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STRENGTHENING SAFETY MANAGEMENT IN AVIATION MAINTENANCE: INSIGHTS FROM EASA AND GLOBAL REGULATORY FRAMEWORKS

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Abstract. Anticipated growth in global commercial aviation poses significant challenges to maintaining established safety levels, particularly in aircraft maintenance. Safety Management Systems (SMS), as defined by the International Civil Aviation Organisation (ICAO) Annex 19, provide a structured framework for hazard identification, risk management, and continuous improvement. This paper examines SMS implementation in the maintenance domain across key jurisdictions, highlighting regulatory variations: mandatory adoption in Europe through the European Union Aviation Safety Agency (EASA), voluntary compliance in the United States under the Federal Aviation Administration (FAA), and structured guidance in Australia via the Civil Aviation Safety Authority (CASA). These differences illustrate the complexity of achieving consistent global safety outcomes. The discussion underscores the need for systematic hazard identification, risk mitigation, and competency development to ensure effective SMS implementation. While ICAO standards offer a foundational schema, regional interpretations and gaps in practical guidance remain challenges. Strengthening SMS understanding and application is critical to sustaining safety performance amid rising operational demands.

Keywords: safety management systems, aviation maintenance, EASA, FAA, aviation.

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1. Introduction

The commercial aviation industry is one of the key enablers of global pecuniary activities and societal progress. The International Civil Aviation Organisation ([ICAO], 2025) discharges its devoir through a harmonised effort across regulated segments such as safety, security and environmental domains. It also has primacy as an enabling colloquium for confederacy amongst the 193 signatory States to the founding Chicago Convention (ICAO, 2006a).

Considerable advances in aviation safety have been made with the advent of ICAO's standards & recommended practices (SARPS) and the Annexes to the Chicago Convention. This body of work is highlighted by documents such as the Global Aviation Safety Plan (GASP) Doc 10004 (ICAO, 2022), which outlines the global strategy for continuous improvements in aviation safety. The 2024 ICAO safety report (ICAO, 2024a) features 2023 safety data, which records an increase from 4.2 billion passengers (carried by commercial operations) when compared to 3.2 billion passengers for the same period in 2022. This was mirrored by a comparable increase in commercial operation departures for 2022 from 31 million to 35 million in 2023. For the 2022–2023 period of comparison, unfortunately a slight increase of 3.1% in accidents reported by ICAO states, and this was on the back of a 13% increase in flight departures over this period. Overall, the global accident rate of 2.05 accidents per million departures in 2022 was down by 17.9% in 2023 to 1.87 accidents per million departures.

The Boeing Company (Boeing, 2025) is forecasting considerable growth over the period of 2025 to 2044, with an anticipated increase in the global passenger fleet to 50,000 active commercial aeroplanes. This represents a 1.8-fold increase from the 2024 fleet of just over 27,000 aircraft. Airbus (2025) proffers similar increases of around 50% in airline traffic over the same period in the future. With such forecasted increases in commercial aviation-related activity, maintaining current established acceptable levels of safety in this segment may be challenging. Therefore, a doubling of activity could yield a corresponding increase in accidents, which would not be acceptable. ICAO (2016) has recognised the impact of these challenges and developed a specific Annex (i.e., Annex 19) which contains standards and recommended practices to assist states and airline operators to formally recognise hazards and risks which are inherent in the sector's activities.

In Europe, these standards are almost fully transposed into the European Union (EU) member state domain regulatory form. Annex 19 (ICAO, 2016) is the baseline document informing the structure and content of a safety management system (SMS) regardless of the aviation segment it affects. Currently, in Europe, airline operators, continuing airworthiness management organisations, aircraft maintenance organisations, design organisations and production organisations are all affected by these requirements. This paper contributes a domain specific analysis of how ICAO Annex 19 has been applied in support of implementing SMS in the aircraft maintenance environment across different jurisdictions and discuss the approach taken in these ICAO member states. Implementing actions to support the effectiveness of SMS will also be considered.

