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Presenting a Model of Factors Affecting on the Productivity of Mining and Mineral Industries Organizations in order to Performance Improvement Using Structural Equation Modeling

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A B S T R A C T

The mining and mineral industries organization is one of the vital pillars in job creation and economic growth and development of many countries, including developing countries. Therefore, the presenting research was conducted with the aim of presenting a model of factors affecting on the productivity of mining and mineral industries organizations in order to performance improvement. Methods and Materials: This study was applied in terms of purpose and cross-sectional from type of descriptive in terms of implementation method. The population of the present research was mining and mineral industries civil activists, including experts, managers, and specialists in the Iranian Mineral Processing Research Center and its parent organization (IMIDRO). The sample size based on the Cochran formula was estimated 174 people, who were selected by stratified random sampling method based on key subgroups (management, engineering, human resources, maintenance and repairs, and safety and environment). The instrument of this study was a researcher-made questionnaire of factors affecting on the productivity of mining and mineral industries organizations in order to performance improvement (67 items), which was completed in person and electronically (Porsline system). The research data were analyzed using exploratory factor analysis and structural equation modeling in SPSS and Smart-PLS version 30 software. Findings: The results of exploratory factor analysis showed that 13 items of factors affecting on the productivity of mining and mineral industries organizations in order to performance improvement were removed from the instrument due to factor loadings less than 0.70 and the final questionnaire had 54 items in 12 components and 6 dimensions. The convergent validity was obtained for the dimensions of intervening conditions and strategies less than 0.50 and for other dimensions above 0.50 and for two components of technological infrastructure and economic factors and macro policymaking less than 0.50 and for other components above 0.50. Also, reliability by Cronbach's alpha and combined methods was higher than 0.70 for all dimensions, reliability with Cronbach's alpha was higher than 0.70 for 9 components and lower than

0.70 for three components of technological infrastructure, technology and innovation, and economic factors and macro policymaking, and reliability with combined method was higher than 0.70 for 11 components and lower than 0.70 for one component (technological infrastructure). In addition, the model of factors affecting on the productivity of mining and mineral industries organizations in order to performance improvement had a good fit, and in this model, causal conditions on the central phenomenon, the central phenomenon, background conditions, and intervening conditions on strategies, and the strategies on outcomes had a significant effect (P<0.001). Conclusion: According to the results of this study, in order to increase the productivity of mining and mineral industries organizations in order to performance improvement can be provided the basis for improving the identified valid dimensions and components.

Keywords: *organizational productivity, mining, mining industries, performance improvement, economic factors, macro policymaking, human capital development.*

1. Introduction

A mine is defined as a location where a valuable substance is extracted, and it includes various types such as subsurface mines (located underground and requiring drilling and extraction, like oil), surface mines (located on the surface, like salt), *muṭba'a* mines (requiring smelting by fire to separate pure materials, like limestone), and *ghayr-muṭba'a* mines (not requiring smelting by fire, like agate and turquoise) (Soto-Vazquez, 2025). The mining and mineral industries organization is regarded as one of the crucial and vital organizations for national economic growth and development and encompasses exploration, extraction, processing, and sale of minerals (Nguyen et al., 2021). This organization supplies raw materials for many industrial and production sectors such as construction, machinery manufacturing, information technology, and defense industries, and it directly and indirectly generates employment; for each hire in a mining organization, three or four hires are created in other sectors, thereby enabling national economic growth and development (Song et al., 2025). In Iran, a review of mineral reserves indicates extensive non-oil mineral resources (metallic and non-metallic) alongside vast oil and gas reserves. Iran ranks fifteenth worldwide in terms of mineral reserves, and 68 types of minerals have been identified in the country. Therefore, given such reserves, it is expected that the mineral industries sector will act as a driver of national and regional economic development—especially in areas with mineral deposits—and help enhance the quality of life of residents in those areas (Adeli Nik & Rajabi, 2023). Work in mining and mineral industries entails greater physical hazards, including mortality, compared with many other occupations; approximately ten percent of incidents are attributable to "hardware" problems and ninety percent to "software" or human-factor problems (Farjana et al., 2019). Employees in mines and mineral industries face numerous physical and psychological problems and illnesses, which reduce their energy and lead to declines in job and professional performance (Biswas et al., 2024).

