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Evaluation of Occupational Safety and Health Management and Work Risk on a National Road Preservation Project in Lampung, Indonesia

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ABSTRACT: Occupational safety and health (OSH) management is essential for reducing workplace hazards in road preservation projects, where construction activities involve heavy equipment, moving traffic, and variable environmental conditions. This study evaluates OSH management practices and perceived occupational risks in a national road preservation project in Lampung, Indonesia. A quantitative descriptive approach was employed using a structured questionnaire administered to 30 project personnel. The initial questionnaire consisted of 50 statements covering seven OSH management dimensions and five occupational risk categories. Responses were recorded using a five-point Likert scale. Following item validity testing, 16 OSH management items and nine occupational risk items were retained. Cronbach's alpha coefficients for the retained items were 0.948 and 0.915, respectively, indicating high internal consistency. Safety training received the highest management score (87.33%), followed by safety briefings (82.67%) and safety policy implementation (78.93%). Supervision received the lowest score (63.73%), indicating a potential weakness in the consistent implementation and monitoring of safe work practices. Regarding perceived occupational risks, traffic interaction received the highest score (92.50%), followed by slips and trips (91.11%) and heavy equipment operations (89.83%). These percentages reflect respondents' perceptions of workplace hazards rather than measured accident probabilities, injury severity, or formal risk ratings. The findings suggest that greater emphasis should be placed on strengthening field supervision, traffic management, housekeeping, and operational safety controls while maintaining existing safety training and briefing practices. Given the descriptive research design, small sample size, and single-project setting, the findings should be interpreted as a site-specific assessment rather than as generalizable estimates of construction safety performance.

KEYWORDS: Occupational safety and health; construction safety; road preservation; risk perception; safety management; Lampung

1. Introduction

Construction projects involve various activities that expose personnel to multiple occupational safety and health (OSH) hazards. These hazards may arise from equipment operations, interactions between workers and vehicles, material handling, environmental conditions, and inadequate implementation of safe work procedures. Road construction and preservation projects present additional challenges because activities are frequently conducted near active traffic, requiring effective coordination between construction operations and public vehicle movements. Consequently, effective safety management requires not only formal procedures but also their consistent implementation at construction sites [1–8].

Recent studies have examined construction safety from various perspectives, including safety performance indicators, hazard recognition, worker behavior, safety training, risk assessment, and technology-based monitoring [1–10]. These studies suggest that safety performance is influenced by several interacting factors. Although formal safety policies and training provide an essential foundation, their effectiveness also depends on adequate supervision, worker participation, compliance with standard operating procedures (SOPs), and the implementation of appropriate risk control measures [11–16]. In road construction projects, interactions among workers, construction equipment, and public traffic further emphasize the importance of effective safety management practices [17–24].

In Indonesia, occupational and construction safety management is governed by several regulations, including Law No. 1 of 1970 concerning Work Safety, Government Regulation No. 50 of 2012 concerning the Implementation of Occupational Safety and Health Management Systems, and Minister of Public Works and Housing Regulation No. 10 of 2021 concerning Construction Safety Management Systems [25–27]. These regulations establish an institutional framework for identifying, assessing, and controlling workplace hazards. However, compliance with formal regulatory requirements does not necessarily ensure the consistent implementation of safety practices during daily construction activities. Therefore, site-specific evaluations are necessary to identify implementation gaps and areas requiring improvement.

Although construction safety has been extensively investigated, a practical research gap remains in understanding how specific OSH management practices relate to perceived workplace hazards within operational national road preservation projects. In particular, evaluating both safety management dimensions and occupational risk categories can help identify differences between reported management practices and the hazards perceived by project personnel. This distinction is important because a project may provide adequate safety training and communicate safety procedures while continuing to experience challenges related to field supervision, traffic management, and operational hazard control. Examining these aspects within the same project provides a more comprehensive understanding of its reported safety conditions.

This study addresses this gap by evaluating OSH management practices and perceived occupational risks in the Sp. Bukoposo–Bumi Harapan–Exit Tol Way Kenanga national road preservation project in Lampung, Indonesia. Seven OSH management dimensions were examined: safety policy, personal protective equipment (PPE), safety briefings, safety training, supervision, compliance with SOPs, and risk control. In addition, five categories of perceived occupational risks were assessed: heavy equipment operations, traffic interaction, slips and trips, dust and heat exposure, and construction materials. These dimensions provide a

structured basis for examining reported safety management practices and identifying prominent workplace hazards.