2. Background

An accident (or serious incident) can occur if, according to Perrow (1999, p. 357), "...we need to have just the right combination of conditions in the response system and the surrounding environment for the catastrophic potential to be realised". For the purpose of learning through establishing causation, aircraft accidents and incidents are investigated under an international article which is enabled by a legal obligation (Annexes 13 (ICAO, 2024b) and 19 (ICAO, 2016)) placed on a member State within which an accident or (defined) incident occurs. States are required to institute and manage an inquiry in accordance with the guidelines as the laws permit. From a proactive perspective, it is a fundamental ICAO requirement for all (aviation) design, production, operational and maintenance organisations to subscribe to an occurrence reporting system. For example, in European Commission Regulation (EU) No 1321/2014 (European Commission, 2014a) that relates to the aircraft maintenance code Part 145 requires entities and individuals involved in maintenance to consider and report defined occurrences to several parties. In parallel, flight crew and other professionals have specific obligations under operational requirements (EU OPS 965/2012) (European Commission, 2012). From an aircraft production and design perspective, SMS is linked to the certification of the organisation responsible for the type design and production of aircraft, engines or propellers, and not directly to the certification of the product.

For EU-regulated maintenance and continuing airworthiness activities, the Part 145 (European Commission, 2014a) maintenance reporting requirement is predominantly intended to highlight technical and design issues that affect or could affect aircraft safety. EU member states mandate reporting of any issue that could result in or has resulted in an unsafe condition that seriously hazards flight safety. Following a comprehensive review of the EU legislation that supports accident and incident investigation, Regulation (EU) No 376/2014 (European Commission, 2014b) was developed. Some of the tasks and responsibilities associated with this regulation are the brief of dedicated air accident investigation entities and competent authorities. Member state occurrence reporting obligations appoint aviation entities such as aviation authorities to oversee the establishment "*of an occurrence reporting system as part of the management system... in order to contribute to the aim of continuous improvement of safety*" (European Commission, 2018). This is also a key tenet of SMS and risk mitigation and is strongly reflected within the structure of ICAO Annex19 (ICAO, 2016) being applicable to states and service providers alike.

Risk is ubiquitous in many facets of aviation activity. With an understanding of the impact of such risks in an operating environment, some risks may be acceptable, some not and more it may be possible to develop effective mitigating measures to limit consequences. Gigerenzer (2003, p. 25) defines an 'ignorance of risk' in which "*a person does not know, not even roughly, of how large a personally or professionally relevant risk is*". According to Dekker (2011, p. 13), "*Rational decision making requires a massive amount of cognitive resources and plenty of time*". Investments in safety should advocate some guarantee of safety and also profitability in an aviation organisation. In the airline industry, the travelling public appreciates an acceptable level of safety and at the same time it expects more services at less cost. In tandem, the corporate shareholders will continue to anticipate increasing return on investment (Carroll & Fahlbruch, 2011). However, the overall cost of an aircraft accident or serious incident is difficult to measure in addition to loss of life, reputational damage and in monetary terms. The UK CAA CAP 795 (United Kingdom Civil Aviation Authority, 2015) espouses SMS, "*as a proactive and integrated approach to managing safety including the necessary organisational structures, accountabilities, policies and procedures*". Many sources of risk are easy to detect and action as necessary. Quiescent or unrevealed risks are often more difficult to uncover and attempt to introduce effective measures for. For example, safe aviation operation is hugely reliant on well-executed maintenance and competent management of the functions. In comparison to other inputs to aircraft operations, underperformance relating to maintenance intervention may often be difficult to detect. There can be latent issues remaining undiscovered for some time until the necessary conditions arise for an undesirable event to occur. Valuable insights into how design deficiencies can set up an unintentional path to maintenance errors are clearly revealed by Karanikas et al. (2018). The recent introduction of SMS to the maintenance sector of the European industry underscores the need to manage such risks. The safety management obligations for ICAO states, tasked with the implementation and oversight of SMS, are clearly outlined in Annex 19 (ICAO, 2016) and follow the same generic structural content as for the affected industry organisations (e.g., safety policy and objectives, safety risk management, safety assurance & safety promotion). This construct is known as a state safety programme (SSP). Each ICAO member state has an obligation to efficaciously apply an appropriate SSP commensurate with the size and complexity of the aviation activity within that state, to achieve an established level of safety.