One of the factors affecting the job status of individuals working in mining and mineral industries organizations is organizational productivity. Productivity refers to maximizing the utilization of resources and is a combination of efficiency and effectiveness. Organizational productivity denotes doing things right and adopting necessary scientific measures to reduce costs and increase the satisfaction of employees, managers, and consumers (Firdaus et al., 2024). Organizational productivity is a key concept in managing organizations to optimize interactions among different organizational elements; it reflects an organization's ability to use its resources (financial, human, equipment, time, etc.) efficiently and effectively to achieve specific goals—namely, maximizing goods production and optimizing services (Suoniemi et al., 2021). Factors influencing organizational productivity include internal factors (human resources, employee compensation, employee training, technology, incentives and rewards, management style and method, etc.) and external factors (political, economic, social, and cultural), which together lead to optimal use of scarce resources, a more pleasant work environment, lower prices, improved quality, enhanced customer satisfaction, greater employee motivation and interest in work, and organizational growth and development (Apendi et al., 2025). Moreover, organizational productivity depends on multiple factors, including new technologies, human resource management, capital management, production processes, and managerial and systemic capabilities. Accordingly, examining the realization of productivity helps identify challenges and opportunities for performance improvement (Kour et al., 2019). Organizational productivity plays an effective role in improving organizational performance. Performance improvement is a systematic process to enhance efficiency, elevate effectiveness, and increase an organization's long-term sustainability to achieve organizational objectives (Chen et al., 2020). Performance improvement requires identifying strengths and weaknesses; this creates the basis for targeted training and individual and organizational development and prepares employees to assume more significant and prominent roles. Above all, improving any organization's performance depends on its human resources, and attention to this vast potential resource enables the organization's flourishing and empowerment (Nguyen et al., 2026). An organization that seeks performance improvement in terms of human resources, finance, and processes can deliver distinctive products and services and build a competitive advantage (Nevries & Wallenburg, 2021).

Only a small and scattered body of research has examined factors affecting organizational productivity for performance improvement in mining and mineral industries, and most such studies are qualitative. For example, in a study on designing a dynamic balanced scorecard as an industrial safety management system in metallurgical mining, factors included the dynamic balanced scorecard (with components of dynamic simulation for organizational learning and strategic improvement in safety performance measurement), soft systems methodology and systems approach (with components of solving complex human and organizational problems in mining environments, better interdepartmental alignment, and more comprehensive decision-making), and industrial safety (with components of a preventive safety culture, reduced incidents, reduced downtime, increased employee motivation, leadership commitment to safety, and occupational illnesses among mining personnel) (Mayo-Alvarez et al., 2024). In a study on factors affecting capital productivity in the mining sector, it was found that per-capita capital, the mineral price index, energy-use efficiency, and the private sector's ownership share play influential roles in mining capital productivity; thus, increasing energy-use efficiency, reducing per-capita capital, and increasing mineral prices raise average capital productivity (Agheli & Hosseini, 2022). In another study on labor productivity in mines, results indicated that the share of skilled workers, private ownership of mines, per-capita capital, and wages and salaries positively affect labor productivity in mining; therefore, increasing labor productivity in mines requires designing a pay and reward system aligned with workers' value-added, adopting labor-using technologies (advanced mining equipment) in extracting deep and high-risk mines, privatizing non-strategic mines, increasing labor's share in mineral sales and profits, and attending to substitutability/complementarity relations among labor, energy, and capital in extraction and processing of minerals (Agheli, 2020). In research on copper-mining productivity, declines in labor productivity were attributed to four factors: real mining wages, electricity prices, copper prices, and ore grade (De Solminihac et al., 2018). In a study on energy prices, energy productivity, and capital productivity—along with empirical examinations and policy implications—it was shown that increases in energy prices, the energy-to-capital ratio, and the energy-to-output ratio affect capital productivity and may sometimes cause price shocks (Gamtessa & Olani, 2018).

In today's world, productivity in mining and mineral industries is one of the main pillars of countries' economic development, and Iran—endowed with rich mineral reserves—is among the most important countries holding mineral resources; nevertheless, productivity in the mining sector remains far from global standards. Therefore, it is necessary to investigate factors affecting the productivity of mining and mineral industries organizations with the aim of improving and enhancing performance. A review of prior studies indicates that research on factors affecting mining and mineral industries has been conducted, but such studies are both very limited and highly scattered in content and have targeted different parts of the organization. Importantly, the present study's results can substantially assist officials, managers, and planners in the mining and mineral industries to better understand the current situation and to design programs for its improvement and enhancement. In addition, mining and mineral industries organizations are vital pillars of job creation and of the economic growth and development of many countries, including developing countries such as Iran. Therefore, the present research was conducted with the aim of presenting a model of factors affecting the productivity of mining and mineral industries organizations for performance improvement.

