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Designing an Open Innovation Model for Human Resource Management in the Petrochemical Industry

Yaser. Rashidfarokhi[1,2], Hassan. Darvish[3]*

[1] PhD student in Public Administration, Department of Management, Payam Noor University, Tehran, Iran
[2] Business Administration, Middle-East-Consult, Düsseldorf, Germany
[3] Associate Professor, Department of Public Administration, Payam Noor University, Tehran, Iran

*** Corresponding author email address**: Dr_darvish@pnu.ac.ir

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A B S T R A C T

Objective: The purpose of this study was to design an open innovation model for human resource management in the petrochemical industry.

Method: The population consisted of 17 university professors specialized in human resources and experts and senior managers of the petrochemical industry, selected through purposive sampling. The main tool used in this study was semi-structured interviews, and open, axial, and selective coding methods were used for data analysis with the assistance of MAXQDA 2020 statistical software.

Results: The results of open coding revealed that a total of 215 open codes were identified, forming 83 categories.

Conclusion: Ultimately, the final examination of these categories determined that the most important factors affecting open innovation include human resource management, organizational leadership, knowledge management, organizational infrastructure, collaboration with universities and research institutions, and external participation. Furthermore, organizational structure, information technology capabilities, and social media were identified as intervening factors, while organizational relationships, organizational culture, and managers' emotional intelligence were recognized as contextual factors in the implementation of open innovation. Among the strategies for improving the open innovation paradigm are organizational learning, idea evaluation structures, micro and macro investments, business intelligence, organizational entrepreneurship, and growth centers, leading to organizational readiness, improved absorptive capacity, cultural infrastructure enhancement, knowledge resource updating, intellectual property, outsourcing approach, organizational performance improvement, and market change adaptability.

Keywords: *Petrochemical Industry, Open Innovation, Human Resource Management*

1 Introduction

Among the diverse activities of human resource management, human development is considered one of the most conventional and cost-intensive activities. This activity encompasses acquiring new skills, improving existing skills, behaviors, and effective work methods. Human resource development is related to the training and development activities in organizations, assisting them in creating a specific cultural environment where employees can reach their potential for the benefit of both individuals and organizations. In this context, human resource development closely aligns itself with organizational development (Dirani et al., 2020).

To properly manage human resources, it is essential to enhance the knowledge, information, skills, and capabilities of the employees. Human resource development is not just the result of extensive training; it must be planned and systematic. If we consider the importance of human resources in today's organizations and their developmental role, the distinction between societies and organizations lies in their knowledge and ignorance, and the main challenge among organizations is the competition for knowledgeable and capable human resources (Swanson, 2022).

Recent changes in global markets and the energy sector highlight the reality that without a strategic plan and a clear vision for progress, along with a forward-thinking mental paradigm, success in achieving the goals of the vision document is very slim (Mousavi & Lohrasbi, 2020). This has led to open innovation being recognized as beneficial in both public and private sectors for addressing unknown problems that require novel approaches (Guinan et al., 2013). Accordingly, everything that exists in human resource management principles can also find application in the context of open innovation. For instance, issues such as organizational culture and structure, knowledge management, strategic management, reward systems, training and empowerment are aligned with the open innovation paradigm and are essential for its realization (Mirhadyan et al., 2021).

Examining the determinants of open innovation adoption is important as it explains the choice of open innovation strategy by public organizations. Additionally, identifying and understanding these determinants offer insights into factors that may hinder or facilitate the introduction of a new innovation model in public organizations. Currently, existing knowledge on the determinants of open innovation adoption in the public sector is limited in several ways: (a) prior studies have usually focused on one or a few determinants in a limited number of organizations or diverse policy areas (Mergel, 2021; Smith et al., 2019; Zhang et al., 2017); (b) many studies provide case studies and emphasize deep insights over generalizability (Torfing, 2019); and (c) many studies have focused on descriptive analyses, leading to a theoretical gap for strengthening the theoretical foundations of open innovation research using relevant organizational theories and examining how they extend to explain the phenomenon of open innovation in the public sector (Kankanhalli et al., 2017).

To provide a suitable theoretical basis for a deeper understanding of the concept of open innovation, relevant factors have been categorized based on three established theoretical perspectives concerning the nature of organizations, which include transaction cost theory, resource-based theory, and institutional theory. These organizational theories provide a useful theoretical foundation for the research objective of this study as they help understand the nature of the variable of open innovation in organizations, behaviors, actions, decision-making, and the outcomes of those actions such as organizational structures. Transaction cost theory offers an economic perspective focused on the characteristics of open innovation transactions, resource-based theory examines the resources that guide organizational decision-making, and institutional theory emphasizes social pressures on public organizations about what constitutes appropriate behavior. Therefore, combining these three theories allows the identification of various economic, strategic, and relational elements that influence the design of an open innovation model (De Coninck et al., 2023).