3. The basis for implementing a safety management system (SMS)

ICAO defines a safety management system (SMS) as a "systematic approach to managing safety, including the necessary organizational structures, accountability, responsibilities, policies and procedures". In general terms, an SMS is a schema that provides a framework that can be customised to meet each organisation's specific safety outcomes. At a high level, ICAO Annex 19 (ICAO, 2016) and related documents such as Doc 9859 (ICAO, 2018) are transposed into guidance that is used as the basis of States' SMS oversight methodologies. The following paragraphs will record the main aspects of SMS implementation documentation existing in the public bailiwick.

Annex 19 (ICAO, 2016) arose because of the important focus by ICAO on the necessity to develop a dedicated Annex (in the form of standards and recommended practice) capable of assisting States in managing their safety risks. This Annex is intended to provide the basis of a strategy for States and organisations that are obliged to systematically identify, mitigate and manage safety risks that are inherent in the affected domains. At a high level, States are required by the Annex to establish a state safety programme (SSP). The SSP is a State led, "*integrated set of regulations and activities aimed at improving safety*". Appendix I of the document outlines the State safety oversight (SSO) system which is comprised of eight critical elements (CE) (Primary legislation; specific operating regulations; state system and functions; qualified technical personnel; technical guidance, tools and provision of safety-critical information; licensing, certification, authorization and approval obligations; surveillance obligations; resolution of safety issues). These elements form the basis of an SSP.

Specific organisational requirements for airline operators, airport operators, maintenance organisations, engine and propeller manufacturers and type design holders are contained in Chapter 4 of the Annex. Presently, these requirements are not applied to international general aviation (GA) operations. The SMS framework for organisations is contained in Appendix II and serves as the basis for the implementation of a service provider's SMS. ICAO Annex 19 (ICAO, 2016) defines the following integrated components of an SMS (and SSP) as:

- Safety policy and objectives.
- Safety risk management.
- Safety assurance.
- Safety promotion.

The Annex also extends to providing guidance on the protection of safety data, safety information & related sources and decrees the importance of a germane approach to the management and sustainability of SMS principles. For States to mandate ICAO standards and recommended practices, these requirements must be transposed in accordance with each ICAO member State's unique national framework. According to ICAO Doc 9734 (ICAO, 2006b) implementing the eight critical elements mentioned earlier is a positive indication of the presence in statute of a State's operational safety oversight capability. However, there are challenges within some countries when it comes to developing and implementing regulations. This can often be the case because different legal frameworks and systems may interpret these provisions in slightly different ways. This is a primary reason why standards and recommended practices (SARPS) are only designed to provide the minimum necessary and desirable requirements. In practice, the content of SARPs does not contain detailed content and specific structure to enable verbatim legal transposition. It is the responsibility of each ICAO member State to develop regulations that contain adequate detail yet remain within each underpinning legal framework (ICAO, 2006b).

4. Implementing exemplars

Differences in safety standards and safety performance are evident and verifiable from multiple sources. The ICAO global accident rate illustrates an overall indicator of safety performance for air transport operations. Documents such as the Global Aviation Safety Plan (GASP) (ICAO, 2022) presents a global strategy for the continuous improvement of aviation safety. EASA states, "*Safety management seeks to proactively identify hazards and to mitigate the related safety risks before they result in aviation accidents and incidents. Safety management enables an organisation to manage its activities in a more systematic and focused manner*" (European Union Aviation Safety Agency [EASA], 2025b). Many organisations, regardless of their geographic location, will have some appreciation of the concept and may even have some of the necessary components in place. Therefore, some differences may exist between jurisdictions when it comes to regional interpretation, cultural norms and legal frameworks. Three main centres of aviation activity are considered in the review of basic implementation documentation, i.e., Europe, the USA and Australia.