The contribution of this study lies in its integrated descriptive assessment of OSH management practices and perceived occupational hazards within a specific national road preservation project. Unlike studies focused on developing predictive risk models or estimating accident probabilities, this investigation emphasizes identifying relative strengths and weaknesses in reported safety management practices and hazard perceptions. The findings provide practical insights for prioritizing improvements in field supervision, traffic management, housekeeping, and equipment-related safety controls. Nevertheless, the results should be interpreted within the limitations of the relatively small sample size, single-project setting, and reliance on self-reported questionnaire data. Therefore, this study aims to (1) evaluate the perceived implementation of OSH management practices, (2) identify the occupational hazards perceived as most prominent by project personnel, and (3) formulate practical recommendations for improving safety management in national road preservation activities.

2. Materials and Methods

2.1. Research Design and Study Location.

This study employed a quantitative descriptive design to evaluate occupational safety and health (OSH) management practices and perceived occupational risks in a national road preservation project in Lampung, Indonesia. The study was conducted at the Sp. Bukoposo–Bumi Harapan–Exit Tol Way Kenanga road preservation project. A descriptive research design was selected because the primary objective was to summarize respondents' assessments of existing safety management practices and workplace hazards. The study did not aim to establish causal relationships between safety management practices and occupational accidents or to calculate formal risk ratings based on accident likelihood and consequence severity. Instead, the approach focused on identifying perceived strengths and weaknesses in OSH management and determining which occupational hazards were considered most prominent by project personnel.

2.2. Population and Sample.

The study involved 30 personnel engaged in various activities within the selected road preservation project. Respondents were selected through purposive sampling based on their involvement in project management, field supervision, safety management, equipment operation, or construction activities. This sampling approach was intended to obtain assessments from personnel with direct knowledge of worksite conditions, operational hazards, and safety management practices. The sample consisted of one site manager, four safety officers, four field supervisors, four heavy equipment operators, two foremen, and 15 field workers. The inclusion of these occupational groups provided perspectives from personnel responsible for implementing and supervising safety procedures, as well as workers directly involved in construction activities and exposed to operational hazards. The sample size of 30 respondents was determined by the scope of the selected project, the availability of eligible personnel, and the practical feasibility of data collection. The sample was considered appropriate for a preliminary, site-specific descriptive assessment and questionnaire item

analysis. However, it was not intended to provide statistically representative estimates of OSH management practices across national road preservation projects in Indonesia. Accordingly, the limited sample size was considered when interpreting the findings, particularly those related to item validity, reliability, and the generalizability of the results.

2.3. Respondent Characteristics.

Respondent characteristics were recorded to describe the demographic and occupational composition of the study sample. The variables included age, educational background, and project role. As presented in Table 1, the 30 respondents represented different age groups, educational qualifications, and occupational responsibilities. Field workers constituted the largest group, accounting for 50% of the sample, while the remaining respondents were involved in project management, safety management, field supervision, heavy equipment operation, and foreman duties. The respondents also represented different educational backgrounds, ranging from junior high school to bachelor's degree qualifications. This variation provided perspectives from personnel with different levels of formal education and work responsibilities. The inclusion of both supervisory personnel and field workers allowed the study to capture perceptions of safety management practices and occupational hazards from different operational perspectives. Nevertheless, the composition and relatively small size of the sample limit the extent to which the findings can be generalized to other construction projects.

Table 1. Characteristics of Respondents.