Considering the explanations provided for the open innovation paradigm, applying this paradigm to human resource management seems to be a complex task, requiring attention to many internal and external components. For example, studies have shown that other organizational sectors such as human resources (Brunswicker & Chesbrough, 2018), strategy (Bogers et al., 2018), organizational structure and technology level, as well as external factors like government support, environmental, cultural, political, and legal issues contribute to the implementation of this paradigm (Pervan et al., 2015). Thus, as it appears, attention to issues such as organizational strategy, structure, IT-based work systems, organizational learning, employees, reward systems, etc., are important for the implementation of open innovation in human resource management (Hakaki et al., 2021).

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On the other hand, due to the emphasis on the 20-year vision of the country on a knowledge-based oil industry economy, recognizing the challenges and requirements for achieving the vision document in this industry in 2025 has attracted the attention of scholars, practitioners, and experts, reiterating the need for strategic planning in the development of human capital (Alavi et al., 2022). Although the need for high technology and knowledge-based human resources with strategic thinking has been discussed for some time, the groundwork and requirements for this planning are still in the initial stages of formation (Roodari et al., 2020).

In line with achieving added value based on a knowledge-based economy, enhancing the status and primary position of human capital, and the necessity of alignment in the overall chain of human resource development in various sectors of the petrochemical industry, having a human resource development document based on a specific model is essential. In recent years, organizations and governmental and non-governmental institutions have designed human resource development documents. Nonetheless, designing an open innovation model for human resource management is an overlooked area in human resource documents, which is of great importance in today's fast-paced and constantly changing world.

Paying attention to approaches such as open innovation and their widespread adoption can lead to the psychological well-being and peace of mind of human resources, which are the most important pillar and asset of the industry, and cause the revitalization of skilled and specialized human resources in this industry. Therefore, considering the explanations mentioned for open innovation and its importance in organizations, it can be said that the results of the current study, while valuing the human capital of the country in the petrochemical industry, strive to contribute to the dynamism of work environments and increase innovative activities by employees by considering the perspective of open innovation in human resource management. Thus, this study seeks to answer the question: What is the open innovation model for human resource management in the petrochemical industry?

2 Methods and Materials

2.1 Study Design and Participants

In terms of data collection, the present research was conducted qualitatively and is categorized as a descriptive and cross-sectional survey. It investigated the perspectives and opinions of a group of experts active in the field of human resources and internal management methods in the petrochemical industry within a specific time frame. For data collection, primary interview questions were designed using library resources, and then semi-structured interviews were conducted to identify dimensions and components related to designing an open innovation model for human resource management. At the end of the interview coding analysis process, the extracted components were examined within the framework of grounded theory. Grounded theory, or data-based theory, is built on systematically generating theory from data that is methodically obtained. Therefore, in grounded theory, the final model is derived from data that have been systematically collected and analyzed throughout the research process. Instead of relying on pre-existing theories and models, the effort is made to extract data through qualitative methodology and conducting various interviews, and this process continues until reaching theoretical saturation in that field.

The participants in the semi-structured interviews included university professors specialized in human resources, as well as experts and senior managers in the petrochemical industry, all of whom had a complete understanding of the interactions and communications in this industry and various aspects of open innovation. Reaching saturation (repetitive answers) was the sufficient criterion for the sample size. In other words, sampling was carried out until no new concepts or points were added to the data and categories obtained by that time. In the present study, theoretical saturation was achieved after conducting 17 interviews with experts, as the participants started to repeat information. Purposive sampling was used to select participants, choosing only those experts who had a deep and good understanding of the research topic.

2.2 Data Analysis

For data analysis from the interviews, open, axial, and selective coding methods were used along with the MAXQDA 2020 statistical software. This entailed placing the full text of the interviews into the software and then classifying the data into different codes, identifying the common aspects of the codes placed in various categories, and determining the most important dimensions and components related to open innovation for human resource management. In the first phase, by reviewing the data from the interviews and breaking down this information, initial concepts (codes) were identified, and in the second phase, these concepts were categorized to determine the main

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categories (factors). Finally, the final model was drawn, the results of which can be seen in the next section.

