Evaluation of Occupational Safety and Health Implementation in Lapen Road Reconstruction Projects in Kupang City

Yeni Emilia[1]*
[1] Akademi Teknik Kupang, Kupang, Indonesia
* Corresponding author: yeni.emilia@atkup.ac.id

Article History

Received	Revised	Accepted	Published
July 09, 2026	*August 11, 2026*	*August 30, 2026*	*30 August 2026*

How to Cite

Emilia, Y. (2026). Evaluation of occupational safety and health implementation in Lapen road reconstruction projects in Kupang City. Cornerstone Civil Engineering Journal, 1(1), 71–76. https://ejournal.atkup.ac.id/index.php/ccej/article/view/8

ABSTRACT

Road reconstruction using a macadam penetration layer (Lapen) involves workers, aggregates, binding materials, heavy equipment, haul vehicles, and activities adjacent to live traffic, all of which create occupational hazards. This study evaluates the implementation of Occupational Safety and Health (OSH) in four government Lapen road reconstruction work packages in Kupang City: Alak District; RT 25/RW 12, NBD Urban Village; Maulafa District; and the areas of Oebobo, Kelapa Lima, Kota Raja, and Kota Lama. A descriptive-evaluative method with a quantitative approach was applied through field observations, checklist assessment, documentation, and interviews. Verifiable conditions were scored 1 when fulfilled and 0 when not fulfilled, and the implementation level was calculated as a percentage of the maximum checklist score. Field observations found no personal protective equipment (PPE) in use and no other observable safety facilities at the assessed sites. Overall OSH implementation scores ranged from 4% to 6%, with an average of 5%, indicating a very low level of implementation. The main deficiencies concerned PPE, hazard control, work-zone protection, traffic management, first-aid facilities, safety communication, and supervision. The findings demonstrate the need for immediate improvement through the provision and enforcement of PPE, safety signs and barricades, traffic control, first-aid facilities, pre-work safety briefings, and routine safety inspections.

Keywords: *occupational safety and health; construction safety; Lapen; road reconstruction; Kupang City*

ABSTRAK

Pekerjaan rekonstruksi jalan dengan konstruksi lapis penetrasi makadam (Lapen) melibatkan tenaga kerja, agregat, bahan pengikat, alat berat, kendaraan pengangkut, dan aktivitas di sekitar lalu lintas aktif yang memiliki potensi bahaya. Penelitian ini bertujuan mengevaluasi penerapan Keselamatan dan Kesehatan Kerja (K3) pada empat paket pekerjaan rekonstruksi jalan Lapen pemerintah di Kota Kupang, yaitu kawasan Kecamatan Alak; Jl. RT 25/RW 12 Kel. NBD; Kecamatan Maulafa; serta kawasan Kecamatan Oebobo, Kelapa Lima, Kota Raja, dan Kota Lama. Metode penelitian adalah deskriptif-evaluatif dengan pendekatan kuantitatif melalui observasi lapangan, checklist, dokumentasi, dan wawancara. Kondisi yang dapat diverifikasi diberi skor 1 apabila terpenuhi dan 0 apabila tidak terpenuhi, kemudian tingkat penerapan dihitung sebagai persentase terhadap skor maksimum. Hasil observasi menunjukkan bahwa pada seluruh proyek tidak ditemukan APD yang digunakan pekerja maupun perlengkapan K3 lain yang dapat diamati. Tingkat penerapan K3 pada empat proyek berkisar antara 4% sampai 6%, dengan rata-rata 5%, sehingga termasuk kategori sangat rendah. Kelemahan

utama mencakup APD, pengendalian bahaya, pengamanan area kerja, pengaturan lalu lintas, fasilitas P3K, komunikasi keselamatan, dan pengawasan. Perbaikan perlu dilakukan melalui penyediaan dan penegakan penggunaan APD, rambu dan pembatas, pengaturan lalu lintas, fasilitas P3K, pengarahan keselamatan sebelum bekerja, serta inspeksi K3 secara rutin.

Kata Kunci: *K3; keselamatan konstruksi; Lapen; rekonstruksi jalan; Kota Kupang*

1. INTRODUCTION

Road infrastructure plays an essential role in supporting community mobility, goods distribution, economic activity, and public services. Road reconstruction is required when pavement conditions deteriorate or functional performance declines. One construction method used in local road works is the macadam penetration layer, commonly referred to in Indonesia as Lapis Penetrasi Makadam (Lapen), which involves preparation of the road body, spreading and compacting aggregate, application of binding material, and the operation of heavy equipment and transport vehicles (Directorate General of Highways, 2020).