2. Methods and Materials

This study was applied in terms of purpose and cross-sectional of a descriptive type in terms of implementation method. The statistical population of the present research included mining and mineral industries activists such as experts, managers, and specialists at the Iranian Mineral Processing Research Center and its parent organization (IMIDRO). The sample size was estimated to be 174 people based on the Cochran formula, and they were selected by a stratified random sampling method according to key subgroups (management, engineering, human resources, maintenance and repairs, and safety and environment). In this sampling method, the volume of each key subgroup in the population was calculated, and then, sampling was performed proportionally to the sample size.

The implementation process of the present research was as follows: initially, interviews were conducted with 30 experts, senior managers, and specialists in the mining and mineral industries until theoretical saturation was reached. The validity of the findings obtained from the interviews was confirmed by the triangulation method, and their reliability was obtained through the inter-coder agreement coefficient of 0.86. Subsequently, based on the conducted analyses, a researcher-made questionnaire on the factors affecting the productivity of mining and mineral industries organizations for performance improvement was designed. In the next stage, sampling was carried out among mining and mineral industries activists, and 174 individuals were selected as the sample using the stratified random method. The importance and necessity of the research were explained to them, and they were assured about compliance with ethical considerations. The participants were asked to carefully study the research tools (demographic information form and researcher-made questionnaire) and to answer them accurately and completely. It should be noted that the instruments were completed in person for some participants and electronically via the Porsline system for others due to limited accessibility.

In this research, two tools were used to collect data: the first tool was the demographic information form, and the second was the researcher-made questionnaire. The demographic form included questions about gender, age, education level, and work experience. The researcher-made questionnaire contained items about the factors affecting the productivity of mining and mineral industries organizations for performance improvement, which was designed by the present researchers after conducting interviews with experts. The designed questionnaire on the factors affecting the productivity of mining and mineral industries organizations for performance improvement included 67 items in six dimensions. Each item was answered on a five-point Likert scale ranging from very low (score 1), low (score 2), medium (score 3), high (score 4), to very high (score 5). Finally, the research data were analyzed using exploratory factor analysis and structural equation modeling (SEM) through SPSS and Smart-PLS version 30 software.

3. Findings and Results

No sample dropout occurred in the present research, and analyses were conducted on 174 mining and mineral industries activists. The frequency and percentage distribution of demographic characteristics of the participants, including gender, age, education level, and work experience, are presented in Table 1.

Table 1

Frequency and Percentage Distribution of Demographic Information of Mining and Mineral Industries Activists

Variable	Level	Frequency	Percentage (%)
Gender	Male	131	75.29
	Female	43	24.71
Age	21–30 years	10	5.75
	31–40 years	52	29.88
	41–50 years	74	42.53
	Over 50 years	38	21.84
Education level	Bachelor's degree	44	25.29
	Master's degree	94	54.02
	Ph.D.	36	20.69
Work experience	1–5 years	12	6.90
	6–10 years	24	13.79
	11–15 years	29	16.67
	Over 15 years	109	62.64

According to the results presented in Table 1, most of the mining and mineral industries activists were male (75.29%), aged between 41 and 50 years (42.53%), held a master's degree (54.02%), and had more than 15 years of work experience (62.64%). The results of the exploratory factor analysis of the factors affecting the productivity of mining and mineral industries organizations for performance improvement are presented in Table 2.

Table 2

Results of Exploratory Factor Analysis of the Factors Affecting the Productivity of Mining and Mineral Industries Organizations for Performance Improvement

