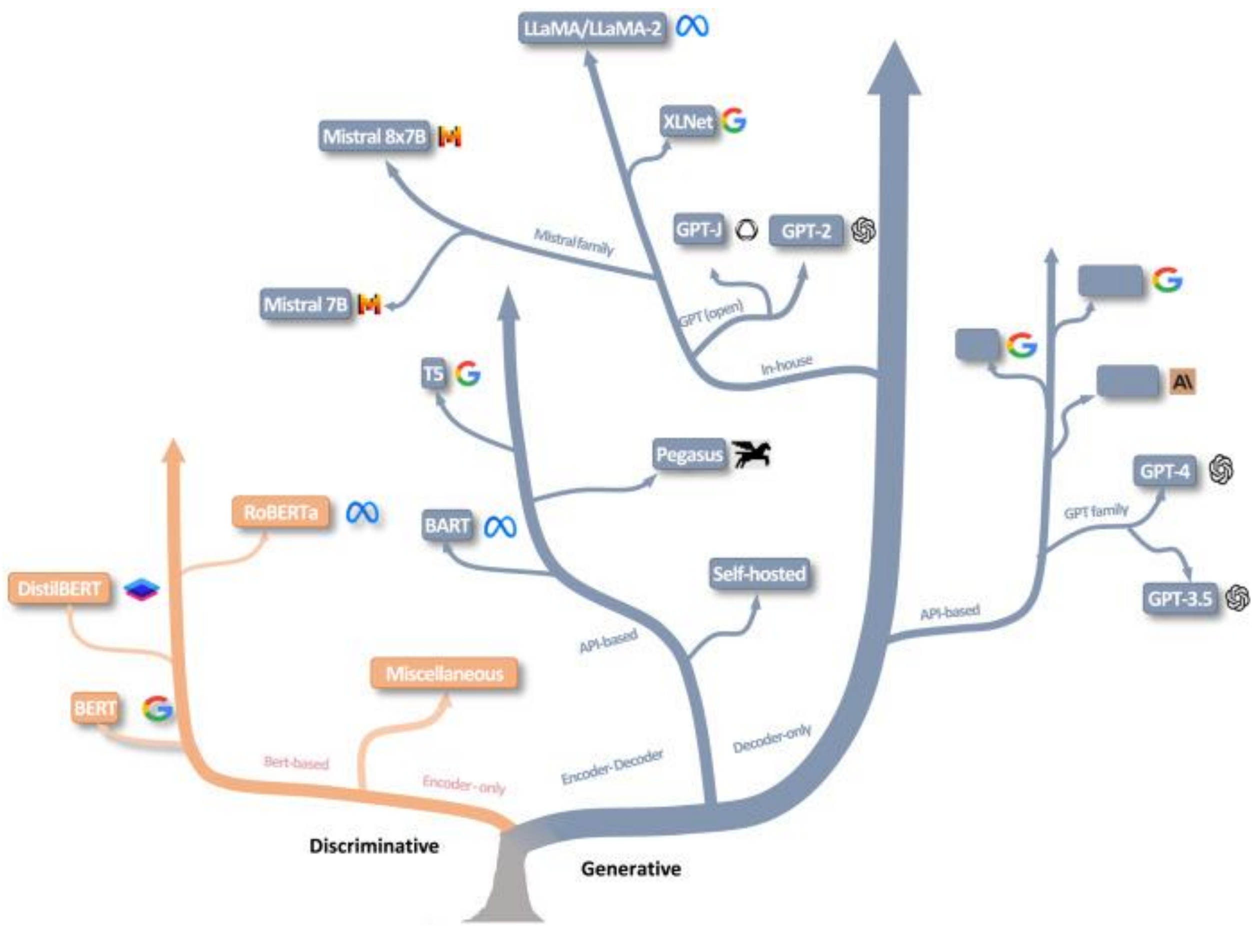
adoption demonstrates that as AI adoption rates increase, data center growth, energy consumption, water usage, and carbon emissions rise substantially . Their simulations over 365 days show that even slight increases in AI adoption significantly elevate resource consumption across all measured dimensions. The implication for HR systems is that the aggregate computational demand of AI-driven processes scales with adoption, potentially offsetting per-transaction efficiency gains.

3.2 The Complexity Effect: Model Sophistication Drives Resource Intensification

The second mechanism concerns the trajectory of AI model development. As organizations gain experience with basic AI tools, they pursue more sophisticated applications, larger models, more training data, more frequent retraining cycles, and more complex architectures. Each step in this trajectory increases computational requirements and, consequently, energy and water consumption (L. Hughes, F. et al.,2026) .

This complexity effect is amplified by what Laddha and colleagues term the "feedback loop" between AI capabilities and data requirements: as models become more sophisticated, they demand more data, which in turn requires more storage and processing capacity, which enables more sophisticated models . This virtuous cycle for AI capability is a vicious cycle for resource consumption (Li, Yang & Feng, et al., 2026).

In the HR domain, this might manifest as the progression from basic resume screening to predictive attrition modeling to organization-wide sentiment analysis to dynamic workforce optimization, each step requiring more data, more processing, and more energy. The environmental cost of this progression is seldom included in AI adoption business cases.



