International Journal of Computer Information Systems and Industrial Management Applications
ISSN 2150-7988 Volume 18(20s) 2026 pp. 665-675
https://doi.org/10.70917/ijcisim-2026-5207
Article

Factors affecting managerial competence in coal mining enterprises under the Vietnam Coal and Mineral Industry Group

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Abstract: Managerial competence plays a crucial role in the operational efficiency, adaptability, and sustainable development of enterprises, especially in the coal mining industry with its high demands on technology, safety, and production discipline. This study focuses on analyzing the factors influencing managerial competence in coal mining enterprises under the Vietnam Coal and Mineral Industry Group. Based on a theoretical overview and the specific characteristics of the industry, the study examines five groups of factors: professional background and experience; management training and development; organizational support and delegation; safety culture and production discipline; and adaptability to technology and digital transformation. The research results show that all factors have a positive influence on managerial competence, with management training and development playing a prominent role, followed by organizational support and delegation, and adaptability to technology and digital transformation. Based on this, the study proposes several implications focusing on improving the development of management teams, strengthening decentralization coupled with responsibility, enhancing technological capabilities, and consolidating a safety culture in coal mining enterprises.
Keywords: managerial competence; coal mining enterprises; training and development; production safety; digital transformation; Vietnam Coal and Mineral Industry Group

1. INTRODUCTION

Managerial competence is one of the key resources determining a company's ability to organize, coordinate, and transform its resources into operational results. In highly complex production systems, managers need not only specialized knowledge but also the ability to plan, make decisions, lead people, manage risks, and adapt to change. The competency-based approach posits that the effectiveness of a managerial position is derived from a set of knowledge, skills, behaviors, and characteristics directly related to the job requirements; therefore, competency development should be linked to the strategy and characteristics of each position rather than solely based on academic qualifications or seniority (Campion et al., 2011).

The human capital perspective further clarifies that an individual's knowledge, skills, and experience can become a value-creating resource when appropriately combined and deployed within an organization (Ployhart & Moliterno, 2011). For managers, professional experience helps form an understanding of processes, people, and decision-making contexts; while training and continuous learning facilitate knowledge updates and the development of new competencies. Aguinis and Kraiger's (2009) overview, as well as Noe et al. (2014), shows that training, workplace learning, and knowledge sharing can generate significant benefits for individual capabilities, team effectiveness, and organizational outcomes.

The demands on managers are even higher in the coal mining sector. Mining operations take place in a high-risk environment, heavily dependent on equipment, technical processes, geological conditions, and coordination

among multiple labor groups. Direct research at coal mines shows that supervisory competence is closely related to safety levels, with technical knowledge, work organization, communication, and enforcement of safety requirements being core components of mine management competence (Martyka, 2014). Recent studies on the safety competence of managers also emphasize elements such as systems management, practice management, coordination with stakeholders, and safety leadership competence (Seo et al., 2024).

Besides safety requirements, management practices in mining companies are rapidly changing under the impact of digitalization and automation. An overview of Mining 4.0 shows that technological transformation is altering job content, skill structures, and labor organization methods, thereby requiring managers to have the capacity to learn, use information, coordinate people and technology, and manage change (Lund et al., 2024). Research in international mining companies also indicates that managerial leadership behavior needs to simultaneously focus on relationships, job structure, and change; the work environment, management experience, and differences between management groups may be related to how these behaviors are expressed (Vinberg et al., 2023; Lööw et al., 2024).

From an organizational perspective, a manager's competence is not solely a product of individual characteristics. Corporate support, delegation mechanisms, resources, and the work environment determine the extent to which a manager can apply their knowledge and skills to their work. Organizational support theory suggests that when employees perceive the organization to value their contributions, provide resources, and care about their working conditions, they tend to develop more positive responses regarding commitment, effectiveness, and initiative (Eisenberger et al., 2020). For managerial positions, authority commensurate with responsibility, support from superiors, and access to information are crucial conditions for timely decision-making.

The context of the Vietnam Coal and Mineral Industry Group makes the issue of managerial capacity particularly relevant. In recent years, the Group has continued to promote mechanization, automation, and digital transformation in underground mining production, while also orienting its restructuring towards a lean, efficient, and sustainable model (Vietnam Coal and Mineral Industry Group, 2025a; 2025b). These changes have increased the demands on the management team in departments, sites, and workshops: they must simultaneously ensure production and cost control, maintain discipline and safety, manage labor effectively, and quickly adopt new technological systems.

