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Designing an Indigenous AI-Based Smart Human Resource Management Model in the Petrochemical Industry Using a Grounded Theory Approach

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Abstract

The present study aimed to design an indigenous model of artificial intelligence (AI)-based smart human resource management (SHRM) in the petrochemical industry. In terms of purpose, the study was applied, and in terms of nature, it was qualitative and based on the grounded theory approach. The research participants consisted of managers, specialists, and experts with direct experience or relevant expertise in the petrochemical industry in the fields of human resource management, information technology, digital transformation, strategic planning, organizational excellence, health, safety, and environment (HSE), and process management. Data were collected through 12 semi-structured interviews, which continued until theoretical saturation was achieved. Data analysis was conducted using the constant comparative method through the stages of open, axial, and selective coding. The findings resulted in the development of a paradigmatic model comprising six components: causal conditions, the central phenomenon, contextual conditions, intervening conditions, action–interaction strategies, and consequences. During axial coding, the central phenomenon was conceptualized as the "transition toward an indigenous, smart, data-driven, predictive, and human-centered human resource management system in the petrochemical industry." The results indicate that smart human resource management in the petrochemical industry is not merely a technological project; rather, it constitutes a multidimensional organizational transformation whose success requires alignment among data, technology, people, culture, governance, safety, and indigenous contextual requirements.

Keywords: smart human resource management, artificial intelligence, petrochemical industry, grounded theory, indigenous model, data governance.

1. Introduction

Human resource management (HRM) is undergoing a profound transformation as organizations increasingly integrate artificial intelligence (AI), advanced analytics, digital platforms, automation, and intelligent decision-support systems into workforce-related processes. Traditional HRM systems were largely designed around administrative control, periodic reporting, standardized procedures, and retrospective decision-making; however, contemporary organizations operate in environments characterized by technological turbulence, accelerated knowledge obsolescence, workforce mobility, competitive pressure, and growing demands for agility, sustainability, and evidence-based management. Under these conditions, HRM is

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expected not only to perform administrative functions but also to contribute directly to strategic decision-making, organizational resilience, workforce optimization, innovation, and sustainable value creation. The concept of smart human resource management has emerged in response to this transition and reflects a movement from conventional, fragmented, and primarily reactive HR practices toward integrated, technology-enabled, data-driven, adaptive, and increasingly predictive systems. Kambur and Yildirim conceptualize this transition as a fundamental shift from traditional HRM toward smart HRM in which digital technologies change not merely the tools used by HR professionals but also the structure, logic, and strategic role of the HR function (Kambur & Yildirim, 2023). Similarly, the growing literature on Smart HRM 4.0 emphasizes that the strategic value of intelligent HR systems arises from their ability to transform organizational resources and information into dynamic capabilities that enhance organizational performance (Pillai & Srivastava, 2022). Thus, smart HRM should be understood not simply as the digitalization of existing HR procedures but as a broader organizational transformation in which technology, data, competencies, governance, and managerial processes are reconfigured around more intelligent forms of workforce management.

Artificial intelligence has become one of the most influential technological drivers of this transformation. AI-based applications can potentially support recruitment and candidate screening, competency assessment, workforce planning, performance management, learning and development, succession planning, employee retention, workforce scheduling, and predictive analysis of human capital risks. In comparison with conventional human resource information systems that primarily store, retrieve, and report data, AI-enabled systems can identify complex patterns in large datasets, generate predictions, personalize interventions, and provide decision recommendations to managers. Recent evidence concerning AI-powered digital transformation in human resource management indicates that the literature is increasingly moving toward the integration of AI, data analytics, automation, and intelligent governance within the HR function (Bian et al., 2025). In the Iranian context, research has similarly highlighted the growing role of AI technologies in developing HRM functions in public organizations and has emphasized their potential to increase decision quality, accelerate organizational processes, improve analytical capability, and support more sophisticated approaches to human resource development (Rahdarpour et al., 2024). At the technical level, big-data-assisted frameworks further demonstrate that the effectiveness of smart HRM depends on the ability to integrate large-scale organizational information with analytical systems capable of converting dispersed data into actionable intelligence (Zhao, 2024). Accordingly, the transition toward AI-based HRM involves a qualitative change in decision logic: organizations move from relying predominantly on managerial intuition and historical reports toward combining professional judgment with real-time information, predictive models, and algorithmically generated insights.

Nevertheless, the adoption of intelligent HR technologies does not automatically produce strategic value. The effectiveness of such technologies depends on whether they are embedded within appropriate organizational structures, digital infrastructures, competency systems, management practices, and governance arrangements. Smart HRM therefore represents a socio-technical system rather than a purely technological application. Structural research on smart human resource architecture has shown that successful digital transformation requires coherent relationships among technological infrastructure, organizational processes, human capital capabilities, and the institutional architecture through which HR decisions are made (Rastgar et al., 2022b). Related research on the requirements and technology-oriented foundations of smart HRM has similarly indicated that organizations must establish appropriate technological, structural, cultural, and competency foundations before intelligent HR practices can operate effectively (Rastgar et al., 2022a). These findings are important because organizations frequently approach AI adoption through isolated technology projects, purchasing software or implementing algorithms without first resolving problems of fragmented data, unclear process ownership, weak digital competencies, limited interoperability, and resistance to change. Such an approach can generate technically sophisticated systems that remain disconnected from actual organizational requirements. A genuinely smart HRM architecture therefore requires integration among data quality, analytical capability, technological readiness, organizational strategy, managerial support, employee participation, and human oversight.

The strategic relevance of smart HRM is also increasingly associated with innovation and organizational competitiveness. When digital technologies are integrated effectively into human resource systems, organizations may improve their capacity to acquire, develop, mobilize, and retain human capital in ways that strengthen innovation performance. Empirical research has shown that smart human resource management can play a significant role in the relationship between technology application

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and organizational innovation performance, suggesting that technological resources generate stronger organizational outcomes when they are complemented by intelligent HR practices (Al-Faouri et al., 2024). This perspective positions HRM as an enabling mechanism through which digital technologies are translated into behavioral, organizational, and performance outcomes. At the managerial level, digital transformation also changes the behavioral requirements placed on leaders and managers. Managers operating in digitally transformed environments must develop competencies related to technology acceptance, data-based decision-making, learning orientation, flexibility, collaborative leadership, and the management of organizational change. Research using grounded theory to develop a behavioral model for managers in the digital era has emphasized that successful digital transformation is closely related to managerial behavioral capabilities rather than being determined exclusively by technological infrastructure (Abdollahzadeh Namini et al., 2024). Consequently, the implementation of AI-based HRM requires not only intelligent systems but also managers capable of interpreting algorithmic outputs, coordinating interdisciplinary actors, building employee trust, and integrating technology with organizational goals.

