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E-HRM framework for sustainable performance in higher education

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ABSTRACT

Integrating digital technology into human resource management (HRM) enhances sustainable performance in higher education and presents challenges to well-being and organizational culture. This study examines the strategic role of E-HRM, mediated by green digital culture (GDC) and moderated by green transformational leadership (GTL) in Indonesian private universities. A survey was conducted using questionnaires distributed to 480 randomly selected academic and administrative staff. Data analysis using structural equation modeling (SEM) confirms that E-HRM significantly impacts sustainable performance directly and through GDC, while GTL strengthens this relationship by driving strategic change. The study positions E-HRM as both an administrative tool and a strategic enabler of sustainability. The theoretical contributions highlight the synergy between E-HRM, GTL, and GDC in fostering sustainability. At the same time, the practical implications emphasize the need for strong leadership and a digital culture to maximize E-HRM's benefits. This includes enhancing efficiency, communication, and resource optimization while mitigating risks to well-being. This study provides new insights into how E-HRM can serve as a strategic tool for enhancing sustainable performance in higher education, with GDC driving cultural transformation and GTL reinforcing its effectiveness. By developing a framework for E-HRM in sustainable performance, this study advances the understanding of sustainability-driven digital transformation in higher education.

Introduction

The study of E-HRM as a strategic endeavor is advancing alongside the integration of technology into university governance structures [43,69]. The role of HRM in higher education institutions is critical to institutional effectiveness and adapting to ongoing challenges [34]. E-HRM refers to the use of information technology (IT) to digitally manage HR processes and functions (De Alwis et al., 2022; [48]). It is positioned as a strategic tool to drive institutional performance [49,66], with significant potential to enhance the efficacy of HRM governance within higher education. E-HRM can enable HR to function as a core business unit and strengthen its strategic role in organizational development [30,94].

Although E-HRM has evolved as a strategic tool in university governance, its optimal implementation still faces various challenges that require further examination [7,69]. However, further research is necessary to delve into optimal E-HRM implementation, the challenges encountered, and its impact on various aspects of institutional performance. Digital integration into HR systems is relatively recent, and the role of AI in HRM remains debated among both employees and managers [80]. Barriers such as infrastructure limitations and conceptual frameworks continue to challenge E-HRM implementation in Indonesian universities, which often have low adoption rates of strategic HR technology, limited to 30 %–40 % in strategic HR applications, while administrative tools are used by over 90 % of organizations, including private educational institutions [88]. Adequate infrastructure improvements are essential to support digital transformation across sectors in Indonesia (Wantiknas, 2023). The adoption of digital technology in E-HRM systems within education is the lowest among sectors [67].

Beyond technical and infrastructure challenges, E-HRM also impacts social and organizational culture, raising concerns about balancing digital efficiency and sustainability at the micro level, such as employee well-being, which reflects broader sustainability goals [33,58,60]. While E-HRM offers significant benefits to organizations, its design and implementation must prioritize employees, as they are the key factor in ensuring system effectiveness [8,66].

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While E-HRM provides numerous benefits, it also has potential drawbacks that need to be explored, such as effects on employee well-being, social interaction, and perceptions of HR's strategic value. Organizations that lack readiness or face technological limitations may struggle with the stability of E-HRM systems, which also pose data security risks [78]. A more in-depth study of E-HRM in higher education is crucial to realize its full potential as a strategic contributor in university settings. Higher education institutions are seen as key agents of sustainability in Indonesia, and understanding E-HRM in this context is essential.

Challenges in E-HRM implementation are not limited to technical aspects but also reflect a conceptual gap in the literature. A broader understanding is needed to distinguish E-HRM from other HR systems and align it with academic and organizational sustainability goals. There exists a notable gap in the understanding of E-HRM, both conceptually and in its implementation across different contexts. A broader scope of E-HRM research is necessary to support the generalization and applicability of E-HRM in diverse environments [24,72,77], highlight the need for a clearer understanding of E-HRM, as it frequently overlaps with human resource information systems (HRIS) and enterprise resource planning (ERP) systems, leading to confusion in both academic and practical applications. In the education sector, studies on HRM are crucial to reassessing existing models and practices, particularly about achieving academic and organizational sustainability goals [34]. E-HRM holds the potential to drive sustainability since higher education institutions serve as key agents of sustainability. However, the concepts and explanations of various critical sustainability-related variables within E-HRM remain underexplored. This limited discussion represents a critical gap in the literature, underscoring the need for further research to establish comprehensive E-HRM frameworks that can support the unique sustainability challenges in higher education contexts [62].

Furthermore, while E-HRM primarily functions as an administrative tool, it also holds strategic potential in shaping organizational culture and long-term performance in higher education institutions [66,67]. E-HRM has a strategic function. E-HRM can foster a culture that supports long-term organizational performance. The role of e-HRM in shaping culture has been discussed by [32,71] and [85]; however, the development of a culture that reflects diverse organizational orientations toward sustainability remains untested, particularly within higher education institutions. The impact of e-HRM on culture is a suggested agenda for future research [66]. E-HRM also promotes operational efficiency through automation and digitalization, streamlining administrative tasks. It enables data-driven employee performance monitoring, supporting more effective HR planning. E-HRM facilitates the achievement of sustainable and effective performance, adding value to higher education institutions in building a modern and innovative image. However, e-HRM's function in promoting performance that considers the environmental impact of organizational operations remains untested. The implementation of e-HRM also requires the support of organizational resources, people, technology, and social factors [95]. Leadership is an essential factor that supports e-HRM with a multidimensional role, moderating HRM functions as discussed in the literature. Studies on the role of leadership in higher education related to e-HRM and culture remain insufficient and require further exploration [54]. Considering the strategic role of E-HRM in organizational culture in the digital era and sustainability, it is crucial to explore how leadership factors and organizational resources can support more effective implementation.

The transformation and functionalization of E-HRM cannot be separated from the role of leadership [73], including in higher education institutions [69]. The lack of support from HEI leaders is a major barrier to the implementation of sustainability policies [2]. One leadership style recognized and adopted to realize sustainability is Green Transformational Leadership [31,59].

The influence of leadership is not always linear and may exhibit a threshold effect [35,40,64], which can take the form of a U-shape or an inverted-U [10,45]. As E-HRM systems mature, higher education institutions develop self-organizing capabilities that reduce the need for moderating influences through hierarchical control mechanisms such as GTL, in line with Anderson, [12] and Uhl-Bien et al., [86]. Dinh & Lord, [29] emphasize that the effect of leadership systematically decreases in the implementation of a mature E-HRM system and is not always linear. On the other hand, transformational leaders may experience mental fatigue [1,4,20]. Therefore, exploring the interaction between leadership and E-HRM in developing a conceptual framework for higher education performance is necessary, given the limited prior research on this issue.