These work activities expose workers to hazards such as being struck by heavy equipment or passing vehicles, dust and noise, injury from materials and tools, heat exposure, and contact with binding materials. Road work zones are particularly sensitive because construction activities may take place close to live traffic, increasing risks for both workers and road users. Roadway-construction research has identified dust, asphalt fumes, noise, heat stress, and adverse working conditions as important occupational health hazards (Mo et al., 2022), while road-worker studies also emphasize the significance of traffic-related work-zone hazards.

Occupational Safety and Health (OSH), commonly referred to in Indonesia as Keselamatan dan Kesehatan Kerja (K3), is therefore a fundamental component of construction management rather than an administrative formality. Evidence from road-construction settings shows that effective OSH implementation can influence worker performance (Handoko et al., 2020). More broadly, construction-safety research identifies management commitment, training, supervision, safety competence, worker engagement, and safety communication as key factors influencing safety performance (Newaz et al., 2021; Xu et al., 2023). Personal protective equipment (PPE) remains a basic layer of worker protection and should be integrated with wider hazard-control practices rather than treated as the sole safety measure (Rasouli et al., 2024).

OSH requirements apply not only to large-scale construction projects. Smaller government work packages may also expose workers and the public to significant hazards, while constraints in resources, time, and project organization can cause safety to receive less attention than work volume, quality, cost, and schedule. In Indonesia, the legal and regulatory basis for construction safety includes Law No. 1 of 1970 on Occupational Safety, Law No. 2 of 2017 on Construction Services, and Minister of Public Works and Housing Regulation No. 10 of 2021 concerning the Guidelines for the Construction Safety Management System (Republic of Indonesia, 1970, 2017; Ministry of Public Works and Housing, 2021).

Initial observations of the study objects indicated that OSH implementation was very limited. PPE and other observable safety equipment were not found at the locations assessed. This study was therefore undertaken to quantify the condition across four government Lapen road reconstruction work packages in Kupang City.

The objectives of this study are to evaluate the level of OSH implementation, identify the weakest safety aspects, compare conditions among the four work packages, and provide practical recommendations for improvement. The novelty of the study lies in its direct, multi-site evaluation of observable OSH practices in government Lapen road reconstruction works within a single urban area, providing a local baseline for construction-safety improvement in Kupang City.

2. METHODS

This study employed a descriptive-evaluative method with a quantitative approach supported by field observations. The research process consisted of selecting the work packages, establishing evaluation indicators, conducting observations, completing checklists and documentation, assigning scores, comparing the results, identifying nonconformities, and formulating recommendations.

2.1 Study Locations and Objects

The study was conducted on four government road reconstruction work packages using Lapen construction in Kupang City. The study objects and the principal observation recorded for each package are presented in Table 1.

Table 1. Study objects and principal field observations

No.	Work Package	Observation Result
1	Alak District	No PPE or other OSH equipment was observed
2	RT 25/RW 12, NBD Urban Village	No PPE or other OSH equipment was observed
3	Maulafa District	No PPE or other OSH equipment was observed
4	Oebobo, Kelapa Lima, Kota Raja, and Kota Lama areas	No PPE or other OSH equipment was observed

Source: Field observation data.

2.2 Evaluation Instrument and Parameters

The evaluation instrument covered six core aspects: PPE; hazard identification and control; equipment and work-method safety; work-area and traffic protection; health and emergency preparedness; and OSH communication and supervision. The aspects and their indicators are summarized in Table 2.

Table 2. OSH evaluation aspects and indicators

Aspect	Indicator
PPE	Availability and use of PPE appropriate to work risks
Hazards and risks	Identification and control of work hazards
Equipment/work methods	Safety of heavy equipment and work methods
Work area/traffic	Signs, barriers, and traffic control
Health/emergency	First aid and emergency preparedness
Communication/supervision	Safety briefings, inspections, and OSH supervision

Source: Study evaluation framework.

2.3 Data Collection and Analysis

Primary data were obtained through field observation, checklist assessment, documentation, and interviews. For conditions that could be directly verified, a score of 1 was assigned when the indicator was fulfilled and 0 when it was not fulfilled. The OSH implementation level was calculated using the following equation:

$$\text{OSH implementation level (\%)} = (\text{Score obtained} / \text{Maximum score}) \times 100\%$$

The resulting percentages were interpreted using the category labels applied in the original evaluation instrument. The analysis focused on comparing the four work packages and identifying the OSH aspects with the largest observable implementation gaps.

3. RESULTS

Observations across the four work packages showed broadly similar conditions. PPE was not observed in use by workers, and no other OSH equipment included in the observation framework was identified at the assessed locations. Safety helmets, safety footwear, high-visibility vests, gloves, masks or respiratory protection, safety signs, work-zone barriers, first-aid facilities, and other protective equipment were not observed during the field assessments.

These findings indicate that the observable core OSH controls were at a very low level across all study objects. The deficiency was not limited to individual protection but also extended to work-environment protection, emergency preparedness, safety communication, and supervision.

