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Research Article

Unifying HRM 4.0 and Sustainable Innovation in the Framework of Industry 5.0 and Society 5.0

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Abstract: In the past decade Industry 4.0 and its component technologies have influenced all functional areas of business. Human Resource Management (HRM) has undergone significant transformation due to the adoption of industry 4.0 and thus the concept of HRM 4.0 was born. The present paper explores the nexus between HRM 4.0 and sustainability, emphasizing the importance of aligning human resource strategies with the goals of sustainable development. Drawing from an extensive review of current literature, the paper examines the role of advanced technologies, such as artificial intelligence (AI), big data analytics, and the Internet of Things (IoT), in shaping HRM practices that support sustainable business models. The paper further integrates concepts from Industry 5.0, which emphasizes the symbiotic relationship between humans and machines, and society 5.0, which envisions a human-centered society supported by digital innovation. By analyzing these paradigms, the paper highlights the potential for HRM 4.0 to drive high-quality development that balances economic growth with environmental stewardship and social equity. Moreover, the paper proposes future courses of action for HRM practitioners and researchers and policy makers. We conclude with recommendations for policy makers to support the integration of HRM 4.0 with sustainability objectives, ensuring that organizations contribute positively to the broader goals of high-quality development in an increasingly complex and interconnected world. This study not only advances the theoretical understanding of HRM 4.0 and sustainability but also provides a foundation for future research and practical applications in the context of Industry 5.0, High Quality Development and Society 5.0 an all.

Keywords: HRM 4.0, Sustainability, Industry 4.0, Industry 5.0, Society 5.0, Artificial Intelligence, Big Data, Internet of Things, Sustainable Development, Human-Machine Symbiosis, High-Quality Development.

INTRODUCTION

The dynamic growth of sustainability concepts and practices in Human Resource Management (HRM) strategies is gaining importance as organizations associate themselves with such complex socio-environmental issues and as they continue to deliver value in the long term. The current literature reaffirmed the importance of incorporating sustainability in HRM approaches as preconditioned by the increasing level of popularity of implementing sustainable business practices globally and improving social and environmental features (Papademetriou et al., 2025). The practices that can best be seen at the crossroads of HRM and sustainability include Green HRM and corporate social responsibility (CSR), whereas sustainable HRM, as a more comprehensive and strategic framework, is relatively unexploited (Banga & Gobind, 2025). Industry 5.0 is another reason that the necessity to integrate the above should not be ignored because it encourages people to think about technological development as not only efficient but ethical, inclusionary, and human-centered.

Industry 5.0 is a shift in paradigm towards a more balanced concept which will focus more on humans than machines and will aim at intelligent automation, focused on sustainability. The federated learning, collaborative robotics and autonomous systems are among technologies that have already been used to streamline operational efficiency and nowadays also to promote ethical and inclusive industrial systems (Zia & Haleem, 2025). The amount of innovation is shifting the topography of work, and employees' professional competences, functions, and learning processes, are requiring wholesome reconsideration (Aruna & Khlie, 2025). Moreover, Industry 5.0 provides novel solutions to many environmental issues as well as a way to improve productivity, but it poses new challenges of morality, especially about data protection and possible displacement of workforce (Aruna & Khlie, 2025). These disjunctions, in turn, place significant emphasis on the fact that research is urgently required that examines how HRM can facilitate such shifts and make technological changes in line both with the goal of sustainability (in general) and ethical goals as well. The framework suggested by Singh et al. (2025) is especially informative in this context. It integrates the principles of Industry 4.0 technologies with such concepts as the circular economy and green HRM practices to influence sustainable change and presents an opportunity to explore synergies between those areas. On the same note, Garrido et al. (2024) point

