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Construction Safety Management System Implementation: Current Practices and Gaps in the Indonesian Construction Industry

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ABSTRACT

The implementation of the Construction Safety Management System (CSMS) is a critical requirement for ensuring worker safety, public protection, and project success in the Indonesian construction industry. Despite the existence of regulatory frameworks such as Minister of Public Works and Housing Regulation (Permen PUPR) No. 10 of 2021, the level of CSMS implementation varies significantly across projects. This study evaluates the current practice of CSMS in a road and bridge preservation project: the BTS Kota Palopo – BTS Kabupaten Luwu project in South Sulawesi, executed by PT. Millenium Persada. A mixed-method approach was employed, combining field observations, document reviews, and structured interviews with project personnel, guided by the audit criteria in Permen PUPR No. 10 of 2021. The assessment covered five core elements of CSMS: Leadership and Worker Participation, Hazard Identification and Risk Assessment, Operational Safety Management, Internal Audit, and Management Review. The results indicate an overall implementation level of 80.93%, categorized as "Good" according to Government Regulation No. 50 of 2012. However, several gaps were identified, including inconsistent communication, inadequate supervision, insufficient safety training, and non-compliance in equipment operation procedures. Using Analytic Hierarchy Process (AHP) analysis via Expert Choice software, key improvement strategies were prioritized: strengthening internal supervision, enhancing safety training programs, improving safety signage, and adopting digital monitoring tools. This study provides empirical evidence of CSMS performance in infrastructure preservation projects and offers practical recommendations for contractors and regulatory bodies to improve safety outcomes and move toward zero accident goals.

Keywords: Construction Safety Management System (CSMS), SMKK, safety performance, hazard identification, operational safety, Indonesia

INTRODUCTION

The construction industry plays a pivotal role in national development, particularly in infrastructure expansion and economic growth. However, it remains one of the most hazardous sectors, with a high incidence of workplace accidents, injuries, and fatalities. In Indonesia, the increasing complexity of construction projects, coupled with dynamic site conditions and human factors, has underscored the necessity for a systematic and integrated approach to construction safety management. To address these challenges, the Ministry of Public Works and Housing (PUPR) issued Regulation No. 10 of 2021 on the Construction Safety Management System (CSMS), commonly known as Sistem Manajemen Keselamatan Konstruksi (SMKK). This regulatory framework mandates contractors to implement a comprehensive safety management system throughout the project lifecycle, covering aspects such as leadership commitment, hazard identification, risk assessment, operational controls,

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and continuous improvement through internal audits and management reviews (Republik Indonesia, 2021).

Despite the existence of such regulations, the implementation of SMKK across construction projects in Indonesia remains inconsistent. Several studies have revealed significant gaps between policy requirements and on-site practices. For instance, Ma'ruf (2023) reported a 91.2% compliance rate in a high-rise building project, while Sarif et al. (2021) found lower adherence in a stadium construction project in West Sumatra. These variations suggest that the level of SMKK implementation is influenced by project type, contractor capacity, management commitment, and supervisory effectiveness. Moreover, infrastructure preservation projects—such as road and bridge maintenance—often face unique challenges, including working on existing structures, traffic management, limited workspace, and aging materials, which can further complicate safety management efforts.

This study focuses on the evaluation of SMKK implementation in the BTS Kota Palopo – BTS Kabupaten Luwu Road and Bridge Preservation Project in South Sulawesi, executed by PT. Millenium Persada. Unlike new construction, preservation projects require specific safety protocols due to operational constraints and the need to maintain public access during construction. The research aims to assess the current level of SMKK application based on the audit criteria outlined in Permen PUPR No. 10 of 2021, identify key gaps in implementation, and prioritize improvement strategies using the Analytic Hierarchy Process (AHP) with Expert Choice software. By providing empirical evidence from a real-world infrastructure project, this study contributes to the understanding of safety management practices in Indonesia and offers practical recommendations for enhancing construction safety performance toward the goal of zero accidents.

LITERATURE REVIEW

Regulatory Framework for Construction Safety Management in Indonesia

The implementation of a Construction Safety Management System (CSMS), locally known as Sistem Manajemen Keselamatan Konstruksi (SMKK), is mandated by the Indonesian Ministry of Public Works and Housing (PUPR) through Regulation No. 10 of 2021. This regulation provides a comprehensive framework for managing safety, health, security, and environmental aspects throughout the construction project lifecycle. It emphasizes five core elements: (1) Leadership and Worker Participation, (2) Hazard Identification and Risk Assessment, (3) Operational Safety Management, (4) Internal Audit, and (5) Management Review (Republik Indonesia, 2021). These elements are aligned with Government Regulation No. 50 of 2012, which establishes the legal basis for occupational safety and health (K3) in construction and defines performance criteria for safety management systems.

