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Self Reported Safety Understanding and Audit Priorities in an Indonesian Coal Mining Operation

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Abstract

High self-reported understanding of a mining safety system can coexist with incomplete implementation evidence. This study examines these complementary profiles at the ABKL district of PT Pamapersada Nusantara, East Kalimantan, Indonesia. Observations, supervisor interviews, and document reviews conducted from March to May 2023 supported a self-assessment of the implementation element of the Indonesian Mining Safety Management System (SMKP). A questionnaire covered 70 of 103 eligible core personnel and contained 62 items across 11 domains. Secondary reconstruction of the item-level appendices reproduced all 4,340 responses and the total score of 18,914. The resulting questionnaire index was 87.16% of the maximum score, with domain indices of 83.52–90.86% and Cronbach's alpha values of 0.801–0.948. The reported implementation score was 103/132, or 78.03%, within the assessed element. Workplace environmental management and operational safety contributed 17 of the 29 unachieved audit points, or 58.62%. Off-the-job safety had the lowest proportional attainment, 1/3, despite a questionnaire index of 88.64%. These results support domain-specific review of execution evidence alongside learning needs. The contribution is a reproducible questionnaire reconstruction and audit-deficit decomposition, rather than a causal estimate of understanding on implementation. Different measurement constructs, mixed questionnaire wording, leadership-focused sampling, and unresolved audit applicability decisions limit interpretation. Improvement should prioritize verified control execution and competence records while retaining targeted learning assessment.

Introduction

A mining safety management system requires more than documented procedures and employees who report understanding them. It also requires evidence that controls operate as intended under field conditions. In Indonesia, the good mining practice framework and the technical guidance for the Mining Safety Management System, or Sistem Manajemen Keselamatan Pertambangan (SMKP), formed the regulatory basis used in this 2023 case assessment [1], [2]. The present study focuses on the implementation element, rather than evaluating the entire system or determining current certification status.

Occupational health and safety management systems provide a structure for managing hazards and continual improvement [3]. However, implementation is sensitive to organizational and workplace context. The global review by Johanes et al. identified limitations in the examination of implementation challenges and argued for contextualized approaches [4]. The bibliometric review by Wang et al. linked research on management systems with risk management, safety culture, and health outcomes [5]. Together, these perspectives suggest that a favorable aggregate score should lead to examination of the underlying practices and evidence, rather than a conclusion that safety performance has been demonstrated.

Mining research similarly treats knowledge and organizational conditions as distinct influences. A systematic review of mining safety culture identified management commitment as an important

contributor [6]. Haas et al. examined personal and organizational safety-climate constructs in relation to worker performance [7], while Haas and Yorio found differences among mining sectors [8]. Studies of management-focused safety training [9] and psychosocial safety climate among miners [10] further illustrate that learning, support, and behavior are related but separable dimensions. These findings do not establish which mechanism explains incomplete implementation at an individual Indonesian operation.

An Indonesian SMKP evaluation by Rianti et al. assessed all seven system elements [11]. By contrast, this case pairs a detailed implementation-element assessment with a questionnaire organized around its 11 domains. Pairing evidence sources can help distinguish a need to clarify procedures from a need to improve execution, resources, or verification. The distinction between organizational safety activities and the safety of operational work discussed by Rae and Provan [12] is relevant: preparing a document or conducting a campaign does not by itself show that an exposure or hazardous condition has been controlled.

The contribution of this article is a reproducible reconstruction of the 70-person questionnaire and a decomposition of the reported implementation deficit into domain priorities. It asks where high self-ratings coexist with incomplete audit evidence and what should be verified next. The study does not treat the two percentage indices as a common measurement scale or infer that understanding causes implementation. Its practical value lies in making the evidence behind improvement priorities explicit, while identifying limitations in the questionnaire and audit records.

Research Method

Study setting and participants

The assessment was conducted from March to May 2023 at the ABKL district of PT Pamapersada Nusantara, associated with a coal mining operation in Purwajaya village, Loa Janan district, Kutai Kartanegara, East Kalimantan, Indonesia. The cross-sectional design combined field observations, document and record reviews, structured interviews with an occupational safety and health supervisor, and a questionnaire. The implementation assessment concerned 11 SMKP subelements covering operational, environmental, health, engineering, contractor, and emergency-related activities.

The questionnaire targeted 103 eligible core personnel because its content was designed for leadership and supervisory roles. Seventy responded, representing 67.96% of the stated eligible population. The reported positions were one project manager, six department heads, 13 section heads, 48 group leaders, and two personnel in the FGDP category. Department counts were Plant 34, Production 12, Engineering 10, SHE 5, HCGS 5, SM 2, IT 1, and FA 1. Operators and mechanics outside this core-personnel roster were not included. These counts describe coverage and composition; the selection mechanism does not establish a probability sample of the entire workforce.