out that people, sustainability and organizational resilience are also becoming very relevant in operations management and that the academic writing on the human aspects of Industry 5.0 need to be pursued further. The ability to merge these issues is critical in creating future-ready organizations that are resilient to shocks in the global system but promote the interests of the society. Such considerations are particularly relevant when the organization faces the growing intensity of climate change, discontinuous technological shift, and socio-economic disparities worldwide. The connection between HRM and Industry 5.0 and Society 5.0 is synthetic to a certain intellectual trend applying towards a reconciliation of technological progress and human-oriented values. This discussion gets further elaborated in society 5.0, which was first envisioned in Japan, proposing a concept of a super-smart society, in which social issues are solved with digital innovation, and the well-being of humankind is advanced (Huang et al., 2022). Industry 5.0 and Society 5.0 work hand-in-hand to ensure sustainable and inclusive growth because the pillars of this approach include the enhancement of ethical governance, have technology and human capital integration structured as one unified approach. The bibliometric study by Ben Youssef and Mejri (2023) notes that academic interest in Industry 5.0 is increasing, especially in such countries as India, China, and the United States, and that the research areas with the highest interest are currently sustainable development, human-centricity, and smart manufacturing.

Bakator et al. (2024) have addressed how the intersection of Marketing 5.0, Industry 5.0, and Society 5.0 are convergent and have provided an example of how such intersection can be applied by policy makers and business leaders. The nature of their work demonstrates that the emerging paradigms not only increase the competitiveness of organizations but they also make a significant contribution to the global sustainability agenda. Kutaula et al. (2024) have researched the influence of sustainable HRM practices improving the sustainability performance of small and medium enterprises (SMEs), especially through employee participation and co-worker support mediation. This observation plays a crucial role in the realization of the ways in which internal organizational processes may help to achieve the more general strategic goals related to sustainability and human well-being. Ren et al. (2023) provide a conceptual basis of sustainable HRM through the views of the institutional theory, stakeholder theory, and the framework of sustainable careers. Through their study, they have placed HRM as a cog in the actualization of its sustainability ambitions, especially in a world that is characterized by volatility and fuelled by technology. At the same time, Mourtzis et al. (2022) focus on setting human well-being and organizational resilience as the main aim of transition between Industry 4.0 and Industry 5.0, not as economic efficiency and productivity. In line with the conclusions of the study conducted by Picinin et al. (2023), the paradigm shift requires a change in the behavior of the employees, skills, and educational models with the critical importance of HRM to ensure that voices are prepared to endure the changes in the future.

The studies present the emergence of a widespread agreement about the necessity to match technological innovation with humanistic values and sustainability principles. The explanation of HRM in terms of Industry 5.0 and Society 5.0 offers great perspectives through which organizations have to work through challenges and opportunities of the digital age. Since the barriers between technology, society and the work place are being dangerously blurred, HRM should transform itself to serve as a strategic ally in an effort to construct resilient, ethical and sustainable organizations. In this way, the task of this research paper is to investigate the theoretical connections and practical implications of the association of HRM 4.0 with sustainability in the context of Industry 5.0 and Society 5.0.

Research Objectives

The major purpose of this study is to examine and develop theoretical connections amongst Human Resource Management 4.0 (HRM 4.0), sustainability practices, as well as the emerging theories of Industry 5.0 and Society 5.0. In particular, the investigation will address the following objectives:

1. Examine how the sustainability of HRM can be combined strategically with new technologies and humanized theories in Industry 5.0.
2. Explore how HRM could be viewed in relation to ethical, environmental, and social problems brought about by digital transformation and intelligent automation.
3. Determine major facilitators, obstacles, and skills connected with aligning HRM with the sustainability objectives fitted with Society 5.0.
4. Give a theoretical contribution and provide future research opportunities to contribute to organizational resilience, sustainability performance, and worker well-being with HRM innovation.