3 Findings and Results

Given that the population in the current study consisted of two groups of individuals (university professors and experts and senior managers in the petrochemical industry), the demographic questions presented to these individuals included issues such as gender, direct work experience in the petrochemical industry, study or work experience in the petrochemical industry, the highest educational degree, and age. The majority of participants are male (88.2%), with a smaller proportion being female (11.8%). Among the participants, 58.8% have previous work experience in the petrochemical industry, while 41.2% do not. In terms of study duration, 35.3% have 11-15 years of experience, and 52.9% hold a Ph.D. degree. Regarding age, the largest age group is 41 to 50 years (47.1%), followed by 30 to 40 years (41.2%), and only a small portion of participants are above 50 years old (11.8%). These statistics provide an overview of the demographic and professional characteristics of the study participants.

In the first phase of the coding process, an effort was made to extract key concepts from the qualitative responses of the interviewees and present these in the form of open codes, along with the interview numbers related to each code mentioned in the interviews. Also, for the initial categorization and perception of these open codes, they were presented in the form of separate categories, which are considered as subsidiary categories related to the subject and can be used in the axial coding phase. On the other hand, open codes also serve as an initial basis for forming concepts in the second phase of coding. Thus, the main activities of this phase included finding open codes and then identifying and assimilating common concepts, based on which codes with common aspects were either merged or separated. From the 17 interviews conducted, 215 open codes were extracted, presented in the form of 83 categories. After identifying the categories and open codes in the open coding phase, it was time to present the subsidiary categories and concepts related to each of the main branches of the Strauss and Corbin model (including causal conditions, intervening conditions, contextual factors, strategies, and outcomes). The components of axial coding include main categories, subsidiary categories, and related concepts, based on which all details related to the analysis of interviews are presented, and the results can be seen in Table 1.

Table 1

Summary of Qualitative Analysis

Main Category	Subcategory	Concept
Causal Conditions	Human Resource Management	Developing job standards at different stages
		Supportive laws
		Monitoring systems
		Directing employee attitudes
	Organizational Leadership	Leadership style
		Team activities in work environments
		Developing interpersonal relationships
	Knowledge Management	Networking
		Interaction with intermediary groups for gaining experience
		Knowledge-sharing culture
		Collaborative work environment
	Organizational Infrastructure	Preparing suitable organizational platforms
		Employing capable and specialized managers
		Infrastructure development
	Collaboration with Universities and Research Institutions	University-industry connection
		Collaboration with research and study institutions
	Foreign Participation	Searching and attracting foreign knowledge
		Knowledge and technology transfer to/from abroad
		Outsourcing
		Presence in international arenas
Contextual Conditions	Organizational Relationships	Formal relationships
		Informal relationships
		Horizontal relationships
		Vertical relationships

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	Organizational Culture	Risk-taking
		Detail-oriented
		Result-oriented
	Emotional Intelligence of Managers	Social management
		Understanding emotions
		Using emotions
		Managing emotions
Intervening Condition	Organizational Structure	Complexity
		Formality
		Concentration
	Information Technology Capabilities	Information technology infrastructure
		Technology business experiences
		Information technology communication resources
		Human resources in information technology
	Social Media	Media structure
		Knowledge and experience transfer
		Legitimization and information dissemination
Central Phenomenon	Open Innovation	Organizational readiness
		Collaborative capabilities
		Absorptive capacity
Strategies	Organizational Learning	Management commitment
		Systemic view
		Open and experimental space
	Idea Evaluation Structure	Idea generation
		Idea screening
		Implementing ideas
	Micro and Macro Investments	Investing in intellectual assets
		Joint investment with other competitors
		Investing in research and development
	Business Intelligence	Data integration
		Data analysis ability
		Data content quality
		Data access
		Using information in business
		Analytical decision-making culture
	Organizational Entrepreneurship	Self-renewal
		Pioneering
		Innovation portfolio
	Growth Centers	Facilitating innovative actions
		Providing financial facilities
		Comprehensive support for innovative ideas
Consequences	Organizational Readiness	Adaptability and flexibility to changes
		Enhancing individual and group creativity
	Improving Absorptive Capacity	Employing foreign innovations
		Increasing research and development activities
		Identifying applied knowledge
	Improving Cultural Infrastructure	Strengthening group activities
		Culture of interaction with different groups
		Organizational environment based on mutual trust
	Updating Knowledge Resource	Participation in international events
		Familiarity with new technologies
		Joint investments
	Outsourcing Approach	Maintaining competitive advantage
		Benefiting from external capacities
		Cost management
	Enhancing Organizational Performance	Facilitating business collaborations
		Revenue generation
		Benefiting from new opportunities
	Adaptability to Market Changes	Responding to technological changes
		Quick access to new knowledge

