

Analysis of Workers' Compliance with Occupational Safety and Health (K3) Protocols: Qualitative Descriptive Study of Mining Workers at Pt. Tonasa Cement

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Abstract

Occupational Safety and Health (OSH/K3) compliance is an important issue in mining operations because workers are exposed to various occupational hazards that may threaten safety, health, and operational continuity. In the context of PT Semen Tonasa, Pangkep Regency, South Sulawesi, inconsistencies in safety compliance remain a concern, particularly in high-risk operational areas where workers interact with heavy equipment, environmental hazards, and strict work procedures. This study aims to analyze workers' compliance with OSH protocols and identify factors perceived to influence compliance in the mining operations of PT Semen Tonasa. This research employed a descriptive qualitative approach. Data were collected through semi-structured interviews, direct observation, and documentation analysis. Six informants were selected using purposive sampling, consisting of a mining coordinator, field supervisor, OSH staff, a safety permit officer, and mining workers who were directly involved in OSH implementation. The findings indicate that OSH compliance has been supported by formal mechanisms such as routine supervision, safety talks, training and certification programs, PPE provision, and safety culture initiatives. However, compliance practices remain inconsistent, particularly in PPE use, safety facility completeness, and monitoring consistency across operational units. The most frequently emphasized factors related to compliance were supervision and safety culture, while training and PPE availability supported workers' knowledge, readiness, and protection. These findings suggest that improving OSH compliance requires integrated efforts, including stronger field supervision, regular risk-based training, consistent PPE monitoring, improved safety signage, and continuous reinforcement of safety culture across all mining operational areas.

Keywords: *Compliance, Mining Workers, Occupational Safety and Health, Personal Protective Equipment, Safety Culture*

Introduction

Occupational Safety and Health (OSH) is a fundamental component of industrial operations, particularly in high-risk sectors such as mining (Akpan et al., 2025). The mining industry is inherently exposed to various hazards, including material collapse, explosions, dust exposure, and extreme environmental conditions that may lead to both acute injuries and long-term occupational diseases (Burtan et al., 2025). These risks not only threaten workers' safety but also disrupt operational continuity and organizational performance (Cacciuttolo et al., 2024). Therefore, consistent implementation of OSH protocols and workers' compliance with safety regulations are critical in minimizing workplace accidents and ensuring a safe working environment (Li et al., 2022).

In Indonesia, this commitment is reinforced by Law No. 1 of 1970 on Occupational Safety, which mandates that every worker has the right to protection in carrying out their duties (Pratiwi,

2020). Despite the existence of such regulations, ensuring compliance in practice remains a persistent challenge, especially in complex work settings such as mining operations (Cvetkovski & Weston, 2025). From a theoretical perspective, OSH compliance behavior can be explained through several behavioral and organizational theories (Le & Nguyen, 2025).

The Theory of Planned Behavior by Ajzen suggests that individual compliance is influenced by attitudes, subjective norms, and perceived behavioral control (Sun et al., 2025). In addition, Safety Climate Theory by Zohar emphasizes that workers' safety behavior is strongly shaped by organizational priorities, managerial commitment, safety communication, and perceived safety policies (Sari et al., 2025). Meanwhile, Human Factors Theory by Ferrell highlights that workplace accidents are often the result of interactions between human behavior, environmental conditions, organizational factors, and system design (Gonyora & Ventura-Medina, 2024). These theoretical perspectives indicate that OSH compliance is not a single-dimensional issue but a multidimensional construct influenced by both individual and organizational factors (Alifariki, 2026).

Workplace accidents can be associated with human and organizational factors, particularly employee discipline, professionalism, work readiness, and the quality of workplace management practices (Sulaiman et al., 2024; Syam, 2025). Previous studies have consistently shown that employee behavior and performance are influenced by various determinants, including time management, work discipline, professionalism, self-efficacy, human resource management practices, and supportive work environments (Fatimah et al., 2024; Sulaiman et al., 2024; Arfah, 2026). Education level, work experience, and OSH training have been found to significantly influence workers' compliance in industrial settings (Pandiono & Amar, 2025). Safety perception, PPE usage, and the availability of safety facilities also significantly shape workers' safety behavior (Wenno et al., 2021). In addition, age, training, knowledge, and PPE utilization are important factors in determining compliance in construction environments (Mulyono et al., 2024).

