

# **Integrating Human and AI Insights in HR Functions to Drive Breakthrough Innovation Engagement**

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This study looks at the effects of HR factors on engagement in breakthrough innovation in Saudi Arabian software firms, with an emphasis on how Human Intelligence (HI), Artificial Intelligence (AI), and hybrid AI moderate this relationship. The study's overarching goal is to shed light on the ways in which various AIs and HR practices work together to generate novel results. A quantitative approach was used, with 233 software developers from different software houses making up the sample. Using validated scales that were adopted from previous research, data were collected through a structured questionnaire. To test the hypothesised correlations and assess the model fit, the analysis was undertaken using Stata-SEM (Structural Equation Modelling). According to the findings, human resource factors have a substantial impact on the level of participation in breakthrough innovations. Additionally, this relationship is somewhat mitigated by both AI and human intelligence, with hybrid intelligence also playing an important moderating role. According to these results, combining various types of intelligence with HR practices has a major effect on encouraging innovation. This study provides a comprehensive framework that integrates traditional human resource management theories with contemporary intelligence insights and provides actionable implications for organisations seeking to enhance innovation through strategic HR practices and intelligent systems. Academic researchers and practitioners in human resource management and innovation will benefit from its findings.

**Keywords:** Human resource's function, Artificial intelligence, Human intelligence, Hybrid intelligence, Breakthrough innovation engagement.

## Introduction

Academics and practitioners have focused on HRM and innovation in recent years. Global markets are complex and ever-changing, therefore companies are trying to stay competitive (Tariq et al., 2024b). Innovation, especially breakthrough innovation, is becoming increasingly important, therefore understanding what causes these revolutionary developments in companies is critical (La Sala et al., 2024). According to Khalife (2024) study, breakthrough innovations are technological advances or goods and techniques that disrupt or develop new markets, giving them huge competitive advantages. These advances help organisations survive and grow in fast-changing, competitive industries (Venigandla et al., 2024). Human resources have grown in importance since people drive innovation in every organisation. Thangaraja et al. (2024) claim that good HR practices can boost innovation. Enhancing staff skills, motivation, and creativity helps generate and implement creative ideas (Qamar et al., 2023). Human intelligence (HI), AI, and hybrid intelligence interact to influence the relationship between human resource factors and breakthrough innovation (Dobrin, 2024). This complex interaction is moderated by many factors. HRM prioritises human capital management and enhancement to optimise organisational performance. However, AI and hybrid intelligence systems have changed human-machine relations. AI can make human resource practices more data-driven and imaginative, according to Sharma and Kumar (2024). Artificial intelligence can efficiently analyse massive amounts of data and predict insights to improve HR practises. Hybrid intelligence, which combines human and artificial intelligence, allows for comprehensive problem-solving and decision-making, which is essential for revolutionary inventions (Chaudhary et al., 2024). These changes have encouraged scientists to study how intelligence and human resource issues affect innovation outcomes (Tariq et al., 2024a). To advance this field, this study examines how human, artificial, and hybrid intelligence moderate the relationship between HR parameters and breakthrough innovation engagement (Grilli & Pedota, 2024). This will reveal organisational innovation mechanisms.

Studies on human resource management and innovation show that human resources drive revolutionary inventions (Nalini, 2024). Mariani and Dwivedi (2024) found that continuous training, performance management, and employee empowerment boost corporate creativity. (Thakur, 2024) found that companies that actively develop and support learning are more inventive. These programs improve employees' knowledge and skills, enabling them to create more effectively. Studies on transformational leadership in human resource management support creativity (Abbas et al., 2023a; Pandey et al., 2023). According to Abbas et

al. (2023b), transformational leaders inspire and empower their subordinates hence fostering an environment for invention and revolution. Further studies reveal that hybrid and artificial intelligence can enhance HR operations linked to creativity (Pandey et al., 2023). AI based HR data can expose employee performance and potential, hence enhancing talent management. This enables companies to identify and grow outstanding leaders (Mer, 2023). Using artificial intelligence to analyse workforce data, companies who did so were more able to link their human resource strategy with innovation goals, therefore enhancing the results of innovation (Raisch & Fomina, 2023). Hybrid intelligence systems which mix artificial intelligence data processing with human creativity help to improve innovative decision-making. According to Budhwar et al. (2023), hybrid intelligence increases human-machine cooperation, so producing more creative ideas. These results underline the need of including modern technologies into human resource management to increase creativity (Budhwar et al., 2023). Furthermore investigated in empirical research how human intelligence influences human resource qualities and creativity is human intelligence. Cognitively gifted workers, according to Mariani et al. (2023), are more sure of their human resource management abilities. This raises involvement in innovative revolution. Mer and Viridi (2023) found that cognitive flexibility, an important part of human intelligence, helps employees adapt to new challenges and come up with creative solutions. Human intelligence and human resource management are linked, thus companies must consider employees' cognitive talents while creating and implementing innovative HR practices (Piller et al., 2023). These empirical results lay the groundwork for comprehending the complex relationships between human resource traits, cognition, and creativity (Bahoo et al., 2023). They also help examine ways to improve these interactions to boost creativity.

