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Analysis of the Impact of the Implementation of the Construction Safety Management System (SMKK) on the Cost and Time of Implementation of the River Normalization Project

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Abstract: The implementation of the Construction Safety Management System (SMKK) has become a regulatory mandate in Indonesia and plays a vital role in enhancing infrastructure project performance. This study aims to evaluate the impact of SMKK implementation on cost and time performance, using the Kali Banter River normalization project in Desa Tani Bhakti, Loa Janan District, Kutai Kartanegara Regency as a case study. The project had a contract value of IDR 777,777,700, with safety-related allocations—covering personal protective equipment (PPE), training, signage, insurance, and safety personnel—constituting 3.61% of the total budget. A quantitative descriptive approach was applied to assess cost distribution and time deviations based on weekly progress reports. The results indicate that, despite its relatively low financial allocation, the SMKK significantly contributed to the project being completed on schedule, with zero deviations across the 13-week execution period. These findings suggest that safety investments are instrumental in mitigating operational risks and ensuring schedule adherence. The study highlights the importance of integrating SMKK not only as a regulatory requirement but also as a strategic and cost-effective management approach. Furthermore, it underscores the need for local governments and contractors to reinforce their commitment to construction safety culture, particularly in public infrastructure development.

Keywords: Construction Safety; Project Scheduling; River Normalization

1. Introduction

Safety in construction project implementation has emerged as a major focus within modern project management practices. The construction industry is widely recognized as a high-risk sector (Timofeeva et al., 2017), particularly for field operations such as river normalization works, which involve heavy equipment, deep excavations, and unstable environmental conditions (Alwi & Hampson, 2003; Tam et al., 2004). In response, the Indonesian government has mandated the implementation of Construction Safety Management Systems (SMKK) through Ministerial Regulation of the Ministry of Public Works and Housing No.10/PRT/M/2021, positioning SMKK as an integral component of construction project execution (Kementerian PUPR, 2021). However, the level of understanding and commitment toward SMKK implementation still varies widely across projects, and limited academic studies have evaluated its direct impact on cost and time performance.

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Previous research suggests that the application of systematic and structured safety systems (Sarvari et al., 2025) positively affects work productivity (Tsopa et al., 2022), cost efficiency (Shirali et al., 2018), and the reduction of project delays (Gibb et al., 2014; Hinze, 1997). In medium-scale construction projects, investments in personal protective equipment (PPE), safety training, and designated safety officers are often perceived as additional costs (Lee et al., 2025). Nevertheless, their long-term influence on project smoothness is substantial (Choudhry et al., 2008; Mohamed, 2002). Moreover, visual elements such as safety signage, warning boards, and worker engagement in safety campaigns have been shown to improve on-site awareness and compliance (Fang et al., 2004; Lingard et al., 2014). Hence, an empirical assessment is necessary to determine the extent to which SMKK elements contribute to project execution, particularly in the Indonesian context.

This study aims to analyze the influence of SMKK implementation on both cost and time performance in river normalization projects, specifically focusing on the "Kali Banter Normalization Project" located in Desa Tani Bhakti, Kutai Kartanegara. Employing a quantitative approach based on actual project data, this research seeks to strengthen the justification for SMKK investments during project planning and provide policy input regarding SMKK application at the local government level. The findings are expected to serve as a practical reference for project implementers and policymakers in improving execution efficiency through a structured and measurable safety management approach (Kartam et al., 2000; Sawacha et al., 1999).

2. Materials and Methods

2.1. Research Location

This study was conducted on the Continuation Project of Kali Banter River Normalization, located in Desa Tani Bhakti, Loa Janan Subdistrict, Kutai Kartanegara Regency, East Kalimantan Province. The project is part of a watershed revitalization program managed by the Department of Public Works (DPU) of Kutai Kartanegara Regency. The planned duration of the project was 120 calendar days, with a Budget Plan (RAB) amounting to IDR 777,777,777.00, which included a dedicated cost allocation for the implementation of the Construction Safety Management System (SMKK).

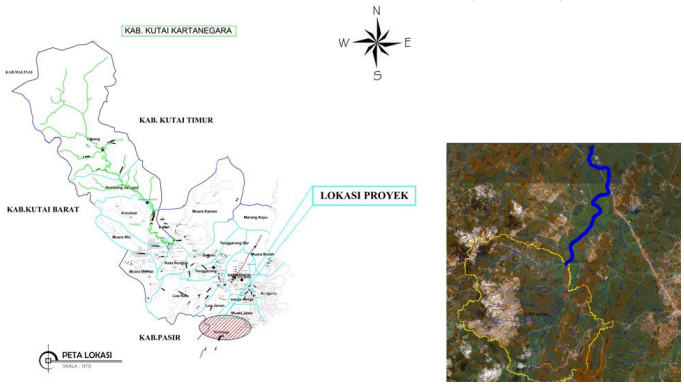

Figure 1. Reseach Location

2.2. Research Design

The research design used was a case study with a qualitative descriptive approach (Sugiyono, 2019). This model was chosen to gain an in-depth understanding of the technical conditions of the drainage system, the application of hydrological and hydraulic analysis, and project management within the context of drainage system planning in the study area.