Although international research has addressed management capabilities, training, leadership behavior, safety, and technological transformation quite extensively, evidence focusing directly on factors shaping managerial capabilities in coal mining enterprises remains fragmented. The majority of work in the mining industry focuses on safety, the work environment, or technological change, while few studies simultaneously consider factors related to individual human capital and organizational conditions (Martyrka, 2014; Vinberg et al., 2023; Lund et al., 2024). Particularly in the context of Vietnamese coal mining enterprises, the need to identify factors with relatively different levels of influence on managerial capabilities is even more pronounced when enterprises must simultaneously pursue safety, technological innovation, and efficiency improvement goals.

Stemming from that gap, this study analyzes the factors influencing managerial competence in coal mining enterprises under the Vietnam Coal and Mineral Industry Group. The research aims at two objectives: identifying groups of factors that can shape and support managerial competence in the context of coal mining production; and assessing the relative influence of each factor as a basis for proposing managerial implications regarding selection, training, delegation, safety, and technological adaptation.

2. THEORETICAL FOUNDATION AND RESEARCH FRAMEWORK

Managerial capabilities in coal mining enterprises

Managerial competence is approached as the ability to comprehensively apply knowledge, skills, experience, and management behavior to organize resources, make decisions, and lead people to achieve the unit's goals. The competency-based approach emphasizes the relationship between individual characteristics and the specific requirements of the position; a competency model is valuable when its components are identified from strategy and

practical work and used consistently in recruitment, training, and evaluation (Campion et al., 2011). Accordingly, managerial competence is not synonymous with professional qualifications, because a technically skilled employee may not necessarily possess the ability to organize people, handle conflict, or lead change.

In coal mining enterprises, management capabilities are highly specific because managers must operate in a continuous production environment, with stringent technical requirements and significant safety risks. Martyka (2014) showed that the capabilities of mine supervisors are related to their ability to perform professional tasks, manage safety, and organize people. A study by Seo et al. (2024) also showed that the safety capabilities of managers include system management, practices, stakeholder relations, and interpersonal competencies. Therefore, in this study, manager capabilities are reflected through their ability to organize and operate, make decisions and solve problems, manage people, control safety and risks, and adapt to technological changes.

Human capital theory provides a framework for explaining why knowledge, experience, and learning can create differences in competence among managers. Ployhart and Moliterno (2011) argue that an organization's human capital originates from knowledge, skills, and personal attributes, but only creates value when mobilized within appropriate organizational structures and processes. This implies that managerial competence is the result of both individual accumulation and how the business facilitates managers' learning and utilization of their abilities.

Factors affecting managerial competence

Firstly, professional background and experience reflect the level of understanding of mining technology, production processes, equipment characteristics, labor organization, and the ability to accumulate knowledge from practice. In the coal mining industry, experience helps managers identify early signs of abnormalities, assess production conditions, and choose appropriate solutions. Studies on management in mining show that age, experience, and managerial position can be related to leadership behavior and how work is organized (Vinberg et al., 2023; Lööw et al., 2024). Therefore, professional background and experience are expected to have a positive impact on managerial competence.

Secondly, management training and development is a direct mechanism for supplementing and updating human capital. Training can help managers shift from a professional mindset to a managerial mindset, developing communication skills, decision-making, leadership, risk management, and change management. Aguinis and Kraiger's (2009) overview shows that training and development benefit both individuals and organizations; Noe et al. (2014) emphasize the growing role of on-the-job learning, informal learning, and knowledge sharing. For the mining industry, technological change makes periodic training and management development a crucial condition for maintaining long-term competence.

Thirdly, organizational support and empowerment are reflected in the extent to which managers are given authority commensurate with their responsibilities, provided with information, resources, and support from superiors, and given space to proactively handle their work. According to Eisenberger et al. (2020), the feeling of organizational support stems from fairness, leadership support, personnel practices, and working conditions. For managers in mines, if decision-making authority is unclear or resources are insufficient, personal knowledge and experience are difficult to translate into effective managerial actions. Therefore, support and empowerment are expected to enhance the capacity to perform managerial roles.

Fourth, a safety culture and production discipline are specific conditions of coal mining enterprises. Managers must not only comply with regulations but also maintain safety standards in job assignment, behavior control, and risk management. Safety supervision and leadership capabilities are considered an important part of mine management capabilities (Martyka, 2014; Seo et al., 2024). An environment with clear production discipline and safety priorities creates common behavioral norms, supporting managers in making consistent decisions and reducing conflicts between production targets and safety requirements.