The contribution of this study is to expand a more comprehensive understanding of e-HRM in achieving sustainable performance within higher education institutions by addressing how the dark side of e-HRM can be minimized. Higher education institutions are currently in a transitional phase between the operational and relational stages of digital adoption, as noted by Anggoro et al., [13], while also displaying some elements of the strategic phase of e-HRM. Therefore, a clear understanding of the concept and application of e-HRM is deemed essential. Secondly, the study highlights the importance of both organizational roles and resources, such as leadership, in supporting e-HRM to optimize its functions. The research also reveals the role of a green digital culture as an output of the e-HRM system design. The study also examines the role of Green Transformational Leadership in this context, where knowledge about GTL functions remains fragmented.

This study aims to fill the research gap by providing a comprehensive understanding of E-HRM in the context of higher education while highlighting the role of green digital culture as an outcome of E-HRM system design. The research objectives are based on the following research questions:

RQ1: How does e-HRM contribute to promoting sustainable performance, directly and through green digital culture?

RQ2: Does green transformational leadership moderate the influence of e-HRM on green digital culture and sustainable leadership?

The structure of this research paper is divided into six sections. The first section, Introduction, addresses conceptual and empirical gaps related to the variables in this study. The second section, the literature review, provides relevant foundational theories for building hypotheses and discussing research findings. The third section covers the research method. the fourth section, results, presents the causal relationships between the study variables using structural equation modeling (SEM) procedures. The fifth section, Discussion, interprets the findings in light of previous studies and outlines the study's contributions. Finally, section 6 presents the conclusion, implications, and limitations of the study, with recommendations for future research.

Literature review

E-HRM and sustainable performance

E-HRM is broadly defined as the use of information technology (IT) to perform HRM functions and processes digitally, enhancing efficiency, decision-making, and strategic HR roles [66]. E-HRM as a system that supports HR functions through IT to enhance efficiency and effectiveness [15,27]. E-HRM is a transformative paradigm in contemporary organizational management that integrates advanced digital technologies with strategic human resource practices. E-HRM represents a critical intersection between technological innovation, strategic organizational management, human capital development methodologies and digital transformation paradigms.

E-HRM serves as a tool to support the quality of intangible HR services, which occur simultaneously and involve customer participation [23]. It facilitates functions such as recruitment, training, performance evaluation, and employee data management digitally, ultimately contributing to more sustainable organizational performance [44,69]. E-

HRM ensures easy and quick access to internet services and ERP software, which support all e-HRM functions seamlessly. E-HRM promotes organizational sustainability by transforming traditional work models into efficient, resource-saving, and strategic digital systems, thereby supporting long-term growth and competitive advantage [19]. E-HRM facilitates digital transformation, operational efficiency, and overall improvements in performance and sustainability reputation [11,79].

The adoption of e-HRM in the higher education sector is driven by external pressures for sustainability and competitive performance, making e-HRM not merely an option but a necessity for survival and growth in a dynamic educational sector. HR governance systems impact sustainability performance [87]. E-HRM is seen as a facilitative tool that enhances communication among stakeholders, including HR professionals, line management, employees, and prospective employees [77], to support sustainability. E-HRM enhances operational efficiency, productivity, strategic decision-making, and agility by leveraging an integrated HR information system. It also positions HR as a strategic partner in supporting the long-term sustainability of higher education institutions [9]. In general, E-HRM adoption contributes to organizational sustainability.

However, E-HRM implementation also has potential negative impacts due to the complex nature of technology and its application across various organizations [15,66,93]. Technological disruption affects HRM adoption [27,68], along with challenges specific to higher education institutions [69]. As E-HRM improves HR efficiency and service quality, its adoption has become a key strategy for enhancing organizational sustainability particularly in higher education despite the challenges of complexity and technological disruption [63]. Based on this statement, we hypothesize that:

Hypothesis 1: E-HRM affects sustainability performance

E-HRM, green digital culture and sustainable performance

Green Digital Culture is a concept developed based on an interdisciplinary approach. Culture is a system of beliefs, values, ideas, and attitudes that shape organizational behavior (Schein [75]). In the ecological paradigm, the concept of culture evolves into green culture. Green culture is an aspect of organizational culture that refers to a set of values, symbols, assumptions, and policies that reflect a commitment to operating as an environmentally friendly organization [53]. Cultures that are oriented toward sustainability create an environment where everyday conversations incorporate a sustainability perspective, and decisions made within the organization consider the triple bottom line, rather than focusing solely on economic factors ([56]; Baghbadorani et al. 2022). A green culture demonstrates an institution's commitment to supporting environmentally-friendly operational changes (C. H [89]; Qu et al., 2022). green culture acts as a primary driver of organizational sustainability, enhancing sustainable performance [32,39,87]. Green culture in high educational digital process refers to the values, beliefs, and behaviors within an organization that drive environmental sustainability [13]. A green culture within the transformation process fosters a sense of responsibility and ownership toward sustainability issues [3].

Normative shifts in organizational understanding of digital sustainability have driven the development of Green Digital Culture (GDC). Green and digital activities complement each other in achieving sustainability goals, which are embodied in Digital Green Culture. A Digital Green Culture refers to an organizational environment that supports sustainability-oriented digital practices, enabling the adoption of a green digital mindset [6]. Previously, Green Digital Culture was defined as a set of values, beliefs, and collective behaviors that prioritize sustainability through digital technologies [70]. In this study, GDC is constructed as an organizational environment that supports sustainability-driven digital practices, encompassing values, beliefs, and collective behaviors that emphasize the use of digital technology to reduce environmental impact and enhance resource efficiency.

This green digital culture encourages active participation and awareness of the environmental impact of work processes and technology on sustainability in digital Transformational process. Green digital culture facilitates organizational members in sharing a common vision, perspectives, assumptions, and beliefs about sustainability issues. Organizations with a green culture are more likely to reduce waste, improve energy efficiency, lower greenhouse gas emissions, develop green spaces, and offer environmental education programs [5]. Green digital Culture influences organization's sustainability by establishing norms and practices that integrate green and digital aspects, such as energy-efficient digital device usage, e-waste management, and resource efficiency.

This culture promotes the adoption of a green digital mindset among the academic community, manifested through the use of eco-friendly technology, sustainable digital policies, and digital-based innovations to support university sustainability goals. GDC, as a concept developed based on digital culture and green culture, focuses on digital transformation while ensuring sustainable practices. GDC is more specific and operational compared to digital sustainability, which is broader and more strategic [6]. GDC is developed from an understanding of the importance of sustainability values and digital innovation, where employees are responsible for the environment. Proposed hypothesis:

Hypothesis 2: Green digital culture has a positive influence on sustainable performance

Green digital culture serves as a pathway to achieving sustainable performance, as highlighted in [85]. Green Digital Culture as a tool to drive a focus on sustainability performance. E-HRM fosters an innovative culture within organizations [11]. Culture serves as a resource to support E-HRM practices in achieving sustainable performance [19]. E-HRM fosters a culture that creates stability in the implementation of green initiatives, as it introduces and even shapes norms, beliefs, and identities, including providing the foundational assumptions for employees to achieve sustainable performance for the organization. Culture helps maintain consistency in the behavior of organizational members. These tools facilitate supporting sustainability initiatives through a cultural configuration that encourages sustainability-oriented behaviors. E-HRM fosters a green-oriented culture through an effective reward and motivation system [79]. E-HRM promotes cultural change and reduces resistance to norms, values, or beliefs that support sustainability.