4.1. European Aviation Safety Agency (EASA)

In Europe, the European Union Aviation Safety Agency (EASA, 2025a) is responsible for ensuring safety and environmental protection in many aspects of civil aviation. Development and implementation of SMS falls within the Agency's remit. EASA has prepared a comprehensive management system assessment tool (MSAT) (EASA, 2023) to support organisations (and competent authorities) with the implementation of SMS. The document provides a template which can be customised for the initial evaluation of the EASA codes, and as an aide memoire for continued oversight of the subject activities and the implementation of SMS in aircraft maintenance organisations.

The MSAT tool features two main aspects of an EU management system.

- The SMS elements, integrating ICAO Annex 19 (ICAO, 2016), and its legacy framework.
- The compliance monitoring system, intended to verify compliance with the associated EU requirements.

The inceptive purpose when applying the MSAT analysis process is to gauge the applicant organisation's state of readiness to confirm the necessary elements of an SMS system are 'Present' and 'Suitable', thus assuring an examining competent authority the required system enablers are in place. The template can also be applied in support of the continued oversight by the organisation. Additionally, it can be used by the overseeing competent authority within the first oversight planning cycle to confirm the necessary ineluctable SMS processes are 'Present', Suitable' and 'Operating'. EASA encourages stakeholders to use the MSAT also to continuously reevaluate the SMS outputs and aggregate these with meetings, visits and desktop reviews to discern and validate 'Effectiveness'.

Strict adherence to the applicable content under examination has inherent potential to yield a thorough review of the subject code. While the MSAT (EASA, 2023) contains a terse description of training on how to use the tool; there are no specific domain requirements that could be integrated into a user competence assessment. Equally, best practice guidelines or staff qualifications for the subject domains when conducting effective hazard identification and risk assessments are not articulated. Addressing these points in future iterations of the document could potentially enable a standardised approach (and output) by industry and competent authority users alike

4.2. Federal Aviation Administration (FAA)

The FAA advisory circular (AC 120-92D) (FAA, 2024) sensibly recommends a pragmatic approach to constructing an SMS by forming the architecture of the system around the ICAO structure. The AC 120-92D (FAA, 2024) provides a method enabling implementation for SMS in certain aviation service providers. The airworthiness circular states the document "… *provides information to assist aviation organisations including but not limited to those regulated under Title 14 of the Code of Federal Regulations* (FAA, 2025) *parts 91, 121, 133, 135, 137, 141, 142, 145, and 147*", in developing a voluntary safety management system (SMS). Effectively, compliance with Chapter 1, Part 5 of Title 14 of the Code of Federal Regulation (CFR) is achieved if the proposed SMS meets the specified requirements. Compliance times and milestones for the introduction of SMS are outlined in the different elements of Title 14 CFR, and the document can also be applied to assist with the development and management of a voluntary SMS. The AC 120-92D (FAA, 2024) mirrors the ICAO Annex 19 (ICAO, 2016) requirements and content. The concept of safety management is well explained and supports a clear assimilation for the reader of the process architecture.