Characteristic	Category	Number	Percentage (%)
Age	17–20 years	3	10.00
	21–30 years	11	36.67
	31–40 years	10	33.33
	Over 40 years	6	20.00
Education	Junior high school	7	23.33
	Senior/vocational high school	14	46.67
	Diploma	3	10.00
	Bachelor's degree	6	20.00
Project role	Site manager	1	3.33
	Safety officers	4	13.33
	Field supervisors	4	13.33
	Heavy equipment operators	4	13.33
	Foremen	2	6.67
	Field workers	15	50.00
Total		**30**	**100.00**

2.4. Questionnaire Development and Structure.

The questionnaire was developed to assess two main constructs: OSH management practices and perceived occupational risks. The initial instrument consisted of 50 statements, comprising 33 statements related to OSH management and 17 statements addressing occupational risks. The questionnaire was structured to capture respondents' perceptions of existing safety management practices and the prominence of workplace hazards associated with road preservation activities. The OSH management construct comprised seven dimensions: safety policy, personal protective equipment (PPE), safety briefings, safety training, supervision,

compliance with standard operating procedures (SOPs), and risk control. These dimensions were selected to represent key aspects of organizational safety management and the implementation of preventive measures at construction sites. The occupational risk construct covered five hazard categories: heavy equipment operations, traffic interaction, slips and trips, dust and heat exposure, and construction materials. These categories reflected common operational conditions and potential hazards encountered during road preservation activities.

The questionnaire domains were developed based on safety management practices and hazard categories relevant to road construction activities. Their conceptual scope was consistent with the general principles of construction safety management and the Indonesian regulatory framework [25–27], as well as previous studies addressing construction hazards, safety practices, and occupational risk perception [1–8]. Each statement was evaluated using a five-point Likert scale. Higher scores indicated stronger agreement with positively worded safety management statements or a greater perception of the prominence of specific occupational hazards, depending on the construct being assessed. Therefore, the interpretation of each response depended on the wording and purpose of the corresponding statement. In particular, a high score for a hazard-perception item indicated that respondents considered the hazard prominent rather than demonstrating a high probability of an occupational accident. The initial questionnaire underwent item validity testing to determine the suitability of individual statements for subsequent analysis. Items meeting the adopted validity criterion were retained, while those failing to meet the criterion were excluded. Following this procedure, the number of OSH management statements was reduced from 33 to 16, while the occupational risk statements were reduced from 17 to nine. Consequently, the final descriptive analysis and reliability assessment were conducted using 25 retained statements.

2.5. Item Validity and Reliability.

Item validity was assessed by examining the correlation between individual item scores and their corresponding construct scores. This analysis aimed to determine whether each statement demonstrated sufficient statistical consistency with the construct it was intended to measure. The Pearson product–moment correlation coefficient was employed as the item validity statistic. With 30 respondents, the degrees of freedom were calculated as $df = n - 2 = 28$. At a significance level of 0.05, the corresponding two-tailed critical correlation coefficient was approximately 0.361. Items with item–total correlation coefficients exceeding this threshold were considered to satisfy the statistical criterion for retention. Statements that did not meet this criterion were excluded from the final questionnaire.

Following the validity assessment, 16 of the initial 33 OSH management items and nine of the initial 17 occupational risk items were retained. This reduction indicated that several statements did not demonstrate sufficient item-level consistency within the study sample. However, the exclusion of these statements should not be interpreted as evidence that the corresponding safety management aspects or occupational hazards were unimportant. Instead, the retained statements formed the basis for calculating the reported construct scores and conducting subsequent descriptive analyses. Internal consistency reliability was evaluated using Cronbach's alpha coefficient. Reliability coefficients were initially calculated for the original item sets and subsequently recalculated after the exclusion of items that failed to meet the validity criterion. The initial Cronbach's alpha coefficients were 0.896 for OSH

management and 0.813 for occupational risks. Following item selection, these coefficients increased to 0.948 and 0.915, respectively.

The higher Cronbach's alpha coefficients obtained after item selection indicated stronger internal consistency among the retained statements within the study sample. However, Cronbach's alpha does not independently establish construct validity or confirm that the instrument adequately represents all relevant aspects of occupational safety. High reliability coefficients may also indicate similarities or redundancy among questionnaire items. Furthermore, given the relatively small sample of 30 respondents, the reliability estimates should be interpreted as preliminary findings specific to the study population.

2.6. Data Analysis.

Data were analyzed descriptively using response frequencies, mean scores, and percentage scores. First, the mean score for each item or dimension was calculated by dividing the total score by the number of valid responses. This calculation is expressed in Equation (1).