The implementation of digitally-based HR functions enables the efficient and effective achievement of sustainability through the development of GDC. E-HRM promotes micro-level practices directly related to sustainability at the employee level. It fosters the institutionalization of green values within the digital transformation processes in private universities, which generally occur on a massive scale in Indonesia. E-HRM facilitates the recruitment of candidates with a strong orientation toward sustainability. Training and learning processes are driven by sustainability goals, while sustainability-based performance evaluations become more effective by clearly identifying individual contributions to support sustainability through E-HRM. The processes and mechanisms of E-HRM encourage changes in norms, values, and underlying assumptions that lead to sustainable behavior at the micro level. Recruitment, placement, compensation, and evaluation emphasizing individual-level implementation are carried out to support sustainability. Through E-HRM, sustainability is advanced by cultural transformation. Efficiently managed digital-based systems for recruitment, placement, training, rewards, and compensation are developed to build a green digital culture. GDC serves as a critical mediator in optimizing the functions of E-HRM to achieve sustainable performance. Based on this statement, we hypothesize that:

Hypothesis 3: Green Digital Culture mediates the influence of E-HRM on sustainable performance

Green transformation leadership

Higher education leadership today faces changes that demand both efficiency and sustainability. Managing the transition process in digital transformation presents a leadership challenge (F [51]). Identifying leadership styles in the context of educational digitization is not an easy task (Krein, n.d.; [91]). Green Transformational Leadership (GTL) is a leadership structure that guides by inspiring and motivating followers to achieve the organizational vision [81,83]. The digitalization of HR functions for sustainability cannot be separated from the vision of GTL. The GTL vision drives changes in cognitive schemas, enabling individuals to understand the importance of sustainable behavior and their personal contributions to sustainability, particularly in higher education institutions that serve as knowledge agents.

Green transformational leadership strengthens the influence of e-HRM on the development of digital culture by expanding and reinforcing the green vision in the design of e-HRM. Leadership influences efforts to support sustainability through a green culture [17]. The interaction between leadership, HRM, and culture enhances performance and promotes more sustainable business practices [42]. This dynamic interaction helps create an organizational environment where sustainability is integrated into both leadership strategies and HRM systems, fostering long-term sustainability in the organization. The green transformation leadership integrates and directs e-HRM practices, motivating, stimulating, and challenging the status quo assumptions that lack a sustainability orientation. Leaders assist HRM in creating a culture of shared responsibility and ownership for environmental performance related to sustainability [14,55]. The success of e-HRM is highly dependent on support from top management and visionary leadership. Leadership that supports digital innovation motivates the entire team to adopt more efficient new technologies for sustainability [69]. Drawing from transformational leadership theory and identity theory, employees strive to align their values and green identity with that of their leaders (X. Wang et al., 2018). Transformational leadership moderates the relationship between HRM practices by inspiring a shared vision, empowering employees, developing innovation, and modelling ethical behavior to create a sustainability culture [83]. Proposed hypothesis:

Hypothesis 4: GTL moderates the influence of E HRM on GDC

Green transformational leadership (GTL) emphasizes the importance of environmental sustainability and inspires followers to engage in pro-environmental behaviors [16,50]. Green transformational leadership (GTL) refers to the behaviors of leaders who encourage followers to achieve environmental goals and inspire them to exceed expected levels of environmental performance ([6]; Y. S [25]).GTL creates a shared vision, inspiring and preparing the organization to face sustainability goals. Leadership ensures that the adoption of digital technologies is integrated with sustainability goals, at the micro (individual), *meso* (group), and macro (organizational) levels [6,65]. GTL is the ability to transform an organization's mindset toward sustainability through the integration of digital technology into functional structures, fostering innovation, and maintaining a sustainability-oriented approach. The GTL concept is developed based on the foundation of digital transformation integration, environmental sustainability orientation, and the dynamics of transformational leadership in achieving sustainability goals. Based on this framework, we hypothesize that GTL moderate sustainability performance. However, the influence of GTL in high power distance structures, as proposed by Hofstede, [41], indicates that cultures with high power distance may exhibit a slower diminution of GTL's moderating effects due to stronger expectations for hierarchical leadership and reduced acceptance of technological authority substitution [46,92].

Hypothesis 5: GTL moderates the influence of GDC on sustainable performance.

The proposed model in this study is shown in Fig. 1

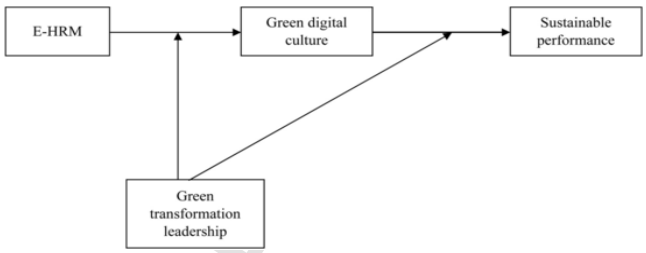

Fig. 1. . Roposed model.

Methodology

The research design uses a causal study to test the hypothesis [76] by the research objectives.

Sample respondents

The respondents were lecturers and academic staff, with a total sample size of 480. The sampling process in this study followed a purposive sampling approach, selecting respondents who had worked for at least one year and were either foundation employees or contract staff at the university. Subsequently, proportional stratified sampling was used to determine the number of respondents at each university based on the total number of employees and permanent staff. To reach the respondents, the researcher utilized social networks within the academic community. After identifying universities that have integrated technology into HRM based on interview results, the researcher determined the number of respondents for each university. Ten private universities were identified as having undergone the digital transformation process, with a minimum accreditation score of B. The researcher then determined the sample size proportionally based on the number of employees and permanent staff at each university [8].

The authors utilized social networks that enable the collection of large amounts of data at low cost. Well-established social networks among lecturers and academic staff, such as the Indonesian Lecturers Association and APTISI (the Association of Indonesian Private Higher Education Institutions), strongly support research conducted by their members. Through these associations, the authors obtained an informal assurance that lecturers and staff would participate in the study by providing responses consistent with their knowledge and experience.

Measurement of research variables

The measurement of the E-HRM variable was developed based on Theotokas et al., [85] in a contextually appropriate manner, comprising 11 statements, such as: 1) E-HRM increases the focus of lecturers and administrative staff on their core tasks, and 2) E-HRM reduces the average amount of ineffective time during working hours. Previous studies indicate that the instrument is adequate, with the lowest loading factor value at 0.528 and the highest at 0.926.

