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Enhancing Safety Culture Among Subcontractors to Improve Safety Performance in the Indonesian Construction Industry

Willy Resnick Siregar[1], Rossy Armyn Machfudiyanto[1*], Bimo Prasetyo[2], Akhmad Suraji[3]

[1] Department of Civil and Environmental Engineering, Faculty of Engineering, Universitas Indonesia, Depok 16424, Indonesia
[2] Citra Marga Lintas West Java Limited Liability Company, Bandung Regency, West Java 40911, Indonesia
[3] Department of Civil Engineering, University of Andalas, Padang 251263, Indonesia

Corresponding Author Email: rossyarmyn@eng.ui.ac.id

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ABSTRACT

The construction industry is one of the largest sectors in Indonesia, playing a pivotal role in the country's economic growth. However, it faces significant challenges related to high occupational risks, as demonstrated by the persistently high rate of construction accidents. This ongoing issue reflects the low maturity of safety culture within construction companies, including subcontractors. Insufficient attention to safety culture is a major contributing factor to these accidents, highlighting the need for comprehensive solutions to create safer and more productive work environments. In response to this challenge, this study seeks to validate and analyze the factors influencing construction safety culture among subcontractors to improve safety performance. The validation process employed the Delphi Method, involving construction experts to reach a consensus on key factors. The study successfully identified 27 factors that significantly contribute to the development of construction safety culture. These findings provide a critical foundation for developing strategies to enhance safety culture, particularly in Indonesia. Furthermore, the identified factors cover various aspects, such as managerial roles, worker characteristics, work methods, and safety management, all of which play a crucial role in shaping safety culture on construction sites. The implications of this study are significant for improving subcontractor safety performance. By understanding these factors, construction management can implement more effective strategies to reduce occupational accident risks, enhance compliance with safety standards, and foster safer and more sustainable work environments. The results of this study are expected to serve as a valuable reference for improving subcontractor's construction safety performance in Indonesia.

1. INTRODUCTION

The construction industry in Indonesia plays a significant role in contributing over 10% to the GDP and maintaining a stable growth of around 5% per year [1]. However, despite its size, the construction industry in Indonesia faces safety challenges, with 11 incidents in 2019, 9 incidents in 2020, 8 incidents in 2021, and 4 incidents in 2022 [2]. It's important to address these safety concerns to ensure the well-being of workers and the sustainability of the industry.

The high number of construction accidents in Indonesia indicates that there is still room for improvement in the safety culture within construction companies in the country, as they are currently at a reactive level [3]. The most significant impact of construction accidents is the loss of human lives [4] and the demotivation of workers, leading to decreased morale [5]. This can result in conflicts with workers, causing strikes due to issues such as safety and compensation, ultimately leading to reduced productivity [6], as well as delays and cost overruns due to litigation, conflicts, and compensation for accidents [7].

The causes of construction accidents can be attributed to several factors such as project characteristics, including project nature, construction methods, boundary locations, project duration, design complexity, construction level, and subcontractor usage [8].

Subcontractors play a significant role in construction accidents, as they handle around 70% to 90% of the work on construction projects [2]. However, despite the significant workload assigned to subcontractors, work accidents often occur in the tasks they handle [9, 10]. This is influenced by several factors, including the weak safety culture and lack of serious consideration for safety among subcontractors [9, 11].

Promoting a strong safety culture among subcontractors is crucial for enhancing overall project performance. This can be effectively assessed through various safety performance metrics, which include tracking accidents and incidents. To evaluate safety performance in construction, we can utilize both leading and lagging indicators [12]. Leading indicators are proactive and preventive practices that include risk assessment, thorough planning, routine inspections, and regular audits, which help identify potential risks before they

develop into issues [13-15]. On the other hand, lagging indicators provide valuable historical insights by analyzing recorded safety data and accident occurrences, including accident reports and incident frequency rates [13-15]. By focusing on both types of indicators, we can create a comprehensive approach to improve safety and reduce incidents on construction sites.

2. METHOD

2.1 Research strategy

The research approach employed a combination of methods, including experiments, surveys, document analysis, literature reviews, historical analysis, and case study discussions [16]. This multifaceted approach provided a systematic framework for data collection and analysis [17]. Furthermore, a review of previous studies was conducted to identify factors influencing the safety culture among subcontractors.

