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Comparative Safety Outcomes between Business Aviation Operators with and Without Advanced SMS Implementation

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Abstract

The shift toward the implementation of Safety Management Systems (SMS) in business aviation has become both an operational and regulatory necessity in the last twenty years. There are still some differences in the SMS implementation depth and maturity among operators, even with global mandates from the International Civil Aviation Organization (ICAO). This study assesses the differences in safety outcomes within business aviation operators with advanced SMS structures and those without, using an article review of empirical studies published from 2010 to 2023. It has been observed that the advanced SMS systems have a direct positive impact on safety performance. Organizations that advanced systems, reported significantly lower incident rates and enhanced hazard reporting culture. There was also a noted increase in regulatory compliance when compared to organizations that did not have structured systems in place. There are still some gaps in the standard SMS systems, including a standardization of metrics, regional enforcement, and integration of digital tools. This paper recommends enhanced monitoring systems for SMS maturity that include cross-industry benchmarking and suggest a shift towards cultural transformation for the organization.

Keyword: *Safety, Business Aviation, Operators, SMS, Digital Tools.*

I. INTRODUCTION

Business aviation continues to occupy an important place in the global air transport ecosystem, facilitating timely and effective travel for individuals, company executives, and government leaders. Unlike the commercial sector, which relies on a large fleet and operates on a set schedule, business aviation includes a myriad of operators ranging from small private jet management companies to large corporate flight departments which operate differently and have different safety management systems. This variety results in disparate safety oversight throughout the entire sector.

In recent years, business aviation has also adopted the Safety Management System (SMS) as a critical framework aimed at improving the sector's safety performance. As defined by ICAO (2022) "SMS is an organized, systematic approach to managing safety at an institution which integrates safety at all levels of operations". It also organizes safety as a coordinated system in which the interrelated parts have defined functions, levels, policies, and standing operating procedures. This method restructures management to enable the identification and management of potential safety threats before they escalate.

Adopting SMS allows business aviation operators to cultivate proactive safety processes and continuously evolving safety cultures instead of merely complying with regulations. SMS frameworks ensure operators, irrespective of their size, comply with industry standards and best safety practices and go beyond simple compliance to protecting passengers, crew, and equipment. The diverse nature of business aviation creates a rationale for uniform adoption of SMS in the industry which would ensure a singular benchmark for safety performance and uplift safety standards globally.

The gap in adoption of Safety Management Systems (SMS) is particularly pronounced in business aviation, and their demonstrable advantages in safety enhancement and operational efficiency are consistently overlooked. The unregulated environment in which business operators are allowed to function leads to a culture of ticking the box, an

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environment where formal safety structures are absent. Others choose to implement uncoordinated random safety practices void of oversight which leads to a lack of uniform safety cultures and performance across the industry. This naturally leads to the question, do organizations with sophisticated SMS outperform their peers in safety performance? This document intends to explore that by conducting a safety performance and safety culture comparison SMS framework analysis of the proprietary literature published between 2010 and 2023. It aims to look into the safety culture between operators who have implemented advanced SMS frameworks and those who have not. The resulting conclusions will assist to answer the question that has been circulating: does active, systematic, and organized safety management enhance safety metrics and operational resilience in the context of business aviation.

II. LITERATURE REVIEW

The literature demonstrates the importance of Safety Management Systems (SMS) in improving aviation safety. As noted by Stolzer et al. (2018), the SMS frameworks enable aviation operators to proactively identify safety issues, perform risk evaluation, and enable safety measures to be updated and evaluated regularly. This proactive approach aids aviation operators in resolving safety issues long before they become incidents or accidents. Research however, emphasizes the positive effects of advanced SMS on operational incidents. Their research showed that operators who maintained advanced SMS frameworks, especially, showed a reduction in runway incursions and maintenance errors. These findings strongly support the need to invest on advanced SMS capabilities to enhance safety performance.

Not all operators possess the same level of maturity with SMS. Li et al. (2019) and Goh & Hum (2020) studied the smaller business aviation operators and reported that they had difficulty adopting SMS due to a lack of funding and personnel. Such financial and personnel constraints hinder the ability to meet the standards set in ICAO Annex 19, which offers standards and recommended practices for safety management.

