

## ORIGINAL ARTICLE

# The role of internal control and corporate management: the case of a mining company in Peru

### ABSTRACT

Peru is a country that stands out for its important mining sector; therefore, the following study analyzes the relationship between internal control and business management within a mining company in the country. The methodology considers the basic type, descriptive-correlational level, and cross-sectional design, the universe being 379 workers of the mining company analyzed and the sample is made up of 178 workers. The research instruments used to obtain data and measure research variables are questionnaires and content analysis. The results revealed a significant relationship between internal control and corporate governance. Therefore, it can be concluded that the company lacks strength with regards to internal control culture. It is therefore recommended that training and awareness programs be implemented to strengthen internal control culture, so that employees may understand the importance of their role in business management, and the effective implementation of these controls.

**Keywords:** transparency; ethics; profitability; sustainability; efficiency.

**Ximena Rocío Valdivia  
Holguín**

ximena.valdivia@unmsm.edu.pe

ORCID: <https://orcid.org/0009-0000-7896-0421>

Universidad Nacional Mayor de  
San Marcos, Facultad de Ciencias  
Contables, Lima, Perú.

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## INTRODUCTION

There are countries such as Peru that stand out for their mining sector, which is crucial for the Gross Domestic Product (GDP), as it generates jobs and income for its citizens. Thus, mineral resources diversity has fostered a solid mining industry. In such a context, the importance of internal control for corporate management, social responsibility and the environmental aspect is emphasized.

Nowadays, business management and administration in the mining industry is a topic of interest due to its significant contribution to the country's GDP (Flores, 2020). Likewise, the mining sector represents approximately 10% of the national GDP and 60% of the country's total exports (Vásquez, 2021). In this context, internal control plays a fundamental role in ensuring operational efficiency, financial transparency and regulatory compliance in mining companies (Sáenz *et al.*, 2023).

At the international level, SOX compliant companies are governed by the COSO framework for internal controls (Committee of Sponsoring Organizations of the Treadway Commission) [COSO], 2013). This framework includes five interrelated components: control environment, risk assessment, control activities, information and communication, and oversight. Furthermore, the mining industry in countries such as Ecuador and Colombia face significant challenges in terms of risk management and environmental sustainability (Gil & Moreno, 2021). According to Sobotka (2024), approximately 64% of mining companies worldwide identify risk management as one of the most important challenges facing their business. Furthermore, pressure from environmental groups and increasingly stringent regulations demand an environmentally sustainable approach (Valladares *et al.*, 2020).

Thus, the mining industry in Peru faces additional challenges related to corporate governance and corruption (Calle *et al.*, 2020). According to the Corruption Perception Index (2023), Peru ranks 101 out of 180 countries assessed in terms of corruption perception. This situation raises concerns about the integrity of business practices in the mining sector and the need to strengthen internal controls to prevent

and detect possible acts of corruption (Vásquez, 2021).

The mining company under study faces specific challenges related to operational, financial and compliance risk management. Approximately 43% of mining companies in Peru identify risk management as one of their main concerns (Pacheco, 2023). Furthermore, 28% of these companies face difficulties in complying with government regulations and international standards of transparency and business ethics (Pozo and Ferreiro, 2020).

The underlying causes of these challenges can be attributed to the lack of robust internal control systems, the complexity of mining operations, the pressure to maximize financial returns, and the influence of external factors such as metal price volatility and changes in government regulations. Addressing these causes would help to improve the corporate governance and the mining company's internal control (Montaño, 2020). If these issues are not adequately addressed, they could have serious consequences for mining companies in Peru, including financial losses, damage to corporate reputation, legal sanctions, and safety risks for workers (Huiman, 2022). Furthermore, they could hinder the country's sustainable development and negatively affect local communities that depend on the mining industry for their economic livelihood. (Ruiz *et al.*, 2020).

Therefore, research on the role of internal control and corporate governance in mining companies in Peru is of vital importance towards improving operational efficiency, strengthen corporate governance, promote financial transparency, and foster sustainable development in the country (Ospina *et al.*, 2021). Furthermore, it provides statistical data for business leaders, government regulators, and other stakeholders interested in improving the competitiveness and sustainability of the Peruvian mining industry (Ortiz *et al.*, 2023).

