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Research Note

The Mediating Role of Entrepreneurial Innovation in the Impact of Environmental Policy on Performance: Evidence from Iran's Steel Industry

H. R. Amel Ardestani *[1], A. Shah Nazari Darcheh [2], A. Bagheri [3], M. Dastgerdi [4]

[1,2,4] *Department of Business Management, Payame Noor University, Tehran, Iran*
[3] *Department of Agriculture, Payame Noor University, Tehran, Iran*

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ABSTRACT

This study aimed to investigate the role of entrepreneurial innovation as a mediating variable in the relationship between environmental policy instruments, organizational learning, intellectual capital, and organizational performance at Mobarakeh Steel Company of Isfahan. The statistical population consisted of 300 managers and experts from this company, of whom 171 were selected as the sample using simple random sampling. The present study is applied in terms of purpose, employing a descriptive-survey methodology. Data were collected through standard questionnaires and analyzed using structural equation modeling. The findings indicated that environmental policy instruments, organizational learning, and intellectual capital have a positive and significant effect on entrepreneurial innovation. Furthermore, entrepreneurial innovation plays a key mediating role in enhancing organizational performance across economic, social, and environmental dimensions. The results provide an integrated framework for understanding the interplay between these factors, emphasizing the need for industrial managers to enhance organizational learning and intellectual capital, while adopting green policies to foster entrepreneurial innovations and improve organizational performance.

1. Introduction

In today's knowledge-based economy, achieving sustainable competitive advantage no longer depends solely on the management of financial resources and physical assets. Rether, it relies increasingly on organizational capabilities to create, manage, and exploit intangible, knowledge-based assets [1]. Within this context, intellectual capital, comprising human, structural, and relational capital, serves as the primary source of value creation and dynamic organizational capabilities. Simultaneously, organizational learning acts as the engine that drives knowledge creation and sharing. Together, these factors play an indispensable role in enabling organizations to adapt to rapid environmental changes and generate new competitive advantages [2]. However, the mere presence of these assets does not guarantee success, as their transformation into tangible, value-creating outcomes requires an effective mechanism [3]. This challenge is particularly pronounced within energy-intensive industries such as steel, which form the economic backbone of many countries. These industries

* *Corresponding Author*
Email: hamid.amel@gmail.com
Address: Department of Business Management, Payame Noor University, Tehran, Iran
1. Assistant Professor, 2. Assistant Professor, 3. Assistant Professor, 4. M.S.c

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face not only traditional competitive pressures to improve economic performance indicators (such as productivity and profitability) but also increasing challenges in the realms of social responsibility and environmental stewardship [4]. Stricter international regulations, rising stakeholder expectations, and the imperative to transition towards green production have compelled companies in this sector to fundamentally rethink their processes and business models [5]. Under such conditions, reliance on traditional methods is no longer sufficient, necessitating an innovative and entrepreneurial approach to organizational management [6].

In response to this need, entrepreneurial innovation emerges as a critical intermediary and transformation mechanism. This concept refers to an organization's ability to identify new opportunities, generate novel ideas, and convert them into value-creating products, services, or processes. It can simultaneously help organizations address competitive pressures while meeting environmental and social requirements [7]. Consequently, a fundamental question arises as to whether entrepreneurial innovation can play a mediating role in transforming intellectual capital and organizational learning into superior organizational performance. This study seeks to address this theoretical gap by focusing on Mobarakeh Steel Company of Isfahan, one of the largest and most advanced steel producers in Iran and the Middle East. It further investigates the mediating role of entrepreneurial innovation and provides an operational framework for industrial managers.

A systematic review of the existing literature reveals that three distinct yet interconnected streams of research have shaped the current understanding of the factors influencing organizational performance. The theoretical framework introduced in the present study integrates the "Resource-Based View (RBV)" [1] and "Organizational Learning Theory" [8]. From an RBV perspective, intellectual capital is considered a valuable, rare, inimitable and non-substitutable (VRIN) strategic resource that can drive sustainable competitive advantage [1]. On the other hand, Organizational Learning Theory is based on the principle that organizations must acquire, share, and apply knowledge to adapt to a dynamic environment and achieve continuous improvement [8]. Following the oil and gas industries, the steel industry is among the world's most crucial sectors, accounting for a significant share of international trade. In Iran, this industry plays a pivotal role in gross domestic product (GDP), economic development, and employment generation [9]. Iran's steel industry holds a distinctive position and can be regarded as a leading industry and a fundamental pillar of national development. The approximately 20% share of steel products in total non-oil exports substantiates this claim. The development of this foundational industry is not only of paramount economic importance but also contributes significantly to economic independence by increasing non-oil foreign exchange revenues.