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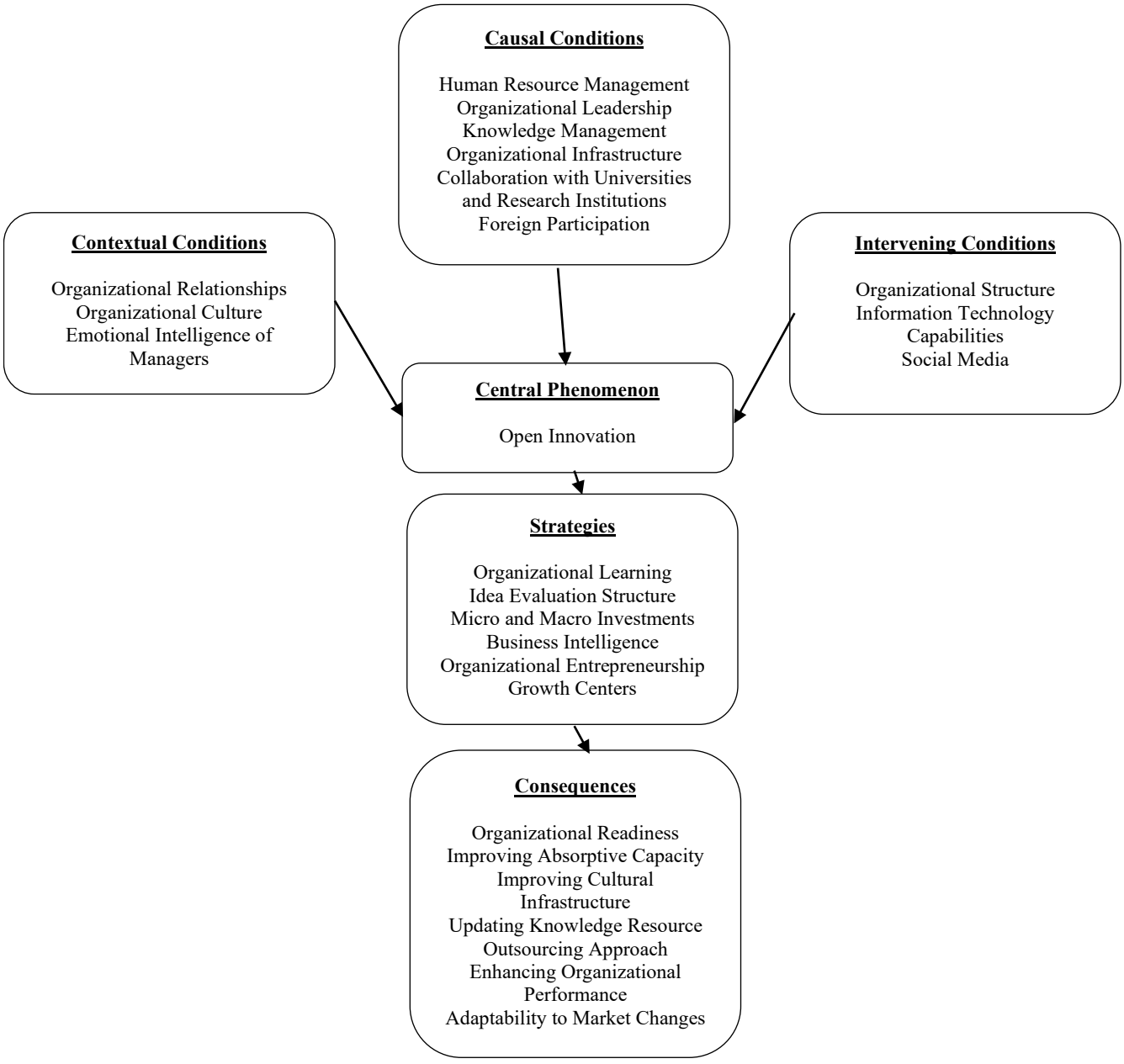
In the final phase of the coding process, the results from the open and axial phases, along with findings extracted from theoretical foundations and the research's literature review, were merged and displayed in the form of a general model of open innovation for human resource management in the petrochemical industry, which can be seen in Figure 1. It is worth mentioning that all the mentioned stages were carried out iteratively and through an interactive process with theoretical foundations and research literature.