Existing research on human resource management and innovation leaves gaps (Anghel, 2023). There is little research on how HR elements combine with human, artificial, and hybrid intelligence to enable breakthrough innovation engagement. Few research integrate these traits into a framework (Rascão & Marques, 2023). The aggregate impact of these cognitive categories on innovation is poorly researched. AI and hybrid intelligence's effects on HR and innovation are unknown. Intelligence and creativity have been studied, however the data is insufficient (Einola & Khoreva, 2023). Given that companies use AI and HI to improve HR processes and innovation, this difference is substantial. Understanding how these technologies interact with human intelligence and HR practices to encourage breakthrough creativity is essential to developing more effective innovation strategies (Sharma et al., 2022). The

current research ignores contextual factors influencing the capacity of HR policies to support significant innovation. This discrepancy is significant (Verma & Singh, 2022). Investigating how HR policies, organisational culture, structure, and outside environment influence innovation is still much needed (Alebr, 2022). It has been demonstrated that some HR policies encourage innovation. Still, further study is required to really understand. Depending on organisational size, business type, and market conditions, Qamar et al. (2023) propose that HR actions could foster innovation. Empirical study has not, however, looked at these factors. Research on human resource strategies for innovative ideas is much awaited (Bhatti, 2023). Unlike little improvements, breakthroughs call for distinct tools, knowledge, and organisational support. Dealing with these contextual elements allows us to know when human resource policies support innovative thinking (Garg et al., 2022). Most studies also centre on big, reputable companies. Though we are not sure, human resource policies and cognitive skills could influence innovation in SMEs and startups (Bhatti, 2023). Many times lacking resources, these businesses battle to be creative. Particularly in developing and highly technologically advanced fields, they are absolutely vital for creativity (Sin, 2022). Investigating how startups and SMEs may customise their hybrid intelligence systems and human resource strategies to fit their requirements and constraints will help to increase innovation.

Different ideas allow one to investigate how hybrid intelligence influences human resources and innovative creativity. Underlying this research is the firm's Resource- Based View (RBV). According to Mahmood (2022), this concept holds that an organization's internal resources including human capital and technology determine whether or not it can outperform rivals. This concept holds that organisational culture, knowledge, and skills can increase creativity. Managing and making use of these resources significantly benefits from modern technology such artificial and hybrid intelligence. According to the Resource- Based View (RBV), incorporating artificial and human intelligence into HR processes will maximise internal resource use and inspire fresh ideas, hence enhancing creativity. One of the main theories that combines social and technology systems in companies is social-technical systems (Bhatti et al., 2022). Trist developed this viewpoint. According to the STS theory, by organising social and technical elements, including artificial and human intelligence into HR processes can increase creativity. Theoretically, a hypothesis supports this harmony guarantees that people and technologies cooperate, therefore promoting innovative development. This paper investigates, using STS theory, how hybrid intelligence in HR systems generates a creative socio-technical environment. These studies investigate how hybrid, artificial, and human

intelligence affect the link between human resource factors and breakthrough innovation.

### **Literature Review**

Human cognition has long been associated with artificial intelligence (AI), whose fundamental concepts are inspired by it (Tariq et al., 2024b). This link displays the ongoing endeavour to replicate and improve human intellect by means of robots. Combining computational techniques with human thought processes including learning, reasoning, perception, and decision-making, artificial intelligence research creates intelligent systems (Khalife, 2024). Cognitive science and neuroscience theories have helped to clarify how people acquire knowledge so that algorithms could replicate human problem-solving (Thangaraja et al., 2024). Inspired by the human brain, deep learning in artificial intelligence draws on neural networks. These systems manage enormous amounts of data across several layers so that machines may identify trends and make decisions akin to human ones (Sharma & Kumar, 2024). Furthermore influencing artificial intelligence is the study of human social and emotional intelligence. As they develop, artificial intelligence systems are including social interaction and empathy (Tariq et al., 2024a). One example of this is affective computing wherein machines identify and react to human emotions. These advances illustrate that artificial intelligence seeks to replicate human emotions and social dynamics as well as reason and analysis (Nalini, 2024). Especially in healthcare, education, and customer service where knowledge of human emotions is essential this integration aims to make artificial intelligence more relevant and efficient in practical applications (Thakur, 2024). Human intelligence and artificial intelligence keep producing innovations reflecting and improving the complex capacity of the human mind (Abbas et al., 2023a).

Human resource factors influencing workforce capacities include employee skills, motivation, training, leadership, organisational culture, and training (Mer, 2023). Especially in companies that give breakthrough innovations top priority for disrupting or creating new markets top importance, these traits significantly affect employees' innovative attitudes (Budhwar et al., 2023). Innovative engagement of employees in transforming innovation processes is known as breakthrough innovation. It entails generating fresh ideas, daring, and putting them into use inside a company (Mariani et al., 2023). These factors are connected since employee breakthrough creativity can be much influenced by human resource management support and tools. Many studies have looked at

how human resource problems impact the results of innovation, especially for original ideas (Piller et al., 2023). Organisations with strong human resource policies such as ongoing education, cooperative work conditions, and good leadership have repeatedly shown high rates of innovation (Anghel, 2023). Organisations that engage in human capital development that is, training and skill augmentation have higher rates of radical innovation (Einola & Khoreva, 2023). Transformational leaders who inspire and empower staff members promote breakthrough innovation, according to Qamar et al. (2023) Crucially, human resource policies shape company culture. Driving innovation participation depends on a society that supports creativity, risk-taking, and honest communication, claims Verma and Singh (2022). These studies support strategic human resource management as fostering innovative ideas. Empirical studies suggest that human resource problems could affect involvement with breakthrough innovation (Garg et al., 2022). Organisations that give staff development first priority, foster a creative and innovative culture, and use leadership styles that inspire autonomy and creative thinking show more breakthrough inventive engagement (Mahmood, 2022). By raising individual talents, fostering an inspiring workplace, and matching organisational goals with innovative projects, human resources influence innovation. Employee skill, motivation, and empowerment increase their capacity to participate in and execute innovative ideas, therefore improving the performance of the company. Studies show that employee participation in radical innovation activities is much influenced by human resource issues (La Sala et al., 2024).