Implementation self-assessment

Observations, interviews, and available inspection, patrol, and procedural records were assessed against the source's 2019 SMKP scoring framework [2]. Criterion scores were aggregated into domain scores. The reported maximum was 132 applicable points and the achieved score was 103. The applicable denominator excluded an explosives-warehouse criterion and an occupational-disease diagnosis criterion. The latter exclusion was justified in the source by the absence of reported disease cases; its appropriateness requires further review. Scores are retained as historical reported self-assessment results, not as independent certification findings.

For each domain d, normalized audit attainment and unachieved points were calculated as:

$$A_d\,(\%) = 100 \times \text{achieved points}_d / \text{maximum points}_d;$$

$$U_d = \text{maximum points}_d - \text{achieved points}_d. \quad (1)$$

The 11 domain totals sum to 103/132 = 78.03%. Because the implementation element carries a 35% weight in the source framework, its contribution would be 35 × 103/132 = 27.31 percentage points of

the full-system weighting. This contribution is distinct from a complete SMKP score, which would require the other six elements. Missing-point shares were used to describe opportunities to improve the weighted audit score, rather than to estimate accident burden or determine hazard severity.

Questionnaire construct and reconstruction

The questionnaire contained 62 items in 11 sections, with respectively 7, 10, 10, 7, 4, 5, 4, 3, 4, 4, and 4 items. The method text describes response options from very low to very high perceived understanding, whereas the appended questionnaire labels them from strongly disagree to strongly agree. Item wording also mixes statements of knowledge, perceived capability, participation, and agreement with the adequacy of company provisions. We therefore describe the aggregate as a self-reported understanding and agreement index rather than an objective test of safety knowledge or a validated safety-climate scale.

The item-level appendices were reconstructed by respondent number within each section. All 70 numbered rows were present in every section, and each item value was between 1 and 5. We recalculated totals from the item values rather than relying on printed row-total columns. One discrepancy occurred in section 5, respondent 19: four values of 5 sum to 20, while the printed total is 15. Retaining the displayed item values reproduced the source's overall response frequencies and total score of 18,914, providing an internal cross-check. Confirmation against the original form export remains necessary. For section d with kd items and 70 respondents, the descriptive maximum-score index was:

$$Qd\ (\%) = 100 \times \Sigma i \Sigma j\ xijd / (70 \times kd \times 5). \qquad (2)$$

The overall index weights all 62 items equally, whereas an average of the 11 section indices weights domains equally. These are separate summaries. We retained the source's 1–5 coding for transparency, without treating the resulting index as the percentage of correctly answered questions. Its possible range is 20–100%, and its zero point does not represent absence of knowledge. Discussion of rating-scale summaries by Norman [13] provides methodological context, but arithmetic aggregation cannot resolve ambiguities in the meaning of the items.

Internal consistency and comparative analysis

Cronbach's alpha was recalculated for each domain from its item matrix using sample variances. Reproducing the reported coefficients to three decimal places served as an additional transcription check. Alpha measures internal consistency under assumptions; it does not establish content validity, dimensionality, stable responses over time, or actual competence. The cautions discussed by Taber [14] and Dunn et al. [15] inform this interpretation. Item-total correlations reported in the source were not treated as sufficient validation of the complete questionnaire.

Audit attainment and questionnaire indices were compared descriptively within matched domains. The audit has one organizational score per domain, while the questionnaire has individual responses. Consequently, the data do not contain 70 independent paired implementation measurements. No individual-level correlation, regression, causal effect, or significance test between understanding and implementation was estimated. Numerical subtraction of the two indices was avoided because their denominators and constructs differ. Audit-deficit concentration was calculated from unachieved points, and representative findings were used to identify verification priorities.

Results and Discussion

Reconstructed questionnaire and audit profiles

The reconstruction yielded 4,340 item responses: 1,677 ratings of 5, 2,552 of 4, 101 of 3, eight of 2, and two of 1. Their weighted score is 18,914 out of 21,700, corresponding to an overall index of 87.16% and a mean item rating of 4.358. This corrects the denominator shown in one source calculation, where the displayed formula divides by the number of answers rather than the maximum possible score. The recalculated equal-domain average is 87.04%, which differs from the item-weighted index and from the source's domain-average summary.

Table 1. Reported audit scores and reconstructed questionnaire statistics by domain.

