

Risk-Based Analysis of Occupational Safety and Health Financing: A Case Study of Small-Scale Construction in Bandung City

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ABSTRACT

The financing of Occupational Safety and Health (OSH) is frequently neglected in Indonesian small-scale construction, despite evidence that project scale does not mitigate accident risks. This study aims to identify work-related risks using Job Safety Analysis (JSA), evaluate current OSH implementation by contractor "X" in Bandung, and determine the necessary budget allocation based on risk levels. Utilizing a descriptive-quantitative approach, the research benchmarks field practices against Minister of PUPR Regulation No. 10/2021 regarding the Construction Safety Management System. Findings reveal that while basic measures exist, critical gaps remain in Collective Protective Equipment, specifically safety signage and fall protection. Quantitative analysis shows current OSH expenditure accounts for only 0.64% of the total project value, falling significantly below the mandated 1.0%–2.5% range. The study identifies a "Safety Gap" in high-risk phases (Risk Score = 12), where the Cost-to-Risk Ratio is zero. It concludes that an additional budget of IDR 4,480,000.00 is required to achieve a safe OSH proportion of 1.53%. By aligning OSH costs with actual risk profiles through JSA-based budgeting, small-scale contractors can fulfill regulatory requirements and enhance worker safety without compromising project viability.

Keywords: Job Safety Analysis, OSH Costs, Project Financing, Risk Management, Small-scale Construction.

ABSTRAK. Analisis Berbasis Risiko Pembiayaan Keselamatan dan Kesehatan Kerja: Studi Kasus Konstruksi Skala Kecil di Kota Bandung. Pembiayaan Keselamatan dan Kesehatan Kerja (K3) sering kali diabaikan pada konstruksi skala kecil di Indonesia, padahal risiko kecelakaan tetap tinggi tanpa memandang skala proyek. Penelitian ini bertujuan mengidentifikasi risiko pekerjaan menggunakan Analisis Keselamatan Kerja (AKK), mengevaluasi implementasi K3 kontraktor "X" di Bandung, serta menentukan alokasi anggaran yang sesuai dengan profil risiko. Melalui pendekatan deskriptif-kuantitatif, praktik lapangan dikomparasikan dengan Peraturan Menteri PUPR No. 10/2021 tentang Sistem Manajemen Keselamatan Konstruksi. Hasil penelitian menunjukkan adanya kesenjangan kritis pada Alat Pelindung Kolektif (APK), terutama rambu keselamatan dan perlindungan jatuh. Analisis kuantitatif mengungkap pengeluaran K3 hanya sebesar 0,64% dari nilai proyek, jauh di bawah standar mandat 1,0%–2,5%. Identifikasi "Kesenjangan Keselamatan" pada fase berisiko tinggi (skor risiko 12) dengan Rasio Biaya terhadap Risiko bernilai nol. Penelitian ini menunjukkan bahwa diperlukan tambahan anggaran Rp 4.480.000,00 agar pembiayaan K3 mencapai angka ideal 1,53% sesuai profil risiko proyek. Penyelarasan biaya K3 melalui penganggaran berbasis AKK, kontraktor skala kecil dapat memenuhi regulasi sekaligus meningkatkan keselamatan pekerja tanpa mengorbankan kelangsungan proyek.

Kata kunci: Analisis Keselamatan Kerja, Konstruksi Skala Kecil, Manajemen Risiko, Pembiayaan K3, Pembiayaan Proyek.

1. INTRODUCTION

Financing plays a crucial role in determining the success of a project, necessitating accurate calculations to allocate resources efficiently to materials, labor, and safety infrastructure. However, Occupational Safety and Health (OSH) remain frequently marginalized in construction projects, particularly in developing regions where rising accident rates signal a disconnect between policy and practice ((Baghdadi, 2024)(Jaafar et al., 2018)(Kelmendi et al., 2024). In Indonesia, the Social Security Administration Agency (BPJS) Employment reported a 5.65% increase in work accidents in 2021, highlighting a critical gap between safety regulations and site implementation. Primary contributors to this trend include inadequate OSH education and project budgets that fail to allocate sufficient funds for safety measures, often viewing these costs as a burden rather than a strategic investment (Permana et al., 2025)(Fryatt & Blecher, 2023).