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n} \tag{1}$$

where $\bar{x}$ represents the mean score, x_i denotes the score assigned by respondent i, and n is the total number of valid responses.To facilitate comparisons across dimensions, observed scores were converted into percentages of the maximum possible Likert-scale score using Equation (2).

$$P = \frac{\sum x_i}{5n} x100 \tag{2}$$

where P is the percentage score, $\sum x_i$ is the total observed score, 5 indicates the maximum possible score for an individual response, and n denotes the number of valid responses.When percentages are derived from the same five-point scale, the equivalent mean score can be determined via Equation (3).

$$\bar{x} = \frac{P}{20} \tag{3}$$

Equation (3) was utilized to compute the mean equivalents presented alongside the percentage scores in Tables 2 and 5 (rounded to two decimal places), assuming the percentages were calculated relative to the maximum possible score of the five-point Likert scale.

In the context of occupational safety and health (OSH) management, percentage scores and their corresponding mean equivalents were employed to compare the seven management dimensions. For work-related risks, these metrics assessed respondents' perceptions regarding the prominence of five hazard categories. Because the questionnaire measured subjective perceptions rather than actual accident occurrences, the resulting percentages were not interpreted as accident probabilities, injury-severity estimates, or formal Hazard Identification, Risk Assessment, and Risk Control (HIRARC) ratings.

3. Results and Discussion

3.1. Evaluation of OSH Management Practices.

The descriptive assessment of the seven occupational safety and health (OSH) management dimensions is presented in Table 2, which summarizes the percentage scores and their equivalent mean scores on a five-point Likert scale. The results reveal noticeable differences in the perceived implementation of OSH management practices across the assessed dimensions. Safety training received the highest percentage score (87.33%), corresponding to a mean score of 4.37, followed by safety briefings (82.67%; mean = 4.13) and safety policy implementation (78.93%; mean = 3.95). In contrast, supervision received the lowest score (63.73%; mean = 3.19), indicating a potential weakness in the consistent monitoring and enforcement of workplace safety procedures.

Table 2. Descriptive Assessment of OSH Management Practices.

No.	OSH management dimension	Percentage score (%)	Equivalent mean score (1–5)
1	Safety policy	78.93	3.95
2	Personal protective equipment	74.22	3.71
3	Safety briefings	82.67	4.13
4	Safety training	87.33	4.37
5	Supervision	63.73	3.19
6	Compliance with SOPs	73.83	3.69
7	Risk control	73.33	3.67

Note: Equivalent mean scores were calculated using Equation (3), assuming that the reported percentage scores were normalized against the maximum possible score on the five-point Likert scale.

As shown in Table 2, safety training and safety briefings emerged as the strongest components of OSH management. The relatively high scores suggest that respondents generally perceived safety-related information, instruction, and communication activities positively. These findings may indicate that the project places considerable emphasis on communicating safety requirements and preparing personnel to recognize potential workplace hazards. Regular training and briefings are particularly relevant to road preservation activities, where changing work locations, heavy equipment movements, and interactions with public traffic require continuous safety awareness. Nevertheless, high perception scores do not necessarily demonstrate that training activities have effectively reduced unsafe behavior or occupational accidents, as these outcomes were not directly measured in this study.

Safety policy implementation also received a relatively favorable score of 78.93%, suggesting that respondents generally recognized the presence and implementation of formal safety management requirements. However, the lower scores for PPE (74.22%), compliance with SOPs (73.83%), and risk control (73.33%) indicate that the perceived implementation of operational safety measures was less favorable than that of training and communication activities. This difference suggests a possible gap between the communication of safety requirements and their consistent application during daily construction operations. For example, personnel may be familiar with safety procedures but still encounter challenges in maintaining appropriate protective measures, following established work instructions, or implementing hazard controls under changing site conditions.

The supervision dimension deserves particular attention because it recorded the lowest percentage score, approximately 23.60 percentage points below safety training. This

substantial difference suggests that respondents perceived field supervision less positively than other management activities. In road preservation projects, effective supervision is important for monitoring worker behavior, identifying unsafe conditions, ensuring compliance with established procedures, and coordinating construction activities near moving traffic. Therefore, strengthening routine site inspections, supervisory accountability, and immediate corrective actions may help address this perceived weakness.