Among the background information reviewed in the international context, Escobar *et al.* (2023) showed that internal control was low (62%) and the profitability analysis showed an increase in the metrics for the 2021 period as follows: Return on Assets (ROA<sup>1</sup>) was 10%;

<sup>1</sup> ROA is the English acronym for Return on Assets.

Return on Equity (ROE<sup>2</sup>) was 19%, and Return on Sales (ROS<sup>3</sup>) was 10%, indicators that did not exceed 20%. This suggests the positive impact of internal control on the profitability of an organization and highlights the need to improve the effectiveness of internal control in order to achieve better results. Furthermore, Macias-Briones and Vegas-Meléndez (2022) conducted a study where they found that the main internal control strategies adopted by microenterprises, such as billing, resource planning systems, and process control, were favorable in their implementation.

Likewise, Vega de la Cruz and Marrero Delgado (2021) conducted research to highlight the importance of internal control in Cuban companies, pointing out the need to manage internal control in an integrated manner with a quantitative approach, supported by an information system that effectively and reasonably allows the achievement of organizational objectives. They also noted that internal control is the backbone of Cuban organizations and must be managed in an integrated manner. Mendieta *et al.*, (2022) pointed out that COSO methodology elements led to increased ROE, with control and risk assessment activities being the most influential, in contrast to the limited impact of information and communication. Thus, the research by Mendoza-Zamora *et al.*, (2019) also considers that the process of implementing public resources and the internal management procedures implemented during the management process will enable the strengthening of the public expenditure management system and improve the approval, execution and accountability of allocated resources.

Furthermore, in the national context, Vergaray *et al.*, (2022), conducted a study to analyze the correlation between internal control and corporate governance in a microfinance institution. According to the results obtained, a correlation coefficient of 0.709 was observed, which indicates the existence of a positive and significant relationship between internal control and business management in the microfinance institution. This means that as internal control increases, corporate governance also increases. Likewise, Espinoza *et al.*,

(2021), found that internal control was significantly associated with business management in 77.8% of the companies, which is a direct relationship.

Vásquez (2021) also found that the introduction of the internal control system, in accordance with Act 28716, increased the efficiency of the administration, which led to an improvement in the quality of work and services provided. Therefore, the implementation of internal control leads to the achievement of institutional goals and objectives, as well as administrative and financial management. Likewise, Reyes (2020) stated that the need to establish organizations and activities is essential for good governance, identifying many problems that can be solved with greater coordination. Thus, communication was emphasized as a priority of the company and was found to be maintained at an acceptable level, within certain parameters. Furthermore, Estrada (2019), in the results of his research, through Kendall's Tau-b statistical test, found a value of .414, which indicates a relationship of 41.4% between the variables, suggesting that internal control influences administrative management by 27.8%. Likewise, internal control reflects the organizational culture by formalizing the values, principles and standards that guide the behavior of its members, aligning daily practices with the mission and vision of the organization, and acting as a channel for the transmission of organizational values (Ysla, 2024). In addition, it is part of the current legal framework, serving as a document that adapts external regulations to the specific needs of the organization, thus ensuring compliance with legal provisions and acting as a bridge between general legislation and internal operations (Aguilar *et al.*, 2020).

It is also conceived as an essential component of the organizational structure, based on the need to establish rules that regulate the behavior of the members of an entity, thus guaranteeing order and operational coherence. This normative approach seeks not only to ensure compliance with institutional objectives, but also to align the individual behaviors that govern the organization. In this way, it acts as a frame of reference that legitimizes internal practices, allowing for the proper management

<sup>2</sup> ROE is the English acronym for Return on Equity.

<sup>3</sup> ROS is the English acronym for Return on Sales.

of human resources and the reduction of labor conflicts (Escobar *et al.*, 2023; Vásquez, 2021).

