

Compliance With Standard Operating Procedures, Personal Protective Equipment Use, and Occupational Accidents Among Construction Workers: A Cross-Sectional Study at CV. Gavra Perkasa Gresik

Sholichudin*, Alfu Zukhrufu Firdausu

Universitas STRADA Indonesia, East Java, Indonesia

*Corresponden Author: Sholichudin (solehudin@stada.ac.id)



ARTICLE INFO

Keywords:

Construction Workers, Occupational Accidents, Occupational Safety, Personal Protective Equipment, Safety Compliance, Standard Operating Procedures.

ABSTRACT

Background: Occupational accidents remain a major occupational safety and health concern in construction, where compliance with standard operating procedures (SOPs) and personal protective equipment (PPE) use are central components of safety compliance. This study examined the associations of SOP compliance and PPE use with self-reported occupational accidents among workers at CV. Gavra Perkasa Gresik.

Methods: An analytic cross-sectional study was conducted from March to May 2023. The study population comprised 78 workers, and 65 workers were selected by simple random sampling. SOP compliance and PPE use were assessed by questionnaire, while occupational accidents were defined as self-reported work-related accidents during the preceding 12 months. Because the 2×2 tables contained sparse cells, Fisher's Exact Test was used as the primary inferential test. Crude prevalence ratios (cPRs) with 95% confidence intervals (CIs) were calculated to describe the magnitude of association.

Results: Fifteen of 65 workers (23.1%) reported an occupational accident. All 13 workers classified as non-compliant with SOPs reported an accident compared with 2 of 52 compliant workers (3.8%), corresponding to a cPR of 26.00 (95% CI 6.68–101.20; Fisher's exact $p = 6.39 \times 10^{-12}$). All 12 workers classified as non-compliant with PPE use reported an accident compared with 3 of 53 compliant workers (5.7%), corresponding to a cPR of 17.67 (95% CI 5.89–53.03; Fisher's exact $p = 1.13 \times 10^{-10}$).

Conclusion: SOP compliance and PPE use were strongly associated with reported occupational accidents in this workforce. However, the cross-sectional design, retrospective accident reporting, sparse cells, and absence of multivariable adjustment preclude causal interpretation. The findings support strengthening compliance-related safety practices within a broader occupational safety management system and hierarchy of controls.

INTRODUCTION

Construction work is characterized by dynamic work environments, changing tasks, multiple contractors, physical demands, and frequent exposure to hazards such as work at height, moving equipment, sharp objects, falling materials, and unstable surfaces. Consequently, occupational accident prevention in construction requires not only the availability of safety equipment but also reliable implementation of organizational procedures and safe work practices.

Safety compliance refers to the core behaviors required to maintain workplace safety, including adherence to established rules, standard operating procedures, and the appropriate use of personal

Received 13 May 2026; Accepted 29 July 2026; Published 15 August 2026

Published by Griya Eka Sejahtera. This is an open access article under the CC BY NC SA license (<http://creativecommons.org/licenses/by-nc-sa/4.0/>). DOI: <https://doi.org/10.55700/oahsj.v7i2.258>

protective equipment. Evidence from construction safety research shows that unsafe behavior is shaped by interacting individual, task-related, supervisory, and organizational factors rather than by worker choice alone (Xia et al., 2020; Meng et al., 2021; Liu et al., 2025). Reviews of construction safety climate further emphasize the roles of management commitment, communication, supervision, training, and consistent enforcement in shaping worker safety behavior (Goh et al., 2021; Mohammadfam et al., 2022).

PPE is an important protective layer when hazards remain after higher-order controls have been implemented. However, PPE effectiveness depends on availability, correct selection, fit, comfort, training, and consistent use. Construction-focused evidence has identified several barriers to PPE compliance, including discomfort, poor fit, inadequate knowledge, time pressure, weak supervision, and organizational shortcomings (Sehsah et al., 2020; Ammad et al., 2021; Al-Bayati et al., 2023). Recent meta-analytic evidence also supports an association between PPE use and lower occupational injury risk, while emphasizing the importance of implementation conditions and organizational support (Malta et al., 2024; Santos et al., 2025).

CV. Gavra Perkasa Gresik operates in the construction services sector. Internal company accident data summarized in the source manuscript recorded 12 occupational accidents in 2019, 18 in 2020, and 14 through October 2021, including falls, nail puncture injuries, slips, and injuries caused by falling objects. These historical figures provide contextual evidence of continuing occupational hazards, although more recent aggregate company accident data for 2022–2023 were not available in the source manuscript. Pre-study observations described in the source manuscript also suggested inconsistent use of SOPs and PPE among some workers; these observations are treated as contextual background rather than as outcomes of the main study.

