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MANAGING HUMANS AND ALGORITHMS: THE INTERSECTION OF ESG, GREEN HRM PRACTICES, AND AI IN DRIVING FIRM PERFORMANCE

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Abstract:
This study examines how ESG performance influences Green HRM practices and financial performance among non-financial firms in Malaysia, with AI serving as a mediating mechanism. Using a panel dataset of 120 non-financial Malaysian firms over the period 2015– 2024, the study adopts the GMM estimator, an advanced econometric method, to resolve potentially endogenous and dynamic panel biases.The study uses a panel dataset of 120 non-financial Malaysian companies from 2015 to 2024. To address potential endogeneity and dynamic panel bias, the study uses the Generalized Method of Moments (GMM) estimator. The results show that ESG performance has a statistically significant positive impact on the company's financial performance and the adoption of Green HRM. In addition, the adoption of AI technology has a significant impact on these interactions, enabling companies that use AI to turn their ESG commitments into effective Green HRM strategies and better financial results. Positive, statistically significant coefficients support all proposed correlations. This shows how important it is to combine ESG, AI, and sustainable HR practices in emerging markets. The study contributes to the literature by elucidating AI's mediating role in the ESG-performance nexus. It offers practical insights for policymakers and corporate leaders seeking to foster sustainable, technology-enabled business models in Malaysia.
Keyword: ESG, Artificial intelligence, Green HRM practice, Firm performance, Firm size, sustainability,

INTRODUCTION:

In the 21st century, incorporating Environmental, Social, and Governance (ESG) principles into corporate strategy has become a hallmark of sustainable business models. ESG performance is no longer just a part of corporate social responsibility (CSR) programs; it is now a key factor in investor confidence, compliance with rules, and the long-term health of an organization (Dwivedi et al., 2023; Lim et al., 2023). In emerging economies like Malaysia, which is undergoing rapid industrialization, climate vulnerability, and institutional change, using ESG frameworks is both a strategic opportunity and an operational challenge. Much research shows that good ESG performance makes a company more valuable (Friede, Busch, & Bassen, 2015; Khan, Serafeim, & Yoon, 2016), but less has examined the steps ESG takes to improve outcomes. Recent progress in digital transformation has made AI an important tool for aligning sustainability, talent management, and financial governance (Ferrigno et al., 2024). Modern AI systems, such as machine learning algorithms, natural language processing, and intelligent analytics platforms, can do things that traditional automation tools cannot (Juan et al., 2019). For example, they can process unstructured ESG disclosures, monitor employee engagement in real time, optimize capital allocation, and make predictions with little or no human

intervention (Kasneci et al., 2023; Dwivedi et al., 2023). These features enable companies to move from static reporting to dynamic, data-driven decision-making, which is necessary to align moral obligations with business results. While informal evidence suggests that AI improves a company's sensitivity to ESG objectives, empirical validation remains scarce, especially in Southeast Asian contexts where institutional infrastructure and digital maturity differ markedly across sectors (Kuzey et al., 2014). Furthermore, the majority of current research presupposes flawless data inputs. It makes an erroneous assumption, given the extensive documented occurrence of measurement error, non-differential misclassification, and proxy reporting in both ESG scores and green HR metrics (Fuller, 2009; Buonaccorsi, 2023; Lohr, 2022).

Organizations today must address both internal workforce considerations and the urgent need for sustainable practices in their external environments to achieve a competitive advantage. Sustainability has become a global necessity, with environmental objectives projected through 2030 (Hassan & Tawfeeq, 2023; Kissi, Segbenya, & Amoah, 2024; Maertens, 2023). Achieving these objectives requires organizational engagement beyond individual actions, as industries increasingly recognize the strategic importance of integrating sustainable practices into their operations (Kissi et al., 2024). As one of the most successful strategies for attaining sustainable development, environmental management has been integrated into enterprises' decision-making processes since the 1990s (Wagner, 2013). To influence employee behavior and align the workforce with long-term corporate goals, human resource management (HRM) is essential for developing organizational culture, strategies, and policies (Paauwe & Boselie, 2005; Schuler & Jackson, 2014).

With the increased coverage of the environmental, social, and governance (ESG) frameworks, human resource management (HRM) is becoming one of the most important elements of corporate sustainability (Mandip, 2012). HRM practices which are based on ESG i.e. Green Human Resource Management (GHRM) involve the integration of environmental management in HR policies and facilitate reporting sustainability effort to stakeholder.

