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A PERFORMANCE-BASED APPROACH TO SAFETY MANAGEMENT: MAPPING SAFETY INDICATORS AND TARGETS IN MULTI-APPROVAL TRAINING ORGANIZATIONS

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ABSTRACT
Safety Management Systems (SMS) are formally required across aviation training organizations; however, institutions holding multiple operational approvals frequently encounter difficulties in translating regulatory requirements into coherent and measurable safety performance indicators and targets. In practice, safety performance monitoring is often fragmented, approval-specific, and insufficiently aligned with a performance-based oversight philosophy. This study addresses this gap by examining how safety indicators and targets can be systematically mapped within a unified SMS framework for multi-approval aviation training organizations. This research adopted a qualitative design-based approach, combining document analysis, internal stakeholder interviews, comparative benchmarking with peer training organizations, and focus group discussions involving regulators, operators, and safety managers. Data triangulation was applied to ensure consistency and analytical validity throughout the framework development process. The results demonstrate that safety performance expectations differ substantially across approvals due to distinct operational risk characteristics. Nevertheless, these differences can be integrated through a common safety assurance structure without compromising regulatory specificity. The study identifies approval-specific safety performance indicators and targets for pilot training, aircraft maintenance, and maintenance training activities, and shows that an integrated performance-based mapping improves safety oversight, strengthens compliance mechanisms, and enhances organizational accountability. From a theoretical perspective, this study extends performance-based safety management literature by situating safety performance measurement within a multi-approval governance context. Practically, it offers aviation training organizations and regulators a structured and adaptable framework for harmonizing safety performance monitoring across approvals. The study contributes a transferable model that supports resilient and performance-oriented SMS implementation in complex aviation training environments.
Keywords: *Safety Management System, Safety Performance, Safety Indicators, Safety Targets, Approved Training Organization*

1. Introduction

Human capability remains a decisive factor in the safety and reliability of aviation systems, particularly within organizations responsible for educating future aviation professionals. While technological advancement and procedural standardization continue to enhance operational performance, the effectiveness of these systems ultimately depends on how individuals and organizations interact with them. In aviation training environments, weaknesses in organizational governance, instructional systems, or safety oversight may not immediately manifest as incidents, yet they often shape the latent conditions from which future operational risks emerge (Nguyen et al., 2023).

As a vocational aviation education institution, Politeknik Penerbangan Indonesia Curug (PPI Curug) operates at the intersection of education, training, and operational safety. Its institutional mandate, as defined under the Minister of Transportation Decree No. PM 100 of 2021, assigns responsibilities not only for academic delivery but also for applied research and contributions to national aviation safety objectives. Prior research has shown that vocational aviation institutions play a strategic role in preparing personnel capable of adapting to technological change and evolving safety demands, particularly when educational processes are aligned with operational realities and industry expectations(Gauthama et al., 2025).

Within this context, the governance of safety in aviation training organizations has become increasingly prominent. Internationally, the International Civil Aviation Organization (ICAO) has established Safety Management Systems (SMS) as a mandatory framework for aviation service providers, including Approved Training Organizations (ATOs). The introduction of ICAO Annex 19 signaled a departure from purely prescriptive regulation toward a performance-based philosophy, emphasizing proactive hazard identification, continuous monitoring, and preventive risk management rather than reactive compliance alon (Kurt, 2021). This shift reflects accumulated evidence from accident investigations indicating that organizational and systemic factors, alongside human and technical issues, significantly influence safety outcomes (Kartal & Bayramoğlu, 2024).

A central expectation of performance-based SMS lies in an organization's ability to demonstrate safety performance in measurable terms. Safety Performance Indicators (SPIs) and Safety Performance Targets (SPTs) are intended to serve this function by translating safety objectives into observable and evaluable parameters. ICAO Document 9859 positions these elements as core components of safety assurance, supporting informed decision-making and regulatory oversight. Nevertheless, empirical findings suggest that many aviation organizations encounter persistent difficulties in defining SPIs and SPTs that are both operationally meaningful and reflective of actual risk exposure (Bartulović, 2021; Kobaszyńska-twardowska et al., 2023).

These difficulties become more pronounced in organizations operating under multiple regulatory approvals. Aviation training institutions frequently hold approvals for pilot training, aircraft maintenance, and maintenance training activities, each governed by distinct regulatory frameworks and operational characteristics. In practice, safety management arrangements are often developed separately for each approval, resulting in fragmented documentation and disjointed performance monitoring practices. Such fragmentation may satisfy formal compliance requirements, yet it limits the organization's ability to obtain a consolidated understanding of its overall safety performance.

The existing body of SMS literature has largely concentrated on conceptual dimensions such as safety culture, leadership commitment, and organizational attitudes toward safety (Adjekum, 2014; Kartal & Bayramoğlu, 2024). Other studies have examined methodological challenges associated with safety performance measurement, including the reliance on lagging indicators and the inherent difficulty of quantifying complex sociotechnical risks (Verstraeten, n.d; Kaspers et al., 2019a).While these contributions have advanced theoretical understanding, they provide limited empirical insight into how safety performance indicators and targets are operationalized within aviation training organizations, particularly those characterized by multi-approval structures.

Recent analyses of safety performance measurement further highlight recurring shortcomings in SMS implementation, such as the use of generic indicators, weak integration between safety data and organizational decision-making, and insufficient linkage between safety assurance outcomes and governance processes (Na & Choi, 2023; Orogun & Issa, 2022). These findings suggest that the principal challenge lies not in the absence of SMS documentation, but in the lack of coherent mechanisms for integrating safety performance measurement across diverse operational domains.

In multi-approval aviation training institutions, this challenge carries significant implications. SMS manuals are frequently developed to meet individual approval requirements rather than to function as integrated performance management tools. As a result, SPIs and SPTs may exist formally but fail to support proactive oversight or continuous improvement. This limitation is particularly evident in vocational aviation settings, where instructional, maintenance, and operational activities are closely interconnected within a single organizational system.