The FAA Order 8000.369C (FAA, 2020) augments the existence of ICAO Annex 19 (ICAO, 2016) and achieves this by establishing SMS policy and requirements for the FAA and defining product/service providers. The FAA applies regulatory efforts as one means of controlling sector safety risk, coupled with its oversight activities. The Order is very specific when it emphasises the FAA has no responsibility for performing risk management or safety assurance on behalf of subject organisations. The overall concept of SMS and its relationship with other highly coupled management propositions, including risk-based data monitoring, regulatory compliance and safety reporting, is contained in FAA Order 8000.72 (FAA, 2017). This Order presents an integrated overview of the overall dependencies that affect the diffusion of SMS amongst regulatory and industry stakeholders. To strengthen the advancement of SMS, the Order also establishes a safety risk management policy for the FAA by defining a consistent approach to the management of and safety data for decision makers. Specific compliance times for air operators (e.g., Title 14 CFR Parts 121 and 135) (FAA, 2025) and guidance on the voluntary implementation of SMS are contained in FAA Order 8900.1A (FAA, 2022), Volume 27, Section 1. These requirements extend to organisations already operating in the specified categories and to new applicants, as outlined in Table 1 below.

Currently, the FAA has expanded the requirements for implementation of SMS voluntary programmes (SMSVP) to the following 14 CFR organisations:

- Part 91 Living History Flight Experience (LHFE)
- Part 91K – Fractional Ownership Operations

Table 1. 14 CFR Part 5 SMS compliance (source: FAA, 2026)

(a) Any person that holds or applies for a certificate issued under part 119 of this chapter authorizing the person to conduct operations under part 121 of this chapter.
(b) Any person that holds or applies for a certificate issued under part 119 of this chapter authorizing the person to conduct operations under part 135 of this chapter.
(c) Any person that holds or applies for a Letter of Authorization issued under § 91.147 of this chapter.
(d) Any person that holds both a type certificate and a production certificate issued under part 21 of this chapter for the same product.
(e) Any person that holds a production certificate issued under part 21 of this chapter for a product for which the person is a licensee of the type certificate for the same product.
(f) Any person that applies for a production certificate under part 21 of this chapter for a product for which the person is the holder or licensee of the type certificate for the same product.
(g) Any person that holds a type certificate issued under part 21 of this chapter for a product, except for persons that hold only type certificates issued under § 21.29 of this chapter, that allows another person to use the type certificate to manufacture the same product under a production certificate.

SMSVP eligibility for the following organisations remains unchanged:

- Part 125 Operations
- Part 133 Rotorcraft External Loads
- Part 137 AG (agricultural) Operations
- Part 141 Pilot Schools
- Part 142 Training Centers
- Part 145 Repair Stations; and Part 147 Aviation Maintenance Tech Schools

4.3. Civil Aviation Safety Authority (CASA) Australia

The Civil Aviation Safety Authority (CASA) (CASA Australia, 2025) website landing page for SMS contains a clear architecture of supporting documentation for organisations that wish to implement or improve an SMS. In one of the documents contained in the development resource kit, the regulator states, "*Those in business know a structured approach to safety management is something which complements good management, engineering and human factors*". The content and context of the guidance are well displayed and provide a clear overview of the requirements. In total, nine booklets (including a remotely piloted aircraft systems (RPAS) booklet) supplemented by videos are provided on the portal. The documentation (CASA Australia, 2025) (SMS 1, P. 5) mentions that implementing an SMS can produce "*several business benefits*". This assumes that a structured approach to safety management will reduce the possibility of unwelcome safety-related events in an organisation. The implementation documentation firmly identifies risk management as a key component of an effective SMS, which comprises identifying hazards, assessing risks and mitigating their potential to cause harm. Like other jurisdictions, a gap analysis tool template and other exemplars are provided to support implementation and continuous system monitoring. The CASA approach offers a schema that supports a clear view of how to implement, scale and maintain an ICAO Annex 19 (ICAO, 2016) compliant SMS regardless of organisation size.

5. Discussion

Safe air travel is an expectation that the public often invest little or no thought in. Fortunately, the industry has evolved to a stage where major air accidents are relatively rare. However, as highlighted by Woodlock (2023), "*Over the past two decades, research has suggested that 15–18% of serious aviation accidents are in some way associated with shortcomings in aircraft maintenance*". When an unwelcome event arises, at first glance, it is often too easy to suggest causation is rooted in 'fate or chance'. A different view usually emerges when a thorough investigation is performed, and root causation is examined. The sole involvement of providence can therefore often be discounted.