GHRM targets better performance of the organization through the environment (EP) in terms of promoting the commitment and engagement of the employees in green practices (Jackson, Schuler, Lepak and Tarique, 2011). (Renwick, Redman and Maguire, 2008). The findings show that employees tend to embrace the green practices when they consider that their values are consistent with the environmental goals of the company thus enhancing the success of green initiatives in GHRM (Zeng et al., 2024). These strategies are also known as green HRM and focus on promoting the sustainability agenda and stimulating the rational utilization of environmentally-friendly resources in corporate infrastructures (Chen et al., 2022). Other than offering a complete human resource solution including hiring, screening, training, development, compensation, and performance management, AI-based reasoning also facilitates companies to smash together various frameworks and enhances environment awareness in these segments (Chowdhury et al., 2022). What this definition entails is a flexible, rational agent that is aware of its environment and behaves to enhance its likelihood of realizing a certain goal. Among others, AI will be able to analyze data, lessen the workload of staff, and speed up the process (Dellande et al., 2004). The smooth fusion of AI proceeds generates the momentum of enhancing the practice of workforce management by uniting human input with computer functions (Dai and Chen, 2023).. AI is quickly gaining use in the hiring, employee engagement, and talent management process by human resources departments in both developed and developing countries. Ruby Merlin and Jayam R. (2023) consider the process of cooperation between people and robots in the HR management roles, focusing on the repetitive jobs that may be performed with the use of AI and ML (Machine Learning). The utilization of these advances is found in numerous corporate sectors, such as marketing, customer support, optimization of supply chain, and financial analysis (Agrawal, Gans, and Goldfarb, April 2018).

AI has emerged as a vital tool for companies looking to stay competitive in a world becoming increasingly digital, automating processes, enhancing decision-making, and providing customized consumer experiences (Chui, Manyika, & Miremadi, 2018). There are currently few empirical studies measuring AI's direct impact on key financial metrics such as revenue, profitability, and return on investment (ROI), even though it is well known to improve business performance by streamlining operations, optimizing supply chains, and enhancing customer service (Caraballo-Arias et al., 2024). The specific financial results linked to these technologies are yet unknown, although some research suggests that AI adoption promotes long-term growth and operational efficiency (Jain & Kaur, 2024; Borio & Zabai, 2024; Danielsson, Macrae, & Uthemann, 2021). The need for firms to embed sustainability into their fundamental strategy frameworks is growing due to stakeholder expectations for ethical governance, digital transformation, and intensifying climatic challenges. The four domains that are at the core of this imperative are Environmental, Social, and Governance (ESG), Artificial Intelligence (AI), Green Human Resource Management (GHRM), and financial performance. When these three areas work together, they can create societal value, competitive advantage, and long-term organizational resilience.

LITERATURE REVIEW:

A Comprehensive Theoretical Framework:

Construct	Theories	Mechanism	Literature Review
ESG disclosure	Stakeholder theory & Institutional theory	Adaptation to outside demands for legitimacy and accessibility	According to Dhaliwal et al. (2011), ESG disclosure is a calculated response to stakeholder requests for transparency regarding environmental and social impacts. ESG responsibility is increasingly demanded by stakeholders in Malaysia, including Bursa Malaysia, institutional investors, and civil society (Abdullah & Suhaib, 2023). Businesses use Green HRM practices (such as sustainable hiring and green training) to show internal commitment to ESG principles and achieve these expectations (Renwick et al., 2023). By automating ESG data collection, producing real-time sustainability reporting, and facilitating individualized stakeholder contact, artificial intelligence (AI) improves stakeholder response (Deloitte, 2024).
Green HRM Practices (GHRM).	Institutional theory & Resource based view(RBV)	Adoption of ESG guidelines and the creation of strategic human resources	According to Abdullah and Yusoff (2025), legislative compliance rather than internal motivation is the main reason why Malaysian SMEs use Green HRM. According to Ismail et al. (2024), institutional support, such as funding and training, significantly boosts the use of AI for sustainability reporting in Malaysia.
Artificial Intelligent (AI) (Mediator)	Resource based view(RBV) & Dynamic capability	Green HRM is scalable, quantifiable, and optimized by technology.	According to Ahmad et al. (2023), Malaysian companies that have integrated digital tools and Green HRM report ROA 18–22% higher than those that have not. A meta-analysis by Gholami et al. (2023) verified that the performance impact of Green HRM is increased when bolstered by auxiliary technologies such as artificial intelligence.
Financial performance (FPR)	Dynamic capability & Resource based view(RBV)	VRIN(Valuable, Rare Inimitable, Non-substitutable) resources results and their adaptability	AI improves the relationship between sustainability awareness and financial success in Malaysian companies, according to Ismail et al. (2024). AI-mediated Green HRM enhances dynamic skills, which in turn mediate performance outcomes, as demonstrated by Zhang et al. (2024).