LITERATURE REVIEW

Sustainability in HRM

The incessant trend of sustainable in Human Resource Management (HRM) denotes the rising level of dedication in the accomplishment of long term social and environmental outcomes in organizations. Researchers claim that the involvement of sustainability in HR processes like recruitment, training, and performance management increases the employee engagement levels, resilience, and a sustainable performance of the organization overall (Papademetriou et al., 2025; Soekotjo et al., 2025). In despite the mentioned developments, implementation of truly sustainable HRM practices is not very widespread. Organization depends on Green HRM and corporate social responsibility (CSR) that appear to be more visible than the concept of sustainable HRM which is both broader and strategic (Banga & Gobind, 2025). The gaps in reporting systems like ESG (Environmental, Social, Governance) and GRI (Global Reporting Initiative) have been found with the research to be substantial, especially to the HRM-specific metrics, which restrains thorough assessment of the role of HR in sustainability (Moreira et al., 2025). Unlike traditional or Green HRM, sustainable

HRM has a broader scope that can be observed by paying attention to the issues of the triple bottom line and promoting the long-term well-being of the employees and society (Kramar, 2022; Purga l-Popiela, 2024). Nevertheless, initiating such integration may sometimes be accompanied by the necessity to reconsider the current capitalist forms of organization (Bal & Brookes, 2022). Incorporation of sustainability into HRM is now becoming an important aspect to guide organizations through environmental and social challenges facing them globally as they develop (Kutaula et al., 2024).

Industry 5.0's Human-Centric Shift

Industry 5.0 represents a paradigm shift to the human-centred nature of Industry 4.0, with an orientation on collaboration with machines and ethical control, inclusivity and sustainability (Trstenjak et al., 2025; Aruna & Khlie, 2025). Such a shift prospects the combination of the advanced technologies (artificial intelligence, robotics, blockchain, and digital twins) and human needs and values with the aim to increase the productivity without harming human well-being (Alves et al., 2023; Fraga-Lamas et al., 2024). The most important piece to this vision is the evolution of human-cyber-physical systems (HCPS) allowing dynamic interaction between humans, digital environments and physical assets in a wide range of industrial processes (Lou et al., 2025). System design involving human interaction and re-skilling are important facilitators to this transition since organizations need to ready workforces to intelligent automation and dynamic skill utilization (Castagnoli et al., 2024; Trstenjak et al., 2025). Such technologies as Human Digital Twins (HDTs) increase customization and safety even more in the manufacturing process (Bucci et al., 2024). Nevertheless, there are also ethical dilemmas to consider when undergoing this transition, such as data privacy issues and a possibility of job replacement (Aruna & Khlie, 2025; Grosse et al., 2023). There are insufficient empirical studies on human-AI interaction, specifically to touch upon the notions of trust, autonomy, and motivation, which are psychosocial variables in the industries 5.0 (Passalacqua et al., 2024; Rejeb et al., 2024).

Challenges in Industry 5.0

Although Industry 5.0 is a paradigm shift in moving to human and sustainable production, it imposes a number of critical challenges that have to be overcome prior to success in its implementation. One of the fundamental ones is the ethical aspect of connecting the high technologies such as artificial intelligence, robotics, and digital twins with human employees. Such technologies bring up the urgent question about data privacy, surveillance, and phenomena of job replacement, especially with the increase in the number of responsibilities of autonomous systems as they make decisions in industrial settings (Aruna & Khlie, 2025; Grosse et al., 2023). Even though Industry 5.0 is of global interest, there is a gap in research between the developed and developing state institutions, which restricts the inclusive innovation process and best practice sharing (Rejeb et al., 2024). In addition, psychosocial factors, including trust in AI, employee motivation, and the autonomy of workers, are underrepresented, which reduces the possibility of something that can be called genuinely human-centric systems (Passalacqua et al., 2024). Human-digital interaction and cognitive ergonomics still have barely explored placed in the literature. Moreover, there is a need to address an aging workforce, to re-skill and up-skill workers, urgently (Castagnoli et al., 2024). The only way to address these issues is to apply transdisciplinary methods and international collaboration in future research in order to create ethical, inclusive, and resilient Industry 5.0 systems (Lou et al., 2025; Alves et al., 2023).