Current academic discourse emphasizes the "Safety-Production Conflict," where project managers prioritize speed over safety to maintain profit margins (Hashemian & Triantis, 2023). National research has established that OSH implementation in Indonesia is heavily governed by Minister of Public Works and Public Housing (PUPR) Regulation No. 10 of 2021, which mandates that Construction Safety Management System (CSMS) costs be explicitly detailed in project estimates. These costs encompass Personal Protective Equipment (PPE) such as helmets and vests and Collective Protective Equipment (CPE) such as safety nets, railings, and shoring (Kementrian PUPR, 2021). International studies suggest that the relationship between OSH investment and accident reduction is non-linear; initial investments in safety infrastructure yield the highest reduction in fatality rates (Li et al., 2021).

Despite these regulations, a significant gap exists in the small-scale construction sector. While large-scale infrastructure projects often have dedicated safety departments, small-scale contractors frequently omit safety items from the Bill of Quantities (BoQ) to remain competitive, leading to a chronic lack of PPE and CPE on site (Bachar et al., 2025). Most existing literature focuses on large-scale civil works, leaving a void in understanding how small-scale contractors in urban centers like Bandung manage the correlation between Job Safety Analysis (JSA) and actual budgetary allocation (Putra & Armada, 2023). There is a lack of empirical data demonstrating the variance between actual contractor spending and the requirements dictated by a formal risk profile (Belihu et al., 2026).

The relationship between risk and OSH costs is fundamental to construction management science. A higher risk score—calculated through probability and severity—theoretically necessitates a higher investment in mitigation (Salahuddin Araibi et al., 2024). For instance, work at heights requires body harnesses and safety nets (PPE), which are significantly more expensive

than basic gloves (CPE). Research indicates that every \$1 invested in OSH can yield a return on investment (ROI) of up to \$2.20 by preventing work stoppages and legal liabilities (Sudiarno & Putri Maharani, 2024). Furthermore, integrated safety budgeting has been shown to improve overall project performance by reducing the frequency of unplanned safety-related disruptions (Weeks et al., 2025). Therefore, using JSA as a financial tool allows contractors to transition from "reactive spending" to "risk-based budgeting" (Dian & Faturohman, 2023).

The purpose of this study is to examine the implementation of Occupational Safety and Health (OSH) in "contractor X" in Bandung, evaluating the risks identified by the Job Safety Analysis (JSA) and assessing whether the current funding aligns with the standards prescribed by Permen PUPR No. 10/2021 (Kementrian PUPR, 2021). This study significantly contributes to the scientific discipline of construction management by formulating a scalable and risk-based budgeting model, adapted to small-scale residential projects. This research quantifies the so-called "safety gap" in monetary terms, providing a policy justification for the inclusion of mandatory Occupational Safety and Health (OSH) items in small-scale bidding processes. In this way, safety is established as a non-negotiable fixed cost rather than a variable general expense (Ria Novasari Mei Astuti & Doni Hikmat Ramdhan, 2024) (Hana Fajrianti & Mila Tejamaya, 2024).

2. METHODOLOGY

A research flow diagram has been developed for the planning of OHS financing investigations. It delineates the procedure from the commencement of study to its conclusion, as depicted in Figure 1.

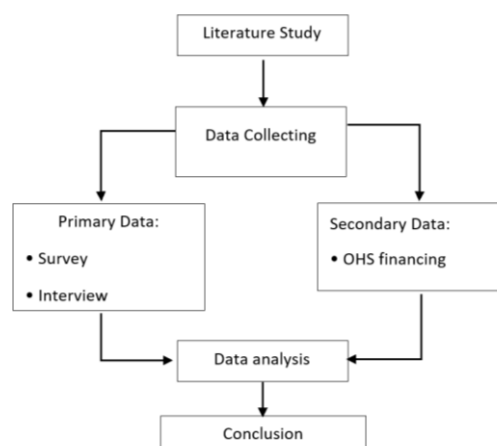


Figure 1. Research Flow Chart

The reviewed contractor X project is located at Bandung City, West Java (Figure 2).