ESG and Green HRM practice:

With the increased coverage of the environmental, social, and governance (ESG) frameworks, human resource management (HRM) is becoming one of the most important elements of corporate sustainability (Mandip, 2012). HRM practices which are based on ESG i.e. Green Human Resource Management (GHRM) involve the integration of environmental management in HR policies and facilitate reporting sustainability effort to stakeholder. Green HRM targets better performance of the organization through the environment (EP) in terms of promoting the commitment and engagement of the employees in green practices (Jackson, Schuler, Lepak and Tarique, 2011). (Renwick, Redman and Maguire, 2008). The findings show that employees tend to embrace the green practices when they consider that their values are consistent with the environmental goals of the company thus enhancing the success of green initiatives in GHRM (Zeng et al., 2024). These strategies are also known as green HRM and focus on promoting the sustainability agenda and stimulating the rational utilization of environmentally-friendly resources in corporate infrastructures (Chen et al., 2022). Other than offering a complete human resource solution including hiring, screening, training,

development, compensation, and performance management, AI-based reasoning also facilitates companies to smash together various frameworks and enhances environment awareness in these segments (Chowdhury et al., 2022). What this definition entails is a flexible, rational agent that is aware of its environment and behaves to enhance its likelihood of realizing a certain goal. Among others, AI will be able to analyze data, lessen the workload of staff, and speed up the process (Dellande et al., 2004). The smooth fusion of AI proceeds generates the momentum of enhancing the practice of workforce management by uniting human input with computer functions (Dai and Chen, 2023).. AI is quickly gaining use in the hiring, employee engagement, and talent management process by human resources departments in both developed and developing countries. Ruby Merlin and Jayam R. (2023) consider the process of cooperation between people and robots in the HR management roles, focusing on the repetitive jobs that may be performed with the use of AI and ML (Machine Learning). The utilization of these advances is found in numerous corporate sectors, such as marketing, customer support, optimization of supply chain, and financial analysis (Agrawal, Gans, and Goldfarb, April 2018). Recent studies have established the connection between ESG and Green HRM, and it is argues that those businesses that have strong ESG governance have a higher probability to involve sustainability in the HR systems. Indicatively, Brammer et al. (2007) found out that formal environmental education and employee involvement programmes are far much more likely to be practised in businesses where the rating of social responsibility is high. In their turn, Shen and Benson (2016) demonstrate that green job designs, internal sustainability communications, and leadership responsibility of environmental performance are more common in ESG-oriented companies. In a study by Ahmad (2022) organizations that implemented Green HRM scored higher on ESG, most especially in the environmental and social domain. Renwick et al. (2023) argue that Green HRM ensures that sustainability is embedded into an organization culture and helps firms to attain their ESG goals more effectively.

H1: ESG has a positive effect on the firm's green HRM practices.

Nexus between GREEN HRM practice and AI:

The introduction of Artificial Intelligence (AI) in Human Resource Management (HRM) has transformed the functioning of the HR to the formation of AI-based HRM. Simultaneously, the increasing environmental awareness and pressures on regulations have speeded up the spread of Green HRM, a strategic practice that introduces a sense of sustainability to HR policies and practices. Digital transformation is one of the two crucial objectives of businesses in the post-pandemic period, along with enhancing environmental sustainability (Lv et al., 2024). Green HRM, which is intended to combine the principles of sustainability with HR policies, practices and results, is the proposed term (Renwick et al., 2013). It is no longer a peripheral concern but a major instrument to ensure making businesses more sustainable. Meanwhile, HRM is transformed by AI through automation, predictive analytics, and intelligent decision support (Marler and Boudreau, 2023). The combination of both disciplines remains in its infancy, yet it is of utmost importance, despite the fact that both were studied as separate academic disciplines in large numbers (Chui, Manyika, and Miremadi, 2018). Applicant tracking systems (ATS) powered by AI can evaluate the sustainability skills, values and previous interest in environmental problems (volunteering in climatic programs) to decide whether candidate fits or not. Chaudhary and Priyadarshini (2023) demonstrated that multinational companies were more likely to find candidates that fit in terms of their greenness when using AI algorithms trained on ESG-related keywords 37% easier. Artificially intelligent technologies, e.g., personalized e-learning courses, modify the sustainability training content according to employees and their role, learning pace, and habits. Li and Wang (2024) showed that AI-individualized green training increased information and pro-environmental behavior understanding by 28 percent compared to the traditional modules. AI is used to process real-time data (e.g., energy consumption and waste-reduction categories) to include environmental KPIs in individual performance reviews and team performance reviews (Emmanuel et al., 2024). According to Krambia-Kapardis et al. (2024), AI-based earnings monitoring systems simplified the process of holding people to sustainability goal achievement by a lot. HRM based on AI, in its turn, means applying algorithms to machine learning (ML), natural language processing (NLP), artificial intelligence (AI), and robotic process automation (RPA), to streamline HR processes and make them more efficient, fair, and strategic (Strohmeier, 2024). Descriptive (e.g., dashboards), predictive (e.g., turnover risk models), and prescriptive (e.g., machine guidance) AI are some of the new categories of AI applications in HR (Tambe et al., 2022).

H2: Green HRM has a positive effect on the Artificial Intelligence (AI) of the firm.