In this context, business management is essential because it addresses different environmental circumstances that influence business. Therefore, internal and external factors are considered important for achieving short, medium and long-term objectives (Picado Juárez and Golovina, 2021). Furthermore, this management generates a competitive environment that is currently experiencing the volatility of social changes, aspects that allow companies to react and generate competitive advantages, as well as strategies and ways to manage their permanence in global markets through management (Julio, 2020).

Internal control is therefore essential for efficient management, as it ensures the proper use of resources and the identification and management of risks. Furthermore, it is key to business management, aligning processes with strategic objectives that allow for improved efficiency and productivity (Cumbicos *et al.*, 2023). Thus, this relationship between internal control and business management is essential to mitigate risks and promote sustainability in the mining industry. Therefore, mining companies with solid internal control systems tend to have better financial results and a higher reputation in terms of corporate social responsibility.

This paper focuses on a SOX compliant mining company in Peru. In this context, deficiencies are identified in the culture of compliance with internal controls and in processes such as fixed asset inventories and human resource management, as well as in the review of environmental, social and corporate governance indicators. Therefore, a sound internal control system promotes transparency, minimizes the risk of fraud and/or corruption, and supports ethical business practices. All of this contributes to sustainable economic growth and the achievement of the Sustainable Development Goals (SDGs), such as decent work, economic growth and peace, justice and strong institutions.

In this research process the identified problem is posed as follows: What is the relationship between internal control and cor-

porate governance in the context of a mining company in Peru, 2023? Adding the objective of analyzing the relationship between internal control and corporate governance in the context of a mining company in Peru during the year 2023.

## METHODS

This research paper was a quantitative approach, since it obtained and analyzed data, it also considered the basic type, because with its formulation was known more about the proposed variables, and of descriptive correlational level and cross-sectional design, due to the fact that these variables presented relationship among them. In addition, the following general hypothesis of the research was considered: “existe relación significativa entre el control interno y la gestión empresarial en el contexto de una empresa minera en Perú, 2023” [There is a significant relationship between internal control and corporate governance in the context of a mining company in Peru, 2023], being the main hypothesis on which the results were analyzed and developed.

Research variables were also defined, as well as the related dimensions and indicators. Thus, two variables were considered; the first independent variable, which is internal control, and the second dependent variable, which is corporate governance. In the case of the first variable, the dimensions were control environment, risk assessment, control activities, information and communication and supervision, while in the second variable, they were planning, organization, management and control.

The research level was descriptive correlational because, as indicated by Hernandez-Sampieri and Mendoza (2018), correlational research is a scientific investigation that involves evaluating the relationship between two or more variables to determine the correlation. In this study, the relationship between the independent variable and the dependent variable, that is, between internal control and corporate governance, is carried out.

The data collection was done through people, specifically the workers of a mining company in Peru in the year 2023. Thus, the



population was the set of all cases that met certain specifications (Hernández-Sampieri and Mendoza, 2018). In this case, the population consisted of 379 employees of the mining company, using a confidence level of 95% for the selection of the sample. In addition, a margin of error of 5% was established and the sample size was corrected, resulting in a sample of 128 workers.

The instrument that was used was made reliable by means of Cronbach's Alpha ( $\alpha = .983$ ;  $\alpha = .976$ ), which was "apt" and validated by four experts in the field, who provided the corroboration for the application to the sample. Questionnaires were used as instruments to collect data and to measure the research variables. Therefore, this questionnaire was applied in a survey directed to the workers and then processed in the SPSS Statistics software version 27, which generated descriptive and inferential tables and figures. Subsequently, the results of the survey and the documentary information were analyzed in order to continue solving the problem in accordance with the objectives set in this research.

## RESULTS

The Control Theory formulated by Sunder, who argues that it focuses on the relationship between control systems and human behavior in the context of accounting, should be considered, with the emphasis that control systems are included in the policies, procedures, and practices in which people and organizations interact with financial information (Prieto and Therán, 2018). To this we add what is considered in the theory of administrative processes, which is based on the idea that management can be understood and improved through the

division of labor into smaller and more manageable processes, where these processes are considered essential for effective management in institutions (Córdoba, 2012).

