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Research article

Examining the Sustainable Integration of Artificial Intelligence in Human Resource Digitalization in the Context of Industry 4.0

Examinando la integración sostenible de la inteligencia artificial en la digitalización de los recursos humanos en el contexto de la Industria 4.0

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Abstract:
Introduction: Artificial Intelligence (AI) is reshaping workplace innovation through technologies such as robotics, augmented reality, IoT, and the metaverse. Within the Industry 4.0 paradigm—centered on flexibility, resilience, precision, and productivity—Human Resources (HR) must adapt to align human potential with technological advancements. **Methodology:** This study explores AI integration in HR functions, focusing on HR automation, organizational network analysis, and structural design, in the context of technological convergence and agile practices. **Results:** The analysis reveals that all five AI dimensions—employee performance, occupational safety, salary administration, employee morale, and real-time feedback—significantly affect organizational network analysis. However, only employee performance, salary administration, and morale impact HR digitalization. In terms of organizational design, morale, safety, and real-time feedback are key influencing factors. The conceptual model shows that 75% of the variation in organizational network analysis is explained by the five AI dimensions. **Discussion:** These results underscore the critical role of AI in supporting agile HR practices that enhance talent retention, performance alignment, and workforce optimization. **Conclusions:** Strategically integrating AI into HR functions is essential for creating synergy between human capital and technological infrastructure, fostering innovation, operational efficiency, and sustainable growth within Industry 4.0 environments.

Keywords: HR Agility; Human Resource Functions; Industry 4.0; Structural Equation Modeling.

Resumen:
Introducción: La inteligencia artificial (IA) está transformando la innovación en los entornos laborales mediante tecnologías como la robótica, la realidad aumentada, el Internet de las Cosas (IoT) y el metaverso. En el marco de la Industria 4.0—centrada en la flexibilidad, la resiliencia, la precisión y la productividad—los Recursos Humanos (RR. HH.) deben adaptarse para alinear el potencial humano con los avances tecnológicos. **Metodología:** Este estudio analiza la integración de la IA en funciones de RR. HH., enfocándose en la automatización, el análisis de redes organizacionales y el diseño estructural, considerando la convergencia tecnológica y la implementación de prácticas ágiles. **Resultados:** El análisis revela que las cinco dimensiones de la IA—desempeño laboral, seguridad ocupacional, administración salarial, moral del empleado y retroalimentación en tiempo real—impactan significativamente en el análisis de redes organizacionales. No obstante, solo el desempeño, la administración salarial y la moral influyen en la digitalización de RR. HH. Además, la moral, la seguridad y la retroalimentación afectan el diseño organizacional. El modelo conceptual explica el 75 % de la variación en el análisis de redes. **Discusión:** Estos resultados destacan el papel de la IA en prácticas ágiles de RR. HH. **Conclusiones:** Integrar estratégicamente la IA es clave para generar sinergia entre tecnología y capital humano, impulsando innovación, eficiencia operativa y crecimiento sostenible.

Palabras clave: Agilidad de RR.HH.; Funciones de Recursos Humanos; Industria 4.0; Modelado de Ecuaciones Estructurales.

1. Introduction

In the era of technological advancement, to ensure sustainable development, achieving cohesion between men, machines, and technology is crucial. As a pivotal function in industries, HR plays a crucial role in attaining a coupling and cohesion between technology and human resources.

Although Industry 4.0 overlooked the human-centric approach and took over the traditionally human-handled jobs, the deployment of flexible HR functions can address the issues concerning managing people in the organizations. Technology can enhance agility within HR processes and functions, leading to increased flexibility in the way those processes are conducted. Agility refers to the ability of an organization to adapt and respond quickly to the internal and external environments (Seal, 2019; Qamar et al.., 2021).

The corporate giants, including Microsoft, Facebook, Apple and Google, have adopted agile practices to bring more flexibility to their practices. To utilize the full potential of the employees ensuring retention and alignment with the organizational objectives, agile HR practices are critical for the firms. When the standardization of a function is difficult with a volatile nature, agile HR practices can bring in flexibility in the HR functions (Chakraborty et al., 2019, Goyal and Patwardhan, 2021).

The workforce should prioritize customer requirements and deliver value to the customers to ensure the sustainability and agility of the organizations. As traditional HR functions are not directly linked to customer interaction, employees are often censured for their slow responses leading to the loss of their morale. This scenario can be addressed by making the HR team more resilient and responsive to technological advancements and customers' demands and by absorbing suitable talents in the HR team (Kim et al., 2018). Organizations can attain more agility by adopting resilient and sustainable practices in its core functions of recruitment, selection, training and development and performance appraisal.