The SMKK is designed not only to comply with legal requirements but also to foster a proactive safety culture, reduce workplace incidents, and ensure the well-being of workers and the public. Contractors are required to develop a Rencana Keselamatan Konstruksi (RKK) and conduct regular internal audits and management reviews to ensure continuous improvement. The effectiveness of SMKK implementation is typically evaluated using a scoring system, where compliance levels are categorized as "Not Implemented" (<50%), "Fair" (50–69.99%), "Good" (70–84.99%), and "Excellent" (85–100%) (Permen PUPR No. 10 of 2021).

Previous Studies on SMKK Implementation

Several studies have assessed the level of SMKK implementation across various construction projects in Indonesia, revealing both progress and persistent challenges.

Ma'ruf (2023) evaluated SMKK implementation in the construction of a Mother and Child Health Care Center at Dr. Wahidin Sudirohusodo Hospital. The study reported a high

compliance rate of 91.2%, categorized as "Excellent," indicating strong management commitment and effective safety planning. However, minor and major non-conformities were identified in areas such as personal protective equipment (PPE) compliance and emergency response procedures.

In contrast, Sarif et al. (2021) conducted a case study on the West Sumatra Main Stadium project and found a lower level of SMKK implementation, with several critical gaps in hazard identification, worker training, and documentation. Their findings highlighted the influence of project complexity and contractor capacity on safety performance.

Sutandi et al. (2022) examined multiple construction projects in Surabaya and reported that SMKK implementation ranged from "Moderate" to "Good" based on the Relative Importance Index (RII). They emphasized the need for stronger organizational structures for safety management and recommended the formation of dedicated SMKK management teams to improve accountability and coordination.

Rossy and Sahli (2022) focused on toll road infrastructure projects during the COVID-19 pandemic and identified unique challenges, including workforce mobility restrictions and changing safety protocols. Their study recommended enhanced supervision, regular safety patrols, and incentive programs to motivate safe behavior.

Another relevant study by Aditya et al. (2023) on the Pandan River Bridge construction project emphasized the importance of digital tools and real-time monitoring in improving safety compliance. They suggested integrating technology such as safety management apps and CCTV-based monitoring systems to strengthen operational control.

Research Gap

While existing studies provide valuable insights into SMKK implementation in new construction projects—such as hospitals, stadiums, and bridges—there is limited research focusing on infrastructure preservation projects, such as road and bridge maintenance. These projects often involve working on existing structures, traffic management, limited workspace, and aging materials, which present distinct safety challenges compared to new construction.

Furthermore, most prior studies rely solely on qualitative assessments or basic scoring methods without prioritizing improvement strategies using multi-criteria decision-making tools. This study addresses these gaps by evaluating SMKK implementation in the BTS Kota Palopo – BTS Kabupaten Luwu Road and Bridge Preservation Project, and by employing the Analytic Hierarchy Process (AHP) with Expert Choice software to systematically prioritize corrective actions based on expert judgment and consistency analysis.

This approach not only provides a quantitative assessment of current safety practices but also offers a structured framework for decision-makers to allocate resources effectively and enhance safety performance toward the goal of zero accidents.

MATERIALS AND METHODS

This study evaluates the implementation level of the Construction Safety Management System (CSMS) in a road and bridge preservation project in South Sulawesi, Indonesia. The research was conducted using a mixed-method approach, combining qualitative and quantitative data collection techniques to ensure comprehensive and reliable findings.

Research Location and Duration

The case study was carried out on the BTS Kota Palopo – BTS Kabupaten Luwu Road and Bridge Preservation Project, located in the Palopo and Luwu regions of South Sulawesi. The project, executed by PT. Millenium Persada , involved the maintenance and structural improvement of existing road and bridge infrastructure to enhance safety, serviceability, and

longevity. Data collection was conducted over a period of three months, from March to May 2023, covering both the active construction and monitoring phases of the project.

Research Design

The research followed a descriptive-analytical design, consisting of field observations, structured interviews, and document reviews. The study was structured into five main stages: (1) identification of research objectives, (2) data collection based on Permen PUPR No. 10 of 2021, (3) data processing and analysis, (4) identification of gaps and root causes, and (5) prioritization of improvement strategies using the Analytic Hierarchy Process (AHP).