Although previous studies have examined PPE use, safety behavior, and occupational accidents, evidence from smaller Indonesian construction-service workplaces remains limited, and relatively few site-level studies have examined SOP compliance and PPE use simultaneously in the same workforce. Assessing these two dimensions together may provide a more integrated view of safety compliance at the workplace level. Therefore, this study aimed to analyze the associations between SOP compliance, PPE use, and self-reported occupational accidents among workers at CV. Gavra Perkasa Gresik.

METHODS

Study Design and Setting

This study used an analytic observational design with a cross-sectional approach. Data collection was conducted at CV. Gavra Perkasa Gresik from March to May 2023.

Population and Sampling

The source population consisted of 78 workers employed at the study site. A total of 65 workers were selected using simple random sampling, representing 83.3% of the source population. The final analytic sample comprised 65 respondents. The source manuscript did not report the a priori sample-size calculation, detailed inclusion and exclusion criteria, or the procedure used to generate the random sequence; these details should be supplied by the authors before journal submission.

Variables and Operational Definitions

The independent variables were SOP compliance and PPE use. Both variables were categorized as compliant or non-compliant on the basis of the questionnaire classification used in the original study. For reproducibility, the exact scoring ranges, cut-off values, and justification for these classifications should be inserted from the original study protocol or instrument documentation.

The dependent variable was occupational accident experience, operationalized as a self-reported work-related accident during the preceding 12 months (yes/no). The source manuscript did not specify whether near misses, first-aid-only events, or different injury-severity categories were included. Accordingly, the outcome should be interpreted as self-reported accident experience rather than as a standardized injury-severity endpoint.

Instruments and Data Collection

Data were collected using questionnaires. The PPE-use instrument consisted of 13 items and had undergone validity testing. Instrument reliability was assessed using Cronbach's alpha. The questionnaire was pilot-tested among 20 workers with similar occupational characteristics at PT Adhi

Karya Tbk, Grand Dhika Commercial Estate Project, Semarang City. The pilot participants were from a separate site and were not part of the 65-worker analytic sample at CV. Gavra Perkasa Gresik.

Statistical Analysis

Descriptive analysis was used to summarize respondent characteristics and the distributions of SOP compliance, PPE use, and occupational accident experience. The associations between each compliance variable and occupational accidents were examined in 2×2 contingency tables. Because at least one expected cell count was below five and an observed cell count was zero in both analyses, Fisher's Exact Test was treated as the primary inferential test. Crude prevalence ratios (cPRs) with 95% confidence intervals (CIs) were calculated from the 2×2 tables to quantify the magnitude of association. The prevalence-ratio CIs were calculated on the log scale. Statistical significance was assessed at $\alpha = 0.05$. Pearson Chi-square statistics from the original analysis are not used as the primary basis for interpretation because of the sparse cell structure.

RESULTS

Participant Characteristics

A total of 65 workers were included in the analysis. Most respondents were male (61.5%), had worked for more than three years (70.8%), and had completed senior high school (56.9%).

Characteristic	n	%
Sex		
Male	40	61.5
Female	25	38.5
Length of employment		
≤3 years	19	29.2
>3 years	46	70.8
Educational attainment		
Elementary school	3	4.6
Junior high school	17	26.2
Senior high school	37	56.9
Higher education	8	12.3

Regarding the study variables, 52 workers (80.0%) were classified as compliant with SOPs and 13 (20.0%) as non-compliant. For PPE use, 53 workers (81.5%) were classified as compliant and 12 (18.5%) as non-compliant. Fifteen workers (23.1%) reported an occupational accident during the preceding 12 months.

Association Between SOP Compliance and Occupational Accidents

SOP compliance	Accident, n (%)	No accident, n (%)	Total	cPR (95% CI)	Fisher's exact p
Non-compliant	13 (100.0)	0 (0.0)	13	26.00 (6.68–101.20)	6.39×10^{-12}
Compliant	2 (3.8)	50 (96.2)	52	Reference	
Total	15 (23.1)	50 (76.9)	65		

All workers classified as non-compliant with SOPs reported an occupational accident, compared with 3.8% of compliant workers. SOP non-compliance was therefore associated with a markedly higher prevalence of reported accidents (cPR 26.00, 95% CI 6.68–101.20). Fisher's Exact Test indicated strong statistical evidence of an association ($p = 6.39 \times 10^{-12}$). The very wide confidence interval reflects the small sample and sparse cell counts and should be considered when interpreting the magnitude of association.