The results of the individual construct testing for the variable are acceptable in this research. The Goodness of Fit (GOF) indices indicate a good fit, with values of CMIN/DF = 1.96, GFI = 0.93, CFI = 0.93, PNFI = 0.76, RMSEA = 0.041, and SRMR = 0.012.

In this research Green Digital Culture (GDC) variable in Organization was developed based on Lin et al., [53] and adapted to the relevant context. The lowest loading factor is 0.548, while the highest is 0.708. Previous instrument testing results from [87] indicate that the instrument is acceptable, with an AVE value of 0.747, a lowest loading factor of 0.760, and a highest loading factor of 0.919. It comprises seven statements, including the availability of information for all employees to support sustainability, the promotion of sustainability as a critical ac-

tivity, and clear policies to support sustainability. The Goodness of Fit (GOF) indices indicate a good fit, with values of CMIN/DF = 2.96, GFI = 0.91, CFI = 0.92, PNFI = 0.78, RMSEA = 0.031, and SRMR = 0.002.

The measurement of Green Transformational Leadership was developed based on Singh et al., (2020) with six statements as indicators, such as: 1) The leader inspires every member of the organization, 2) The leader provides a clear environmental vision, and 3) The leader stimulates all organization members. The lowest loading factor is 0.826, while the highest is 0.986. The study by [82] indicates that the instrument has a loading factor > 0.5, with an AVE value of 0.753. In the conducted study, the Goodness of Fit (GOF) indices indicate a good fit, with values of CMIN/DF = 1.96, GFI = 0.92, CFI = 0.94, PNFI = 0.80, RMSEA = 0.021, and SRMR = 0.003.

The measurement of Sustainable Performance was developed based on Mousa & Othman, [57], with three dimensions environmental, economic, and social adapted to the context. Examples of environmental performance include: 1) The institution is committed to reducing toxic emissions from campus operations, and 2) The institution strives to increase the volume of recycled materials and reduce waste. Examples of economic performance include 1) Increased institutional revenue related to efficiency and reduced consumption of energy and materials, and 2) Enhancement of institutional reputation and strengthening of the campus's image in the community through sustainable practices. Examples of social performance include: 1) Increased attention to employee health and safety, and 2) Development of economic activities in the surrounding community and the creation of job opportunities. Previous studies indicate that the instrument has an adequate level of validity and can explain the latent variable based on the Fornell-Larcker criterion, with an AVE value of 0.809. The Goodness of Fit (GOF) indices are acceptable, with values of CMIN/DF = 2.22, GFI = 0.91, CFI = 0.93, PNFI = 0.780, RMSEA = 0.051, and SRMR = 0.013.

The results of the expert judgment assessment, conducted with peer reviewers at Telkom University, indicate that each instrument has a strong conceptual foundation, including its measurement. E-HRM as a Transformation Infrastructure reflects the integration of digital technology in HR management, facilitating data-driven decision-making and HR process optimization. Green Digital Culture (GDC) serves as a value framework that fosters critical environmental awareness through technology and establishes ecology-based performance metrics. Green Transformational Leadership acts as a catalyst for leading sustainable transformation, environmental strategic vision, and organizational adaptation to sustainability pressures. Sustainable Performance is positioned as an outcome based on ecological criteria, technological efficiency, and long-term sustainability.

Answers from 1 to 5, both answers using a differential rating scale and Likert, are by the statements in the questionnaire. Before testing the instrument's reliability using construct validity, composite reliability, and GOF, the instrument was first evaluated for validity and reliability. The lowest validity value recorded was 0.642, while the lowest reliability value was 0.898.

Common biased method

To reduce common method bias, the researcher separated data collection into distinct periods: the first week for the E-HRM variable, the second week for the Green Digital Culture and Green Transformational Leadership variables, and the third week for the Sustainable Performance variable. Additionally, the researcher compared sustainable performance based on respondents' feedback with data from the institution on three main activities: research, community service, and teaching. Clear instructions were provided in the questionnaire, and respondents were assured of anonymity. Harman's single-factor test or confirmatory factor analysis (CFA) was used to identify the presence of common method bias. The researcher included statements with varied response options to reduce response patterns and acquiescence bias.

Research ethics

This study was conducted by research ethics standards, including allowing respondents the freedom to discontinue their participation at any time. Prior to distributing the questionnaire, the researcher obtained informed consent from participants, ensuring their involvement was voluntary and without coercion. The researcher explained the potential benefits of the research to society, including to the respondents themselves. There were no risks to respondents regarding their employment, and they were free to respond based on their knowledge and experience. Respondents were also given fair access to the benefits of the research.

Data collection techniques using questionnaires with answers 1 to 5 ranging from never to always. A total of 600 questionnaires were distributed, and 480 responses were received within a two-week period.

Data analysis

Data analysis using SEM based on [36]. The first step is measurement model development, where latent variables are defined based on a literature review. The key constructs in this study include E-HRM, Green Digital Culture (GDC), Green Transformational Leadership (GTL), and Sustainable Performance, measured using validated indicators from previous research.Next, validity and reliability evaluation is conducted, followed by Structural Model Development to confirm causal relationships between variables. The model estimation uses Maximum Likelihood Estimation (MLE), suitable for normally distributed data. Goodness of Fit (GOF) is assessed using accepted fit indices.After model refinement, hypothesis testing is performed. Moderation analysis is conducted by examining interactions between the moderator and independent variables on the dependent variable using SPSS 25 Process Macro by Hayes. Finally, results are interpreted, and theoretical and practical implications are discussed.

Results

Developing the overall measurement model

The instruments used in the study have a construction that is acceptable theoretically and empirically. The results of the CFA test are as follows (see Fig. 2)

According to Fig 2, convergent validity in this study is achieved, as evidenced by high factor loadings (>0.5). The results of the discriminant validity test indicate that each indicator differentiates its respective latent variable, meaning there is no cross-loading on other constructs. The relationships between constructs are consistent with the underlying theory, indicating that nomological validity is also achieved. The results of the construct validity test (convergent validity, discriminant validity, and nomological validity) indicate that the model is acceptable, as shown in Table 1 [38,61].

All constructs (E-HRM, GDC, GTL, and SP) demonstrate adequate discriminant validity. Each observed variable explains its respective latent variable better than it does other constructs. The AVE values are adequate, and the composite reliability of the constructs is very high. The measurement model is suitable for further structural analysis.