Domain	Items	Audit score / max	Audit (%)	Questionnaire index (%)	Alpha
D1 Operational management	7	9/11	81.82	90.86	0.801
D2 Workplace environmental management	10	30/40	75.00	85.60	0.922
D3 Occupational health management	10	20/24	83.33	87.23	0.948
D4 Mining operational safety	7	13/20	65.00	87.06	0.928
D5 Explosives and blasting management	4	12/12	100.00	88.07	0.873
D6 Design and engineering systems	5	4/6	66.67	86.86	0.894
D7 Purchasing systems	4	4/4	100.00	86.14	0.855
D8 Mining-service contractor management	3	5/6	83.33	83.52	0.839
D9 Emergency management	4	3/3	100.00	87.00	0.892
D10 First-aid provision and readiness	4	2/3	66.67	86.50	0.832
D11 Off-the-job safety	4	1/3	33.33	88.64	0.886

The highest questionnaire index was operational management, 90.86%, and the lowest was contractor management, 83.52% (Table 1). All domains had high average self-ratings. However, 97.44% of item responses occupied the two highest categories, indicating strong upper-end concentration and limited spread for differentiating learning needs. This percentage refers to answers across items, not the proportion of employees who have demonstrated competence. The mixture of knowledge and agreement wording makes a uniformly high profile compatible with several interpretations, including familiarity with procedures and favorable perceptions of company arrangements.

Reported audit attainment was much more variable, ranging from 33.33% for off-the-job safety to 100% for blasting, purchasing, and emergency management. The overall value of 78.03% applies only to the implementation element and its retained denominator. A maximum domain score means that the assessed criteria were credited within the available self-assessment; it does not demonstrate zero residual risk, perfect field execution, or successful performance under every operating condition.

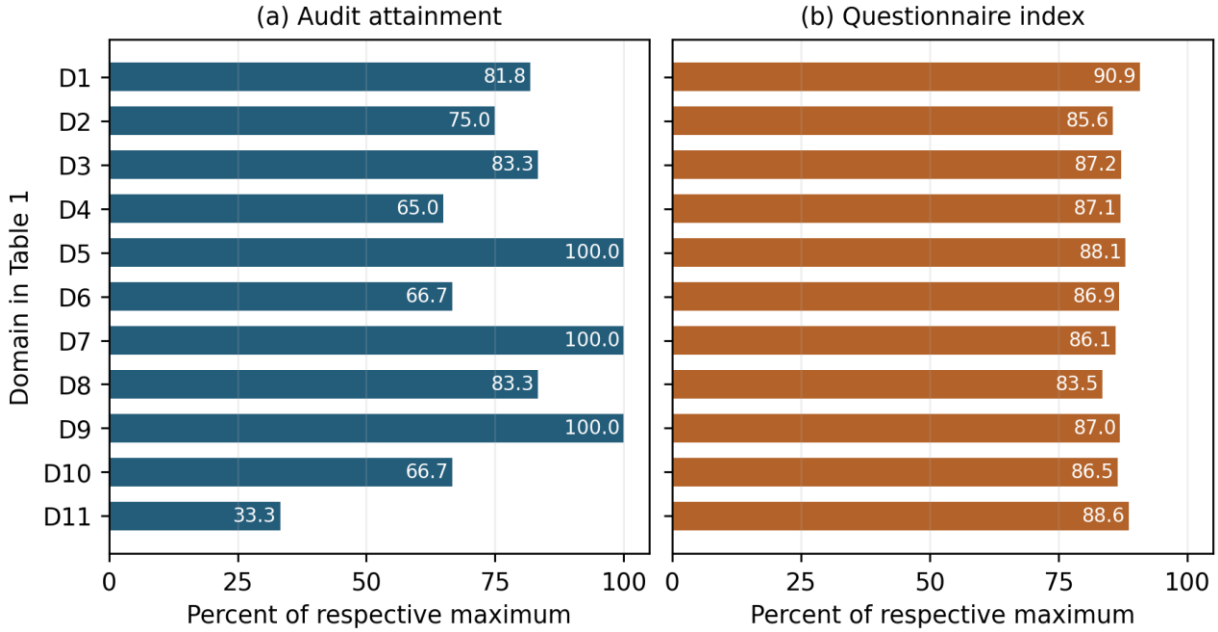

Figure 1. Separate domain profiles of audit attainment and questionnaire ratings. Each panel uses its own measurement construct and denominator; equal percentages do not imply equal performance.