In today's fast-paced and competitive business environment, organizations are compelled to pursue continuous innovation and implement novel strategies across all functional areas to ensure survival and achieve sustainable competitive advantage [10]. Innovation is recognized not only as a driver of growth and development but also as a foundation for enhancing organizational performance across economic, social, and environmental dimensions [11]. With increasing pressures arising from environmental issues and climate change, organizations are confronted with the necessity of revising traditional processes and shifting towards new sustainable development models [5]. In this context, environmental policy instruments, particularly supportive and market-based policies, play a significant role in stimulating green innovations and enhancing organizational performance [12].

Intellectual capital refers to the set of intangible knowledge-based assets that function as the primary source of value creation for an organization [3]. This construct is typically examined across three main dimensions: human capital (including employee knowledge, skills, and abilities), structural capital (including processes, systems, and databases), and relational capital (including the network of relationships with key stakeholders). Previous studies have conclusively demonstrated that intellectual capital exerts a positive and significant impact on organizational performance [13]. Organizational learning is also defined as an organization's capability to create, share and apply knowledge [14]. Organizations that institutionalize a culture of continuous learning possess superior performance through a greater ability to identify opportunities and solve problems. This capability allows them to learn from past experiences and convert knowledge into improved actions, ultimately leading to enhanced performance [15]. The literature on the variables in this study can be categorized into two main categories, including domestic and international, the key evidence of which is outlined below. Darvishi and Ziaei [16] investigated the impact of green intellectual capital dimensions on innovation in the oil, gas, and petrochemical industry of Khuzestan, using structural equation modeling. Their findings demonstrated a positive correlation between green human and structural capital and various types of innovation, highlighting the pivotal contribution of environmental training to developing green human capital. In a mixed-methods study on Tehran pharmaceutical companies, Hosseini Mirza et al. [17] found that intellectual capital affects innovation only through organizational learning (and not directly). In a study using structural equation modeling in private banks, Rezvani and Karimi [18] concluded that relational capital has the strongest impact on performance, and that innovation strengthens this relationship.

In the realm of environmental policies, Mohammadi et al. [9] surveyed steel companies and found that incentive-based policies (such as green subsidies) have a greater impact on environmental performance than command-and-control policies. Similarly, Ghasemi and Rezaei [19] employed a survey methodology within the cement industry and demonstrated that technology-based standards are the most effective instruments for stimulating innovation. Moreover, the relevant literature emphasizes the interactions among the core constructs in this research. In their survey of the automotive industry, Ghaffari and Shariati [20] found that double-loop learning has a greater impact on green innovation than single-loop learning. Another study conducted by Norouzi et al. [21], using structural equation modeling in mining companies, indicated that structural capital has the greatest impact on sustainable performance. Furthermore, Amini and Soltani [22] performed a survey study, which indicated entrepreneurial innovation as a full mediator in the relationship between organizational learning and performance. Using a survey method, Heidari et al. [23] also demonstrated that intellectual capital and organizational learning have a positive and synergistic interactive effect on performance.

At the international level, Kumar et al. [24] investigated 247 Indian industrial firms using a survey, demonstrating that green human and structural capital affect overall performance through innovation and environmental performance. Similarly, in a study using structural equation modeling, Qiu et al. [15] found that green human resources improve environmental performance through intellectual capital and innovation. Through panel data analysis in polluting industries, Toll and Jiang [25] demonstrated that green innovation has a significant non-linear effect on productivity. In their survey study of agricultural firms, Su et al. [26] concluded that green innovation plays a mediating role between environmental leadership and performance. Wang et al. [27] performed a review of literature, emphasizing that organizational learning is a necessary condition for sustainable innovation. Through econometric analysis, Zhang and Li [28] also showed that environmental taxes have a greater impact on innovation than subsidies. Finally, García-Sánchez et al. [29] employed regression analysis in their study and found that good corporate governance mechanisms strengthen the relationship between innovation and sustainable performance.