3.2. Personal Protective Equipment.

The assessment of personal protective equipment (PPE) practices is presented in Table 3, which summarizes the mean scores and corresponding percentages for six indicators related to PPE use and availability. The indicators included the use of safety helmets, reflective vests, safety footwear, protective gloves, and masks, as well as the availability of complete PPE. The results indicate variations in respondents' perceptions of PPE implementation across different categories. Safety footwear and masks received the highest mean scores of 4.000 (80.00%), followed by protective gloves with a mean score of 3.867 (77.33%). In contrast, reflective vests and the availability of complete PPE received the lowest mean scores of 3.433 (68.67%), while safety helmets recorded a mean score of 3.533 (70.67%).

Table 3. Assessment of PPE-Related Practices.

No.	Indicator	Mean score (1–5)	Percentage (%)
1	Use of safety helmets	3.533	70.67
2	Use of reflective vests	3.433	68.67
3	Use of safety footwear	4	80
4	Use of protective gloves	3.867	77.33
5	Use of masks	4	80
6	Availability of complete PPE	3.433	68.67

As shown in Table 3, the relatively high scores for safety footwear and masks suggest that respondents perceived these protective measures as more consistently implemented than other PPE categories. Safety footwear is particularly important in road preservation activities because workers may encounter uneven surfaces, sharp construction materials, and moving equipment. Similarly, masks provide protection against airborne dust and particulate matter generated during road maintenance, material handling, and equipment operations, although their effectiveness depends on the type of respiratory protection used and the exposure conditions. The comparatively favorable score for protective gloves also suggests greater reported attention to hand protection during activities involving construction materials, tools, and equipment. However, these findings represent respondents' assessments rather than independently verified PPE compliance rates.

In contrast, the lower scores for reflective vests and safety helmets indicate potential weaknesses in the perceived implementation of protective measures associated with visibility and head protection. Reflective vests are particularly important in road preservation projects because construction personnel frequently work near moving vehicles, heavy equipment, and active traffic lanes. Inadequate visibility may increase exposure to vehicle-related hazards, especially during periods of reduced lighting, adverse weather, or complex traffic movements. The relatively low score for safety helmets also warrants attention because workers may be exposed to falling objects, equipment movements, and accidental contact with construction

materials. These findings suggest that PPE management should place greater emphasis on ensuring that appropriate protective equipment is consistently used during activities involving elevated occupational hazards.

The availability of complete PPE received one of the lowest scores (68.67%), suggesting that respondents perceived potential limitations in the provision or accessibility of protective equipment. This finding is important because effective PPE implementation depends not only on worker awareness and willingness to use protective equipment but also on its availability, suitability, condition, and proper fit. Project management should therefore consider conducting routine PPE inspections, maintaining adequate equipment inventories, replacing damaged protective items, and ensuring that protective equipment meets the requirements of specific construction activities. Supervisors should also reinforce appropriate PPE use through regular field inspections and immediate corrective actions when deficiencies are identified.

3.3. Safety Briefings.

The item-level results for safety briefings are presented in Table 4. The results distinguish the frequency of briefings, hazard discussions, explanations of safe work procedures, and worker participation. The discussion of workplace hazards received the highest score, with a mean of 4.667 or 93.33%. Daily safety briefings also received a high score of 86.00%. However, explanations of safe work procedures and worker participation received lower scores, at 75.33% and 76.00%, respectively. This pattern suggests that hazard discussion may be a more established part of daily communication than the detailed explanation of work procedures or active worker participation. Briefings could be strengthened by using task-specific examples, asking workers to identify hazards, confirming their understanding of control measures, and encouraging them to report unsafe conditions before work begins.

Table 4. Assessment of Safety Briefing Practices.

No.	Indicator	Mean score (1–5)	Percentage (%)
1	Conduct of daily safety briefings	4.3	86
2	Discussion of workplace hazards	4.667	93.33
3	Explanation of safe work procedures	3.767	75.33
4	Worker participation in briefings	3.8	76

3.4. Perceived Work Risks.

The percentage scores for the five work-risk categories are presented in Table 5. The table also provides equivalent mean scores to facilitate comparison on the original five-point scale. Traffic interaction received the highest perceived-risk score (92.50%), followed by slips and trips (91.11%) and heavy equipment operations (89.83%). The traffic interaction was the highest-scoring category, indicating that respondents considered interactions with moving vehicles a prominent worksite hazard. Slips and trips and heavy equipment operations were also perceived as important concerns. Dust and heat exposure and construction materials received slightly lower, but still substantial, scores. The item-level findings further illustrate these concerns. The statement concerning workers being struck by vehicles received a score of 98.00%, while the statement concerning danger from public vehicles received 96.67%. Scattered construction materials received 98.00%, heavy equipment accidents received 94.67%, and asphalt fumes received 94.00%.