The core components of HR agility include swift response to the issues emerging, minimizing the implantation time to the identified solutions and design thinking to predict, plan and explore innovations for optimal results (Qamar et al., 2021) Profound advancements in the practices and processes of HR in across the industries are due to the integration of AI tools in human resources management. As many organizations are in the track of technological advancements, exploring the impact of AI integration in HR functions will provide fruitful insights to the stakeholders in understanding the impacts of AI in occupational safety, salary administration automation, employee performance, real-time feedback and employee morale (Urba et al., 2022).

The present research examines the correlation between the adoption of AI tools in the functional areas of HR and its effect on the automation of HR activities, organizational structure and organizational network analysis. The research study explores how AI integration contributes to employee morale, employee productivity, occupational safety, salary administration, real-time feedback and the advantages and challenges of AI integration in HR functions. (Sarkar et al., 2021; Panicker et al., 2021). Furthermore, the research endeavors to provide recommendations on the effective integration of AI tools in HR practices to enhance the overall effectiveness of the firms.

To answer the research objectives, the prominent application areas of AI on HR practices have been identified, a conceptual model was developed, and relevant literatures were identified to support the hypotheses framed. It is expected that the study results could assist the stakeholders in getting insights into the integration of AI tools in HR functions and its impacts on the organization.

2. Literature Review

Human resources functions are considered to be dynamic and have undergone significant updates over time. Literature reviews revealed that the integration of AI tools in the functional areas of a firm can enhance its overall effectiveness (Cayrat and Boxall, 2023). The core focus areas of Industry 4.0, digitalization, automation of jobs, flexibility, resilience and agility in the organizational practices can be attained through AI integration in the functional areas.

AI can automate all the core functions of HR, including recruitment, selection, onboarding and performance appraisal. By analyzing the trends and patterns of employee data, AI could suggest proactive intervention strategies to enhance employee morale and productivity. The successful implementation of AI tools in HR functions hinges on the attainment of an optimal balance between automation and an empathetic approach (Maganti, 2023).

2.1. Occupational safety in the Workplace

AI-driven systems can contribute to the enhancement of occupational safety. The identification of workplace hazard with the aid of AI integrated surveillance systems can help the organizations to implement proactive measures to prevent workplace accidents (Wang et al., 2020). AI integration could also assist in the iteration of health risks by analyzing the health data of the employees' existing health issues, which enables the HR team to provide preventive measures and customized health recommendations (Ngai et al., 2020).

For addressing the employees' queries, providing safety guidelines, emergency protocols and instant information assistance on routine affairs, AI-assisted chatbots can be used by the firms (Arias, 2021). Additionally, AI-assisted systems can be used to monitor workplace movements and to alleviate trauma disorders, leading to the enhancement of workplace ergonomics.(Jerman et al., 2020)

2.2. Employee Morale

AI-integrated systems can contribute to the enhancement of employee comfort in the workplace. To optimize workplace conditions, AI-integrated systems can gather inputs from temperature and humidity sensors and suggest the optimal comfort levels, which in turn can improve employee morale and productivity (Zhang et al., 2021). Tailor-made recommendations to suit employees' preferences, including table heights and seating arrangements, can also be suggested by AI-powered systems (Yu and Lee, 2020). AI tools help in providing targeted interventions to overcome stress levels and to boost employees' comfort by identifying workplace stressors, examining the patterns of communication of the employees and individual engagement levels (Ugwu and Abdelrahman, 2020)

2.3. Employee Performance

Deploying AI tools in routine administrative jobs enables the HR professionals to devote more time towards strategic planning (Czarnitzki et al., 2022). Analyzing task completion against the targeted time with AI tools helps in the assessment of employee productivity levels (Bäck et al., 2022). AI enabled systems are capable of providing instant feedback to employee performance improvement. Compared to conventional evaluation systems, AI-integrated systems can provide impartial assessment reports of the employees which are supported by data (Strohmeier, 2020).

2.4. Automated Salary Administration

AI-supported systems can automate the computation of employee remuneration, deductions, incentives, taxes and employee records (Mohamed, 2022). Salary automation improves the accuracy of payroll processing and eliminates probable errors in payroll management (Zadorozhnyi, 2022). AI-driven systems can gather data from the regulatory platforms to ensure that the salary administration procedures comply with the governing regulations (Leaders, B, 2022).