Looking back through the lens of learning from previous events, we can see that many incidents and accidents are preventable if appropriate measures are taken to establish causation and develop actions to prevent recurrence. To the credit of lawmakers and regulators, reporting (voluntary and mandatory) of prescribed events is maturing and offers a baseline for safety initiatives. Accident causation researchers once mainly blamed the operators involved, but now also consider the impact of system deficiencies (Harvey & Stanton, 2014, Dekker, 2016). This development has contributed significantly to a better understanding of the causes of accidents. Heinrich ratio (Heinrich, 1941) in its basic form emphasises that every accident with serious consequences is often framed against the backdrop of numerous seemingly insignificant events. Indeed, this 'philosophy' might be extended to consider a situation where, for every incident or occurrence identified, many undetected conditions that could contribute to latent failures exist. Such a scenario often results in 'breaches' of an organisation's physical and procedural system defences. According to Heinrich, in a grouping of 330 similar accidents, 300 will result in no injuries; 29 will result in minor injuries, and one injury will be of a serious nature. This implies that some benefits might accrue if the minor issues were identified and addressed where necessary before an issue can escalate further. Heinrich's ratio concluded that for every 300 incidents one fatal accident may occur, Wright and van der Schaaf (2004), thus suggesting the 1:300 ratio. Later, following Heinrich, Bird (Bird et al., 1986) conducted a similar study and deduced a ratio of 1:600. However, these presented ratios are proffered by the authors as one means of highlighting the importance for organisations to maintain a watching brief on seemingly insignificant minor events. Accordingly, the potential risk posed by any collection of minor events will be directly related to the activity in the sector, the organisation's accepted appetite for risk and mitigation measures each organisation decides to systematize. This concept is an underpinning aspect of safety management systems. In concert with SMS, proactively learning from incidents can provide potential solutions to preventing safety crises in the future by looking back at what has happened, deriving lessons learned and predicting probable future challenges (Bond, 2002). 'Learning from incidents' (LFI) is a valuable tool in many domains (Clare & Kourousis, 2021). Many researchers have devoted time to understanding how this process could be better expressed and measured, how worthwhile lessons can be learned through more efficient and effective learning, e.g. (Drupsteen & Guldenmund, 2014; Chatzi et al., 2024).

5.1. Preventing accidents and achieving acceptable levels of safety performance

The ICAO document (ICAO, 2018) defines safety in an aviation context as, "the state in which damage is reduced to, and maintained at or below, an acceptable level through a continuing process of hazard identification and safety risk management". Verifiable benefits of a consistent approach to safety management include safer systems of work, safer operations, reduction of and/or elimination of harm to the travelling public, improved compliance with regulation and procedural form, tangible increases in production and operational activity and an enhanced safety culture. The enhanced approach to safety presented by SMS should allow for improvements in the management of hazards and associated risk in organisational areas that enjoy the benefits of such a formalised approach. Evidently, aviation domain activities can pose a great degree of risk and are not always clement of associated hazards. Regulatory form has evolved to a position where aviation standards and recommended practices tend to be biased towards accident prevention and augmenting safety efforts. Safety in aviation has unfolded along a progressive continuum: beginning in the early 1900's where design and mechanical issues contributed greatly to aircraft accidents (ICAO, 2018). Following a plateau that contributed to addressing the offending technical factors, the remaining challenges then related to human performance and limitations. However, subsequent investment and research in developing human factor initiatives continued to witness accidents and incidents occurring. Hobbs (2001) associates the prevalence of such events with a recognition in the 1990s that several factors outside of the human input had a potential to negatively influence safety. Today's systematic approach to safety arose from this revelation (Leveson, 2011). Reason (1997, pp. 71–73) is a strong proponent of reinforcing the notion that risk and danger are ubiquitous in high-reliability industries. ICAO doc 9859 (ICAO, 2018) clearly recognises, "aviation systems cannot be completely free of hazards and associated risk". However, it is strongly acknowledged that subject to appropriate measures being applied, a satisfactory balance between production and protection can be achieved. Perrow (1999) seconds this postulation when he acknowledges, "we load our complex systems with safety devices in the form of buffers, redundancies, circuit breakers, alarm bells and whistles", because no system is perfect. Echoing this, ICAO Doc 9859 (ICAO, 2018) recognises the need for a dynamic system capable of managing safety performance by continuous recognition and management of hazards and associated risk.