HRM as a Sustainability Enabler

Human Resource Management (HRM) has a key role in promoting sustainability in the organizational context through the adoption of the environmental and social responsibility into the mainstream functions of HR. The sustainable HRM practices (including green recruitment, training sustainability-oriented, and environmental performance evaluation 2-setting perceptions) in business have been identified to develop an organizational culture of sustainability that influences positively the performance of the organization (Papademetriou et al., 2025). The mentioned practices prove to be particularly efficient in small and medium-sized enterprises (SMEs) where the involvement of the employees and long-term approach enhance the effects even more (Kutaula et al., 2024).

The most frequently adopted means of HR-related sustainability is Green HRM and corporate social responsibility (CSR), whereas means of fully integrated sustainable HRM is less common (Banga & Gobind, 2025). The trend is the adoption of circular economy and Sustainable Development Goals (SDGs) within the context of HRM with the goal of harmonizing HR practice to the wider sustainability initiatives being undertaken globally (Banga & Gobind, 2025). Besides, green innovations act as middlemen between the green HRM and sustainable performance that contributes to the formation of dynamic organizational capabilities (Wang & Makhbul, 2024). However, such developments are not free of difficulties, especially in times of economic vagary that are likely to impede the process of implementing sustainable HRM (Saleem, 2022). Such theoretical approaches as strategic HRM, institutional theory, and stakeholder theory can inform us about the sustainability-enabling role of HRM (Ren et al., 2023). Additional studies representing the HRM-sustainability nexus should investigate more themes such as mental health, gender equality, climate action and responsible production (Campos-Garc lika et al., 2023).

Society 5.0 and Human-Centric Innovation

Society 5.0 is an incremental breakthrough of technocentric industry 4.0 to humanistic, sustainable, and robust innovative model (Carayannis et al., 2024; Troisi et al., 2023). It underlines how the adoption of new and advanced technologies, like artificial intelligence (AI), the Internet of Things (IoT), big data, and others, can combine with human ideals and address the complicated issues affecting the world, e.g., risk management, sustainable development, improvement of living standards (Ramrez-Marquez et al., 2024). Comparing to the older industrial systems, Society 5.0 demands the multi-level strategy that will involve both

digital innovation and social, institutional, and knowledge-based components to create the balance between the technological progress and human progress (Troisi et al., 2023). It has been demonstrated that in the manufacturing industry, Society 5.0 oriented Industry 5.0 model contributes to sustainable product development, particularly in the cases of active employee participation (Horvat et al., 2024). Nevertheless, the relationship between human-centricity and the innovation in the digital sphere is still complicated and understudied (Carayannis et al., 2024). In addition, Society 5.0 requires an innovative ecosystem composed of government, academic, industry, civil organizations, and environmental players to adopt inclusive and sustainable innovations (Carayannis et al., 2024). The ability to transform aspects of quality management mechanics through this paradigm is also shaping how the effect of well-being of peoples and sustainable development targets in society is attended (Maljugic et al., 2024; Tornjanski, 2023).

Need for Strategic HRM in the Digital Era

Digitization of Human Resource Management (HRM) is becoming a strategically imperative change that cannot be ignored; this is most notable within the post-COVID age when flexibility, resilience, and innovation have increasingly become key drivers of organizational survival. With the transition in automation pre-smarter to driverless vehicles and advanced human AI interaction, this event has brought a major transformation in HRM study and the practice (Bindra et al., 2025). HR professionals must strike a balance between technological solutions and human values in such areas related to digital technology as recruitment, performance management, employees' engagement, and remote job (Ali Fenwick et al., 2024; Bhardwaj et al., 2025). The digital era of HRM involves positioning HR operations in line with business needs and utilizing AI, machine learning, and data analytics in decision-making and training of employees (Ahmed M. Asfahani, 2024). Nonetheless, the success of digital HRM is contextual, particularly in the case of the public sector environment, where managing and strategic certainty are needed (Knies et al., 2024). Presentiment, governance, talent management, and practitioner skills are the major aspects that organizations should enhance to increase their digital maturity in HR (Md Shahiduzzaman, 2025). Moreover, generative AI (GAI) implementation also led to the suggestion of novel strategic HRM models based on ongoing learning, innovation and ethical embedding (Chowdhury et al., 2024). Such shifts require active responding to the digital disruption, securing future competitiveness and long-term stable organizational development (Kim et al., 2022; Shiferaw & Birbirsa, 2025).