2.3. Research Method

This study adopts a quantitative case study with a descriptive-analytical approach. The research focuses on:

1. Analyzing the cost contribution of the Construction Safety Management System (SMKK) to the total project cost;
2. Evaluating the impact of SMKK implementation on project time performance.

This approach is intended to allow replication in similar civil infrastructure projects (Chinda & Mohamed, 2008; Kartam et al., 2000).

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2.4. Data Collection Methods

2.4.1. Primary Data Collection

Primary data were obtained through direct access to the following project documentation:

- Project Budget Plan (RAB)
- SMKK documentation: Construction Safety Plan (RKK), Environmental Safety Plan (RKPPL), Safety Mitigation and Emergency Response Plans (RMLLP and RMPK)
- Project execution records: weekly progress reports and actual S-curves

2.4.2. Secondary Data

Secondary data included:

- Academic literature related to SMKK and occupational health and safety (OHS) in construction projects
- Relevant regulations, such as Ministry of Public Works Regulation No.10/PRT/M/2019 and ISO 45001:2018
- Benchmark documents on standard safety costs from similar infrastructure projects

2.5. Research Variables and Operational Definitions

The instruments used in this study include the following variables:
Independent Variable:

- Implementation of SMKK (measured through SMKK cost allocation in the project budget)

Dependent Variables:

- Percentage contribution of SMKK cost to total project cost
- Time efficiency (measured through deviation between planned and actual S-curve progress)

3. Results

3.1. SMKK Components and Cost Allocation

Based on the project budget data, the total cost allocated for the Construction Safety Management System (SMKK) was IDR 28,077,700, equivalent to approximately 3.61% of the total contract value. The major components and their corresponding costs are as follows:

- Personal Protective Equipment (PPE) and Restricted Area Barriers: IDR 5,950,000
- Construction Safety Officer (K3): IDR 3,300,000
- First Aid Kits (P3K) and Fire Extinguishers (APAR): IDR 1,100,000
- Insurance and Expert Consultation: IDR 1,500,000
- Safety Signage and Training Activities: IDR 1,000,000+

3.2. Analysis of Project Time Performance

The project's execution schedule spanned 90 calendar days (August to September 2024). Based on weekly monitoring through S-curve analysis, the following findings were observed:

- Cumulative work progress reached 100% on time, with no delays in weekly targets;
- No significant deviations were recorded between the planned and actual progress, with the final week showing a deviation of 0%.

These results suggest that the SMKK implementation contributed to stable and uninterrupted project execution.

Figure 1. Visualization of the cost distribution for the Construction Safety Management System (SMKK) in relation to the total project budget. The diagram indicates that the Personal Protective Equipment (PPE) and Restricted Area Barriers account for the largest share of safety-related expenses (approximately 0.76% of the total project value), followed by the Construction Safety Officer (K3) and Insurance & Consultation components.

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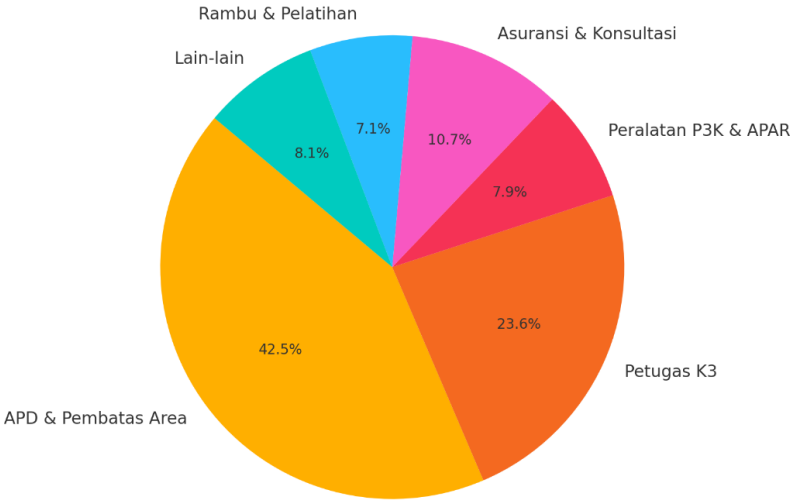

Figure 1. Distribution of SMKK Costs to Total Project

3.3. SMKK Cost Distribution

To assess the extent of budget allocation toward construction safety, a breakdown was conducted on each component categorized under the Construction Safety Management System (SMKK). The findings indicate that, out of a total project budget of IDR 777,777,700, an amount of IDR 28,077,700, or approximately 3.61%, was dedicated to safety-related provisions.

