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AI-Enabled HR Practices and Sustainable Business Productivity: The Mediating Role of Workforce Agility

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ABSTRACT

The recent use of artificial intelligence (AI) in human resource management offers opportunities and challenges to promote Sustainable Business Productivity. Despite the investments in technology, the organisations struggle to integrate AI-enabled HR practices in tangible performance outcomes. This study explores the effects of AI in recruitment and selection, AI-based HR analytics, AI-driven employee engagement systems, AI-driven Performance Management, and AI-enabled training and development on Sustainable Business Productivity, with workforce agility as a mediator and automation in HR operations as a potential moderator. A quantitative research design was used, where data were collected from 300 HR professionals and managers using a structured questionnaire. Partial Least Squares Structural Equation Modeling (PLS-SEM) was used for analysis. Results show that the impact of AI-enabled HR practices on workforce agility is quite positive, with the path coefficients ranging between 0.188 and 0.299 ($p < 0.001$). The agility of the workforce, therefore, has a significant impact on the Sustainable Business Productivity ($\beta = 0.500$, $p = 0.001$). Mediation analysis confirmed that workforce agility mediates the relationship among AI-driven engagement system ($\beta = 0.149$, $p = 0.004$), Performance Management ($\beta = 0.117$, $p = 0.004$), training and development ($\beta = 0.094$, $p = 0.009$) and productivity outcomes. The study suggests investing in workforce agility programmes, combining AI with training programmes and automating in balance with the aim of maximum productivity gains.

Keywords: AI-enabled HR Practices, Workforce Agility, Sustainable Business Productivity, HR Automation, Employee Engagement Systems.

INTRODUCTION

The accelerated rise of digital technologies has changed the way organisations manage talent and deliver long-term performance outcomes. Artificial intelligence (AI) in human resource management has moved beyond the

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areas of simple administrative automation to be more strategic in its functions and to provide data-driven insights capable of enhancing decision-making, workforce development, and operational efficiency of the organisation. According to recent studies, Artificial intelligence (AI)-enabled human resources (HR) systems that include predictive recruitment tools, algorithmic performance assessment, digital engagement platforms and personalised learning systems can enable improvements in the accuracy, speed and transparency of HR operations when effectively implemented (Malik et al., 2023; Nawaz, 2024).

Despite these advancements, AI-enabled practices in the HR sector and how they contribute to Sustainable Business Productivity have only been partially understood. Sustainable productivity expands the traditional framework of performance indicators to emphasise long-term value creation, responsible use of resources and continued organisational resilience. It calls for more than just technological adoption and is instead dependent on aligning digital tools with the capabilities of human beings. Studies show that digital technologies provide performance advantages when employees can adapt, learn, and react rapidly to changes in the situation, making workforce agility more important than ever (Alviani, 2024; Sherehiy & Karwowski, 2014).

Workforce agility is the ability of employees to detect the impending change in the market, acquire professional skills, shift roles, and solve complex problems in a dynamic environment. Scholars suggest that agility acts as a key mechanism of action through which HR technologies get translated into organisational outcomes, as agile employees are more capable of using AI insights, working together with digital systems, and translating new information into effective action (Alviani, 2024; Davenport et al., 2010). This implies that the association between AI-enabled HR practices and Sustainable Business Productivity could be indirectly mediated by adaptability at the employee level.

Furthermore, there is a growing level of automation in HR operations that organisations are developing to improve on routine chores and lower administrative burdens. However, the extent to which it is a contextual factor is unclear. While the advantages of automation in business may lead to a boost in productivity and efficiency, automation may undermine the human ADIs if not balanced with the development of human capabilities. This begs the question: do automation technology and/or efficiency increase or reduce the inherent pathways between AI-enabled HR practices, workforce agility, and sustainable productivity (Filippi et al., 2023)?

Given these unresolved issues, there is a strong need to investigate the impact of different AI-enabled HR practices on Sustainable Business Productivity and establish whether workforce agility is a mediating mechanism in these relationships. Understanding these dynamics is key to organisations seeking to use

digital HR innovations and realise long-term performance gains rather than short-term efficiency improvements.

Problem Statement

While practices enabled by AI are becoming common in HR, there is empirical evidence that it has an inconsistent direct impact on Sustainable Business Productivity. Several organisations invest in AI for recruitment, analytics, training, Performance Management, and employee engagement, but there are often no observable productivity improvements as a result. Existing research suggests that the missing explanation link may lie in workforce agility, which allows employees to utilise AI tools effectively. However, the mediating role of workforce agility has not been adequately laid out in different HR technologies. Additionally, the moderating effect that automation has on HR operations is not well understood, so it leaves in doubt whether automation is a complement or weakens the impact of AI-enabled HR practices on agility and long-term productivity. This study fills in these gaps with a comprehensive model of the mediation and the moderated mediation effects.

Research Objectives

- To analyse the direct effects of AI-enabled HR practices, namely AI in recruitment and selection, AI-based HR analytics, AI-driven employee engagement systems, and AI-driven Performance Management, as well as AI-enabled training and development, on workforce agility.

- To measure the direct impacts of these AI-enabled HR practices on Sustainable Business Productivity.

- To assess the mediating role of workforce agility in the HR practices, AI-enabled technologies, and Sustainable Business Productivity relationships.

- To find out whether HR operations automation moderates the relationships between Artificial Intelligence (AI) enabled HR practices and workforce agility.

- To assess whether moderated mediation takes place, which means the indirect effects of the impact of AI-enabled Human Resource Practices on Sustainable Business Productivity through the agility of the workforce, with differing levels of automation.

LITERATURE REVIEW

AI-Enabled HR Practices

Artificial intelligence (AI) for human resource management involves the application of machine learning, predictive analytics, and algorithmic systems in supporting recruitment, training, performance gauging, and engaging employees. Research demonstrates that AI-based recruitment makes the hiring process smarter and results in better hiring choices by a better match between candidate competencies and job requirements and by mitigating human bias (Malik et al., 2023; Nawaz, 2024). Similarly, the HR analytics based on AI gives better workforce planning, actionable insights drawn from the employee data to managers to identify the skills gap, predict turnover, and optimize human capital deployment (Davenport et al., 2010; Budhwar, 2022).