**H1.** Human resources factors influence the breakthrough innovation engagement.

Empirically, human intelligence, human resource elements, and results of innovation have been investigated extensively (Venigandla et al., 2024). Human intelligence enhances innovative-oriented human resource projects in terms of problem-solving, creativity, and learning. Higher cognitive capacity individuals make greater use of training and development possibilities, which increases innovation according to studies (Dobrin, 2024). Crucially for creativity, Chaudhary et al. (2024) discovered that cognitive flexibility and intelligence enable workers manage difficult and uncertain environments. Human intelligence can improve the influence of human resource factors on creativity by increasing employees' capacity to absorb, process, and apply new knowledge and skills in original ways (Grilli & Pedota, 2024). Given the relevance of human intelligence, it could help to reduce the link between human resource variables and involvement with breakthrough

innovation. Intelligent workers hence are more likely to gain from HR policies that increase innovation (Mariani & Dwivedi, 2024). This theory holds that intelligence increases a person's capacity for using organisational tools and support. Intelligent workers are more likely to solve issues creatively which is necessary for breakthrough innovation when given the correct tools, training, and support (Abbas et al., 2023b). According to the moderating role of intelligence, worker cognitive ability may determine the effectiveness of human resource aspects even if their importance for innovation is evident (Pandey et al., 2023). Companies who value employee intelligence and use it are more likely to observe how HR projects affect results on innovation. High-IQ employees could value hard work, independence, and environments free of risk (Raisch & Fomina, 2023). People are more ready to manage challenging and innovative problems, so this alignment can increase the involvement in breakthrough innovation. Human intelligence is supposed to directly affect innovation and improve the efficacy of human resource variables in encouraging breakthrough innovation engagement (Budhwar et al., 2023).

**H2.** Human intelligence significantly moderates the relationship of human resources factors and breakthrough innovation engagement.

Recent empirical study has focused on how AI might improve organisational outcomes, particularly innovation (Mer & Virdi, 2023). Artificial intelligence has changed business innovation and human resource management. This is because AI can manage large volumes of data, automate monotonous activities, and give accurate predictive insights (Bahoo et al., 2023). Research suggests that artificial intelligence can improve human decision-making and expedite HR processes, affecting creativity. Rascão and Marques (2023) say artificial intelligence can improve human management by recognising high-potential employees and generating personalised development plans to boost innovation. Sharma et al. (2022) suggest using AI-driven analytics to identify breakthrough innovation skills. Integrating HR strategy with innovation goals achieves this. These findings suggest that artificial intelligence boosts creativity rather than assuming the role of human resources (Alembri, 2022). These statistics suggest that artificial intelligence can affect human resource factors and innovative development partnership. Human resources departments seeking creativity can benefit from artificial intelligence's ability to examine complex data and deliver insights (Sin, 2022). Artificial intelligence technologies can analyse employee performance data to forecast creativity. Human resource managers could customise therapies to boost innovation. Artificial

intelligence can provide quick feedback and continuous learning, which are essential for innovative technology (Tariq et al., 2024b). Timely and meaningful feedback encourages innovation in employees. Due to AI's moderating influence, integrating it into HR processes can boost creativity by encouraging fresh ideas (Venigandla et al., 2024). Organisations can moderate their interaction between HR components and innovative innovation by using artificial intelligence in HR operations. Artificial intelligence can help human resource workers make better decisions and boost creativity by offering more accurate data insights (Sharma & Kumar, 2024). Artificial intelligence can identify talent gaps and predict future skill shortages, enabling HR to create new training programs. Human resources might use AI to create personalised growth strategies based on employee strengths, increasing innovation (Grilli & Pedota, 2024). AI promotes efficiency and effectiveness in human resource management and strengthens the link between HR and technical innovation (Thakur, 2024).

**H3.** Artificial intelligence significantly moderates the relationship of human resources factors and breakthrough innovation engagement.

Combining human cognitive ability with artificial intelligence's analytical capacity, hybrid intelligence has grown to be a major focus in corporate innovation (Pandey et al., 2023). Studies reveal that hybrid intelligence can increase the innovative capacity of human resource policies. Studies show that human intuition and the data processing capacity of artificial intelligence can help to improve decision-making and problem-solving qualities absolutely essential for breakthrough innovation (Budhwar et al., 2023). Combining human and artificial intelligence experience, hybrid intelligence systems which Mer and Viridi (2023) showed can enhance creative processes by providing fresh insights and identifying trends humans would overlook. Integration lets companies exploit computer and human strengths for more creativity. Furthermore enhancing human-AI cooperation is hybrid intelligence, which helps to generate and execute fresh ideas (Anghel, 2023). Hybrid intelligence might drastically change the interaction between engagement in breakthrough innovation and human resource aspects. By merging human invention and judgement with AI insights, hybrid intelligence increases HR activity (Sharma et al., 2022). Combining artificial intelligence's capacity to examine vast amounts of data with human managers' contextual and organisational knowledge helps hybrid intelligence uncover creative talent in talent management (Garg et al., 2022). By means of continuous feedback and data analysis, hybrid intelligence can change training and development initiatives in real time

to guarantee that employees possess the most current skills and knowledge for innovative ideas. quickly innovation can provide a corporation an advantage in the quickly changing corporate environment of today (Sin, 2022). Therefore, hybrid intelligence is a main driver of organisational innovation in the digital era since it enhances human resource practices and increases participation of breakthrough ideas.

**H4.** Hybrid intelligence significantly moderates the relationship of human resources factors and breakthrough innovation engagement.

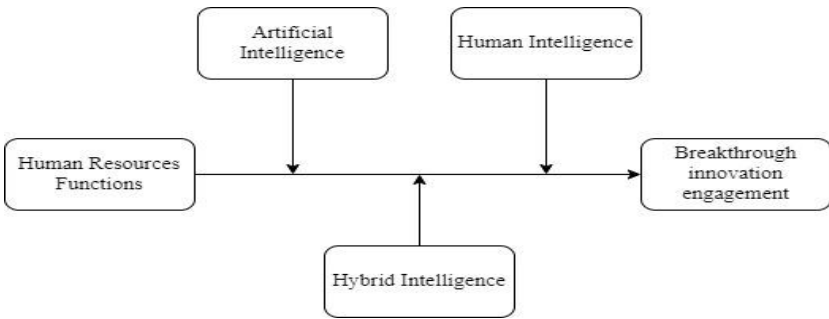


Figure 1: Conceptual Model

### Methodology

This quantitative study examined the links between human resource factors, intelligence, and breakthrough innovation engagement in Saudi Arabian software houses. The study examined 233 software developers from various software firms to understand how these variables interact in this business. A diverse range of software developers from various software companies around the Kingdom were included in the sample, which was meticulously selected to represent this wide array of individuals. The participants' validity and reliability were assessed using a standardised online questionnaire that was delivered during the study. The study comprehensively addressed a diverse array of subjects, such as human resources, human intelligence, artificial intelligence, hybrid intelligence, and engagement in breakthrough innovation. The selection of participants was conducted using purposive sampling to include software professionals with significant competence. Through the utilisation of this approach, substantial and enlightening data was obtained.