The largest cost component was the procurement of Personal Protective Equipment (PPE) and work area barriers, which included safety helmets, goggles, masks, gloves, safety shoes, life vests, and safety vests. This allocation is considered significant as it directly represents physical protection for workers operating in the field.

The second-largest contribution was for the Construction Safety Officer (K3 personnel), who played a critical role in monitoring, supervising, and ensuring compliance with all safety procedures throughout the project duration. Meanwhile, items such as first aid kits (P3K), insurance, safety signage, and fire extinguishers (APAR), although relatively low in monetary value, are essential elements in supporting the emergency response infrastructure on the project site.

3.4. Evaluation of Schedule Performance

The analysis of time deviations revealed that there were no schedule shifts throughout the 13-week execution period of the project. Both the planned and actual weekly progress curves consistently reflected 100% completion in accordance with the targeted schedule. By the 13th week, there was zero deviation, indicating that the implementation of the Construction Safety Management System (SMKK) helped mitigate potential work disruptions caused by accidents or procedural violations.

This high level of time efficiency can be attributed to improved operational discipline driven by several key factors:

- Safety training and orientation sessions conducted at the beginning of the project;
- Clear operational safety procedures communicated to all workers;
- Visual presence of safety elements such as signs, banners, and warning boards that raised awareness among site personnel;
- Continuous on-site monitoring by the assigned safety officer (Petugas K3) throughout the project duration.

Hence, it can be concluded that even a modest financial investment in SMKK yielded a substantial positive impact on the smoothness of project execution, particularly in terms of time performance.

4. Discussion

The analysis indicates that the implementation of the Construction Safety Management System (SMKK) in the Kali Banter River normalization project had a significant impact on the overall success of the project, particularly in terms of time efficiency. Despite the safety-related expenditure accounting for

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only 3.61% of the total project value, the project was completed on time within 90 calendar days, with no deviations or delays recorded during any phase of weekly execution.

This finding reinforces the hypothesis that effective SMKK implementation does not necessarily require substantial financial investment, but rather depends on the commitment and awareness of all project stakeholders. Several key components were identified as the most influential factors contributing to this success:

- The provision of comprehensive personal protective equipment (PPE), which helped reduce the risk of occupational accidents;
- The presence of a dedicated safety officer (Petugas K3) who served as both supervisor and in-house educator for safety protocols;
- Initial safety orientation and short training sessions, which ensured workers understood and adhered to safe working procedures.

These findings suggest that SMKK serves not only as a regulatory compliance mechanism but also as a strategic management tool that reduces the risk of schedule disruptions due to workplace incidents, worker unpreparedness, or procedural conflicts.

Theoretically, this is in line with previous studies by Gibb et al. (2014) and Hinze (1997), who argued that construction projects with strong safety systems tend to demonstrate more stable performance in terms of both time and quality. This is largely attributed to reduced external disturbances and improved workforce productivity in a well-organized, safety-oriented environment.

Moreover, the visual and symbolic elements of SMKK—such as safety banners, signage, and informational posters—contributed to a more disciplined work atmosphere. These elements had a positive psychological effect, encouraging workers to comply more closely with operational procedures and instructions.

Nevertheless, the effectiveness of SMKK implementation remains highly dependent on the discipline of the project team, proactive internal supervision, and strong coordination among the contractor, supervising consultant, and project owner. Strengthening internal safety audits, increasing training frequency, and implementing real-time safety monitoring are recommended to optimize SMKK outcomes in future projects.

Overall, the findings demonstrate that while the financial contribution of SMKK to total project cost is relatively small, its impact on project success—especially in terms of schedule performance—is both substantial and tangible.

5. Conclusions

This study demonstrates that the implementation of the Construction Safety Management System (SMKK) in the Kali Banter River normalization project had a positive impact on the project's time efficiency, despite consuming only approximately **3.61% of the total project budget**. With actual work progress reaching **100% completion on schedule**, and no significant weekly deviations recorded, it can be concluded that SMKK played a critical role in maintaining the smooth operation of the construction process.

Investments in safety components such as personal protective equipment (PPE), safety training, dedicated safety officers (Petugas K3), and emergency response facilities proved effective in preventing potential disruptions and accidents that could otherwise result in project delays. In addition to providing physical protection for workers, consistent SMKK implementation fostered a more disciplined and productive work culture.

However, this study is limited by its reliance on a single case study project of moderate complexity. To strengthen generalizability, future studies are recommended to involve a variety of construction projects with differing risk levels and scales. From a practical perspective, the findings reinforce the urgency of positioning SMKK not merely as a regulatory requirement, but as a strategic component for enhancing cost and time efficiency in construction project planning and execution.

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