Dimension	Component	Item	Factor Loading	Confirmed/Not Confirmed
Causal Conditions	Organizational Structure and Process Improvement	Q1	0.379	Not Confirmed
		Q2	0.586	Not Confirmed
		Q3	0.799	Confirmed
		Q4	0.806	Confirmed
		Q5	0.818	Confirmed
		Q6	0.829	Confirmed
	Technological Infrastructure	Q7	0.701	Confirmed
		Q8	0.783	Confirmed
		Q9	0.847	Confirmed
		Q10	-0.018	Not Confirmed
		Q11	0.391	Not Confirmed
	Technology and Innovation	Q12	0.852	Confirmed
		Q13	0.908	Confirmed
		Q14	0.877	Confirmed
		Q15	-0.175	Not Confirmed
Central Phenomenon	-----	Q16	0.907	Confirmed
		Q17	0.911	Confirmed
Contextual Conditions	Human Resource Empowerment	Q18	0.717	Confirmed
		Q19	0.752	Confirmed
		Q20	0.724	Confirmed
		Q21	0.355	Not Confirmed
		Q22	0.813	Confirmed
		Q23	0.782	Confirmed
		Q24	0.733	Confirmed
		Q25	0.821	Confirmed
	Economic Factors and Macro Policymaking	Q26	0.392	Not Confirmed
		Q27	0.577	Not Confirmed
		Q28	0.739	Confirmed
		Q29	0.706	Confirmed
		Q30	0.734	Confirmed
Intervening Conditions	Leadership, Management, and Policymaking	Q31	0.875	Confirmed
		Q32	0.831	Confirmed
		Q33	0.598	Not Confirmed
		Q34	0.648	Not Confirmed
	Risk and Organizational Safety Management	Q35	0.783	Confirmed
		Q36	0.822	Confirmed
		Q37	0.800	Confirmed
		Q38	0.750	Confirmed
		Q39	0.826	Confirmed
		Q40	0.802	Confirmed
	Supply Chain and Resources	Q41	0.796	Confirmed
		Q42	0.877	Confirmed
		Q43	0.795	Confirmed
		Q44	0.851	Confirmed
		Q45	0.647	Not Confirmed
Strategy	Operational Management and Productivity	Q46	0.796	Confirmed
		Q47	0.800	Confirmed

		Q48	0.725	Confirmed
		Q49	0.633	Not Confirmed
		Q50	0.810	Confirmed
	Human Capital Development	Q51	0.827	Confirmed
		Q52	0.575	Not Confirmed
		Q53	0.743	Confirmed
		Q54	0.774	Confirmed
		Q55	0.831	Confirmed
		Q56	0.841	Confirmed
Outcomes	Economic and Financial Performance	Q57	0.847	Confirmed
		Q58	0.832	Confirmed
		Q59	0.876	Confirmed
		Q60	0.880	Confirmed
		Q61	0.808	Confirmed
		Q62	0.716	Confirmed
		Q63	0.801	Confirmed
	Sustainability and Social Responsibility	Q64	0.899	Confirmed
		Q65	0.889	Confirmed
		Q66	0.924	Confirmed
		Q67	0.825	Confirmed

According to the results presented in Table 2, a total of 13 items related to the factors affecting the productivity of mining and mineral industries organizations for performance improvement were removed from the instrument due to factor loadings less than 0.70. Consequently, the final questionnaire contained 54 items in 12 components and six dimensions. Factor loadings below 0.70 indicated non-confirmation, while loadings above 0.70 indicated confirmation of the items' factor validity. The results of the convergent validity analysis using the Average Variance Extracted (AVE) method for the factors affecting the productivity of mining and mineral industries organizations for performance improvement are shown in Table 3.

Table 3

Results of Convergent Validity Analysis Using Average Variance Extracted (AVE) Method for the Factors Affecting the Productivity of Mining and Mineral Industries Organizations for Performance Improvement

Dimension	Convergent Validity	Confirmed/Not Confirmed	Component	Convergent Validity	Confirmed/Not Confirmed
Causal Conditions	0.686	Confirmed	Organizational Structure and Process Improvement	0.522	Confirmed
			Technological Infrastructure	0.395	Not Confirmed
			Technology and Innovation	0.587	Confirmed
Central Phenomenon	0.827	Confirmed	-----	-----	-----
Contextual Conditions	0.669	Confirmed	Human Resource Empowerment	0.527	Confirmed
			Economic Factors and Macro Policymaking	0.414	Not Confirmed
Intervening Conditions	0.496	Not Confirmed	Leadership, Management, and Policymaking	0.558	Confirmed
			Risk and Organizational Safety Management	0.636	Confirmed
			Supply Chain and Resources	0.636	Confirmed
Strategy	0.499	Not Confirmed	Operational Management and Productivity	0.571	Confirmed
			Human Capital Development	0.594	Confirmed
Outcomes	0.646	Confirmed	Economic and Financial Performance	0.680	Confirmed
			Sustainability and Social Responsibility	0.783	Confirmed

According to the results of Table 3, the convergent validity for the dimensions of intervening conditions and strategies was below 0.50, while it was above 0.50 for other dimensions. Moreover, among the components, technological infrastructure and economic factors and macro policymaking had AVE values below 0.50, whereas other components had AVE values above 0.50. An Average Variance Extracted (AVE) value below 0.50 indicated non-confirmation, and a value above 0.50 indicated confirmation of the dimensions and components' validity. The results of reliability analyses using Cronbach's alpha and composite reliability methods for the identified dimensions and components of the factors affecting the productivity of mining and mineral industries organizations for performance improvement are presented in Table 4.

