Competence Over Cost: Reassessing the Determinants of Construction Safety Planning Quality

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ABSTRACT
The assumption that financial investment is directly proportional to the quality of construction safety planning is commonly used as a basis for project budgeting. However, the persistently high rate of occupational accidents indicates a gap between cost allocation and the effectiveness of risk mitigation in practice. This study aimed to evaluate the relationship between the allocation of Construction Safety Management System costs and the quality of Construction Safety Plan documents, as well as to identify cost efficiency across construction work packages. This study employed a descriptive-analytical approach using document-based data obtained from Construction Safety Plan documents across several construction work packages. Document quality was assessed using a scoring method and further analyzed using a cost-effectiveness analysis approach to evaluate efficiency. The findings indicate that low-cost work packages are capable of producing high-quality Construction Safety Plan documents, while high-cost packages tend to be inefficient and fail to meet substantive performance evaluation criteria. These results suggest that planning quality is more influenced by personnel competence than by budget size. In conclusion, budget size does not necessarily guarantee compliance with construction safety standards. Therefore, safety planning evaluation should prioritize technical substance and regulatory compliance to enhance the effectiveness of worker protection.
Keywords: cost effectiveness; construction safety plan; regulatory compliance; occupational safety

INTRODUCTION
The construction services industry plays a pivotal role in accelerating national infrastructure development and supporting broader economic growth. Yet, despite its strategic importance, the sector remains globally recognized as one of the most hazardous industries in terms of occupational safety. International evidence consistently demonstrates that construction work involves complex, dynamic, and high-risk environments characterized by heavy machinery, elevated workspaces, and diverse subcontracting structures. The International Labour Organization (ILO) reports that the construction sector contributes a disproportionately high share of global occupational fatalities, reflecting the persistent challenges in managing safety risks across varying project scales and contexts [1]. This global pattern resonates strongly with the situation in Indonesia, where the incidence of workplace accidents has continued to rise despite ongoing regulatory reforms and safety initiatives.

National data from the Ministry of Manpower reveal a significant increase in reported occupational accidents, rising from 370,747 cases in 2023 to 462,241 cases in 2024, an alarming 24.68% escalation within a single year [2]. Such a sharp increase suggests that regulatory compliance alone has not been sufficient to curb accident rates. Instead, it highlights deeper systemic issues, including inconsistent implementation of safety protocols, limited safety culture maturity, and gaps in contractor capacity, particularly among small and medium-scale construction firms. These challenges are further compounded by rapid infrastructure expansion, which places additional pressure on project timelines and resource allocation, often at the expense of safety considerations.

Beyond the human toll, occupational accidents impose substantial economic burdens on both project stakeholders and the national economy. Direct costs include medical treatment, compensation, and equipment damage, while indirect costs encompass productivity losses, project delays, reputational damage, and increased insurance premiums. Despite these far-reaching consequences, investments in safety management systems and preventive technologies are frequently perceived as cost-intensive obligations rather than strategic investments. This perception persists even though numerous studies have demonstrated that the financial losses resulting from accidents far exceed the costs of preventive measures [3]. Such misconceptions contribute to underinvestment in safety planning and hinder the development of robust safety management practices.

Recognizing these challenges, the Government of Indonesia introduced the Ministerial Regulation of Public Works and Housing No. 10/2021 concerning the Construction Safety Management System (*SMKK*). This regulation mandates the integration of safety planning into all stages of project procurement and execution, including the preparation of a Construction Safety Plan (*Rencana Keselamatan Konstruksi/RKK*) as a core requirement [4]. The RKK serves as a foundational document outlining hazard identification, risk mitigation strategies, safety resource allocation, and monitoring mechanisms. Its quality is therefore critical in shaping the effectiveness of safety implementation throughout the project lifecycle.

