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Analysis of Budget Constraints, Technical Constraints, and Institutional Integration on Performance: A Literature Review Study

Gatot Cahyo Sudewo
State Maritime Polytechnic of Indonesia, Semarang, Indonesia, gatot@polimarin.ac.id

Corresponding Author: gatot@polimarin.ac.id

Abstract: This study aims to analyze the influence of budget constraints, technical constraints, and institutional integration on performance. The method used is descriptive-qualitative, with an approach of *literature review*. This study synthesizes findings from various relevant internationally indexed academic articles. Data were collected from reputable internationally indexed articles obtained through databases such as Scopus, Web of Science, Emerald, Springer, and Google Scholar. The selected literature was analyzed using reduction techniques, data presentation in matrix form, and comparative synthesis to find patterns, similarities, and differences between studies. The results of the study show that Budget Constraints, Technical Constraints, and Institutional Integration affect Performance. The contribution of this study is to provide significant theoretical and practical contributions to the national transportation safety committee. The novelty of this study lies in the integration of models in analyzing the relationship between Budget Constraints, Technical Constraints, and Institutional Integration on Performance in the specific context of the National Transportation Safety Committee, which has not been widely studied in academic literature.

Keywords: Performance, Budget Constraints, Technical Constraints, Institutional Integration.

INTRODUCTION

Transportation safety has become a diverse global strategic issue, driven by increased mobility, technological advances, and complex cross-modal governance challenges. Rising global trade and supply chain complexities have increased safety and security risks, requiring a strong response from governments and industry to mitigate potential threats, including terrorism and natural disasters (Ibragimova et al., 2025). However, the rapid pace of technological integration also introduces new vulnerabilities, complicating the governance landscape as policymakers strive to balance the benefits of hypermobility with associated risks, such as pollution and congestion (Fiorentin, 2025).

The performance of the National Transportation Safety Committee in Indonesia is significantly hampered by systemic constraints, including budget limitations, technical challenges, and suboptimal institutional integration among transportation stakeholders. Budget

constraints limit the implementation of necessary safety technologies and innovations, as highlighted in maritime transportation, where high costs and regulatory barriers hinder the adoption of advanced safety systems (Sarjito, 2024).