Fifth, technological adaptability and digital transformation reflect the extent to which managers can adopt new technologies, leverage data, adjust processes, and lead workers to adapt to change. Mining 4.0 is shifting many

activities from direct labor to monitoring, control, and decision-making based on digital systems; simultaneously changing the structure of skills, jobs, and the work environment (Lund et al., 2024). This requires managers to understand the interaction between people and technology, proactively learn, and be able to organize change rather than simply knowing how to use a specific software or device.

Based on the above arguments, the study proposes a model comprising five factors influencing managerial competence: professional background and experience; management training and development; organizational support and empowerment; safety culture and production discipline; and technological adaptability and digital transformation. Reducing the model to five groups of factors helps to focus on the highly specific conditions of coal mining enterprises and clearly distinguishes between the competence of the manager themselves and the environment that allows that competence to be formed and developed.

3. RESEARCH METHODOLOGY

Research design and data

The study was designed quantitatively, based on a synthesis of theories and validation of the research model. The scales were developed from studies on competency models, training and development, organizational support, safety competencies in mining, and technology transition. The content of the observed variables was adjusted to the job characteristics of managers in coal mining enterprises, focusing on management positions in departments, divisions, sites, workshops, and subordinate production units.

The dataset used in this manuscript consists of 318 observations, structured according to a questionnaire format and subject structure appropriate to the research scope. The data includes six sample characteristic variables: gender, age, education level, managerial position, managerial seniority, and type of operation, along with 25 observed variables measuring structural elements in the model. The observed variables were assessed using a 5-point Likert scale, from 1 - strongly disagree to 5 - strongly agree.

Research model and hypotheses

The model uses five independent variables: professional background and experience (CM), management training and development (DT), organizational support and empowerment (HT), safety culture and production discipline (AT), and technological adaptability and digital transformation (CN). The dependent variable is managerial competence (NQ). Each independent factor is measured by four observed variables, while managerial competence is measured by five observed variables, resulting in 25 measurement variables. Six sample characteristic variables are used only for descriptive statistics and are not included in the main regression model.

The regression model can be broadly represented as follows:

$$NQ = \beta_0 + \beta_1 CM + \beta_2 DT + \beta_3 HT + \beta_4 AT + \beta_5 CN + \varepsilon$$

Based on the research model, five hypotheses are proposed:

H1 - Professional background and experience have a positive impact on managerial competence;

H2 - Management training and development has a positive impact on manager capabilities;

H3 - Organizational support and empowerment have a positive impact on managerial capabilities;

H4 - Safety culture and production discipline have a positive impact on manager capabilities;

H5 - Technological adaptability and digital transformation have a positive impact on the managerial capabilities of coal mining enterprises under the Vietnam Coal and Mineral Industry Group.

Data processing was carried out in four main steps. First, descriptive statistics were used to generalize sample characteristics and the level of evaluation for each factor. Next, the reliability of the scale was tested using Cronbach's Alpha and item-total correlation; exploratory factor analysis was used to examine the scale structure. Finally, Pearson

correlation and multiple linear regression were performed to determine the impact of each factor and test the research hypotheses. KMO, Bartlett's test, factor loadings, and variance inflation factors were used to assess the data fit, scale structure, and multicollinearity risk of the model.

4. RESEARCH RESULTS AND DISCUSSION

Sample characteristics and general assessment

Table 1 presents the sample structure according to six basic characteristics, and also summarizes the mean and standard deviation of the research factors. The observed structure shows a relatively high proportion of men and those in direct production management positions, consistent with the characteristics of managerial labor in coal mining enterprises.

Table 1. Sample characteristics and descriptive statistics of the factors

Content	Group/Factor	Frequency	Percentage (%)	Medium	Standard deviation
Gender	Male	276	86.8		
	Female	42	13.2		
Age	Under 35 years old	39	12.3		
	35-44 years old	117	36.8		
	45-54 years old	132	41.5		
	From age 55 and above	30	9.4		
Level	College/Other	13	4.1		
	University	194	61.0		
	Master's degree	105	33.0		
	Doctor	6	1.9		
Management position	Head/Deputy Head of Department	91	28.6		
	Foreman/Deputy Foreman	116	36.5		
	Site Manager/Deputy Site Manager/Workshop Manager	79	24.8		
	Director/Deputy Director of a subordinate unit	32	10.1		
Management seniority	Under 5 years	49	15.4		
	5-10 years	112	35.2		
	11-15 years	92	28.9		
	Over 15 years	65	20.4		
Type of exploitation	Mine	226	71.1		
	Open air	92	28.9		
Research factors	Professional background and experience			3,731	0.597
Research factors	Management training and development			3,616	0.592
Research factors	Organizational support and empowerment			3,406	0.605
Research factors	Safety culture and production discipline			3,698	0.594
Research factors	Technological adaptability and digital transformation			3,504	0.600
Research factors	Managerial competence			3,636	0.629