The introduction of SMKK requirements has direct implications for project budgeting, particularly regarding the allocation of safety-related costs within the Bill of Quantities. However, practical implementation reveals persistent discrepancies between budget allocations and the quality of RKK documents produced. In many cases, cost estimations for safety activities are inaccurate due to limited understanding of actual field needs, insufficient technical expertise, or reliance on generic templates that fail to reflect project-specific risks [5]. Furthermore, safety programs in some projects remain largely administrative, focusing on document completion rather than substantive implementation. When safety planning becomes a procedural formality rather than a strategic process, its impact on actual safety performance becomes minimal [6].

These conditions underscore a critical gap between administrative compliance and cost-effectiveness in the preparation of RKK documents. The mere allocation of funds does not guarantee the production of high-quality safety plans, and larger budgets do not necessarily translate into improved safety outcomes. This misalignment suggests potential inefficiencies in the use of safety budgets and raises concerns about the effectiveness of current regulatory enforcement mechanisms. While previous research has examined the influence of SMKK elements on construction safety performance, there remains a notable lack of studies specifically evaluating the cost efficiency of RKK preparation processes [7]. This gap limits the ability of policymakers and practitioners to assess whether safety investments are being utilized optimally and whether current regulatory requirements effectively drive improvements in safety planning quality.

Given these challenges, there is a pressing need for analytical approaches that can systematically evaluate the relationship between safety planning costs and the quality of resulting safety documents. Cost-effectiveness analysis offers a suitable framework for this purpose, as it enables the assessment of whether financial resources allocated to safety planning yield proportional improvements in document quality and, by extension, potential safety outcomes. Such an approach can provide valuable insights into budget efficiency, highlight areas of overspending or underinvestment, and inform evidence-based improvements in safety management practices. The explicit purpose of this study is to evaluate the

efficiency of financial allocations for the preparation of Construction Safety Plans by analyzing the cost-to-quality relationship using a cost-effectiveness analysis framework, thereby identifying whether current budgeting practices support the development of high-quality and regulation-compliant safety planning documents.

METHODS

This study employs an analytical quantitative approach [8-12] with a comparative evaluative study design to examine the relationship between safety investment and the quality of the resulting technical documents. This design is particularly suitable for assessing variations in efficiency across multiple construction work packages, as it enables systematic comparison of cost allocations and their corresponding outputs. The evaluative nature of the design allows the research to move beyond descriptive cost reporting by incorporating a structured assessment of how effectively financial resources are transformed into measurable improvements in document quality. In this context, the quality of the Construction Safety Plan is treated as a critical output variable, given its central role in risk mitigation and regulatory compliance within the Construction Safety Management System framework [4].

The analytical framework applied in this study is cost-effectiveness analysis (CEA), an established economic evaluation method widely used in public policy, health economics, and safety management research. CEA is designed to compare the ratio between the costs incurred and the outcomes achieved, thereby enabling the identification of interventions that deliver the greatest benefit per unit of expenditure [5]. In the context of construction safety, this method provides a structured mechanism for determining whether investments in safety planning, particularly those related to the preparation of RKK documents yield proportional improvements in document quality. By quantifying both cost inputs and quality outputs, CEA offers a more nuanced understanding of budget efficiency than traditional cost analysis alone.

The study was conducted on six construction work packages during February 2026. These packages were selected based on their completion of the tendering and SMKK evaluation processes, ensuring that all relevant documentation was available for analysis. The data used in this study are secondary in nature, obtained through document review of internal reports from a construction services company and contractual documents that had undergone formal procurement and safety management evaluation. The use of secondary data is appropriate for evaluative studies of this type, as it allows for objective assessment of cost and quality variables without influencing project implementation.