Data Collection Techniques

Data were collected through the following methods:

1. Field Observation: Direct observation was conducted on-site to assess the actual implementation of safety practices, including worker behavior, equipment handling, signage, and compliance with safety procedures.
2. Structured Interviews: Semi-structured interviews were conducted with key personnel involved in safety management, including the Site Manager,HSE Officer, and Construction Safety Expert (Ahli K3). A total of 30 respondents participated in the survey, selected based on their roles and responsibilities in the CSMS implementation.
3. Document Review: Relevant project documents were reviewed, including the Rencana Keselamatan Konstruksi (RKK), organizational structure for safety management, audit reports, training records, and risk assessment documentation.

Data Types and Sources

The data used in this study were categorized into two types:

- Primary Data: Collected directly from the field through observation and interviews. This included responses from a structured questionnaire based on the audit criteria in Permen PUPR No. 10 of 2021.

- Secondary Data: Obtained from project documents, previous studies, regulations, and technical reports related to CSMS implementation.

Research Instruments

The primary instrument used was a structured questionnaire developed based on the five core elements of CSMS as defined in Permen PUPR No. 10 of 2021:

1. Leadership and Worker Participation (X_1)
2. Construction Safety Planning (X_2)
3. Construction Safety Support (X_3)
4. Construction Safety Operations (X_4)
5. Construction Safety Performance Evaluation (X_5)

Each element consisted of 10 sub-indicators, resulting in a total of 50 assessment items. The questionnaire used a Likert scale (1–5), where:

- 1 = Not Implemented
- 2 = Poor
- 3 = Fair
- 4 = Good
- 5 = Excellent

Data Analysis Methods

Data analysis was conducted in two stages:

1. Descriptive Analysis: The level of CSMS implementation was calculated using the following formula:

$$\text{Implementation Level (\%)} = \frac{\text{Total Achieved Score}}{\text{Maximum Possible Score}} \text{ x } 100\%$$

The results were categorized based on Government Regulation No. 50 of 2012:

- <50% : Not Implemented
- 50–69.99% : Fair
- 70–84.99% : Good
- 85–100% : Excellent

2. Analytic Hierarchy Process (AHP): To prioritize improvement strategies, the AHP method was applied using Expert Choice 11software. AHP enabled the systematic comparison of alternative solutions based on expert judgment, ensuring consistency and objectivity in decision-making. The process involved:

- Developing a hierarchical structure of criteria and alternatives.
- Conducting pairwise comparisons.
- Calculating priority weights.
- Performing consistency ratio (CR) tests to ensure logical coherence (CR < 0.1 was considered acceptable).

Validity and Reliability Testing

To ensure data quality, the questionnaire was tested for validity and reliability. Validity was assessed using Pearson correlation, and all items showed significant correlation ($p < 0.05$). Reliability was evaluated using Cronbach's Alpha, yielding a coefficient of 0.87, indicating high internal consistency.

Conceptual Framework

The research followed a structured conceptual framework, beginning with data collection based on regulatory criteria, followed by performance assessment, gap analysis, and finally, the prioritization of corrective actions. The flow of the research methodology is illustrated in Figure 1.