The existing literature highlights the importance of intellectual capital, organizational learning, and environmental policy instruments in achieving superior innovation and performance. However, few studies have examined the role of entrepreneurial innovation as a comprehensive mediating mechanism in heavy industries. This study, aims to address this gap through an examination of Iran's steel industry.

The conceptual model of this research was developed based on the reviewed theoretical foundations and empirical literature. According to this model, environmental policy instruments, intellectual capital, and organizational learning, as independent variables, affect organizational performance both directly and indirectly through the mediating role of entrepreneurial innovation (Fig. 1.). This relationship constitutes the main objective of the study.

2. Research Method

2.1. Type of Research

In terms of purpose, this study is applied, seeking to generate practical knowledge and solutions within a specific domain. Regarding data collection, the study employs a descriptive-survey approach with a correlational design, aiming to provide practical solutions for real-world problems. Accordingly, the main objective of this study is to provide practical insights and solutions to the managers of Mobarakeh Steel Company and other stakeholders in the steel industry to improve organizational performance by strengthening intellectual capital, organizational learning, and entrepreneurial innovation. The survey approach enables data collection from a large sample and generalizes the results to the statistical population. Furthermore, given the research objective of examining relationships among variables, a correlational design was employed.

2.2. Statistical Population and Sample

The statistical population of this research consisted

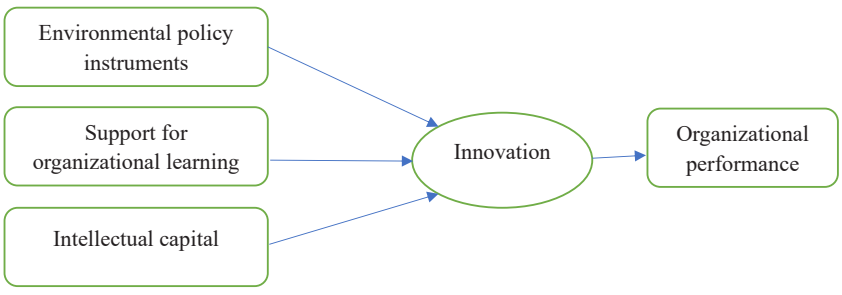

Fig. 1. Conceptual model of the research.

of all managers and senior experts of Mobarakeh Steel Company of Isfahan, leading to a total number of 300 individuals, according to the Human Resources Unit. These individuals were selected as the target population due to their specialized knowledge and involvement in relevant decision-making processes. Using Cochran's formula for finite populations and considering the parameters N=300, a 95% confidence level (d=0.05), and maximum variance (p=q=0.5), the required sample size was calculated as 171 individuals. Sample members were selected through simple random sampling.

2.3. Data Collection Instrument

The primary research instrument was a researcher-made questionnaire designed based on theoretical foundations and previous standard questionnaires. This questionnaire consisted of two sections:

1. Demographic data: Including gender, work experience, and education level.
2. Main Questions: This section included 28 items on a 9-point Likert scale, ranging from 1 (Strongly Disagree/ Very Low) to 9 (Strongly Agree/Very High). These items were designed to measure the five main research variables: Environmental Policy Instruments (7 items), Intellectual Capital (5 items), Organizational Learning (4 items), Entrepreneurial Innovation (7 items), and Organizational Performance (5 items), as detailed in Table 1.

Based on theoretical foundations and previous standard questionnaires, environmental policy instruments were measured according to the extent and type of influence of various policy tools, such as technological standards, tax incentives, and green subsidies [28]. In order to measure the construct of intellectual capital, the items were aligned with employee knowledge and skills, organizational systems and processes and relationships with stakeholders [3]. The framework employed for the measurement of organizational learning was based on the organization's capability to create, share, and utilize knowledge [8]. The items for the entrepreneurial innovation variable were designed around the axes of identifying new opportunities, generating novel ideas, willingness to take risks in commercializing ideas, and value creation [6]. Finally, organizational performance was measured across three dimensions—economic, social and environmental—using criteria such as profitability, stakeholder satisfaction, process innovation, and reduction of environmental impacts [30, 31].