The research variables consist of two primary components: input variables and output variables. The input variable represents the total cost associated with preparing the SMKK implementation documents. This includes expenditures for occupational safety experts, administrative documentation processes, and coordination activities required during document preparation. These cost components reflect the financial resources invested in ensuring that the RKK meets regulatory and technical requirements. The output variable is the quality score of the RKK document, which is assessed by an authorized evaluation team using the official assessment instrument stipulated in the Ministerial Regulation of Public Works and Housing No. 10/2021. This scoring system evaluates multiple dimensions of safety planning, including hazard identification, risk control strategies, resource allocation, and monitoring mechanisms, thereby providing a comprehensive measure of document quality.

Data analysis was conducted in three major stages. The first stage involved standardizing cost data and document quality scores to ensure comparability across the six work packages. Standardization is essential because variations in project scale, complexity, and administrative processes may influence raw cost figures and quality scores. The second stage consisted of calculating the cost-effectiveness ratio (CER) for each work package using the following formula:

$$\text{CER} = \frac{\text{Ci}}{\text{Ei}}$$ (Ci represents the total cost of document preparation for the i-th work package, and Ei represents the corresponding RKK quality score)

The CER provides a quantitative indicator of how efficiently financial resources were converted into document quality. Lower CER values indicate higher cost-effectiveness, meaning that a given level of quality was achieved with relatively lower expenditure. The third stage involved comparative analysis to classify the work packages based on their cost-effectiveness levels. This classification enables the identification of packages that demonstrate efficient use of safety planning budgets as well as those that exhibit potential inefficiencies. Such comparative insights are valuable for informing future budgeting practices, improving safety planning processes, and supporting evidence-based decision-making within construction project management.

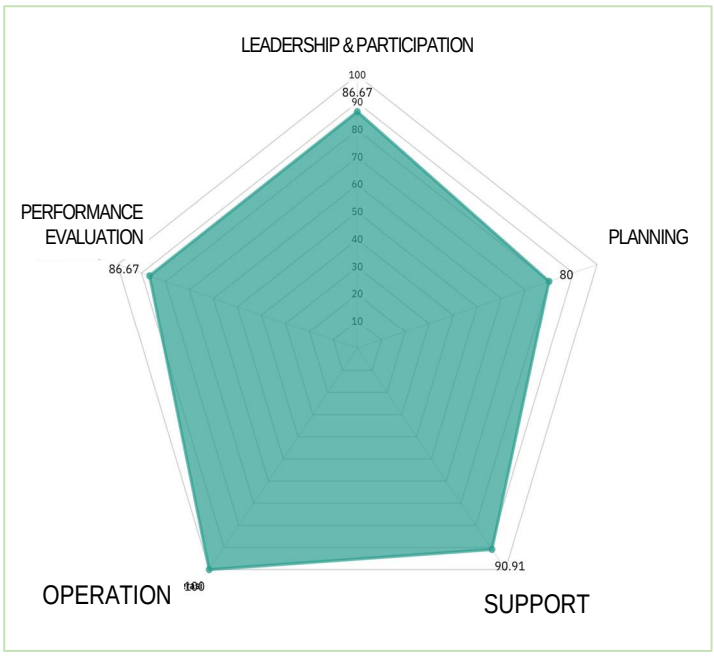
RESULTS

The research data were obtained from the evaluation results of technical proposal documents and contractual records across six construction work packages (Package A through Package F). The primary variables analyzed consist of the Cost of Preparing the Construction Safety Management System (SMKK) Implementation Documents as the input variable and the Assessment Score of the Construction Safety Plan (RKK) as the output variable. Table 1 reveals substantial variation in the allocation of SMKK implementation costs across the six work packages. The lowest expenditure is observed in Package D, amounting to IDR 2,200,000, whereas the highest cost is recorded in Package F at IDR 52,500,000. Despite this wide disparity in cost allocation, the differences in RKK quality scores do not increase proportionally with the level of expenditure. This indicates that higher investment does not necessarily guarantee superior document quality. Among the six packages, Package D demonstrates the lowest CER value at 26,203, signifying the most optimal cost-effectiveness in producing a high-quality RKK document. Conversely, Package F exhibits the highest CER value at 535,113, suggesting that the cost required to achieve one unit of document quality is significantly higher compared to the other packages. When examined comparatively, the cost per unit of quality in Package F is approximately twenty times greater than that of Package D, despite the difference in their quality scores being relatively modest. This discrepancy underscores the presence of substantial inefficiencies in certain packages, particularly those with disproportionately high expenditures.