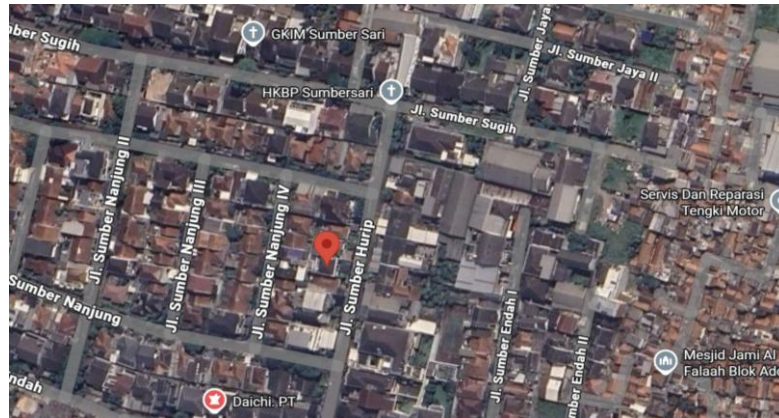


Figure 2. Project Location

This study utilizes a descriptive-quantitative methodology to assess the correlation between safety risks and financial distribution in small-scale construction. The research progresses systematically from qualitative identification to quantitative analysis, encompassing four separate phases:

1. Preliminary data gathering,
2. Quantitative risk assessment,
3. Financial gap analysis, and
4. Regulatory benchmarking.

2.1. Data Acquisition and Tools

Primary data was collected via semi-structured interviews with the project owner of "Contractor X" and direct site audits at the residential project in Bandung. The audit instrument was organized into nine categories in accordance with the technical directives of Ministry PUPR No. 11/SE/M/2019 (Kementrian PUPR, 2019), with specific emphasis on: activities for socialization and promotion of safety. The acquisition of Personal Protective Equipment (PPE) and Collective Protective Equipment (CPE) was also incorporated. Staff proficiency, healthcare institutions, and accident mitigation infrastructure. Secondary data, comprising the project's Bill of Quantities (BoQ) and technical specifications, were employed to compare current expenditures with market price indices for OSH equipment in Bandung City (2025/2026 price standards).

2.2. Quantitative Risk Assessment (Job Safety Analysis-Based)

With the aim of quantifying the level of risk, each measure listed in the Job Safety Analysis (JSA) was evaluated using a 5×5 Risk Matrix. This methodology determines the Risk Score (RS) by multiplying the Probability and Severity (Hacibektasoglu et al., 2021):

$$RS = P \times S \quad (1)$$

where:

Probability (P) : Evaluated on a scale ranging from 1 (Rare) to 5 (Almost Certain).

Severity (S) : Evaluated using a scale ranging from 1 (Insignificant/First Aid) to 5 (Catastrophic/Fatality).

The resulting findings are classified as follows:

Low (1–4): Tolerable risk that requires the implementation of standard administrative procedures.

Medium (5–12): Moderate risk, requires concrete mitigation and allocated budgetary resources.

High (15–25): Critical risk that requires the implementation of mandatory engineering controls (APK) and priority investment.

2.3. Financial Analysis: The Cost-to-Risk Ratio (CRR)

The essence of this methodology is the use of the Cost-to-Risk Ratio (CRR) (Jiménez Carabalí & Afonso, 2023). This statistic assesses the contractor's investment relative to the inherent risk of a certain work phase.

$$CRR = \frac{\text{Allocated Budget for Phase n}}{\text{Risk Score (RS) for Phase n}} \quad (2)$$

An excessive capital reserve ratio (CRR) during high-risk stages (such as roofing or demolition) acts as the primary indicator of an "under-budgeted risk," highlighting areas where the project is more susceptible to setbacks due to financial constraints.

2.4. Regulatory Benchmarking and Proportionality

The final evaluation quantifies the costs incurred by Contractor X in relation to the mandatory components of the Construction Safety Management System (CSMS), as specified in Article 40 of Permen PUPR No. 10/2021 (Kementrian PUPR, 2021). The study determines the Actual Safety Proportion (P_a) with respect to the total value of the project (Akawi & Musonda, 2021):

$$P_a = \left(\frac{\sum \text{OSH Costs}}{\text{Total Project Value}} \right) \times 100\% \quad (3)$$

The findings diverge from the officially advised range of 1.0% to 2.5%. This enables the research to pinpoint a "safety gap": the quantifiable difference between current expenditures and the minimal investment necessary for regulatory compliance and risk mitigation.

3. RESULTS

3.1. Quantitative Risk Profile (JSA Analysis)

From every work process carried out on a construction project, some hazards must be controlled so that the risk of these hazards does not occur to workers carrying out construction

activities or to the environment around the project. Every potential hazard in this project work is contained in the Job Safety Analysis (JSA) form, which can be seen in Table 1.