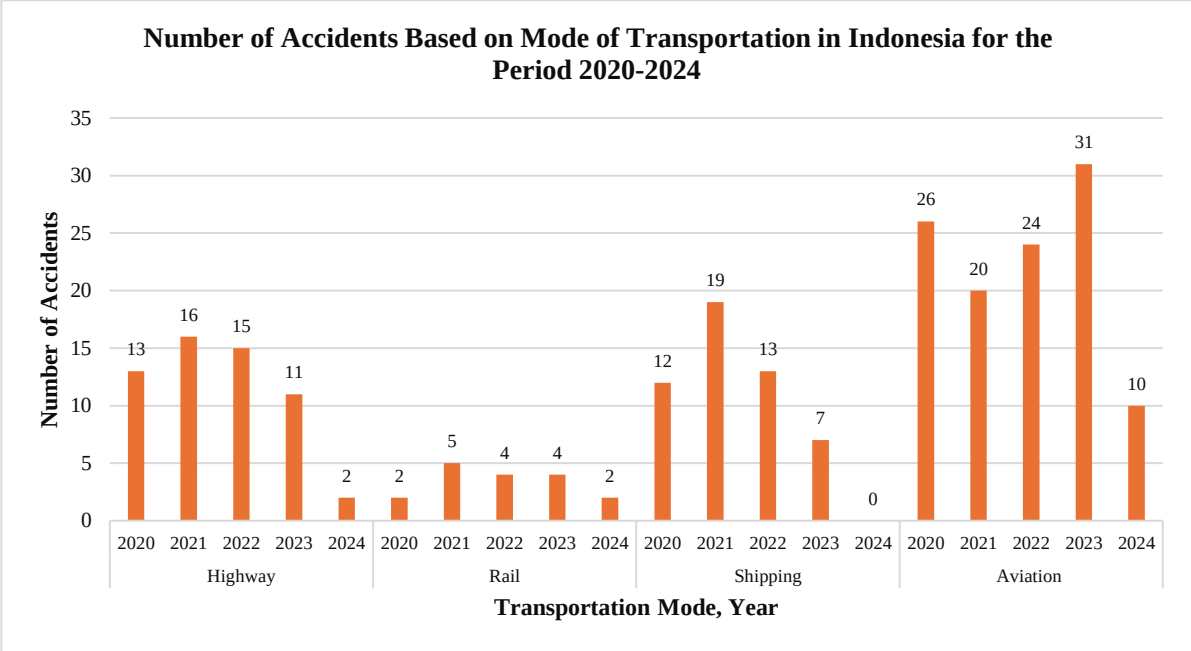

Figure 1. Number of Accidents by Transportation Mode in Indonesia, 2020-2024
Source: (Javier, 2024)

Figure 1, which shows the number of accidents based on modes of transportation in Indonesia for the period 2020-2024, indicates that the national transportation safety risk profile is heterogeneous and varies between modes, meaning that a uniform approach to safety management is not feasible. The data shows that air transportation still contributes to the highest number of accidents in the five-year period compared to sea, road, and rail transportation, indicating that the land sector has a much greater exposure to operational risks, a lower level of control, and a much more massive intensity of use by the public (Yusnandi et al., 2021).

This phenomenon confirms that Indonesia's transportation safety system is still concentrated on the modes most used by the public, but is not yet balanced by adequate risk mitigation and safety standardization for those modes. On the other hand, air transportation shows a relatively low and stable accident rate, reflecting the strength of international safety standards used, such as ICAO Annex, operator audit systems, procedural standardization, and high-tech forensic investigation systems. Sea and rail modes show more moderate but still fluctuating accident rates, reflecting the existence of inconsistent operational safety management issues, limited monitoring technology, and challenges in cross-agency integration in safety supervision (Manalu & Wijaya, 2024).

The interpretation of Figure 1 directly reinforces the urgency of the NTSC's role as a national cross-modal investigation authority, as the accident patterns show that the NTSC must be able to prioritize investigation interventions based on the most risky modes, not just on the annual caseload. This is where the three research variables—budget constraints, technical constraints, and institutional integration—have direct empirical consequences. Budget constraints potentially delay investigations into high-risk modes such as land transport, technical constraints hamper precise forensic analysis in high-tech modes such as air transport, and weak institutional integration hinders cross-mode coordination such as sea and rail transport. Thus, Figure 1 is not only descriptive accident data, but also provides evidence

justifying why improving the performance of the National Transportation Safety Committee (KNKT) must be based on strengthening budget capacity, investigation technology, and institutional integration mechanisms as a single national transportation safety system (Pratama et al., 2023).

The integration of budget constraints, technical constraints, and institutional integration into a single conceptual model for analyzing KNKT performance has not yet been explored in the existing literature. While individual studies discuss these variables, such as the impact of budget planning and organizational commitment on performance results (Kuntadi & Rosdiana, 2022).

This research is important to clarify the most critical and strategic policy intervention space in strengthening KNKT performance improvement based on academically verified literature evidence.

Problem Formulation

Based on the background of the problem above, the following research questions were formulated to obtain hypotheses for further research: 1) Does budget constraints affect performance?; 2) Do technical constraints affect performance?; 3) Does institutional integration affect performance?.

METHODS

This study uses a qualitative design with a descriptive approach based on *a literature review*. This approach was chosen because it allows researchers to investigate, understand, and critically analyze the factors that influence performance by synthesizing previous studies. The qualitative method with a *literature review* approach not only focuses on presenting a summary of findings but also conducts a comparative evaluation to identify similarities, differences, and patterns of interrelationships between variables, (Boulton, M. J., & Houghton, 2021).