A comparison of these studies reveals that most empirical evidence has been generated from manufacturing and construction sectors, where working conditions, risk structures, and organizational systems differ significantly from mining operations. While these studies provide valuable insights, their findings may not fully represent high-risk extractive industries such as cement-based mining. Mining environments involve more complex hazard exposure, including confined spaces, heavy machinery interaction, and continuous environmental pressure, which may alter compliance behavior patterns.

Furthermore, prior research tends to emphasize individual determinants of compliance, such as knowledge, training, and demographic characteristics, while relatively limited attention has been given to the interaction between organizational systems—such as managerial supervision, safety culture, and enforcement mechanisms—and environmental risk intensity. This indicates a theoretical and empirical gap in understanding OSH compliance as an integrated system rather than isolated variables.

In the context of PT. Semen Tonasa, a state-owned cement company in South Sulawesi, Indonesia, limestone mining operations represent a high-risk working environment with significant exposure to physical, chemical, and ergonomic hazards. Although the company has implemented OSH programs such as safety training, PPE enforcement, environmental monitoring, and compliance with Government Regulation No. 50 of 2012 concerning SMK3, inconsistencies in worker compliance still occur. Internal observations suggest that compliance

levels vary across operational units, particularly in high-risk areas such as Kiln and Coal Mill operations, where accident exposure is relatively higher.

These inconsistencies indicate a gap between formal OSH policies and actual worker behavior in practice. Factors contributing to this issue include limited hazard awareness, discomfort in PPE usage, work pressure, and varying levels of supervisory enforcement. Moreover, the internalization of safety culture has not been fully achieved across all organizational levels, leading to inconsistent behavioral outcomes.

Based on these gaps, this study aims to analyze workers' compliance with OSH protocols in the mining operations of PT. Semen Tonasa by (1) assessing the level of compliance, (2) identifying influencing factors such as managerial supervision, training, PPE availability, and safety culture, and (3) exploring barriers and supporting factors in OSH implementation.

The novelty of this study lies in its integrative approach, which combines individual, organizational, and environmental dimensions to explain OSH compliance behavior in a high-risk mining context. Unlike previous studies that focus on isolated determinants or non-mining sectors, this research provides a more comprehensive explanation of compliance dynamics in cement mining operations. Theoretically, it contributes to the expansion of OSH compliance literature by contextualizing behavioral safety models in extractive industries. Practically, the findings are expected to support the development of more effective safety management strategies, improve compliance behavior, and reduce workplace accidents in high-risk industrial environments.

Method

This study employed a descriptive qualitative approach to analyze workers' compliance with Occupational Safety and Health (OSH/K3) protocols in the mining operations of PT Semen Tonasa. This approach was selected because the study aimed to obtain an in-depth understanding of compliance behavior, influencing factors, and implementation barriers within a high-risk industrial environment. Through a qualitative design, the study explored how workers perceive, interpret, and practice OSH procedures in their daily work activities.

The participants of this study were selected using purposive sampling based on specific criteria. The criteria included workers who were directly involved in mining operational activities, particularly in high-risk areas such as Kiln and Coal Mill units, and those who had worked for at least one year to ensure adequate experience with OSH implementation in the workplace. A total of six informants were involved, consisting of a mining coordinator, field supervisor, OSH staff, safety permit officer, and mining workers. The selection of these informants was intended to obtain diverse perspectives from managerial, supervisory, safety, and operational levels.

