A Common Approach to Safety Performance Measurement

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This paper was prepared by the Measurements Workgroup of the Safety Management International Group (SM ICG). The purpose of the SM ICG is to promote a common understanding of Safety Management System (SMS)/State Safety Program (SSP) principles and requirements, facilitating their application across the international aviation community.

The current core membership of the SM ICG includes the National Civil Aviation Agency (ANAC) of Brazil, the Civil Aviation Safety Authority (CASA) of Australia, the European Aviation Safety Agency (EASA), the Federal Office of Civil Aviation (FOCA) of Switzerland, the United States Federal Aviation Administration (FAA) Aviation Safety Organization, the International Civil Aviation Organization (ICAO), Transport Canada Civil Aviation (TCCA) and the Civil Aviation Authority of United Kingdom.

Members of the SM ICG:

- Collaborate on common SMS/SSP topics of interest
- Share lessons learned
- Encourage the progression of a harmonized SMS
- Share products with the aviation community
- Collaborate with international organizations such as ICAO and civil aviation authorities that have implemented or are implementing SMS

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SUMMARY

The objective of this paper is to contribute to the discussion on a common approach to safety performance measurement. Measurements of safety performance at the State level and at the individual service provider level are essential for effective safety management. This is not only a sound safety management practice, a methodology for developing safety performance measures and safety performance indicators (SPIs) will also be needed to support the ICAO-proposed continuous monitoring approach (CMA). This paper will propose a safety measurement matrix that is based on a foundation of three tiers of system behavior.

1. INTRODUCTION

Measures of safety performance are necessary for effective safety management and decision making. A measurement strategy should provide a set of measures, rather than a single "magic number." These measures should also be interactive, cover all aspects of the systems that they address, and reflect both system failures (e.g. accidents, incidents, regulatory violations) and indicators of the proper functioning of critical system components.

In order to develop guidance on how to develop such a set of measures, a sub-group of the Safety Management International Collaboration Group (SM ICG). This paper was developed collaboratively by this SM ICG workgroup.

It is the aim of the SM ICG to further define the concept of safety performance measurement in a harmonized fashion.

2. SYSTEM BEHAVIOR AND SAFETY PERFORMANCE MEASAUREMENT

If we look at the meaning of "safety" in the dictionary it will tell us that it implies the absence of potential harm. This is an obviously unattainable goal. However, the standard definition of risk in terms of severity (how much harm) and likelihood (the probability of being harmed) gives us a more practical basis for a correlation between outcomes such as accident rates and more tangible, measurable things that can be under our control.

ICAO Doc 9859, *Safety Management Manual (SMM)* provides a useful operational definition of safety (paragraph 2.2.4), "The state in which the possibility of harm to persons or property is reduced to and maintained at or below, an acceptable level through a continuing process of hazard identification and safety risk management."

It follows from this definition that measures of safety and safety performance should focus on the aviation systems' ability to manage safety risk to acceptable levels. If we emphasize the system behaviors that can reduce the likelihood of an accident or the resulting severity of those that do occur, we can better define meaningful targets for measures.

The limitations of a prescriptive regulation for safety management are increasingly acknowledged internationally.[1] Performance-based regulation is considered to be an effective tool to manage safety in high consequence operations. Performance-based regulation concentrates on the measurable outcomes to assess system safety performance.