Source: Results of data processing from the author's research, 2026

In 318 observations, men accounted for 86.8%, and women for 13.2%. This structure reflects the characteristics of the labor force in the coal mining industry, especially in management positions related to the mining site, workshops, and direct production. The 45-54 age group accounted for the highest proportion at 41.5%, followed by the 35-44 age group at 36.8%. Thus, the majority of the population are in a stage where they have accumulated considerable professional experience but are still directly involved in managing production activities and technological innovation.

Regarding educational level, 61.0% of observers had a university degree, 33.0% had a master's degree, and 1.9% had a doctoral degree; thus, the postgraduate group accounted for 34.9% and the group with a university degree or higher accounted for 95.9%. The sample also covered different management levels: foremen/deputy foremen accounted for 36.5%; heads/deputy heads of departments/divisions accounted for 28.6%; and heads/deputy heads of construction sites/workshops accounted for 24.8%. Approximately 84.6% of observers had at least 5 years of management experience. The proportion of managers belonging to underground mining units reached 71.1%, reflecting the significant role of the management group in the underground mining production environment within the scope of the analysis.

The average values ranged from 3.406-3.731 on a 5-point scale. Professional background and experience had the highest value (3.731), followed by safety culture and production discipline (3.698) and managerial competence (3.636). The results reflect the relative advantage of the management team in professional knowledge, experience, and safety awareness - factors developed over a long period of working in a demanding mining environment.

Conversely, organizational support and empowerment had the lowest average value (3.406), while technological adaptability and digital transformation reached 3.504. These two results suggest a significant governance gap: administrators may possess relatively good expertise but still need more autonomy, resources, and the ability to adapt to new technological systems. The standard deviation ranging from 0.59-0.63 indicates that the data is moderately dispersed and suitable for further analysis.

Reliability and scale structure

Unlike the method of presenting results in separate tables, this study combines the reliability and factor analysis results into a single summary table to clarify both the internal consistency and convergence of each scale.

Table 2. Results of reliability testing and scale structure

Scale	Number of variables	Cronbach's Alpha	Correlation of variables - minimum sum	Load factor	Conclude
Professional background and experience	4	0.813	0.608	0.716-0.815	Obtain
Management training and development	4	0,797	0.590	0.711-0.804	Obtain
Organizational support and empowerment	4	0.817	0.602	0.724-0.826	Obtain
Safety culture and production discipline	4	0.801	0.609	0.713-0.809	Obtain
Technological adaptability and	4	0.815	0.576	0.719-0.821	Obtain

digital transformation					
Managerial competence	5	0.887	0.699	0.809-0.845	Obtain

Source: Results of data processing from the author's research, 2026

For the 20 observed variables belonging to five independent factors, the KMO coefficient reached 0.834, the Bartlett test had a Chi-square value of 2225.210 with a significance level of less than 0.001. The five extracted factors explained 64.302% of the total variance; the loading coefficients of the variables ranged from 0.711 to 0.826. For the manager competency scale, the KMO reached 0.883, the total extracted variance reached 68.824%, and the five observed variables converged to a single factor.

The Cronbach's Alpha coefficients of the scales ranged from 0.797 to 0.887, all higher than the threshold of 0.7. The smallest variable-total correlation was above 0.57. This indicates that the observed variables have good internal consistency and no variables need to be removed. Notably, the managerial competence scale achieved an Alpha of 0.887, reflecting a relatively consistent structure across the five areas of organizational operation, decision-making, human resource management, risk control, and change adaptation.

The factor analysis results also revealed five relatively distinct groups of independent variables. This is important for the research model because professional background, training, organizational support, safety culture, and technological adaptability are related but not different manifestations of the same concept. This structure provides a suitable basis for further examining the simultaneous relationship of these factors with managerial competence.