The significance of these issues becomes particularly pronounced in the petrochemical industry. Petrochemical organizations operate in complex, capital-intensive, technologically sophisticated, and high-risk environments in which human resource decisions are closely connected to operational continuity, production efficiency, process safety, environmental performance, and strategic resilience. Workforce planning in this sector cannot be treated as an ordinary administrative activity because shortages of specialized expertise, retirement of experienced employees, migration of technical professionals, contractor dependence, geographical concentration of facilities, shift work, and the need for highly specialized competencies may directly influence operational performance. Research concerning personnel infrastructure in Iran's gas and petrochemical cluster has demonstrated the importance of developing systematic mechanisms for meeting workforce requirements and aligning human capital infrastructure with the specific developmental needs of the sector (Daniali et al., 2022). In such a context, AI-based smart HRM may provide substantial value by enabling organizations to predict workforce shortages, identify competency gaps, improve succession planning, optimize personnel allocation, detect turnover risk, personalize training, and generate early warnings concerning human factors that may affect safety or performance. Yet the same industrial characteristics that increase the potential value of AI also increase the consequences of poorly designed algorithmic systems. A flawed recommendation concerning workforce deployment, competence assessment, or safety-sensitive personnel may have implications extending beyond HR administration to production reliability and occupational or process safety.

The petrochemical context also intensifies the importance of sustainability and responsible management. Contemporary organizations are increasingly expected to align human resource systems with environmental, social, and governance objectives rather than evaluating HR technologies solely in terms of efficiency or cost reduction. AI can contribute to this agenda by improving workforce planning, supporting green competencies, enabling better resource allocation, and strengthening the integration of human capital decisions with environmental and social objectives. A systematic review of AI-supported HR practices for environmental, social, and governance integration has highlighted the growing role of artificial intelligence in shaping sustainable business strategies and connecting HR transformation with broader sustainability priorities (Zulkarnaini et al., 2025). Likewise, research examining organizational smart technology, AI, robotics, and algorithmic capability has demonstrated that these capabilities may contribute to green human resource management and environmental sustainability when they are strategically integrated into organizational practices (Ogbeibu et al., 2024). For the petrochemical industry, this linkage is especially relevant because human behavior, process discipline, training, safety practices, and environmental performance are interdependent. Therefore, the concept of smart HRM in this industry should encompass not only productivity and workforce efficiency but also employee well-being, safety, responsible technology use, environmental considerations, and long-term organizational resilience.

Despite these opportunities, the implementation of smart and sustainable HRM in the petrochemical industry is subject to significant contextual barriers. Organizational transformation is frequently constrained by bureaucratic structures, fragmented information systems, limited data quality, insufficient digital capabilities, resistance to change, financial limitations, regulatory uncertainty, and weak coordination between HR and technical departments. Research on barriers to sustainable human resource management in the National Petrochemical Company has shown that the realization of advanced HR practices in this sector is conditioned by a complex set of organizational and environmental obstacles (Omranzadeh & Shakeri, 2024). These barriers become more consequential when AI is introduced because algorithmic systems require reliable, standardized, accessible, and

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secure data as well as clearly defined governance mechanisms. Furthermore, the implementation of AI in HRM raises important questions regarding privacy, transparency, algorithmic bias, fairness, accountability, explainability, and the appropriate boundary between automated recommendations and human managerial authority. These concerns are particularly salient in employment-related decisions because AI outputs may influence recruitment, promotion, performance appraisal, training opportunities, workforce allocation, and retention. Therefore, responsible AI governance must be incorporated into the design of smart HRM rather than treated as a secondary compliance issue after technological implementation.

The governance dimension is especially critical in contexts characterized by distinctive institutional, regulatory, and organizational arrangements. Research on smart human resource governance in Iran's public sector, particularly within the National Iranian Oil Company, has demonstrated that smart HR transformation requires governance mechanisms capable of coordinating technology, data, organizational structures, institutional rules, and human resource policies (Mirzaei et al., 2025). Such findings are highly relevant to the petrochemical industry, where companies may differ significantly in ownership structures, organizational autonomy, contractor arrangements, regulatory obligations, technological maturity, and access to financial and technical resources. The design of AI-based HRM must therefore account for these differences rather than assuming that a standardized model developed in another organizational or national setting can be transferred directly. The Iranian industrial environment also includes contextual conditions such as technological sanctions, exchange-rate volatility, restrictions on access to international software and platforms, domestic knowledge-based technology providers, and distinctive labor and data governance requirements. These conditions can simultaneously constrain technological adoption and create incentives for local innovation. Consequently, an indigenous model is needed to explain how organizations can combine international developments in AI and smart HRM with the institutional, cultural, technological, economic, and operational characteristics of the Iranian petrochemical sector.

This need for contextualization is reinforced by the fact that the relationship between AI and HRM is inherently multidimensional. An organization may possess advanced software but lack trustworthy data; it may possess data but lack analytical competence; it may possess technical competence but face employee resistance; or it may possess all of these capacities but lack clear ethical and governance principles for high-stakes decisions. Smart HRM therefore depends on the alignment of technological readiness, data readiness, human capability, organizational readiness, leadership commitment, cultural acceptance, and governance structures. Furthermore, the adoption process is unlikely to be linear. Organizations may need to begin with limited, low-risk applications, evaluate their outcomes, build confidence among stakeholders, improve data infrastructure, and gradually scale intelligent solutions across HR functions. This dynamic-capability perspective is consistent with the argument that Smart HRM 4.0 should enable organizations to sense changes, seize technological opportunities, and reconfigure organizational resources in response to evolving competitive conditions (Pillai & Srivastava, 2022). It also corresponds with the broader transition from traditional HRM to smart HRM, in which intelligence emerges from the interaction between technological systems, organizational routines, and human decision-makers rather than from automation alone (Kambur & Yildirim, 2023).

Another critical issue concerns the balance between algorithmic intelligence and human judgment. AI can increase analytical speed, identify hidden relationships, standardize certain evaluations, and provide predictive insights, but employment decisions often involve contextual, ethical, interpersonal, and safety-related considerations that cannot be reduced entirely to numerical optimization. In the petrochemical industry, this issue becomes particularly important because human resource decisions may affect safety-critical positions, technical competence, team coordination, shift arrangements, and operational reliability. Therefore, the objective should not be to remove humans from HR decision-making but to create a human-in-the-loop system in which AI strengthens managerial decision capacity while accountability remains clearly assigned. The growth of AI-powered HR transformation documented in contemporary literature demonstrates the considerable potential of algorithmic technologies but also underscores the need for governance frameworks that integrate technological innovation with responsible organizational decision-making (Bian et al., 2025). Similarly, studies of AI in Iranian organizations indicate that effective implementation requires attention not only to technology but also to organizational structures, human capabilities, and the conditions under which AI-generated information is interpreted and used (Rahdarpour et al., 2024). Thus, human-centeredness is not incompatible with technological intelligence; rather, it is a necessary principle for ensuring that AI enhances rather than undermines the strategic and social functions of HRM.

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A further gap in the literature concerns the integration of safety with smart human resource management. Much of the existing discourse emphasizes recruitment efficiency, performance, innovation, digital transformation, or organizational productivity, whereas in high-risk industries such as petrochemicals, human resource intelligence must also be connected to HSE and process-safety objectives. Workforce fatigue, inadequate competence, inappropriate job-person fit, insufficient training, succession gaps, excessive workload, and poor workforce allocation can become precursors to operational error and safety events. Intelligent HR systems may therefore have the potential to combine human resource, operational, and HSE information to support early risk detection, targeted competency development, safer workforce deployment, and more informed managerial decisions. The technological architecture described in smart HR research provides foundations for such integration (Rastgar et al., 2022b), while technology-oriented requirements identified in the literature emphasize the importance of infrastructure and organizational readiness for advanced HR analytics (Rastgar et al., 2022a). However, there remains a need to conceptualize how safety should be embedded directly into the architecture and governance of AI-based HRM, especially within the distinctive operational environment of petrochemical organizations.