These percentages indicate strong respondent concern about the specified hazards. They do not demonstrate that 98% of workers experienced a vehicle strike or that an accident has a 98% probability of occurring. Instead, the values summarize responses on a normalized Likert scale and should be interpreted as descriptive indicators of perceived hazard prominence.

Table 5. Respondents' Perceptions of Work-Risk Categories.

No.	Work-risk category	Percentage score (%)	Equivalent mean score (1–5)
1	Traffic interaction	92.5	4.63
2	Slips and trips	91.11	4.56
3	Heavy equipment operations	89.83	4.49
4	Dust and heat exposure	86.22	4.31
5	Construction materials	86.22	4.31

Note: Equivalent mean scores were calculated using Equation (3), assuming normalization against the maximum possible five-point Likert score. These scores represent perceived hazard prominence, not measured accident probability, severity, or a formal HIRARC risk rating.

3.5. Validity and Reliability Results.

The item-selection and reliability results are summarized in Table 6, including the number of initial items, the number retained after validity testing, and the Cronbach's alpha coefficients before and after item selection. the item-validity assessment retained 16 of the 33 initial OSH management items and nine of the 17 initial work-risk items. The retained items produced Cronbach's alpha coefficients of 0.948 and 0.915, respectively. The increase in alpha after item selection indicates greater internal consistency among the retained statements. However, this increase should not be interpreted as proof that the revised questionnaire is universally valid or superior for every construction project. The reduction in item numbers may also narrow the range of safety topics represented. In addition, the relatively small sample limits the precision and generalizability of the psychometric estimates. Future applications should therefore re-evaluate the instrument using larger and more diverse samples.

Table 6. Questionnaire Validity And Reliability Results.

Construct	Initial items	Retained items	Initial Cronbach's alpha	Alpha after item selection
OSH management	33	16	0.896	0.948
Work risk	17	9	0.813	0.915

3.6. Strengths and Weaknesses in OSH Management.

The results show that safety training was the highest-scoring management dimension, at 87.33%, while supervision was the lowest, at 63.73%. This difference suggests that the project's safety-management performance may be stronger in the provision or recognition of training than in the day-to-day monitoring of work practices. Training provides workers with knowledge of hazards, safe procedures, and preventive measures. However, training alone cannot ensure that safe practices are consistently applied under changing worksite conditions. Construction activities require workers to make decisions while interacting with equipment, materials, and other personnel. Consequently, safety knowledge needs to be reinforced through field supervision, feedback, and timely correction of unsafe conditions [1, 9–11].

The comparatively lower supervision score may reflect a perceived gap between safety expectations and their implementation during daily operations. Nevertheless, the questionnaire did not directly measure supervisor-to-worker ratios, the frequency of inspections, or the

quality of corrective actions. Therefore, the findings do not establish the specific cause of the low score. Instead, they identify supervision as a priority area for further evaluation and improvement. The safety briefing results provide additional insight. Respondents gave high scores to hazard discussion and daily briefings, but lower scores to the explanation of safe work procedures and worker participation. This suggests that communication may be more effective when identifying hazards than when translating those hazards into detailed operational instructions or involving workers in the selection of controls. Briefings should therefore connect each identified hazard to specific actions, responsible personnel, and verification procedures.

3.7. PPE Use and Consistency of Safety Practices.

PPE-related results show that safety footwear and masks received relatively high scores, while reflective vests and the availability of complete PPE received lower scores. In road preservation work, reflective clothing is particularly relevant because workers may be exposed to moving vehicles and heavy equipment. The lower score for reflective vests warrants a practical review of PPE availability, suitability, and consistent use in active traffic areas. The availability of complete PPE also received a relatively low score. This result highlights the importance of distinguishing between PPE use and PPE provision. Workers cannot consistently comply with requirements if the required equipment is unavailable, unsuitable, damaged, or difficult to access. Project management should therefore verify that the PPE required for each task is provided, maintained, replaced when necessary, and checked during field inspections. Supervisors can reinforce these measures by checking PPE before work begins, observing compliance during operations, and correcting deficiencies immediately. Such measures are particularly important for workers exposed to traffic, equipment movement, dust, heat, and construction materials.