2.5. Real-time Feedback

AI enables continuous tracking of employee performance, furnishing prompt feedback on progress and areas for enhancement (Rydén and El Sawy, 2022). This feedback is tailored to meet individual needs, facilitating targeted improvements in specific skill sets. Secondly, AI enhances the objectivity of feedback by relying on data and analytics, mitigating biases inherent in traditional subjective evaluation methods (Vrontis, 2022). This data-driven approach ensures the accuracy and reliability of feedback provided. Lastly, AI expedites the feedback process by swiftly processing vast amounts of data, enabling real-time or near real-time feedback delivery. This immediacy empowers employees to promptly address performance gaps and make necessary adjustments.

2.6. Automation of HR Functions

AI-powered systems are instrumental in automating various HR jobs, spanning shortlisting, recruiting, induction, appraisal of performance and employee engagement. AI-enabled systems can screen and list the applications as per the requirements of the firms (Sharma et al., 2022). Additionally, AI facilitates automated onboarding processes by offering tailored training and development initiatives for new hires [49].

Furthermore, AI enables real-time tracking of the performance of the employees, furnishing data-driven insights pivotal for enhancing performance management and fostering the involvement of the employees (Li et al., 2023). Beyond operational efficiency, the integration of AI also assists in elevating decision-making quality by providing data-driven insights [51]. For instance, AI aids in identifying skills gaps within the workforce, enabling HR professionals to design targeted training and development schemes for skills enhancement (Dolan et al., 2022)

2.7. Organizational Network Analysis

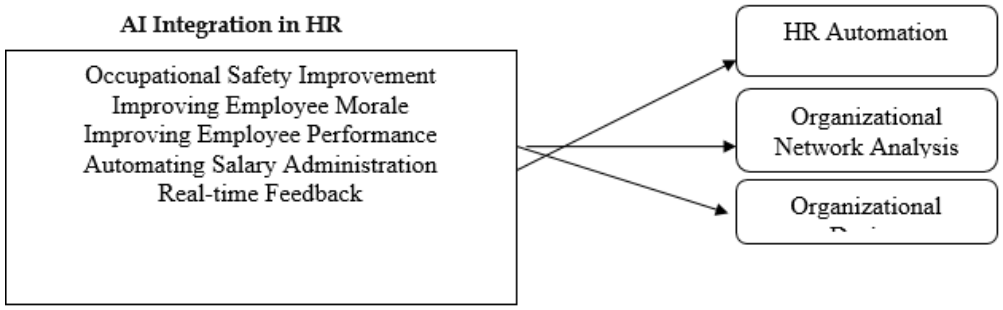
In organizational network analysis, AI-integrated systems can automate the process of data collection and interpretation as per the customized requirements. Email communications can be scrutinized with the help of AI tools to identify trends and patterns and to fetch influencers. Employee survey details can be analyzed with AI tools to iterate the factors contributing to employee involvement and collaboration. AI tools can also be employed for the identification of gaps in the network and to deploy strategies to ratify the discrepancies. The integration of AI-powered tools enables the detection of communication breakdowns and system obstacles, empowering HR teams to implement targeted interventions aimed at enhancing collaboration and communication effectiveness.

2.8. Organizational Structure

AI-integrated systems are instrumental in data analysis automation pertinent to organizational design. With the help of AI tools, data can be analyzed to match the candidates' profiles with the skill set and experience requirements for various job roles (Murugesan et al, 2023). AI integration in HR can contribute to talent development by identifying the preferences and interests of the employees. AI enables the adoption of flexible structures within the organization by facilitating the HR professionals to assign job roles to the employees in accordance with the changing customer demands and market trends.

Figure 1.

Conceptual Model



Source: Own elaboration.

3. Research Design

Descriptive research is adopted for the present study. The human resource professionals working in manufacturing, IT, ITEs and service segments in Trivandrum, Kochi and Kozhikode contribute to the population for the study. The respondents were selected through multi-stage sampling. Out of the 350 questionnaires distributed through google sheets, the 283 eligible responses were used for data analysis of the study. The reliability of the eight constructs used in the study was ensured through a reliability test, and it was observed that Cronbach's coefficient of alpha was above 0.89 for all the constructs (Hundleby, 1967). SPSS was used to analyze the collected data, and the proposed model was validated with AMOS.

In the present study, skewness and kurtosis values fall within the acceptable range (-2 and +2), indicating the multivariate normality of the variables. The constructs used in the study were subject to Confirmatory Factor Analysis (CFA) to ensure their validity and reliability. The validity and reliability of the constructs were ensured through CFA. It was ensured that the Composite Reliability (CR) for all the constructs employed were above the threshold value 0.7.