Table 4

Results of Reliability Analysis Using Cronbach's Alpha and Composite Reliability Methods for the Identified Dimensions and Components of the Factors Affecting the Productivity of Mining and Mineral Industries Organizations for Performance Improvement

Dimension	Cronbach's Alpha	Composite	Confirmed/Not Confirmed	Component	Cronbach's Alpha	Confirmed/Not Confirmed	Composite	Confirmed/Not Confirmed
Causal Conditions	0.835	0.866	Confirmed	Organizational Structure and Process Improvement	0.805	Confirmed	0.861	Confirmed
				Technological Infrastructure	0.393	Not Confirmed	0.550	Not Confirmed
				Technology and Innovation	0.618	Not Confirmed	0.786	Confirmed
Central Phenomenon	0.791	0.905	Confirmed	-----	-----	-----	-----	-----
Contextual Conditions	0.844	0.876	Confirmed	Human Resource Empowerment	0.863	Confirmed	0.896	Confirmed
				Economic Factors and Macro Policymaking	0.635	Not Confirmed	0.772	Confirmed
Intervening Conditions	0.925	0.935	Confirmed	Leadership, Management, and Policymaking	0.732	Confirmed	0.831	Confirmed
				Risk and Organizational Safety Management	0.885	Confirmed	0.913	Confirmed
				Supply Chain and Resources	0.854	Confirmed	0.896	Confirmed
Strategy	0.897	0.915	Confirmed	Operational Management and Productivity	0.812	Confirmed	0.869	Confirmed
				Human Capital Development	0.859	Confirmed	0.896	Confirmed
Outcomes	0.945	0.952	Confirmed	Economic and Financial Performance	0.921	Confirmed	0.937	Confirmed
				Sustainability and Social Responsibility	0.907	Confirmed	0.935	

According to the results presented in Table 4, reliability calculated by Cronbach's alpha and composite methods was higher than 0.70 for all dimensions. Cronbach's alpha values were above 0.70 for nine components and below 0.70 for three components (technological infrastructure, technology and innovation, and economic factors and macro policymaking). The composite reliability values were above 0.70 for eleven components and below 0.70 for one component (technological infrastructure). Reliability values below 0.70 indicated non-confirmation, while values above 0.70 indicated confirmation of the dimensions and components' reliability. The results of model fit using the R^2 and Q^2 indices for the factors affecting the productivity of mining and mineral industries organizations for performance improvement are presented in Table 5.

Table 5

Results of Model Fit Using R² and Q² Indices for the Factors Affecting the Productivity of Mining and Mineral Industries Organizations for Performance Improvement

Dimension	Component	R^2	Confirmed/Not Confirmed	Q^2	Confirmed/Not Confirmed
Causal Conditions	Organizational Structure and Process Improvement	0.861	Confirmed	0.417	Confirmed
	Technological Infrastructure	0.622	Confirmed	0.221	Confirmed
	Technology and Innovation	0.808	Confirmed	0.446	Confirmed
Central Phenomenon	-----	0.432	Confirmed	0.341	Confirmed
Contextual Conditions	Human Resource Empowerment	0.921	Confirmed	0.450	Confirmed
	Economic Factors and Macro Policymaking	0.447	Confirmed	0.168	Confirmed
Intervening Conditions	Leadership, Management, and Policymaking	0.661	Confirmed	0.343	Confirmed
	Risk and Organizational Safety Management	0.849	Confirmed	0.504	Confirmed
	Supply Chain and Resources	0.857	Confirmed	0.511	Confirmed
Strategy	Operational Management and Productivity	0.819	Confirmed	0.435	Confirmed
	Human Capital Development	0.885	Confirmed	0.490	Confirmed
Outcomes	Economic and Financial Performance	0.936	Confirmed	0.594	Confirmed
	Sustainability and Social Responsibility	0.844	Confirmed	0.621	Confirmed

According to the results in Table 5, the model of factors affecting the productivity of mining and mineral industries organizations for performance improvement demonstrated a good fit. Furthermore, the model's Goodness of Fit Index (GOF) was obtained as 0.652, which, being higher than the threshold value of 0.36, indicated an acceptable model fit. The results of Structural Equation Modeling (SEM) for the model of factors affecting the productivity of mining and mineral industries organizations for performance improvement are presented in Figures 1 and 2 and Table 6.