In terms of control and supervision, a structure is provided for the evaluation of performance and compliance with standards, allowing the organization to take timely corrective measures. Therefore, control is an indispensable tool to maintain discipline and order, ensuring that all members of the organization act in accordance with established expectations. This comprehensive approach covers regulatory, cultural, legal and operational aspects, underlining its relevance as a pillar in organizational governance, consolidating its role as a guarantor of institutional stability and efficiency (Tejada *et al.*, 2020).

The results obtained and derived from the general hypothesis test demonstrate that there is a significant correlation between internal control and business management (sig. .000 < .005) among the workers of a mining company in Peru. It should also be noted that the higher the level of internal control, the higher the level of business management, where the Spearman's Rho correlation is expressed as rho = .820, which represents a very strong positive correlation.

Furthermore, there is a significant correlation between the internal control dimensions, which are control environment, risk assessment, control activities, information and communication, and supervision with business management. This relationship exceeds .780, indicating a significant positive correlation. See Table 1.

**Table 1**  
*Correlations and Dimensions*

Correlations		Internal control	Control environment	Risk assessment	Control activities	Information and communication	Supervision
Business management	Correlation coefficient	.820**	.820**	.806**	.782**	.795**	.785**
	Sig. (two-tailed)	.000	.000	.000	.000	.000	.000
	N	125	125	125	125	125	125

Note \*\*. The correlation is significant at the 0.01 level (two-tailed). Prepared by the authors, 2024.

In addition, 17.2% (22) perceive the internal control variable as poor, 43.8% (56) say it is average and 39.1% (50) say it is good, highlighting the average level among the employees of a mining company in Peru. Regarding the management of the company, 14.8% (19) consider it to be poor, 46.1% (59) consider it to be fair and 39.1% (50) consider it to be good, highlighting the fair level among the workers of this mining company. These descriptive results are consistent with the results of Estrada (2019), who obtained the existence of 41.4% among the variables formulated in this paper, and also explains that administrative management is influenced in 27.8% by internal control. See Figure 1.

## DISCUSSION

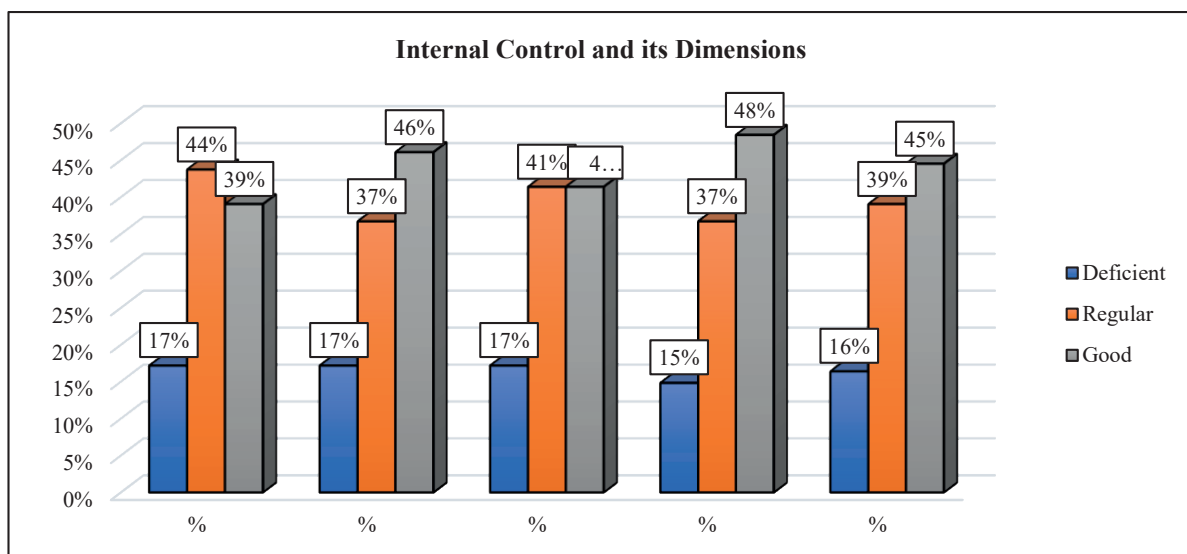
Within the framework of the research on the relationship between internal control and corporate governance in the context of a mining company in Peru, the general objective found that there is a very strong positive correlation ( $\rho = .820$ ) between both variables, according to Spearman's coefficient. This finding is consistent with the research of Vergaray et al. (2022), who also reported a significant positive relationship ( $\rho = .709$ ) between internal control and corporate governance.