2.4. Data Analysis Method

The Kolmogorov-Smirnov test was used after data collection to ensure the normal distribution of the data. In addition, convergent validity approaches (Average Variance Extracted) were employed to examine the validity of the research instrument, while Cronbach's alpha and composite reliability indices were used to ensure the reliability of the research instrument. Data analysis was performed in SPSS software. Furthermore, the relationships between the research constructs were analyzed using partial least squares structural equation modeling (PLS-SEM) in SmartPLS software.

The Sobel test is widely employed to examine the effect of a mediating variable and determine the significance of a variable's mediating effect in the relationship between two other variables. The test statistic for the Sobel technique is calculated using the following formula:

Eq.(1)

$$Z - value = \frac{a \times b}{\sqrt{(b^2 \times s_a^2) + (a^2 \times s_b^2) + (s_a^2 \times s_b^2)}}$$

Here, a is the path coefficient between the independent variable and the mediator, b indicates the path coefficient between the mediator and the dependent variable, Sa is the standard error of the path between the independent variable and the mediator, and Sb represents the standard error of the path between the mediator and the dependent variable [1].

3. Results and Discussion

According to the results presented in Table 2., the Kolmogorov-Smirnov test for the research variables exhibited statistical significance. Therefore, the null hypothesis regarding the normality of the variables is not accepted, necessitating the use of non-parametric methods, such as structural equation modeling, to analyze

Table 1. Distribution of Questionnaire Items.

Variable	Number of Items	item Numbers	Source
Environmental Policy	7	1, 6 , 7, 10, 16, 20, 25	Zhang and Li, [28]
Capital Intellectual	5	2, 9, 13, 19, 23	Stewart [3]
Learning Organizational	4	14, 18, 28, 27	Argote [8]
Innovation	7	3, 5, 8, 12, 21, 22. 30	Drucker [6]
Performance Organization	5	4, 17, 29, 26, 24	Epstein and Roy [30] Kaplan and Norton [31]

the data and test the research hypotheses. An examination of construct reliability based on Cronbach's alpha and composite reliability indices indicates the appropriate reliability of the research constructs (above the standard threshold of 0.7). Furthermore, convergent validity, assessed through the Average Variance Extracted (AVE) for the constructs, was obtained above the desirable threshold of 0.5, indicating that these constructs possess convergent validity.

Descriptive analysis revealed that 52% of the respondents (n-89) were married. Furthermore, individuals with less than 15 years of work experience made up the majority of the managers in the sample, accounting for 57.9% of the statistical sample (n=99). In terms of education, the highest frequency belonged to individuals with a bachelor's degree, comprising 109 individuals in the sample (63.7%). Individuals with a master's degree (29.2%) and those with a diploma or associate degree (7%) ranked next in order.

Based on the fitted structural model, the research hypotheses were examined using path analysis and standardized coefficients. The results of these analyses are presented in Tables 3 and 4., which report the direct and indirect effects of the research variables, respectively. According to the results reported in Table 3., the t-statistic values for the relationships between environmental policy instruments (6.01), organizational learning (7.59), and intellectual capital (10.83) and the performance of the steel company are greater than 1.96, supporting the research (sub) hypotheses related to direct effects. Moreover, the positive coefficients of the paths indicate that the aforementioned variables have a positive and significant impact on company performance.

Furthermore, Table 4. presents the results concerning the primary research hypothesis, which assumes a mediating role for entrepreneurial innovation. The Sobel test was employed to examine the significance of the mediating role of entrepreneurial innovation. The results demonstrate that entrepreneurial innovation, as a mediating variable, creates a significant relationship between the independent variables of the research and organizational performance. Specifically, the indirect effect coefficient of environmental policy (0.428), the indirect effect coefficient of intellectual capital (0.295) and the indirect effect coefficient of organizational learning (0.260) on company performance through innovation were all statistically significant ($p < 0.01$). These results strongly support the main hypothesis of the research, highlighting the key role of entrepreneurial innovation as a mediating mechanism.

Table 2. Assessment of Validity, Reliability of the Questionnaire and Normality of Research Variables.