Association Between PPE Use and Occupational Accidents

PPE use	Accident, n (%)	No accident, n (%)	Total	cPR (95% CI)	Fisher's exact p
Non-compliant	12 (100.0)	0 (0.0)	12	17.67 (5.89–53.03)	1.13×10^{-10}
Compliant	3 (5.7)	50 (94.3)	53	Reference	
Total	15 (23.1)	50 (76.9)	65		

All workers classified as non-compliant with PPE use reported an occupational accident, compared with 5.7% of compliant workers. PPE non-compliance was associated with a higher prevalence of reported accidents (cPR 17.67, 95% CI 5.89–53.03; Fisher's exact $p = 1.13 \times 10^{-10}$). As with the SOP analysis, the large effect estimate and wide confidence interval should be interpreted cautiously because the data contain a zero cell and were not adjusted for potential confounders.

DISCUSSION

This study found strong crude associations between both dimensions of safety compliance—adherence to SOPs and PPE use—and self-reported occupational accidents among workers at CV. Gavra Perkasa Gresik. The direction of the findings is consistent with the broader safety-behavior literature, in which compliance with required safety procedures constitutes a core component of individual safety performance (Xia et al., 2020; Mohammadfam et al., 2022; Liu et al., 2025). However, the size of the observed associations should not be interpreted as a direct causal effect because of the study design, sparse data, and absence of covariate adjustment.

The SOP finding is plausible from an occupational risk-management perspective. SOPs standardize task performance, communicate expected controls, and reduce unnecessary variation in how hazardous work is performed. Nevertheless, compliance is unlikely to be determined by worker behavior alone. Construction safety research indicates that supervision, safety climate, work pressure, training, risk perception, and management systems can shape whether procedures are followed in practice (Meng et al., 2021; Goh et al., 2021). Thus, a non-compliant worker may also be operating in a context with weaker supervision, poorer communication, more hazardous job assignments, or other unmeasured conditions that increase accident risk.

The PPE finding is also consistent with previous construction-worker evidence. Sehsah et al. (2020) reported that PPE use was associated with occupational accidents among construction workers and identified barriers such as discomfort, inadequate knowledge, and poor fit. Al-Bayati et al. (2023) similarly identified multiple contributing factors to PPE non-compliance among construction practitioners, supporting the view that PPE behavior is influenced by organizational and task-level conditions as well as individual attitudes. Systematic reviews of PPE use in construction further emphasize safety instruction, monitoring, equipment characteristics, and organizational safety management as important determinants of effective use (Ammad et al., 2021).

At the same time, PPE should be interpreted within the hierarchy of controls rather than as the primary or sole accident-prevention strategy. Elimination and substitution of hazards, engineering controls, and administrative controls should be prioritized where feasible, with PPE functioning as an additional protective layer against residual risk. Evidence from construction safety practice shows that overreliance on lower-level controls can limit the effectiveness of occupational safety programs (Ajslev et al., 2022). Therefore, the present findings should support improved PPE compliance without shifting responsibility for hazard control disproportionately to individual workers.

The broader evidence base also suggests that PPE works best when embedded in an organizational system that supports correct selection, availability, training, fit, comfort, supervision, and reinforcement. Malta et al. (2024) and Santos et al. (2025) synthesized evidence across high-risk occupations and concluded that PPE use is associated with reduced occupational injury, while also emphasizing that implementation conditions materially influence protective effectiveness. Similarly, Setyawan et al. (2020) found that PPE compliance among Indonesian cement workers was related to behavioral factors and management policies. These findings support a systems-oriented interpretation of the present results. The local context may partly explain the exceptionally strong crude associations observed in this study. The non-compliant groups were small, and every worker in those groups reported an accident. Such

complete separation produces very large effect estimates and wide confidence intervals. It is also possible that workers who had previously experienced an accident subsequently changed their behavior and became more compliant, creating reverse causation. Because current compliance was measured during the study period while accidents were recalled over the previous year, the temporal sequence between exposure and outcome cannot be established.

Potential confounding is another important consideration. Age, job category, specific hazard exposure, work unit, safety training, supervision, tenure, work pressure, and risk perception could influence both compliance and accident occurrence. These variables were not simultaneously controlled in the source analysis. Consequently, the cPRs reported here are crude estimates and should not be interpreted as independent effects of SOP or PPE compliance.

This study has several limitations. First, it was conducted in a single company with a relatively small sample, limiting generalizability. Second, occupational accident history was self-reported for the preceding 12 months and may therefore be affected by recall or reporting bias; verification against company accident records was not described. Third, the cross-sectional design does not establish temporality and permits reverse causation. Fourth, sparse cells and complete separation in the 2×2 tables reduce the precision of the effect estimates. Fifth, the available source manuscript did not provide complete operational details for the compliance instruments, raising the possibility of exposure misclassification. Sixth, the study did not use multivariable analysis and therefore could not adjust for important worker- or job-level confounders. Finally, the outcome definition did not distinguish accident severity or clarify the inclusion of near misses and first-aid-only events.