Advanced SMS-equipped operators usually come with dedicated safety personnel, advanced data analytics, and integrated reporting systems (Kraus & Probst, 2021). Such operators actively utilize and SMS maintenance, which in turn, SMS functioning improves safety outcomes.

The implementation of SMS has been documented widely, as emphasized in comparative studies. Wu et al. (2022), for example, has remarked that advanced operators with SMS recorded up to 35% fewer safety incidents compared to those without. Morales and Ríos (2023) further Sara's arguments stating that SMS maturity improves the safety culture within the organization, which in turn, makes employees more willing to report unsafe conditions and adhere to standard operating procedures.

Regardless of the strong arguments put forth, some researchers have emphasized the need to consider the cultural and contextual frameworks within which the SMS is thought to operate. Antonsen et al. (2021) argue that in the absence of authentic leadership commitment or organizational buy-in, SMS has the potential to devolve into a "paper exercise" with no real-world impact. This underlines the need to focus on the safety culture within the organization and the real commitment to safety that is required to implement SMS systems genuinely.

The literature demonstrates notable examples of SMS's effectiveness in improving aviation safety. Its impact, however, is contingent on the implementation level and the organizational culture. Safety SMS frameworks should be emphasized as priorities, alongside the cultivation of a robust safety culture within the organization.

III. METHODOLOGY

This study utilizes a systematic article review method, gathering findings from empirical studies published in peer-reviewed journals from 2010 to 2023 and available on Google Scholar. Some of the keywords used include business aviation safety, Safety Management System, SMS implementation, aviation incidents, and safety outcomes comparisons.

Out of an initial pool of 126 articles, 38 were selected based on their relevance to business aviation and SMS implementation outcomes. These included incident data quantitative assessments and safety culture qualitative evaluations. The data were extracted and compared under themes such as incident reduction, safety culture, compliance with regulations, and organizational performance.

The review approach allows for the examination of recurring patterns across studies while accounting for areas of agreement or disagreement in the findings.

IV. FINDINGS

- *Incident Reduction Trends*

The reviewed studies show that aviation operators with fully functional advanced Safety Management Systems (SMS) tend to have much lower accident and incident rates compared to those without. For instance, Stolzer et al. (2021) demonstrated that operators with fully developed and implemented SMS programs experienced a 35% reduction in incident frequency. Strong supporting data also come from the NBAA, which found that advanced SMS enabled operators to record accident rates as low as 0.15 per 100,000 flight hours, which is less than half the rate 0.39 per 100,000 flight hours reported by operators without SMS. Further supporting this, Vasigh and Fleming (2022) conducted a cross-regional study that found operators with SMS were much faster in hazard identification and corrective action, which lowered safety incidents. These studies collectively showed that with the

proper SMS in place, aviation operators cultivate a more proactive approach to risk management and detection, which lessens operational disruptions and improves safety Performance.

- *Safety Reporting Culture*

From different studies, it is apparent that there is a major disparity within safety reporting cultures for operators who possess advanced Safety Management Systems (SMS) as compared to those who do not. According to Kanki et al. (2019), operators that possess advanced systems display compliance reporting levels 50–70% higher than those who do not use these systems. This is probably due to the non-SMS operators suffering from chronic underreporting issues for a number of reasons. These reasons are often rooted in the fear of punitive measures, a lack of proper feedback systems, or a lack of proper feedback mechanisms, as pointed out by Reason (2016). On the flip side, ICAO (2018) notes that advanced SMS frameworks create what is referred to as "just culture," which promotes safe reporting of hazards by employees who feel safe and secure reporting within the organization. This type of cultural transformation acts to improve overall communication within the organization and not only improves communication, but improves the quantity and quality of safety information that is gathered, thereby enhancing the precision and efficacy of predictive risk assessments. In the end, such a reporting culture fosters the ability to proactively identify safety threats and improve safety dramatically.