Designing a study to produce empirical results (sample size, estimation model i.e. MLE, missing data; identification problems

The data are normally distributed with a p-value of 0.291 ($p > 0.05$). There are no missing data, and no identification issues were

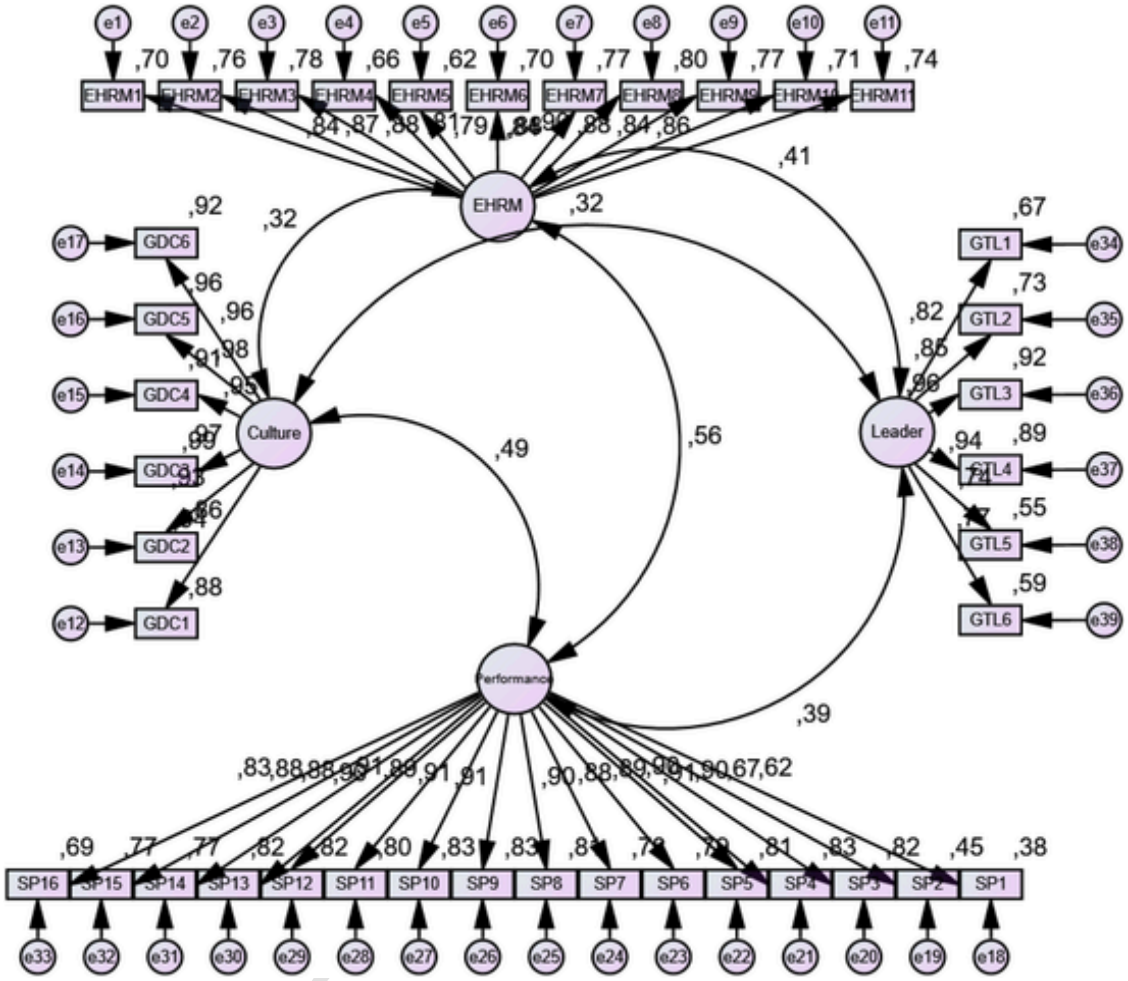

Fig. 2. Measurement theory model (CFA).

Table 1
Standardized factor loadings, average variance extracted, and reliability estimates, discriminant validity.

Laten Variable	Discriminant validity			
	EHRM	GDC	GTL	SP
E-HRM	0.854			
Green digital culture	0.080	0.958		
Green transformational leadership	0.087	0.059	0.866	
Sustainable performance	0.119	0.101	0.042	0.851
Average variance extracted	0.730	0.918	0.724	0.749
Composite reliability	0.960	0.984	0.938	0.977

Source: 2025 data processing results.

Table 2
Indeks Uji *Goodness of fit.*

Type of Measurement	Measurement	Stage 1	Correction	Conclusion
Absolute fit measures	p-value-	0.000	0.000	Moderate
	RMSEA	0.099	0.037	Fit
	RMR	0.040	0.030	fit
	GFI	0.747	0.912	Fit
Incremental fit measure	NFI	0.879	0.967	Fit
	TLI	0.89	0.984	Fit
	RFI	0.87	0.962	Fit
	CFI	0.897	0.986	Fit
	AGFI	0.712	0.893	Moderate Fit
Parsimonius fit measure	PNFI	0.819	0.848	Fit

found. The relationships between variables are linear, allowing for analysis without any data-related constraints.

Model evaluation

The test results assessing the measurement model validity for overall fit show that each GOF criterion is met, as can be seen in Table 2 as follows.

Source: 2025 data processing results

The GOF test results in this study show that, in the first stage, only the RMR criterion was met (< 0.05). The PNFI value exceeded 0.6. Computational results indicate that both endogenous and exogenous variables have p-values (probabilities) < 0.05, indicating high significance, which means that the constructs (E-HRM, GDC, GTL, and SP) possess adequate discriminant validity, AVE, and composite reliability. Following Byrne (2017), model adjustments were made based on relevant theory and modification indices (correlations between relevant error terms). These model refinements were theory-driven and iterative to ensure empirical validity and theoretical integrity. For example, an adjustment was made by correlating e1 and e2: e-HRM1 represents lecturers' and staff's focus on core tasks, while e-HRM2 refers to the reduction of ineffective time. Both are closely related to the concept of time efficiency achieved through E-HRM. The correlated errors are influenced by the same context, such as system changes and reduced admin-

istrative workload due to digital support. The authors also linked e12 and e13 for model improvement, as both are associated with educational practices and efforts to promote sustainability awareness. Correlations between residuals were retained only when substantively relevant and not conflicting with the assumption of indicator independence.

Hypothesis testing

The results of the hypothesis test can be seen in Table 3 as follows

The results of the relationship test indicate the presence of connections between variables with varying degrees of influence. Green transformational leadership plays a crucial role in strengthening the culture and implementation of e-HRM, which subsequently contributes to sustainable performance. Green digital culture facilitates the functioning of e-HRM for sustainability. All these relationships are statistically significant, indicating that these factors are significantly related to one another in the context of digital transformation and sustainable performance. Next are the results of testing the mediation variables as can be seen in Table 4 as follows.

The results of the analysis show that the implementation of EHRM contributes to strengthening green digital culture, which in turn improves organizational performance. The results of the moderation test are as follows (see Fig 3).