3.8. Priority Work Hazards.

Traffic interaction received the highest perceived-risk score (92.50%). This finding is consistent with the nature of road preservation work, in which construction operations may occur alongside moving public traffic. Road work zones require clear separation between work activities and traffic wherever practicable, adequate warning signs, visible traffic-control devices, and coordination between traffic controllers, equipment operators, and field workers [5, 6, 8]. The item-level scores for vehicle strikes and danger from public vehicles reinforce the need to prioritize traffic protection. Practical measures may include reviewing the traffic-management plan, maintaining clear work-zone boundaries, positioning warning signs appropriately, providing high-visibility PPE, establishing safe crossing points, and assigning trained personnel to traffic-control duties. The implementation of these measures should be verified through documented inspections rather than assumed from the presence of a written plan.

Slips and trips received the second-highest perceived-risk score (91.11%). The high score for scattered construction materials indicates that housekeeping deserves particular attention. Materials should be stored in designated locations, walking routes should be kept clear, and uneven or slippery surfaces should be identified and addressed promptly. Housekeeping should be incorporated into routine worksite inspections and included in daily safety briefings. Heavy

equipment operations received a score of 89.83%. These activities may involve blind spots, reversing movements, limited visibility, and interactions between equipment and workers. Appropriate controls include separating pedestrian and equipment routes where practicable, establishing exclusion zones, using trained operators and designated signalers, checking equipment before use, and maintaining effective communication during maneuvering.

Dust and heat exposure and construction materials each received a score of 86.22%. Although these scores were lower than those for traffic interaction and slips and trips, they remain important areas for preventive action. Dust and asphalt fumes should be controlled through appropriate work methods, exposure controls, and task-specific protective equipment. Heat-related measures may include access to drinking water, rest breaks, shaded recovery areas where practicable, and monitoring of working conditions. Materials should be stored, handled, and transported to minimize obstruction, falling-object hazards, and unnecessary manual handling. Importantly, the ranking of these categories should be used to guide further inspection and control planning, not to replace a formal risk assessment. A complete risk evaluation would require information on exposure, incident history, potential consequences, and the effectiveness of existing controls. These variables were not measured by the present questionnaire.

3.9. Implications for Field Supervision.

The difference between the training score (87.33%) and supervision score (63.73%) suggests that the project could benefit from stronger links between safety instruction and field verification. The result does not prove that supervision is the cause of the perceived hazards, but it identifies a practical management opportunity. Supervision can be strengthened through several complementary actions. First, supervisors should conduct structured inspections at the beginning of shifts and during high-risk activities. These inspections should verify PPE use, work-zone boundaries, housekeeping, equipment condition, and compliance with task-specific procedures. Second, traffic and equipment operations should be coordinated through clearly assigned responsibilities. Workers should understand pedestrian routes, equipment exclusion zones, reversing procedures, and communication signals. Supervisors should intervene when traffic or equipment movements create unsafe interactions. Third, housekeeping should be treated as a continuous operational responsibility rather than a task performed only at the end of a shift. Scattered materials and obstructed access routes should be corrected as soon as they are identified. Fourth, safety briefings should include worker participation. Supervisors can ask workers to identify hazards associated with the day's tasks, explain the controls that will be applied, and report changes in site conditions. This approach may help translate general safety knowledge into task-specific decisions. Finally, inspection findings and corrective actions should be documented. A simple monitoring record can identify recurring problems, responsible personnel, completion dates, and unresolved issues. Such documentation allows management to assess whether corrective actions are implemented consistently rather than relying exclusively on general perceptions. These measures are practical implications derived from the observed pattern of questionnaire scores. Their effectiveness was not directly tested in this study and should be evaluated through subsequent monitoring.