Data were collected using semi-structured interviews, direct observation, and documentation analysis. Semi-structured interviews were conducted to explore workers' perceptions, experiences, and understanding of OSH compliance, including supervision, training, PPE use, safety culture, and barriers to implementation. Direct observation was used to assess actual compliance behavior in the field, particularly in relation to the use of personal protective equipment and adherence to safety procedures. Documentation analysis was carried out by reviewing company OSH policies, training records, safety reports, inspection records, and other relevant documents related to OSH implementation.

To ensure the validity of the research instruments, expert validation was conducted involving OSH and occupational health experts as well as academic reviewers in the field of occupational safety management. The experts evaluated the interview guidelines, observation checklists, and documentation review formats in terms of content relevance, clarity, and alignment with the research objectives. Based on their feedback, revisions were made to improve question clarity, eliminate ambiguity, and ensure that the instruments accurately captured the dimensions of OSH compliance behavior.

The research process also maintained qualitative trustworthiness through credibility, dependability, confirmability, and transferability. Credibility was strengthened by comparing information obtained from interviews, field observations, and company documents. Dependability was supported by using consistent interview guidelines, observation checklists, and documentation review formats during data collection. Confirmability was maintained by recording field notes and ensuring that interpretations were based on collected data rather than researcher assumptions. Transferability was addressed by providing a clear description of the research location, informant criteria, and OSH implementation context.

Data analysis was conducted using an interactive model consisting of data reduction, data display, and conclusion drawing. In the data reduction stage, interview results, observation notes, and documentation data were organized and categorized based on relevant themes, including supervision, training, PPE availability and use, safety culture, and barriers to OSH compliance. In the data display stage, the categorized data were presented in narrative form to identify patterns and relationships among findings. In the conclusion drawing stage, the researcher interpreted the findings and verified them through triangulation of sources and methods by comparing interview results, observational data, and document analysis.

Results

Informant Characteristics

The informants in this study were selected using purposive sampling to ensure that all participants had relevant knowledge, experience, and direct involvement in the implementation and supervision of Occupational Safety and Health (OSH/K3) protocols at PT Semen Tonasa. A total of six informants representing different organizational roles were involved, including managerial personnel, supervisors, OSH staff, safety permit officers, and operational workers. This variation enabled the study to capture both managerial perspectives and actual field practices related to OSH compliance.

The first informant was the Mining Coordinator, who is responsible for overseeing mining operations and ensuring that work activities are carried out according to established procedures and safety standards. The second informant was a Field Supervisor, who directly monitors workers' activities in the mining area. The third and fifth informants were OSH staff members who are involved in implementing safety programs, monitoring PPE use, conducting inspections, and providing safety education. The fourth informant was a safety permit officer responsible for ensuring that work activities are properly authorized and meet safety requirements before execution. The sixth informant was a mining worker who provided information on the practical implementation of OSH protocols at the operational level.

All informants had at least one year of work experience and were familiar with the implementation of OSH procedures in their respective work areas. The interviews were conducted between 4 and 5 March 2026 at several locations within the company's operational

area, including the mining site and administrative offices. The findings are presented based on themes generated from the data analysis process, namely supervision, training and competency development, PPE availability and use, and safety culture. These themes were derived from interview data and verified through field observations and supporting company documents.

Implementation of Occupational Safety and Health (OSH) Programs

The findings indicate that the implementation of OSH programs at PT Semen Tonasa has been carried out systematically to support safe working conditions in mining operations. The program consists of several key components, including supervision, training, PPE provision, and safety culture development. These components are implemented to reduce workplace risks, increase workers' awareness, and maintain operational continuity in a high-risk work environment.

Supervision Practices

Supervision emerged as a central component of OSH implementation, as reflected in interview findings, field observations, and supporting documents. The results show that monitoring activities are conducted routinely, particularly through daily safety briefings or safety talks before work begins. Based on informants' explanations, safety talks are carried out every morning to remind workers about potential hazards before entering the work area. This finding was supported by field observations, which showed that supervisors provided brief instructions related to unsafe conditions, unsafe actions, PPE use, and safe work procedures before operational activities started.