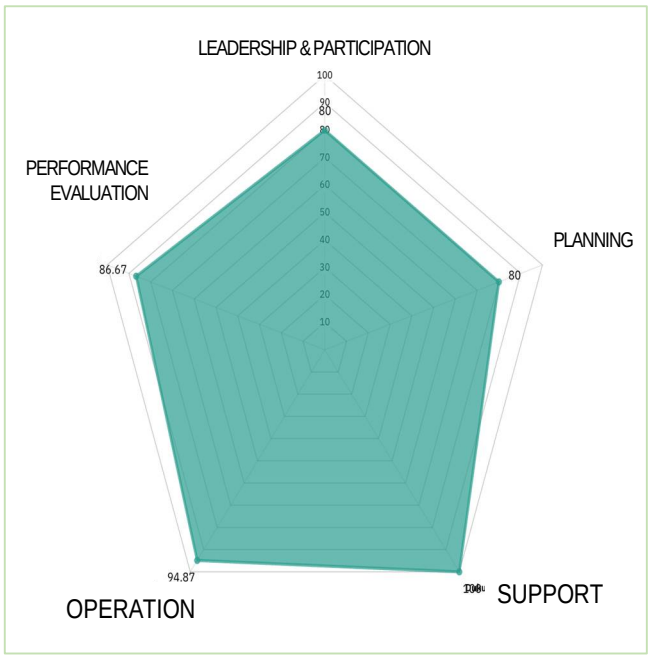
Table 1. Summary of SMKK implementation costs, RKK scores, and CER

Work package	SMKK implementation cost (IDR)	RKK assessment score (scale 100)	Cost-effectiveness ratio (CER)
Package A	5,000,000	91.51	54,639
Package B	15,000,000	90.57	165,618
Package C	7,500,000	82.08	91,374
Package D	2,200,000	83.96	26,203
Package E	15,000,000	83.96	178,656
Package F	52,500,000	98.11	535,113

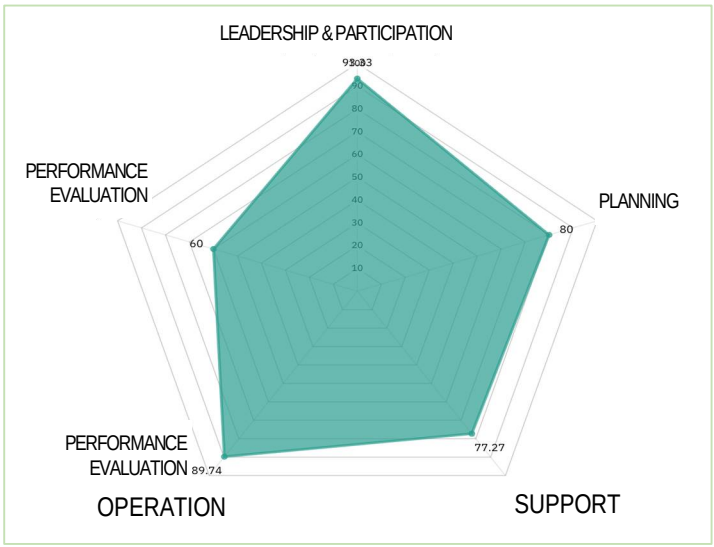
To further examine the composition of document quality, the analysis extends to the five core elements that contribute to the overall RKK score for each work package. The distribution of element-level performance is illustrated in Figures 1 through 6.