Table 6

Path Results in the Model of Factors Affecting the Productivity of Mining and Mineral Industries Organizations for Performance Improvement

Path	t-statistic	Significance Level	Confirmed/Not Confirmed
Causal Conditions → Central Phenomenon	10.422	0.001	Confirmed
Central Phenomenon → Strategies	10.086	0.001	Confirmed
Contextual Conditions → Strategies	5.774	0.001	Confirmed
Intervening Conditions → Strategies	6.892	0.001	Confirmed
Strategies → Outcomes	28.713	0.001	Confirmed

Figure 1

Results of Structural Equation Modeling (SEM) for the Factors Affecting the Productivity of Mining and Mineral Industries Organizations for Performance Improvement in the t-statistic state (Legends: PADIDEH= Core Category, ELI = Causal Conditions, RAHBORD = Strategy, MODAKHELE= Intervening Conditions, ZAMINEH = Contextual Conditions)

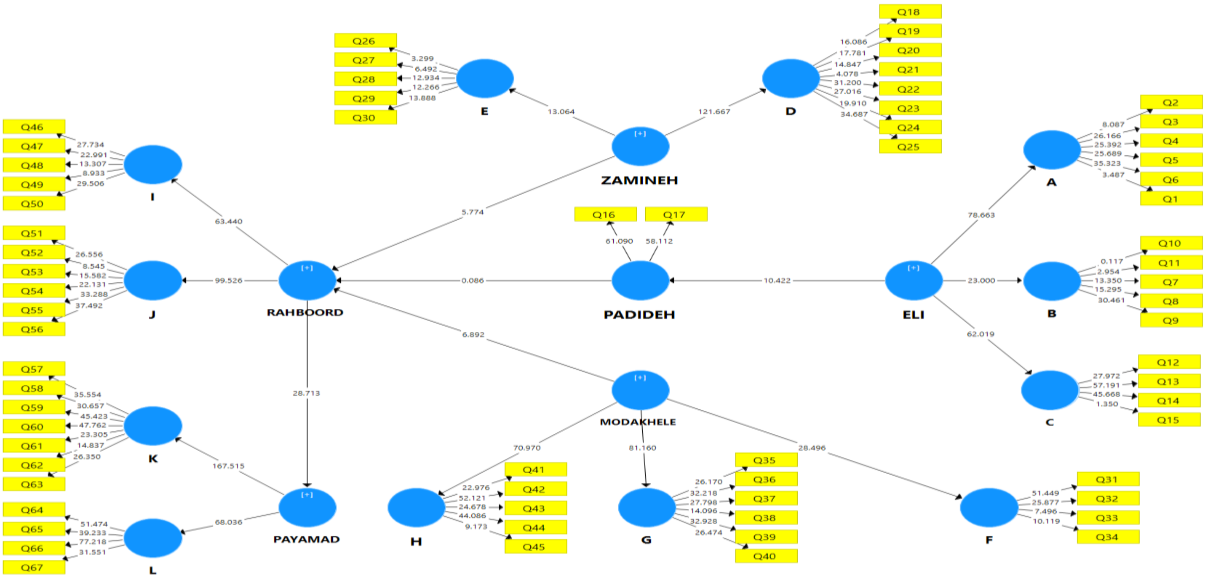
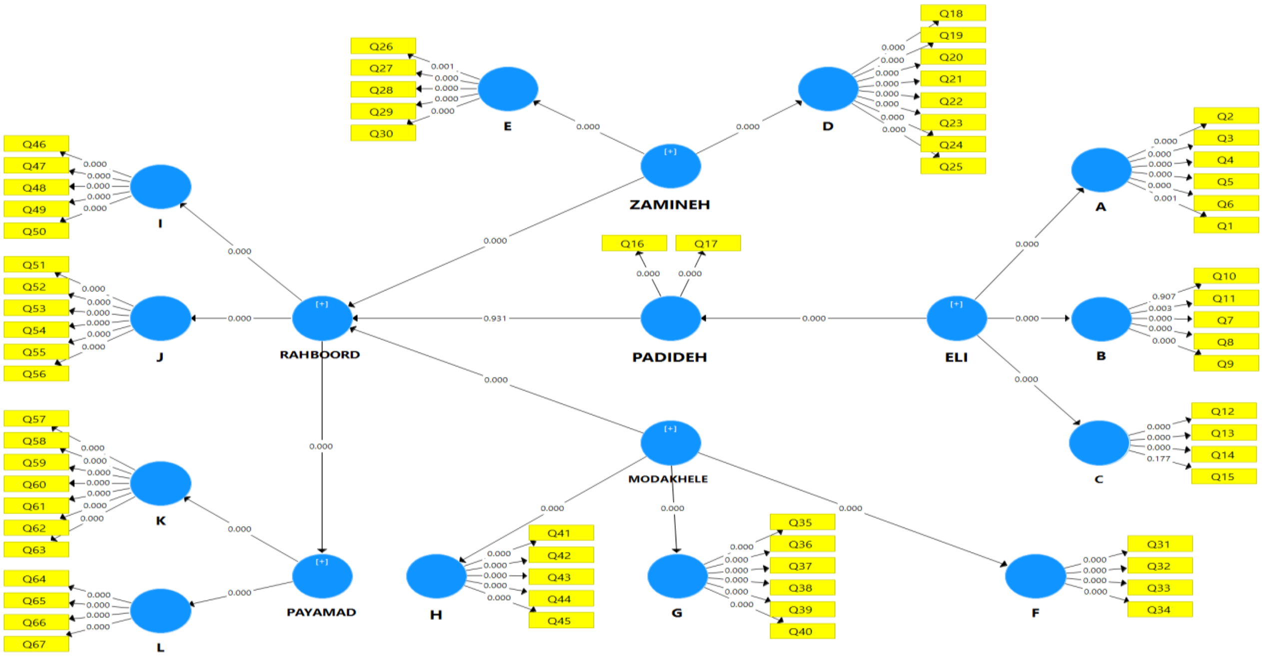