The available studies therefore provide valuable but fragmented insights. Existing scholarship has examined the transition from traditional HRM to smart HRM (Kambur & Yildirim, 2023), the performance implications of Smart HRM 4.0 (Pillai & Srivastava, 2022), technology-oriented foundations and architecture (Rastgar et al., 2022a, 2022b), the contribution of smart HRM to innovation (Al-Faouri et al., 2024), big-data-supported HR frameworks (Zhao, 2024), AI-driven digital transformation of HRM (Bian et al., 2025), managerial behavior in the digital age (Abdollahzadeh Namini et al., 2024), and the role of AI in Iranian HRM contexts (Rahdarpour et al., 2024). Other studies have emphasized smart HR governance in Iran's oil-sector institutions (Mirzaei et al., 2025), personnel infrastructure in gas and petrochemical clusters (Daniali et al., 2022), barriers to sustainable HRM in petrochemical organizations (Omranzadeh & Shakeri, 2024), the relationship between smart technologies and green HRM (Ogbeibu et al., 2024), and AI-enabled integration of HR practices with sustainability and ESG strategies (Zulkarnaini et al., 2025). Nevertheless, these streams have rarely been integrated into a comprehensive indigenous theoretical model that simultaneously incorporates AI, data intelligence, human-centeredness, governance, organizational readiness, industrial safety, contextual constraints, and sustainability within the petrochemical sector.

Accordingly, a grounded theory approach is particularly suitable for addressing this gap because the phenomenon under investigation is still evolving, context dependent, and shaped by interactions among technological, organizational, human, institutional, and industrial factors. Rather than imposing a predefined model derived from other sectors, grounded theory makes it possible to generate categories and relationships from the experiences of managers and experts who are directly involved with human resources, digital transformation, information technology, strategic planning, organizational excellence, HSE, and operational processes. Such an approach can reveal not only the technological components of smart HRM but also the causal pressures that make transformation necessary, the organizational conditions that facilitate or constrain it, the external and intervening factors that shape implementation, the strategies required for responsible deployment, and the range of human, operational, economic, safety, strategic, resilience, and sustainability outcomes that may result. Developing such an integrated model can contribute theoretically by clarifying the architecture of AI-based smart HRM in a high-risk industrial setting and practically by providing petrochemical organizations with a contextually grounded framework for planning and governing intelligent HR transformation.

Therefore, the aim of the present study was to design an indigenous AI-based smart human resource management model for the petrochemical industry using a grounded theory approach.

2. Methods and Materials

In terms of purpose, the present study was applied, and in terms of nature, it was qualitative. It was conducted using grounded theory based on the systematic approach developed by Strauss and Corbin. This method was selected because of the complex and context-dependent nature of smart human resource management and the need to develop an indigenous model grounded in the experiences and perspectives of actors associated with the petrochemical industry. In this approach, data collection and

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analysis are conducted simultaneously and iteratively, while concepts and relationships among categories gradually emerge through the continuous comparison of data.

The research participants included managers, specialists, and experts with direct experience or relevant expertise in the petrochemical industry in areas such as human resource management, information technology and digital transformation, safety and HSE, strategic planning, organizational excellence, and process management. Participants were initially selected through purposive and snowball sampling; subsequently, as emerging concepts and conceptual gaps became evident, the logic of theoretical sampling was adopted. The principal criterion for participant selection was sufficient experience and knowledge of human resource management issues, technology, and the organizational conditions of the petrochemical industry. The primary data collection instrument was semi-structured interviews. The interview guide was developed according to the logic of the grounded theory paradigm model and covered dimensions such as causal conditions, the central phenomenon, contextual conditions, intervening conditions, action–interaction strategies, and consequences. The flexibility of semi-structured interviewing allowed follow-up questions to be posed in accordance with participants' responses and emerging concepts, in addition to the predetermined themes. Each interview was recorded after obtaining participants' informed consent and was subsequently transcribed verbatim. Data collection continued until theoretical saturation was achieved. A total of 12 interviews were conducted. The analytical process demonstrated that almost all major categories had been identified by the ninth and tenth interviews. The tenth and eleventh interviews primarily contributed to elaborating relationships among the concepts, while the twelfth interview generated no new major category or fundamental relationship. Accordingly, given the substantial decline in the emergence of new concepts and the recurrence of previously identified relationships, the theoretical adequacy of the data and theoretical saturation were confirmed. Data analysis was conducted concurrently with data collection using the constant comparative method. During open coding, the interview transcripts were examined line by line and conceptually, and initial codes were extracted. Similar codes were merged, ambiguous codes were refined, and broad concepts were decomposed into more precise components. This process continued consistently from one interview to another to preserve the connection among raw data, concepts, and categories. During axial coding, the concepts generated through open coding were compared and organized into main and subcategories. Relationships among categories were also examined according to the logic of causal conditions, the central phenomenon, contextual conditions, intervening conditions, strategies, and consequences. At this stage, the objective was not merely the thematic classification of data; rather, an effort was made to identify the conceptual position of each category within the paradigmatic structure and explain its relationship with other components of the model.

During selective coding, the major categories were integrated around a core category, and the storyline of the study was developed. At this stage, relationships among the categories were once again compared with the primary data, and the final model was formulated through theoretical integration. MAXQDA software was used for qualitative data management and analysis. To ensure the rigor and trustworthiness of the findings, Lincoln and Guba's criteria of credibility, transferability, dependability, and confirmability were applied. Credibility was strengthened through the purposive selection of experienced participants, disciplinary diversity within the sample, constant comparison of data, continuation of analysis until theoretical saturation, and review of codes and categories. Dependability was addressed through the systematic implementation of the analytical stages, documentation of the coding process, and maintenance of an audit trail. To enhance confirmability, the linkage among interview transcripts, codes, and categories was maintained, and analytical decisions were documented. Furthermore, by describing the research context, participants' professional characteristics, and the organizational and operational conditions of the petrochemical industry, sufficient information was provided to enable judgments regarding the transferability of the findings to similar contexts.

3. Findings and Results

In this study, 12 managers, specialists, and experts associated with the petrochemical industry participated in the interview process. The composition of the participants was designed to cover the domains of human resource management, organizational transformation, information technology, data analytics, strategic planning, organizational excellence, HSE, and process safety. Most participants had extensive professional experience in the petrochemical industry and related fields, including several managers with more than two decades of professional experience. This disciplinary diversity enabled smart human resource management to be examined from human, organizational, technological, operational, and safety perspectives.