Package A



Package B



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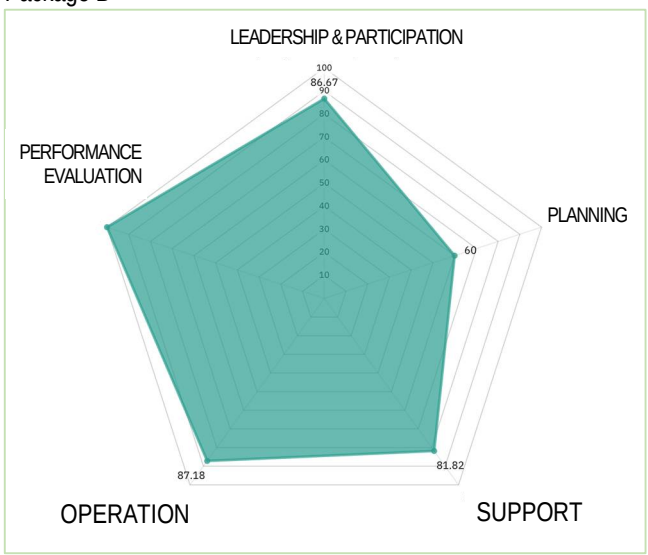
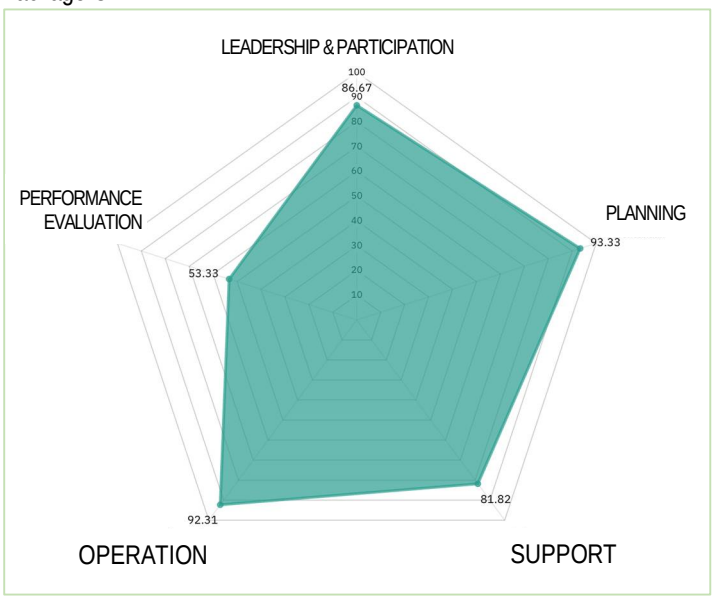
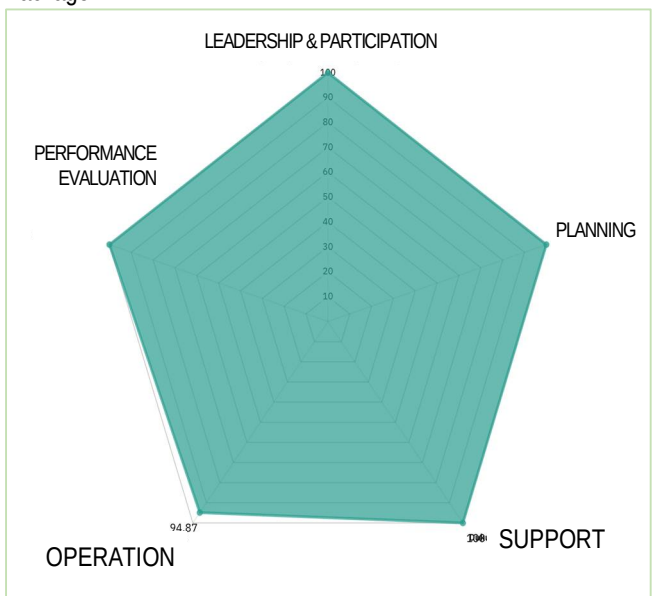