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AI Model Families and Architectures - A Taxonomy for HR Applications. Adopted from: J. Yang, et al.,(2023) arXiv preprint arXiv:2304.13712. https://arxiv.org/abs/2304.13712

3.3 The Oversight Effect: Algorithmic Outputs Generate New Categories of Human Labor

The third mechanism addresses the human dimension of AI-driven HR processes. Contradicting the narrative of labor displacement, evidence suggests that AI adoption often creates new categories of human labor rather than eliminating them. In the IBRS analysis, attendees reported that "two or three prompts at minimum" are required to obtain a reasonable output from generative AI, with average users requiring approximately eight prompts before achieving satisfactory results. Each cycle of prompting requires human attention, and subsequent validation and correction requires additional time. Moreover, every context switch between AI tools and human judgment imposes a "switching cost" of 15 to 20 minutes of refocusing time. The consequence, the IBRS notes, is that "AI can be less efficient than existing approaches" when the full workflow of prompting, validation, and correction is considered. This suggests that the labor savings promised by AI-driven HR may be partially offset by the new labor demands of managing AI systems and validating their outputs (Benabou, Adil & Touhami, Fatima. (2025).

The oversight effect has particular salience for HR processes that involve sensitive decisions affecting employee careers. AI-generated recommendations for hiring, promotion, or termination require human review to ensure fairness and legal compliance, adding new tasks rather than eliminating existing ones.

IV. TOWARD THE NET-HR CARBON ACCOUNT: A METHODOLOGICAL FRAMEWORK

The mechanisms identified in Section 3 suggest that assessments of AI-driven HR's sustainability impact must account for systemic effects, not merely direct substitutions. We propose the Net-HR Carbon Account framework as a methodological response.

4.1 Principles of the Framework

The Net-HR Carbon Account draws on Life Cycle Assessment (LCA) principles from engineering and applies them to HR processes. Three principles guide the framework:

First, boundary expansion: Rather than assessing only the direct energy consumption of HR computing systems, the framework includes the full chain of energy and resource consumption, including data storage, model training, infrastructure construction and maintenance, and the human labor required to support AI systems.

Second, counterfactual comparison: Rather than assessing absolute consumption, the framework compares AI-enabled processes against the pre-AI baseline, accounting for both the energy savings from automation and the additional energy consumed by computational infrastructure.

Third, rebound accounting: Rather than assuming a linear relationship between efficiency gains and resource savings, the framework explicitly models scaling, complexity, and oversight effects as potential offsets to efficiency gains.

4.2 Operationalization

Operationalizing the Net-HR Carbon Account requires integration of data from three sources:

First, HR process analytics: Data on transaction volumes, cycle times, and labor inputs for core HR processes (recruitment, performance management, workforce planning) before and after AI adoption. This establishes the baseline and enables tracking of scaling effects.

Second, energy informatics data: Data on the computational energy consumption of AI systems, including model training, inference, data storage, and cooling. Tools such as Carbontracker and CodeCarbon offer standardized methodologies for quantifying computational emissions . The Punitha and colleagues'

Smart HR Sustainability System provides an example of integrating energy-efficient AI architectures with HR metrics, employing predictive models (Random Forest, SVM, CNN) within a carbon-aware framework .

Third, labor process data: Data on the time spent prompting, validating, and correcting AI outputs, as well as the training and skill development required for effective human-AI collaboration. This captures the oversight effect that may offset labor savings.