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Table 1. Characteristics of the Research Participants

Code	Main Field/Position	Approximate Experience	Education/Main Specialization	Area of Experience
I01	Senior Manager of Human Resources and Organizational Transformation	24 years	Master's degree in Strategic Human Resource Management	HR, organizational transformation, petrochemical industry
I02	Human Resources and Administrative Affairs Manager	20 years	PhD in Executive Management	HR, administrative affairs, petrochemical holding company
I03	Human Resources Manager/Consultant	22 years	Master's degree in Strategic Human Resource Management	HR, empowerment, and training
I04	Human Resources and Contractor Affairs Manager	16 years	Master's degree in Business Administration	Contractor management and workforce supply
I05	Human Resources Manager and Academic Faculty Member	18 years	PhD in Public Administration	HR, higher education, petrochemical industry
I06	Health, Safety, Environment, and Process Manager	24 years	Master's degree in Process and Safety Engineering	HSE and process safety
I07	Information Technology Manager	20 years	PhD in Information Technology Management	HRIS, BI, digital transformation
I08	Organizational Excellence and Strategic Planning Manager	19 years	Strategic Management and Organizational Excellence	Planning, excellence, process improvement
I09	Expert/Manager Associated with Smart Human Resource Management	—	—	Petrochemical industry
I10	Senior Human Resource Transformation Consultant	More than 20 years	PhD in Management	SHRM, HR analytics, safety, and sustainability
I11	Human Resources Manager	28 years	Master's degree in Public Administration–Human Resources	Human resources in the oil, gas, and petrochemical industries
I12	Petrochemical Human Resources Manager	25 years	Master's degree in Strategic Management	Human resource management and petrochemical industry

Following transcription of the interviews, data analysis began by segmenting the text into meaning units. During open coding, initial codes were extracted while maintaining close correspondence with participants' language and experiences. Subsequently, through constant comparison, similar codes were organized into concepts, subcategories, and main categories. During axial coding, relationships among categories were examined, and their positions within the paradigmatic structure were determined. Finally, during selective coding, the major categories were theoretically integrated around the core category. Examination of the theoretical saturation process indicated that nearly all major categories had been established by the ninth and tenth interviews. The tenth and eleventh interviews mainly contributed to elaborating and refining relationships among existing categories, while the twelfth interview produced no new major category, fundamental relationship, or negative case. Accordingly, given the marked reduction in newly emerging concepts and the recurrence of existing relationships, theoretical saturation was confirmed at the conclusion of the twelfth interview.

Analysis and integration of the data indicated that smart human resource management in the petrochemical industry cannot be regarded merely as a consequence of adopting digital technologies or using artificial intelligence. Rather, its formation results from the interaction of environmental and organizational pressures, internal organizational capabilities, contextual and intervening conditions, and managerial strategies. Accordingly, the paradigmatic model developed in this study was organized into six components: causal conditions, the central phenomenon, contextual conditions, intervening conditions, action–interaction strategies, and consequences.

Table 2. Components of the Final Paradigmatic Model

Model Component	Main Categories
Causal Conditions	Inefficiency of the traditional HR system; complexity and risk of the petrochemical industry; human capital market pressures; need for forward-looking decision-making; pressures arising from digital transformation and competition
Central Phenomenon	Indigenous and human-centered transformation of human resources through data-driven, safe, and sustainable intelligence
Contextual Conditions	Organizational structure and culture; organizational type and ownership; data readiness; technological readiness; human and digital readiness and competencies; organizational and leadership readiness; operational and geographical characteristics
Intervening Conditions	Sanctions; economic and financial conditions; laws and regulations; industrial accidents and crises; climate change; knowledge-based companies; technological developments
Strategies	Gradual implementation; data integration and governance; competency development; change management; responsible AI governance; safety by design; localization; cross-functional governance; paradox management
Consequences	Improved decision-making; human outcomes; operational and economic outcomes; safety; strategic outcomes and resilience; sustainability

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The final analysis of the categories indicated that smart human resource management in the petrochemical industry cannot be explained as a linear or exclusively technological process. Rather, it results from the interaction among organizational and industrial imperatives, contextual and intervening conditions, and action–interaction strategies. The structure of the paradigmatic model is presented in Figure 1.

Gradual implementation; data integration and governance; competency development; change management; responsible AI governance; safety by design; localization; cross-functional governance; paradox management

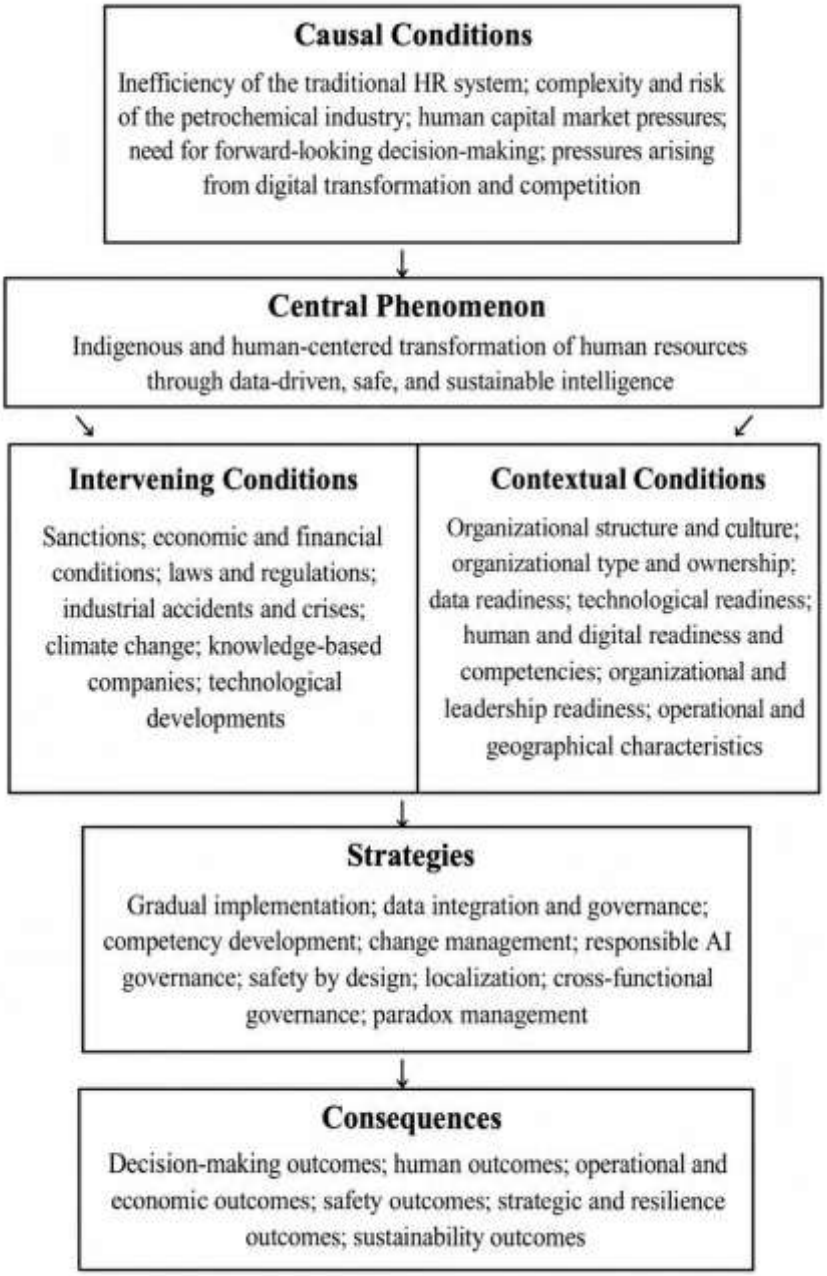


Figure 1. Indigenous Paradigmatic Model of AI-Based Smart Human Resource Management in the Petrochemical Industry