Package D



Package E



Package F

Figure 1. Element fulfillment diagram

Based on Figure 1, Package A demonstrates strong performance across most elements, including a perfect score (100%) in the Construction Safety Operations element. This is particularly noteworthy given that Package A operates with a relatively modest budget of IDR 5,000,000. In contrast, Figure 2 shows that Package B, despite allocating IDR 15,000,000, does not achieve maximum scores in several elements, with Construction Safety Operations reaching only 94.87%. This suggests that increased expenditure does not automatically translate into optimal quality improvements. Figure 3 reveals that Package C exhibits a pronounced weakness in the Construction Safety Performance Evaluation element, scoring only 60.00%, even though other elements fall within acceptable ranges. A similar pattern appears in Figure 5, where Package E records the lowest score in the same element at 53.33%, despite having a relatively high cost allocation. Meanwhile, Figure 4 shows that Package D maintains consistent performance across all elements, reinforcing its position as the most cost-efficient package. Figure 6 illustrates that Package F achieves near-perfect scores across almost all elements, with most reaching 100% and only a slight reduction in the Construction Safety Operations element (94.87%). However, this high level of quality is achieved at an exceptionally high cost, resulting in the least efficient CER value among all packages.

Overall, the findings from Table 1 and Figures 1 through 6 collectively demonstrate that there is no linear relationship between SMKK implementation costs and the resulting RKK document quality. Several low-cost packages are able to produce quality levels comparable to, or even exceeding those of high-cost packages. These results highlight significant variations in cost-efficiency across work packages and suggest that factors other than budget size; such as personnel competence, planning rigor, and organizational safety culture may play a more decisive role in determining the quality of construction safety documentation.

DISCUSSION

The findings of this study provide compelling empirical evidence that challenges the widely held assumption that higher financial investment is inherently associated with superior construction safety planning quality. Within the broader context of rising global occupational accident rates, as consistently highlighted by international organizations [1], the observation that work packages with relatively modest budget allocations can still produce high-quality Construction Safety Plans (RKK) is particularly noteworthy. This phenomenon underscores the notion that the effectiveness of safety planning is not determined solely by the magnitude of financial resources, but rather by the rigor, precision, and methodological soundness of the planning process itself. This aligns with previous studies indicating that safety budgeting practices often rely on generalized lump-sum estimations that lack accuracy and fail to reflect actual field requirements [13].

Furthermore, the practice of allocating safety costs without a needs-based analytical foundation frequently leads to distortions in project cost structures. Several studies have documented that contractors tend to embed safety-related expenditures within general overhead costs without clear itemization, thereby obscuring the true value of safety investments [14]. Such practices reduce transparency and weaken accountability in safety cost management, ultimately diminishing the effectiveness of RKK implementation in the field. Consequently, the quality of an RKK document is more accurately understood as a function of precise risk identification and technically sound planning aligned with regulatory standards [4].

The analysis of high-cost work packages with low cost-effectiveness ratios reveals a pattern consistent with the principle of diminishing marginal returns. This finding is aligned with the Cost of Quality (CoQ) framework, which posits that beyond a certain threshold, additional spending on preventive measures no longer yields proportional improvements in quality [5]. In some cases, excessive investment in administrative aspects of safety management may even reduce organizational efficiency, as resources are diverted away from more critical risk-control activities [15]. Thus, increasing expenditure without corresponding improvements in technical substance may lead to inefficiencies in construction safety management.

From an operational perspective, the ability of low-cost packages to achieve high-quality outcomes can be explained through the Resource-Based View (RBV). This theoretical framework emphasizes that organizational advantage is driven more by intangible assets; such as personnel competence, expertise, and experience than by financial resources alone [6]. In this context, the skill of document preparers in identifying hazards and formulating appropriate mitigation strategies becomes a decisive factor in determining RKK quality. This interpretation is supported by research demonstrating that human resource capacity has a significant influence on the effectiveness of construction safety management systems [16].