The research data was sourced from secondary data obtained through journal articles, digital books, research reports, and academic publications relevant to the variables of Budget Constraints, Technical Constraints, Institutional Integration, and Performance. The literature was collected from reputable international databases such as Scopus, Web of Science, Taylor & Francis, Emerald, Sage, Springer, Elsevier, DOAJ, and EBSCO. Additionally, further searches were conducted through Google Scholar to ensure broader literature coverage. Literature selection was carried out systematically by considering topic suitability, publication quality, and relevance to the research focus, (Susanto et al., 2024).

Data analysis was conducted using a comparative analysis approach. In the first stage, the literature obtained was reduced to ensure that only articles that met the criteria were used. The next stage was data presentation, in which previous research findings were arranged in a matrix or summary table to facilitate the comparison process. The analysis then focused on identifying similarities, differences, and patterns of relationships between variables. The final stage was drawing conclusions through synthesizing the analysis results to obtain a comprehensive understanding of the influence of Budget Constraints, Technical Constraints, and Institutional Integration on Performance, (Dewi, 2024).

The validity of the research is maintained through the selection of literature sources from reputable international academic databases, as well as the screening of articles based on their relevance to the context and substance of the research. The reliability of the research is strengthened by the use of various sources from diverse geographical contexts and industrial sectors, so that the results of the analysis are not only partial but can provide a more general picture. With this approach, the research results have academic credibility and can be accounted for in the development of literature in the field of human resource management.

RESULTS AND DISCUSSION

Results

The following are the findings of the study, taking into account the context and problem formulation:

Performance

The performance of the KNKT is the level of effectiveness and efficiency of the implementation of the core functions of national transportation safety investigations by the National Transportation Safety Committee (KNKT), which includes the quality of investigations, the accuracy of safety recommendations, the timeliness of investigations, sustainability of recommendation implementation, systemic risk mitigation capabilities, the level of behavioral change in institutions/operators/manufacturers/regulators after recommendations are issued, as well as the outcome of a reduction in fatalities and an improvement in national safety performance across all modes of transport (Gustian et al., 2025).

The indicators or dimensions contained in the Performance variable include: 1) Accuracy and Speed of Investigation Completion: The extent to which transportation accident investigations are conducted in a timely manner, in accordance with SOPs, and without delaying the process of clarifying technical data so that the results of the investigation can be immediately useful; 2) Quality of Safety Recommendations: The degree to which KNKT recommendations are clear, specific, evidence-based, actionable, measurable in their implementation, and capable of driving real changes in safety procedures; 3) Level of Recommendation Implementation by Regulators/Operators: The degree of acceptance, willingness to implement, and realization of KNKT recommendations by the Ministry of Transportation, aviation, shipping, railway, highway operators, state-owned enterprises, and technical OEMs; 4) Impact on Risk Reduction and National Safety Improvement: The extent to which KNKT recommendations contribute to reducing recurring accidents, improving safety culture, early warning, and promoting the maturity of the national safety system (Ma'arif et al., 2025).

Performance variables are relevant to previous studies conducted by: (Sembiring et al., 2024), (Priaardanto, 2023), (Moengin et al., 2021).

Budget Constraints

Budget constraints are a condition in which the amount of fiscal resources/funding available is insufficient to meet all operational needs, system modernization, function expansion, human resource capacity building, maintenance of investigative technology, forensic laboratory infrastructure, record keeping, databases, and institutional research and development in fulfilling the mandate of the state. Budget constraints in the context of the transportation and safety investigation sector can result in low investigative capacity in the field, a lack of ability to deploy investigators to remote locations, a lack of updates to modern investigative tools, a lack of international training collaboration, low access to global data sharing systems, a lack of ability to conduct proactive safety studies, and limited ability to monitor early warning (Widad et al., 2025).