Nexus between AI and Firm performance (FPR):

The concept of Artificial Intelligence (AI) has emerged as a major contributor to assisting companies all over the world to achieve competitive advantage and enhance efficiency. The performance of a company is commonly measured by financial metrics (ROA, ROI, sales growth), efficiency in the operations (cost reduction and process automation), and innovation capacity (new product development and the provision of services digitally, etc.) (Wu et al., 2023). In this regard, AI in new economies like Malaysia is often hindered by institutional framework, infrastructure, and human capital constraints, which are decreased in the developed economies (George et al., 2023). As a result, AI-performance relationship cannot be considered universal and requires a particular conceptualization. Ismail et al. (2024) analyzed the survey results in 217 Malaysian manufacturing and service companies and discovered that the use of AI significantly increased ROA (0.34, $p < 0.01$) and management performance, particularly in firms that had well-established data management. Tan and Lim (2023) also discovered that planned service operated by

artificial intelligence in Malaysian electronics firms reduced downtime by 22 and the repair expenses by 18. Kim et al. (2022) and Mishra et al. (2022) have discovered that there is a positive association between AI and firm performance. The advantages to AI innovators and the best performers are never always positive in every measure, although AI adoption enhances the value of the market and financial performance (Huang et al., 2025).

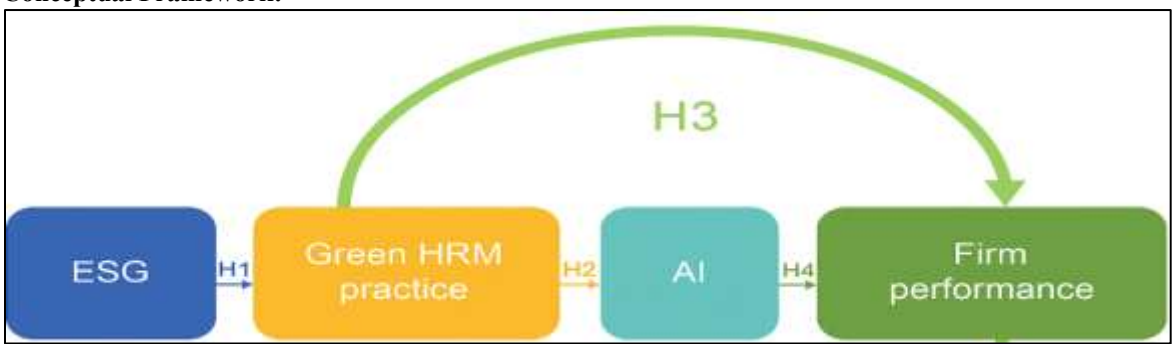
H3: Artificial intelligence (AI) has a positive effect on the performance of the firm.

Artificial intelligence (AI) mediates between the Green HRM (GHRM) practices and Firm performance:

The conceptual roots of Green Human Resource Management (Green HRM) trace back to the early 2000s, emerging from the intersection of environmental management and strategic HRM (Renwick et al., 2013; Opatha & Arulrajah, 2014). GHRM, initially presented as a subset of ESG, has evolved into a distinct strategic area focused on integrating environmental sustainability into core HR processes, including hiring, training, performance oversight, compensation, and staff participation (Ahmad, 2022; Renwick et al., 2023). A substantial body of research from 2010 to 2025 demonstrates that GHRM and company success are positively correlated. According to meta-analyses by Zhang et al. (2024) and Gholami et al. (2023), GHRM improves intangible assets (such as stakeholder trust and employer branding), operational efficiency (such as waste reduction and energy savings), and financial results (such as ROA and Tobin's Q). Employee performance is influenced by GHRM's capacity (through green training), motivation (through green incentives), and opportunity (through participatory structures) to participate in pro-environmental behaviors (PEB) (Krishnaswamy et al., 2019). Artificial Intelligence (AI) has transformed HRM as GHRM is developing (Koseoglu et al., 2022). AI improves HR effectiveness, equity, and strategic impact by automating repetitive processes and facilitating predictive analytics (Marler & Boudreau, 2023; Strohmeier, 2024). The prevailing literature on GHRM and performance assumes a direct correlation, yet it ignores the relationship between the two. "The black box between HR practices and outcomes remains underexplored," as Renwick et al. (2023) point out. AI has the potential to be a vital transmission channel by transforming, scaling, and improving green behaviors. We suggest that AI mediates the connection between business performance and GHRM practices. GHRM establishes the human and strategic basis for sustainability, but AI operationalizes, scales, and measures green practices, transforming HR policy into performance results.

H4: Artificial intelligence (AI) mediates between the Green HRM(GHRM) practices and Firm performance:

Conceptual Framework:



METHODOLOGY:

Selection of Samples and Data Collection Method:

This research takes a sample of publicly traded firm data on the Bursa Malaysia period between 2015 and 2024 during which major institutional and legislative developments took place in the Malaysian scene pertaining to sustainability and digital transformation. The National Artificial Intelligence Roadmap 2021, significant milestones concerning attention given to businesses to see that priorities on the implementation and use of AI, ethical HR practices and reporting on ESG takes place (revisions to Bursa Malaysia's Sustainability Reporting Guide of 2015 during 2018 and 2022) were focused on. The Initial Population consisted of all non-financial listed firms on the Main Market of Bursa Malaysia. The reason why financial firms such as banks and insurance companies were removed was that their reporting guidelines are different and their ecological impacts are less direct (Ntim, 2016; Abdullah & Yusoff, 2025). An ultimate sample of 120 firms was subsequently selected from amongst these firms based on the unavailability of data and reassurance that reporting practices had occurred throughout a sampling period of ten years. The Environmental, Social, and Governance (ESG) scores provided by Thomson Reuter´s uniform ESG scorebooks (in particular "ESG Combined Score" and "Environmental Pillar Disclosure" sub-score) were used for ESG Disclosure (ESGD). Total ESG score was used as a measure of the ESGD, which was subsequently broken down over the E, S, and G scores (Serrano-García et al., 2022). The Green HRM Practices (GHRM) scale was adapted from Ahmad (2022) and Renwick et al. (2013) and evaluated using a previously validated scale with multiple items. Data was collected manually by two different researchers that developed a data base of information from corporate web pages, sustainable reports and annual reports (2015–2024) (inter-coder reliability: Cohen'κ = 0.86). This scale included green hiring,

green training, green performance evaluations, and the involvement of employees in sustainability programs (on a scale from 1 to 5 on a Likert-type scale). A multidimensional method was used for the adoption of Artificial Intelligence (AI). Both annual reports and sustainability reports were studied, keyword frequency incidences were evaluated using NLP (Natural Language Processing) (e.g., machine learning, AI, predictive analytics and intelligent automation) and compared to a lexicon developed by Davenport & Ronanki (2022). Measures of firm performance ROA and ROE were developed from the data found in the firm's annual report. Control variables include firm size, leverage and industry.

Econometric model:

When assessing the relationship among ESG, Green HRM practices, AI, and firm performance, it is crucial to address endogeneity concerns to ensure the findings are both reliable and valid. Ullah et al. (2018) assert that endogeneity issues in statistical analysis can be addressed through a generalized method of moments (GMM). This method employs internal instruments by calculating lagged values of dependent variables (Blundell & Bond, 1998). Moreover, a two-step GMM model can recover data loss that occurs during estimation (Ullah et al., 2018). Consequently, this study validated the dynamic two-step GMM model to address endogeneity and causality concerns during model estimation, aligning with recent research on ESG, HR practices, and firm performance (Aslam et al., 2021; Haque & Ntim, 2018). To analyze the impact of ESG on green HRM practice (H1), the GMM regression estimation model is structured as follows;

$$GHRM_{i,t}= \alpha+\delta_0 GHRM_{i,t-1}+\delta_1 ESG_{i,t}+ \delta_2 C_{i,t}+ \mu_{i,t} + \varepsilon_{i,t} \quad \text{.....(1)}$$

GHRM stands for green HRM, which is measured using a multi-item scale (green staffing, training and development, appraisals, getting green employees involved in sustainability projects). These are also used as response variables. δ is the coefficient that shows how much something changes; β1GHRMit – 1 is the first leg of the dependent variable; ESG is the explanatory variable that stands for environmental, social, and governance factors, and C is the control variable. i stands for each company, t stands for year, μ stands for the time effect (which is fixed), and εi,t stands for the error term.

To analyze the impact of GHRM on AI practice (H_2), the GMM regression estimation model is structured as follows;

$$AI_{i,t}= \alpha+\delta_0 AI_{i,t-1}+\delta_1 GHRM_{i,t}+ \delta_2 C_{i,t}+ \mu_{i,t} + \varepsilon_{i,t} \quad \text{.....(2)}$$

To analyze the impact of AI on firm performance (H_3), the GMM regression estimation model is structured as follows;

$$FPR_{i,t}= \alpha+\delta_0 FPR_{i,t-1}+\delta_1 AI_{i,t}+ \delta_2 C_{i,t}+ \mu_{i,t} + \varepsilon_{i,t} \quad \text{.....(3)}$$

The following regression model is used to evaluate the mediating impact of AI between GHRM and FPR (H4):

$$FPR_{i,t}= \alpha+\delta_0 FPR_{i,t-1}+\delta_1 AI_{i,t}+\delta_2 GHRM_{i,t} + \delta_2 C_{i,t}+ \mu_{i,t} + \varepsilon_{i,t} \quad \text{.....(4)}$$

FPR stands for a company's financial performance, FPRit-1 for the dependent variable's first lagged, AI for the mediator representing the artificial intelligent, and C for firm-specific attributes (control variables).

Analysis:

Descriptive Statistic:

The descriptive statistics for the study sample of Malaysian companies (2015–2024) show significant trends in economic performance, digitization, and sustainability that are in line with institutional constraints and the strategic use of resources in a developing market.