Conversely, the weaknesses observed in the performance evaluation element across several work packages indicate deficiencies in the application of the quality management cycle. Low scores in this element suggest that RKK documents remain static and fail to incorporate mechanisms for continuous feedback and improvement. This contradicts the Plan-Do-Check-Act (PDCA) principle that underpins international safety management systems [7]. When viewed through the lens of the Swiss Cheese Model, weaknesses in the evaluation stage represent latent conditions that create gaps in organizational defenses, increasing the likelihood of accidents [8].

The study also identifies a tendency toward institutional isomorphism, wherein organizations produce standardized safety documents primarily to satisfy regulatory requirements rather than to address project-specific risks. This practice contributes to the emergence of *paper safety*, a condition in which safety is represented only in administrative documentation without substantive implementation in the field [9]. Prior research has shown that administrative compliance alone is insufficient to reduce accident rates unless accompanied by strong supervision and a robust safety culture [10,17]. Thus, the mere existence of voluminous and costly RKK documents does not guarantee worker protection if they are not operationalized effectively.

The disconnect between safety planning costs and document quality has serious implications for the rising trend of occupational accidents. When RKK documents are treated merely as administrative requirements, failures in the planning stage directly contribute to accidents during project execution. This aligns with the Domino Theory, which posits that workplace accidents result from a chain of failures beginning with deficiencies in planning and management. Therefore, efforts to improve safety performance must extend beyond worker behavior modification and begin with the development of high-quality, context-specific, and practically applicable planning documents [18].

The practical implications of this study call for a paradigm shift in how safety costs are evaluated by Commitment-Making Officials (PPK). Evaluations should not focus solely on nominal values but must also consider the substantive quality and relevance of cost components to risk-mitigation activities. An activity-based costing approach offers a promising solution for enhancing transparency and effectiveness in safety cost allocation [19]. By linking each cost component to its contribution to risk reduction, budget utilization becomes more rational and targeted.

Theoretically, this study enriches the literature by applying cost-effectiveness analysis (CEA) to evaluate the efficiency of construction safety documentation. The findings demonstrate that institutional pressures may drive cost escalation without corresponding improvements in substantive safety quality [20]. This reinforces the need for organizations to cultivate a strong safety climate, wherein genuine commitment to safety is reflected in practical actions rather than merely in administrative documentation [21].

Despite its contributions, this study has several limitations. First, the sample size, limited to six construction work packages may constrain the generalizability of the findings. Second, reliance on secondary data restricts the researcher's ability to explore contextual field factors that may influence RKK quality. Third, the study does not examine the direct relationship between cost efficiency and actual accident rates. Future research

is therefore recommended to incorporate larger sample sizes and integrate field-level safety performance data to obtain a more comprehensive understanding of the relationship between planning efficiency and safety outcomes.

CONCLUSION

The findings of this study demonstrate that the magnitude of financial allocation for construction safety does not directly determine the quality of the Construction Safety Plan. The observed cost efficiency indicates that planning quality is more strongly influenced by personnel competence and the accuracy of needs analysis than by budget size. Moreover, high expenditures that are not oriented toward substantive content tend to generate administrative inefficiencies and do not guarantee compliance with construction safety regulations. These results underscore the need for safety planning evaluations to prioritize the technical substance and the relevance of cost components to risk-mitigation activities. Activity-based budgeting approaches, combined with strengthened human resource competencies, constitute key factors for enhancing the effectiveness of construction safety implementation.

Ethical consideration, competing interest and source of funding

-Because this study relies exclusively on secondary data and does not involve direct interaction with human subjects, ethical approval was not required. Nevertheless, the researcher adhered to ethical principles by maintaining data confidentiality and ensuring that all information was used solely for research purposes. Sensitive project details were anonymized to protect organizational and contractual privacy.
-The authors have no competing interests.
-Source of funding is authors.

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