Research Gap

The literature review indicates that more studies have become interested in incorporating sustainability in Human Resource Management (HRM), especially using initiatives such as Green HRM and corporate social responsibility. Sustainable HRM has however continued to be poor and not consistent among organizations although there is the interest. Most studies lay a lot of stress on being environment-friendly and CSR but fail at long-term strategic integration of the principles of sustainability into the various functions of HRM. Furthermore, although both these systems (Industry 5.0 and Society 5.0) are human-oriented, ethical, and inclusive, the absence of extensive studies that draw direct comparisons between these theories and HRM strategies can be seen.

The extent to which the HRM can promote the human-machine cooperation that Industry 5.0 is deemed highly relevant is also under-researched, particularly with respect to cognitive ergonomics, psychosocial acculturation and human health. In this regard, further, the literature on Society 5.0 pays much attention to the field of technological innovation and social consequences but not to structural HR practices to stimulate this transition. Although the emergence of HRM as an area undergoing a digital transformation has been considered, especially following the COVID-19 situation, the existing research has seldom tied the development to sustainability practices and humanistic principles. There is yet another research hole in the unevenness of research outputs both in geographical compartmentalization as well as lacking hybrid research and the representation of less developed economies. Additionally, strategic guidelines that can integrate digital HR practice with sustainability and inclusivity remain non-existent or highly abstract and do not have any empirical support. The interaction between AI, digitalization and sustainable HRM involves a more targeted investigation in order to inform successful implementation. In general, it is obvious that the integration, future orientation, strategic HRM, sustainability, and human-centered innovation in terms of Industry 5.0 and Society 5.0 require research.

METHODOLOGY

Conceptual Framework

The given theoretical outline named as "Strategic HRM 4.0 Framework" is a graphical version of the functioning of the Strategic Human Resource Management (HRM 4.0) as the focal point and driving force of delivering sustainability, innovation, and social performance regarding the environment of Industry 5.0 and Society 5.0.

The central point of the framework is HRM 4.0 that is consideration of advanced digital technologies (AI, data analytics, automation) in human resource practice. This digital revolution remakes the manner in which HR services are defined and provided like recruitment, training or performance management, and employee engagement. It goes outside administrative efficiency to protect organizational and societal objectives.