Despite growing attention to SMS effectiveness, empirical studies that explicitly address the mapping and integration of SPIs and SPTs across multiple approvals in aviation training organizations remain limited. Most existing research focuses on single-approval contexts, such as airlines or maintenance organizations, without sufficiently addressing the governance complexity inherent in multi-approval training institutions. Consequently, guidance on harmonizing approval-specific safety performance requirements within a unified SMS framework remains underdeveloped.

Responding to this gap, the present study advances a performance-based approach to mapping Safety Performance Indicators and Safety Performance Targets within a multi-approval Safety Management System framework. By examining SMS implementation across pilot training, aircraft maintenance, and maintenance training activities within a single Approved Training Organization, this research seeks to align approval-level safety performance requirements with organizational-level safety governance. In doing so, the study aims to contribute empirical insight and a transferable mapping model that supports more coherent and performance-oriented safety management in complex aviation training environments.

Accordingly, this study addresses the following research question: *how can Safety Performance Indicators and Safety Performance Targets be systematically mapped and integrated within a performance-based SMS framework to support effective safety governance in a multi-approval aviation training organization?*

2. Literature Review

2.1 Safety Management System (SMS) as an Evolving Safety Governance Paradigm

Safety Management Systems (SMS) have progressively evolved from being perceived as supplementary safety programs into becoming a central element of organizational governance within the aviation sector. Conceptually, SMS is understood as a structured and systematic management framework designed to identify hazards, assess and mitigate risks, and continuously monitor safety performance through formalized processes and organizational accountability mechanisms (Stolzer et al., 2023; Stolzer et al., 2018). Early improvements in aviation safety were largely driven by technological advancements, including enhanced aircraft design, more reliable propulsion systems, and increasingly sophisticated avionics(Oster et al., 2013).These developments contributed significantly to reducing accident rates, particularly those associated with mechanical failure.

However, as accident investigation methodologies matured, it became evident that technological reliability alone could not fully account for the persistence of safety occurrences. Subsequent analyses revealed that organizational decisions, management practices, and systemic interactions frequently play a decisive role in shaping unsafe conditions. This recognition prompted a fundamental reorientation in aviation safety thinking, culminating in the widespread adoption of SMS as a proactive, performance-based approach to safety management rather than a reactive, rule-compliance exercise (Kurt, 2021).

The institutionalization of SMS through ICAO Annex 19 represents a global consensus that safety must be managed as an organizational process embedded within daily operations. Unlike prescriptive regulatory models, which emphasize adherence to detailed rules and procedures, the SMS framework prioritizes continuous performance monitoring, organizational learning, and anticipatory risk management. Nevertheless, while the regulatory intent behind SMS is broadly shared, the manner in which these principles are translated into operational practice varies considerably across organizations and regulatory jurisdictions.

2.2 Regulatory Interpretations and Comparative SMS Approaches

Although ICAO provides the overarching framework for SMS implementation, national and regional aviation authorities have adopted distinct approaches in operationalizing SMS requirements. ICAO promotes a performance-based and scalable SMS model, allowing organizations to tailor their safety management practices according to operational complexity and risk exposure. In contrast, the European Union Aviation Safety Agency (EASA) emphasizes structured safety assurance processes, including documented performance monitoring and systematic internal oversight. Similarly, the Federal Aviation Administration (FAA) integrates SMS requirements closely with organizational accountability and compliance verification, while the United Kingdom Civil Aviation Authority (UK CAA) places strong emphasis on governance, leadership responsibility, and organizational learning mechanisms.

These regulatory variations underscore an important observation within the literature: while SMS principles are globally harmonized, their implementation, particularly in relation to safety performance measurement, remains context-dependent. As a result, organizations operating within complex regulatory environments, such as aviation training institutions holding multiple

approvals, often face additional challenges in aligning safety management practices with diverse regulatory expectations.

2.3 SMS, Safety Culture, and Organizational Learning

A substantial portion of the SMS literature has focused on the relationship between SMS implementation and the development of safety culture. Empirical studies consistently suggest that effective SMS implementation is associated with improved safety awareness, increased reporting of hazards and incidents, and more proactive safety behaviors among personnel (Adjekum, 2017; Adjekum & Tous, 2020; Saliba, 2024). These findings reinforce the argument that SMS functions not only as a technical management system but also as a social mechanism influencing organizational values and behaviors.

Nevertheless, several authors caution against equating safety culture with safety performance. While a positive safety culture is widely regarded as a necessary condition for effective safety management, it does not automatically translate into measurable safety outcomes.(Ceballos Martínez & Krstikj, 2025) argue that safety culture initiatives may remain abstract or symbolic if they are not supported by concrete performance metrics and systematic evaluation mechanisms. (Robertson, 2018; Saliba, 2024)further emphasizes that continuous assessment of SMS effectiveness is essential to prevent safety culture from becoming a static organizational attribute rather than a dynamic driver of improvement.

2.4 Safety Performance Measurement and Its Methodological Challenges

Safety performance measurement constitutes one of the most complex and contested dimensions of SMS implementation. Traditional safety indicators, such as accident and incident rates, have long been criticized for their retrospective nature and limited capacity to capture emerging risks. As aviation systems become more resilient and accidents increasingly rare, reliance on lagging indicators alone provides insufficient insight into the underlying safety health of an organization (Bzdyk et al., 2024; Paidisetty et al., 2024; Zhang et al., 2025).

Contemporary safety management literature therefore advocates the integration of leading indicators, which aim to capture proactive safety activities, process effectiveness, and early warning signals. (Bartulović, 2020; Zhang et al., 2025)argue that predictive and process-oriented indicators offer greater potential for anticipating safety degradation, particularly in complex organizational systems. However, the development and validation of such indicators present significant methodological challenges, including issues of measurability, data reliability, and contextual relevance.

Recent empirical studies highlight persistent weaknesses in how organizations operationalize safety performance measurement. (Bartulović, 2021) observes that many organizations adopt standardized indicators that satisfy regulatory expectations but offer limited insight into actual operational risk.(Kobaszyńska-twardowska et al., 2023)further demonstrate that safety performance data are frequently underutilized, with limited integration between Safety Risk Management (SRM) outputs and Safety Assurance (SA) activities. As a result, performance data often fail to inform strategic decision-making or organizational learning processes.