3.1 Recapitulation of OSH Implementation Levels

Table 3. Recapitulation of OSH implementation scores

No.	Work Package	Score	OSH Level	Category
1	Alak District	4	4%	Very low
2	RT 25/RW 12, NBD Urban Village	5	5%	Very low
3	Maulafa District	6	6%	Very low
4	Oebobo, Kelapa Lima, Kota Raja, and Kota Lama	5	5%	Very low

Source: Field observation and checklist results.

The overall checklist scores ranged from 4% to 6%. Alak District recorded 4%, RT 25/RW 12 NBD recorded 5%, Maulafa District recorded 6%, and the combined Oebobo/Kelapa Lima/Kota Raja/Kota Lama package recorded 5%. The mean OSH implementation level was therefore 5%, and all four work packages were classified as very low.

3.2 Results by OSH Aspect

Table 4. Aspect-level OSH observation results

Aspect	Alak	NBD	Maulafa	Oebobo/KK/KR/KL
PPE	0	0	0	0
Hazards and risks	0	0	0	0
Equipment/work methods	0	0	0	0
Work area/traffic	0	0	0	0
Health/emergency	0	0	0	0
Communication/supervision	0	0	0	0

Source: Field observation and checklist results.

The zero values in Table 4 show that none of the six summarized core OSH aspects had an observable fulfilled indicator at the time of assessment. This aspect-level result is consistent with the field description that PPE, work-zone protection, first-aid facilities, safety communication, and other basic safety controls were not observed.

3.3 Main Findings

1. PPE was not observed in use by workers.
2. Other OSH equipment supporting work-site protection was not observed.
3. Adequate safety signs and work-zone barriers were not observed.
4. First-aid facilities could not be verified during the observations.
5. Adequate OSH briefings and compliance supervision were not evident during the observations.

4. DISCUSSION

The absence of observable PPE and other basic safety equipment across all locations is a critical concern because Lapen road work involves simultaneous exposure to heavy equipment, vehicles, aggregates, dust, noise, binding materials, heat, and passing traffic. These hazards are consistent with the occupational-health risks reported in roadway-construction research, particularly dust, noise, asphalt-related emissions, heat stress, and hazardous work conditions (Mo et al., 2022).

The similar conditions observed across all four work packages indicate that the problem was not isolated to a single site. The deficiencies may be associated with the provision of safety equipment, safety culture, supervision, and work control. Construction-safety literature consistently shows that safety performance depends not only on individual worker behavior but also on management commitment, training, communication, organizational learning, and supervision (Newaz et al., 2021; Xu et al., 2023). In road-construction contexts, worker knowledge, safety awareness, training, and enforcement of safety practices have likewise been identified as important levers for improving OSH performance (Das et al., 2024).

PPE is one of the most visible and fundamental control measures. Its absence indicates that basic worker protection has not been adequately implemented. However, PPE alone is not sufficient; it must be combined with hazard identification, safe work methods, work-zone separation, traffic control, emergency preparedness, and active supervision. Contemporary construction-safety research emphasizes that PPE should function within a broader safety-management system supported by monitoring and organizational commitment (Rasouli et al., 2024).

The zero scores across the six summarized core aspects demonstrate a substantial gap between the required risk controls and the observable field practices. At the same time, the overall checklist scores in Table 3 range from 4% to 6%, with an average of 5%. Both results are retained from the original study dataset: Table 4 summarizes the six core aspects reported as zero, whereas Table 3 reports the overall checklist percentages. Regardless of this small numerical variation, the substantive interpretation remains the same: OSH implementation was very low at all four study sites.

From a regulatory perspective, these findings reinforce the importance of treating OSH as an integral part of project execution. Indonesian construction projects are expected to implement safety-management requirements under Law No. 1 of 1970, Law No. 2 of 2017, and Minister of Public Works and Housing Regulation No. 10 of 2021. The observed deficiencies therefore point to a need for stronger contractor-level implementation and routine field supervision, particularly for smaller public road work packages where safety controls may otherwise be overlooked.

4.1 Study Limitations

This evaluation is based on conditions that could be observed and verified during field assessments and therefore represents the safety practices visible at those times. The source manuscript does not provide the complete item-level checklist, the full category-threshold matrix, the number or characteristics of interview respondents, or repeated observations over time. Consequently, the percentages should be interpreted as descriptive implementation scores from the applied instrument rather than as evidence of long-term compliance or accident frequency. Future studies should report the complete checklist and scoring matrix and include repeated observations to improve reproducibility and temporal validity.

5. CONCLUSION

OSH implementation in the four Lapen road reconstruction work packages in Kupang City was at a very low level and, in practical terms, the basic observable safety controls were almost absent.