Variable Name	Kolmogorov-Smirnov test	Significance Level	AVE	Cronbach's alpha	Composite reliability
Environmental Policy instruments	0.856	0.00	0.851	0.806	0.704
Capital Intellectual	0.749	0.00	0.844	0.851	0.57
Learning Organizational	0.692	0.00	0.817	0.804	0.61
Innovation	0.781	0.00	0.829	0.812	0.59
Performance Organization	0.829	0.00	0.877	0.845	0.68

Table 3. Testing the Sub-Hypotheses of the Research (Direct Effects).

Hypothesis	Path Coefficient	T-test	Sig.	Result
Environmental Policy → Organizational Performance	0.812	6.01	0.00	Confirmed
Organizational Learning → Organizational Performance	0.787	7.59	0.00	Confirmed
Intellectual Capital → Organizational Performance	0.641	10.83	0.00	Confirmed

Table 4. Results of the Sobel Test for the Mediating Role of Entrepreneurial Innovation.

Mediation Path	Indirect Effect Coefficient	Standard Error	Sobel test	Sig.	Result
Environmental Policy → Ent. Innovation → Org. Performance	0.428	0.068	6.44	0.00	Confirmed
Organizational Learning → Ent. Innovation → Org. Performance	0.260	0.055	4.73	0.00	Confirmed
Intellectual Capital → Ent. Innovation → Org. Performance	0.295	0.063	4.68	0.00	Confirmed

4. Conclusions

The findings of this study indicate that three factors - environmental policy, intellectual capital and organizational learning - act as strong and positive predictors of organizational performance in Mobarakeh Steel Company of Isfahan. The main contribution of this study is to confirm the unique role of entrepreneurial innovation as a critical mechanism. The data demonstrate that intellectual capital and organizational learning affect organizational performance not only directly but also indirectly through increasing entrepreneurial innovation. The Sobel test confirmed this mediating role in three paths: environmental policy, intellectual capital, and organizational learning. The practical difference is in the organization's ability to transform these resources and capabilities into innovative actions and achievements. Entrepreneurial innovation acts as the driving force that converts raw knowledge and learning capabilities into new products, improved processes, transformative business models, and superior performance.

4.1. Comparative Studies and Explanation of Findings

Comparing the findings of this research with the existing literature reveals both areas of alignment and distinction. Regarding the first hypothesis, the findings are consistent with those, which emphasize the stimulation of innovation by environmental policies. Concerning the second hypothesis, the results align with research, which identify organizational learning an essential foundation for innovation. Furthermore, this study supports the perspective on "knowledge-creating companies", demonstrating that organizational learning at Mobarakeh Steel Company has acted as a key mechanism for converting knowledge into practical innovations. Regarding the third hypothesis, the findings support the theoretical framework of the "Resource-Based View" and "Intellectual Capital Theory. This research specifically indicates that intellectual capital has served as the driving force for innovation in areas such as green technologies and production process improvements.

4.2. Research Implications

Theoretically, this study contributes significantly to the existing literature by providing empirical evidence for the mediating role of entrepreneurial innovation and integrating three key constructs into a unified model. The findings demonstrate that these factors operate systematically and complementarily, expanding our understanding of how value is created from intangible assets in an organizational context. Achieving excellent and sustainable performance requires a shift in focus from an exclusive emphasis on short-term financial indicators to long-term investment in human and organizational capital. Accordingly, it is recommended that industry managers prioritize investments in developing human capital.

In summary, this research confirms that in the contemporary knowledge-based economy, the path to superior and sustainable performance in heavy industries lies in the simultaneous enhancement of intangible assets (intellectual capital), dynamic capabilities (organizational learning), responsiveness to external requirements (environmental policy), and ultimately, the purposeful transformation of all these factors into value-creating entrepreneurial innovations. Entrepreneurial innovation is the vital intermediary link that bridges resources and outcomes, enabling the conversion of knowledge into wealth and sustainability.

4.3. Limitations and Suggestions for Future Research

Limitations of this study include its cross-sectional nature and focus on a single company. It is suggested that future research employ longitudinal designs for more precise causal investigations. Investigating the distinct impact of different types of environmental policy instruments (e.g., taxes versus subsidies) or various dimensions of entrepreneurial innovation could also open valuable research avenues.

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