Table 1. Research strategy

Research Question	Question Type	Research Strategy
What variables and indicators are essential for developing a subcontractor safety culture in Indonesia?	What	Archive analysis, surveys, and expert validation using the Delphi method)

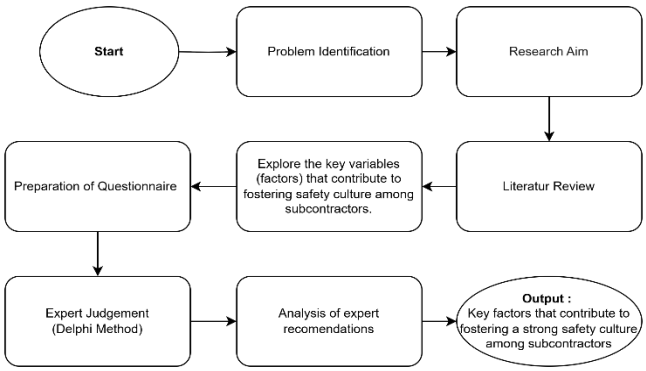

Figure 1. Research design

Table 1 and Figure 1 outline a clear strategy for addressing the research question through the Delphi method, incorporating factors identified during the literature review process. Experts participated by completing a questionnaire designed to assess the relevance of these factors in promoting a strong construction safety culture. Their input was crucial, as they were also encouraged to suggest any necessary adjustments to improve the accuracy and effectiveness of the identified factors.

2.2 Delphi method

The Delphi method is a structured communication technique initially developed as a systematic and interactive forecasting method relying on a panel of experts [18]. Additionally, Delphi can be utilized to facilitate the consensus of experts and to develop professional guidelines [19]. The two-round Delphi technique was employed to validate and discuss the essential strategies for enhancing Safety Culture Development among construction subcontractors, aiming to elevate safety performance in Indonesia. The proposed evaluation model consisted of five validation levels and included 27 questions. Panellists were informed of the preliminary results to facilitate further discussion and refinement, then considering individual participants' comments and summarizing their responses increased the number of formal questions to evaluate the model, and decreased the number of rounds required to reach a consensus [20].

2.3 Expert criteria

The resource team includes at least five qualified experts, each with a bachelor's degree and a minimum of 15 years of professional experience in the construction industry, ensuring a high level of expertise and professionalism [21].

3. RESULT AND DISCUSSION

3.1 Propose factors influencing safety culture among subcontractors

Upon reviewing previous studies, it has been identified that several factors have the potential to influence safety culture among subcontractors positively.

3.1.1 Leadership

Leadership and a strong commitment to safety are vital for cultivating an organization's safe and healthy work culture [10]. In the construction industry, the safety culture is largely influenced by management's dedication to promoting and prioritizing worker safety [22]. Effective two-way communication is essential, ensuring that safety-related information is conveyed from top management to frontline workers to enhance safety performance [23].

Moreover, management must lead by example in promoting safe behavior, as this sets the tone for a strong safety culture [24]. Conversely, if management demonstrates unsafe practices, it may encourage employees to neglect safety measures on the construction site [25].

3.1.2 Competence

Competence is crucial in the construction work environment, closely related to safety. It is defined as the "success" of performing certain tasks or activities or having "adequate" knowledge in a specific field or skill [26]. This includes recognizing and addressing risks and hazards, which can significantly contribute to a safer work environment [27]. Subcontractor experience plays a significant role in assessing and responding to accidents and unsafe working conditions, impacting how people assess and deal with accident situations. Additionally, experience affects perceptions of work safety status, both safe and unsafe [28]. Subcontractors with a good understanding of safety practices will have a strong awareness of the importance of safety in the work environment. Effective education and training enable subcontractors to understand potential risks, identify necessary preventive measures, and adopt safe behaviors [29]. Subcontractors need to comply with the general minimum requirements for safety and health programs established by the main contractor [30].

3.1.3 Construction method

Effective work methods in construction go beyond just efficient techniques; they actively prioritize safety. Subcontractors who embrace safe work practices that meet industry safety standards play a crucial role in cultivating a strong safety culture at project sites. While new technologies are developed to improve both efficiency and safety, their successful integration into construction environments often requires thoughtful adaptations, which can minimize potential accident risks [31].

Furthermore, careful planning of industrial layouts is essential to prevent injuries to construction personnel and the public, as well as to avoid damage to property and the environment [32]. To that end, subcontractors engaged in construction projects have a valuable opportunity to enhance safety conditions at their work sites. This can be achieved through proactive measures such as the elimination, reduction, and control of identified risks. Adopting such an approach not only strengthens safety performance but also fosters a culture of continuous improvement within construction projects [33].