Concentration of unachieved audit points

The total audit deficit was 29 points. Workplace environmental management accounted for 10, and mining operational safety for seven; together these domains contained 17/29 = 58.62% of the unachieved points. Occupational health contributed four, while operational management, design and engineering, and off-the-job safety contributed two each. Contractor management and first-aid readiness contributed one each. This decomposition identifies where most weighted score improvement is possible, but domain weights are not calibrated measures of injury or disease consequences.

The environmental-management findings were concentrated in radiation, chemical, and biological factors, each scored 1/4, and workplace cleanliness, scored 3/4. Thus, a 75% domain total could conceal substantial differences among exposure-management activities. The domain's questionnaire index of 85.60% does not verify that particular exposure controls were implemented. Follow-up should match each criterion to a defined hazard inventory, monitoring coverage, functioning controls, and documented corrective-action closure. Training is appropriate where knowledge is deficient, but its attendance record cannot substitute for those forms of evidence.

Operational safety scored 13/20 despite a questionnaire index of 87.06%. Recorded findings included incomplete inspection or maintenance evidence, a vehicle with an expired commissioning status, and gaps in technical competence records. The technical-competence criterion received 1/4. Such findings concern organizational assurance and authorization as well as individual knowledge. They call for reviewing the availability and currency of competence evidence, the allocation of qualified personnel, and the conditions under which equipment is released for operation.

Off-the-job safety had the lowest proportional attainment, 1/3, while its questionnaire index was 88.64%. The source describes communication of the topic but incomplete documentation and implementation across departments. This pairing suggests a distinction between awareness of a program and evidence of its organizational coverage. It does not establish that particular respondents failed to apply knowledge outside work. Its two-point deficit is small in the aggregate score, yet its low relative attainment remains useful for planning a focused review of program scope and records.

Interpreting self-ratings alongside implementation evidence

High questionnaire ratings and incomplete audit evidence can coexist without a contradiction in individual behavior. The survey asks core personnel what they know or agree with; the audit asks whether organizational criteria have supporting evidence. A respondent may understand the requirement for technical competence while the operation still lacks complete certification records. Conversely, a procedure may be well implemented by a specialist team even when some leaders rate their own familiarity lower. The two sources should therefore guide different questions rather than form a single percentage-point knowledge-to-action gap.

The mining-culture review [6] and the NIOSH safety-climate report [7] support examining organizational practices alongside personal factors. Haas and Yorio's sector comparison [8] further cautions against transferring a uniform interpretation across different mining settings. In this case, the evidence does not identify whether production demands, resource availability, role boundaries, communication, or another factor caused any recorded shortfall. The source's attribution to worker ethics or intentional unsafe acts is not retained as a demonstrated causal explanation because no corresponding behavioral or incident analysis was supplied.

Leadership learning remains relevant, but its contribution should be evaluated against a defined need. The Montana mining case examined management-oriented safety leadership training [9], while research on psychosocial safety climate considers broader organizational influences on miners' behavior [10]. These studies provide alternative avenues for investigating implementation problems. They do not justify concluding that more generic SMKP training alone would close the audited deficits. A follow-up assessment should distinguish procedural recall, practical capability, authority to act, and access to the necessary resources.

The distinction between safety activities and operational safety in [12] helps interpret why procedural documentation is necessary but insufficient. Provan et al. also discuss changes in safety practice through a resilience-engineering perspective [16]. For this operation, observations of real task conditions would help identify where procedures are difficult to execute and what adaptations occur. That investigation could inform practical revisions, while preserving required controls; it is a proposed research direction, not an explanation already demonstrated by the present data.

Measurement quality and applicability decisions

Recalculated domain alpha values ranged from 0.801 to 0.948, reproducing the source coefficients after rounding. This consistency supports the reconstruction, but it does not validate an interpretation of the scale as objective understanding. The source's operational-management item X1.7 had an uncorrected item-total correlation of 0.328 and a corrected correlation of only 0.156. Including an item in its own total can inflate that association. The item should be reviewed for construct fit rather than automatically accepted because its uncorrected coefficient exceeds a threshold.

Taber [14] cautions against treating alpha as a sufficient basis for instrument quality, and Dunn et al. [15] discuss alternatives for internal-consistency estimation. Boateng et al. describe a broader process of scale development and validation [17]. A revised instrument should separate knowledge, perceived capability, agreement with provisions, and observed behavior, then evaluate content and structure. The high concentration of favorable responses may reflect genuine familiarity, response style, or social-desirability pressures; none of these mechanisms was measured here. The review of common method bias by Podsakoff et al. [18] supports addressing these possibilities through design rather than assuming that they are absent.