Indicators or dimensions included in the Budget Constraints variable are: 1) Operational Investigation Funding Constraints: Low availability of budget for field investigation activities, travel, logistics, testing, sampling, and technical team deployment; 2) Limitations in Funding for Technological Modernization: Minimal investment in the renewal of modern investigation tools such as FDR/CVR analyzers, AI crash modeling, drone surveillance, and 5.0 technology; 3) Limitations in Budget for Capacity Building and International Training: Minimal funding for the improvement of investigators' human resources in participating in global certification, international research, and IATA/ICAO/IMO/UIC workshops; 4) Trade-offs in Government

Fiscal Priorities: The investigation safety budget is less of a priority than the political sector, infrastructure development, and social spending, resulting in a chronic resource gap (Suhariadi, 2025).

The Budget Constraints variable is relevant to previous studies conducted by: (Nariasih et al., 2022), (Salim & Abdullah, 2023), (Nurpratama & Yudianto, 2021).

Technical Challenges

Technical challenges refer to any form of operational, technological, instrumentation, data system, infrastructure, investigative equipment, testing equipment, technology availability (hardware or software), access to black box data, limitations of forensic tools, laboratory limitations, limitations of system interoperability standards, limitations of technical documentation, difficulties in obtaining sensor data, and system errors in the technical transportation investigation process that directly hinder the effectiveness of the investigation and the quality of the resulting safety recommendations (Kendek et al., 2022).

Indicators or dimensions included in the Technical Constraints variable are: 1) Limitations of Forensic Laboratory Equipment and Infrastructure: Investigation equipment is outdated, inaccurate, incomplete, or does not support the investigation of the latest critical components; 2) Limited Access to Technical Data and Black Boxes: Difficulty in obtaining flight data recorders, voyage data recorders, sensors, telemetry, maintenance records, or OEM technical documents; 3) Digital System / ICT / Cyber Risk Disruptions: Obstacles in digital data processing, system errors, unstable digital integration, and the potential for cyber manipulation that could compromise evidence; 4) Technical Difficulties at the Accident Site: The crash site is difficult to access (deep sea, mountains, forests, extreme weather), making the investigation process slow and high risk (Nabela et al., 2023).

The Technical Constraints variable is relevant to previous studies conducted by: (Suhariadi, 2025), (Novita et al., 2022), (Jabrial, 2024).

Institutional Integration

Institutional integration is the level of alignment, connectivity, clarity of coordination governance, functional alignment, regulatory alignment, standard operating procedure alignment, common goals, data consistency, public information consistency, and program synergy between government agencies (KNKT, Ministry of Transportation, state-owned operators, airport/port authority regulators, investigators, industry, technical ministries) in supporting national transportation safety. Institutional integration reflects the quality of cross-actor governance, which includes information flow, technical documentation, post-accident response procedures, response to the implementation of recommendations, standardization of monitoring the implementation of recommendations, and cross-ministerial collaboration in resolving systemic root causes originating from national governance (Nuraini et al., 2024).

Indicators or dimensions contained in the Institutional Integration variable include: 1) Cross-Ministry/Agency Coordination: The level of smooth communication, assignment, and response between entities such as the National Transportation Safety Committee (KNKT), Ministry of Transportation, Financial Services Authority (OJK) Transportation, State-Owned Enterprises (BUMN) Transportation, and the Police; 2) Synchronization of Safety Regulations and SOPs: Alignment of standards, operating guidelines, supervisory policies, and safety management procedures between agencies to avoid conflicts; 3) Interoperability and Data Sharing in Transportation Systems: The ability of agencies to integrate digital data, synchronize, share data via APIs, and ensure consistency in the national safety database; 4) Consistency in Implementing Recommendations: How harmonious and consistent government agencies are in following up on KNKT recommendations so that there are no gaps in implementation between actors (Edwina et al., 2020).

