A critical review of African aviation safety management system GAP analysis

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ABSTRACT:
ICAO recommends that every aviation service provider implement an SMS within the appropriate framework and commensurate with the size and the complexity of its products. To comply with the ICAO SARPs and the local regulations, African aviation authorities had established guides to implement SMS within the aviation organizations under their control. The ICAO and national authorities have also edited different GAP Analysis checklists to analyze the SMS implementation’s maturity.

In this paper, we will compare different tools used as references by aviation authorities in Africa with the ICAO requirements and then identify the strengths, weaknesses, and breaches to enable us to find a way to align those tools with the international requirements and levels.

In the first step, we analyzed the different SMS GAPs Analyses edited by different national regulators. Then we compared them with the ICAO Gap analysis checklist and the ICAO SMS framework. We identified the lack and the surplus of each questionnaire. This work will serve as a basis to create a tool that eliminates the lacks, leaves the value-added, and respects all the ICAO requirements, recommended practices, and specific national requests.

KEYWORDS: SMS, Safety, Aviation, Gap analysis,

1. Introduction to Aviation SMS

1. A brief history of aviation SMS ICAO regulations

In 2006, ICAO published, the Safety Management Manual (SMM, Doc 9859) which gives directives to implement the state safety management plans (SSP) and the safety management system (SMS) required for the aviation service providers. In 2010, the High-level Safety Conference (HLSC) recommends developing a new ICAO Annex dedicated to the Safety Management System and gathering all SARPs regarding safety responsibilities framed under the State Safety Program (SSP) and the framework of the implementation of safety management systems (SMS) for aviation service providers. In 2013, the ICAO adopted Annex 19 to the Chicago convention. It merges existing resources concerning the State Safety programs (SSP) and the Safety Management System. This annex constitutes a milestone in the continuous improvement of the international safety strategy based on a more proactive and systemic safety risk management.

2. Aviation SMS definitions

Safety is a generic concept. Its definition depends on a particular state, situation, and activity. Safety is the freedom from something that might have bad consequences that could harm, the human, the equipment, or the economic reputation. Safety can also be defined as the condition where we avoid the occurrence of unexpected events such as an incident, accident, or near-miss [1]. Within the aviation context, ICAO defines “safety as The state in which risks associated with aviation activities, related to, or indirect support of the aircraft operations, are reduced and controlled to an acceptable level” [2]. An acceptable level means to keep aviation safety risks under an appropriate level of control. The safety management system has gradually evolved into an aviation fundament since its first academic introduction in 1973 [3]. A Safety Management System (SMS) can be defined as a planned, documented, and verifiable method of managing hazards and associated risks [2].

3. Aviation Safety evolution

Aviation safety is dynamic and open. New hazards and risks continuously emerge and must be mitigated and kept under an appropriate level of control to keep a safe system. Aviation safety evolved with time. This progression can be defined as follow (fig.1):

- Technical ERA (before the 1970s): technical factors and technological failures were the first contributors to safety mishaps. All the efforts were focused on improving product reliability.
- Human factors ERA (starting 1970s): despite the decline of aviation accidents due to the enhancement of technical aspects, many aviation mishaps were found related to human factors. Man/machine interfaces were included as accidents’ contributing factors. Human factors tend to consider only persons without the interference of the operational and organizational context.
Organizational ERA (starting from the mid-1990s): safety is more considered from a systemic perspective combining technical, human, and organizational factors. Data are collected and analyzed to gather the emerging safety trends.

Total system ERA: starting from the first decade of the 21st century, States and service providers started implementing SSP and/or SMS. The safety approaches evolved and became more mature. Safety benefits started to be collected and recognized.

4. SMS Components:
A safety management system is a series of defined, organization-wide processes that provide for effective risk-based decision-making related to the organization’s daily business. The correct SMS implementation enables a proactive control of risk, continuous improvement, and compliance with appropriate standards and regulations. Safety management seeks to use a proactive approach to mitigate safety risks before they result in any aviation disasters. SMS goes beyond simple regulatory compliance and enables to enhance the business resilience and adaptation to the variability of operational situations encountered using reactive, proactive, and predictive management tools. According to ICAO, the SMS is based on four pillars, and twelve elements (Fig.2) [2]. This framework constitutes a rational guide for implementing and monitoring a service provider's SMS.

a. Safety Policy and Objectives
The ICAO requires each service provider to define a Safety Policy that meets international and national requirements and regulations, reflects the management’s commitment to safety, and encourages and promotes a positive safety culture[2]. This component is composed of five elements:

- Management commitment: The accountable manager should show a visible endorsement of the policy, includes safety as a key input of decision making and provides the required resources to manage and monitor the safety.
- Safety accountability and responsibilities: Designation of an accountable manager with the final accountability and responsibility to implement an effective SMS.
- Appointment of key personnel: the organization employs a competent person to fulfill the role of the safety manager and execute the daily SMS functions.
- Coordination of Emergency Response Planning (ERP): The ERP should address all probable emergencies and identify actions, processes, and controls to effectively mitigate and manage aviation-related emergencies while ensuring a safe continuation of operations.
- SMS documentation: an SMS Manual that defines the organization’s safety policy, safety objectives, SMS Process, SMS procedures, SMS requirements, SMS accountabilities, authorities, and responsibilities.

b. Safety Risk Management (SRM)
ICAO recommends that every service provider develop SRM processes that identify all hazards that may be provoked during the execution of its activities, assess, and mitigate all related risks. The SRM component includes two elements:

- Hazard Identification (HI): Proactively identify hazards before they contribute to any safety-related occurrences. The hazard identification process combines reactive, proactive, and predictive safety data analysis to identify adverse trends and predicts emerging hazards.
- Safety Risk Assessment and Mitigation (SRAM): Risk assessment is based on judgment, experience, and inputs from data collection. Once safety risks have been

Fig.1: Safety evolution[2]
assessed, the organization determines what safety risk controls are needed using an appropriate data-driven decision-making process to decide what acceptable or unacceptable risks are for the systems.

c. **Safety Assurance (SA)**

Safety assurance provides the organization with the necessary processes to monitor the performance of operational processes and continuously improve the level of safety performance. The SA component includes three elements:

- **Safety Performance Monitoring and Measurement:** a combination of tools to assess the effectiveness of the safety controls, ensure that they are achieving the intended results, and identify new hazards that may emerge from day-to-day operation.

- **The Management of Change:** Changes need to be made effectively and efficiently and implemented safely. Change even to improve safety may introduce safety risks and affects the existing risk controls elsewhere. The organization has to adopt a risk-based approach to plan change, identify, analyze, evaluate, reduce risk and negative impact, and maximize potential benefits.

- **Continuous Improvement of the SMS:** it is the day-to-day work to assess and monitor the SMS effectiveness by all verifications, internal audits, and follow-up actions.

d. **Safety Promotion**

Positive safety culture is the foundation to achieve safety objectives. Training and communication are the two key areas of safety promotion.

- **Training and education:** A suitable safety training program crafted and tailored to staff categories and individual implications concerning SMS.

- **Safety Communication:** Effective communication involves adjusting the communication’s content and the delivery method to suit the target receiver. A suitable communication strategy allows safety communication by receiving safety-related information through safety notifications, announcements, briefings, or training.

![Fig.2: Safety management system components](Image)
II. Research methodology and materials

1. Methodology

For the research methodology, we decided to use qualitative research. Qualitative research is an empirical tool, the researcher collects a sense of data about the phenomenon under study and works on them, organizes them, and holds them up against ideas, hypotheses, and categorical definitions as a way of testing them [5]. Qualitative research helps communicate a “theory” by showing its applicability and emphasizing the key elements and relationships [6].

In our case, we use qualitative research and analysis to understand how the ICAO suggested analyzing the safety management system implementation by different service providers by proposing an SMS GAP analysis checklist [4] and how African aviation authorities developed their SMS GAPs analysis. The qualitative research is appropriate to our research case and the question we are about to answer in this paper. We used for our research external secondary data that was published by civil aviation authorities.

During the data collection process, we collected SMS GAPs analysis checklists and evaluation tools developed by civil aviation authorities and used as guides to assess an organization’s SMS either for initial implementation assessment or during the ongoing regulatory oversight and surveillance.

The purpose of our research is to analyze those checklists and compare them with the ICAO Annex 19 safety management framework.

We used the descriptive content and thematic analysis method for our data analysis. This technique is suitable for our research paper as it allows us to accomplish a comparative discussion of definitions, aims, Descriptions, inductive and deductive interpretation, and emphasizing context[7]. We performed data coding used to break data separately and look for meanings of a word or phrase related to the aviation context and its place in the evaluation tool[8]. In this perspective, we realize a review of each evaluation guide’s contents and compare it with the reference framework as per ICAO document 9859 and ICAO Annex 19. This led us to spot certain similarities and differences and gaps between the ICAO framework and the Evaluation tools. We came out with the lacks and the surplus of each national authority questionnaire.