Employee engagement systems using AI are part of the productivity road by also tracking the pattern of sentiments, participation, and collaboration of employees so that individualized interventions and motivational goals could enhance it (Gusti, 2024). AI-driven Performance Management platforms help automate labour evaluations, give real-time performance feedback, and recommend individualised learning opportunities to help employees enhance their performance and enable them to align their performance goals with organisational objectives (Malik et al., 2023; Nawaz, 2024). AN AI-enabled training and development system personalizes the learning pathway based on skill deficiencies, thereby increasing the speed of skill acquisition and employee adaptability (Sherehiy & Karwowski, 2014; Alviani, 2024).

Workforce Agility

Workforce agility is the capacity of employees to readily adapt to shifting work jobs, roles, and environments. It includes learning ability, flexibility, proactivity, and responsiveness to internal and external challenges (Sherehiy & Karwowski, 2014). Empirical studies have shown that AI-enabled human resources practices increase workforce agility through providing timely information, automating routine tasks, and facilitating continuous skill development (Alviani, 2024; Gusti, 2024). Agile workforces are better able to make strategic changes, cope with market disruptions and achieve operational efficiencies, making agility a critical mediator of HR technology and organisational outcomes (Davenport et al, 2010).

Sustainable Business Productivity

Sustainable Business Productivity focuses on the long-term performance and efficiency in the utilisation of resources and is consistent with social and

environmental standards. It incorporates traditional measures of productivity and issues of sustainability to generate lasting value for stakeholders (Harvard Business School Online,2018). Prior research suggests that the productivity of the organisation is driven not only by the technological tools, but also by human and organisational capabilities, such as workforce agility, leadership, and employee engagement (Filippi et al., 2023; Khammadee, 2023). Organisations that bring together AI empowered HR practices and capability development show that they are more adaptive, and more efficient and can achieve sustainable efficiency outcomes in productivity.

Automation in HR Operations

Automation in HR operations is the process of using technology to conduct mundane and administrative operations like performing payroll, managing expenses, and maintaining records. While automation can enhance the level of efficiency, its contribution to workforce agility has multiple facets. Studies suggest that AI-driven HR practices may be complemented by automation, which frees them to work in strategic and adaptive areas. However, a too heavy reliance on automation can decrease opportunities for reflection and the development of skills and learning, which can lead to a weakening of the benefits of AI-enabled HR interventions (Filippi et al., 2023; Budhwar, 2022). Consequently, automation acts as a moderator that may strengthen or reduce the effects of AI practices on workforce agility and sustainable productivity.

Role of Workforce Agility in Mediation

Several studies focus on the mediating role of workforce agility in the relationship between HR technologies and organisational outcomes. AI-enabled HR practices provide value to one's employees, but sustainable productivity arises from employees using these tools comprehensively. Workforce agility enables employees to bridge the AI-to-action gap by turning AI insights into deeds (Alviani, 2024), dealing with changing work dynamics at work and maintaining the workforce's level of performance over the long term (Sherehiy, 2014; Karwowski, 2014; Davenport et al., 2010). Empirical findings indicate that organisations that do not promote agility at the employee level often see poor benefits in terms of productivity despite the use of advanced technologies in HR.

Moderating Role of Automation in HR Operations

Automation may interact with HR practices that are enabled by AI to influence workforce agility. Conditional efforts of research explained that the degree of effectiveness of AI interventions is moreover inconsistent depending on the level of automation that exists within HR processes (Filippi et al., 2023; Khammadee, 2023). When automation assists artificial intelligence-enabled tools

without replacing important human undertakings, it can reduce agility by taking care of administrative burdens and enabling employees to focus on adaptive functionality. Conversely, automated replacements of decision-making functions could reduce the positive impact of AI practices on agility, as a demonstration of the importance of a balanced approach of technology and people.

Theoretical Framework

The theoretical framework for this study combines the Resource-Based View (RBV) theory and the Dynamic Capability Theory to investigate the concept of how HR practices enabled by AI affect Sustainable Business Productivity through workforce agility.

Resource-Based View (RBV)

The RBV argues that organisational resources that are valuable, rare, inimitable, and non-substitutable constitute a sustainable competitive advantage (Barney, 1991; Davenport et al, 2010). AI-enabled HR practices are a strategic resource as they give the organisation the ability to better acquire, develop and retain talent than its competitors. Workforce agility, as an intangible capability, enables organisations to use AI tools to maximise utilisation of human capital to generate ongoing performance improvements, achieving the RBV criteria for competitive advantage (Alviani, 2024).

Dynamic Capability Theory

Dynamic capability theory focuses on the capacity to integrate, build, and reconfigure internal competencies in response to environmental changes in the organisation (Teece, 2014; Filippi et al, 2023). In the HR context, AI-enabled HR practices help organizations get the tools to sense the possibilities, HR data analysis, and implementations to strengthen agility. Workforce agility serves as an agility capability, a dynamic mediating capability between AI-enabled HR tools and sustainable productivity outcomes. Automation in HR operations is an environmental factor or factor one in which the organization is sufficiently structurally positioned to moderate the effectiveness of deployment of these capabilities, consistent with the contingency view of dynamic capabilities (Khammadee, 2023; Budhwar, 2022).

Conceptual Model

The conceptual model for this study can be summarised thus:

- Independent Variables (IVs): The use of AI in recruitment and selection, The use of AI as a form of HR analytics, The applications of AI in employee

engagement systems, The applications of AI in Performance Management systems, The applications of AI in training and development.

- Mediator (M): Workforce agility.
- Dependent Variable (DV): Sustainable productivity of business
- Moderator (Mo): Automation in HR operations.