2.5 Safety Performance Indicators (SPIs) and Safety Performance Targets (SPTs)

Within the SMS framework, Safety Performance Indicators (SPIs) and Safety Performance Targets (SPTs) serve as primary instruments for translating abstract safety objectives into measurable and actionable parameters. SPIs provide qualitative or quantitative measures of safety-related processes, conditions, or outcomes, while SPTs define acceptable or desired levels of performance against which safety outcomes can be evaluated. ICAO guidance positions these instruments as the foundation of safety assurance, enabling organizations to demonstrate compliance with acceptable levels of safety and to support evidence-based oversight.

Despite their conceptual centrality, empirical research reveals considerable variation in how SPIs and SPTs are defined, validated, and applied. (Sultana et al., 2019) emphasize that effective SPIs must be achievable, relevant, and closely aligned with organizational safety objectives. However, (Bartulović, 2021) notes that many organizations struggle to establish

meaningful targets or to validate indicators against actual risk exposure, resulting in weak linkage between safety measurement and management action.

Moreover, most existing studies on SPI - SPT implementation focus on single-approval operational contexts, such as airlines, airports, or maintenance organizations. Research examining aviation training institutions remains limited, and studies explicitly addressing organizations holding multiple approvals within a single SMS framework are particularly scarce.

2.6 SMS Implementation in Multi-Approval Aviation Training Organizations

Multi-approval aviation training organizations present a distinctive set of challenges for SMS implementation. Each approval; pilot training, aircraft maintenance, and maintenance training operates under different regulatory requirements, operational scopes, and hazard profiles. (Faturachman et al., 2023; Lestary, 2020)argue that safety performance indicators must reflect these contextual differences while remaining coherent at the organizational level.

In practice, however, safety performance indicators are often developed independently for each approval, leading to fragmented documentation and parallel safety management processes. This fragmentation complicates organizational-level safety oversight and limits the ability of management to obtain a holistic understanding of safety performance. As a result, SMS manuals in multi-approval organizations may satisfy regulatory requirements without fully supporting proactive safety governance.

2.7 Research Gap and Positioning of the Present Study

The reviewed literature reveals several unresolved issues that collectively define a clear research gap. First, while SMS has been widely implemented across the aviation sector, the operationalization of safety performance measurement; particularly the development and integration of SPIs and SPTs, remains uneven and under-theorized. Second, empirical studies addressing SPI - SPT implementation within aviation training organizations are limited, with an even greater absence of research focusing on multi-approval institutional contexts. Third, existing literature provides little guidance on how approval-specific safety performance requirements can be harmonized within a unified SMS manual while preserving regulatory specificity.

Responding to these limitations, the present study advances a performance-based approach to mapping Safety Performance Indicators and Safety Performance Targets within a multi-approval Safety Management System framework. By examining an Approved Training Organization operating under CASR Part 141, Part 145, and Part 147, this research seeks to bridge the gap between regulatory compliance and integrated safety governance. In doing so, the study extends existing SMS performance literature and contributes an empirically grounded framework for safety performance measurement in complex aviation training environments.

3. Research Methods

3.1 Research Design and Rationale

This study employed a qualitative design-based research approach to examine and develop a structured mapping of Safety Performance Indicators (SPIs) and Safety Performance Targets (SPTs) within a multi-approval Safety Management System (SMS) framework. A qualitative approach was selected because the research seeks to understand how safety performance indicators are interpreted, constructed, and integrated across different regulatory approvals within a single aviation training organization. Such processes are inherently contextual, organizational, and interpretive in nature, making qualitative inquiry particularly suitable for capturing stakeholder perspectives and institutional practices (Creswell, 2018, Fischer et al., 2007.; Sugiyono, 2018).

Design-based research was considered appropriate because this study goes beyond descriptive analysis and involves the iterative development, refinement, and validation of an applied safety performance mapping framework. This approach allows empirical findings to directly inform the design of an operational artifact, namely, the SPI - SPT mapping embedded within the SMS manual; while simultaneously contributing to conceptual understanding of performance-based safety governance (Chen et al., 2021; Jennings & Schulberg, 2009).

3.2 Research Setting and Unit of Analysis

The research was conducted at Politeknik Penerbangan Indonesia Curug (PPI Curug), an Approved Training Organization operating under multiple regulatory approvals, including CASR Part 141 (Pilot Training), CASR Part 145 (Aircraft Maintenance Organization), and CASR Part 147 (Aircraft Maintenance Training Organization). This institutional setting represents a complex organizational environment in which distinct operational domains coexist within a single SMS framework.

The primary unit of analysis in this study is the SPI - SPT mapping within the institutional SMS manual, as this mapping constitutes the core object through which safety performance is operationalized and monitored. Secondary units of analysis include the study programs and operational units responsible for implementing SMS under each approval. Defining the unit of analysis at both the organizational and approval levels enables the study to examine alignment and integration between approval-specific safety requirements and organization-wide safety governance (Chai et al., 2022; Guo et al., 2021).

3.3 Sampling Technique and Participant Characteristics

A purposive sampling technique was applied to ensure the inclusion of participants with direct involvement and decision-making authority in SMS implementation and safety performance monitoring (Donkoh, 2023; Morgan, 2024; Sugiyono, 2018). Participant selection was guided by predefined criteria, including professional role, regulatory responsibility, and experience with SMS operations.

Participants comprised three main groups:

a. Internal stakeholders at PPI Curug, including Heads of Study Programs, Heads of Operational Units, and Safety and Quality Managers responsible for CASR Part 141, Part 145, and Part 147 approvals.
b. External operators and benchmarking partners, representing aviation training organizations and maintenance organizations operating under equivalent regulatory frameworks.
c. Regulators and subject-matter experts, including aviation safety inspectors and officials involved in approval, oversight, and standardization processes.

Most participants occupied senior or expert-level positions and possessed extensive professional experience in aviation training, maintenance, or regulatory oversight, thereby ensuring the credibility and relevance of the data collected (Elbardan & Kholeif, 2017; Kwon, 2021).