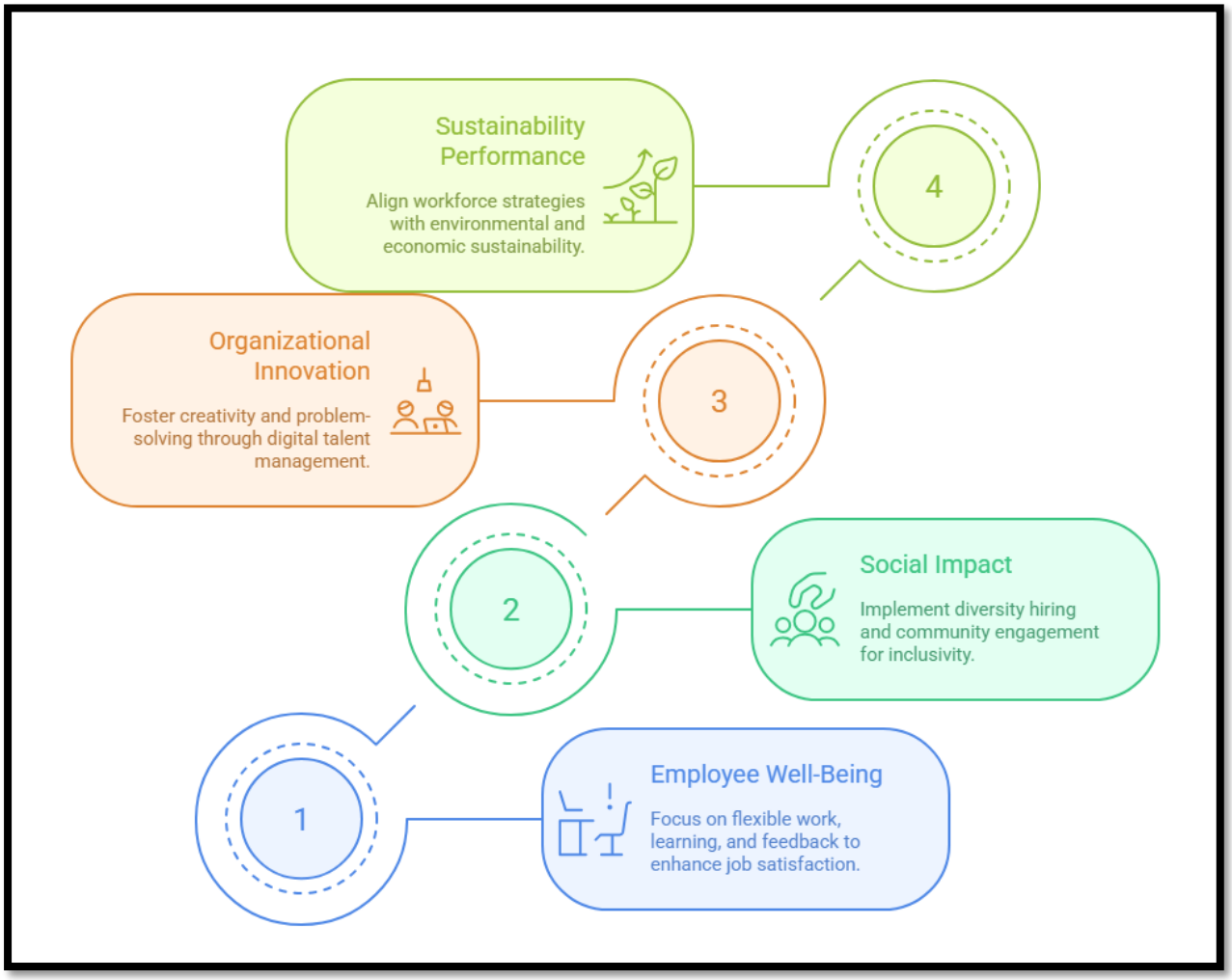

Fig.01

The four interrelated outcomes surround the core:

Improved Employee Well-Being

HRM 4.0 promotes well-being through the development of flexible, accommodating and even personal employment conditions. Digital tools provide constant learning opportunities, the opportunity to work remotely, as well as feedback in real-time, all of aiding external psychological safety and job satisfaction. Due to the human-centricity of the industry 5.0, this result fits its vision of the ethical and inclusive workplaces.

Social Impact and Inclusivity

The dimension corresponds with the reason HRM 4.0 enables the concept of sustainable HR practices including but not confined to hiring diversity, inclusive leadership, and community engagement. Aligning HR practices with the principles of a Society 5.0 allows organizations to deal with society-wide concerns in addition to relieving inequality and access to opportunity and, in the process, increased legitimacy and social capital.

Organizational Innovation

The model shows the way HRM 4.0 is an innovation driver. With the support of technological tools of talent management and collaborative ecosystems, such as social platforms available on the digital level, an organization can embrace the creativity, resilience, and problem-solving that lie at the heart of Industry 5.0 and the intelligent, responsive systems that it aims to introduce.

Enhanced Sustainability Performance

The HRM 4.0 facilitates sustainability of environmental and economic aspects by incorporation of Green HRM practices as well as integration of workforce strategy deployment with sustainability measures. It promotes sustainable praxis, facilitates the shifts to the circular economy, and makes workforce planning long-term viable. Mediating Factors including organization culture, leadership commitment, digital maturity as well as the digital literacy of employees are situated at the bottom of the framework. These have an impact on how well, HRM 4.0 is implemented. HRM 4.0 has great potential that will not be fully achieved unless there are appropriate alignment and readiness. The model can also be viewed as a strategic playbook of how the digital transformation of HR can be connected with the overall visions of sustainability and humanistic innovation, and it would be relevant to companies entering into Industry 5.0 and Society 5.0 cultures.