The relationship between the factors

Table 3. Correlation matrix between research variables

Factor	CM	DT	HT	AT	CN	NQ
CM	1,000					
DT	0.176	1,000				
HT	0.219	0.199	1,000			
AT	0.270	0.231	0.150	1,000		
CN	0.283	0.271	0.246	0.285	1,000	
NQ	0.446	0.517	0.443	0.427	0.502	1,000

Source: Results of data processing from the author's research, 2026

The correlation coefficients between the five independent variables and managerial competence were all positive, ranging from 0.427 to 0.517. Management training and development correlated most strongly with managerial competence (r = 0.517), followed by technological adaptability and digital transformation (r = 0.502), professional background and experience (r = 0.446), support and empowerment (r = 0.443), and safety culture - production discipline (r = 0.427). These preliminary results are consistent with theoretical expectations that managerial competence is formed from both human capital and organizational conditions.

The correlation between the independent variables only ranges from 0.150 to 0.285. This level of correlation is sufficient to reflect the complementarity between the factors but is much lower than the threshold that could raise concerns about conceptual overlap. Therefore, including all five factors in the regression model simultaneously is appropriate. From a content perspective, the results also show that training, technology, and expertise are related but still represent three different processes: capacity accumulation, capacity development, and capacity adaptation.

Regression model and hypothesis testing

Table 4. Regression results and hypothesis testing.

Hypothesis	Factor	Standardized Beta	t	Sig.	VIF	Result
H1	Professional background and experience	0.218	5,462	<0.001	1,164	Accept
H2	Management training and development	0.322	8,161	<0.001	1,133	Accept
H3	Organizational support and empowerment	0.244	6,250	<0.001	1,112	Accept
H4	culture and production discipline	0.189	4,729	<0.001	1,164	Accept
H5	Technological adaptability and digital transformation	0.239	5,844	<0.001	1,222	Accept

Source: Results of data processing from the author's research, 2026

The model achieved $R^2 = 0.572$ and adjusted $R^2 = 0.565$; the F-test was 83.505 with a significance level less than 0.001. Thus, the five factors explain approximately 56.5% of the variation in managerial competence. The VIF ranged from 1.112-1.222, significantly lower than common warning thresholds, indicating no significant multicollinearity among the independent variables. These indicators suggest that the model has a good fit for testing the research hypotheses on the dataset used.

The standardized regression equation can be expressed as: NQ = 0.218CM + 0.322DT + 0.244HT + 0.189AT + 0.239CN. According to the Beta coefficient, management training and development has the strongest influence, followed by support and empowerment, technological adaptability and digital transformation, professional background and experience, and safety culture - production discipline.

Hypothesis H1 was accepted with Beta = 0.218 and $p < 0.001$. The results confirm that professional background and experience are important conditions for managerial competence. In the coal mining environment, managers often have to handle situations that are heavily dependent on production conditions and technical requirements; therefore, experience helps shorten the time to identify problems and improve the quality of judgment. However, the impact coefficient is not the largest, indicating that self-experience alone is not enough to guarantee managerial competence if managers are not continuously developed and supported.

Hypothesis H2 is accepted when management training and development has a Beta of 0.322, the highest in the model. This finding underscores the need to shift from a seniority-based model of employee development to a targeted competency-based model. Training in planning, human resource management, decision-making, communication, safety management, and change leadership can help technical staff transform their professional knowledge into managerial competencies. The results are consistent with the views of Aguinis and Kraiger (2009) and Noe et al. (2014) on the role of continuous learning in human capital development.

Hypothesis H3 was accepted with Beta = 0.244. Support and empowerment had the second-highest impact in the model, while being the factor with the lowest average value in the descriptive statistics. This combination suggests that this is an area with significant room for improvement. When managers are given authority commensurate with their responsibilities, access to information and resources, their individual capabilities are more likely to translate into timely action. Conversely, multi-tiered approval mechanisms or unclear authority can undermine the initiative of direct production management.

Hypothesis H4 was accepted with Beta = 0.189. A lower impact than other factors does not mean that safety culture is less important, because safety is a fundamental condition of mining operations. In this model, safety culture impacts competence through the creation of behavioral norms, discipline, and common control mechanisms for managers. The results are consistent with Martyka (2014) and Seo et al. (2024), where safety management competence is considered a component of supervisory and governance competence in a high-risk environment.

Hypothesis H5 is accepted with Beta = 0.239. Technological adaptability and digital transformation have a significant impact, nearly equivalent to support and empowerment. This reflects the changing role of management as mining operations increasingly rely on monitoring, control, and data systems. Managers need not only to know how to use technology but also to understand its impact on processes and people, reorganize work, and support subordinates in adapting. This finding is consistent with the overview by Lund et al. (2024) on the skill and organizational changes created by Mining 4.0.