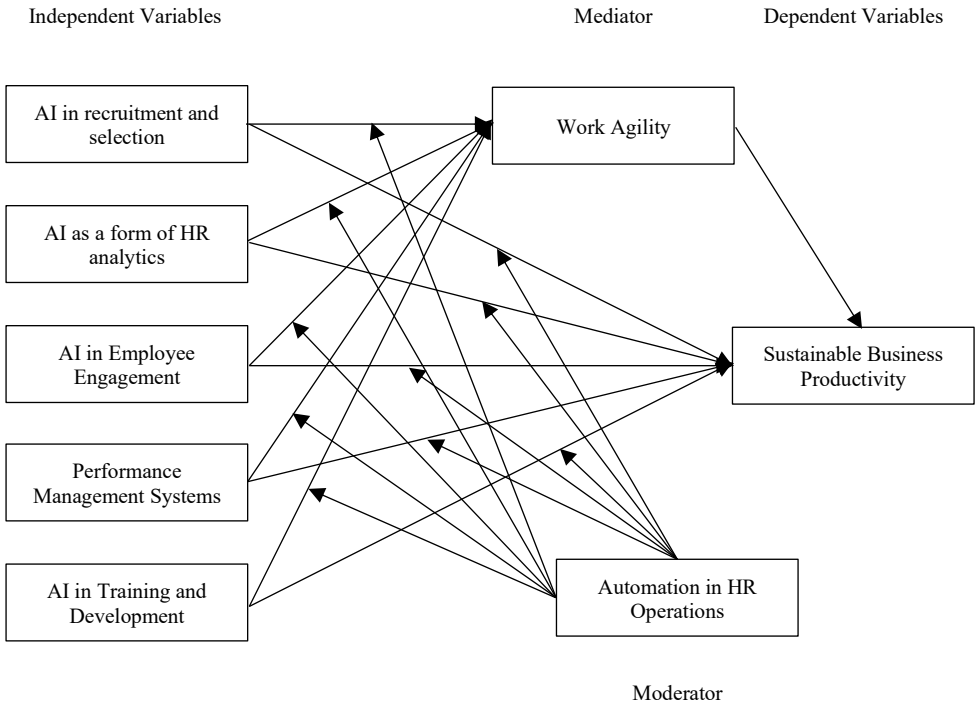


Figure 01: Conceptual Framework

Study Hypotheses

Direct Relations

H_1: The AI in Recruitment & Selection has a significant relationship with Sustainable Business Productivity.

H_2: AI in Recruitment & Selection has a significant relationship with Workforce Agility.

H_3: AI-based HR Analytics has a significant relationship with Sustainable Business Productivity.

H_4: HR Analytics based on Artificial Intelligence has a significant relationship with Workforce Agility.

H_5: AI-driven Employee Engagement Systems have a significant relationship with Sustainable Business Productivity.

H_6: AI-driven Employee Engagement Systems have a significant relationship with Workforce Agility.

H_7: AI-driven Performance Management has a significant relationship with Sustainable Business Productivity.

H_8: Workforce Agility has a significant relationship with AI-driven Performance Management.

H_9: The AI-Enabled Training & Development has a significant relationship with Sustainable Business Productivity.

H_{10}: AI-Enhanced Training & Development has a significant relationship with Workforce Agility.

H_{11}: Automation in HR Operations has a significant relationship with Workforce Agility.

H_{12}: Workforce Agility has a significant relationship with Sustainable Business Productivity.

Mediation (Indirect)

H_{13}: Workforce Agility mediates the relationship between AI in Recruitment & Selection and Sustainable Business Productivity.

H_{14}: Workforce Agility mediates the association between AI-based HR Analytics and Sustainable Business Productivity.

H_{15}: Workforce Agility mediates the relationship between AI-driven Employee Engagement Systems and Sustainable Business Productivity.

H_{16}: Workforce Agility mediates the effect of AI-driven Performance Management on Sustainable Business Productivity.

H_{17}: Workforce Agility mediates the association between AI-enabled Training & Development and Sustainable Business Productivity.

H_{18}: Workforce Agility mediating the relationship between Automation in HR Operations and Sustainable Business Productivity.

Moderation (Interaction)

H_{19}: Automation in HR Operations moderates the relationship between AI in Recruitment & Selection and Workforce Agility.

H_{20}: Automation in HR Operations moderates the relationship between AI-based Human Resources Analytics and Workforce Agility.

H_{21}: Automation in HR Operations moderates the relationship between AI-driven Employee Engagement Systems and Workforce Agility.

H_{22}: Automation in HR Operations moderates the relationship between AI-driven Performance Management and Workforce Agility.

H_{23}: Automation in HR Operations mediates the link between the AI-enabled Training & Development and Workforce Agility.

Moderate Mediation

H_{24}: Indirect effect of AI in Recruitment & Selection on Sustainable Business Productivity through Workforce Agility is conditional on the degree of Automation in HR Operations.

H_{25} The indirect impact of AI-based HR Analytics on Sustainable Business Productivity in the form of Workforce Agility depends on the degree of Automation that exists within HR Operations.

H_{26}: Indirect effect of AI-driven Employee Engagement Systems on Sustainable Business Productivity by Workforce Agility is conditional on the degree of Automation in HR Operations.

H_{27}: The indirect effect of AI drives Performance Management on Sustainable Business Productivity through Workforce Agility, which is dependent on the level of Automation in HR Operations.

H_{28}: The indirect influence of Artificial Intelligence-enabled Training & Development on Sustainable Business Productivity through Workforce Agility is moderated by the level of Automation in HR Operations.

RESEARCH METHODOLOGY

Research Design

This research takes a quantitative research design to empirically investigate the correlations between AI-enabled HR practices, workforce agility, automation of HR operations and Sustainable Business Productivity. A quantitative approach can be used appropriately to assess hypotheses and model latent constructs with structural relationships (Haji Othman, Yusuff, & Md Hussain, 2024). Given the complexity of the conceptual model - multiple independent variables, a mediator, a moderator, and a dependent variable - there is the ability to assess hypotheses as rigorously as possible through the application of structured equation modelling.

Population, Sampling, and Data Collection

The target population for this research includes HR professionals, mid and senior management and employees in organisations implementing AI-enabled HR systems. Using a probability sampling method (e.g., stratified, or simple random sampling), the study seeks to obtain a representative sample to increase generalisability. Similar survey-based approaches have been used in studies of HRM and analytics to gather perceptions and behaviours at a large scale (Elnaqib, provisional 2022; Paul & Khan, 2024). Data will be collected using a self-administrable structured questionnaire including valid scales for all latent variables. Participants will be invited to complete the survey either through an online survey or face-to-face, as much as possible.

Measurement Instruments

All latent constructs (e.g., AI in recruitment & selection, AI-based HR analytics, workforce agility, Automation in HR operations, Sustainable Business Productivity) will be operationalised through multi-item Likert scale measures adapted from prior validated measures. The scales will be assessed for reliability (Cronbach's alpha, composite reliability) and validity (convergent and discriminant validity) when conducting the measurement-model check. This methodological strategy is in accordance with the best practices when conducting PLS - SEM research (Haji Othman et al., 2024).