Table 1. Job Safety Analysis

No	Step Activity	Potential Accident/Hazard	Current Control
1	Demolition of existing house	Injuries to feet caused by demolition or construction materials. Slipping due to uneven surfaces. Workers struck by debris falling from higher areas during demolition. Workers injured by excavators. Loss of control of excavators. Excavators colliding with neighboring buildings.	Always wear safety shoes when entering the project area. Always use safety helmets while in the project area. Access is restricted around the excavator work zone. Only trained personnel are permitted to operate the excavator. Supervision and guidance will be provided during excavator operations. Trained people must carry out excavator operations. There is supervision and guidance in operating the excavator.
2	Creation of the Board of Directors	Injured hands due to wood splinters. Falls due to weak wood.	Use gloves when making a board. Check the dimensions of the wood and make sure it is strong.
3	Excavation of sloof line	The excavator lost control. Worker hit by excavator. The excavator hit the neighboring building. The excavator entered a hole.	There are restrictions on the area around the excavator work area. Trained people must carry out excavator operations. There is supervision and guidance in operating the excavator. The path for the excavator to run is determined in advance before starting work.
4	Foundation excavation	Falling into a hole. Wounds on the hand due to being scratched by a digging tool. Fainting due to prolonged exposure to sunlight.	Use of safety shoes when entering the project area. Checking the footing that will be used as support, it must be ensured to be strong. Use gloves when doing activities that involve hands. Use of safety helmets to minimize direct sunlight on the head.
5	Reinforcement of foundation and sloof	Wounds on the hand due to being scratched by reinforcing iron. Being trapped when bending iron. Being stabbed by a wire on the leg. Being crushed by reinforcing iron when being moved.	Wear gloves when doing work. Create a special area for assembling reinforcement. Disposal of unused waste materials. This work is carried out by experts who are accustomed to doing reinforcement. Wear safety shoes to protect feet from sharp objects. Conduct a safety briefing before work begins.

Table 2. Job Safety Analysis (continued)

No	Step Activity	Potential Accident/Hazard	Current Control
6	Casting of foundation and sloof	Skin irritation due to the cement mixture. Workers fall during casting.	Use of safety shoes when performing casting activities. Use of gloves when performing casting activities. Limit the areas where casting is being carried out.
7	Work floor casting	Skin irritation due to the cement mixture. Workers fall during casting.	Use of safety shoes when performing casting activities. Use of gloves when performing casting activities. Limit the areas where casting is being carried out.
8	Column formwork installation	Workers fall from a height due to weak support. Hands hit by a hammer when hammering nails. Hands scratched by building materials.	Ensure that the support used when installing the formwork is strong. Use gloves, avoid direct friction on the skin. Communication between workers must be good. Hammer nails carefully.
9	Column casting	Skin irritation due to the cement mixture. Workers fall during casting.	Use gloves when carrying out casting activities. Limit the areas where casting is being carried out. Check the strength of the formwork first.
10	Beam reinforcement and beam formwork installation	Wounds on the hand due to being scratched by reinforcing iron. Being trapped when bending iron. Being stabbed by a wire on the leg. Being hit by reinforcement when being moved. Hand hit by hammer when hitting nails. Hand scratched by building materials.	Wear gloves when doing work. Create a special area for assembling reinforcement. Disposal of unused waste materials. This work is carried out by experts who are accustomed to doing reinforcement. Wear safety shoes to protect feet from sharp objects. Conduct a safety briefing before work begins. Communication between workers must be good. Hammer nails carefully.
11	Beam casting	Skin irritation due to the cement mixture. Workers fall during casting.	Use of safety shoes when carrying out casting activities. Use gloves when carrying out casting activities. Limit the areas where casting is being carried out.
12	Installation of bond deck and wire mesh plate	Stuck on wire mesh plate. Feet injured by wire mesh scratches.	Wear safety shoes when doing work.

Table 3. Job Safety Analysis (continued)

No	Step Activity	Potential Accident/Hazard	Current Control
13	Plate casting	Skin irritation due to the cement mixture. Workers fall during casting.	Use of safety shoes when performing casting activities. Use of gloves when performing casting activities. Limiting the areas where casting is being carried out.
14	Wall installation	Skin irritation due to the cement mixture. Falling from a height. Hit by a brick.	Use gloves when doing work. Use work aids such as ladders or ensure that the footrest is strong and safe.