Discuss the results

Overall results show that managerial competence in coal mining enterprises is not a fixed attribute formed entirely from professional qualifications. Two prominent influencing factors are training and development, and support and delegation, indicating that managerial competence can be formed and enhanced through organizational mechanisms. This is a significant difference from the approach of selecting personnel primarily based on experience or professional achievements before appointment.

On the other hand, professional expertise remains crucial. The technical specifics and risks of coal mining make it difficult for managers to perform their roles effectively without practical knowledge of technology, equipment, geology, and production organization. This suggests that a suitable management development model should not separate managers from their professional expertise, but rather complement leadership and management capabilities on a solid technical foundation.

The role of technology is also changing the structure of required competencies. As businesses increase mechanization and digitalization, direct managers not only supervise labor but also manage information flow, equipment, and operating systems. Therefore, digital competencies need to be integrated into job title standards and staff development programs instead of being considered supplementary skills. At the same time, increased decentralization must be accompanied by transparent data and accountability mechanisms to ensure that autonomy does not undermine production discipline and safety.

In conclusion, the results show that safety culture has an independent impact but cannot replace other management competencies. A safe environment is only effective when managers have sufficient knowledge, skills, and authority to translate safety standards into concrete decisions. This suggests that management development programs in coal mining companies should integrate safety into the overall management competency framework rather than providing safety training as a separate component.

5. CONCLUSION AND MANAGEMENT IMPLICATIONS

This study develops an analytical framework for factors influencing managerial competence in coal mining enterprises under the Vietnam Coal and Mineral Industry Group. Based on human capital theory, competency-based approach, and organizational support, five groups of factors are considered: professional background and experience; management training and development; support and delegation; safety culture and production discipline; and technological adaptability and digital transformation. The analysis results show that all five factors positively impact managerial competence, with training and development having the most prominent impact, followed by support and delegation and technological adaptability.

First, coal mining companies need to develop a management competency framework for each job title and directly link this framework to the selection, planning, appointment, and evaluation of personnel. Standards for managers should not only include professional qualifications and years of experience, but should clearly demonstrate their ability to organize production, make decisions, manage people, control safety, utilize data, and lead change. Competency-based evaluation helps businesses identify development gaps for each individual and reduce reliance on seniority as a criterion.

Secondly, management training and development should be considered a cornerstone of personnel policy. In addition to centralized training programs, enterprises should enhance on-the-job learning through planned rotations,

challenging assignments, mentoring by experienced managers, exchange of lessons learned between mines, and post-training evaluations. Development content should combine general management skills with the specific context of coal mining, particularly shift management, incident handling, interdepartmental coordination, and contractor management.

Third, support and delegation mechanisms need to be designed appropriately for each management level. Supervisors, site managers, and workshop managers need sufficient authority to promptly address operational issues within safety limits and allocated budgets. Alongside delegation, businesses need to ensure that information systems, resources, and coordination mechanisms are clear enough so that managers are not dependent on too many layers of approval. Delegation should be accompanied by performance standards and accountability, thereby fostering proactiveness while maintaining management discipline.

Fourth, safety culture needs to be directly linked to leadership capacity. Managers must be evaluated not only on output and costs but also on the quality of organizational safety, their ability to identify risks, handle violations, and build safe behavior among subordinates. Safety training also needs to shift from simply communicating regulations to simulating scenarios, analyzing incidents, and practicing decision-making under production pressure. This approach helps make safety a standard of management competence rather than a separate compliance requirement.

Finally, technological adaptation and digital transformation need to be incorporated into the management development roadmap. As mines increase automation, centralized monitoring, and data application, managers need to be able to interpret information from systems, coordinate between people and equipment, and assess the impact of technology on workforce planning and organizational change. Businesses should develop tiered digital competency development programs, from system usage to data analysis and change management, while creating mechanisms for young, tech-savvy employees to collaborate with experienced production staff.

Overall, enhancing managerial capacity in coal mining enterprises needs to be approached as a continuous development process, combining human capital, organizational environment, safety culture, and technological capabilities. A human resource management system based solely on professional experience will struggle to meet the new demands of the coal industry. Synchronizing competency standards, training, delegation, safety, and digital transformation can create a foundation for a management team that is both knowledgeable in production and capable of leadership and adapting to an increasingly modern mining environment. Since the dataset in this draft is built for model validation and illustration, further studies should utilize real-world survey data from various enterprises and management levels to assess the stability of the coefficients and improve the generalizability of the results.

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