**Table 1**

Questionnaire of research

Sr. No	Variable Name	No of Items	Reference
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1	Human resource's function	5	(Shahzad et al., 2023)
2	Artificial intelligence	7	(Ahmad et al., 2023)
3	Human intelligence	11	(Hameed et al., 2023; Yazon & Manaig, 2019)
4	Hybrid intelligence	4	(Abbas et al., 2023b)
5	Breakthrough innovation engagement	5	(Abbas et al., 2023b)

In this analysis, we used established research scales to ensure the accuracy and consistency of our findings. Various forms of intelligence, such as human intelligence, artificial intelligence, hybrid intelligence, and breakthrough innovation engagement, were assessed using established scales during the evaluation process. In order to ensure consistent and reliable measurement of components, the scales included both things with known properties and items that had been tested through experimentation. The existing scales were utilised to maintain a high level of measurement precision and ensure compatibility with the existing literature. The data was analysed and the hypothesised variable connections were tested using Stata-SEM. The Stata-SEM software was selected because to its resilience in handling complex models and providing accurate model fit and parameter estimates. The study commenced by doing an initial examination to identify any missing numbers and outliers. The validity of the measurement model was assessed by confirmatory factor analysis (CFA) to ensure that the observed variables accurately represented the underlying components. In order to examine the hypotheses and assess the relationships between human resource variables, intelligence kinds, and engagement in breakthrough innovation, the structural model was estimated following the confirmatory factor analysis (CFA). Stata-SEM provided a comprehensive analysis of the research hypotheses by highlighting the robustness and significance of these associations.

## Results

Table 2 presents the reliability and validity metrics for the key variables of the study. Cronbach's Alpha, Composite Reliability, and Average Variance Extracted are shown for each variable in the table. Cronbach's Alpha measures internal consistency, or how closely variables' items correspond. Cronbach's Alpha scores show inconsistent reliability in this investigation. The Cronbach's Alpha for Human Resource's Function is 0.740, which indicates good internal consistency but is lower than other variables. Cronbach's Alpha of 0.795 indicates good reliability and internal consistency for AI. Human Intelligence and Hybrid

Intelligence have even higher internal consistency (0.837 and 0.860). These higher values indicate that the items measure these constructs accurately. Breakthrough Innovation Engagement has a good Cronbach's Alpha of 0.778, indicating item internal consistency.

**Table 2**  
Variables reliability and validity

Variable	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)
Human resource's function	0.740	0.926	0.512
Artificial intelligence	0.795	0.871	0.514
Human intelligence	0.837	0.906	0.542
Hybrid intelligence	0.860	0.856	0.527
Breakthrough innovation engagement	0.778	0.823	0.657

Composite dependability (CR) assesses latent construct dependability by assessing how well scale items measure the construct they are supposed to. The variables have Composite Reliability ratings of 0.823–0.926. Human Resource Function components have a high Composite Reliability of 0.926, suggesting strong reliability. Artificial and Human Intelligence have Composite Reliability ratings of 0.871 and 0.906, respectively, over the 0.70 threshold, indicating strong reliability. Though significantly lower than the others, Hybrid Intelligence has good Composite Reliability of 0.856. Breakthrough Innovation Engagement items have a Composite Reliability of 0.823, indicating reliability but not as strong as the others. Average Variance Extracted (AVE) measures how much a latent concept explains indicator variable variance. High AVE values imply that the construct explains much of the variance in its indicators. Variable AVE values are 0.512–0.657. Human Resources Function and Artificial Intelligence have AVE values of 0.512 and 0.514, respectively, which are slightly above the 0.50 criterion, showing that these constructs explain some variance in their indicators. Human Intelligence and Hybrid Intelligence have higher AVE values of 0.542 and 0.527, respectively, showing that these constructs explain a lot of indicator variance. Breakthrough Innovation Engagement has the greatest AVE score of 0.657, showing strong convergent validity and a large explanation for its indicators.