3.4 Data Collection Methods and Instruments

To enhance analytical rigor, data were collected using multiple qualitative methods and integrated through data triangulation, which allows findings to be cross-validated across different sources and perspectives (Meydan & Akkaş, 2024; Wijaya et al., 2023). The primary data collection methods included:

a. Document analysis, involving a systematic review of SMS manuals, safety policies, SOPs, hazard identification and risk assessment (HIRA) documents, internal audit reports, and regulatory guidance materials. Document analysis focused on identifying existing SPIs, SPTs, and gaps in safety performance measurement (Bowen, 2009).
b. Semi-structured interviews, conducted using interview protocols specifically developed for this study. Interview questions were aligned with the SMS framework outlined in ICAO Document 9859, particularly the Safety Assurance component related to safety performance monitoring and measurement.
c. Comparative interviews and benchmarking discussions, conducted with external training organizations and maintenance organizations operating under CASR Part 141, Part 145, and Part 147 approvals, to identify similarities and differences in SPI - SPT practices.
d. Focus Group Discussions (FGDs), which brought together internal stakeholders, external operators, and regulators to validate, refine, and contextualize the proposed SPI - SPT mapping framework. FGDs were selected due to their effectiveness in generating collective insights and facilitating consensus-building among diverse stakeholder groups (Schuster et al., 2023; Wollney et al., 2024).

3.5 Data Analysis Procedures

Data analysis followed a thematic analysis approach, combining inductive and deductive reasoning to identify patterns across data sources (Braun & Clarke, 2006; Naeem et al., 2023). The analytical process consisted of several iterative stages:

a. Data familiarization, involving repeated reading of interview transcripts, FGD summaries, and documentary materials.
b. Initial coding, in which segments of data relevant to SPI - SPT development, validation, and integration were identified and labeled.
c. Theme development, whereby codes were grouped into broader analytical categories reflecting cross-approval patterns, such as regulatory alignment, operational risk differentiation, and safety assurance effectiveness.
d. Pattern matching and mapping, through which themes were translated into structured SPI - SPT components aligned with each approval and subsequently integrated into an organization-wide SMS framework.

This analytical process emphasized the transformation of qualitative data into a coherent and operational safety performance mapping, rather than mere narrative description (Lim, 2025; Naeem et al., 2023).

3.6 Validation and Trustworthiness

Several strategies were employed to enhance the trustworthiness of the findings. Data triangulation was used to compare insights obtained from documents, interviews, and FGDs, thereby strengthening credibility (Schuster et al., 2023; Sugiyono, 2018)Following the FGDs, expert judgment validation was conducted, whereby regulators and senior safety practitioners reviewed the proposed SPI - SPT mapping to assess regulatory consistency, operational relevance, and practical feasibility. Feedback from this validation stage informed revisions to the final mapping framework, ensuring alignment with both regulatory expectations and organizational needs (Blišťanová et al., 2021; Serey et al., 2023).

3.7 Research Framework

The research framework followed a sequential and iterative process. Initial document analysis and internal interviews were conducted to identify existing SMS practices and safety performance indicators. These findings informed the development of an initial SPI - SPT mapping (Draft 1). Comparative analysis and benchmarking with external organizations were then used to refine the mapping (Draft 2). Finally, FGDs and expert judgment validation were employed to finalize the integrated SPI - SPT framework (Draft 3). This framework provides a transparent methodological pathway linking data collection, analysis, and applied outcomes.

3.8 Internal Interviews and Data Collection Schedule

Internal interviews constituted the first empirical stage of data collection and were conducted to capture approval-specific perspectives on existing Safety Performance Indicators (SPIs) and Safety Performance Targets (SPTs) within the institutional Safety Management System (SMS). These interviews aimed to identify current practices, implementation challenges, and perceived gaps in safety performance measurement across operational units.

To ensure systematic data collection, internal interviews were conducted according to a predefined schedule, as summarized in **Table 1**. The interviews involved key personnel from the Quality Assurance Unit, the Pilot Study Program, the Aircraft Engineering Study Program, and the Aircraft Workshop Unit, as well as the respective Safety and Quality Managers responsible for CASR Part 141, Part 145, and Part 147 approvals. The staged scheduling allowed the research team to progressively refine interview focus areas based on emerging findings from earlier sessions.

Table 1 - Data Collection Schedule (Internal Interviews)

No.	Date of Data Collection	Units / Locations
1	20–24 May 2024	1. Quality Assurance Unit 2. DIV Pilot Study Program 3. SQM CASR Part 141 (Pilot School)
2	27–31 May 2024	1. DIV Aircraft Engineering Study Program 2. SQM CASR Part 147 (AMTO)
3	3–7 June 2024	1. Aircraft Workshop Unit 2. SQM CASR Part 145 (AMO)

3.9 In-Depth Interviews and Comparative Needs Assessment

Following the completion of internal interviews and the development of the initial SPI - SPT mapping (Draft 1), the second stage of the research involved in-depth interviews and comparative analysis. This stage was designed to benchmark internal findings against external organizations operating under equivalent regulatory approvals, thereby enhancing analytical depth and external validity.

Comparative in-depth interviews were conducted with stakeholders from Approved Training Organizations and Aircraft Maintenance Organizations operating under CASR Part 141, Part 145, and Part 147 approvals. These organizations included Angkasa Aviation Academy and Nurtanio University Bandung. The primary objective of this stage was to compare approaches to SPI - SPT formulation, validation, and integration across similar operational contexts, identifying both convergent practices and contextual differences.

The outcomes of this comparative analysis formed Draft 2 of the SPI - SPT mapping framework. The schedule for this needs assessment phase is presented in **Table 2**, ensuring transparency regarding the timing and scope of stakeholder engagement.