The Average Variance Extracted (AVE) was above the recommended level of 0.5 (Fornell and Larcker, 1981). It was also identified that the AVE is higher than the Minimum Shared Value (MSV) and Average Shared Value (ASV), showing that the study constructs satisfy the recommended Discriminant Validity (Bagozzi and Yi, 1988). The results of the confirmatory factor analysis are depicted in Table 1.

The value of the Kaiser-Meyer-Olkin (KMO) statistics for the study was 0.834 which indicated the adequacy of the sample for conducting factor analysis. Bartlett's test of Sphericity revealed that significant correlation exists among some of the variables in the correlation matrix, and it was concluded that the test was highly significant at $p<0.001$ with test value 879.88 having degree of significance < 0.0001. Therefore, it was concluded that the variables employed were not orthogonal.

Table 1.

Construct Validity and Reliability

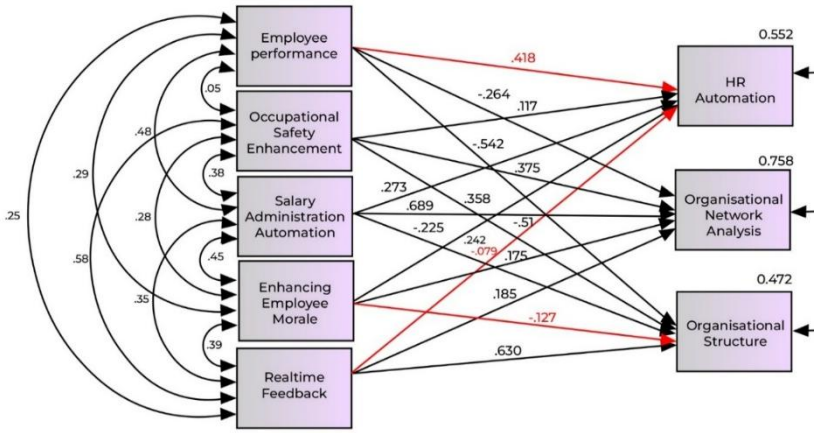
Constructs	α	CR	AVE	MSV	ASV	OSE	EEM	EPI	ASA	RTF	AHR	ONA	OS
Occupational Safety Enhancement	.935	.921	.625	.621	.531	.821							
Enhancing Employee Morale	.928	.921	.571	.521	.510	.712	.755						
Employee performance improvement	.931	.641	.561	.54	.435	.713	.651	.761					
Automating Salary administration	.950	.951	.758	.551	.323	.621	.561	.521	.873				
Real-time Feedback	.901	.899	.513	.512	.371	.674	.587	.536	.546	.735			
Automation of HR	.911	.931	.523	.335	.251	.492	.521	.472	.40	.401	.710		
Organizational Network Analysis	.921	.921	.511	.471	.467	.672	.659	.745	.584	.557	.472	.741	
Organizational Structure	.913	.920	.661	.651	.551	.812	.756	.702	.623	.661	.553	.729	.858

Source: Own elaboration.

4. Results Analysis and Interpretation

Figure 2.

Structural Model



Source: Own elaboration.

The Structural Equation Modelling (SEM) approach was applied to establish the relationship between the factors of AI integration and the factors contributing to HR agility. The SEM results imply that all five dimensions of AI integration in HR functions employee performance, occupational safety, automated salary administration, employee morale, and real-time feedback significantly influence organizational network analysis. The dependent variable digitalization in HR is influenced by only three dimensions of AI integration in HR: employee performance, salary administration and employee morale.

Three dimensions, employee morale, occupational safety and real-time feedback, influence organizational design. The results of the conceptual model reveal that 75 percent of the variations in organizational network analysis were due to all five dimensions of AI integration in HR. Among the five dimensions, occupational safety was found to be the most influencing factor, with a standardized coefficient of 0.690. It was observed that 55 percent of the variations in HR digitalization is due to the factors of employee performance, salary administration and employee morale. All the dimensions of HR integration except enhancing employee morale contributed to 44 percent variations in organizational structure. The result of the hypothesized conceptual model is illustrated in Table 3.

Table 2.

Model Fit Indices

	CMIN	RMSEA	CFI	IFI	GFI	AGFI	RMR	P
Model value	1.552	0.052	0.987	0.952	0.963	0.918	.008	0.165
Recommended Value	<3	<.08	>.90	>.90	>.90	>.90	<.08	>.05

Source: Own elaboration

Table 3.