Data Analysis Method: PLS-SEM

Partial Least Squares Structural Equation Modeling (PLS - SEM) will be applied to assess the measurement and structural models (Hair, Sarstedt, Ringle, & Gudergan, 2017). PLS-SEM is most suitable for the objectives of this study because it will allow for complex models with multiple mediators and moderators, and PLS-SEM does not require normal distribution of data (Haji Othman et al., 2024). The

above analysis will be conducted in two steps: measurement model (reliability, validity) and the structural model (path coefficients, R2, mediating and moderating effects).

Mediation and Moderation Testing

To analyse the mediating role of workforce agility and the moderating role of automation in HR operations, analysis based on bootstrap procedures will be conducted using the PLS-SEM framework. The study will assess for some indirect effects to assess the mediation and interaction terms to explore the moderation based on some already established statistical guidelines (Hagi Ochman et al., 2024). Conditional indirect effects will also be assessed to see if the mediation paths differ depending on levels of automation.

Ethical Considerations

Permission through ethical approval will be obtained from the respective institutional review board prior to data collection. Participation will be voluntary, and informed consent will be sought from researchers and respondents. The survey will ensure anonymity and confidentiality, and data will be securely stored and used for research purposes only. In reporting results, only the aggregated data will be presented to prevent the identification of individuals/organisations.

Limitations of Methodology

While the quantitative cross-sectional approach enables hypothesis testing and model estimation, it may reduce the ability to make causal inferences because of the snapshot data collection process. Longitudinal or mixed-method designs could complement the current approach in future studies to give insights into temporal and richer contextual information (Paul & Khan, 2024). Furthermore, there is the potential for common method bias as the data of all the variables is gathered from the same respondents; statistical remedies (e.g, Harman's single factor test) will be used to overcome this potential risk.

ANALYSES AND INTERPRETATIONS

Table 01: Demographic Profile of Respondents

Demographic Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	180	60
	Female	120	40
Age	20–30 years	90	30
	31–40 years	120	40
	41–50 years	60	20
	51+ years	30	10
Education Level	Bachelor's Degree	90	30
	Master's Degree	180	60
	PhD	30	10
Experience in HR	0–5 years	60	20
	6–10 years	120	40
	11–15 years	60	20
	16+ years	60	20
Organization Type	Private	180	60
	Public	90	30
	Multinational	30	10

Table 01 shows the demographic characteristics of the 300 respondents who participated in the study. Regarding the gender breakdown, there were 180 males (60%) and 120 females (40%), which means that there are slightly more males in HR definite members in the workforce surveyed. The age distribution reveals most of the respondents (40%) are in the age group of 31-40 years of age, followed by 20-30 years 30%, 41-50 years 20% and 51 years and above 10%. This distribution implies that most of the participants were in early to mid-career stages, which is characteristic of professionals actively participating in AI-enabled HR processes.

In terms of educational background, 60% of respondents had a master's degree, 30% had a bachelor's degree and 10% had a PhD. This suggests that those

surveyed were highly educated and ready to work with complex HR technologies. Regarding professional experience in HR, 40% had a work experience of 6-10 years, 20% had a work experience of 0-5 years, 20% had a work experience of 11-15 years, and 20% had a work experience of more than 16 years, indicating a combination of both starting and experienced HR practitioners. Lastly, the organisational type of distribution shows that 60% of the respondents came from private organisations, 30% from public organisation and 10% from a multinational company indicating a diversity of organisational context of AI adoption in HR practices.

Table 02: Descriptive Statistics of Main Variables

Variable	Mean	Standard Deviation	Minimum	Maximum
AI in Recruitment & Selection	3.85	0.72	1	5
AI-based HR Analytics	3.78	0.69	1	5
AI-driven Employee Engagement Systems	3.92	0.71	1	5
AI-driven Performance Management	3.80	0.74	1	5
AI-enabled Training & Development	3.76	0.70	1	5
Automation in HR Operations	3.68	0.73	1	5
Workforce Agility	3.90	0.65	1	5
Sustainable Business Productivity	3.88	0.68	1	5

Table 02 summarizes the descriptive statistics of the main variables of the research, such as the means and standard deviations, minimum and maximum values of the variables. The variable "AI-driven Employee Engagement Systems" had the highest mean (M = 3.92, SD = 0.71), because the respondents considered that engagement systems are the most active practice of AI. Similarly, "Workforce Agility" (M = 3.90, SD = 0.65) and "Sustainable Business Productivity" (M = 3.88, SD = 0.68) also have high mean scores, indicating positive perceptions in terms of agility and productivity outcomes in the organisations adopting AI-enabled HR practices.

Other practices of AI (i.e., AI in recruitment and selection (M = 3.85, SD = 0.72), AI - driven Performance Management (M = 3.80, SD = 0.74), AI - based HR analytics (M = 3.78, SD = 0.69), AI - enabled training and development (M = 3.76, SD = 0.70) - show somewhat lower values of mean but still represent above average adoption. The variable "Automation in HR Operations" had the lowest mean (M = 3.68, SD = 0.73), which implies that automation initiatives were

in place, but may be less common compared to other HR practices enabled by AI. Overall, the descriptive statistics show that the respondents perceive a level of AI integration and workforce agility to be moderate to high, as well as productivity outcomes in their organisations.

Table 03: R Square

	R-square	R-square adjusted
Sustainable Business Productivity	0.147	0.130
Workforce Agility	0.768	0.759

Table 03 shows the results of the R-squared statistics. The percentage of variance of the dependent variable that is accounted for by its predictor variables. Sustainable Business Productivity has an R-squared value of 0.147, indicating that predictors explain 14.7 percent of the variation in Sustainable Business Productivity, resulting in a modest explanatory strength. In comparison, Workforce Agility has a much higher R-squared result of 0.768 - 76.8 percent of Workforce Agility's variation is explained in the model. These figures suggest more influence for the independent variables on Workforce Agility and a more moderate impact on Sustainable Business Productivity.

Table 04: Reliability Analysis

	Cronbach's alpha
AI in Recruitment & Selection	0.974
AI-based HR Analytics	0.971
AI-driven Employee Engagement Systems	0.970
AI-driven Performance Management	0.971
AI-enabled Training & Development	0.969
Automation in HR Operations	0.963
Sustainable Business Productivity	0.981
Workforce Agility	0.972

In the table 04, the results of the reliability assessment show that all constructs have excellent internal consistency. Cronbach's alpha results of 0.963 to .981 are all well above .70, which is considered the cutoff score. This means that the measurement items for each construct consistently represent the construct. The

organisation with the most reliability is Sustainable Business Productivity (0.981), and the least reliable (although still reliable) is Automation in HR Operations (0.963). Thus, the items in the scale used in the study are reliable.