Table 2 - Data Collection Schedule (In-Depth Interviews with Stakeholders)

No.	Organization / Location	Regulatory Approval	Date
1	Angkasa Aviation Academy (Triple A)	CASR Part 141 (Pilot School)	10–14 June 2024
2	Angkasa Aviation Academy (Triple A)	CASR Part 145 (AMO)	17–21 June 2024
3	Nurtanio University Bandung	CASR Part 147 (AMTO)	17–28 June 2024

3.10 Focus Group Discussion (FGD) as a Validation Mechanism

The third empirical stage employed Focus Group Discussions (FGDs) as a structured validation and refinement mechanism. In this stage, the researcher assumed the role of facilitator, guiding interactions among participants rather than engaging in direct questioning. This approach is consistent with established FGD methodologies that emphasize collective dialogue, shared reflection, and consensus-building among diverse stakeholders (Nyumba et al., 2018; Schuster et al., 2023).

Participants in the FGD included representatives from aviation regulatory authorities, aviation safety program units, airworthiness and aircraft operation directorates, the Civil Aviation Human Resources Development Center, and external training organizations. The inclusion of regulators, operators, and academic institutions enabled the integration of multiple perspectives on the feasibility, regulatory alignment, and operational relevance of the proposed SPI - SPT mapping.

FGDs were conducted online and spanned three consecutive days, with each session lasting approximately three hours. During these sessions, participants reviewed Draft 2 of the SPI – SPT mapping framework, discussed approval-specific requirements, and provided structured feedback on integration across CASR Part 141, Part 145, and Part 147 approvals. The outcomes of the FGD process were used to refine and finalize the mapping framework, resulting in Draft 3, which represents the validated version of the SPI - SPT model.

3.11 Informant Selection and Ethical Procedures

Informant selection followed a purposive and criterion-based approach to ensure that participants possessed relevant expertise and decision-making authority related to SMS implementation and safety performance oversight. Formal letters requesting participation were issued to internal stakeholders and external informants, signed by the Head of the Center for Research and Community Service and the Director of PPI Curug, respectively.

Selection criteria included professional role, regulatory involvement, and familiarity with the institutional SMS manual and multi-approval framework. Informants comprised senior regulators, heads of units, safety and quality managers, and subject-matter experts involved in national aviation safety programs. Follow-up communication was conducted to confirm participation and ensure completeness of representation. The final list of respondents is presented in **Table 3**, which reflects the diversity of institutional roles and regulatory perspectives involved in the study.

Table 3 - List of Respondents

No.	Organization	Respondents	Role in Study
1	Secretariat of Directorate General of Civil Aviation	Acting Director of Airworthiness & Aircraft Operation	FGD
2	Directorate of Airworthiness and Aircraft Operation	Acting Director of Airworthiness & Aircraft Operation Junior Expert Airworthiness Inspector First Expert Airworthiness Inspector	FGD
3	State Safety Programme (SSP) Task Force	Chief Executive of National Aviation Safety Program SSP Vice Chair / Head of SSP Standardization Sub-Team	FGD
4	Center of Human Resources Development on Civil Aviation	Head of Center	FGD
5	Training Organization - Flight School (Angkasa Aviation Academy)	President Director Safety and Quality Manager	Comparative Analysis & FGD
6	AMTO - Nurtanio University Bandung	Safety and Quality Manager	Comparative Analysis & FGD
7	Politeknik Penerbangan Indonesia Curug	Head of Quality Assurance Unit SQM/TM 139 SQM/TM 141 SQM/TM 142 SQM/TM 143 SQM/TM 145 SQM/TM 147	Data Triangulation, Comparative Analysis & FGD

3.12 Data Processing and Integration

Data processing followed a sequential and integrative approach. Initial data triangulation was conducted using responses from the online survey, document analysis, and internal interviews. These data sources were then synthesized to identify preliminary themes related to SPI - SPT formulation, implementation challenges, and approval-specific requirements.

Subsequently, insights from the comparative analysis and in-depth interviews were integrated to refine the initial mapping and identify alignment or divergence across organizations. These findings informed the design of FGD discussion points, ensuring that validation sessions were grounded in empirical evidence rather than abstract assumptions. All feedback and recommendations were evaluated against current regulatory requirements and benchmarked against practices observed in comparable training organizations.

3.13 Data Analysis Technique

Data analysis was conducted using a thematic and narrative analytical approach, focusing on the transformation of qualitative data into a structured SPI - SPT mapping framework. Following data organization and categorization, themes were developed to describe the current state of safety performance measurement at the study program and unit levels. These themes included approval-specific risk profiles, existing performance indicators, and organizational readiness for integrated safety governance.

The analytical process emphasized pattern identification across stakeholder perspectives, allowing the researchers to construct an integrated understanding of how safety performance indicators and targets are interpreted and applied within the institutional SMS. Interactions with regulators, operators, and training organizations were systematically reviewed to ensure that the resulting SPI - SPT mapping reflects both regulatory expectations and operational realities.

4. Results and Discussions

This section presents an integrated results and discussion of the mapping of Safety Performance Indicators (SPIs) and Safety Performance Targets (SPTs) within the multi-approval Safety Management System (SMS) implemented at Politeknik Penerbangan Indonesia Curug (PPI Curug). The discussion is grounded in empirical evidence obtained from document analysis, internal and external interviews, comparative benchmarking, and focus group discussions (FGDs). Rather than reiterating normative descriptions of SMS or regulatory frameworks, this section critically examines what the SPI - SPT mapping reveals about organizational safety performance, SMS maturity, and governance effectiveness within a vocational aviation training institution operating under multiple regulatory approvals.

4.1 Mapping of Existing Safety Performance Indicators and Targets

The initial results indicate that PPI Curug has formally implemented SMS in accordance with ICAO Annex 19 and ICAO Doc 9859, as reflected in the institutional SMS documentation and governance structure. The existence of a consolidated SMS Multi-Approval Manual, illustrated in **Figure 1 (Structure of the SMS Multi-Approval Manual),** demonstrates an institutional commitment to integrating multiple regulatory approvals; CASR Parts 91, 139, 141, 142, 143, 145, and 147, within a single safety governance framework. This structural integration is significant, as prior international studies note that fragmented SMS documentation often undermines safety performance monitoring in multi-activity aviation organizations (Bartulović, 2021; Kaspers et al., 2019).