Despite these limitations, the study provides site-level evidence that SOP and PPE compliance warrant attention within the company's occupational safety program. The findings support consistent communication of procedures, practical safety training, active supervision, appropriate PPE selection and availability, and corrective feedback for non-compliance. These recommendations should be implemented as part of a broader hierarchy of controls and safety-management system, rather than interpreted as interventions proven effective by this cross-sectional study. Future research should use prospective designs, standardized and fully validated instruments, verified accident records, and multivariable models to clarify the independent and temporal relationships among safety climate, compliance behavior, hazard exposure, and occupational accidents.

CONCLUSION

SOP compliance and PPE use were strongly associated with self-reported occupational accidents among workers at CV. Gavra Perkasa Gresik. Workers classified as non-compliant showed substantially higher crude prevalence of reported accidents than compliant workers. However, these findings are associative rather than causal because the study was cross-sectional, relied on retrospective self-report, contained sparse cells, and did not adjust for confounding. The results support strengthening SOP implementation and PPE compliance as components of a broader occupational safety management system and hierarchy of controls. Prospective and multivariable studies are needed to determine whether improving these safety practices independently reduces occupational accident risk.

REFERENCES

- Ajslev, J. Z. N., Møller, J. L., Andersen, M. F., Pirzadeh, P., & Lingard, H. (2022). The hierarchy of controls as an approach to visualize the impact of occupational safety and health coordination. *International Journal of Environmental Research and Public Health*, 19(5), 2731. <https://doi.org/10.3390/ijerph19052731>
- Al-Bayati, A. J., Renner, A. T., Listello, M. P., & Mohamed, M. (2023). PPE non-compliance among construction workers: An assessment of contributing factors utilizing fuzzy theory. *Journal of Safety Research*, 85, 242–253. <https://doi.org/10.1016/j.jsr.2023.02.008>
- Ammad, S., Alaloul, W. S., Saad, S., & Qureshi, A. H. (2021). Personal protective equipment (PPE) usage in construction projects: A systematic review and Smart PLS approach. *Ain Shams Engineering Journal*, 12(4), 3495–3507. <https://doi.org/10.1016/j.asej.2021.04.001>

- Goh, Y. M., Li, H., & Chen, H. (2021). A review of construction safety climate: Definitions, factors, relationship with safety behavior and research agenda. *Safety Science*, 142, 105391. <https://doi.org/10.1016/j.ssci.2021.105391>
- Liu, S., Wei, Y., Yang, D., & Zhang, J. (2025). A systematic review of antecedents of workers' safety behavior: A grounded theory analysis. *Safety Science*, 185, 106778. <https://doi.org/10.1016/j.ssci.2025.106778>
- Malta, G., Matera, S., Plescia, F., Calascibetta, A., Argo, A., & Cannizzaro, E. (2024). Occupational accidents and the use of PPE: A global meta-analysis. *Frontiers in Public Health*, 12, 1368991. <https://doi.org/10.3389/fpubh.2024.1368991>
- Meng, Q., Liu, W., Li, Z., & Hu, X. (2021). Influencing factors, mechanism and prevention of construction workers' unsafe behaviors: A systematic literature review. *International Journal of Environmental Research and Public Health*, 18(5), 2644. <https://doi.org/10.3390/ijerph18052644>
- Mohammadfam, I., Mahdinia, M., Aliabadi, M. M., & Soltanian, A. R. (2022). Effect of safety climate on safety behavior and occupational injuries: A systematic review study. *Safety Science*, 156, 105917. <https://doi.org/10.1016/j.ssci.2022.105917>
- Santos, W., Lorente, A., Rojas, C., Mariscal, G., & Lorente, R. (2025). Impact of personal protective equipment in preventing occupational injuries: A systematic review and meta-analysis. *Frontiers in Public Health*, 13, 1720363. <https://doi.org/10.3389/fpubh.2025.1720363>
- Sehsah, R., El-Gilany, A. H., & Ibrahim, A. M. (2020). Personal protective equipment (PPE) use and its relation to accidents among construction workers. *La Medicina del Lavoro*, 111(4), 285–295. <https://doi.org/10.23749/mdl.v111i4.9398>
- Setyawan, F. B., Supriyanto, S., Ernawaty, E., & Lestari, R. (2020). Developing a holistic-comprehensive assessment model: Factors contributing to personal protective equipment compliance among Indonesian cement workers. *Indian Journal of Occupational and Environmental Medicine*, 24(1), 19–24. https://doi.org/10.4103/ijoem.IJOEM_115_19
- Xia, N., Xie, Q., Griffin, M. A., Ye, G., & Yuan, J. (2020). Antecedents of safety behavior in construction: A literature review and an integrated conceptual framework. *Accident Analysis & Prevention*, 148, 105834. <https://doi.org/10.1016/j.aap.2020.105834>