As illustrated in Figure 1, the inefficiency of the traditional human resource management system, the complexity and risk inherent in the petrochemical industry, human capital market pressures, the need for forward-looking decision-making, and the pressures arising from digital transformation and competition constitute the causal conditions underlying the transformation. These conditions necessitate the transition toward an indigenous, data-driven, predictive, and human-centered system. In this

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context, organizational structure and culture, ownership type, organizational readiness, data readiness, technological readiness, and human and digital competencies establish the foundation for implementing this transformation. At the same time, factors such as sanctions, economic conditions, laws and regulations, industrial accidents, climate conditions, the capabilities of knowledge-based companies, and technological developments may either facilitate or constrain the implementation of the relevant strategies.

In response to these conditions, a set of interconnected strategies emerges, including gradual and problem-oriented implementation, data integration and governance, competency development, change management, responsible AI governance, preservation of the human role in sensitive decisions, safety by design, localization, cross-functional governance, and paradox management. Implementing these strategies can improve decision-making quality, enhance productivity, support talent retention and development, improve the employee experience, reduce costs and errors, enhance safety, increase resilience, and strengthen organizational sustainability.

Causal Conditions

Causal conditions refer to the set of factors that create or intensify the need to transition from traditional human resource management to smart human resource management. Data analysis revealed five major categories in this domain: inefficiency of the traditional human resource management system, complexity and risk of the petrochemical industry, human capital market pressures, the need for rapid and forward-looking decision-making, and pressures arising from digital transformation and competition. Inefficiency of the traditional human resource management system. One of the most frequently recurring themes in the interviews concerned the limitations of the traditional human resource management system. From the participants' perspectives, this system was predominantly reactive, slow, bureaucratic, retrospective, and reliant on experience and intuition. Manual processes, periodic and subjective evaluations, fragmented information, and the absence of analytical and predictive capabilities have reduced its ability to respond effectively to the complex requirements of the industry. Complexity, sensitivity, and risk of the petrochemical industry. The second factor concerns the specific nature of the petrochemical industry. Within this industry, employees' knowledge, skills, and behaviors are closely connected to production, safety, and operational continuity. Consequently, human resource decisions do not merely have administrative implications but may also generate operational and safety consequences. This characteristic reinforces the need for a more accurate, rapid, and intelligent human resource management system. Human capital market pressures. Shortages of specialized personnel, migration, turnover among key employees, retirement of experienced personnel, competition for talent acquisition, and skill gaps were repeatedly identified during the interviews. Such conditions increase the need for capabilities such as predicting employee turnover, identifying appropriate successors, diagnosing competency gaps, and developing targeted plans for human capital development and retention. The need for forward-looking decision-making. Another contributing factor was the limited ability of traditional systems to anticipate future challenges. Within these systems, information is generally recorded and analyzed after events have occurred, whereas smart human resource management requires a transition from reactive decision-making toward early identification of emerging issues and prediction of future conditions. Pressures arising from digital transformation and competition. The development of digital technologies, data analytics, and artificial intelligence, combined with increasing organizational competition, has made continued reliance on traditional approaches increasingly difficult. These conditions encourage petrochemical companies to adopt more systematic applications of data and intelligent technologies in human resource decision-making.

Central Phenomenon

During axial coding, the phenomenon under investigation was initially conceptualized as the "transition toward an indigenous, smart, data-driven, predictive, and human-centered human resource management system." Through theoretical integration during selective coding, this concept was subsequently defined as the final central phenomenon of "indigenous and human-centered transformation of human resources through data-driven, safe, and sustainable intelligence." This phenomenon consists of several interconnected characteristics: data-driven decision-making, referring to the reliance of decisions on valid data and evidence; integration, referring to the elimination of fragmented and siloed data and processes; prediction, aimed at the early identification of future conditions; decision support, referring to the use of artificial intelligence to assist managers without completely replacing human judgment; personalization of human resource interventions according to the individual and job; human-centeredness and avoidance of reducing individuals to algorithmic outputs; indigenous adaptation of the system to the conditions of Iran's petrochemical industry; safety orientation through incorporation of safety considerations from the

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design stage; and, finally, sustainability, whereby value creation extends beyond economic productivity to encompass human, safety, and environmental dimensions.

Contextual Conditions

Contextual conditions constitute the immediate organizational and operational environment within which smart human resource management is implemented. Data analysis indicated that the success of HR digital intelligence depends on multidimensional organizational readiness. This readiness can be explained across several principal domains, including organizational structure and culture, organizational type and ownership, organizational and leadership readiness, data readiness, technological readiness, human and digital readiness and competencies, and operational, occupational, and geographical characteristics. Organizational structure and culture. The degree of bureaucracy, hierarchy, transparency, learning culture, data-driven culture, and cultural readiness to accept change were among the components capable of influencing the implementation of smart human resource management. In organizations characterized by restricted information flows, centralized decision-making, and strong cultural resistance to change, the capacity to leverage intelligent technologies is correspondingly more limited. Organizational type and ownership. The data demonstrated that differences in ownership type and organizational structure can alter the priorities associated with HR digital intelligence. In some state-owned companies, compliance, accountability, safety, transparency, and succession planning were more prominent, whereas in some private companies greater emphasis was placed on speed, productivity, and talent attraction and retention. Differences between principal companies and contractors also influence the requirements and priorities associated with implementing smart human resource systems. These differences should be interpreted as patterns observed within the data rather than as definitive rules applicable to all organizations. Organizational and leadership readiness. Senior management support, the existence of strategic orientation, resource and budget allocation, project ownership, and the capacity to coordinate different organizational units constituted the principal components of this type of readiness. Successful implementation of smart human resource management becomes possible when this transformation is recognized as a strategic organizational issue rather than being assigned exclusively to the human resources or information technology departments. Data readiness. Data quality represented one of the fundamental elements of the model. Accuracy, completeness, timeliness, integration, standardization, analyzability, security, and controlled accessibility were among the most important dimensions of data readiness. Merely possessing a large volume of data does not indicate readiness; data become valuable when they are reliable, consistent, and usable for analysis and decision-making. Technological readiness. The availability of human resource information systems, network infrastructure, processing and storage capacity, analytical tools, information security, and interoperability among systems were identified as additional contextual requirements. Furthermore, the ability to establish connections between human resource systems and operational and HSE systems is of particular importance in the petrochemical industry. Human and digital readiness and competencies. Digital literacy, data literacy, analytical capability, knowledge of technology and artificial intelligence, professional HR competencies, and the ability of HR, IT, HSE, and operations specialists to collaborate were major components of this category. This finding indicates that smart transformation without the simultaneous development of human capabilities risks being reduced to a purely technological project. Finally, operational, occupational, and geographical characteristics also constituted part of the context in which the model is implemented. The process-oriented and high-risk nature of the industry, shift work, climatic conditions, geographical dispersion of facilities, and differences among permanent, contracted, and project-based personnel can all affect the design and implementation of a smart human resource management system. F1(1)