Figure 2

Results of Structural Equation Modeling (SEM) for the Factors Affecting the Productivity of Mining and Mineral Industries Organizations for Performance Improvement in the path coefficient state (Legends: PADIDEH= Core Category, ELI = Causal Conditions, RAHBORD = Strategy, MODAKHELE= Intervening Conditions, ZAMINEH = Contextual Conditions)



According to the results presented in Figures 1 and 2 and Table 6, within the model of factors affecting the productivity of mining and mineral industries organizations for performance improvement, causal conditions had a significant effect on the central phenomenon; the central phenomenon, contextual conditions, and intervening conditions had significant effects on strategies; and strategies had a significant effect on outcomes ($P < 0.001$).

4. Discussion and Conclusion

Identifying the factors influencing the productivity of mining and mineral industries organizations plays a critical role in understanding the current situation and designing and implementing programs to improve performance. Therefore, this study was conducted with the aim of presenting a model of factors affecting the productivity of mining and mineral industries organizations for performance improvement.

The findings of this research indicated that the factors influencing the productivity of mining and mineral industries organizations for performance improvement consisted of 54 items across 12 components and six dimensions: causal conditions (including three components—organizational structure and process improvement, technological infrastructure, and technology and innovation), the central phenomenon (without components), contextual conditions (including two components—human resource empowerment and economic factors and macro policymaking), intervening conditions (including three components—leadership, management and policymaking, risk and organizational safety management, and supply chain and resources), strategies (including two components—operational management and productivity and human capital development), and outcomes (including two components—economic and financial performance and sustainability and social responsibility). The convergent validity for the dimensions of intervening conditions and strategies was below 0.50 and above 0.50 for other dimensions, while for the two components of technological infrastructure and economic factors and macro policymaking, it was below 0.50 and above 0.50 for the rest. Moreover, reliability values obtained using Cronbach's alpha and composite reliability were above 0.70 for all dimensions; Cronbach's alpha was above 0.70 for nine components and below 0.70 for three components (technological infrastructure, technology and innovation, and economic factors and macro policymaking), and composite reliability was above 0.70 for eleven components and below 0.70 for one (technological infrastructure). Furthermore, the model of factors affecting the productivity of mining and mineral industries organizations for performance improvement demonstrated a good fit, in which causal conditions had a significant effect on the central phenomenon; the central phenomenon, contextual, and intervening conditions significantly influenced strategies; and strategies had a significant effect on outcomes.

Although no quantitative research was found regarding the factors influencing organizational productivity for performance improvement in mining and mineral industries—and existing studies in this field are limited and scattered—the current findings were consistent, to some extent, with the prior studies (Agheli, 2020; Agheli & Hosseini, 2022; De Solminihac et al., 2018; Gamtessa & Olani, 2018; Mayo-Alvarez et al., 2024).