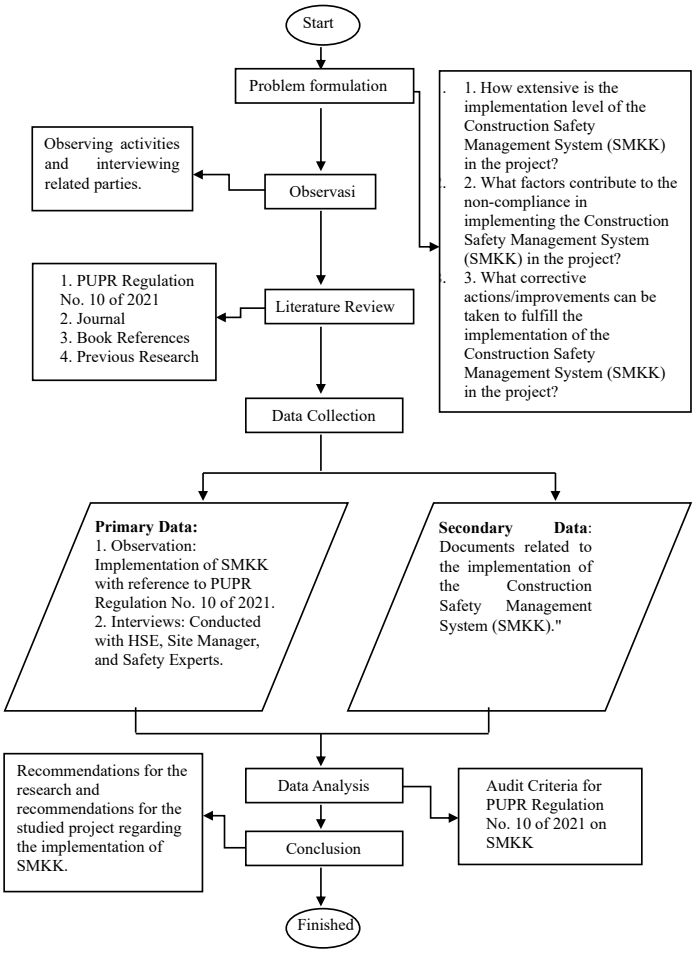

Figure 1. The flow of the research methodology

RESULTS AND DISCUSSION

Level of SMKK Implementation

The evaluation of the Construction Safety Management System (CSMS) implementation was conducted based on five core elements as stipulated in Minister of Public Works and Housing Regulation (Permen PUPR) No. 10 of 2021. Data were collected from 30 respondents through structured questionnaires, field observations, and document reviews on the BTS Kota Palopo – BTS Kabupaten Luwu Road and Bridge Preservation Project.

The overall implementation level of SMKK was calculated by aggregating the scores across all 50 sub-indicators, with each indicator scored on a 5-point Likert scale. The results are summarized in Table 1.

Table 1. Percentage Achievement of SMKK Implementation

SMKK Element	Code	Total Score	Maximum Score	Achievement (%)
Leadership and Worker Participation	X_1	398	500	79.60%
Construction Safety Planning	X_2	414	500	82.80%
Construction Safety Support	X_3	402	500	80.40%
Construction Safety Operations	X_4	407	500	81.40%
Construction Safety Performance Evaluation	X_5	397	500	79.40%
Overall Implementation Level	—	2018	2500	80.72%

The total implementation level of SMKK in the project was 80.72%, which falls within the "Good" category according to Government Regulation No. 50 of 2012 (70–84.99%). This indicates that the contractor, PT. Millenium Persada, has established a functional safety management system with a structured approach to hazard control and worker protection.

Among the five elements, Construction Safety Planning (X_2) achieved the highest score (82.80%), reflecting the project's strong emphasis on risk assessment, method statements, and emergency preparedness. In contrast, Construction Safety Performance Evaluation (X_5) scored the lowest (79.40%), suggesting weaknesses in internal auditing, management review, and continuous improvement processes.

Sub-Element Performance Analysis

A more granular analysis was conducted at the sub-indicator level to identify specific strengths and weaknesses. The results revealed several areas of concern:

- $X_5.3$ (Internal Audit Documentation): Scored only 75.3%, indicating inconsistent documentation of audit findings and corrective actions.
- $X_4.10$ (Safe Operation of Equipment): Achieved 78.9%, highlighting lapses in equipment inspection and operator certification.
- $X_1.1$ (Management Commitment to Safety): Scored 77.8%, suggesting that leadership involvement in safety activities is not consistently demonstrated.

These findings align with previous studies, such as Sarif et al. (2021), which identified similar gaps in audit documentation and equipment safety in infrastructure projects.

Root Cause Analysis of Implementation Gaps

To identify the underlying causes of non-conformities, a root cause analysis was performed based on interview responses and field observations. The primary factors contributing to the gaps in SMKK implementation are presented in Table 2.

Table 2. Major Factors Hindering SMKK Implementation

Factor	Frequency	Percentage (%)	Cumulative (%)
Poor Communication	9	29.03%	29.03%
Inadequate Supervision	8	25.81%	54.84%
Lack of Training	7	22.58%	77.42%
Unclear Procedures	4	12.90%	90.32%
Insufficient Resources	3	9.68%	100.00%
Total	31	100.00%	—

As shown in Table 2, poor communication emerged as the most significant barrier, accounting for nearly 29% of the reported issues. This includes ineffective information flow between management and workers, lack of safety briefings, and inadequate dissemination of safety procedures. Inadequate supervision ranked second, indicating a shortage of dedicated HSE personnel and irregular site inspections.

These findings are consistent with Rossy and Sahli (2022), who emphasized that weak supervision and communication are critical factors affecting safety performance, especially in remote infrastructure projects. The lack of regular training (22.58%) further exacerbates the problem, as workers may not be fully aware of safety protocols or hazard response procedures.

Prioritization of Improvement Strategies Using AHP

To address the identified gaps, an Analytic Hierarchy Process (AHP) analysis was conducted using Expert Choice 11 software. Five improvement strategies were evaluated based on expert judgment: (1) Strengthening internal supervision, (2) Enhancing safety training

programs, (3) Improving safety signage and communication, (4) Implementing digital monitoring tools, and (5) Conducting regular management reviews.