Table 05: Residual Correlations

	Sustainable Business Productivity	Workforce Agility
Sustainable Business Productivity	1.000	-0.039
Workforce Agility	-0.039	1.000

The residual correlation table shows the unexplained variance relationship between Sustainable Business Productivity and Workforce Agility after accounting for all the predictors. The correlation value of -0.039 shows a very weak, insignificant negative relationship, which implies that the model has explained most of the systematic relationship between these variables and that there is no worrisome residual association, indicating that the model is not a good fit.

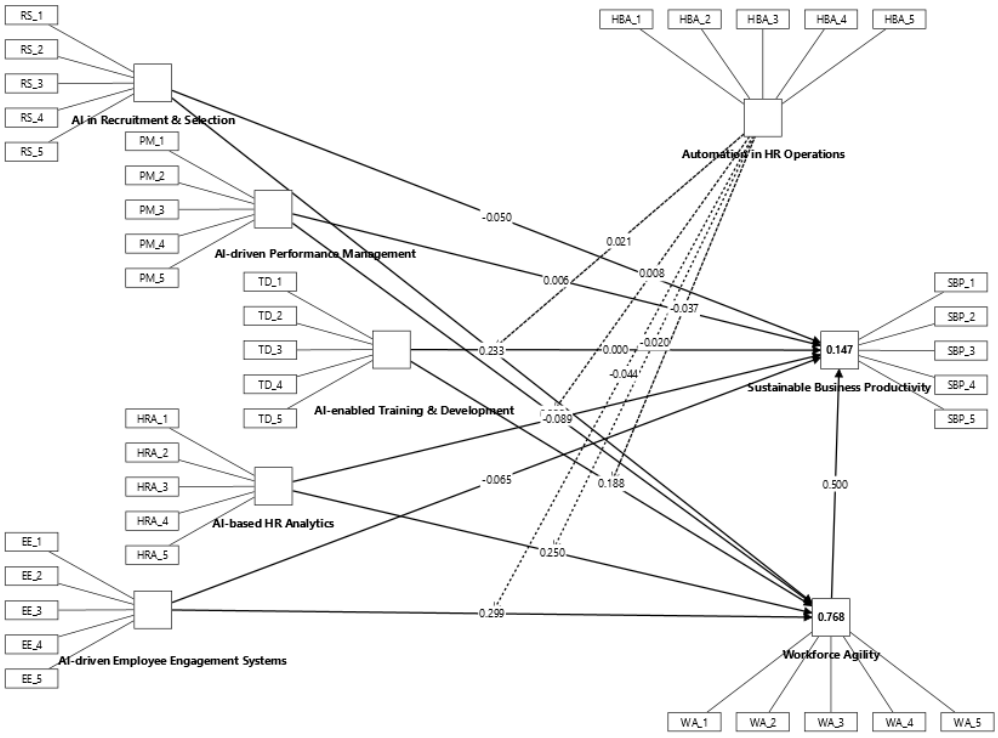


Figure 02: Structural Model

Table 06: Path Coefficient

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
AI in Recruitment & Selection -> Sustainable Business Productivity	-0.050	-0.050	0.051	0.974	0.330
AI in Recruitment & Selection -> Workforce Agility	0.233	0.232	0.034	6.940	0.000
AI-based HR Analytics -> Sustainable Business Productivity	-0.089	-0.086	0.081	1.108	0.268
AI-based HR Analytics -> Workforce Agility	0.250	0.251	0.034	7.369	0.000
AI-driven Employee Engagement Systems -> Sustainable Business Productivity	-0.065	-0.059	0.046	1.400	0.162
AI-driven Employee Engagement Systems -> Workforce Agility	0.299	0.298	0.035	8.602	0.000
AI-driven Performance Management -> Sustainable Business Productivity	0.006	0.007	0.045	0.138	0.890
AI-driven Performance Management -> Workforce Agility	0.233	0.232	0.033	7.151	0.000
AI-enabled Training & Development -> Sustainable Business Productivity	0.000	-0.002	0.029	0.001	0.999
AI-enabled Training & Development -> Workforce Agility	0.188	0.188	0.033	5.772	0.000
Automation in HR Operations -> Workforce Agility	-0.013	-0.014	0.031	0.427	0.669
Automation in HR Operations x AI in Recruitment & Selection -> Workforce Agility	0.021	0.021	0.032	0.674	0.501
Automation in HR Operations x AI-based HR Analytics -> Workforce Agility	-0.020	-0.020	0.034	0.589	0.556
Automation in HR Operations x AI-driven Employee Engagement Systems -> Workforce Agility	-0.044	-0.043	0.041	1.059	0.290
Automation in HR Operations x AI-driven Performance Management -> Workforce Agility	0.008	0.011	0.030	0.263	0.793
Automation in HR Operations x AI-enabled Training & Development -> Workforce Agility	-0.037	-0.036	0.032	1.167	0.243
Workforce Agility -> Sustainable Business Productivity	0.500	0.490	0.157	3.186	0.001

The results of path analysis show that most of the predictors are significantly impacted by Workforce Agility, while their direct impact on Sustainable Business Productivity is not significant. AI in Recruitment & Selection, AI-based HR Analytics, AI-based Employee Engagement Systems, AI-based Performance Management and AI-enabled Training & Development are shown to display a great positive impact on Workforce Agility. None of these variables shows a substantial direct impact on the Sustainable Business Productivity, as shown by all p-values exceeding 0.05. Conversely, Workforce Agility itself has a significant positive impact on Sustainable Business Productivity, which suggests that it acts as an important mechanism by which AI-enabled HR practices contribute to organisational outcomes.