Intervening Conditions

Intervening conditions are factors that may facilitate, constrain, or shape the implementation of smart HRM strategies. In the present study, sanctions, economic and financial conditions, laws and regulations, industrial accidents and crises, climatic and environmental conditions, the capabilities of knowledge-based companies, and technological developments were identified as the principal intervening conditions. Sanctions demonstrated a dual nature: on the one hand, they restrict access to foreign technologies, software, and knowledge; on the other hand, they may stimulate the development of indigenous solutions. Economic conditions and exchange-rate fluctuations likewise affect an organization's capacity to invest in digital transformation. Labor laws, regulations concerning employee data, privacy requirements, and legal ambiguities surrounding the application of artificial intelligence may constrain or regulate the scope within which data and algorithms can be used. Industrial accidents and crises may increase managerial sensitivity toward preventive and predictive capabilities. Climatic and environmental conditions, particularly heat and difficult working environments, are also associated with fatigue, employee

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health, and the likelihood of human error, thereby increasing the need for solutions tailored to environmental conditions. Conversely, knowledge-based companies and domestic technology providers may play a facilitating role by developing indigenous technologies and reducing dependence on foreign solutions. Rapid technological developments also continually generate new opportunities and constraints for smart human resource management.

Action–Interaction Strategies

Data analysis indicated that implementing smart human resource management requires a coordinated set of strategies. Nine principal strategies were identified: gradual and problem-oriented implementation; establishment and governance of data infrastructure; development of human capabilities and competencies; change management and trust building; responsible AI governance; safety by design; localization; paradox management; and cross-functional governance.

The first strategy is gradual and problem-oriented implementation. According to this strategy, smart transformation should begin with a real, bounded, low-risk, and measurable problem and should subsequently be expanded to other domains after piloting, evaluation, and organizational learning. The logic of this strategy begins with problem identification and continues through data assessment, selection of a value-creating project, pilot implementation, evaluation, refinement, and scaling. The second strategy concerns the establishment, integration, and governance of data infrastructure. Data cleansing and standardization, quality enhancement, systems integration, establishment of access rules, security provision, and preparation of data for analysis constitute the main components of this strategy. Under this logic, the development of artificial intelligence capabilities should occur only after the necessary data infrastructure has been adequately prepared. The third strategy concerns the development of human capabilities and competencies, emphasizing improvement in digital and data literacy, analytical skills, understanding of artificial intelligence, and the ability of human resource professionals to collaborate effectively with technical units. Alongside this strategy, change management and trust building are pursued through training, employee participation, transparency, the use of change champions, demonstration of early successes, and explicit redesign of organizational roles. The logic underlying this strategy is that participation and transparency enhance trust, which ultimately strengthens technology acceptance. Responsible artificial intelligence governance constitutes another central strategy. Privacy protection, security, fairness, bias control, transparency, explainability, accountability, and clear specification of the limits of algorithmic authority constitute its principal elements. In sensitive decisions, humans should remain in the decision-making loop and retain the authority to modify or reject algorithmic recommendations. The safety-by-design strategy is based on the principle that safety considerations should be embedded in the intelligent system from the initial stages of design. Integration of HR data with HSE and operational data, monitoring of human factors, targeted safety training, risk prediction, and analysis of human error are manifestations of this strategy. Localization and contextual fit also occupy an important position within the model. Localization does not simply mean using domestically developed software; rather, it involves adapting solutions to the country's and industry's economic, institutional, cultural, organizational, operational, and HSE conditions. In addition, management of smart transformation paradoxes requires establishing a balance between productivity and safety, transparency and privacy, algorithmic decision-making and human judgment, speed and accuracy, standardization and personalization, and automation and job security. Finally, cross-functional governance emphasizes coordinated collaboration among human resources, information technology, HSE, operations, and senior management, as well as clear specification of roles, responsibilities, and project ownership.

Consequences

The consequences of the model were classified into six principal levels: decision-making outcomes, human outcomes, operational and economic outcomes, safety outcomes, strategic and resilience outcomes, and sustainability outcomes. At the decision-making level, improved decision quality and speed, reduced reliance on purely intuitive judgment, enhanced predictive capability, and early detection of emerging problems were among the most important outcomes. At the human level, reduced turnover, talent retention, improved recruitment, targeted training, strengthened succession planning, increased employee satisfaction, and enhanced employee experience were identified. In the operational and economic dimension, increased productivity and efficiency, reduced errors, shorter process cycle times, more effective workforce allocation, lower administrative costs, and reduced costs arising from inappropriate decisions were identified. In the safety domain, reduction of human error, early risk detection, increased preventive capacity, improved safety training, and enhanced HSE decision-making constituted major outcomes. At the strategic level, transformation of the HR function from a predominantly administrative role toward a more strategic role, improvement in the organization's ability to manage the future workforce, and enhanced

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organizational flexibility and resilience were emphasized. With respect to sustainability, employee health and well-being, green behaviors, more efficient resource utilization, reduced environmental impacts, and stronger alignment between human capital and organizational sustainability objectives were highlighted.

During selective coding, the categories and relationships developed through axial coding were integrated at a higher level of abstraction. This process resulted in the extraction of the core category entitled "indigenous and human-centered transformation of human resources through data-driven, safe, and sustainable intelligence." This core category indicates that smart transformation of human resource management in the petrochemical industry is not limited merely to increased technology use or process automation. Rather, it requires simultaneous transformation in decision-making logic, data quality and integration, human capabilities, technology governance, safety, and alignment with indigenous contextual conditions. Accordingly, the core category connects the other components of the model within a unified theoretical logic. Based on theoretical integration, the final definition of smart human resource management developed in this study is as follows:

"Smart human resource management is an indigenous and integrated system for transforming human resource decision-making and processes that, through the responsible use of data, analytics, and artificial intelligence, develops predictive, personalized, adaptive, and decision-support capabilities and, while preserving human judgment, safety, and ethical requirements, seeks to create human, operational, and sustainable value for the organization."

Accordingly, the central theoretical proposition of the study is formulated as follows:

"The transformation of human resources into a smart system in the petrochemical industry leads to sustainable value creation when data-driven and artificial intelligence capabilities are deployed within a context characterized by multidimensional organizational readiness, responsible governance, human–machine collaboration, safety orientation, and adaptation to indigenous conditions."

4. Discussion and Conclusion

The present study developed an indigenous AI-based smart human resource management model for the petrochemical industry through a grounded theory approach. The findings showed that smart HRM in this context is not adequately explained as a simple process of digitalization, software adoption, or automation of conventional HR activities. Rather, it represents a multidimensional organizational transformation generated through the interaction of causal pressures, contextual readiness, intervening conditions, coordinated managerial strategies, and a wide range of human, operational, safety, strategic, and sustainability consequences. The central phenomenon that emerged from the analysis was defined as an indigenous and human-centered transformation of human resources through data-driven, safe, and sustainable intelligence. This finding is consistent with the broader transition described in the literature from traditional HRM toward smart HRM, in which digital technologies alter not only HR tools but also the architecture, decision logic, and strategic position of the HR function (Kambur & Yildirim, 2023). It also aligns with the dynamic capability perspective on Smart HRM 4.0, which argues that intelligent HR systems create value when they enable organizations to sense change, seize technological opportunities, and reconfigure human and organizational resources in support of performance (Pillai & Srivastava, 2022). The present findings extend these perspectives by showing that, in the petrochemical industry, smart HRM must simultaneously incorporate data intelligence, human judgment, safety considerations, sustainability, and contextual adaptation.