These briefings function as a preventive mechanism to increase workers' awareness and reduce unsafe behavior during task execution. In addition to safety talks, routine inspections and periodic evaluations are conducted to ensure that workers comply with established OSH procedures. This was supported by inspection records and informants' explanations indicating that supervisors regularly check work areas, equipment conditions, and workers' adherence to safety rules.

Supervisory practices are not limited to safety briefings but also include enforcement mechanisms such as warnings for violations and continuous evaluation of safety performance. Informants explained that workers who violate safety procedures are given direct warnings by supervisors, particularly when they fail to use PPE or ignore established work procedures. Field observations also showed that equipment safety is addressed through mandatory daily inspections and maintenance checks before operation to ensure that machinery is in proper working condition. Furthermore, technical safety standards are applied in mining areas, including road width specifications, safety railings, and limitations on slope height to prevent accidents. These findings indicate that supervision is implemented in a structured and continuous manner by integrating preventive measures, such as safety talks and equipment inspections, with corrective measures, such as warnings and performance evaluations.

Training and Competency Development

Training is another key element of the OSH program. The results show that training activities are conducted regularly and are considered mandatory, particularly to support the implementation of the Mining Safety Management System. Workers, especially those in supervisory roles, are required to obtain specific certifications according to their level of responsibility. These certifications are structured in tiers to support progressive competency development.

In addition to formal certification programs, the company also conducts routine training sessions, seminars, safety briefings, refresher courses, and basic safety training to improve workers' safety knowledge and awareness. Training programs are adjusted to different roles within the organization, including supervisors, safety officers, technical staff, and operational workers. The scheduling of training activities is arranged flexibly so that workers can participate without disrupting operational activities.

These findings were supported by training records, attendance lists, and certification documents, which showed that safety induction, refresher training, and competency certification were implemented as part of the company's OSH program. Overall, the findings indicate that training and certification function as continuous learning mechanisms to strengthen workers' safety competence and ensure that OSH procedures are understood and applied consistently in daily mining operations.

Availability and Use of Personal Protective Equipment (PPE)

The availability and use of PPE constitute a critical component of OSH implementation. The findings reveal that PPE is provided according to job requirements and risk levels in different work areas. Workers in administrative roles are required to use basic PPE, while workers in high-risk areas are equipped with specialized protective equipment, such as heat-resistant clothing and hearing protection devices.

Although PPE is generally available and its use is mandatory, the results indicate that compliance is not entirely consistent. Several instances of non-compliance were still found in practice, despite the existence of safety regulations and enforcement mechanisms. Supervisors play an important role in monitoring PPE use and ensuring adherence to safety standards. Routine inspections and unannounced checks are conducted to identify violations, and disciplinary measures are applied when necessary.

The findings also show that peer support contributes to PPE compliance. Workers are encouraged to remind each other to use PPE properly, especially before entering high-risk operational areas. This finding was supported by field observations and PPE inspection records, which showed that PPE was available according to work risk levels, although several instances of inconsistent use were still found in operational areas. Overall, while PPE provision is adequate, variations in compliance behavior remain evident and require continuous monitoring.

Safety Culture

The development of a safety culture is identified as an integral part of OSH implementation at PT Semen Tonasa. The findings show that the company promotes safety awareness through continuous campaigns, structured programs, and leadership involvement. This was supported by company safety campaign materials, safety signage, and monitoring records, which indicated that safety messages were regularly communicated to workers through both formal programs and workplace media.

These initiatives have contributed to increased awareness and have made safety a recurring theme in workplace interactions. However, the results also indicate that the implementation of safety culture is not entirely uniform across all units. Some informants reported limitations in supporting facilities, such as incomplete safety signage and monitoring systems, particularly when compared to other operational units within the broader corporate group.