In interpreting these findings, it can be stated that to enhance the productivity of mining and mineral industries organizations for performance improvement, it is essential to identify the causal factors influencing it and to design and implement programs accordingly. For this purpose, programs can be developed for improving organizational structures through establishing leaner structures, implementing process-based systems, reducing bureaucracy, enabling fast decision-making, and fostering agility; leadership and management styles through emphasizing leadership roles, transformational participatory leadership, innovative management styles, and leadership development; organizational interactions through effective communication, teamwork, and internal collaboration; technological innovation through the development and application of clean technologies, smart mining systems, and automation; physical and logistical development through infrastructure improvement, logistics optimization, and reduction of waiting times and transport costs; safety and environmental infrastructure through implementation of HSE systems and standards, strengthening safety culture, accident prevention, pollution control, and environmental monitoring; and technological advancement through adoption of IoT, machine learning, predictive analytics, innovation in extraction and transport, and sensor-based monitoring. In addition, reducing technological obsolescence and digital limitations such as weak IT infrastructure, lack of operational–technological coordination, and data non-standardization should be prioritized.

To enhance the productivity of mining and mineral industries organizations for performance improvement, several strategies should be adopted that, beyond the central phenomenon, are also affected by contextual and intervening conditions. The contextual conditions include continuous and general training, specialized and high-quality professional education, technology-based learning, targeted safety training, accident simulation, human–machine interaction improvement, skill enhancement, technical knowledge development, awareness raising, retraining, human resource preparation and utilization, continuous evaluation systems, reform of performance appraisal processes, educational standards, communication and conflict-resolution training, recruitment of skilled and experienced personnel, motivation and job satisfaction, merit-based selection and promotion, equitable distribution of opportunities, motivational systems, organizational culture, social values, psychological comfort, and social capital. They also include macroeconomic and environmental variables such as economic stagnation, global market fluctuations, mineral price volatility, international sanctions, political changes, decisions of higher institutions, privatization policies, governmental incentives, foreign investment, financial provision, and the reduction of financial constraints, complex tax regulations, and corruption.

The intervening conditions include continuous improvement, total quality management, material flow management, translating macro objectives into operational goals, employee participation in strategy implementation, government facilitation of investment, evidence-based policymaking, and risk management related to human, environmental, and equipment factors. These also involve risk analysis, risk management software, HSE standards, specialized training, periodic audits, reporting and continuous improvement, employee participation in safety programs, risk and incident reporting culture, managerial transparency, psychological support, sustainable development, environmental supervision, optimal resource allocation, quality improvement, understanding customer expectations, reducing fuel consumption, downtime, and integrating the supply chain to improve economic performance.

Strategies for improving productivity in mining and mineral industries organizations for performance improvement include developing clear strategies and operational plans, increasing production without cost escalation, optimizing resources, reducing waste, enhancing machine and material utilization, using new mining technologies, reducing maintenance costs, improving equipment lifespan, implementing performance evaluation and monitoring systems, defining key performance indicators, reducing operational errors, increasing performance improvement rates, effective project execution, enhancing decision-making, ensuring supply chain capacity, promoting continuous learning and empowerment, providing safety training and accident simulation, teaching soft skills such as communication, teamwork, and conflict resolution, recruiting skilled labor, developing managerial and operational competencies, reducing stress and human error, improving mental health and job well-being, and strengthening employee motivation, resilience, and job commitment.

The above strategies lead to outcomes such as increased access to private, public, and international funding; enhanced R&D expenditure; organizational profitability; value-added growth; market share expansion; transport and energy development; technological progress in extraction; increased direct and indirect employment; greater welfare and economic cycles; reduced greenhouse gas emissions; natural resource protection; adoption of green technologies; accident prevention culture; lower accident rates; leadership commitment to safety; social investment and local development; improved public health; and collaboration with government and local institutions.

Every study faces certain limitations during implementation. Major limitations of the present research include the use of self-report instruments, restriction of the sample to mining and mineral industry practitioners, and the scarcity of prior studies on organizational productivity in this sector. Therefore, it is recommended that future research address organizational productivity in mining and mineral industries from different perspectives and employ other data collection methods. Another recommendation is that officials and planners in the mining and mineral industries organization use the current study's questionnaire to assess the existing state of organizational productivity for performance improvement. By identifying strengths and weaknesses, they can preserve and enhance the former while designing and implementing practical programs to address the latter. According to the results of this study, in order to enhance the productivity of mining and mineral industries organizations for performance improvement, it is necessary to create favorable conditions for improving the identified valid dimensions and components, for which specialized training by experts is essential.

Authors' Contributions

Authors contributed equally to this article.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

The authors report no conflict of interest.

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Ethics Considerations

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

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