With regard to causal conditions, the findings indicated that the transition toward smart HRM is primarily driven by the inefficiency of traditional HR systems, the complexity and risk of the petrochemical industry, human capital market pressures, the need for forward-looking decision-making, and the pressures of digital transformation and competition. Participants characterized traditional HR systems as reactive, bureaucratic, fragmented, and overly dependent on experience and intuition. This result is in line with the argument that traditional HR systems are increasingly inadequate in environments requiring real-time responsiveness, integration, and analytics-based decisions (Kambur & Yildirim, 2023). The finding also corresponds with studies emphasizing the growing need for AI-supported digital transformation of HRM, particularly where organizations must manage large volumes of data and increasingly complex workforce requirements (Bian et al., 2025). The emphasis placed by participants on predictive capability is especially important because it signals a transition from retrospective reporting toward anticipatory workforce management. This interpretation is supported by research on big-data-assisted smart HRM frameworks, which demonstrates how integrated data can support more effective enterprise resource planning and intelligent

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human resource decisions (Zhao, 2024). In the Iranian context, the growing importance of AI technologies in HRM has also been associated with improved analytical capacity, faster processes, and more informed decision-making (Rahdarpour et al., 2024).

The findings further showed that the specific nature of the petrochemical industry intensifies the need for smart HRM. Unlike sectors in which HR decisions mainly affect administrative efficiency, in petrochemical organizations personnel-related decisions may directly influence production continuity, process reliability, occupational safety, and environmental performance. This explains why participants repeatedly linked workforce competence, deployment, retention, and succession with operational and safety outcomes. This result is compatible with research on human resource infrastructure in Iran's gas and petrochemical cluster, which emphasizes the strategic importance of aligning workforce supply and capability with the specific developmental and operational requirements of the sector (Daniali et al., 2022). The current study adds to this literature by demonstrating that AI-based HRM in petrochemicals should not merely address talent acquisition and productivity but should also function as part of the organization's risk management and resilience architecture. This sector-specific finding also explains why a generic smart HR model may be insufficient for petrochemical companies.

The central phenomenon identified in the study was an indigenous and human-centered transformation of HR through data-driven, safe, and sustainable intelligence. This conceptualization reflects several dimensions: evidence-based decision-making, data and process integration, prediction, personalization, decision support, preservation of human judgment, local adaptation, safety orientation, and sustainability. The finding that human-centeredness must remain central is particularly important because AI-based HR systems can easily drift toward excessive automation or reduction of employees to numerical outputs. The literature on AI-enabled HR transformation similarly suggests that technological capability should be complemented by governance arrangements that preserve accountability and responsible decision-making (Bian et al., 2025). Research on smart HR governance in the Iranian public sector also supports the need for institutional mechanisms capable of coordinating technology, data, organizational processes, and human resource policies (Mirzaei et al., 2025). Therefore, the current model reinforces the view that the objective of AI in HRM should not be replacement of managerial judgment but augmentation of decision quality through structured human-machine collaboration.

The contextual conditions identified in the study included organizational structure and culture, ownership type, organizational and leadership readiness, data readiness, technological readiness, human and digital competencies, and operational and geographical characteristics. These findings strongly support the idea that smart HRM is a socio-technical transformation rather than a technological installation. Research on smart human resource architecture has similarly emphasized the importance of structural coherence among digital technologies, organizational processes, human competencies, and management systems (Rastgar et al., 2022b). Likewise, research on the technology-oriented foundations of smart HRM has shown that organizations require readiness in technology, culture, structure, and competencies before intelligent HR practices can function effectively (Rastgar et al., 2022a). The current findings provide further specification by showing that readiness is multidimensional and that weaknesses in any one dimension may constrain the entire transformation process. For example, an organization may have sophisticated software but poor data quality, or strong infrastructure but insufficient digital literacy, leading to limited practical value.

Data readiness emerged as one of the most fundamental contextual conditions. Participants emphasized data accuracy, completeness, timeliness, integration, standardization, security, controlled access, and analytical usability. This result directly aligns with research emphasizing the centrality of big data and integrated information architectures in smart HRM (Zhao, 2024). It also explains why AI projects frequently fail to create value when organizations attempt to build predictive models on fragmented or unreliable databases. In practical terms, the finding suggests that AI capability should be viewed as downstream from data governance rather than as a substitute for it. This interpretation is also compatible with the broader smart HR literature, which treats information architecture as a core component of digital HR transformation (Rastgar et al., 2022b). Thus, the present study supports a sequencing logic in which data infrastructure, governance, and standardization precede advanced AI implementation.

Organizational and leadership readiness was another major contextual factor. The findings indicated that senior management support, strategic orientation, resource allocation, project ownership, and cross-unit coordination are essential for successful

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smart HRM. This supports previous research showing that digital transformation depends heavily on managerial behavior, leadership capability, and the ability to coordinate organizational change (Abdollahzadeh Namini et al., 2024). The current findings suggest that smart HRM should not be delegated exclusively to HR or IT departments because its implementation requires coordinated decisions involving strategy, operations, HSE, technology, and senior leadership. This cross-functional requirement is especially important in petrochemical companies, where HR-related analytics may need to interact with operational and safety data. Therefore, leadership commitment must be translated into institutional ownership and coordinated governance rather than limited to symbolic support.

The intervening conditions identified in this study included sanctions, economic and financial constraints, legal and regulatory requirements, industrial accidents and crises, climatic conditions, knowledge-based companies, and technological developments. These findings demonstrate that smart HRM is shaped by external institutional and environmental conditions as well as internal organizational readiness. The dual role of sanctions was particularly noteworthy. Participants regarded sanctions as restrictive because they limit access to software, technology, and international expertise, but also as a potential stimulus for domestic innovation and localization. This finding is consistent with the broader need for context-specific HR governance models in Iran (Mirzaei et al., 2025). The importance of domestic knowledge-based companies similarly reflects the need to reduce technological dependence while developing solutions that are better aligned with local conditions. The identified legal and regulatory issues, including privacy, employee data protection, and uncertainty regarding AI-enabled decisions, also reinforce the importance of responsible governance as an integral part of smart HRM rather than an afterthought.

The action–interaction strategies extracted from the data included gradual and problem-oriented implementation, data integration and governance, competency development, change management and trust building, responsible AI governance, safety by design, localization, paradox management, and cross-functional governance. The strategy of gradual implementation is especially consistent with the logic of dynamic capabilities and organizational learning. Rather than introducing AI on a large scale, the findings suggest that organizations should begin with bounded, low-risk, measurable problems, evaluate early results, refine systems, and then scale successful applications. This incremental logic is compatible with the perspective that smart HRM capabilities develop through iterative organizational reconfiguration rather than one-time technological adoption (Pillai & Srivastava, 2022). It also reflects the practical reality that trust in AI must be built over time through visible and credible outcomes.