Despite these limitations, efforts to strengthen safety culture are evident through consistent communication, training, and leadership involvement. Management commitment is reflected in

the role of leaders and supervisors as models of safety behavior, including compliance with PPE use and adherence to safety procedures. Monitoring mechanisms, such as safety control systems, are also used to assess compliance and address deviations in real time. Overall, the findings suggest that safety culture at PT Semen Tonasa is continuously developed through organizational initiatives, leadership practices, and worker participation, although improvements are still needed in safety infrastructure and monitoring consistency across units.

Discussion

Supervision and Compliance with OSH Protocols

The findings of this study demonstrate that supervision plays a central role in shaping workers' compliance with Occupational Safety and Health (OSH/K3) protocols at PT Semen Tonasa. This occurred because mining activities involve dynamic hazards that require immediate guidance, repeated reminders, and direct correction from supervisors to ensure that formal safety rules are translated into daily work practices (Lyu et al., 2025). Daily safety talks before work function not only as routine briefings but also as risk communication mechanisms that strengthen workers' awareness of unsafe conditions, unsafe actions, PPE use, and safe work procedures (Hakim et al., 2024). The use of direct monitoring, periodic evaluations, and warnings for violations indicates that supervision combines preventive and corrective control, meaning that compliance is built through both continuous guidance and enforcement (Elosta et al., 2024).

The implementation of the Mining Safety Management System (SMKP), daily equipment inspections, and technical safety standards further shows that supervision is not limited to worker behavior but also extends to operational safety management, including equipment readiness and hazard control in the work environment (Rahmat et al., 2024; Sarmidi et al., 2025). This means that OSH compliance at PT Semen Tonasa should be understood as a structured organizational process rather than merely an individual responsibility, because workers' safe behavior is supported by supervisory communication, equipment checks, procedural evaluation, and management follow-up (Hasan Salasa et al., 2024). This study advances understanding by showing that supervision becomes effective when it is embedded in daily routines and connected with safety management systems, training, and safety culture, rather than implemented only as an occasional inspection activity (Supardi, 2025).

Training and Workers' Competency Development

Training is identified as another critical factor influencing compliance with OSH protocols. The findings indicate that training at PT Semen Tonasa functions not only as a knowledge-transfer activity but also as a competency development mechanism that supports workers' readiness to apply OSH procedures in daily operations. The requirement for certification levels such as POP, POM, and POU reflects a competency-based safety management approach that ensures workers have the necessary qualifications to perform tasks safely. This finding indicates that certification is not merely an administrative requirement but serves as a mechanism to align workers' responsibilities with their safety competence. Recent studies show that safety training, safety knowledge, and safety skills are important factors in shaping workers' safety behavior and compliance in high-risk work environments (Azielia & Dwiyanti, 2024; Alruqi et al., 2026).

However, knowledge and certification alone do not automatically guarantee compliance because safe behavior depends on how workers apply their competence in real workplace situations. Therefore, training needs to be reinforced through supervision, safety monitoring,

management commitment, and continuous safety learning to produce stronger safety outcomes (Permana et al., 2025; Mohamed & Vetbuje, 2026). These findings advance existing literature by showing that OSH/K3 compliance is strengthened when certification and training are integrated with supervision, organizational support, and daily safety practices.

Availability and Use of Personal Protective Equipment (PPE)

The availability and use of Personal Protective Equipment (PPE) represent a fundamental aspect of OSH implementation. The findings reveal that PT Semen Tonasa provides PPE according to job requirements and risk levels, indicating that the company has attempted to reduce exposure to occupational hazards through physical protection. However, inconsistencies in PPE usage still occur in practice. This finding indicates that PPE compliance is not determined only by availability but also by continuous monitoring, disciplinary enforcement, and workers' willingness to remind one another in the workplace. Supervisory enforcement is important because monitoring, sanctions, and clear safety guidelines are associated with higher PPE compliance in workplace settings (Hutapea & Lestari, 2025; Teym & Zeleke, 2025). In addition, peer influence contributes to compliance behavior, showing that coworker relationships, social norms, and safety knowledge sharing can encourage workers to follow PPE requirements and other safety procedures (Wang et al., 2025). These findings highlight that PPE compliance requires a combination of adequate PPE provision, enforcement, supervision, and social reinforcement mechanisms.