Institutional Integration variables are relevant to previous studies conducted by: (Suherman et al., 2023), (Lira et al., 2024), (Zen et al., 2021).

Previous Research

Based on the above findings and previous studies, the research discussion is formulated as follows:

Table 1. Relevant Previous Research Findings

No	Author (Year)	Research Results	Similarities With This Article	Differences With This Article	Hypothesis
1	(Nariasih et al., 2022)	The variables of Authority Distribution and Budget Constraints affect KNKT Performance	Similarities with this study are found in the independent variable of Budget Constraints and the dependent variable of KNKT Performance	The difference with this study is in the independent variable, namely Authority Distribution	H1
2	(Pandiangan, 2025)	Technical Constraints and Risk Mitigation Variables Affect the Performance of the National Transportation Safety Committee	Similarities with this study are found in the independent variable of Technical Constraints and the dependent variable of KNKT Performance	The difference with this study is in the dependent variable Risk Mitigation	H2
3	(Purwoko, 2024)	The Institutional Integration variable affects KNKT Performance and Sustainability	Similarities with this study are in the independent variable of Institutional Integration and the dependent variable of KNKT Performance	The difference with this study is in the dependent variable of Sustainability	H3

Discussion

Based on the problem formulation, research objectives, and previous research results above, the discussion in this study is as follows:

The Effect of Budget Constraints on the Performance of the National Transportation Safety Committee

Based on a review of the literature and relevant previous studies, it was found that budget constraints affect the performance of the National Transportation Safety Committee.

To improve the performance of the KNKT despite budget constraints, KNKT leaders must pay attention to four key indicators of budget constraints, including: 1) Limited funding for operational investigations: Determining the priority scale of investigations based on potential safety impacts and losses. Implement cost efficiencies in travel and operations, and maximize cooperation with other parties (such as the Ministry of Transportation or related institutions) for logistical and facility support; 2) Limited funding for technological modernization: Seek strategic partnerships with international institutions (such as the NTSB, AAIB) or universities for technology loans, knowledge transfer, or equipment grants. Focus investment on technology that provides the highest *return on investment* in safety; 3) Limited budget for capacity building and training: Develop internal training programs that utilize senior expertise. Take advantage of more cost-effective *e-learning* or online training resources; 4) Trade-offs in government fiscal priorities: KNKT leaders must actively advocate and communicate publicly about the direct impact of KNKT's performance on national safety and the economy.

If the leadership of the Indonesian National Transportation Safety Committee (KNKT) is able to pay attention to these four forms of budget constraints on an ongoing basis, it will have an impact on the performance of the KNKT, including: 1) Accuracy and speed of investigation completion: Investment in operations and technology enables investigations to be completed more quickly and accurately. This ensures that recommendations can be issued and

implemented immediately to prevent repeat accidents; 2) Quality of safety recommendations: *Capacity building* and technological support will produce competent investigators who are able to analyze root causes in depth and formulate specific, practical, and high-impact recommendations; 3) Level of implementation of recommendations by regulators or operators: High-quality recommendations and strong budget advocacy will increase public and government trust. KNKT leaders must proactively monitor, communicate, and coordinate with regulators/operators to ensure that recommendations are followed up effectively, even though KNKT does not have the authority to impose sanctions; 4) Impact on risk reduction and improvement of national safety: Improvements in the three previous indicators (speed, quality, and implementation) will create a positive cycle in which accident risks are reduced, national safety standards are improved, and potential economic losses/fatalities can be minimized.

The results of this study are in line with previous studies conducted by (Hidayat et al., 2025), which state that there is an influence between budget constraints and the performance of the national transportation safety committee.

The Influence of Technical Constraints on the Performance of the National Transportation Safety Committee

Based on a literature review and relevant previous studies, it was found that technical constraints affect the performance of the National Transportation Safety Committee.