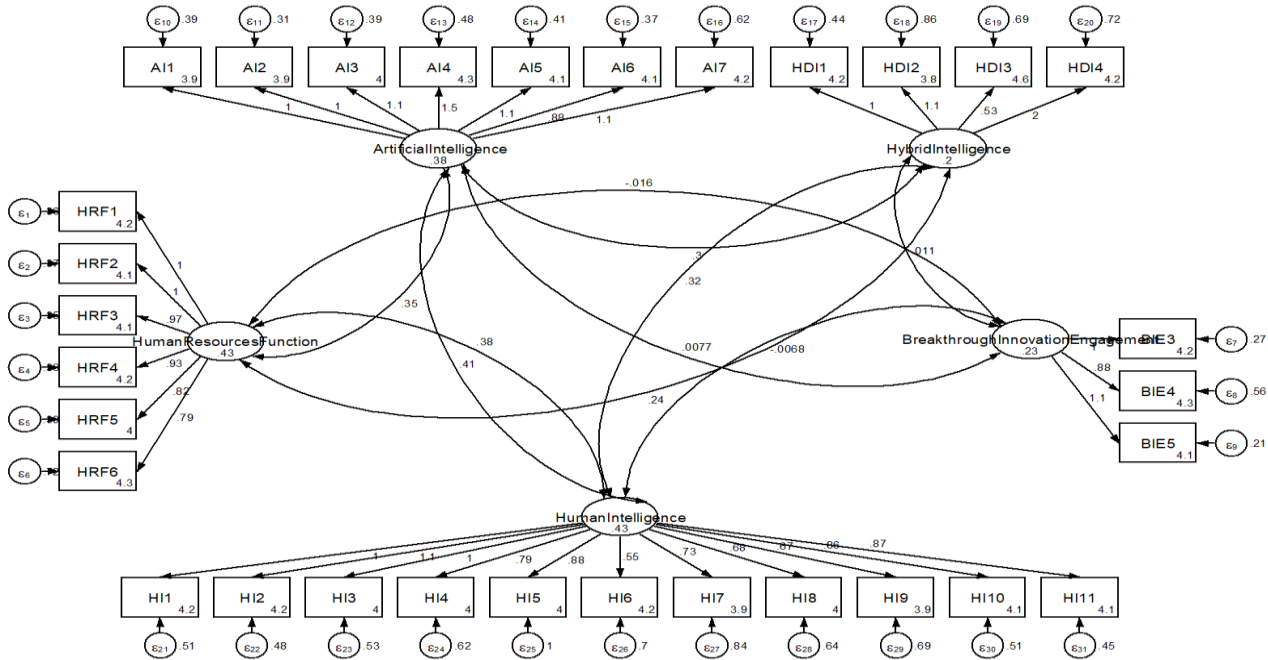


Figure 2: Estimated Model

The study's measuring model's Confirmatory Factor Analysis (CFA) results are in Table 3.

**Table 3**  
Confirmatory Factor Analysis

Measurement	OIM Coef.	Std. Err.	z	P> z	[95% Conf. Interval]
HRF1	1.000	(constrained)			
HRF2	0.557	0.043	9.767	0.000	0.381 0.545
HRF3	0.583	0.046	9.437	0.000	0.149 0.568
HRF4	0.168	0.083	8.777	0.000	0.256 0.831
HRF5	0.214	0.039	73.668	0.000	0.252 0.777
AI1	1.000	(constrained)			
AI2	0.666	0.052	9.870	0.000	0.564 0.762
AI3	0.577	0.080	8.298	0.000	0.153 0.744
AI4	0.610	0.050	9.341	0.000	0.513 0.708
AI5	0.606	0.058	11.389	0.000	0.569 0.727
AI6	0.572	0.041	68.697	0.000	0.204 0.720
AI7	0.494	0.058	8.241	0.004	0.412 0.673
HI1	1.000	(constrained)			
HI2	0.667	0.056	9.052	0.000	0.563 0.626
HI3	0.520	0.074	10.346	0.000	0.280 0.898
HI4	0.551	0.085	8.166	0.000	0.216 0.781
HI5	0.624	0.045	60.828	0.000	0.077 0.183
HI6	0.085	0.087	9.284	0.000	0.348 0.910
HI7	0.668	0.053	9.737	0.000	0.564 0.612
HI8	0.700	0.066	9.889	0.002	0.577 0.705
HI9	0.147	0.082	8.901	0.000	0.252 0.833
HI10	0.664	0.038	71.339	0.000	0.113 0.347
HI11	0.661	0.036	76.706	0.000	0.104 0.379
HDI1	1.000	(constrained)			
HDI2	0.569	0.049	8.938	0.000	0.474 0.660
HDI3	0.730	0.037	77.810	0.000	0.182 0.418
HDI4	0.705	0.052	10.345	0.000	0.610 0.656
BIE1	1.000	(constrained)			
BIE2	0.447	0.050	7.143	0.000	0.353 0.547
BIE3	0.712	0.056	10.204	0.000	0.609 0.663
BIE4	0.286	0.037	77.846	0.000	0.314 0.458
BIE5	0.502	0.038	75.113	0.000	0.311 0.714

Factor loadings, standard errors, z-values, p-values, and 95% confidence intervals are shown for each variable. The CFA findings show significant loading of all items on their factors, as seen by high z-values and low p-values ( $p < 0.05$ ). HRF and AI items had robust loadings of 0.557 to 0.583 and 0.494 to 0.666, respectively, indicating excellent factor validity. Human Intelligence (HI) items also have significant loadings, between 0.085 and 0.700, indicating their construct contribution. The loadings for Hybrid Intelligence (HDI) items range from 0.569 to 0.730, while Breakthrough Innovation Engagement (BIE) items are significant from 0.286 to 0.712. These findings support the validity of this research's constructs by validating the measuring model.

Table 4 shows the original sample values for each measurement item's fitness statistics across factors.

**Table 4**

Measurement Items Fitness Statistics		
Variable	Indicator	Original Sample
Human resources function	HRF1	0.655
	HRF2	0.705
	HRF3	0.726
	HRF4	0.658
	HRF5	0.562
Artificial intelligence	AI1	0.595
	AI2	0.606
	AI3	0.783
	AI4	0.575
	AI5	0.524
	AI6	0.625
	AI7	0.672
Human intelligence	HI1	0.707
	HI2	0.599
	HI3	0.624
	HI4	0.637
	HI5	0.783
	HI6	0.822
	HI7	0.660
	HI8	0.696
	HI9	0.585
	HI10	0.511
Hybrid intelligence	HI11	0.749
	HDI1	0.656
	HDI2	0.683
	HDI3	0.698
Breakthrough innovation engagement	HDI4	0.552
	BIE1	0.545
	BIE2	0.676
	BIE3	0.666
	BIE4	0.765
	BIE5	0.724

The table shows how much each piece contributes to its construct and how well it fits the model. Human Resources Function components HRF1–HRF5 have loadings from 0.555 to 0.726, with HRF3 and HRF2 fitting best. AI3 has the best fit in Artificial Intelligence at 0.783, while AI5 has the worst at 0.524. High fit statistics, especially HI6 with 0.822 and HI11 with 0.749, indicate robust measurement of human intelligence. Hybrid Intelligence items vary from 0.552 to 0.698, indicating good match, with HDI3 and HDI2 being most trustworthy. Breakthrough Innovation Engagement components have strong fit statistics, with BIE4 having the highest value at 0.765. These results confirm the study's measurement items' reliability and validity, representing each construct successfully.