Table 07: Specific Indirect Effect

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
AI-driven Employee Engagement Systems -> Workforce Agility -> Sustainable Business Productivity	0.149	0.147	0.052	2.875	0.004
AI-driven Performance Management -> Workforce Agility -> Sustainable Business Productivity	0.117	0.114	0.041	2.871	0.004
AI-enabled Training & Development -> Workforce Agility -> Sustainable Business Productivity	0.094	0.093	0.036	2.618	0.009
Automation in HR Operations -> Workforce Agility -> Sustainable Business Productivity	-0.007	-0.005	0.015	0.435	0.663
Automation in HR Operations x AI in Recruitment & Selection -> Workforce Agility -> Sustainable Business Productivity	0.011	0.010	0.016	0.660	0.509
Automation in HR Operations x AI-driven Performance Management -> Workforce Agility -> Sustainable Business Productivity	0.004	0.004	0.015	0.261	0.794
Automation in HR Operations x AI-enabled Training & Development -> Workforce Agility -> Sustainable Business Productivity	-0.019	-0.019	0.019	0.992	0.321
Automation in HR Operations x AI-based HR Analytics -> Workforce Agility -> Sustainable Business Productivity	-0.010	-0.009	0.017	0.591	0.555
Automation in HR Operations x AI-driven Employee Engagement Systems -> Workforce Agility -> Sustainable Business Productivity	-0.022	-0.024	0.024	0.895	0.371
AI in Recruitment & Selection -> Workforce Agility -> Sustainable Business Productivity	0.116	0.113	0.038	3.089	0.002
AI-based HR Analytics -> Workforce Agility -> Sustainable Business Productivity	0.125	0.121	0.038	3.325	0.001

The results of the indirect effect analysis show that Workforce Agility mediates several relationships. Significant mediation is noted for AI-driven Employee Engagement Systems, AI-driven Performance Management, AI-enabled Training & Development, AI in Recruitment & Selection and AI-based HR Analytics since all of them have a value which is less than 0.05. These results suggest that these HR technologies positively influence the Sustainable Business Productivity indirectly through the positive influence on the Workforce Agility. In opposition, Automation in HR Operations and all the interaction terms are described by nonsignificant indirect effects, which recommend nonsignificant results to not serve a mediating purpose in this pathway.

Table 08: Conditional Direct Effect

	Original sample (O)	Sample mean (M)	STDEV	T	P values
AI in Recruitment & Selection -> Workforce Agility Automation in HR Operations at +1 SD	0.254	0.254	0.046	5.566	0.000
AI-based HR Analytics -> Workforce Agility Automation in HR Operations at +1 SD	0.230	0.231	0.049	4.708	0.000
AI-driven Employee Engagement Systems -> Workforce Agility Automation in HR Operations at +1 SD	0.255	0.255	0.056	4.570	0.000
AI-driven Performance Management -> Workforce Agility Automation in HR Operations at +1 SD	0.241	0.243	0.046	5.192	0.000
AI-enabled Training & Development -> Workforce Agility Automation in HR Operations at +1 SD	0.151	0.153	0.045	3.346	0.001
AI in Recruitment & Selection -> Workforce Agility Automation in HR Operations at -1 SD	0.211	0.211	0.047	4.522	0.000
AI-based HR Analytics -> Workforce Agility Automation in HR Operations at -1 SD	0.270	0.272	0.047	5.741	0.000
AI-driven Employee Engagement Systems -> Workforce Agility Automation in HR Operations at -1 SD	0.343	0.341	0.052	6.580	0.000
AI-driven Performance Management -> Workforce Agility Automation in HR Operations at -1 SD	0.226	0.222	0.042	5.392	0.000
AI-enabled Training & Development -> Workforce Agility Automation in HR Operations at -1 SD	0.226	0.224	0.046	4.863	0.000
AI in Recruitment & Selection -> Workforce Agility Automation in HR Operations at Mean	0.233	0.232	0.034	6.940	0.000
AI-based HR Analytics -> Workforce Agility Automation in HR Operations at Mean	0.250	0.251	0.034	7.369	0.000
AI-driven Employee Engagement Systems -> Workforce Agility Automation in HR Operations at Mean	0.299	0.298	0.035	8.602	0.000
AI-driven Performance Management -> Workforce Agility Automation in HR Operations at Mean	0.233	0.232	0.033	7.151	0.000
AI-enabled Training & Development -> Workforce Agility Automation in HR Operations at Mean	0.188	0.188	0.033	5.772	0.000

The conditional direct effect table shows the impact of AI-enabled HR practices on Workforce Agility in HR Operations at different levels of Automation in HR. All conditional effects, across +1 SD, -1 SD and mean levels of automation are statistically significant, confirming that the relation between each AI practice and Workforce Agility is positively directed irrespective of the intensity of automation. The size of the effects varies modestly with the level of automation, but the direction and importance of the relations are robust.

Table 09: Conditional indirect effect

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
AI in Recruitment & Selection -> Workforce Agility -> Sustainable Business Productivity Automation in HR Operations at +1 SD	0.127	0.123	0.042	3.046	0.002
AI-based HR Analytics -> Workforce Agility -> Sustainable Business Productivity Automation in HR Operations at +1 SD	0.115	0.113	0.043	2.700	0.007
AI-driven Employee Engagement Systems -> Workforce Agility -> Sustainable Business Productivity Automation in HR Operations at +1 SD	0.128	0.123	0.043	2.936	0.003
AI-driven Performance Management -> Workforce Agility -> Sustainable Business Productivity Automation in HR Operations at +1 SD	0.120	0.118	0.042	2.881	0.004
AI-enabled Training & Development -> Workforce Agility -> Sustainable Business Productivity Automation in HR Operations at +1 SD	0.075	0.074	0.031	2.408	0.016
AI in Recruitment & Selection -> Workforce Agility -> Sustainable Business Productivity Automation in HR Operations at -1 SD	0.106	0.103	0.040	2.622	0.009
AI-based HR Analytics -> Workforce Agility -> Sustainable Business Productivity Automation in HR Operations at -1 SD	0.135	0.130	0.040	3.392	0.001
AI-driven Employee Engagement Systems -> Workforce Agility -> Sustainable Business Productivity Automation in HR Operations at -1 SD	0.171	0.171	0.069	2.497	0.013
AI-driven Performance Management -> Workforce Agility -> Sustainable Business Productivity Automation in HR Operations at -1 SD	0.113	0.110	0.045	2.520	0.012
AI-enabled Training & Development -> Workforce Agility -> Sustainable Business Productivity Automation in HR Operations at -1 SD	0.113	0.112	0.048	2.345	0.019
AI in Recruitment & Selection -> Workforce Agility -> Sustainable Business Productivity Automation in HR Operations at Mean	0.116	0.113	0.038	3.089	0.002
AI-based HR Analytics -> Workforce Agility -> Sustainable Business Productivity Automation in HR Operations at Mean	0.125	0.121	0.038	3.325	0.001
AI-driven Employee Engagement Systems -> Workforce Agility -> Sustainable Business Productivity Automation in HR Operations at Mean	0.149	0.147	0.052	2.875	0.004
AI-driven Performance Management -> Workforce Agility -> Sustainable Business Productivity Automation in HR Operations at Mean	0.117	0.114	0.041	2.871	0.004
AI-enabled Training & Development -> Workforce Agility -> Sustainable Business Productivity Automation in HR Operations at Mean	0.094	0.093	0.036	2.618	0.009

The results of the conditional indirect effect shed new light on the variation of the mediated pathways as a function of the intensity of the automation. Every indirect pathway that emanates from AI-enabled HR practices to Sustainable Business Productivity via Workforce Agility is statistically significant, whether the level of automation is high, low or at its mean. This is a testament to the power and strength of Workforce Agility as a medium across disparate layers of automation. While there are slight differences in the polarization of the magnitude at the +1 standard deviation and the -1 standard deviation level, there is no doubt that overall, the polarities of workforce agility show a positive proof that the influence of these AI-powered HR practices goes to ensure a sustainable level of productivity.