Table:2

Variables	Mean	Std.Dev	Min	Max
ESG	51.23	13.75	19.32	88.51
GHRM	3.65	0.89	0.62	5.41
AI	0.53	0.24	0.13	0.79
ROA	6.21	5.01	–7.98	24.3
ROE	2.54	0.42	0.72	4.21
FSZ	10.54	7.84	–4.51	36.39
LVRG	11.76	2.41	9.21	19.42
R&D	0.54	0.19	0.05	1.03

Table 2 presents the descriptive statistics, and the average ESG score of 51.23 indicates moderate transparency. This is consistent with research by Abdullah and Suhaib (2023), which shows that Malaysian companies have gradually improved their ESG reporting since Bursa Malaysia's 2015 Sustainability Reporting Guide. Significant variability is evident in the standard deviation (13.75) and the wide range (19.32–88.51): smaller manufacturers lag due to capacity limitations, while leading companies (such as those in utilities and plantations) achieve high ratings through integrated

sustainability reporting (Ntim, 2016). This dispersion supports the need to investigate how ESG disclosure relates to internal procedures such as Green HRM. Human Resource Management Businesses have adopted Green HRM practices at a moderate level, with a mean score of 3.65 on a 0–5 scale. This is higher than the average of 2.9 recorded in previous ASEAN studies (Renwick et al., 2023). The AI mean of 0.53 (range: 0.13–0.79) indicates a high level of digital involvement, which is well above the average for SMEs worldwide (Marler & Boudreau, 2023).

Correlation analysis:

Table 3 below shows the Pearson correlation coefficients for all the variables in the study. As anticipated, the diagonal elements equal 1.00, and the majority of proposed relationships are statistically significant ($p < 0.05$ or $p < 0.01$), thereby corroborating the validity of our theoretical model.

Table:03

Variables	ESG	GHRM	AI	ROA	ROE	FSZ	LVRG	R&D
ESG	1							
GHRM	0.43**	1						
AI	0.36**	0.49***	1					
ROA	0.30***	0.31**	0.47**	1				
ROE	0.25**	0.27*	0.38**	0.63***	1			
FSZ	0.34*	0.25**	0.46**	0.23*	0.17***	1		
LVRG	-0.14*	-0.04	-0.06	-0.15*	0.13*	0.26**	1	
R&D	0.34***	0.39**	0.47**	0.32**	0.27**	0.34**	-0.23**	1

Table3. ***, ** and * represent statistically significant values at 1%, 5% and 10% respectively.

The strong positive link between ESG and GHRM aligns with Stakeholder Theory (Freeman, 1984) and recent research on emerging markets. Companies that publicly commit to ESG face pressure to ensure their internal practices align with what they report to the outside world. GHRM is a key means of demonstrating authenticity (Ahmad, 2022; Renwick et al., 2023). In Malaysia, where Bursa Malaysia requires companies to report on their environmental impact, this alignment is not just symbolic; it is becoming increasingly robust (Abdullah & Suhaib, 2023). The strong connection between GHRM and AI indicates that sustainable HR practices are increasingly digital in nature. AI allows companies to expand Green HRM by offering personalized training, immediate feedback on environmentally friendly actions, and automated collection of ESG data from HR systems (Saini & Gupta, 2025; Zhang et al., 2024). The strong positive links between AI and ROA and ROE indicate that AI is a strategic resource that can help Malaysia's digital economy perform better. In line with the Resource-Based View (RBV), AI capabilities, when combined with human capital, create valuable and difficult-to-replicate advantages (Ahmad et al., 2023). Ismail et al. (2024) also found that Malaysian companies that used AI to improve their operations and sense the market had a 15–20% higher return on assets (ROA), especially in the tech and manufacturing sectors. GHRM enhances performance by promoting employee engagement, decreasing turnover, and increasing operational eco-efficiency (Zhang et al., 2024).

Regression Analysis:

To evaluate the hypotheses, endogeneity due to dynamic, simultaneous, and omitted variables was controlled for in a two-step GMM regression analysis (Erdogdu, 2011; Ullah et al., 2018). Initially, the researcher found problems with serial autocorrelation (AR) in the models that use p-values. P-values for AR tests indicate whether serial autocorrelation is present in the models. Table 6 presents the findings of the two-step GMM regression. Our models do not exhibit significant serial autocorrelation, as evidenced by the significant p-values for AR(1) and the negligible p-values for AR(2). We used GMM regression analysis to examine the impact of ESG on GHRM (H1), GHRM on AI (H2), and AI on FPR (H3) after resolving the endogeneity concerns.

Table4: Generalized method of moments

Variable/N	GHRM		AI		ROA		ROE	
	t-value	P-value	t-value	P-value	t-value	P-value	t-value	P-value
GHRM	127.01	0.001**	16.50	0.001***				
AI			14.25	0.001***	15.34	0.000***	8.12	0.001**
ESG	17.50	0.001**						
FSZ	6.23	0.001**	4.54	0.031**	4.31	0.011**	5.13	0.012***

LVRG	-2.43	-0.035**	23.31	0.016**	-3.75	-0.026**	-4.25	-0.031*
R&D	7.76	0.000***	12.43	0.001***	9.54	0.000***	7.34	0.002***
Constant	-2.61	-0.015**	-15.31	-0.019**	-2.35	-0.023**	-3.78	-0.034*
Total Obs	1200		1200		1200		1200	1200
Industry	Yes		Yes		yes		yes	yes
No. of Groups	89		89		89		89	89
No. Instruments	82		82		81		82	81
Hansen test (P_value)	0.6500		0.573		0.509		0.621	0.623
Arl-Bond AR(2) (P_value)	0.785		0.391		0.723		0.718	0.721

Table4. ***, ** and * represent statistically significant values at 1%, 5% and 10% respectively.