Table 5 shows model evaluation Chi-square fit statistics. Comparing the model to the saturated model, the likelihood ratio chi-square value is 1037.217, with a p-value of 0.000, suggesting a substantial deviation. Compared to the saturated model, the baseline chi-square value is 738.221 with a p-value of 0.000, indicating a significant difference. These results suggest that while the chi-square tests show statistically significant differences, additional indices may be needed to fully evaluate model fit.

**Table 5**

Chi-square Fit statistics		
Fit statistic	Value	Description
Likelihood ratio	1037.217	model vs. saturated
p > chi2	0.000	
chi2_bs(2728)	738.221	baseline vs. saturated
p > chi2	0.000	

Table 6 compares R-square statistics for the estimated and saturated models to show construct quality of fit.

**Table 6**

R-square statistics Model Goodness of Fit Statistics			
	Saturated Model	Estimated Model	R Square
SRMR	0.045	0.048	
Artificial intelligence			0.315
Human intelligence			0.337
Hybrid intelligence			0.440
Breakthrough innovation engagement			0.408

The estimated model has a little higher Standardised Root Mean Residual (SRMR) (0.048) than the saturated model (0.045), indicating a minimal residual increase. The model explains 31.5% of the variance in Artificial Intelligence, 33.7% in Human Intelligence, 44.0% in Hybrid Intelligence, and 40.8% in Breakthrough Innovation Engagement, according to R-square values. These numbers show how much variance the model explains for each variable, indicating its explanatory power and modelling fit in capturing construct linkages.

Table 7 shows path analysis results for study hypotheses. The path coefficient (OIM Coef.), standard error (Std. Err.), z-value, p-value, and 95% confidence interval of each hypothesis reveal the variables' strengths and significance. The path coefficient for Hypothesis 1 (H1), which explores how human resource factors affect breakthrough innovation engagement, is 0.625 with a standard error of 0.051. The z-value of 9.553 and p-value of 0.000 show a highly significant link with a 95% confidence interval of 0.526 to 0.718. This high positive correlation supports the

premise that human resource issues affect breakthrough innovation engagement. H2 examines how human intelligence moderates the relationship between human resource factors and breakthrough innovation engagement. The path coefficient is 0.685, with 0.048 standard error. With a confidence interval of 0.590 to 0.619, the moderation effect is extremely significant with a z-value of 10.978 and p-value of 0.000. This supports the premise that human intelligence considerably boosts human resource elements' impact on breakthrough innovation engagement.

**Table 7**

Path Analysis

Hypotheses	OIM Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
H1	0.625	0.051	9.553	0.000	0.526	0.718
H2	0.685	0.048	10.978	0.000	0.590	0.619
H3	0.673	0.053	9.816	0.000	0.569	0.617
H4	0.666	0.052	9.870	0.000	0.564	0.762

Hypothesis 3 (H3) states that artificial intelligence moderates the relationship between human resource factors and breakthrough innovation engagement. The path coefficient is 0.673 with a standard error of 0.053. With a confidence interval of 0.569 to 0.617, the z-value of 9.816 and p-value of 0.000 show a substantial moderating effect. This implies that artificial intelligence increases the link between human resource elements and innovative engagement.

H4 investigates how hybrid intelligence modulates the interaction between human resource elements and engagement with breakthrough innovation. Standard error is 0.052; route coefficient is 0.666. The z-value of 9.870, p-value of 0.000, and confidence interval of 0.564 to 0.762 support a major and favourable moderating effect. This helps to underline how much hybrid intelligence—which blends artificial and human elements—affects human resource variables and innovative activity.