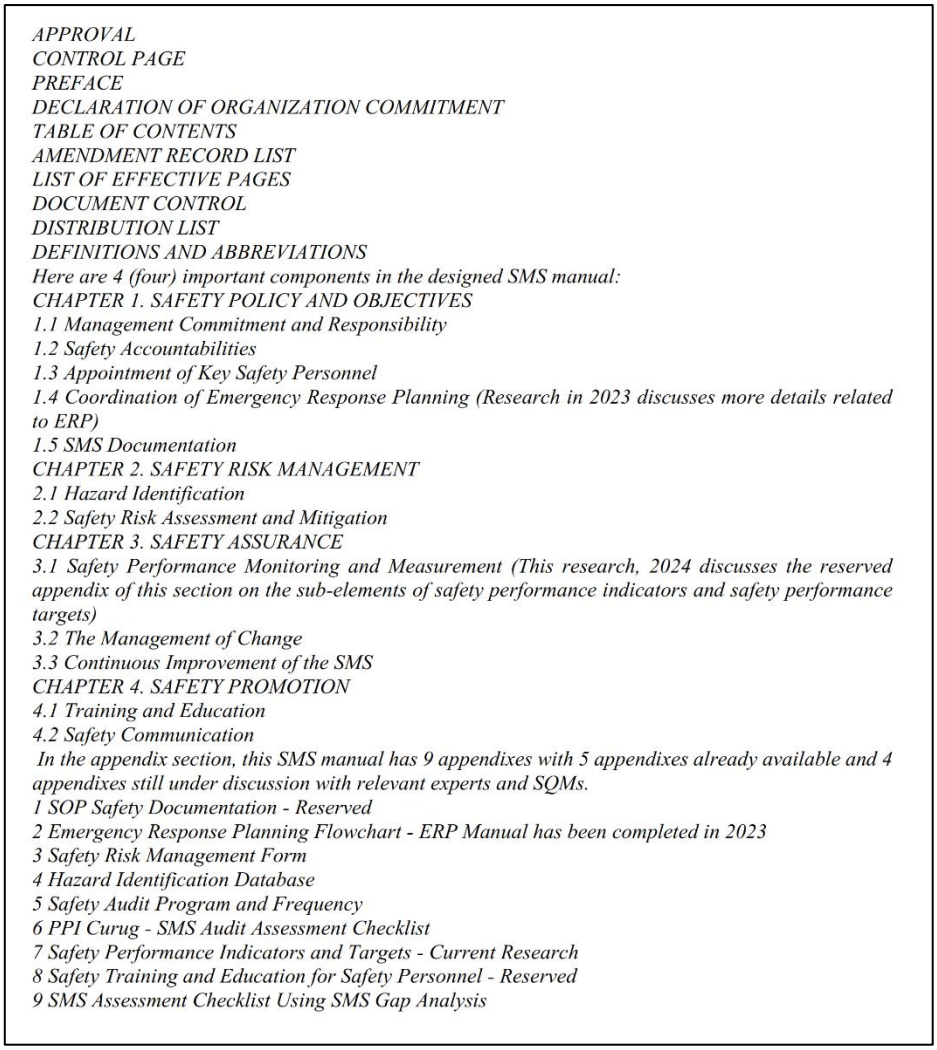

Fig.1. Structure of the SMS Multi-Approval Manual

Empirical findings from interviews and FGDs identify several supporting factors that facilitate SPI - SPT mapping at PPI Curug. These include the availability of an SMS framework aligned with ICAO Doc 9859, institutional experience in managing multiple approvals, and sustained involvement of Safety and Quality Managers in safety assurance activities. Such conditions correspond with enabling factors identified in recent SMS maturity and governance studies, which emphasize management commitment, documentation coherence, and institutional learning capacity as prerequisites for performance-based safety management (Adjekum & Tous, 2020; Kartal & Bayramoğlu, 2024; Na & Choi, 2023).

At the same time, the mapping process reveals hindering factors that limit the effectiveness of SPI - SPT implementation. These include constraints in human resources, overlapping academic and operational responsibilities, and uneven diffusion of SMS knowledge beyond designated safety roles. Interview data suggest that many instructional and operational staff perceive safety performance indicators primarily as compliance instruments rather than as decision-support tools. This finding reflects patterns reported in international studies, where formal SMS adoption does not automatically translate into organizational safety maturity or proactive risk management (Kaspers et al., 2019; Kobaszyńska-twardowska et al., 2023; Robertson, 2018).

4.2 Results of SPI - SPT Mapping by Regulatory Approval

The detailed mapping of SPIs and SPTs across CASR Part 141, Part 145, and Part 147 approvals reveals distinct safety performance profiles corresponding to differing operational risk characteristics.

For the CASR Part 141 Pilot School, the SPI - SPT mapping presented in **Table 4 (Safety Department SPI PSC-141)** identifies seven key performance indicators encompassing safety performance targets, safety reporting systems, safety communication, safety training, safety assurance activities, safety meetings, and emergency response preparedness. These indicators collectively address flight operations, ground operations, and engineering-related safety functions. The breadth of indicators reflects the dynamic and high-risk nature of flight training activities, consistent with findings in recent studies on safety performance measurement in training and operational flight environments (Adjekum, 2017; Na & Choi, 2023; Stolzer et al., 2023).

Table 4 - Safety Performance Indicators and Targets – Pilot School (CASR Part 141)

No.	Safety Area	Key Performance Indicator (KPI)	Measurement Basis	Safety Performance Target (SPT)
1	Safety Performance Target	Overall safety performance level	Area operations per 1,000 flight hours	Zero accidents; zero high-risk severe incidents
2	Safety Reporting System	Effectiveness of hazard and occurrence reporting	Area operations per 3 months	Zero accidents; zero high-risk severe incidents
3	Safety Communication	Safety notices and recommendations issued	Number of safety communications per operational area	≥1 safety notice/recommendation every 3 months
4	Safety Training	SMS and safety training coverage	Attendance records	≥80% of personnel receive safety/SMS training
5	Safety Assurance	Audit, surveillance, and inspection compliance	Execution rate vs. published schedule	Zero accidents; zero high-risk severe incidents
6	Safety Meetings	Compliance with scheduled safety meetings	Meeting completion rate	100% of scheduled meetings conducted
7	Emergency Response Plan (ERP)	ERP readiness and exercise implementation	ERP exercise execution	ERP exercise conducted as scheduled