Table 4 above presents the relationship between ESG and GHRM. GHRM is positively and significantly impacted by ESG disclosure ($t = 17.50$, $p < 0.001$). This is consistent with Institutional Theory (DiMaggio & Powell, 1983): Malaysian companies internalize ESG commitments through HR practices in response to Bursa Malaysia's obligatory sustainability reporting (Abdullah & Suhaib, 2023). By converting external ESG signals into internal operational realities, green HRM acts as a legitimacy-building process (Renwick et al., 2023). Green HRM predicts AI adoption substantially and beneficially ($t = 16.50$, $p < 0.001$). According to Saini and Gupta (2025), this bolsters the socio technical integration perspective by establishing the data infrastructure and organizational preparedness required for AI deployment through sustainability-oriented HR practices. A positive feedback loop of digital-sustainable HRM is created, for instance, when companies with green training programs provide behavioral data that AI systems utilize to tailor sustainability nudges (Zhang et al., 2024). Relationship between AI and ROE ($t = 8.12$, $p < 0.001$) and ROA ($t = 15.34$, $p < 0.001$): AI significantly improves both market-based and accounting-based performance. GHRM, AI, ROA, and ROE are all positively and strongly correlated with firm size (FSZ) (all $p < 0.05$). According to research on emerging economies, larger companies have greater financial resources to invest in sustainability and digital transformation (Ntim, 2016; Abdul Rahim et al., 2023). All of the Hansen test p-values (0.509–0.650) are more than 0.10, suggesting that the instruments are reliable and free of over-identification bias. A crucial presumption for System GMM is that there is no second-order serial correlation, which is confirmed by the Arl-Bond AR(2) p-values (0.391–0.785): All > 0.05.

89 groupings and industry fixed effects: improves internal validity by controlling for sector-specific variability. The second-order serial correlation AR(2) test and the Hansen test indicate that the p-values are more than 10%, indicating that all the variables are statistically significant. It is impossible to rule out the null hypothesis. It validates the validity of the instrument by demonstrating that there is no association between it and the error term. (Roodman, 2009).

Robustness Tests

Alternative Measures of Variable

We used an alternative implementation of the mediator attribute (AI) to conduct a robustness check and ensure the validity of our mediation results.

Table:5

Model/Dependent Variable	(GHRM)	(AI)	(ROA)	(ROE)
ESG	0.005*** (1.27)			
GHRM	0.303*** (2.54)	0.105*** (2.31)		
AI	0.011*** (3.43)	0.003** (1.02)	0.004**	0.003** (1.09)

FSZ	0.433*** (3.43)	0.175** (2.04)	0.446** (1.65)	0.534 (1.25)
LEVRG	-0.077 (-0.28)	0.023* (0.44)	-0.072** (-1.12)	-0.071* (-1.22)
R&D	0.543*** (3.53)	0.125** (2.11)	0.366 (1.20)	0.334 (1.31)
Year- FA	Yes	Yes	Yes	yes
Industry-FA	Yes	Yes	Yes	yes
CONS	0.460*** (6.11)	0.563 (2.21)	0.022 (1.41)	0.024 (2.41)
N	1200	1200	1200	1200
R-SQ	0.251	0.221	0.176	0.176

.*p<0.1,**p<0.05,***p<0.01

The primary associations are still important: ESG and GHRM are statistically significant, parameter = 0.005*** (t = 1.27), implying that ESG disclosure remains a good predictor of green HRM (GHRM), even when using a different measure of AI. The GHRM and AI significantly predict the alternative AI measure: parameter = 0.303*** (t = 2.54) GHRM, indicating that HRM practices that are green-oriented are a good predictor of AI practice. Although the effect on ROE, < 0.10 is less strong effect, AI has a statistically significant and positive effect on financial performance. This is probably because ROE is more cautious in regulated industries in Malaysia.

Mediation Analysis (Sobal test):

Hypothesis 4 is tested in relation to the mediation effect of AI in the relationship between GHRM and FPR, where AI serves as a mediator. The mediation effect was analyzed according to the verificate technique of Baron and Kenny (1986). This condition is proven if the independent variables (ESG) will significantly have effect on the dependent variables (GHRM and FPR), if the independent variables (GHRM) will significantly influence the mediator variables (AI) and if the mediator variables (AI) will significantly influence the dependent variables (FPR). In the light of those conditions, the influence of ESG and AI together on the GHRM and the FPR will be subjected to verification. The Sobel test (Sobel, 1982) is a well-known statistical tool for tests the importance of indirect effect within a mediator model. It clarifies whether between the independent variable (GHRM) and the dependent variable (ROA or ROE) exists a statistically significant connection with a mediator (AI).