Figure 1

Paradigm Model



4 Discussion and Conclusion

Paragraph (4) of the general policies of the system in the oil sector refers to the expansion of fundamental and developmental research and the training of specialized human resources, striving to create a center for attracting and exporting knowledge and technical and engineering services in energy, at the international level, and upgrading technology in the field of oil, gas, and petrochemical

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resources and industries. In the future policies section of the oil industry, paragraph (10) heavily emphasizes the training of specialized and efficient human resources, especially in the upstream sectors of oil and petrochemicals, highlighting the need for investment in the field of human resources. The value chain in the oil and gas industries encompasses exploration, drilling, development, production, transmission, refining, marketing, and sales. In each of these areas, the role of human capital and its optimal management can bring about transformation and improve productivity for the petrochemical industry.

Considering the general and future policy of this industry, the unparalleled importance of the role of human capital at all organizational levels, particularly at management levels that are the creators of systems and organizational culture, is clearly evident. Based on the 20-year vision document in the oil industry, Iran is expected to reach the top rank in terms of the value of petrochemical products in the Middle East and, during this journey, at least 126 million tons of products such as ethanol, methanol, and ammonia need to be produced annually. Therefore, designing a model for efficient human resource management in this industry can be of special importance and necessity; focusing more on open innovation in human resource management and utilizing skilled and motivated personnel can help realize the aforementioned vision.

The results from open coding showed that from the 17 semi-structured interviews conducted in the study, a total of 215 open codes were identified, forming 83 categories. The final examination of the extracted subsidiary categories indicated that the most important causal factors affecting open innovation include human resource management, organizational leadership, knowledge management, organizational infrastructure, collaboration with universities and research institutions, and external participation. On the other hand, organizational structure, information technology capabilities, and social media are identified as intervening factors, while organizational relationships, organizational culture, and the emotional intelligence of managers are important contextual factors in the implementation of open innovation. Among the suggested strategies by experts and specialists to improve the open innovation paradigm are organizational learning, idea evaluation structures, micro and macro investments, business intelligence, organizational entrepreneurship, and growth centers, leading to organizational readiness, improved absorptive capacity, cultural infrastructure enhancement, knowledge resource updating, intellectual property, outsourcing approach, organizational performance improvement, and adaptability to market changes.

The findings of this research align with the results of various previous studies (Bello-Pintado & Bianchi, 2020; De Coninck et al., 2023; Hakaki et al., 2021; HashemiDehaghi, 2019; Jami Pour et al., 2020; Mirhadyan et al., 2021; Oliveira et al., 2021; Remneland Wikhamn et al., 2023; Trzeciak et al., 2022), all of which have emphasized the importance of focusing on the open innovation paradigm and its related factors. In fact, when managers in the petrochemical industry initiate a platform for open innovation, they must have an accurate forecast of the official start time of a project or innovative idea and the point at which the annual sales of that project equal the total investment in research and development. Only then can the success rate of open innovation be determined, considering the net value, capital costs, and estimated product returns.

It is important to note that the technology of hydrocarbon industries and many other industries is not transferable, and in technology transfer, the right to use it is obtained by paying licensing fees. Therefore, to achieve self-reliance and relative independence in implementing projects in the country's hydrocarbon industries, the issue of open innovation must be pursued seriously. Furthermore, experience shows that to implement projects related to hydrocarbon industries, an engineering company needs at least 200 experts in various engineering fields. To maintain this number of experts, in addition to supportive human resources (totaling approximately 600 people), continuity in project implementation, belief, faith, and mutual commitment of the contractor and employer, and comprehensive support from government organizations for the institutionalization and localization of technology and the capability to build projects based on it are required, which is a path that industrialized and advanced countries have also followed.

In any case, sustainable development of the petrochemical industry and strengthening the production chain, as well as the production and supply of various products, optimal utilization of maximum resources and existing investment, and the application of new technology, are realized in the shadow of employing open innovation. For this purpose, the formation of a petrochemical investment center aimed at accelerating the process of attracting domestic and foreign capital, providing consultancy services and obtaining necessary permits, attracting domestic financial resources, shortening the path to attract investors, facilitating the capital attraction in the

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petrochemical industry, aiding in the improvement of investment indicators, and integrating organizations and subordinate departments can be among the suggested strategies towards realizing the vision.

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Declaration of Interest

The authors of this article declared no conflict of interest.

Authors Contributions

In a collaborative effort, Yaser Rashidfarokhi and Hassan Darvish designed a study to create an open innovation model for human resource management in the petrochemical industry. They selected the study population, conducted interviews, and analyzed data together. Their work identified key factors influencing open innovation, proposed strategies for improvement, and jointly shaped the research findings and conclusion before submission.

Ethical Considerations

In this research, ethical standards including obtaining informed consent, ensuring privacy and confidentiality were observed.

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