Green transformational leadership moderates the relationship between e-HRM and green digital culture. However, its level of contribution or influence is relatively low across all categories, as indicated by the low values. At low levels of green transformational leadership, there is a positive influence between e-HRM and green digital culture, but with a gentler slope compared to higher levels. At a medium level, a quadratic relationship pattern emerges, where the influence of e-HRM on green digital culture is non-linear, showing fluctuating effects depending on the e-HRM level. This can be interpreted as, at a moderate level of green transformational leadership, the impact of e-HRM does not increase consistently. At high levels of green transformational leadership, the relationship between e-HRM and green digital culture becomes almost flat, meaning that increases in e-HRM have little to no effect on green digital culture at this level.

However, different results are shown when GTL moderates the effect of green digital culture on sustainable leadership. The moderation test results indicate a significant influence of GTL intensity, whether low, medium, or high, on enhancing the impact of GDC on sustainable leadership. The testing results can be observed as follows (see Fig. 4).

Green digital culture has a greater impact on sustainable performance at low to moderate levels of green transformational leadership. Excessively intense leadership (high level) appears to reduce the effectiveness of green digital culture in driving sustainable performance. These results indicate the presence of a threshold effect in GTL's role in moderating the relationship between E-HRM and GDC, as well as when GTL moderates the relationship between GDC and sustainability performance. The nonlinear interaction pattern reflects a counterintuitive trend consistent with the law of diminishing returns. GTL's moderating influence on the E-HRM–green digital culture relationship decreases as organizational digital maturity advances. A moderate level of leadership seems to strike a balance between leadership direction and employee freedom to implement a green digital culture, which still provides a positive impact on Sustainable Performance. This is supported by the idea that green transformational leadership, combined with green digital culture, can be an effective strategy for enhancing sustainable performance within organizations. The conclusion of the hypothesis testing shows that all research hypotheses are accepted. The implementation of e-HRM, supported by green transformational leadership and green digital culture, can be an effective strategy for enhancing sustainable performance within organizations.

Table 3
Construct correlation matrix (standardized).

			Estimate	S.E.	C.R.	P
EHRM	<—	Culture	0.324	0.044	6469	***
Culture	<—	Leader	0.321	0.038	6379	***
EHRM	<—	Leader	0.411	0.039	7628	***
Culture	<—	Performance	0.49	0.038	8264	***
EHRM	<—	Performance	0.56	0.04	8669	***
Performance	<—	Culture	0.386	0.03	6864	***

Table 4
Mediation test (standardized).

Path					Estimate	P-Value	Conclusion
Performance	<–	GDC	< —	EHRM	0.115	0.000	significant and positive

Discussion

The results of the study indicate the important role of e-HRM in supporting sustainability performance in higher education institutions. This aligns with the concept proposed by [22], where e-HRM not only

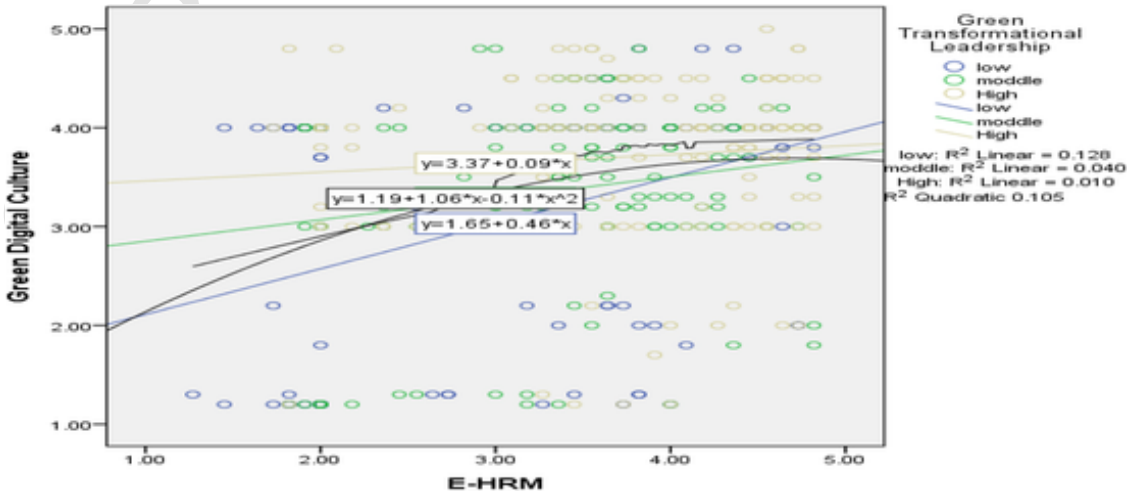

Fig. 3. . The results of the green transformational leadership moderation test in the relationship between green digital culture and E-HRM.

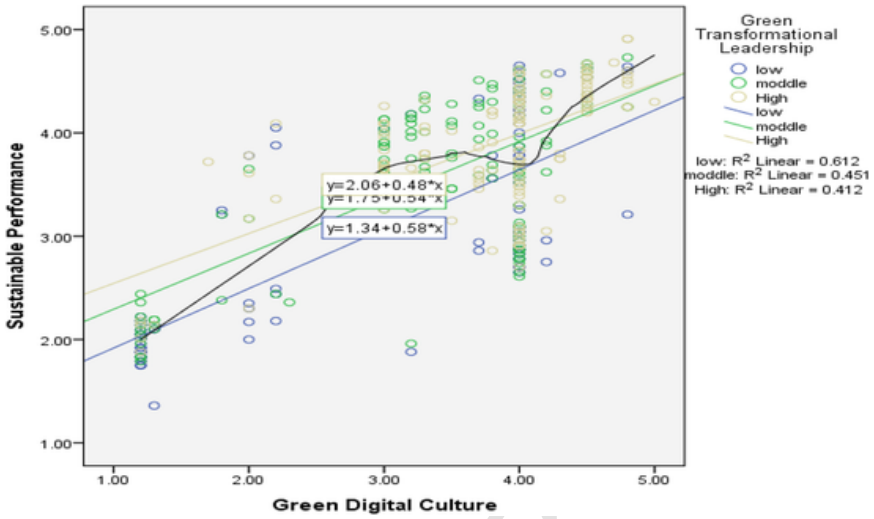

Fig. 4. The results of the green transformational leadership moderation test in the relationship between green digital culture and sustainable performance.

involves participation but also promotes efforts to create value for sustainability, particularly given the strategic role of higher education institutions. Research by [87] and [77] has demonstrated the role of e-HRM in sustainability, such as enhancing communication among various stakeholders, which directs efforts toward sustainability goals. Communication interactions drive changes in the efforts to achieve sustainability. However, the implementation of e-HRM must take into account the dark side of technology, as highlighted in previous studies. This is particularly evident in the research finding that only GTL at low levels strengthens the e-HRM function in shaping Green Digital Culture. This implies that communication in e-HRM has a dark side, as discussed by [21] and [84]. Therefore, understanding e-HRM in higher education requires a comprehensive approach. Leadership and culture can ensure that the negative impacts of e-HRM are anticipated, as noted by [84].