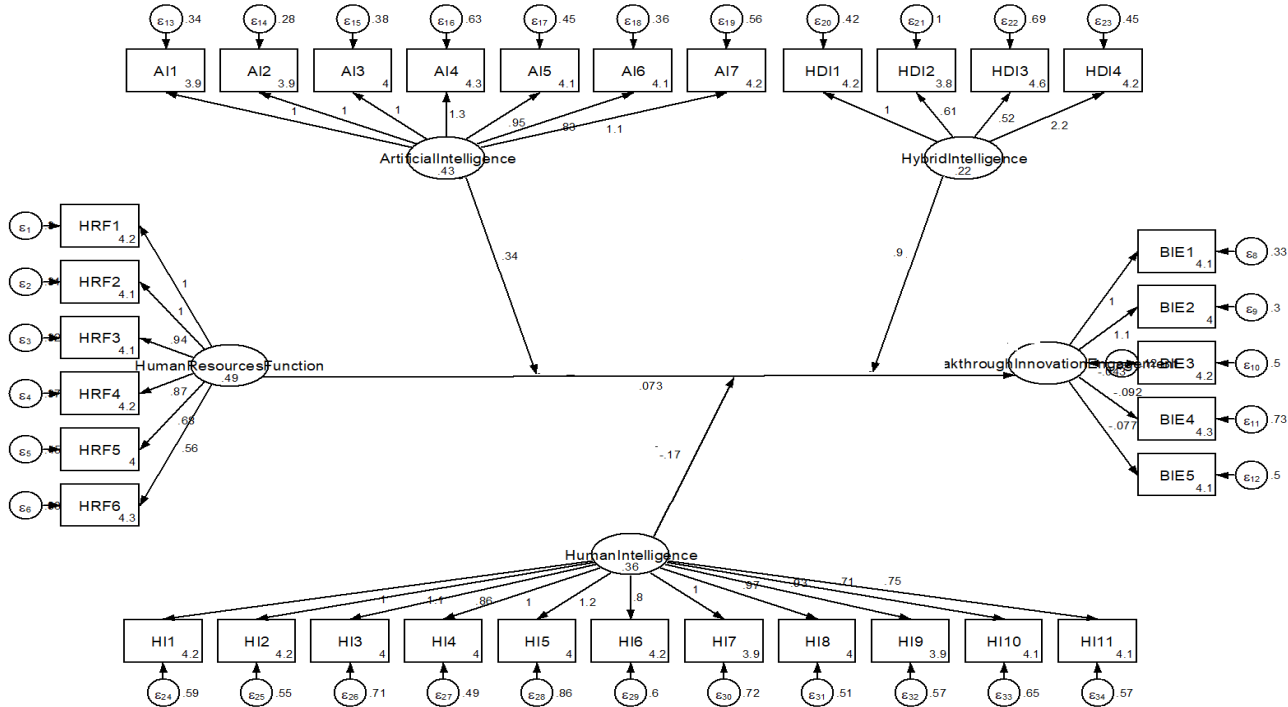


Figure 3: Structural Model for Path Analysis

### Discussion

Today's commercial environment, where invention drives success, requires understanding the complex relationship between human resources, intellect, and pioneering creativity. Human, artificial, and hybrid intelligence are compared to HR components in this study. By incorporating these components, an organization's creativity can improve. Businesses must use smart HR strategies to enhance employee potential. This is needed for disruptive developments in fast-changing technologies. Findings of this study demonstrate that AI in HRM enhances the association between HR characteristics and creativity and creates additional innovation prospects. Every hypothesis tested reveals long-term business success drivers in a competitive industry. Each theory predicts a different future for innovation and HRM.

The underlying concept that human resource features impact groundbreaking innovation has been verified, highlighting the importance of human resource management in stimulating innovation in people and businesses. This confirms critical studies on novel HR strategies (Raisch & Fomina, 2023). In addition to talent management, this study shows that good HRM practices stimulate creativity. Performance management systems that encourage innovation and measured risk-taking allow employees to try new things. Training and development provide workers the confidence to take risks and encourage employees to explore independently to boost creativity and ownership. This discussion suggests HRM may promote organisational innovation strategically. This is especially true when a competitive advantage hinges on groundbreaking innovations. If we adopt the second hypothesis, which states that human intelligence strongly influences the relationship between human resource factors and breakthrough innovation, HRM's role in innovation is challenging. A study found that HR practices boost creativity in cognitively competent workers such skills include creativity, adaptability, and problem-solving. Research shows higher cognitive capacity people benefit more from HR initiatives and innovate more effectively (Budhwar et al., 2023). Current study findings supports these result.

Human resource policies are crucial for innovation because of human intelligence, but their success depends on their employees' cognitive ability. Cognitively gifted employees are more likely to learn, grow in difficult conditions, and create and apply new ideas. Cognitive differences must be considered when designing and implementing HR initiatives that promote creativity, according to this study. Human resources programs that recognise and use cognitive abilities are more likely to spark

creativity. These facts affect theory and practice greatly. They show that human intelligence moderates the relationship between innovation and HRM, making it more complicated than previously imagined. This study emphasises the importance of understanding how personality and HR practices affect creativity. It emphasises this understanding and enhances previous research. According to studies, companies should invest effective HR programs and analyse people' cognitive capacities to boost innovation. Hiring smart people, providing ongoing training, and encouraging creative cognitive use are methods to do this. These findings also suggest tailoring human resource policy to workforce skills and demands and leveraging the potential of highly clever persons. Businesses may boost creativity, gain a competitive edge, and succeed long-term by taking these steps. The third hypothesis states that AI moderates the relationship between human resource factors and breakthrough innovation engagement, which could affect HRM and innovation. The findings show how AI improves, streamlines, and boosts HR innovation. This supports past research suggesting AI may improve data-driven HR initiatives, personnel management, and decision-making (Pandey et al., 2023). AI can analyse big data, forecast patterns, and offer insights. Companies may foster innovation, develop people, and match HR practices with innovation goals. HR managers may utilise AI-driven statistics to find creative people, create development plans, and measure their progress. Companies may nurture innovation and integrate their HR strategy with groundbreaking creativity with this increased capacity. An innovation may succeed.

Artificial intelligence also weakens the link between human resources and innovation, especially in fast-changing technical environments that require complicated problem-solving. In certain scenarios, AI can handle complexity, navigate uncertainty, and make informed decisions that encourage innovation. The study found that HR attributes are more strongly linked to breakthrough innovation in organisations that successfully deploy AI in HR. AI can automate HR tasks so HR pros may focus on creativity. Teamwork, leadership, and learning improve with these exercises. AI may provide fast feedback and continuous improvement for iterative procedures that lead to key discoveries. These findings emphasise the importance of employing AI as a strategic HRM tool, especially for companies seeking to innovate in fast-changing markets.

The fourth hypothesis, that hybrid intelligence moderates the relationship between human resource factors and breakthrough innovation engagement, has improved our understanding of how

intelligence interacts with human resource management to drive innovation. Hybrid intelligence improves innovation, decision-making, and problem-solving. Human cognition and AI analysis are combined. According to statistics, hybrid intelligence-based HR processes boost breakthrough creativity. A recent study found that hybrid intelligence combines human creativity with artificial intelligence's data processing to provide more innovative solutions (Abbas et al., 2023b). This study supports this discovery. The hybrid intelligence moderating effect suggests that firms that blend artificial and human intelligence into human resource management might boost innovation. They can make big advances by combining human and machine benefits. The results also imply that merging artificial and human intelligence creates a flexible, innovative HR environment. Hybrid information helps companies seize opportunities, adapt to market changes, and respond quickly. Hybrid intelligence improves AI and teamwork. This simplifies merging AI-powered data and human ideas into innovation. This collaborative method boosts creativity, problem-solving, and decision-making. Hybrid intelligence may enable lifelong learning. AI may provide instant feedback and insights, helping individuals improve and overcome new difficulties. These findings show hybrid intelligence's growing importance in HR. This is essential for companies seeking innovation and a competitive edge in dynamic marketplaces. Combining artificial and human intelligence can boost employee creativity and resiliency. Thus, original ideas may succeed.

All four predictions came true, demonstrating the importance of artificial and human intelligence to human resource factors and revolutionary innovation. This study found that standard HR practices promote innovation, but artificial, hybrid, and human intelligence improve them. These numbers demonstrate how the digital revolution has influenced HR. To make and maintain breakthroughs, companies must integrate modern technologies into their HR strategies. This study shows how to use workers' entire intellectual capacities to boost innovation, growth, and success. This helps organisations handle modern challenges.