4.3 Contributions to the Literature

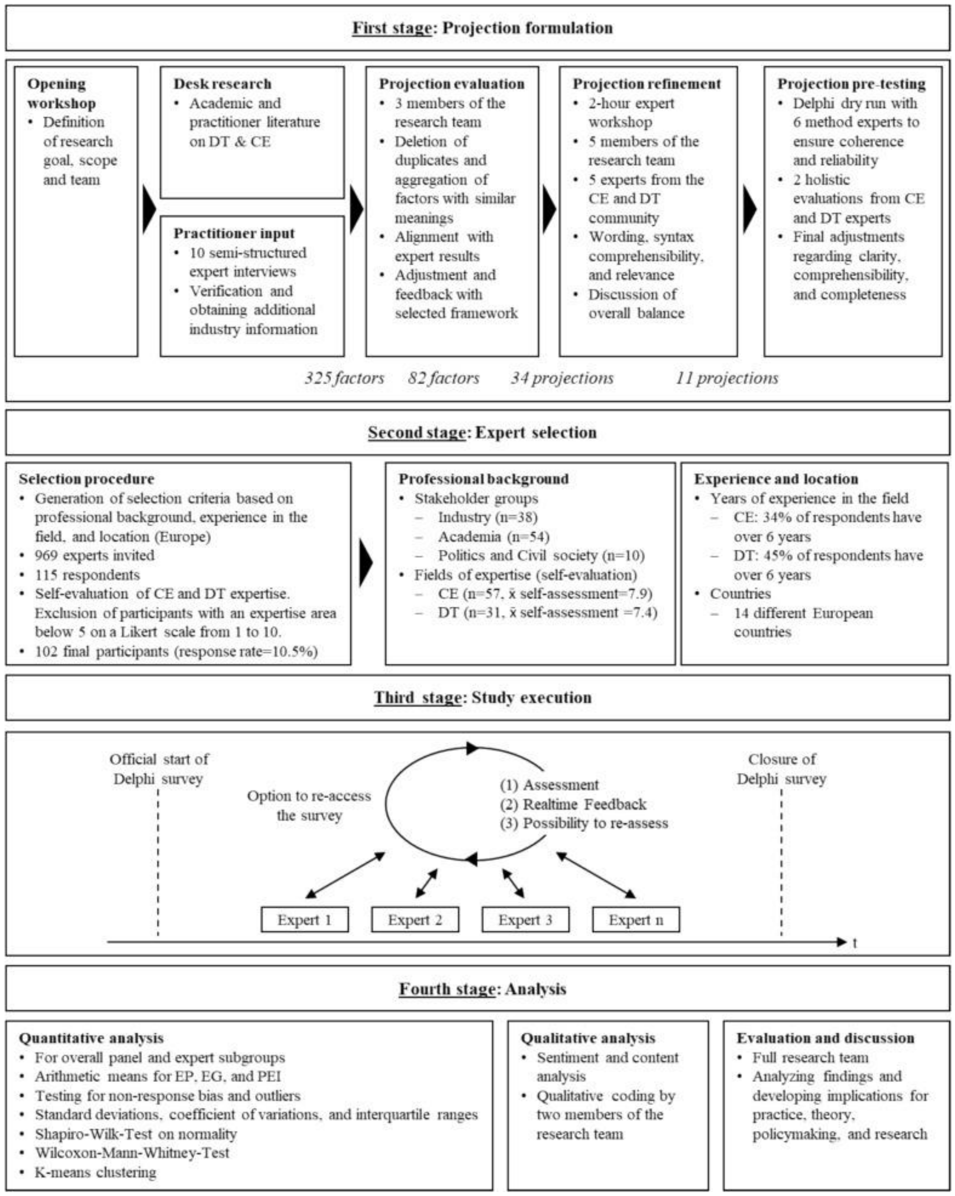
The Net-HR Carbon Account contributes to the emerging literature on Green HRM and digital sustainability in several respects. First, it addresses the "digital sustainability paradox" identified by recent systematic reviews by providing a methodological framework for quantifying both efficiency gains and rebound effects. Second, it bridges the disciplinary gap between HR scholarship and engineering/energy economics, incorporating insights from both domains. Third, it offers a practical tool for organizations seeking to align HR digitalization with sustainability goals, moving beyond surface-level digitization metrics toward comprehensive environmental accounting (Muniba, A. Majeed, et al., 2026).

V. RESEARCH GAPS AND FUTURE AGENDA

5.1 Empirical Evidence

The most pressing gap is the scarcity of empirical evidence on AI-driven HR's net environmental impact. While several studies document the energy consumption of AI systems in general, few have focused specifically on HR applications. Similarly, while organizational case studies document efficiency gains from digital HR, few have measured the computational energy consumption underlying those gains.

We call for mixed-methods research employing the Net-HR Carbon Account framework across diverse organizational contexts. Longitudinal studies are particularly needed to track whether efficiency gains persist or are eroded over time by scaling and complexity effects.



A methodological framework for future empirical validation of the Net-HR Carbon Account Four-stage Delphi process - adapted from Gebhardt et al. (2022), Gnatzy et al. (2011), and Kopyto et al. (2020)

5.2 Theoretical Integration

The theoretical integration between HR scholarship and energy economics remains underdeveloped. While the Jevons paradox is well-established in ecological economics, it has yet to be systematically applied to HR information systems. Future research should develop formal models of HR's rebound effects, specifying the conditions under which scaling, complexity, and oversight effects are likely to dominate.

5.3 Design and Governance

Finally, research is needed on how HR systems can be designed to mitigate rebound effects. This includes energy-efficient algorithm design, transparent resource reporting, and governance frameworks that limit the scope and scale of AI applications based on sustainability criteria. The emergence of "Green AI" principles in computer science offers a starting point, but these must be adapted to the specific characteristics of HR processes .

VI. CONCLUSION

The integration of artificial intelligence into human resource management offers substantial opportunities for efficiency and insight. Yet the sustainability implications of this transformation are more complex than the prevailing narrative suggests. The evidence reviewed here indicates that AI-driven HR processes may generate rebound effects that partially or fully offset efficiency gains, as scaling, complexity, and oversight effects drive increased resource consumption. The Net-HR Carbon Account framework offers a methodological path forward, enabling organizations and scholars to move beyond surface-level assessments toward comprehensive accounting of the energy, water, and human costs embedded in digital talent management.

This review has sought to advance the conversation on sustainable HR by challenging the assumption that digitization is inherently green. The Jevons paradox, far from being a historical curiosity, offers a robust framework for understanding the dynamics of technological efficiency in the AI era. For HR scholarship to contribute meaningfully to organizational sustainability, it must engage with these dynamics systematically and empirically.

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