Safety Culture and Organizational Commitment

Safety culture emerges as a key determinant influencing the sustainability of OSH implementation. The findings indicate that PT Semen Tonasa promotes safety culture through continuous campaigns, structured programs, and leadership involvement, showing that safety is treated as an organizational value rather than merely a procedural obligation (Naji et al., 2026). Leadership commitment plays a critical role in shaping safety culture because leaders influence workers through communication, role modeling, monitoring, and active involvement in safety practices (Piao & Hahn, 2025). However, variations in implementation across units suggest inconsistencies in safety facilities, signage completeness, and monitoring systems. Previous research confirms that the strength of safety culture depends on management commitment, employee participation, adequate resources, training, safety policy, feedback, and continuous monitoring mechanisms (Mandowa et al., 2025; Saik et al., 2025). This indicates that safety culture must be supported not only through behavioral reinforcement but also through structural and managerial consistency. Therefore, strengthening safety culture requires continuous communication, visible leadership commitment, adequate safety facilities, and consistent monitoring across all operational units.

Integration of Findings and Implications

The overall findings of this study indicate that OSH compliance is influenced by an interconnected system of supervision, training, PPE availability, and safety culture. These factors interact dynamically rather than operating independently, as explained in Safety Climate Theory by Zohar, which views safety behavior as the result of workers' shared perceptions of organizational safety priorities, communication, management commitment, and work environment (Nisar et al., 2025; Oruç et al., 2025). Recent studies also confirm that safety behavior is shaped by multiple interrelated determinants, including managerial safety practices, safety awareness, safety competence, supervision, training, PPE availability, and safety culture (Alshammari et al., 2025; Teym & Zeleke, 2025; Naji et al., 2026).

In this study, supervision and training build workers' awareness and competence, PPE provides physical protection against workplace hazards, and safety culture sustains long-term behavioral adherence. These findings show that OSH implementation at PT Semen Tonasa is comprehensive because it integrates behavioral, technical, and organizational safety components. However, the remaining inconsistencies in compliance across operational units indicate that safety implementation still requires stronger behavioral reinforcement, consistent supervision, and continuous safety culture development. This study contributes to OSH literature by extending prior research through an integrated perspective that highlights the interdependence of organizational, behavioral, and environmental factors in shaping compliance behavior in high-risk mining environments.

This study contributes to OSH literature by extending prior research through an integrated perspective that highlights the interdependence of organizational, behavioral, and environmental factors in shaping compliance behavior in high-risk mining environments.

Conclusion

This study examined workers' compliance with Occupational Safety and Health (OSH/K3) protocols in the mining operations of PT Semen Tonasa. The findings indicate that OSH compliance has been supported through several formal mechanisms, including routine supervision, safety talks, training and certification programs, PPE provision, and safety culture initiatives.

However, the implementation of these mechanisms is not always consistent across operational areas. Several gaps remain evident, particularly in the practical use of PPE, completeness of safety facilities, and consistency of monitoring in high-risk work areas such as Kiln and Coal Mill. These findings show that the objectives of the study have been achieved by identifying the main factors related to OSH compliance, namely supervision, training and competency development, PPE availability and use, and safety culture.

The contribution of this study lies in showing that OSH compliance in mining operations should be understood as an integrated process involving behavioral, technical, and organizational aspects. Compliance is not determined by a single factor, but by the interaction between supervisory control, workers' competence, availability of protective equipment, and the development of safety values in daily work practices.

Practically, PT Semen Tonasa should strengthen field supervision, standardize safety monitoring across units, improve the completeness of safety signage and monitoring systems, ensure consistent PPE use through routine checks, and provide refresher training based on specific risks in each operational area. This study is limited by its qualitative design, single-company context, and small number of informants. Future studies are recommended to use mixed-method approaches, involve more informants, compare several mining companies, and examine the role of digital safety monitoring systems in improving OSH compliance.

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