Furthermore, the study by Vásquez (2021) supported these results by stating that the implementation of internal control improved the effectiveness of management and the quality of works and services. Thus, it highlights that internal control has interrelated components, whose process is unified, according to Estupiñán (2015). Likewise, business management is expressed as an activity focused on specialization and training, both aimed at improving institutional objectives and the performance of the company's personnel, according to Koontz et al., (2016).

In this setting, mining highlights several problems. Anastacio (2019) argues that more than 50% of Peru's fiscal deficit in the last two decades is explained by external factors, specifically the price of minerals and, among them, the international price of copper, which is a production problem because it is related to corporate governance. In addition, there is a risk regarding the likelihood and impact of corruption on the legal and ethical awarding of licenses, permits and contracts, which does not comply with the relevant requirements of adequate internal control (Madrid and Ávila, 2020).

**Figure 1**

*Internal control and its dimensions*



Note. Prepared by the authors, 2024.

In relation to the first specific objective, a very strong positive correlation ( $\rho = .820$ ) was found between the internal control environment and corporate governance, in contrast to Reyes (2020), who documented an organization and functions regulation for efficient management, pointing out problems of lack of coordination. However, Acosta (2023) pointed out the influence of the control environment on adequate administrative management, as well as active supervision, which contributed significantly to the creation of a favorable environment.

Regarding the second specific objective, a very strong positive correlation ( $\rho = .806$ ) was found between risk assessment and business management, coinciding with Pomatay (2023), who proposed a risk assessment and control to improve occupational health and safety in a mining company, through adequate supervision and control. Furthermore, Acosta (2023) He explained that a risk assessment is a critical activity in the business framework, aimed at identifying areas of vulnerability that can create significant risks for a company.

As for the third specific objective, a considerable positive correlation ( $\rho = .782$ ) was found between control activities and business management, supported by the research of Mendieta *et al.*, (2022), who indicated an increase in ROE with the implementation of control and risk assessment activities, these elements being those that influenced the company, in contrast to the limited impact of information and communication. Likewise, Vega de la Cruz and Marrero (2021) pointed out that supervision and monitoring function as support processes, in order to improve control and management activities as a result of internal and external audits within a company.

In regard to the fourth specific objective, a significant positive correlation ( $\rho = .795$ ) was found between information and communication and business management, in line with Macías-Briones and Vegas-Meléndez (2022), who highlighted the importance of internal control strategies, such as effective communication, in microenterprises of different sectors. Thus, the information handled by the company, whether public or private, becomes a key factor

that influences the interactions and actions of employees to balance their work style.

About the fifth specific objective, a considerable positive correlation ( $\rho = .785$ ) was observed between supervision and business management, in contrast to Vega de la Cruz and Marrero (2021), who indicated deficiencies in internal control and supervision in their research. Furthermore, Estupiñán (2015) emphasizes that supervision identifies the fulfillment of objectives in the internal control system, highlighting its importance aligned with the company's requirements.

In this context, in the administrative area, the COSO report (2013) points out the importance of risk assessment, which is based on the ability to make changes and improvements in advance, considering previously established limits; therefore, risk assessment is the basis for determining corporate governance. Therefore, it is necessary to develop risk assessments based on health and safety measures, because they will help identify the parts that should be included in your documents and evaluate the risk that may occur in the business plan.