Audit applicability also affects interpretation. The explosives-warehouse exclusion may depend on the division of responsibility between contractor and mine owner and should be supported by a clear scope statement. Absence of reported occupational disease does not, by itself, establish that diagnostic preparedness or surveillance is unnecessary. The article retains the historical score while identifying that decision as unresolved. Reinstating a criterion would require an evidence-based assessment of its numerator and denominator, rather than an automatic zero score. No corrected compliance result is asserted.

Other criterion-level inconsistencies require reconciliation. In contractor selection, the source summary credits 2/2, whereas explanatory text describes a score of 1. The reported domain score of 5/6 and overall score of 103 are retained pending examination of the original audit worksheet. Audit guidance such as ISO 19011:2026 [19] is relevant to a future reassessment of evidence and competence, but the 2026 edition was not used in the original 2023 study. This distinction prevents retrospective attribution of a newer standard to the historical assessment.

Improvement priorities and verification

Table 2 links each improvement focus to evidence that could justify rescoring. It is a proposed verification plan, not proof that changes have been implemented. Larger missing-point totals help allocate audit-improvement effort, while consequence severity and exposure remain separate considerations for operational prioritization. An urgent control issue should not be deferred merely because its rubric weight is small. Similarly, domains already receiving full credit should remain subject to monitoring rather than being removed from review.

Xu et al.'s systematic review of leading indicators in construction [20] offers a methodological example of linking proactive management measures with the processes they are intended to reflect. Its sector-specific framework is not directly imported here. Suitable candidate indicators for a follow-up mining study include verified closure of overdue inspections, current competence coverage, and completed reviews of high-priority exposure controls. Their ability to predict improved outcomes must be tested over time; a rise in audit score alone would not establish reduced injury or disease.

Table 2. Proposed follow-up priorities from recorded audit findings.

Domain focus	Evidence requiring review	Verification before rescoring
Environmental management	Low credited scores for radiation, chemical and biological factors; incomplete cleanliness control	Confirm hazard inventory, exposure-monitoring scope, operating controls and closure records
Operational safety and competence	Inspection and commissioning status; incomplete technical competence evidence	Verify equipment release records, current qualifications and coverage by authorized personnel
Occupational health and first aid	Health records, hygiene and nutrition shortfalls; first-aid implementation evidence	Confirm record completeness, facilities, competent coverage and readiness checks
Design and contractor management	Design-evaluation records; contractor-scope and selection-score inconsistencies	Trace decisions and responsibilities to approved documents; reconcile criterion scores
Off-the-job safety	Incomplete documented program coverage	Define eligible groups, record activities and evaluate coverage across departments

The SMKP case reported by Rianti et al. [11] differs in organization, assessment scope, and evidence. Its whole-system evaluation should not be ranked directly against this implementation-element percentage. The present comparison instead contributes a way to trace favorable questionnaire ratings and audit shortfalls to domain-specific verification needs. A reassessment with independent review, consistent applicability decisions, and repeated measurements could evaluate whether those priorities lead to better documented execution and safer work.

Limitations

The study concerns one district and one cross-sectional assessment period. Survey participation covered core personnel rather than the complete workforce, and selection or nonresponse bias cannot be excluded. The questionnaire mixes response constructs, and its original response-option configuration needs confirmation. The reconstruction matches total frequencies and reliability coefficients, but the original form export remains the authoritative record. Audit scoring and applicability are partly unresolved, and independent inter-rater agreement was not reported.

The audit and survey do not supply matched individual implementation outcomes. No causal relationship, reduction in accident rates, disease-prevention effect, or improvement after recommendations can be estimated. Audit and self-rating indices are complementary descriptive summaries with different meanings. Future work should include frontline and contractor personnel, validate separate constructs, and follow criterion-level evidence and operational outcomes across reassessments. Historical 2023 findings should not be presented as the operation's current condition.

Conclusion

The reconstructed questionnaire yielded an index of 87.16% from 70 respondents and 62 items, while the historical implementation self-assessment reported 103/132, or 78.03%. These indices describe different constructs and cannot establish a causal effect of understanding on implementation. Environmental management and operational safety contained 58.62% of the 29 unachieved audit points. Off-the-job safety showed the lowest proportional audit attainment despite high self-ratings, illustrating the usefulness of examining program execution separately from perceived understanding.

The contribution is a transparent reconstruction and domain-level audit-priority analysis. It identifies where verification of control execution, competence records, and program coverage should accompany targeted learning assessment. Original questionnaire configuration, criterion scores, and applicability decisions require confirmation before submission or operational use. Repeated evidence-based assessment is needed to determine whether improvements extend beyond the audit score to safer mining work.

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