- *Regulatory Compliance and Audit Performance*

The outcomes of regulatory audits show a clear divide in compliance and safety performance between aviation operators with and without advanced Safety Management Systems (SMS). Operators that have implemented robust SMS frameworks demonstrate a 40% higher adherence to regulatory safety requirements compared to non-SMS operators (FAA audits as cited in Stolzer et al., 2021). This compliance level shows the operators' commitment to fulfilling safety standards and effective risk management. On the other hand, non-SMS operators tend to be in a cyclic audit finding situation for critical crew training, maintenance supervision, and fatigue risk management deficiencies (Kearns and Mavin, 2020). Such gaps not only increase operational risks for the operators, but also increase exposure to regulatory enforcement action such as fines, restrictions, or flight suspensions. Advanced SMS frameworks guarantee a systematic risk identification, management, and mitigation strategy that strengthens regulatory alignment. Systems with this set of controls withstand safety compliance failures because SMS frameworks promote ongoing supervision, documentation, and proactive corrective action.

This capability is critical in today's aviation ecosystem, where an integrated safety management approach is an expectation from the oversight authorities, and aviation operators are expected to proactively mitigate incidents. In the end, better safety outcomes from more advanced SMS are achieved through improved risk management. Furthermore, aviation operators are more confident in the acceptance of autonomy, seamless operational flow, and reduced chances of expensive compliance actions.

- *Enhanced Operational Productivity with Reduced Operational Cost*

While the main goal of the Safety Management System (SMS) is to promote safety in operations, at a minimum, the review of the operational and economic advantages in the literature seem to indicate that its advantages are more pronounced. For example, operators with more sophisticated SMS do not experience the delays associated with maintenance concern, which the NBAA noted as an issue that compromises operational productivity in aviation in 2023. The reduction of delays contributes not only to operational productivity but also brings about enhanced cost efficiency by reducing unplanned disruptions Furthermore, Vasigh & Fleming's 2022 work shows that mid-sized operators with SMS programs in place can save $200,000 every year. These savings stem from lower incident-related downtime and flight schedule interruptions and improved risk management practices that lower insurance costs. In contrast, operators lacking an SMS face significantly greater hidden and indirect costs because of chronic operational stagnation and a lack of effective hazard identification and risk management. These operators fail to take a proactive approach, instead reacting to hazards only after they have disrupted operations.

Furthermore, these financial gains highlight the impact of effective SMS implementation on safety resilience and on the sustainability of a business. SMS's preemptive approach to incidents curtails the far-reaching impacts of accidents or mechanical failures on an operator's reputation, customer relations, and finances. The proactive culture fostered by SMS encourages the timely, thorough, and sustained reporting of necessary processes that trims unnecessary delays, thorough investigations, and swift corrective actions, thereby improving resource allocation. The combined evidence strongly points out that SMS provides a comprehensive ROI where safety improvements enhance operational consistency and economic efficiency. The aviation operators of today, grappling with stringent regulations and a high-risk milieu, require SMS due to this unique advantage.

- *Obstacles to the Implementation of SMS*

While the advantages of Safety Management Systems (SMS) are well documented, there are a number of persistent challenges that hinder their adoption, especially for smaller operators. One challenge stems from the lack of available resources. As Kanki et al. (2019) points out, smaller organizations have a particularly hard time allocating the proper financial and human resources to construct, put into place, and sustain a thorough SMS program. In the absence of adequate funding and staffing, the effectiveness of the system suffers. Another major

barrier is the lack of acceptance within the workforce. Reason (2016) points out that a section of the pilots and crew members view SMS as an imposition of red-tape, which does not aid safety and instead adds extra documents and procedures. Such perceptions lead to a reluctance to engage fully with SMS activities and, in turn, dampen commitment to the organization as a whole. In addition, these perceptions, combined with inadequate training, create additional barriers. ICAO (2018) states that the absence of standardized, practical, and accessible training materials leaves many personnel unable to effectively utilize the available SMS tools, thereby diminishing the capacity of many organizations to apply SMS principles in day-to-day safety operations.

The combination of these barriers illustrates the reason many operators, especially smaller operators, continue to do business without such systems, regardless of the evidence supporting the use of SMS in accident reduction and regulatory compliance. Addressing these challenges requires tailored strategies that resolve budget limitations, enhance safety culture, and intense training. In the absence of these specific strategies, the full integration of these systems will remain unachieved, and the safety improvements will continue to be unachieved.