Given this situation, Estupiñán (2015) points out that the operating procedures for including the rest of the staff as part of the organization and understanding the compliance guidelines that must be followed based on the assigned activities must be considered according to each location. Therefore, management activities must include activities related to various areas such as politics, society and culture, which are the most important for the company because activities can be organized and improved according to the monthly or weekly needs of the company.

Thus, internal control in Peru acquires strategic importance in risk management and asset protection in the mining industry. Its implementation ensures the integrity of operational and financial processes, strengthening the ability of companies to face challenges such as market volatility and regulatory changes (Montaño, 2020), and contributes to improving the efficiency and productivity of mining operations. A coherent internal control system makes it possible to identify and correct deviations in processes, thereby optimizing the

allocation of resources and maximizing the return on investment in mining projects (Valladares *et al.*, 2020).

On this point, Koontz *et al.* (2016) define business management as the process of creating and maintaining an environment that enables individuals working within groups to achieve specific goals. This process requires the guidance of a professional management team that can identify factors such as goal clarity, threats, and other factors that affect employee performance.

In this context, business management is fundamental to the competitiveness and sustainability of mining companies in a globalized and dynamic environment. This system is based on a strategic approach to the planning, organization and management of resources, enabling mining companies to adapt to market changes and maintain competitive advantages. (Bobadillo *et al.*, 2023). Therefore, the importance of business management in the Peruvian mining sector is manifested in its capacity to promote innovation and continuous improvement in mining operations, and a systematic approach to the management of processes and technologies allows mining companies to adapt to market demands and develop more efficient and sustainable practices (Sáenz *et al.*, 2023).

From the perspective of Chiavenato (2014), it is pointed out that management involves directing, organizing, planning, managing, and controlling resources to achieve organizational goals. In a business context, these principles seek the interaction between components, creating mutual effects, changes at the group or individual level, and integration and adaptation in response to different expectations. However, these positions and objectives are evolving over time and new types of organizations are emerging that share common goals regardless of the size of the organization (small, medium or large).

Therefore, the conceptualized dimensions are planning, which is a business management process that covers the pre-development phase, which has been elaborated by the Audit Committee. This method aims to understand the cost accounting and provisions defined in the documents. Therefore, it is important that

the planning information is included in the interpretation of the contractual provisions and included in the review process through the contract (Tejada, 2019). Then, planning is also a business activity that anticipates the achievement of objectives and determines the actions necessary to achieve them. This conceptual approach focuses on future actions, starting with setting objectives and providing a specific plan for their successful implementation (Peña-Ponce *et al.*, 2022).

Organization is a fundamental process that extends throughout the company and represents the formal structure of a job or position; therefore, this organizational unit emphasizes the need for teamwork, as it is essential to achieve individual goals. This favors a greater ability to perform tasks through collaboration or coordination between different activities (Tejada, 2019).

Therefore, it should be emphasized that organizations are social entities made up of people who focus on specific objectives, such as profit and/or the provision of social welfare. In addition, the organization has a division of labor and work distributed among its members (Peña-Ponce *et al.*, 2022). Also, leadership is the management process that focuses on the important aspects of the manager's work, which provides the opportunity to establish an organizational structure that facilitates people to achieve their goals and integrate talented people into that structure. In this context, the role of management refers to the contribution of workers to the achievement of organizational goals and highlights the importance of organizational attitudes (Tejada, 2019).

As for the management control function, it measures and adjusts performance to ensure that business objectives and plans are met. This activity is closely related to planning because activities are not expected to be separated or defined. It is argued that the lack of objectives and plans results in a lack of control, since performance must be evaluated according to established criteria (Tejada, 2019).

Accordingly, Chiavenato (2014) argues that the purpose of control is to ensure that the results of activities and planned activities are consistent with the achievement of objectives.



In this sense, the essence of management is to ensure that actions are carried out to achieve the expected objectives and results. Basically, management is the process of directing the actions carried out towards a goal.

Thus, internal control has been established as a key management support that can prevent risks and improve efficiency, effectiveness, transparency and cost savings; therefore, its implementation must focus on protecting public assets and eliminating any form of fraud or corruption. Basically, internal control is understood as a comprehensive set of actions taken by an organization's leaders, managers and employees to prevent threats and ensure security in order to achieve the organization's objectives. That is, it is a special management to reduce the risks that arise during financial management.