2. Materials

We choose for this paper tools used by civil aviation authorities from Africa that have more or less similar aviation environments as Morocco like Egypt and South Africa. To answer the paper’s question we selected the following:

- South African Safety Management System GAP ANALYSIS, Form Number CA 140-02, 08 March 2021.

III. Results and discussion:

SMS framework, defined by ICAO Annex 19, is composed of twelve elements arranged in four components. ICAO has published an “SMS GAP analysis checklist and implementation plan” It can be freely downloaded from the ICAO Safety Website. This checklist serves to conduct an SMS gap analysis. The questionnaire respects the ICAO SMS framework. The tool cites numerous aspects to analyze and questions to answer for each element. The answer has a format of “Yes/No/Partial” responses. “Yes” answer means that the organization meets or exceeds the expectation, “No” answer shows an important gap with the expectations. “Partial” Answer signifies that an improvement is required to meet the expectations [9].

We noticed that the ICAO SMS GAP analysis downloaded from the ICAO website didn’t include questions regarding the safety promotion component, as the fourth component is still part of the SMS framework, we decided to include the corresponding questions from the ICAO DOC 9859 third edition’s appendix 7.

The review of different tools provided by the respective civil aviation authorities is compared to the ICAO requirements and questions of the ICAO SMS Checklist. After the review of the different checklists used as an SMS GAP Analysis by the civil aviation authorities, we found that:

1. All the checklists are adjusted with the ICAO SMS Framework and they contain the four components and the twelve elements.
2. South African SA CAA uses the same ICAO checklist. Indeed, the South African CAA GAP Analysis form CA 140-02 is provided in checklist format and contains the same questions to answer as the ICAO Checklist[10].
3. The Moroccan Civil Aviation Authority (DGAC) uses a checklist developed and published in 2011. The proposed checklist respects the ICAO SMS framework. The questionnaire includes some additional questions required by the ICAO framework. Other questions are not taken into account by DGAC. The Moroccan checklist doesn’t cover all the SMS framework requirements and aspects of the ICAO doc 9859 SMS guidance.

4. The Egyptian authority ECAA published July 2019 an advisory circular EAC No.19-12 SMS Evaluation Tool. It is adopted by the Egyptian Civil Aviation Authority to assess SMS. It is adapted for an initial assessment, continuous surveillance, and oversight. It contains indicators of compliance and performance and indicators for known industry best practices to evaluate SMS efficiency and effectiveness [11]. It is organized of the four components and the twelve elements as the ICAO SMS Framework. Each indicator is assessed using the PSOE level scale (Table 1), at the end of each element’s check the assessor has to fill out a summary judgment to describe its effectiveness. Despite it doesn’t cover all aspects required by the ICAO checklist, a strong aspect of The EAC checklist is that it requires reviewing more additional aspects for each element.

### IV. Conclusion:

Many civil aviation organizations have started implementing the SMS Framework. However, many service providers have found many problems with SMS implementation and have failed to comply with the requirements. To evaluate the service providers' SMS maturity, regulatory authorities have adopted or established tools, checklists, guides, and methods for assessing SMS effectiveness. SMS performance evaluation Tools are a set of methods used to evaluate SMS effectiveness practically, scientifically, and objectively. The objective is to appraise the safety status in the organization, identify any lack in the risk management process and enhance efficiency. The ICAO SMS Framework implementation guidance contained in ICAO DOC 9859 provides Knowledge to service providers on implementing an SMS framework under Annex 19 and supervision for States on SMS oversight [4]. The proposed framework implementation calls for service providers to have an SMS that enables systematic safety management, safety performance, continuous improvement, and proactive mitigation of safety risks before they result in accidents and incidents.

An effective SMS is demonstrated if all relevant SMS framework aspects are implemented, operational and effective. This article reviews the tools developed or adopted by three African authorities to appraise service providers’ SMS. The review of these gap analysis checklists and their comparison with the ICAO checklist and ICAO DOC 9859 guidance shows that they can be improved by adding other aspects for an effective safety management system. The developed checklist can then be adapted on a case-by-case basis.

### Table 1: PSOE level scale

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<th>Level Scale</th>
<th>Definition</th>
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<tr>
<td>Present</td>
<td>The indicator is documented and included in the organization’s SMS documentation or management system</td>
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<tr>
<td>Suitable</td>
<td>The indicator is appropriate to the nature, size, complexity of the organization, and inherent risk in the activity and the industry</td>
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<tr>
<td>Operating</td>
<td>The indicator is operating, used, and there is evidence of produced output.</td>
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<td>Effective</td>
<td>The feature is attaining the expected result and has a positive impact on safety</td>
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### References