The results of the study indicate that e-HRM can play an optimal role at both the strategic and operational levels by leveraging Green Digital Culture as a mediating variable to achieve sustainable performance. E-HRM needs to maintain a balance across various levels. Therefore, strategies are required that can reach all tiers to realize sustainable performance, particularly through Green Digital Culture. This aligns with studies conducted by Schein [74] on the concept of culture, as well as Anggoro et al., [13] and [87]. Designing the configuration of Green Digital Culture becomes a key focus for higher education institutions. This configuration does not obscure the meaning of organizational culture. The configuration that ensures the optimization of e-HRM functions designs a culture facilitating the role of e-HRM.

Unlike previous studies such as Nyathi & Kekwaletswe, [66], which focus on E-HRM configuration in organizational performance, this study acknowledges the challenges associated with E-HRM implementation, including the lack of digital strategies and limitations in HR competencies. However, considering the human capital available in higher education institutions, these constraints can be effectively addressed. A more pressing challenge lies in how to leverage higher education's human capital as a sustainable resource for E-HRM operations. Fedorova et al., [33] highlight concerns related to employee well-being and resistance to technology, particularly in academic settings where diverse workforce cohorts interact differently with E-HRM. For instance, Baby Boomers may exhibit significantly different digital engagement patterns compared to Millennials and Generation Z.

Further, Porkodi & Raman, [67] emphasize data security and infrastructure readiness as critical barriers to E-HRM adoption, suggesting that operational efficiency and academic system integration must account for security and infrastructure concerns. Similarly, Aldiabat, [7] reports low adoption rates of E-HRM in strategic HR management, while Awadh Aljuaid, [15]; Contreras et al., [27] concur that E-HRM serves as a digital HR function aimed at improving efficiency and effectiveness [68]. Overall, these studies indicate that the paradigm shift in HR governance through IT integration has expanded E-HRM's role beyond traditional HRM, positioning it as a long-term sustainability driver. Despite various barriers and challenges, higher education institutions can anticipate, manage, and systematically address these complexities. While these institutions possess adequate human capital, they also face unique hurdles in optimizing E-HRM functions.

Thus, E-HRM can leverage Green Digital Culture (GDC) to align organizational artifacts and individual assumptions with sustainability goals. The development of GDC aligns with organizational culture theories, as proposed by Schein, [74]; Wang, [89] and Anggoro et al., [13]. The conceptualization of Green Digital Culture represents a multidimensional epistemic construct that fundamentally transcends traditional disciplinary boundaries between technology and environmental sustainability.

Green Digital Culture has a strategic function and serves as a pathway to achieving sustainable performance [85]. In the context of higher education institutions in Indonesia, Green Digital Culture (GDC) will support the role of universities as agents of sustainability. The sustainability challenges in Indonesia are significant, with the threat of climate change being a very real issue. Higher education institutions must play a key role in addressing sustainability challenges by optimizing the function of e-HRM and designing effective cultural frameworks. Universities develop underlying assumptions that drive cultural behaviors towards sustainability. E-HRM provides unspoken assumptions, often unconscious to the members of the organization, about sustainability, shaping how sustainability is approached and integrated within the institutional culture. Consistent with Sharma et al., [79], prioritizing sustainability requires cultural transformation by adopting eco-friendly human resource management policies.

E-HRM reshapes work culture by transitioning to a paperless system, contributing to environmental conservation and resource efficiency. To ensure the optimal function of e-HRM at both the operational and strategic levels, it requires leadership support that is oriented towards sustainability, such as green transformational leadership (GTL). The study results indicate that GTL plays a significant role as a moderator between the function of e-HRM and green digital culture for sustainable performance. Leadership and culture not only ensure sustainable performance, but leadership also plays a crucial role in managing transitions during digital processes, as discussed by (W [52]). Lead-

ers inspire followers to engage in pro-environmental behaviors [16,50] by strengthening the role of e-HRM in shaping green digital culture. The interaction between sustainable green leadership, e-HRM, and green digital culture enhances performance and promotes more sustainable educational practices, in line with the findings of [42].

In addition to an effective cultural configuration, the intensity of green transformational leadership (GTL) needs to be adjusted to achieve the optimal influence between e-HRM and Green Digital Culture. This is related to the burden that the use of e-HRM places on employees and faculty members. There is a negative side to the use of e-HRM in strengthening culture. This aligns with the situation in Indonesia, which is still in the early stages of integrating digital technology into human resource management systems. In line with the work of [14] and [55], leaders assist HRM in creating a culture of shared responsibility and ownership of environmental performance related to sustainability.

While E-HRM offers transformative potential, critical scholarly discourse must address several technological and ethical considerations. These include complexities in data privacy and security, the need for algorithmic bias mitigation strategies, the ethical implications of automated decision-making, and the risks associated with technological dependency. Ensuring that E-HRM systems uphold transparency, fairness, and security is essential for sustainable digital HR practices. Beyond ethical concerns, organizational adaptation presents significant challenges in E-HRM implementation. Successful adoption requires comprehensive change management strategies, continuous technological skill development, and an organizational cultural shift toward digital transformation. Additionally, strategic investment in technology infrastructure is crucial to ensure seamless integration, long-term efficiency, and alignment with broader organizational goals.

However, in micro level, a leader must be aware that the implementation of e-HRM can lead to technostress and information overload for subordinates. Technology often increases the speed and volume of work, which can potentially cause employees to feel overwhelmed and experience an imbalance between work and personal life. In some cases, the application of e-HRM may create a less personal work environment, where interpersonal interactions are reduced. This can lead to an environment that is more prone to mistrust, social conflict, and a tendency to withhold knowledge among employees. E-HRM reduces opportunities for HR professionals to interact directly with employees and other stakeholders, diminishing the social aspect of HR and negatively impacting employees' perceptions of HR effectiveness. Therefore, the role of Green Transformational Leadership (GTL) is crucial in optimizing the output of e-HRM. GTL enhances the effectiveness of HR, particularly in building a green digital culture. Green transformational leadership influences e-HRM efforts to shape perceptions, thinking, and environmentally friendly behavior among members, with the assumption that the role of GTL should be moderated to avoid ineffectiveness in moderating the impact of e-HRM on green digital culture (GDC). An excessively intense leadership approach may not always be effective in fostering a Green Digital Culture through e-HRM. Conversely, adjusting the intensity of leadership according to the context and needs of employees might be more effective in achieving optimal results.