5.2. Identifying the precursors

As discussed earlier, Heinrich's ratio (Heinrich, 1941) of 1:300 and later Bird (Bird et al., 1986) who theorises a finer-tuned ratio of 1:600 (after analysing 753,498 accidents reported by 297 cooperating companies) is also relevant in the context of the importance of event antecedents. According to Christensen (Christensen et al., 2008, p. 166) "*preliminary, descriptive bodies of understanding almost always have inductive origins*". In other words, derived from data. One of the ways this data can be improved upon and used is to seek out characteristics that deviate from normal trends. The concept of structuring an SMS to encapsulate the proactive & reactive collection of data is a method that can enable the identification of event precursors and impending trends. The analysis of these precursors, coupled with learning from previous events, offers organisations the capability to identify and categorise risk and inform effective mitigation measures. A structured approach to identifying the event precursors by actively addressing hazards and associated risk is a desired outcome of introducing SMS to continuing airworthiness activities. GM1 to 145.A.200 (EASA, 2014) loosely sets out the capabilities of a hazard identification and risk mitigation process in relation to a systematic approach to safety.

5.3. Making the best use of information

Kuhn (1997, p. 160), a notable scientific historian, states, "*to a very great extent the term 'science' is reserved for fields that do progress in obvious ways*". It could be argued that some safety pursuits, because of their underpinning characteristics, may or may not fall into this qualifying segment. Regardless of pretence relating to the prestige of scientific categories, organisations mandated to implement SMS require competent key persons to implement and manage effective management systems. Of course, the importance of competencies reflecting the necessary knowledge, skills and abilities cannot be overstated. Guidance material to Annex II (contained in European Commission, 2014a) defines competency as "*a combination of individual skills, practical & theoretical knowledge, attitude, training and experience*". The staff responsible for implementing SMS are required to "*embed safety management and risk-based decision making into all their activities*" (European Commission, 2014a). In reality, nominated staff often 'inherit' the task of SMS implementation and administration, which can run in concert with other assigned management duties. Since the introduction of SMS to aircraft maintenance code Part 145 (European Commission, 2014a), as defined in 145.A.200 (safety risk management, internal investigations, safety performance monitoring and measurement), minimal headings have been introduced to the already voluminous content of the generic (initial) human factors syllabus. However, such a sole superficial approach to supporting the knowledge component of competency in the form of terse expanded guidance does not include sufficient SMS fundamentals to guarantee efficacious SMS contrivance with aplomb.

This abridged gap could begin to be closed if a minimum regulatory competency standard for SMS and human factors instructors were developed. Obvious benefits associated with staff meeting a standard would include verifiable competence, structured delivery & approach, credibility, expertise and the ability to gauge learning outcomes. One potential specification for an instructor competence and qualification could include;

- Pedagogical skills – Meeting a minimum standard capable of attesting to an individual's ability to successfully exercise instructional techniques and develop training material (Remains current as an instructor also).
- Safety Management System (SMS) training – Have received training in accordance with a syllabus capable

of augmenting and understanding training material that supports students with an understanding of SMS obligations.
- Human Factors training (HF) – Have received initial and recurrent HF training.
- Industry experience – Have experience in the continuing airworthiness domain.