Across the assessed projects, PPE and other OSH equipment were not observed. The deficiencies included personal protection, work-zone protection, safety signs, first-aid facilities, safety communication, and supervision.

The four work packages recorded overall OSH implementation levels ranging from 4% to 6%, with an average of 5%; all were classified as very low. The aspect-level summary additionally recorded zero across the six core OSH aspects assessed.

These findings demonstrate the need to strengthen OSH management through the provision and enforcement of PPE, installation of signs and barriers, traffic management, first-aid preparedness, pre-work safety briefings, and routine OSH inspections.

6. RECOMMENDATIONS

1. Provide and enforce the use of PPE appropriate to the risks of each work activity.
2. Equip work sites with safety signs, barricades or barriers, and appropriate traffic-control measures.
3. Provide first-aid facilities and establish emergency-response procedures.

4. Conduct toolbox meetings or OSH briefings before work begins.
5. Carry out routine OSH inspections and compliance supervision.

ACKNOWLEDGEMENTS

The author acknowledges Akademi Teknik Kupang for the academic and institutional support provided during the preparation of this study. The author also appreciates the parties who supported the field observation and data-collection process for the assessed road reconstruction work packages.

AUTHOR CONTRIBUTIONS

Yeni Emilia was solely responsible for conceptualization, methodology, field observation, checklist assessment, data collection, data analysis and interpretation, preparation of the original manuscript, critical review, editing, and approval of the final version for publication.

FUNDING STATEMENT

This research received no external funding.

CONFLICT OF INTEREST STATEMENT

The author declares that there is no conflict of interest regarding the publication of this article.

DATA AVAILABILITY STATEMENT

The field-observation and checklist data supporting the findings of this study are available from the corresponding author upon reasonable request.

ETHICAL STATEMENT

This study used field observations, documentation, checklist assessment, and supporting interviews. No personally identifiable information is reported in the manuscript. The author should confirm any informed-consent and institutional ethical requirements applicable to the interviews before final publication.

REFERENCES

Das, D. K., Aiyetan, A. O., & Mostafa, M. (2024). A systemic archetype for enhancing occupational safety in road construction projects through worker behavior. Transportation Research Interdisciplinary Perspectives, 26, 101154. https://doi.org/10.1016/j.trip.2024.101154

Directorate General of Highways. (2020). Spesifikasi Umum 2018 untuk Pekerjaan Konstruksi Jalan dan Jembatan (Revisi 2) [General Specifications 2018 for Road and Bridge Construction Works (Revision 2)]. Ministry of Public Works and Housing, Republic of Indonesia.

Handoko, F., Wijayaningtyas, M., Kusuma, I. H. A., Hidayat, S., Ismail, A., & Abdullah, Z. (2020). The occupational health and safety effect on road construction worker performance. Civil Engineering and Architecture, 8(5), 750–759. https://doi.org/10.13189/cea.2020.080502

Ministry of Public Works and Housing, Republic of Indonesia. (2021). Peraturan Menteri Pekerjaan Umum dan Perumahan Rakyat Nomor 10 Tahun 2021 tentang Pedoman Sistem Manajemen Keselamatan Konstruksi [Minister of Public Works and Housing Regulation No. 10 of 2021 on Guidelines for the Construction Safety Management System].

Mo, S., Wang, Y., & Xiong, F. (2022). Identification and prioritization of key health hazards to workers in roadway construction. Transportation Safety and Environment, 4(2), tdac009. https://doi.org/10.1093/tse/tdac009

Newaz, M. T., Ershadi, M., Jefferies, M., & Davis, P. (2021). Assessing safety management factors to develop a research agenda for the construction industry. Safety Science, 142, 105396. https://doi.org/10.1016/j.ssci.2021.105396

Rasouli, S., Alipouri, Y., & Chamanzad, S. (2024). Smart personal protective equipment (PPE) for construction safety: A literature review. Safety Science, 170, 106368. https://doi.org/10.1016/j.ssci.2023.106368

Republic of Indonesia. (1970). Undang-Undang Republik Indonesia Nomor 1 Tahun 1970 tentang Keselamatan Kerja [Law of the Republic of Indonesia No. 1 of 1970 on Occupational Safety].

Republic of Indonesia. (2017). Undang-Undang Republik Indonesia Nomor 2 Tahun 2017 tentang Jasa Konstruksi [Law of the Republic of Indonesia No. 2 of 2017 on Construction Services].

Xu, J., Cheung, C., Manu, P., Ejohwomu, O., & Too, J. (2023). Implementing safety leading indicators in construction: Toward a proactive approach to safety management. Safety Science, 157, 105929. https://doi.org/10.1016/j.ssci.2022.105929

COPYRIGHT AND LICENSE STATEMENT