3.1.4 Safety management

The implementation of safety management often falls short of the standards outlined on paper. While employees understand the importance of safety and management shows commitment, safety can sometimes be overlooked when other project goals take precedence [34]. Therefore, subcontractors need to develop a comprehensive safety program that encompasses risk identification and appropriate corrective measures to ensure the smooth progression of the project and the well-being of all involved parties [35]. When designing the program, it is crucial to consider cost implications to avoid compromising safety budgets, which could elevate the risk of workplace injuries [36]. Conducting regular inspections is also vital to identify hazards and prevent accidents, thereby ensuring that the safety program is effectively implemented [37].

3.2 Definition of the factors

This section presents a thorough exploration of the key factors that contribute to cultivating a strong safety culture among subcontractors in the construction industry.

3.3 Expert judgement

Table 2 provides a comprehensive overview of the factors identified through the literature review process, consisting of 6 key factors, each accompanied by various indicators that further clarify their explanation and description. To ensure their validity, these factors were reviewed by a panel of experts, all of whom were well-qualified to assess them. A summary of their insights is presented in Table 3.

Table 2. Factor exploration (X)

Research Variable	Sub-Variable	Indicator	Indicator Explanation
Leadership (X.1)	Top Management Commitment (X.1.1)	Management's Concern for External and Internal Issues (X.1.1.1)	Management's focus on safety for both external (society) and internal (workers, environment) concerns [38]
		SMKK Organizational Management (X.1.1.2)	Presence of an Occupational Health and Safety Management System (SMKK) for subcontractors [38]
	Effective Two-Way Communication (X.1.2)	Communication Between Contractor and Subcontractor (X.1.2.1)	Quality and sustainability of safety communication between contractor and subcontractor [39, 40]
		Communication Between Subcontractors and Workers (X.1.2.2)	Communication between subcontractors and workers on safety [41]
		Communication Among Involved Subcontractors (X.1.2.3)	Collaboration and communication among subcontractors on safety [39, 42]
	Safety Role Model (X.1.3)	Commitment of Leaders/Managers/Supervisors (X.1.3.1)	Leaders' adherence to safety protocols, setting an example [42, 43]
		Reward and Punishment (X.1.3.2)	Use of incentives (rewards and penalties) to influence safety behavior [44, 45]
Competence (X.2)	Experience (X.2.1)	Subcontractor Reputation (X.2.1.1)	A strong safety reputation enhances a safety culture [46]
		Completeness of Safety-Related Data History (X.2.1.2)	Comprehensive safety data helps identify and mitigate risks [46-49]
	Education and Training (X.2.2)	Skills and Quality of Human Resources (X.2.2.1)	Skilled human resources ensure a safe work environment [50-52]
		Work Plan (X.2.2.2)	Development of work plans that include safety measures [38]
	Subcontractor Safety Qualifications (X.2.3)	Safety Compliance (X.2.3.1)	Adherence to safety rules and SOPs [53-55]
		Compliance with Construction Safety Standards and Regulations (X.2.3.2)	Compliance with safety standards and regulations [53-55]
Construction Method (X.3)	Technology (X.3.1)	Equipment (X.3.1.1)	Availability and quality of safety-compliant tools and equipment [56, 57]
		Resource Limitation (X.3.1.2)	Identification of resource barriers affecting safety [56-58]
	Risk Assessment (X.3.2)	Hazard Risk Assessment (X.3.2.1)	Comprehensive hazard risk assessment [38, 59]
		Technical Action Plan (X.3.2.2)	Action plans to reduce safety risks [38]
	Work Environment Planning (X.3.3)	Work Environment (X.3.3.1)	Consideration of environmental factors affecting safety [37, 50]
		Project Hazard Level Characteristics (X.3.3.2)	Evaluation of project-specific risks [13, 56, 59-61]
		Worker Health Conditions at the Work Site (X.3.3.3)	Ensuring health and safety conditions on-site [62, 63]