Model Results

Hypothesis	Std. Coef.	P-Val.	R^2
Employee performance => HR Automation	-.418	Sig.	0.552
Occupational Safety Enhancement=> HR Automation	.117	0.80	
Salary Administration Automation=> HR Automation	.273	Sig.	
Enhancing Employee Morale=> HR Automation	.242	Sig.	
Real-time Feedback=> HR Automation	-.079	0.258	
Employee performance => Organizational Network Analysis	-.264	Sig.	0.758
Occupational Safety Enhancement=> Organizational Network Analysis	.375	Sig.	
Salary Administration Automation=> Organizational Network Analysis	.689	Sig.	
Enhancing Employee Morale=> Organizational Network Analysis	.175	Sig.	
Real-time Feedback=> Organizational Network Analysis	.185	Sig.	
Employee performance => Organizational Structure	-.542	Sig.	0.472
Occupational Safety Enhancement=> Organizational Structure	.358	Sig.	
Salary Administration Automation=> Organizational Structure	-.225	Sig.	
Enhancing Employee Morale=> Organizational Structure	-.127	0.073	
Real-time Feedback=> Organizational Structure	.630	Sig.	

Source: Own elaboration

5. Discussion

To stay competitive and sustainable, organizations should adopt the dynamic landscape of human resource management and embrace innovations. The integration of AI in HR can contribute significant benefits to the organization by better understanding the employee concerns and identifying the potential areas for improvement.

HR agility can be enhanced by improving occupational safety and employee morale and considering the feedback from the employees. The integration of AI in HR functions can help the HR team to identify workplace hazards, ensure employee well-being and suggest customized recommendations for enhancing employee comfort. Integration of these technologies can bring in automation of the routine HR tasks, including recruitment, selection, onboarding and performance appraisal, leading to enhanced accuracy and efficiency. In strategic HR planning, AI integration can also help the HR team to improvise the quality of the decisions by analyzing the bulk data and providing better insights. IoT devices can be deployed to gather real-time data on staff well-being and efficiency, enabling the organization to proactively address concerns and enhance employee engagement.

Integration of sensor enabled technologies can provide the HR team with insights regarding work hours and distractions, which enables the organization to optimize the work environment to enhance employee productivity and morale. AI integration can be utilized to schedule equipment maintenance, identify machine malfunctions and detect the changes in the calibrations to ensure occupational safety (Tabiu et al., 2016; Mohanty and Mishra, 2020).

However, there are concerns regarding data privacy and security due to AI integration. The integration of AI in identifying psychological issues such as depression and providing support through counseling sessions might have adverse effects on organizational design. Organizations should ensure that social and ethical concerns are not compromised while enjoying the benefits of AI integration. In the era of mass personalisation and customization, ensuring sustainable practices in the organization by achieving a balance between automation, digitalization, and a human-centric approach is crucial. While employing the technological advancements in Industry 4.0 along with new advancements including Internet of Personalized Products, and Metaverse in Industry 5.0 it should be ensured that the noble goal of sustainable development with scalable personalisation could be achieved with a human-centric approach (Barman and Das, 2018; Randhawa, 2019).

6. Conclusion

The integration of AI in HR functions is of mutual benefit for the organization and for the employees. The present study explores the potential impacts of the integration of AI in HR functions. The study examines how the integration of technology in HR functions can contribute to HR agility and organizational functions' iterative process. The digitization of HR and the utilization of Organizational Network Analysis represent interconnected technological advancements within HR, requiring a resilient organizational design to facilitate their implementation and advancement.

By integrating these components within the framework of Industry 4.0, the study provides valuable insights into navigating the dynamic landscape of HRM in the digital era. The study results imply that all five dimensions of AI integration in HR functions employee performance, occupational safety, salary administration, employee morale, and real-time feedback significantly influence organizational network analysis. The dependent variable digitalization in HR is influenced by only three dimensions of AI integration in HR: employee performance, salary administration and employee morale.

Three dimensions, employee morale, occupational safety and real-time feedback, influence organizational design. The results of the conceptual model reveal that 75 percent of the variations in organizational network analysis were due to all five dimensions of AI integration in HR.

Despite the scope of AI integration in HR functions, the application remains comparatively less developed in developed countries, including India. This low penetration limits the availability of relevant literature in the particular area. Further research with a large number of respondents is suggested to gather more vital inputs on the integration of AI in HR functions. Furthermore, researchers can explore the security concerns and job displacement due to AI integration.

The security concerns underscore the necessity for regulatory frameworks governing the integration of technology across various functions within organizations. Conducting qualitative research into the implementation aspects of technology integration can yield valuable insights for stakeholders tasked with establishing regulations.

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Contributions of the Authors:

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