6. Conclusions

The capability of mature safety management systems to contribute to reducing unwelcome events is admirable and deserves countenance. A suitable SMS that supports an organisation in its plight to systematically identify hazards, associated risks and develop effective mitigating action can augment levels of safety. While ICAO Annex 19 (and antecedent regulatory requirements) are not new, SMS in the continuing airworthiness domain is. Aircraft operators and their own maintenance function tend to have built up a reasonable repository of experience of SMS since its inception in that segment. However, standalone (continuing airworthiness) organisations have joined the SMS continuum in its infancy in those environs and deserve more regulatory support with the development, transfer and subsequent monitoring of SMS. While the MSAT tool is a useful aid for affected EASA continuing airworthiness entities initially scoping out compliance with these requirements, there is a paucity of basic pedagogical information in existence for those responsible for understanding and implementing the risk management and safety performance of safety systems. The current deficit in SMS guidance makes it difficult to proffer an honest answer to the subject catechise. The important point that requires consideration and action is that safety management efforts are continuously effective regardless of the paradigm subscribed to. The lack of specific basic explanatory guidance for key staff on the salient factors supporting an effective SMS is a serious concern relating to embodying and sustaining the concept. To highlight the novelty of this limitation, we draw upon well-established theory that (individual and organisational) effective learning fundamental are influenced by a structured and consistent approach. Most developed learning approaches today owe their origins to robust and seminal theories developed over the last century mainly by a group of professionals with a behaviouristic disposition. Although these distillations are not yet fully applied in continuing airworthiness (maintenance and management), many of the fundamentals enabling learning are recognisable in existing formal domain learning environments where minimum standards are already set for instructors and subject material (e.g. Instructors within EASA Part 147 aviation training organisations). The absence of minimum competence requirement guidelines for staff delivering the fundamentals and advanced SMS theory and practice needs to be addressed without further delay.

Of course, it is recognised that SMS was introduced with some haste into the continuing airworthiness domain, and therefore, such a deficiency is easy to reveal. In basic terms previous continuing airworthiness staff qualifying criteria were expressed in somewhat pellucid regulatory terms. The underpinning code amendments had developed and were recognised and understood. Lamentably, the accepted logic was not employed when EASA issued EU 2021/1963 (European Commission, 2021), implementing SMS in the segment. In retrospect it is clear this departure did not adequately address the fundamentals of change management at implementation level. Although there was a sufficient hiatus prior to implementation, the vacuum was not punctuated with any formal change guidance or specific exemplars applicable to those industry segments with no prior knowledge of SMS. Smaller organisations with less exposure to SMS could have benefitted from appropriate scalable archetypes. As a result, aspirations associated with the high-level content of EU 2021/1963 were not sufficiently understood within regulatory and industry environs. In many cases anecdotes suggest the resulting late submission of expected SMS compliant procedures and processes enabled a situation where regulators were presented with the challenge of approving procedural submissions at or after the effective implementation date. The promptitude of this scenario may in time manifest as a less effective SMS in selected domain segments. Other implementing attempts, such as the CASA approach, define the requirements in explicit form and offer ancillary material to support the user. Different approaches are understandable for many reasons. ICAO and EASA, through their oversight programmes, can assess the presence, suitability, operational status and effectiveness of SMS across all affected domains. Additionally, these audit programmes have contributed positively to achieving acceptable levels of aviation safety across many jurisdictions and can continue to positively enhance this aspect. However, the paucity of a satisfactory definition of explicit SMS fundamentals will need to be addressed. The effectiveness of SMS correlates strongly with the understanding and credible application of the supporting elements by all adopters.

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James Clare: Conceptualisation, Methodology, Validation, Formal Analysis, Investigation, Writing – Original Draft.

Anna V. Chatzi: Conceptualisation, Validation, Investigation, Writing – Review & Editing.

Kyriakos I. Kourousis: Conceptualisation, Validation, Investigation, Resources, Writing – Review & Editing.

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