V. CONCLUSION

From the review article it is clear that there is a distinct relationship between the developing sophistication levels of Safety Management Systems (SMS) and the business risks associated with Safety Management Systems (SMS). Operators with more advanced SMS frameworks tend have a much more evident advantage activities safer compared to those with less developed SMS frameworks. This business advantage stems from the initiatives that the operators with advanced SMS frameworks take towards hazard identification as well as proactively enforcing a positive safety reporting culture. Enhanced safety reporting culture ensures that risk reporting is done well ahead of time and identification of risks is done much in advance. Such reporting enables these operators to have lower incident and accident rates. Such organizations tend to also have much better legal compliance. This ensures that legal penalties are avoided and also helps in reducing operational downtime from activities that have to be paused due legal non compliance. Well developed frameworks also help in having much better operational resilience since there is premised safety culture and risk management processes that are systematic. Operators with less refined SMS frameworks tend to face greater safety concerns compared to others. These operators tend to experience greater safety incident recurrence, inadequate hazard reporting, and weak reporting mechanisms. These issues greatly enable these operators to overcome such reporting deficits.

Seeing through to a successful transition to an SMS may take considerable time, monetary, and cultural investment within an organization. However, the return on investment benefits SMS compliance achieves far outweigh the initial costs. The payoffs include enhanced operational efficiency which leads to improved safety performance, smoother workflows, a decrease in flight delays, and reduction in insurance premiums, all of which strengthens an operator's economic position. These results make a compelling case for all business aviation operators, irrespective of size and resources, to invest in and adopt universal SMS. The maintenance and integration of an SMS by all operators will greatly enhance safety practices in the sector and in turn, elevate the safety standards of the industry. Most importantly, the resource-strapped, smaller operators, can be greatly supported by targeted training on SMS compliance. Closing this gap will ensure the whole community of business aviation advance toward improved safety.

VI. RECOMMENDATIONS

- *Require All Business Aviation Operators, Irrespective of Their Magnitude, To Adopt an SMS System.*

In order to close business aviation safety gaps, it is imperative that all operators are mandated to have an SMS system. This policy will create a uniform baseline safety standard across the industry, ensuring that operators with fewer resources do not fall further behind. Compulsory SMS adoption motivates operators to go beyond the bare minimum, exposing their operations to proactive safety practices that bolster performance across the board.

- *Offer Tailored Training Financial Aid and Technical Assistance to Enable the Smaller Operators to Overcome Resource Constraints.*

The financial and human resource constraints faced by smaller business aviation operators makes it difficult for them to fully implement the SMS programs. Targeted training financial aid helps to offset the financial impacts, and dedicated technical assistance helps provide the needed hands-on direction to implement and maintain strong safety management systems. These steps enable smaller operators to meet the requirements of SMS without undermining the operational safety and the quality of safety culture in the organization.

- *Encourage "Just Culture" Initiatives to Promote Transparent Hazard Reporting.*

Constructing a workplace culture which allows employees to report mistakes or safety issues without risk of reprimand is critical. "Just culture" programs build trust as well as inviting participation and candid information sharing. This honesty allows for better risk and hazards management, and continuous improvement, thus enhancing the effectiveness of the safety management systems (SMS) in every organizational tier.

- *Use Safety Data Analytics Within The SMS Frameworks to Improve Predictive Risk Management.*

Operators can make use of advanced data analytics using SMS frameworks to identify patterns and foresee possible safety concerns long before they escalate to incidents. Analytics helps allocate resources efficiently, as they identify areas most prone to safety breaches, thereby enhancing overall decision-making and risk control. This

transforms the SMS from a reactive approach into a forward-looking, strategic instrument towards the attainment of safety benchmarks.

- *Reluctant Operators Can Be Persuaded by Incorporating the Economic SMS Benefits into Their Long-Term Operating Costs.*

Operators who are apprehensive make a move towards the implementation of the SMS are because of the upfront investment, or the perceived complexity of the system. This can be well addressed by putting forward the SMS as a positive, economically impactful investment, emphasizing the return from the reduced downtime and incidents, and lower insurance premiums.

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