DISCUSSION

The measurement model testifies to excellent internal consistency for all constructs, with the values being between 0.963 and 0.981. Such high reliability suggests that the items scale cohere well, and it is likely that the measure's variance does not result from measurement error and therefore increases confidence in later measurements of structure (Davenport et al., 2010; Espegren, 2023). High reliability for Workforce Agility and Sustainable Business Productivity is testimony to the successful operationalisation of these latent constructs and productises them for the possibility of testing mediation and conditional paths (Sherehiy & Aswari,2014; Alviani,2024).

The R-squared results show that the explanatory power for the 2 endogenous variables has a significant difference. Predictors are significant in explaining 76.8 percent of the variance in Workforce Agility (R2 = .768, adjusted R2 = .759), which shows that the joint effect of the chosen AI-enabled HR practices gives a solid empirical basis explaining workforce flexibility. This finding is consistent with the literature where HR analytics, artificial intelligence (AI)-based engagement, training, and performance systems are identified as key drivers of workforce adaptability and adaptive capacity (Davenport et al., 2010; Budhwar et al., 2022; Alviani, 2024). By contrast, Sustainable Business Productivity is explained to a relatively low degree (R2 = .147, adjusted = .130), an indication that direct determinants of sustainable productivity are broader than HR technologies and workforce attributes, and may capture operational, strategy levels, market, and external environmental levels that are not reflected in the current model (Harvard Business School Online, 2018; Filippi, 2023). In condensed terms, one is that AI-HR practices impose more direct influence on human capability (agility) than they immediately achieve in sustainable organisational outcomes.

Path estimates reveal a clear and consistent pattern: multiple AI status-enabled HR practices have statistically significant positive relationships with Workforce Agility and are small and non-significant. Relationships with Sustainable Business Productivity. Specifically, AI-based HR Analytics, AI-driven Employee Engagement Systems, AI-driven Performance Management, AI in Recruitment & Selection, and AI-enabled Training & Development all generated positive and highly significant coefficients to Workforce Agility (all $p < .001$). These findings reinforce the perspective on how analytics and AI tools augment the capacity of employees to sense, learn, and respond - through providing actionable insights on people, personalised learning opportunities and engagement mechanisms to allow rapid redeployment of skills (Davenport et al., 2010; Budhwar, 2022; Gusti, 2024). The lack of observable and noteworthy direct impacts of those AI practices on Sustainable Business Productivity implies that HR technologies are not guaranteed to produce any measurable improvements in

productivity but instead exert influence through their impact on workforce behaviour and capability.

Workforce Agility itself has a substantial beneficial influence on Sustainable Business Productivity,.500, p -.001. This result substantiates the theoretical assumption that agility - measured as adaptability, proactivity, and resilience - translates into more sustainable productivity outcomes due to agile workforces adjusting the use of resources, innovating processes, and perpetuating performance under changing conditions (Sherehiy &Karwowski, 2014; Alviani, 2024). As such, the powerful mediating effects of Workforce Agility have made it highly likely that the benefits of AI-enabled HR practices will not exhibit direct productivity impacts: benefits arise through human responsiveness and learning capacity improvement, and not as direct inputs to productivity metrics.

The direct effects foster this mediation narrative in more detail. Significant Indirects from AI-based HR Analytics, Employee Engagement Systems powered by AI, Performance Management powered by AI, Training & Development powered by AI and AI-Powered Recruitment & Selection to Sustainable Business Productivity through Workforce Agility are observed, signifying full or partial mediation for those predictors ($p < .01$ for the above-listed indirects). These results are consonant with empirical and conceptual works that frame HR technology as an enabler of capabilities for workforces that drive organisational outcomes (Davenport et al., 2010; Khammadee, 2023). Practically speaking, the findings suggest that investments in AI systems should be accompanied by programmes for strengthening the agility of the workforce (learning programmes, role redesign, cross-training) to have sustainable gains in productivity.

Automation in HR Operations has mixed results. Its direct effect on Workforce Agility is not significant, and the interaction terms (Automation x AI-practice) with most dimensions of AI are also not statistically significant in simple moderation tests. However, conditional direct and indirect results suggest that the positive relations between AI practices and Workforce Agility - and median indirect relations to Sustainable Business Productivity - are maintained across the levels of automation (mean, +1 tests & -1 says SD). In other words, although the relationships are neither amplified nor weakened in simple tests of moderation when automation is purely one's resource, the mediated paths are significantly robust when automation is either high or low. This pattern implies that automation is neither necessary nor adequate as a moderator in the current sample but works as an environmental devastation in which AI attempts still work (Filippi, 2023; Khammadee, 2023). The finding is consistent with research that shows there are limitations in automation (task substitution) and, therefore, the impact of AI-enabled augmentation (decision support), which increasingly depends on

integrating it with human-centred AI and change management (Filippi, 2023; Budhwar, 2022).

Two considerations have been highlighted by recent work and by the present results. For one, evidence derived from studies on workforce well-being warns that technological deployment does have the potential to negatively affect employee quality of life if this is not done with attention to governing procedures, ethics and workload management (Institute for the Future of Work, pouvant IK 2024; The Guardian, funzionando febbraio IK 2024). Even when AI improves agility, the adoption process must be managed by the organisations to prevent adverse impacts on organisational morale and sustainability overall. Second, Sustainable Business Productivity as an outcome is many things and slower moving at the same time; short-term cross-sectional assessment may understate long-run benefits from Digitalisation of HR (Harvard Business School Online, 2018). Longer longitudinal tracking, along with operational and environmental variables, would elucidate the understanding of how HR systems technologies materialise into measurable, sustainable productivity over time.