However, FGD validation indicates that while these indicators are well defined, their practical use remains uneven. Safety personnel demonstrate strong familiarity with the indicators, whereas instructional staff often engage with them only during audits or scheduled reviews. This gap suggests that the performance-based intent of SMS has not yet been fully internalized within daily instructional practices, a challenge similarly reported in international research on safety culture and organizational learning (Kartal & Bayramoğlu, 2024; Yeun et al., 2014)

Within the CASR Part 145 Aircraft Maintenance Organization, safety performance is primarily assessed through outcome-oriented indicators, as shown in **Table 5 (Safety Targets AMO-145)** and **Table 6 (SPI AMO-145)**. These indicators focus on audit findings, service difficulty reports, return-to-operation events, fire or fume occurrences, and maintenance-related injuries. While these metrics meet regulatory requirements, they largely function as lagging indicators. Comparative benchmarking with external AMOs and findings from FGDs confirm that such event-driven approaches provide limited insight into latent organizational risks, echoing concerns raised in recent maintenance safety literature (Bartulović, 2021; Kaspers et al., 2019; Orogun & Issa, 2022).

Table 5 - Safety Targets (Acceptable Level of Safety) – Aircraft Maintenance Organization (CASR Part 145)

No.	Safety Goal Description	Acceptable Level of Safety (ALoS)
1	External audit findings	≤30% open findings

No.	Safety Goal Description	Acceptable Level of Safety (ALoS)
2	Service difficulty reports	≤5 cases per year
3	Return-to-operation due to technical defects	≤5 events per year
4	Fire, smoke, or fume events on aircraft	≤5 events per year
5	Personnel or aircraft injury due to maintenance facilities	≤5 cases per year

Table 6 - Safety Performance Indicators – Aircraft Maintenance Organization (CASR Part 145)

No.	Safety Performance Indicator	Acceptable Level
1	Number of findings in external audits	≤40% open findings
2	Service difficulty reports	≤7 cases per year
3	Return-to-operation due to technical defects	≤7 events per year
4	Fire, smoke, or fume events	≤7 events per year
5	Maintenance-related personnel or aircraft injury	≤7 cases per year

The CASR Part 147 Aircraft Maintenance Training Organization exhibits a hybrid safety performance profile that integrates educational and operational considerations. As presented in **Table 7 (SPI AMTO-147)**, indicators include training facility availability, student failure rates, human error and violation occurrences, audit findings, and safety reporting frequency. These indicators highlight the dual identity of training organizations as educational systems and safety-critical environments. Empirical evidence from interviews suggests that this approval demonstrates greater potential for incorporating leading indicators related to learning quality, human factors awareness, and instructional effectiveness, consistent with contemporary perspectives on training-centered safety performance measurement (Adjekum & Tous, 2020; Kartal & Bayramoğlu, 2024).

Table 7 - Safety Performance Indicators – Aircraft Maintenance Training Organization (CASR Part 147)

No.	Safety Performance Indicator	Acceptable Level
1	Training facility availability	≥90% availability
2	Student failure rate	≤15%
3	Human error or violation (human factors-related)	≤20%
4	Major findings in external audits	≤30%
5	Safety reports and training hours submitted	Reported monthly

4.3 Safety Assurance, ALoS, and Performance Monitoring

Across all approvals, the Acceptable Level of Safety (ALoS) framework serves as a formal reference for safety performance evaluation. Nevertheless, interview and FGD data indicate that ALoS is predominantly interpreted as a regulatory minimum rather than as a dynamic performance benchmark guiding continuous improvement. This static interpretation limits its strategic value as a management tool, a challenge widely reported in recent studies on performance-based regulation and safety assurance (Herrera, 2012.; Verstraeten, n.d.; Kobaszyńska-twardowska et al., 2023).

The Safety Assurance mechanisms described in Chapter 3—including monthly performance reviews, management evaluations, and Safety and Quality Council oversight—demonstrate institutional alignment with ICAO requirements. However, their effectiveness is moderated by resource constraints and competing organizational priorities. Similarly, the Management of Change and Continuous Improvement processes are formally established but remain highly dependent on leadership engagement and institutional capacity, reflecting patterns observed in international SMS maturity models (Na & Choi, 2023).

4.4 Discussion: Comparison with International Studies and Implications

When compared with international studies on SMS performance measurement in ATOs, AMOs, and AMTOs, the findings of this research extend existing knowledge in several important ways. First, they empirically confirm that multi-approval organizations require differentiated yet interoperable SPI - SPT sets to reflect heterogeneous operational risks, supporting arguments advanced by (Bartulović, 2021; Kaspers et al., 2019). Second, the study demonstrates that integration does not require uniform indicators, but rather a coherent governance framework capable of aggregating and interpreting safety performance data across approvals.

From a theoretical perspective, the results contribute to performance-based safety management, safety culture, and resilience engineering literature by illustrating how SPI - SPT mapping functions as a mediating mechanism between regulatory frameworks and organizational practice. The findings reinforce the view that safety performance is shaped not merely by indicator selection, but by organizational capability to interpret, act upon, and continuously refine performance data (Herrera, 2012; Kıvanç et al., 2025; Szabo & Koblen, 2020).

Practically, the findings offer important implications for vocational aviation training institutions and regulators. For training organizations, the results underscore the need to move beyond approval-centric compliance toward integrated safety governance supported by meaningful performance measurement. For regulators, the study provides empirical evidence that performance-based oversight in multi-approval contexts is both feasible and beneficial, aligning with ICAO's strategic direction and recent regulatory developments in performance-based safety oversight (Kartal & Bayramoğlu, 2024; Kıvanç et al., 2025).

4.5 Generalization of Findings

In general terms, these findings confirm that the multi-approval concept provides a more structured, coherent, and analytically robust SPI - SPT mapping framework compared to approaches reported in previous single-approval studies. By enabling cross-approval alignment while preserving operational specificity, the multi-approval SMS model enhances organizational safety oversight, supports continuous improvement, and strengthens the strategic role of safety performance measurement in vocational aviation training organizations.