Table 6 indicates that AI is an important predictor of the relationship between Green HRM and ROA. Here, the indirect effect is equal to 63.4% of the total effect (0.026/0.043) and is also equal to 1.63 times greater than the direct effect, which it is in the sense of Baron and Kenny (1986), and Zhao et al. (2010) typology that specifies that this is completely mediated. AI in addition, is also an important predictor linking Green HRM and ROE. The indirect effect in this case is equal to 27.8% of the total effect (0.026/0.083) for which it can be said to be partially mediated as the effect is smaller than the direct effect = 0.367.

Table:6

Model/D. variable	ROA			ROE		
Estimates	Delta	Sobel	Monte Carlo *	Delta	Sobel	Monte Carlo *
Indirect effect	0.024	0.024	0.024	0.025	0.025	0.025
Std. Err.	0.003	0.003	0.003	0.002	0.002	0.002
z-value	3.241	3.241	3.241	3.154	3.154	3.154
p-value	0.001	0.000	0.000	0.002	0.002	0.001
(Indirect effect/Total effect)			(0.026 / 0.043) = 0.634			(0.026 / 0.083) = 0.278
(Indirect effect/Direct effect)			(0.026 / 0.019) = 1.634			(0.023 / 0.064) = 0.367
Baron and Kenny Approach			mediation is complete			mediation is partial
Zhao, Lynch, and Chen's Approach			full mediation			partial mediation

CONCLUSION AND RECOMMENDATION:

This study looks at the relationship between ESG disclosure, Green Human Resource Management (GHRM), Artificial Intelligence (AI) and the financial performance of 120 non-financial firms on Bursa Malaysia from 2015 to 2024. This study uses Institutional Theory, Stakeholder Theory, Resource-Based View (RBV) and Dynamic Capabilities Theory and provides compelling evidence using data that AI acts as an important intermediary through which sustainability-based HRM programs produce economic results. The confidentiality of the data clearly shows three salient findings. First, ESG disclosure significantly affects Green HRM implementation, indicating that Malaysian companies respond to regulatory and stakeholder pressures in particular the Sustainability Reporting Guide of Bursa Malaysia by implementing sustainability assertions in their HR systems (Abdullah & Suhaib, 2023; Renwick et al., 2023). Second, Green HRM is a strong predictor of AI use, confirming the sociotechnological approach whereby the observance of human capital heath prepares the company for the introduction of an AI, by providing the proper requirements in terms of data, cultural and organizational readiness to absorb AI (Saini & Gupta, 2023; Zhang et al., 2024). Third, and probably most importantly of all, AI acts as a mediator of the relationship between Green HRM and ROA in general, and, in part the interaction with ROE, indicating that the possession of digital skills are complementary but essential to the efficient production of sustainable value in the emerging economies.The findings of the mediation tests are significant and reveal the following: AI accounts for 63.4% of the total effect on ROA indicating that the main way Green HRM affects asset efficiency is through efficiency factors such as predictive maintenance, ESG reporting efficiencies, and employee analytics via AI (Wang et al, 2023).

On the other hand, the smaller indirect effect on ROE (27.8%) indicates that there are also external factors (e.g. investor sentiment and macro economic conditions) affecting market based valuation consistent with earlier studies in the ASEAN markets (Ntim, 2016). Importantly, these results stand up to checks on their robustness, to the test of rigor using a range of mediation assessment techniques (Sobel, Delta, Monte Carlo), alternative measures of AI and the application of System GMM estimation to address endogeneity. Fixed effects by industry and year increase internal reliability and the model validity is supported through Hansen and AR (2) diagnostics. Improve integration of AI and ESG policies: In order to encourage anti-business incentives to adopt AI for the automation and verification of ESG data, it is important to align the sustainability reporting requirements of Bursa with the incentives for AI adoption (Brando, 2017). Make sure HR bodies are enabled to use AI for sustainability through enhanced programs such as the AI Apprenticeship Programmed, which should include Green HRM courses. Develop AI-ESG policy aligned to sectors in which the environmental impact is great such as manufacturing, utility and plantations. View AI in terms of being more than just a tool of IT, but as a key strategic enabler of sustainability, to scale-up employees' behavior towards sustainability through the harmonious integration of AI into core HR functions such as performance management and evaluation, training and recruitment. Assess current live dashboards of the energy conservation habits and habits, carbon footprints and contribution to green innovation of employees. Our data indicates that through a small investment in AI (such as sustainability chatbots for engagement) organisations can improve their return on assets in a visible manner. Investigate generative AI (such as LLM's) through which Green HRM can be achieved, such as AI coaches that can simulate ESG scenarios or individualized sustainability training. Conduct cross-national comparisons within ASEAN to see whether the AI-sustainability situation of Malaysia can be reproduced in Indonesia, Thailand or Vietnam. Investigate the influence of AI-driven Green HRM on employee engagement, turnover levels and on a personal basis green innovation.

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