The theoretical contribution of this study is two-fold. Empirically, it shows that AI-enabled HR practices behave through workforce capabilities rather than generating direct productivity gains, suffering from the mediation-focused theorising in strategic HRM and people analytics-link research (Davenport et al., 2010; Alviani, 2024). Conceptually, the model emphasises the agility of the workforce as a key mechanism linking HR technology to sustainable organisational outcomes to integrate the literature on AI in HR, workforce agility, and sustainability-oriented productivity (Sherehiy & Karwowski, 2014; Gusti, 2024).

Practically, the human side should be a primary concern for managers to deploy AI in HR. Additions to investments for AI-based analytics, engagement platforms, and training technologies should be complemented by matters related to psychological or mental playnotes that promote adaptability, ongoing determination and psychological security in the conditions to enable and empower your employees to turn AI-based info to constructive conduct (Davenport et al.,ಧ 2010; Budhwar,2022). Human-centred implementation and governance processes and ethical supervision are important to help mitigate the possible downsides of automation and technology-driven surveillance (Institute for the Future of Work, 2024).

LIMITATIONS AND ISSUES FOR FUTURE STUDY

The design of the study and the sample used may limit wide generalisation. First, the low R2 for Sustainable Business Productivity indicates omitted variables - for future research, the authors recommend including operational efficiency measures, industry-level controls, and a longer time horizon to include the

dynamics of sustainable productivity research (Harvard Business School Online, 2018). Second, automation's mixed role lends itself to qualitative enquiries into the ways in which organisations combine automation and AI - distinguishing substitutional from augmentative implementations of automation (Filippi, 2023). Third, well-being and ethical implications should be clearly measured in future designs as technology will generate productivity gains at the expense of employee outcomes (Institute for the Future of Work, 2024). Finally, longitudinal, and multi-level designs would provide better representation of causal dynamics and heterogeneity at a firm level of HR practices in terms of returns (Khammadee, 2023; Alviani, 2024).

The evidence shows that HR practices made possible with AI vastly enhance the Workforce Agility, and it is the latter that, in turn, drives Sustainable Business Productivity. AI investments therefore take such effect as they marry both the development of human capability and ethical governance, and the absence of complementarities in those two spheres, while still only having a limited impact on sustainable productivity. The results provide a down-to-earth process of how scholars and practitioners might aim to transform HR technology investments into sustainable, lasting performance enhancements.

CONCLUSION

The findings of this study show that the HR practices enabled by artificial intelligence have a significant indirect impact on the sustainable productivity of the business by virtue of workforce agility, while the direct impact is insignificant. Specifically, AI in recruitment and selection, AI-based HR analytics, AI-based employee engagement systems, AI-based Performance Management and AI-based training and development had a significant positive impact on workforce agility (path coefficients ranging from 0.188 to 0.299, $p < .001$). In turn, workforce agility had a strong and positive effect on Sustainable Business Productivity ($\beta = .500$, $p = .001$). The mediation analysis confirmed that workforce agility has a significant mediating effect on the relationship between the antecedents of AI: engagement systems ($\beta = .149$, $p = .004$), Performance Management ($\beta = .117$, $p = .004$) and training and development ($\beta = .094$, $p = .009$) and its downstream outcome: Sustainable Business Productivity. Automation in HR operations did not show much of a moderating effect on these relationships, suggesting that automation might aid operational efficiency but might not increase the impact that AI-enabled HR practices have on workforce agility and productivity.

Overall, these results highlight that the major means through which AI-enabled HR practices affect Sustainable Business Productivity is by increasing the agility of the workforce. Direct adoption of AI tools without developing adaptability and flexibility among employees is not likely to provide significant productivity gains, and therefore, the importance of human capacity in addition to

technological adoption (Alviani, 2024; Malik, Budhwar, & Kazmi, 2023) is highlighted.

RECOMMENDATIONS

- Develop Workforce Agility Programs. The Organization should focus on developing programmes that boost employee adaptability, problem-solving and continuous learning capabilities to maximize the benefits of AI-enabled HR tools.

- Integrate AI Tools with Training and Development: AI-driven training should be developed in such a way that it can point out the skills gaps in the workforce and personalise learning opportunities to build workforce agility (Sherehiy & Karwowski, 2014).

- Balanced Automation Implementation: Although automation can make work more efficient, it is important for HR departments to carefully balance the automation of routine tasks with employee-driven decision-making to avoid a loss of engagement and adaptability of employees (Filippi, Chiacchio, & Petropoulos, 2023).

- Monitor and Evaluate AI-Enabled HR Practices: Periodical assessment of the effectiveness of AI tools in enhancing the agility and productivity of the workforce is recommended to ensure that they are set in consonance with the goals for the sustainability of the organisation (Nawaz, 2024).

- Strategic Alignment: Organisations should ensure that AI-enabled HR initiatives are strategically aligned with overall organisational goals of sustainable productivity to ensure that investments in technology support human capital development.

LIMITATIONS

- Cross-Sectional Design: The study utilised a cross-sectional design, which limited the possibility of deriving any causal inferences between the concepts of AI-enabled HR practices, workforce agility, and Sustainable Business Productivity (Paul & Khan, 2024).

- Single-Source Data: Data collection from one source - respondents may develop a common method bias. Future studies could include multi-source data and/or longitudinal approaches.

- Generalisability: The sample was taken from organisations that have implemented AI in HR, which may limit the generalisability to other organisations with low AI adoption.

- Limited Moderators: While automation in HR operations was evaluated as a moderator, other contextual factors, for instance, organisational culture, leadership style, or type of industry were not taken into consideration.

SIGNIFICANCE OF THE STUDY

This work gives some theoretical contributions as well as practical ones. Theoretically, it extends knowledge of the relationship between HR practices enabled via AI and the sustainable productivity of businesses, through the mediation of workforce agility, by incorporating knowledge of the Resource-Based View and Dynamic Capability Theory (Barney, 1991; Teece, 2014). Practically, the findings help guide HR managers in the design of AI interventions that are complemented with workforce capability development to ensure that technology investments are used to make long-term, sustainable performance improvements. By emphasising the importance of workforce agility, the study serves as an informative resource for policy and decision-making when it comes to HR strategy, workforce planning, and organisational development (Alviani, 2024; Malik et al., 2023; Filippi et al., 2023).

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