The Job Safety Analysis (JSA) conducted for Project "X" identified 14 primary work steps. While the contractor's initial perception was "low-risk," the application of the quantitative risk formula ($RS = P \times S$) identifies several phases as Medium Risk (RS 9–12). As shown in Table 2, these activities involve work at heights and mechanical demolition, which necessitate structural Collective Protective Equipment (CPE) rather than just Personal Protective Equipment (PPE).

Table 2. Quantitative Risk Assessment of Project "X"

No	Work Activity	Potential Accident/Hazard	P	S	R	Risk Level
1	Demolition of existing house	Struck by falling debris	3	4	12	Medium
3	Excavation of sloof line	Excavator collision/collapse	2	4	8	Medium
8	Column formwork installation	Fall from height	3	4	12	Medium
14	Wall installation	Falling from ladders/scaffold	4	3	12	Medium

3.2. Financial Performance and the Cost-to-Risk Ratio (CRR)

Field observations indicate that OSH implementation on this residential project was suboptimal. For instance, safety helmets were not utilized despite being mandatory. Additional equipment, including safety shoes, was utilized inconsistently—workers often reverted to sandals after finishing cement mixing activities. Despite "Contractor X" supplying BPJS Employment insurance and basic first aid kits, it entirely omitted safety signs, fire extinguishers, and safety nets. Current expenditures in OSH are illustrated in Table 3.

Table 3. OSH Financing on Projects

No	Item Name	Quantity	Unit	Price (IDR)	Total (IDR)
1	Gloves	20	Pair	30,000.00	600,000.00
2	Safety shoes	16	Pair	100,000.00	1,600,000.00
3	First aid kit	1	Ls	1,000,000.00	1,000,000.00
Total					IDR 3,200,000.00

The study reveals a significant inequality in investments in safety. By applying the Cost-Risk Ratio (CRR), we can map the "Safety Gap." A high RS combined with a low CRR indicates a high-risk phase that is severely underfunded as shown in Table 4.

Table 4. Correlation of Risk Score to Actual Safety Investment

No	Work Phase	RS	Actual OSH Budget (IDR)	CRR	Funding Status
1	Demolition	12	100,000*	8,333	Underfunded
8	Formwork	12	0	0	Unfunded Gap
14	Wall work	12	0	0	Unfunded Gap
5	Reinforcement	9	350,000	38,889	Adequate
6	Casting	6	350,000	58,333	Sufficient

**Note: Costs are allocated proportionately according to the duration and equipment lifespan within the designated phase.*

3.3. Project Proportions and Recommended Adjustments

Based on the Job Safety Analysis (JSA) conducted in the previous section, it is evident that the current OSH funding for Project "X" is inadequate to cover high-risk activities. Although the current expenditures focus on basic PPE as in Table 5, it fails to address collective risks.

Table 5. Existing OSH Financing

No	Item Name	Quantity	Unit	Price (IDR)	Total (IDR)
1	Gloves	20	Pair	30,000.00	600,000.00
2	Safety shoes	16	Pair	100,000.00	1,600,000.00
3	First aid kit	1	Ls	1,000,000.00	1,000,000.00
Total					IDR 3,200,000.00

The data in Table 5 indicate a focus on affordable Personal Protective Equipment (PPE). Since the risk value (RS) for formwork and wall assembly is 12, the cost-risk ratio (CRR) for these phases remains zero. To close this "safety gap" and comply with Permen PUPR No. 10/2021 (Kementrian PUPR, 2021), an additional allocation for Collective Protective Equipment (CPE) as well as special protective equipment is required, as detailed in Table 6.

Table 6. Additional OSH Financing

No	Item Name	Quantity	Unit	Price (IDR)	Total (IDR)
1	Body harness	4	Unit	400,000.00	1,600,000.00
2	Fire extinguisher	1	Unit	300,000.00	300,000.00
3	Safety net	1	Ls	1,000,000.00	1,000,000.00
4	Warning signs	3	Unit	100,000.00	300,000.00
5	Protective helmet	16	Unit	50,000.00	800,000.00
6	Safety vest	16	Unit	30,000.00	480,000.00
Total					IDR 4,480,000.00

The integration of additional equipment from Table 6 – particularly safety harnesses, safety nets, and fire extinguishers – transforms the project's status from "critically underfunded"

to " regulatory compliant." This adjustment increases the total investments in OSH by IDR 4,480,000.00 and ensures that an adequate financial risk mitigation strategy is implemented for each identified phase with medium to high risk.