3.10. Methodological Interpretation of Risk Percentages.

The high work-risk percentages require careful interpretation. The questionnaire measured respondents' perceptions of specified hazards. It did not measure accident occurrence, exposure duration, incident frequency, injury severity, or the probability of a particular event. For this reason, the reported percentage for traffic interaction should not be interpreted as a 92.50% probability of a traffic accident. Likewise, the score for slips and trips does not indicate the proportion of workers who have experienced such incidents. These values summarize responses on a normalized Likert scale and are intended to compare perceived hazard prominence within the study. The distinction is important because formal risk assessment generally requires a systematic examination of hazards, exposure, likelihood, consequences, and existing controls. The current results can help identify hazards that warrant closer attention, but they cannot independently determine a formal risk level or replace HIRARC. A subsequent assessment could combine worker perceptions with site inspections, accident and near-miss records, exposure observations, and a documented likelihood–severity matrix.

3.11. Reliability, Item Reduction, and Limitations.

The final Cronbach's alpha coefficients were 0.948 for OSH management and 0.915 for work risk. These values indicate high internal consistency among the retained items in the present sample. The increase relative to the initial coefficients is consistent with the removal of items that did not meet the selected item-validity criterion. However, item reduction from 33 to 16 management statements and from 17 to nine work-risk statements has implications for content coverage. Items may fail a statistical validity threshold because of inconsistent interpretation, limited response variation, or weak correspondence with the construct in this sample. Their exclusion does not necessarily mean that the underlying safety topic is irrelevant. The final instrument should therefore be interpreted as a set of retained indicators rather than an exhaustive representation of every aspect of OSH management and construction risk.

The sample size of 30 also limits the stability of item-level correlations and reliability estimates. High alpha coefficients do not eliminate this limitation and do not establish that the instrument will perform identically in other projects. Further testing with a larger sample, a more diverse set of respondents, and additional evidence of content and construct validity would strengthen the instrument. Several other limitations should be acknowledged. First, the study was conducted at a single national road preservation project, so the findings may not be generalizable to projects with different traffic conditions, work methods, contractors, or safety-management systems. Second, the data were self-reported and may be influenced by individual experience, interpretation, or response tendencies. Third, the study did not independently verify reported practices through systematic field observations or compare perceptions with accident and near-miss records. Finally, the descriptive design does not support causal conclusions regarding the relationship between supervision, training, perceived hazards, and safety outcomes.

4. Conclusions

This study evaluated OSH management practices and perceived work risks on the Sp. Bukoposo–Bumi Harapan–Exit Tol Way Kenanga national road preservation project in

Lampung, Indonesia. The assessment was based on a questionnaire administered to 30 project personnel and analyzed using descriptive statistics, item validity testing, and Cronbach's alpha. Safety training received the highest OSH management score (87.33%), followed by safety briefings (82.67%) and safety policy implementation (78.93%). Supervision received the lowest score (63.73%), indicating that field monitoring and the consistent implementation of safety practices should receive further attention. PPE, SOP compliance, and risk control also provide opportunities for improvement. Traffic interaction was the highest-scoring perceived work-risk category (92.50%), followed by slips and trips (91.11%) and heavy equipment operations (89.83%). Dust and heat exposure and construction materials each received 86.22%. These percentages reflect respondents' perceptions of hazard prominence and should not be interpreted as accident probabilities, injury-severity scores, or formal HIRARC ratings. The findings support several practical priorities: strengthening field supervision, improving the availability and consistent use of PPE, reinforcing task-specific safety briefings, maintaining clear work areas, separating workers from moving traffic and equipment where practicable, and documenting corrective actions. These measures should be implemented alongside formal hazard identification and risk assessment. The study is limited by its small sample, single-project setting, self-reported data, and lack of independent accident or near-miss records. Accordingly, the findings provide a site-specific descriptive assessment rather than a basis for broad statistical generalization. Future research should involve multiple road projects, larger samples, systematic field observations, and documented incident data. Combining perception-based questionnaires with formal risk assessment would also provide a stronger basis for evaluating the effectiveness of OSH management in road preservation projects.

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Author Contribution

Agung Rian Hidayat: Conceptualization, investigation, data collection, data analysis, and original manuscript preparation. Fery Hendi Jaya: Methodology review, supervision, interpretation of results, manuscript review and editing, and correspondence. Both authors approved the final version of the manuscript.

Competing Interest

All authors should disclose any financial, personal, or professional relationships that might influence or appear to influence their research.

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