Integration of Safety Assurance, Management of Change, and Continuous Improvement within the Multi-Approval SMS Framework

Chapter 3 of the Safety Management System (SMS) Manual at Politeknik Penerbangan Indonesia Curug operationalizes the findings of this study by translating the mapped Safety Performance Indicators (SPIs) and Safety Performance Targets (SPTs) into an integrated Safety Assurance framework applicable across multiple regulatory approvals. Within a multi-approval organizational context, Safety Assurance functions as the central mechanism that links performance monitoring, organizational decision-making, and continuous safety improvement. Monthly performance reviews, periodic management evaluations, and oversight by the Safety and Quality Council demonstrate institutional alignment with ICAO Annex 19 and ICAO Doc 9859, while simultaneously accommodating the distinct operational characteristics of CASR Part 141, Part 145, and Part 147 activities.

A critical component of this framework is the Management of Change, which explicitly recognizes that significant changes, whether occurring directly or indirectly can affect product safety and overall system performance. Within the multi-approval SMS, changes in regulations, emerging operational patterns, planned modifications to operational activities, fluctuations in operational output, leadership transitions, and internal organizational restructuring are treated as safety-relevant conditions. These changes are systematically subjected to safety evaluation and risk assessment to determine whether existing risk mitigation measures remain suitable and effective. By doing so, the SMS prevents the erosion of safety controls that may otherwise occur when organizational conditions evolve without corresponding reassessment of risk.

Management of Change further extends to situations involving substantial organizational transformation, including fundamental alterations to systems, processes, or procedures; the introduction of new operational approaches or products; and the deployment of new or advanced

equipment and technologies. In the context of a multi-approval organization, such changes may affect one approval more directly than others. However, by embedding Management of Change within a unified Safety Assurance framework, the SMS ensures that risks introduced within one operational domain are evaluated for their potential impact across all approvals, thereby maintaining coherence and consistency in safety performance management.

Complementing Management of Change, the Continuous Improvement process ensures that Safety Assurance does not remain static, but evolves in response to performance data, audit findings, and organizational learning. To ensure that the SMS performs effectively, PPI Curug continuously evaluates its safety processes through structured internal audits and systematic performance reviews. Each year, prior to the commencement of the new operational cycle, the SMS internal audit program is designed and integrated into the Annual Safety and Quality Internal Audit Master Schedule. This integration ensures that SMS oversight is aligned with broader organizational governance and quality assurance processes.

The SMS internal audit process is guided by a structured assessment protocol, which provides a comprehensive checklist for evaluating key components of the SMS. These components include safety policy, organizational functions and responsibilities, safety objectives and performance metrics, hazard identification and risk management practices, SMS education and training, records and documentation, audit processes, and emergency response planning. By applying this protocol consistently, the organization ensures that both approval-specific and organization-wide safety requirements are systematically assessed.

Findings arising from SMS audits are formally documented within the safety and quality audit system and are addressed through structured corrective action processes. Identified non-conformances are analyzed to determine root causes, and appropriate corrective and preventive actions are recorded and monitored. This process establishes a clear feedback loop between performance monitoring and organizational response, ensuring that deficiencies identified through Safety Assurance activities lead to tangible safety improvements rather than remaining as isolated audit observations.

The effectiveness of Continuous Improvement within the multi-approval SMS is closely linked to the competence of personnel responsible for conducting audits and evaluations. Internal SMS auditors are therefore required to possess adequate training in SMS standards and regulatory guidance issued by the relevant civil aviation authorities. Certified Safety and Quality Auditor credentials are mandated to ensure that auditors possess both technical expertise and regulatory literacy. This requirement reinforces the credibility of audit outcomes and supports consistent evaluation of safety performance across heterogeneous operational domains.

In addition to routine audits, the overall effectiveness of the SMS is assessed on an annual basis. This assessment examines the extent to which the SMS continues to achieve its stated objectives and support acceptable levels of safety. Key elements evaluated during this assessment include the organization’s safety policy and objectives, the adequacy of safety performance metrics and safety targets, the effectiveness of safety reporting systems, the robustness of the internal SMS audit program, and the organization’s preparedness for emergency situations. Through this comprehensive review, the SMS is evaluated not only for compliance, but also for its capacity to support adaptive risk management and continuous organizational learning.

Taken together, Chapter 3 demonstrates how Safety Assurance, Management of Change, and Continuous Improvement collectively operationalize the multi-approval concept within the SMS framework. Rather than treating approvals as isolated entities, these mechanisms ensure that safety performance monitoring, risk reassessment, and corrective action are integrated across pilot training, maintenance operations, and maintenance training activities. In doing so, the SMS supports a performance-based, resilient approach to aviation safety management, where safety performance improvements achieved within one approval are sustained and aligned across the entire organizational system.

5. Conclusion

This study demonstrates that the implementation of a multi-approval Safety Management System at Politeknik Penerbangan Indonesia Curug enables a more structured, coherent, and performance-based mapping of Safety Performance Indicators and Safety Performance Targets

across CASR Part 141, Part 145, and Part 147 approvals. The findings show that while SMS has been formally implemented in accordance with ICAO Annex 19 and national aviation regulations, the effectiveness of safety performance monitoring depends on the integration of approval-specific indicators within a unified governance framework supported by Safety Assurance, Management of Change, and Continuous Improvement processes. Academically, this research contributes to the SMS literature by extending performance-based safety management and safety governance concepts to the context of multi-approval aviation training organizations, an area that has received limited empirical attention. Practically, the study provides regulators and Approved Training Organizations with a validated framework for integrating SPI - SPT mapping into SMS manuals, supporting more effective oversight, organizational learning, and regulatory alignment. Nevertheless, this study is limited by its focus on a single vocational aviation training institution and a qualitative design, which may constrain broader generalization. Future research should therefore examine the applicability of the multi-approval SPI - SPT mapping framework across different aviation training institutions, incorporate quantitative safety performance data, and explore longitudinal assessments to evaluate the impact of integrated SMS implementation on organizational safety maturity and resilience over time.

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