Therefore, an organizational culture focuses on understanding communication and information management. Thus, the openness of data and information contributes to strengthening internal and external trust and strengthening the organization, considering the implementation of transparent and effective communication methods, both internally and externally, and to communicate research results and information. It is important for managers to address these issues in a timely manner, solve problems and strengthen companies.

## CONCLUSIONS

1. The research conducted in this paper finds significant relationships between internal control and corporate governance, with correlations of 82%. This suggests that better internal control is associated with more effective management, which benefits the company's decision making and operational efficiency.
2. In addition, an 82% correlation was found between the control environment and corporate governance. Thus, a sound control environment influences employee behavior, facilitates risk management, and promotes transparency, all of which are critical to the long-term success of the organization. Furthermore,

risk assessment and governance show a correlation of 80.6%, indicating that adequate risk assessment contributes to more effective governance by identifying and mitigating business risks. Regarding the relationship with control activities, a correlation of 78.2% was found.

3. Therefore, a higher level of control activities includes policies and procedures that are associated with more effective business management, improving operational efficiency and informed decision making. In addition, information and communication have a 79.5% correlation with governance, so a higher level in these areas facilitates strategic decision making and effective coordination, thereby improving governance.
4. Supervision has a 78.5% correlation with management. Therefore, continuous supervision helps to identify and correct deviations, evaluate compliance with policies and procedures that ensure the effectiveness of internal controls, and promote responsibility and performance in the organization.
5. It is also an essential part of any management control study, as it provides a consolidated basis for demonstrating the importance of the study and how its results can support knowledge and decision-making in the sector. Therefore, it is essential to be aware of the risks associated with inadequate business management; therefore, by applying adequate internal control, under the evaluation and supervision of management, productivity and efficiency are improved through controls to avoid delays in procedures, low competitiveness and, above all, loss of profitability.
6. The scope of this paper is to deepen the analysis of the internal control and its impact on the management of the sector studied, that is, the mining company; likewise, through the prior evaluation, to improve the weaknesses and propose improvement strategies for optimization. For all these reasons, this paper provides updated information for other organiza-

- tions and/or public entities in the country (such as the mining sector studied), so that they can clarify in depth the level of importance of having an adequate internal control and identify in a timely manner whether the correct application is being carried out within their facilities.
7. This paper can be used to develop concise policies that support a sound organizational environment and to ensure that these policies are communicated at all levels of the organization. In addition, a training program should promote an internal control culture so that all employees understand the importance of their role in managing the entity and the proper functioning of internal controls. In addition, a structured and quantitative approach to risk assessment should incorporate the evaluation of future scenarios into the identification process to ensure timely preparation.
  8. Internal control plays a critical role in creating trust and transparency, both internally and externally. Continuous monitoring ensures the reliability of financial and operational information and strengthens relationships with investors, local communities and regulators.
  9. Corporate governance is positioned as a key pillar for maximizing value and profitability in the mining sector. Therefore, the application of result-oriented management practices enables companies to make the most of their assets and business opportunities and generate favorable returns for investors and stakeholders.
  10. Suggested actions to mitigate these problems include implementing rigorous internal control systems and external audits to detect and prevent corruption and promoting a culture of transparency and ethics through employee policies. It is also advisable to adopt a proactive approach to identifying and managing risks, with an emphasis on planning and continuous monitoring to ensure that operations comply with all regulations and standards to avoid sanctions and legal problems.
  11. It is also important to periodically update the risk assessment to reflect changes in the business environment. These processes help organizations identify opportunities, manage potential problems, and optimize operations in a business environment characterized by uncertainty and complexity, especially in a country like Peru.
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#### Conflict of interest

The author has no conflicts of interest to declare.

#### Author Contribution

Ximena Rocio Valdivia Holguin (lead author): conceptualization, formal analysis, project management, research, methodology, validation, supervision, and writing (original draft, review and editing).