Safety Management (X.4)	Safety Program (X.4.1)	Policy and Safety Procedures (X.4.1.1)	Implementation of safety policies and procedures [38]
		Control of Construction Safety Operations (X.4.1.2)	Implementation of safety control measures [38]
		Emergency Preparedness and Response (X.4.1.3)	Readiness to handle emergencies [38]
	Cost (X.4.2)	SMKK Costs (X.4.2.1)	Budget allocation for safety programs [64-66]
		Cost of Accident Handling (X.4.2.2)	Management of accident-related costs [60, 65]
	Inspection and Audit (X.4.3)	Monitoring and Evaluation (X.4.3.1)	Regular safety monitoring and inspections [39]
		Internal Audit and Safety Management Performance Evaluation (X.4.3.3)	Improving safety programs based on audit data [44]
Leading (Y.1)	Construction Safety Planning (Y.1.1)		A strong safety culture enhances planning to prioritize well-being, with proactive pre-construction and short-term strategies to minimize risks [14, 38, 67]
	Participation (Y.1.2)		An improved safety culture fosters greater engagement and collaboration among stakeholders, supporting the development and continuous improvement of safety practices [14, 67]
Lagging (Y.2)	Accident Reporting (Y.2.1)		Strengthened safety culture reduces accident reports, with comprehensive reporting including analysis, conclusions, and follow-up actions [14, 38]
	Accident Frequency (Y.2.2)		A robust safety culture correlates with fewer accidents, creating a safer work environment [14, 38]
	Severity Rate (SR) (Y.2.3)		Strong safety commitment leads to lower severity rates, reducing lost workdays and serious injuries, including fatalities [14, 38]

Table 3. Experts personal background

Profile	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5
Name	RTH	HNF	HF	BM	LZ
Gender	Female	Female	Male	Male	Male
Profession /Institution	Academic	Academic	Head of IKN Acceleration	PT. Citra Marga Lintas Jabar	Member of Safety Committee in Public Work and Public Housing Ministry of Indonesia
Experience	>15 Years	>15 Years	>15 Years	>15 Years	>15 Years
Education	Doctor	Doctor	Doctor	Doctor	Master

Table 4. Experts' recommendation

Indicator	Explanation
Reward and Punishment (X.1.3.2)	To enhance the focus on construction safety, the designation of the "Reward and Punishment" indicator should be amended to "Reward and Achievement." This change will encourage a more positive perspective on safety practices within the industry
Completeness of Safety-Related Data History for Subcontractors (X.2.1.2)	The description for this indicator should be expanded to include an overview of subcontractor safety statistics and historical performance data
Work Plan (X.2.2.2)	The description for this indicator should explicitly reference the required HR qualifications to ensure that individuals responsible for planning and executing work plans possess the requisite expertise
Compliance with Construction Safety Standards and Regulations (X.2.3.2)	The description for this indicator should incorporate the skills, knowledge, and attitudes necessary for subcontractors to effectively meet applicable safety standards
SMKK Costs (X.4.2.1)	The description for this indicator should include a reference to the Ministry of Public Works and Housing Regulation No. 8 of 2023, ensuring full compliance with regulatory standards in Indonesia

The experts unanimously agree on the relevance of these factors in developing a construction safety culture to enhance the safety performance of subcontractors in Indonesia. Moreover, they propose the application of this approach in similar contexts. In Table 4, the experts' recommendations emphasize the need to make Leadership (X.1), Competence (X.2), and Safety Management (X.4) more specific by adding detailed descriptions [68].

4. CONCLUSIONS

In conclusion, this study represents a crucial foundational step toward developing a targeted construction safety culture among subcontractors in Indonesia. This initiative is particularly relevant in the context of the country's rapid construction development and the increasing demand for resources. The central research question addresses how improving the safety culture among subcontractors can enhance safety performance.

A thorough literature review identified several key factors, which were subsequently validated by experts using the Delphi Method in a qualitative context. These factors include leadership, competence, work methods, and safety management, all of which are instrumental in improving safety performance through both leading and lagging indicators.

Effective leadership is essential for guiding personnel to prioritize safety and efficiently work toward project objectives. Enhancing the competence of team members and workers is critical for aligning with organizational standards. The

methods used in work processes can significantly influence exposure to hazards. Additionally, robust safety management practices are vital for improving project safety, increasing employee awareness, and fostering a positive work culture.

The primary goal of this development is to improve project outcomes, with a particular focus on safety performance. Future research should focus on developing strategies to foster a strong safety culture among subcontractors, further elevating safety standards. Management is encouraged to adopt actionable strategies based on these factors, such as implementing scheduled training sessions to engage workers in safety, documenting violations to encourage positive behavior change, and utilizing technology to manage and monitor safety effectively on-site.

By implementing these initiatives, safety awareness can be significantly enhanced, driving continuous improvements in safety performance. Additionally, assessing the impact of these steps on the establishment of a strong safety culture will ensure ongoing progress and success in safety management.

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