DISCUSSION AND ANALYSIS

The concept of Strategic HRM 4.0 coupled with the principles of sustainability is gaining more and more

importance within the framework of Industry 5.0 and Society 5.0. This study brings out the paradigm-changing nature of HRM 4.0 in bringing a shift in organizational and societal changes by meeting digital innovations with human-oriented principles. The review shows that Green HRM and CSR programs have increasingly become popular, but there exists a vacuum in regard to the adoption of sustainable HRM programs with long-term ecological and social goal embedment in the HR fundamental practices. The focus of Industry 5.0 on human-machine interaction, ethical regulation, and inclusivity raises the need to re-characterize the roles of HR, especially with regards to the employee well-being, reskilling, and digital participation. At the same time, the objectives of Society 5.0 of resolving social issues with the help of innovation contribute to the necessity when HR should not only serve as a support system but as a strategic partner. As shown in the framework above, HRM 4.0 can be used as a means to promote innovation, social value, and sustainability through digital solutions that focus on people. Nevertheless, digital infrastructure, leadership, and workforce preparedness are mediators that take center stage in the successful implementation. That is why a comprehensive strategic approach to HRM is needed in order to reveal all the possibilities of HRM in the promotion of sustainable and inclusive development in the era of digital revolution.

Suggestions and Policy Implications

In the context of Industry 5.0 and the Society 5.0, organizations and policymakers should focus on the combination of digital technology with sustainability and human-focused HR processes in order to realize all the benefits of HRM 4.0. To begin with, businesses should invest in reskilling and upskilling initiatives so that staff are ready to work with the advanced technologies such as AI and robotics. Digital literacy and lifelong learning policies should be encouraged to foster the flexibility of the workforce. Governments and industry organizations must promote sustainable HRM by establishing principles that help coordinate HR activities with environmental and social objectives, e.g. green recruiting, workforce welfare and inclusive workplace. The HR leaders should be educated on how to effectively deal with data by making it private and ethically regarding AI decision-making. Incentives or the digital infrastructure should be offered to small and medium enterprises (SMEs) to embrace the efficiency of HRM 4.0. Such partnership also needs the involvement of each the industry, academia and government to develop strategy HR models to meet organizational and societal needs. Finally, strategic HRM must be integrated into national policies by promoting sustainability and innovation in general as the core contributors to an inclusive and ethical development of the digital economy, with HR professionals being one of its main agents. These will aid in the development of future-ready workforce and robust organizations.

CONCLUSION

The present study indicates that Strategic HRM 4.0 can play a vital role in promoting sustainability, innovation, and human-centers development of Industry 5.0 and Society 5.0 environments. Although the pace of the development of digital transformation in the HRM area has gained momentum, especially after COVID-19, its potential is not realized, and the adoption of single components is currently highly fragmented and unintegrated with the sustainability agenda. The conceptual picture shows how HRM 4.0 when implemented strategically in line with ethical, social, and environmental goals will promote better employee well-being, organizational innovation, and inclusive growth. Nevertheless, the major mediating factors (like leadership, digital infrastructure, and workforce preparedness) should be taken into consideration to be successful. In order to develop resilient and future-oriented organizations, HRM should no longer focus on achieving efficient operations, but to play a strategic role in defining inclusive and sustainable futures.

Limitations of the Study

- The research study lacks primary data collection to empirically validate the study.
- It is primarily concentrated on theoretical approach and might therefore not capture the actual implementation challenges in various industries.
- The differences in digital infrastructure and the HRM practices across regions have not been more developed, which makes it less internationally applicable.
- The impact of cultural and organization differences on HRM 4.0 adoption is avoided.
- The fact that Industry 5.0 and Society 5.0 are dynamic and fast changing may make certain insights time bound or prone to alterations.

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