The pairwise comparison resulted in the following priority weights:

Table 3. Priority Ranking of Improvement Strategies

Improvement Strategy	Priority Weight	Rank
Strengthening Internal Supervision	0.321	1
Enhancing Safety Training Programs	0.278	2
Improving Safety Signage and Communication	0.196	3
Implementing Digital Monitoring Tools	0.123	4
Conducting Regular Management Reviews	0.082	5

The consistency ratio (CR) was calculated as 0.07, which is below the threshold of 0.10, indicating acceptable consistency in expert judgments.

The results show that strengthening internal supervision is the most critical intervention, as it directly addresses the two top-ranked barriers: poor communication and inadequate oversight. This can be achieved by increasing the number of HSE officers, conducting daily safety patrols, and implementing a structured inspection checklist.

Enhancing safety training ranked second, emphasizing the need for regular, job-specific training sessions, including emergency drills and equipment operation. The use of digital monitoring tools, such as CCTV and safety management apps, was also recommended to improve real-time oversight and documentation.

Discussion

The overall SMKK implementation level of 80.72% indicates a relatively good safety performance, particularly in planning and operational control. However, the gaps in performance evaluation and internal communication reveal a need for more robust management systems. Unlike new construction projects, preservation projects like this one involve dynamic conditions—such as traffic control, working on existing structures, and limited workspace—requiring more adaptive and responsive safety management.

The AHP-based prioritization provides a data-driven approach for decision-makers to allocate resources effectively. The top-ranked strategy—strengthening internal supervision—is supported by prior research (Sarif et al., 2021; Rossy & Sahli, 2022), which highlights the role of active supervision in reducing non-compliance and improving safety culture.

Furthermore, the integration of digital tools, though ranked fourth, represents a forward-looking strategy that can enhance transparency, accountability, and efficiency in safety management. As suggested by Aditya et al. (2023), digitalization can bridge communication gaps and ensure timely corrective actions.

In conclusion, while the project meets the regulatory minimum for SMKK implementation, there is significant room for improvement, particularly in closing the gap between policy and practice. A systematic, prioritized approach to safety enhancement can help contractors move from "Good" to "Excellent" performance and ultimately achieve the goal of zero accidents.

CONCLUSION

This study evaluated the implementation level of the Construction Safety Management System (CSMS) in the BTS Kota Palopo – BTS Kabupaten Luwu Road and Bridge Preservation Project in South Sulawesi, Indonesia, based on the criteria stipulated in Minister of Public Works and Housing Regulation (Permen PUPR) No. 10 of 2021. The overall implementation level was found to be 80.72%, which falls within the "Good" category

according to Government Regulation No. 50 of 2012. This indicates that the contractor, PT. Millenium Persada, has established a functional and structured safety management system, particularly in the area of Construction Safety Planning (82.80%), which reflects a strong commitment to risk assessment and operational preparedness.

However, despite this positive assessment, several critical gaps were identified. The lowest performance was observed in Evaluation of Construction Safety Performance (79.40%), specifically in the areas of internal audit documentation, management review, and corrective action tracking. Root cause analysis revealed that the primary barriers to full compliance are poor communication, inadequate supervision, and insufficient safety training, which collectively account for over 77% of the reported issues.

To address these gaps, an Analytic Hierarchy Process (AHP) analysis was conducted using Expert Choice 11 software to prioritize improvement strategies. The results indicate that the most effective intervention is strengthening internal supervision, followed by enhancing safety training programs, improving safety signage and communication, implementing digital monitoring tools, and conducting regular management reviews. These prioritized actions provide a clear roadmap for contractors and project managers to elevate safety performance from "Good" to "Excellent."

This study contributes to the existing body of knowledge by providing empirical evidence of CSMS implementation in a road and bridge preservation project, a context that has been underrepresented in previous research. It also demonstrates the practical application of AHP as a decision-support tool for safety improvement planning.

In conclusion, while the current level of SMKK implementation is satisfactory, continuous improvement is necessary to achieve the ultimate goal of zero accidents. It is recommended that contractors adopt a more proactive and technology-integrated approach to safety management, supported by stronger leadership commitment, consistent worker engagement, and systematic performance evaluation. Regulatory bodies should also consider promoting digital tools and standardized audit practices to enhance compliance and accountability across the Indonesian construction industry.

CONFLICT OF INTEREST

The authors declare no conflict of interest

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