To improve the performance of the KNKT in the face of technical constraints, KNKT leaders must pay attention to four key indicators of technical constraints, including: 1) Limited forensic laboratory equipment and infrastructure: Focus limited budget investments on the most frequently used core forensic tools (e.g., *data retrieval* and *analyzers*). Develop formal partnerships (MoUs) with forensic laboratories owned by universities, state-owned enterprises, or international institutions for further analysis; 2) Limited access to technical data and black boxes: Leaders must advocate for regulatory amendments that strengthen the KNKT's authority to access technical data without hindrance. Create standard protocols and agreements with operators/regulators regarding the automatic and immediate provision of data after an incident, including *Flight Data Monitoring* (FDM); 3) Digital system disruptions: Develop a redundant and secure data storage system (*secure cloud-based system)*; 4) Technical difficulties at the accident site: Establish a special rapid *deployment* technical team equipped with advanced emergency response equipment (e.g., survey *drones*, light diving equipment). Strengthen MoA/SOP with Basarnas, TNI, and POLRI for quick access to transportation and evacuation equipment in difficult terrain.

If the leadership of the Indonesian National Transportation Safety Committee (KNKT) is able to continuously address these four technical challenges, it will have an impact on the performance of the KNKT, including: 1) Accuracy and speed of investigation completion: Improvements in data access, forensic laboratories, and field procedures collectively shorten the investigation cycle (from incident to final report); 2) Quality of safety recommendations: Analysis supported by robust forensic laboratories and digitally secured data will result in evidence-based, in-depth recommendations that directly address systemic root causes; 3) Level of implementation of recommendations by regulators or operators: Recommendations supported by irrefutable technical evidence and credible (high-quality) analysis have greater moral and technical authority, thereby increasing the willingness of regulators/operators to implement them; 4) Impact on risk reduction and improvement of national safety: Timely and high-quality implementation of recommendations will close *safety gaps* in the national transportation system, directly reducing the potential for similar accidents to recur in the future.

The results of this study are in line with previous studies conducted by the National Transportation Safety Committee (Ma'arif et al., 2025), which stated that there is an influence

between technical constraints and the performance of the national transportation safety committee.

The Influence of Institutional Integration on the Performance of the National Transportation Safety Committee

Based on a literature review and relevant previous studies, it was found that institutional integration has an effect on the performance of the National Transportation Safety Committee.

To improve the performance of the KNKT through institutional integration, the leadership of the KNKT must pay attention to three main indicators of institutional integration, which include: 1) Inter-ministerial or inter-agency coordination: Establishing clear Memoranda of Understanding (MoUs) and Joint Standard Operating Procedures (SOPs) for resource mobilization, site access, and evidence submission. KNKT leadership must regularly lead high-level coordination forums for *safety oversight;* 2) Synchronization of safety regulations and SOPs: KNKT leadership uses investigation findings as strong evidence to recommend regulatory harmonization to regulators (Ministry of Transportation/relevant Directorates General). Ensure that safety recommendations do not conflict with other regulations; 3) Interoperability and transportation system data sharing: Encourage the use of uniform technical data standards in the transportation industry. KNKT leaders must build a secure and encrypted data sharing platform or protocol with major operators for proactive access to *Flight Data Monitoring* (FDM) or similar data; 4) Consistency in the implementation of recommendations: Develop a transparent *tracking* and audit system to monitor the implementation status of each recommendation. KNKT leaders must regularly publish implementation status reports and hold mandatory follow-up meetings with relevant parties.

If the leadership of the Indonesian National Transportation Safety Committee (KNKT) is able to pay attention to these four forms of institutional integration in a sustainable manner, it will have an impact on the performance of the KNKT, including: 1) Accuracy and speed of investigation completion: Strong coordination protocols and fast data access eliminate bureaucratic and technical barriers, enabling investigators to work more efficiently; 2) Quality of safety recommendations: Regulatory synchronization ensures that recommendations are systemic and non-contradictory, increasing their relevance and effectiveness in the long term; 3) Level of implementation of recommendations by regulators or operators: A *tracking* system and high-quality recommendations create accountability and trust, encouraging better *compliance* from the authorities; 4) Impact on risk reduction and improvement of national safety: When high-quality recommendations are implemented consistently and quickly by the entire ecosystem (through integration), the root causes of accidents will be comprehensively addressed, reducing the risk of recurrence and significantly improving the level of national safety.