Competency development and change management were also prominent strategies. Participants emphasized digital literacy, data literacy, analytical capability, AI understanding, and collaboration between HR and technical functions. This finding is consistent with studies showing that managerial and employee behavior is critical in the digital era and that successful transformation requires behavioral adaptation alongside technology adoption (Abdollahzadeh Namini et al., 2024). It also aligns with research suggesting that smart HRM can improve innovation performance when technology is embedded within suitable HR practices and organizational capabilities (Al-Faouri et al., 2024). In other words, the benefits of AI are mediated by the competencies of the people who interpret, govern, and apply the technology. This finding challenges deterministic assumptions that technological investment alone will automatically improve HR effectiveness.

Responsible AI governance was another major strategy. The findings emphasized privacy, fairness, bias control, transparency, explainability, accountability, and maintaining humans in the decision loop for sensitive employment decisions. These findings closely align with the governance-oriented perspective of smart HRM identified in the Iranian context (Mirzaei et al., 2025). They are also consistent with the broader literature on AI-driven HR transformation, which increasingly emphasizes the need to balance automation with ethical and institutional safeguards (Bian et al., 2025). The current study therefore adds an important sectoral dimension: in petrochemical organizations, responsible AI governance is not only a matter of employee rights but also a potential contributor to operational and safety reliability.

Safety by design emerged as one of the most distinctive strategies in the model. Participants argued that safety should be embedded in smart HR systems from the initial design stage rather than added later. This means integrating HR data with HSE and operational information, monitoring human factors, predicting risk, targeting safety training, and supporting safer workforce deployment. Although previous smart HR research has strongly emphasized digital architecture and technology-oriented foundations (Rastgar et al., 2022a, 2022b), the present study extends that literature by explicitly positioning safety

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as a design principle of AI-based HRM in a high-risk industry. This is an important theoretical contribution because it shows that the architecture of smart HRM should vary according to sectoral risk characteristics.

The identified consequences included improved decision quality and speed, reduced dependence on intuition, stronger predictive capability, lower turnover, improved talent retention and recruitment, targeted training, stronger succession planning, enhanced productivity, reduced errors and costs, improved safety, greater strategic contribution of HR, stronger resilience, and enhanced sustainability. These outcomes broadly align with previous research linking smart HRM with organizational performance and dynamic capabilities (Pillai & Srivastava, 2022), innovation performance (Al-Faouri et al., 2024), and digital transformation (Bian et al., 2025). The findings also support the growing view that smart HRM can contribute to sustainability. Research has shown that smart technology, AI, robotics, and algorithmic capability can support green HRM and environmental sustainability (Ogbeibu et al., 2024), while AI-supported HR transformation has been increasingly connected to ESG integration and sustainable business strategy (Zulkarnaini et al., 2025). In the present study, however, sustainability was conceptualized more broadly to include employee well-being, safety, efficient resource use, resilience, and environmental considerations.

The findings concerning sustainability are also consistent with research highlighting barriers to sustainable HRM in the National Petrochemical Company (Omranzadeh & Shakeri, 2024). The present model suggests that smart HRM may help overcome some of these barriers by improving information quality, workforce planning, competency development, coordination, and predictive capability. At the same time, the model demonstrates that technology alone cannot resolve structural or cultural barriers. Sustainable value creation requires simultaneous attention to governance, leadership, competencies, organizational culture, and employee trust. This interpretation is important because it avoids an overly optimistic view of AI and instead positions it as one component of a broader organizational transformation.

Overall, the results suggest that the effectiveness of AI-based smart HRM in the petrochemical industry depends on fit rather than technological sophistication alone. The core theoretical proposition of the study is that sustainable value emerges when AI and data-driven capabilities are embedded within multidimensional organizational readiness, responsible governance, human-machine collaboration, safety orientation, and contextual adaptation. This proposition integrates the existing literature on smart HR architecture (Rastgar et al., 2022b), technology-oriented foundations (Rastgar et al., 2022a), dynamic capabilities (Pillai & Srivastava, 2022), innovation performance (Al-Faouri et al., 2024), smart HR governance (Mirzaei et al., 2025), sustainable HRM (Ogbeibu et al., 2024; Zulkarnaini et al., 2025), and sector-specific workforce infrastructure (Daniali et al., 2022). The main contribution of the present study lies in bringing these elements together within a unified grounded model specifically designed for the operational, institutional, and safety conditions of the petrochemical industry.

The present study has several limitations. First, the qualitative nature of the research and the use of 12 expert interviews limit the statistical generalizability of the findings, although theoretical saturation was achieved. Second, participants were selected from individuals with substantial experience in the petrochemical industry, which strengthens contextual depth but may also result in perspectives that differ from those of frontline employees, contractors, union representatives, or technology vendors. Third, the model was developed within the Iranian petrochemical context, and institutional conditions such as sanctions, ownership structures, regulatory arrangements, labor market characteristics, and domestic technological capacity may limit direct transfer to other national settings. Fourth, because the study relied on interview data, the findings reflect participants' interpretations and professional experiences rather than direct measurement of actual AI implementation outcomes. Finally, the study developed a conceptual model but did not quantitatively test the strength of relationships among its components.

Future research should validate the proposed model using quantitative or mixed-method designs across larger samples of petrochemical companies. Structural equation modeling could be used to test the relationships among organizational readiness, data readiness, governance, AI capability, safety orientation, and performance outcomes. Comparative studies between state-owned and private petrochemical companies, principal firms and contractors, or petrochemical organizations in different countries could clarify how contextual conditions modify the model. Longitudinal research would also be valuable for examining how smart HRM capabilities evolve over time and how organizations move from pilot projects to enterprise-wide implementation. Future studies may additionally investigate employee-level outcomes such as trust in AI, perceived fairness,

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privacy concerns, technology acceptance, job insecurity, and psychological safety. Another important line of research would be to examine the integration of HR analytics with operational and HSE data and assess whether predictive HR systems can measurably reduce human error, fatigue-related incidents, competency gaps, or workforce-related safety risks.

For practice, petrochemical companies should approach smart HRM as an organizational transformation program rather than as a software procurement project. Implementation should begin with clearly defined business or workforce problems, supported by reliable data and measurable objectives. Organizations should prioritize data cleansing, integration, governance, cybersecurity, and access rules before deploying advanced AI applications. Senior management should establish cross-functional governance structures involving HR, IT, HSE, operations, legal specialists, and strategic management. Employee participation and transparent communication should be incorporated from the beginning to build trust and reduce resistance. AI should be used as a decision-support mechanism rather than as an autonomous decision-maker in sensitive employment or safety-related matters. Organizations should also develop digital and analytical competencies among HR professionals and managers, integrate safety considerations into system design, and adapt AI solutions to the specific operational, cultural, regulatory, and technological conditions of the petrochemical industry.

Ethical Considerations

All procedures performed in this study were under the ethical standards.

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Conflict of Interest

The authors report no conflict of interest.

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