The current total expenditures for OSH under Project "X" amount to IDR 3,200,000.00. Based on a benchmark for residential construction projects amounting to IDR 500 million, the actual safety share (P_a) is only 0.64%, which is below the standard of Permen PUPR No. 10/2021 (Kementrian PUPR, 2021) of 1.0%–2.5%. To close the "safety gap," an additional investment of IDR 4,480,000.00 as in Table 7 is necessary to acquire mandatory Collective Protective Equipment (CPE) such as safety nets, harnesses, and warning signs.

Table 7. Quantitative Risk Assessment of Project “X”

Metric	Current Expenditure	Recommended (PUPR 10/2021)	Variance (The Gap)
Total OSH Cost	IDR 3,200,000.00	IDR 7,680,000.00	(+) IDR 4,480,000.00
Project Proportion	0.64%	1.53%	(+) 0.89%

3.4. Field Implementation Observation

Seeing the risks in the project makes the implementation of OSH important in the project environment. By implementing a sound safety system, the existing risks can be prevented. Although this project includes several personal protective equipment and first aid for accidents, it can still be said to be incomplete and cannot overcome all existing risks. Several incidents that occurred in the project can be seen in Figures 3 to 5.

Figure 3 shows a worker doing a construction job but not wearing safety shoes, safety vests, and safety helmets. Of course, there will be risks that may occur to the worker.



Figure 3. OSH Evaluation_1

In Figure 4, several workers are in a higher position without using personal protective equipment. This will be dangerous when the worker falls. It would be better if the worker uses personal protective equipment such as a helmet, safety shoes, a vest, and even a body harness to hold the body when falling.



Figure 4. OSH Evaluation_2

In Figure 5, there is a condition that on the 2nd floor, there is no cover or net that can hold goods or building materials that will fall. This is quite dangerous for people or vehicles passing on the road (Jalan Sumber Nanjung), which is located next to the project.



Figure 5. OSH Evaluation_3

Although the implementation of OSH has been carried out on this project, it would be better if all the equipment and the implementation of OSH were fully fulfilled so that the risk of danger and the impact became smaller. Some equipment that can be added includes body harnesses, light fire extinguishers, safety nets, warning signs, protective helmets, and safety vests.

Field evidence (Figures 3–5) confirms the quantitative findings. The zero-budget allocation for high-risk work at heights resulted in the total absence of safety nets and fall arrest systems on the second floor. It was found that workers wore simple gloves (low-cost PPE) but did not have helmets and vests (visible PPE). This implies that the current budget only considers the "most visible" and "most cost-effective" items, but not the "most risk-critical" ones.

4. DISCUSSION

4.1. The “Unfunded Risk” and Safety Production Conflict

The data show a systematic failure of risk-based budgeting, characterized by a cost-risk ratio (CRR) close to zero in critical work phases. For activities with a medium Risk Score (RS = 12), such as formwork and wall assembly, a CRR of 0 was found, which implies that no financial risk reduction is occurring for significant hazards. This phenomenon is a classic manifestation of the "Safety-Production Conflict" (Feng, 2013) (Ghodrati et al., 2022), where small-scale contractors prioritize immediate production costs and profit margins over safety investments that do not offer immediate physical progress. As Yusof & Misnan (2019) found, small construction firms often prioritize "visible" safety measures, such as gloves, over "structural" safety (PPE), as the latter incurs higher upfront costs without accelerating project completion.

4.2. PPE vs. CPE Investment Imbalance and Regulatory Compliance

A notable observation lies in the marked disparity between Personal Protective Equipment (PPE) and Collective Protective Equipment (CPE). In accordance with Permen PUPR No. 10/2021 (Kementrian PUPR, 2021), safety costs must include both categories. However, in project "X," the investment is almost exclusively focused on low-cost PPE (gloves and shoes). The complete absence of personal protective equipment, particularly safety nets and warning signs, constitutes a violation of Article 40, Paragraph 4, of the regulation. This results in a "false sense of security" (Anindya Monika Putri et al., 2025); although gloves protect workers from minor skin irritations, they remain exposed to fatal falls, which are the leading cause of death on construction sites in Indonesia, due to the lack of fall protection systems.