The results of this study are in line with previous studies conducted by (Fitriani & Maulana, 2021), which state that there is an influence between institutional integration and the performance of the national transportation safety committee.

Conceptual Framework

The conceptual framework is determined based on the research questions, research objectives, and previous studies relevant to the literature review in this study:

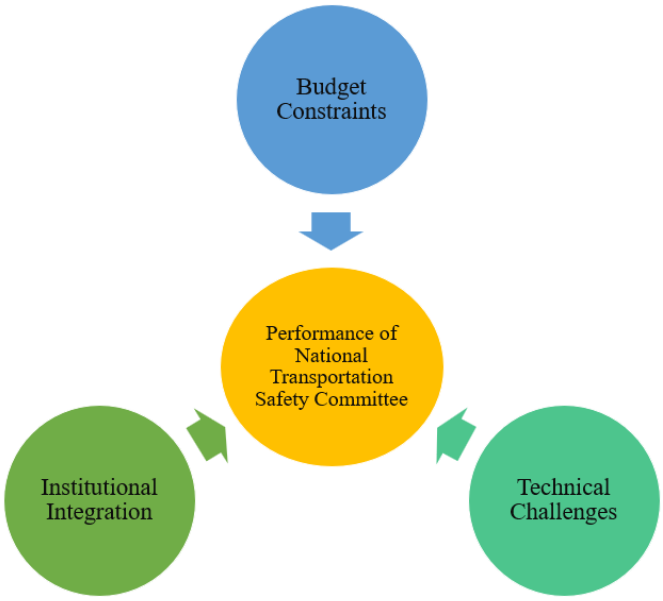

Figure 2. Conceptual Framework

Based on Figure 2 above, budget constraints, technical constraints, and institutional integration affect the performance of the National Transportation Safety Committee. However, in addition to the variables of budget constraints, technical constraints, and institutional integration that affect the performance of the National Transportation Safety Committee (KNKT), there are other variables that also have an influence, including:

1. Information System Quality: (Darma & Sagala, 2020), (Yunas et al., 2023), (Ningrum & Munandar, 2025).
2. Investigator Competency: (Merawati et al., 2025), (Iswahyudi et al., 2025), (Hotimah & Ma'ruf, 2023).
3. Safety Culture: (Camelia et al., 2024), (Nisak & Febrian, 2025), (Safitri et al., 2020), (Sarjito, 2024).

CONCLUSION

Based on the problem formulation, results, and discussion above, the conclusions of this study are: 1) Budget constraints affect the performance of the National Transportation Safety Committee (KNKT); 2) Technical constraints affect the performance of the National Transportation Safety Committee (KNKT); 3) Institutional integration affects the performance of the National Transportation Safety Committee (KNKT).

Based on the above conclusions, the following steps are recommended to improve the organization's performance in a sustainable manner:

1. Optimize budget management, including: a) Implement a performance-based budgeting (PBB) approach; b) Diversify alternative funding sources; c) Increase fiscal transparency and accountability.
2. Strengthening technical capacity, which includes: a) Modernizing technology and management information systems; b) Implementing continuous competency-based training; c) Improving operational infrastructure readiness.
3. Institutional integration reform, including: a) Encourage cross-unit coordination through a Whole of Government approach; b) Harmonize policies and programs between agencies; c) Build effective institutional synergy and communication mechanisms.

This multidimensional approach is expected to improve the effectiveness and efficiency of organizations in achieving their strategic objectives.

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