In contrast, when green transformational leadership (GTL) moderates the relationship between green digital culture (GDC) and sustainable leadership, leadership intervention has a significant impact across all categories. Generally, GTL strengthens the design of green artefacts as the most visible aspect of culture, even though they are often difficult to interpret. Examples include paperless academic guidance, formal letters based on a commitment to sustainability, and the "environmentally friendly" values upheld by higher education institutions. GTL translates information from data or systems applied through e-HRM into tangible actions within the organization. GTL enhances the implementation of principles, philosophies, or standards that are recognized and expressed by organizational members. These values reflect what is believed to be true and serve as a guide for decision-making and the way the organization operates in an environmentally friendly manner. Through its interaction with subordinates, GTL builds deeply ingrained beliefs that are subconsciously held by members of the organization. This includes views on how "the world works," which indirectly shapes the mindset and behavior of organizational members to realize sustainability. The results of this study provide insights suggesting that leaders should adjust the intensity of green transformational leadership based on the needs of the organization. A leadership approach with too high an intensity may not always effectively support the development of a green digital culture of sustainable performance. This condition reflects what is known as a nonlinear effect dynamic or moderation paradox. Green transformational leadership demonstrates a weakening moderating effect at high intensity. Indonesia, as a country with a high-power distance culture, experiences reduced GTL effectiveness due to rigid hierarchies where communication flows top-down, and subordinates tend to passively wait for instructions. In such high-power structures, GTL is perceived as the sole source of decision-making and digital culture design. The transformational potential of this leadership cannot be fully realized because rigid hierarchical structures limit its impact. At high levels of GTL, leader–subordinate interactions tend to weaken, and information flowing upward is often distorted. The GTL vision may not be properly understood at the operational level. Furthermore, green digital culture practices may not be adequately communicated to decision-making levels. Interaction between E-HRM, green digital culture, and GTL weakens under high GTL intensity. The diminished influence of GTL at high intensity is partly due to mental fatigue. Additionally, there is a potential for individual cult formation in high power distance settings. Such conditions reinforce hierarchical dominance and can lead to power concentration. High GTL levels may create a hidden dark side of leadership (dominance) that is difficult to identify explicitly.

Consistent with Dinh & Lord, [29], the effect of leadership systematically decreases in the implementation of a mature E-HRM system. As E-HRM systems mature, higher education institutions develop self-organizing capabilities that reduce the need for moderating influences such as hierarchical control mechanisms like GTL, aligning with Anderson, [12] and Uhl-Bien et al., [86]. However, after a certain point, additional GTL may instead cause stagnation or even decline this reflects a nonlinear effect, which can take the form of a U-shape or an inverted-U [10]. There are threshold effects where the relationship between variables changes dramatically depending on specific variable values, as discussed in studies such as Hansen, [37], Alnoor et al., [10], and Chen et al., [24]. This condition signals the need for higher education institutions to develop a moderately scaled GTL model across various levels to maintain its function and role in supporting the E-HRM framework in driving sustainable performance through green digital culture as a mediator.

Conclusions

E-HRM plays a crucial role in supporting sustainability both directly and through Green Digital Culture as a mediator. E-HRM not only encourages participation but also drives efforts to create sustainability value, which is facilitated by green digital culture. Green transformational leadership (GTL) significantly moderates the relationship between E-HRM and green digital culture, although the intensity of leadership needs to be adjusted for optimal impact. GTL strengthens the design of "green" artefacts within the organization, translating sustainability values into more tangible practices. Through its interactions with subordinates, GTL helps build deeply held beliefs and perspectives within the organization that are oriented toward sustainability. This interaction shapes a mindset that supports long-term sustainability. Additionally, GTL reinforces the relationship between green digital culture and sustainable performance by embedding sustainability values within the organizational culture. However, the increasing intensity of GTL in-

fluence encounters a threshold effect. The nonlinear effect shows that the function of GTL in the relationships between variables does not consistently increase. As a moderating variable, GTL exhibits a nonlinear effect at a certain point within high power distance structures. This alignment of leadership, culture, and HR practices is key to driving continuous, sustainable performance within the organization.

Theoretical implications

E-HRM has a significant impact in supporting organizational sustainability, especially when implemented in higher education institutions that play a role as agents of change. The application of E-HRM, supported by Green Transformational Leadership (GTL) and Green Digital Culture (GDC), can be an effective strategy to enhance sustainable performance in higher education institutions. Leadership oriented towards sustainability, along with a green digital culture, helps transform sustainability values into tangible practices within the organization. Effective GTL is capable of managing the negative impacts of technology use, such as by creating a balanced work environment between technology usage and human interaction. The intensity of GTL must be adjusted to be more effective in moderating the relationship between E-HRM and GDC to achieve sustainability goals. The study offers an understanding of the threshold effect of GTL's role in moderating the influence of E-HRM on GDC as well as in the relationship between GDC and sustainability performance. The threshold effect, which takes the form of an inverted U-shape, indicates diminishing returns in the interaction among GTL, E-HRM, GDC, and sustainability performance.

Practical implications

Higher education institutions can use E-HRM (Electronic Human Resource Management) to enhance sustainability practices. Through the digitization of HR systems, institutions can accelerate communication and improve efficiency in managing human resources, while also reducing paper usage and other physical resources. Effective E-HRM will assist universities in implementing green initiatives in a more structured manner. Sustainability-focused transformational leadership is crucial in driving the adoption of E-HRM and in developing a Green Digital Culture at various levels within the organization. Universities should focus on developing leaders with a green orientation who can inspire and motivate organizational members to implement environmentally friendly practices. Leaders must consider the psychological conditions and workload of staff to ensure that the use of E-HRM does not lead to stress or information overload. The study provides higher education institutions with an early empirical signal that transformational leadership does not always have a linear impact at various levels, allowing them to anticipate this effect.

Limitations for further research directions

This study is limited to higher education institutions in Indonesia, which may have unique characteristics compared to the global context. It is acknowledged that there are limitations in generalization due to the research context within Indonesia's high-power distance culture, the sample drawn from private higher education institutions, and the nonlinear moderating findings (inverted U-shape or threshold effect), which tend to be sensitive to the estimation model. Nevertheless, the study contributes theoretically by highlighting the concept of diminishing returns in designing E-HRM for sustainability performance, positioning GTL as a moderating variable and GDC as a mediating variable between E-HRM and sustainability performance. It also encourages further examination of threshold effects in both developed and developing countries, within institutions that have flat structures as well as those with hierarchical structures, and in public as well as private organizations.

Therefore, future research is encouraged to explore this relationship in different sectors, such as business or government, to better understand the broader implications. Additionally, future studies could investigate how leadership intensity can be adjusted to fit organizational contexts to maximize its influence on Green Digital Culture and sustainable performance. Future research should also focus on exploring cultural configurations within the higher education context, especially about sustainability. Furthermore, studying the dark side of E-HRM is crucial for future research, as this aspect presents challenges that need to be addressed through the development of appropriate research approaches.

Uncited references

[18,26,28,47,90].

CRediT authorship contribution statement

Daniel Kisahwan: Investigation, Formal analysis, Conceptualization. **Deden Komar Priatna:** Resources, Project administration, Data curation. **Winna Roswinna:** Visualization, Validation, Supervision. **Alex Winarno:** Writing – review & editing, Validation, Methodology, Conceptualization. **Deni Hermana:** Writing – original draft, Software, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper

Data availability

Data will be made available on request.

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