### **Conclusion**

This study convincingly examines how human resource issues, intelligence, and groundbreaking innovation connect with one another. It offers theoretical and practical insights. Human resources can significantly impact innovation, according to the study. Adding human, artificial, and hybrid intelligence to these resources boosts this impact. This highlights the importance of integrating advanced intelligence

technologies with human resource operations to efficiently advance. The research shows that human resource management in the digital age is always changing and requires a balanced approach that blends human experience with technology. This is done by highlighting the moderating functions of humans and AI. Given the practical implications, organisations should focus on improving their human resource strategies and using advanced intelligence to maximise creativity. The study's cross-sectional design and sample setting limit its scope, but it opens the door to further research into the dynamic links between different types of intelligence and HR practices. The research greatly affects human resource management and creativity. It provides a strategy framework for firms looking to innovate and acquire a competitive edge in a complex, technology-driven world.

### **Implications of the study**

This study intends to fill up our knowledge of how human, artificial, and hybrid intelligence interact with human resource factors to generate important innovations in creative engagement. These research results have important theoretical ramifications. The study looks at how modern intelligence insights on innovation and conventional human resource management ideas affect one other. Human resource management theories emphasising the moderating roles of artificial and human intelligence help to clarify how improved cognitive and analytical tools affect organisational innovation. According to the research, HRM policies should combine artificial and human intelligence points of view to support hybrid intelligence and the increasing powers of artificial intelligence. This theory suggests that rather than depending just on human resources, innovative discoveries call for a harmonic approach combining many types of intelligence. The study also reveals that the integration of modern intelligent technologies offers a more comprehensive knowledge of how HRM and intelligence influence innovation results, so determining the success of HR strategies in promoting creativity. Combining empirical data with theoretical ideas offers a complete and multifarious knowledge of intelligence within companies. This helps to enable more research into the dynamic link between creative intelligence and human resources.

This study implies that sophisticated intelligence integration together with effective human resource management might boost innovation. According to the research, HR policies should aggressively include artificial and human intelligence to improve involvement in breakthrough innovation. To properly use human intelligence, HR managers should encourage the growth of knowledge, creativity, and improved cognitive

capacities. Using advanced analytics, machine learning, and automation could help HR procedures be better, data-driven insights be given, and decision-making improved. To increase innovation, the research advises devoting funds towards the acceptance of technology and training courses combining human knowledge with AI-driven solutions. This approach improves HR processes and helps companies to foresee and adjust to changes in the market, therefore acquiring their competitive advantage. According to the study, companies should match their HR strategy with their innovation objectives if they are to maintain creativity. One could reach this by combining technology and human resources. These strategies can help companies in developing creativity, improving performance, and reaching leadership.

### **Limitations and Future Research Directions**

Despite the significance it holds, this research has limitations. This research has several limitations even if it is quite valuable. The temporal dynamics of changes in human resource quality, cognition, and participation in breakthrough innovation could not be fully captured by cross-sectional statistics. Consequently, the study might overlook the dynamic changes and longitudinal effects that might affect these correlations. The wide sample of the study is limited to specific geographical and industry settings, so its relevance to a larger population is limited as well. The focus on HR policies and intelligence could unintentionally ignore other factors affecting involvement in innovation. The studies clarify the regulating functions of hybrid, artificial, and human intelligence. It does not, however, look at the relationships among these intelligences or the possible influence of environmental factors as leadership styles or organisational culture.

Longitudinal study has the potential to trace many interactions over time and investigate the effect of intelligence and HR policies on creativity over a long period, therefore transcending these constraints. Including many geographical areas and industry sectors into the sample will help to improve the generalisability and worldwide relevance. Later studies could look at the ways in which several types of intelligence cooperate to boost creativity. Examining organisational culture, leadership styles, and industry-specific traits helps one to see how HR and intelligence initiatives affect breakthrough discoveries. The present work has the possibility to be expanded to provide more exact and useful insights for the domains of human resource management and innovation theory and practice.

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## Appendix 1

### *Human resource's function*

1. IA for technology awareness is more cost-effective than other technologies.
2. IA technology helps HR managers to select the right candidates.
3. IA technology helps HR managers to conduct online training and development sessions for new and existing employees.
4. IA technology provides user-friendly mediums to monitor employees' performance.
5. Tracking employees' activity through artificial intelligence technology is more efficient and time-saving.

### *Artificial intelligence*

1. It is interesting to use AI.
2. AI could make everything better.
3. AI is very important for developing society
4. AI is necessary for everyone
5. AI produces more good than bad.
6. I think AI makes life more convenient.
7. AI helps me solve problems in real life.

### *Human intelligence*

1. I appropriately communicate decisions to stakeholders.
2. I fail to recognize how my feelings drive my behavior at work. (R)
3. When upset at work, I still think clearly.
4. I fail to handle stressful situations at work effectively. (R)
5. I understand the things that make people feel optimistic at work.
6. I fail to keep calm in difficult situations at work. (R)
7. I am effective in helping others feel positive at work.
8. I find it difficult to identify the things that motivate people at work. (R)
9. I consider the way others may react to decisions when communicating them.
10. I have trouble finding the right words to express how I feel at work. (R)
11. When I get frustrated with something at work I discuss my frustration appropriately.

### *Hybrid intelligence*

1. I routinely use hybrid intelligence support in my job

2. I am excited about how hybrid intelligence can help me with my job
3. I am not worried that hybrid intelligence will make my job more complicated
4. I believe hybrid intelligence will be able to understand my job well enough to help

*Breakthrough innovation engagement*

1. Working at breakthrough innovative projects has a great deal of personal meaning to me
2. I am really focused on my job when I am working on breakthrough innovative project
3. When working, I think a lot about how I can give my best
4. I really push myself to work beyond what is expected of me
5. I feel strong sense of belongingness to my job