4.3. Economic Implication and the ROI of Safety

The assessment of the "Safety Gap" has far-reaching economic consequences. From a theoretical perspective, a CRR of 0 during high-risk periods implies that there is no financial buffer for each unit of risk. According to the theory of "ROI of Safety" (Abrahamsen et al., 2021), this budgeting strategy proves to be extremely inefficient. Although "Contractor X" saved approximately 4.48 million Indonesian Rupiah by forgoing PPE, the cost of a single accident during the wall installation phase would likely exceed the entire profit margin of the project. The

shift of a share from 0.64% to 1.53% in the OSH budget not only represents an increase in expenses but also a crucial strategy for risk transfer and loss prevention.

4.4. Practical and Theoretical Implications

Theoretically, this study supports the correlation between risk and costs: safety budgets should not be considered fixed overhead costs, but rather as a variable regulated by the JSA risk score. The study practically emphasizes the vulnerability of small projects in densely populated urban areas like Bandung. The absence of safety nets (see Figure 5) poses a liability risk to pedestrians on Jalan Sumber Nanjung. The remedying of the safety gap thru the implementation of "Additional Funding" (Table 6) ensures that the contractor meets the minimum duty of care required by national law.

4.5. Main Contribution to Construction Management

The primary contribution of this study to the science of construction economics lies in the empirical confirmation of the "risk-budget correlation" in the context of small-scale construction – an area traditionally characterized by informal management and opaque financial reporting. Although the existing literature often considers OSH costs as a fixed percentage of the total contract costs, this study shows that such a "one-size-fits-all" approach does not help reduce high-risk potential hazards. This study presents an innovative indicator for assessing the effectiveness of safety investments thru the implementation of the Cost-to-Risk Ratio (CRR), enabling executives to mathematically identify "unfunded risk gaps."

From a political perspective, this study serves as an essential guide for local authorities in Indonesia to address the enforcement deficiencies of Permen PUPR No. 10/2021 (Kementrian PUPR, 2021). This demonstrates that compliance with occupational safety regulations for small residential construction projects does not impose an unreasonable financial burden, but merely requires a moderate budget adjustment of 0.89% (from 0.64% to 1.53%). These findings provide a scalable justification for local authorities to mandate a mandatory item for health and safety in the Bill of Quantities (BoQ) during the building permit process. This study transforms occupational safety from an optional "safety expense" into a non-negotiable financial derivative of risk and provides a theoretical framework to reduce the high mortality rates prevalent in urban residential construction projects.

5. CONCLUSION

This study evaluated the funding and implementation of "Project X" in the field of Occupational Safety and Health (OSH) in the city of Bandung and revealed a significant discrepancy between perceived risk and financial risk reduction. The results of the investigation lead to the following conclusions:

- a. The Job Safety Analysis (JSA) identified four critical work phases: demolition, excavation, formwork, and wall installation – with an average Risk Score (RS = 12). Despite these hazards, the cost-risk ratio (CRR) for working at heights was reported as 0, indicating that the deadliest risks remained completely unfunded in the contractor's original budget.
- b. According to Regulation No. 10/2021 of the Ministry of Public Works and Housing, Project "X" achieved only a compliance rate of 33%, with only three of the nine mandatory safety components being met. The main deficiency lies in the complete absence of Collective Protective Equipment (CPE), such as safety nets and warning signs, which are essential for the protection of workers and the public environment on Jalan Sumber Nanjung.
- c. The current expenditures for OSH amounting to IDR 3,200,000.00 (0.64% of the project value) are insufficient for high-risk housing construction. To address the identified "safety gap," an additional investment of IDR 4,480,000.00 is necessary. This modification increases the safety share to 1.53%, a figure that complies with national standards and provides a scientifically supported "Budgeting-by-Hazard" model for small entrepreneurs.

It is recommended that "Contractor X" promptly acquire the identified personal protective equipment items to reduce third-party liability and potential costs in the event of fatalities. For policymakers, this investigation implies that small construction projects should require a mandatory position for Occupational Safety and Health (OSH) in the Bill of Quantities (BoQ), based on a standardized Job Safety Analysis (JSA) risk profile instead of a flat overhead percentage.

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