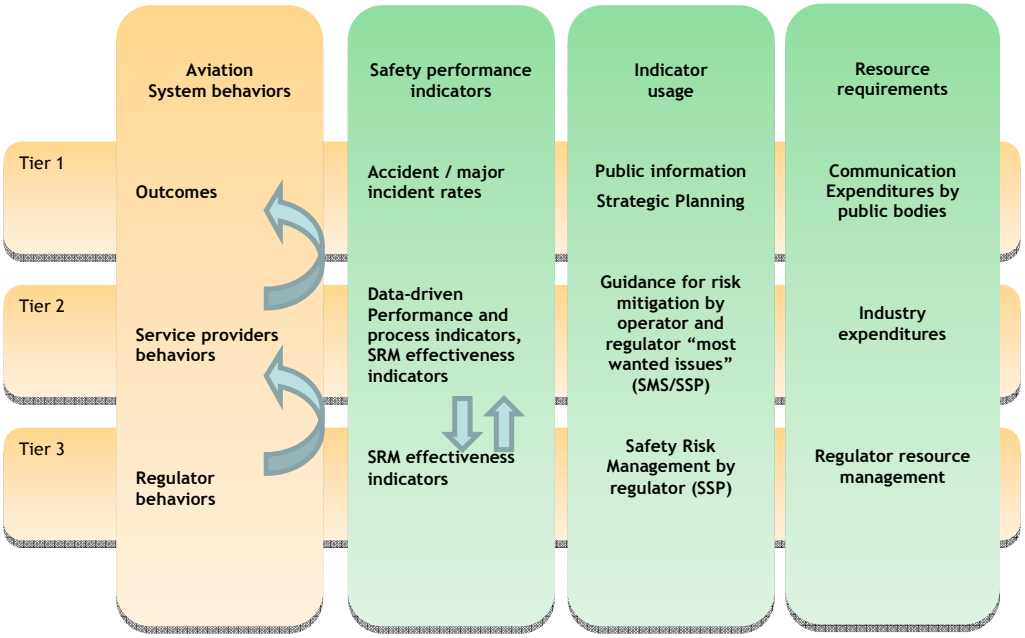
In order to implement performance-based regulation, safety performance indicators (SPIs) need to be defined. The definition of an appropriate measurable SPI thus becomes a key task for the regulator. The quality of an indicator depends both on the subject it is applied to as well as its usage.

[1] Prescriptive regulations mandate controls in response to hazards in the aviation system. They are important as they ensure that a fundamental set of hazards are addressed, but they cannot address all the specific hazards that may exist in the aviation system.

3. THE SAFETY MEASUREMENT MATRIX - OVERVIEW

The matrix is composed of three tiers which describe the different levels of the system and three pillars which describe the way safety is measured and managed.

Figure 1: The safety measurement matrix



The tiers represent the different levels of aviation system behavior. Tier 1 looks at the overall system behavior in terms of safety; in other words the safety outcomes. Tier 2 concentrates on the service provider's behaviors and Tier 3 on the regulator behavior. The three tiers interact vertically as the regulator's behavior is intended to affect the service provider behavior, which in turn has an effect on the overall level of safety.

The three pillars in Figure 1 help to describe how the system behavior is measured at each tier (safety performance indicators), how the indicators are used (indicator usage) and what resource requirements are attached to measuring safety at each of the tiers.

The SPIs at Tier 1 (outcome indicators) can be largely harmonized across States and regions and can thus be defined a-priori. Indicators at Tiers 2 and 3 will be region specific and depend on the regional or national situation and the SSP developed for the respective State.

4. THE SAFETY MEASUREMENT MATRIX – SAFETY PERFORMANCE INDICATORS

SPIs must be simple, measurable and reliable. In order for them to be used for safety management there needs to be a mix of outcome indicators (e.g. accident rates) and process indicators (e.g. validation of safety critical processes, record keeping, and qualification of personnel). Process indicators are a crucial element as measuring safety is about measuring the absence of something. In such cases where the resulting output cannot be measured the industry standard is to validate the underlying processes instead.[2]

[2] E.g. ISO 9001, 7.5.2 "The organisation shall validate any process for production and service provision where resulting output cannot be verified by subsequent monitoring and measuring."

An important concern is the availability of quantitative versus qualitative data. Quantitative data provides a clearer picture of the area being measured but there are many areas where quantitative data is impossible or difficult to obtain. Therefore, one should not exclude such aspects merely for the lack of quantifiable data. Data sources such as employee safety reports and in-depth causal analyses in accident reports are generally qualitative but can be valuable for hazard identification.

Tier 1 SPIs include accident data (damages, injuries, fatalities) and this data represents factual data which attracts a high public interest. However, some considerations should be observed from a safety performance measurement perspective:

- Tier 1 indicators like fatal accident rates are well suited for long term trending and factor analysis applied to strategic planning. However, they should be used carefully for performance measurement of individual service providers or for short-term trending due to the low frequency of these events and, consequent large variations

- Incident data is another important potential source of Tier 1 indicators. However, for incident data to be used in predictive measures it must be correlated with the causal chain leading to fatal accidents. It is now widely accepted that many types of typical low-level events (e.g. ground damage, in-flight turbulence injuries) may not adequately predict the occurrence of fatal accidents. Root causes of minor incidents may not correlate highly with causes of more serious events unless underlying causes are analyzed thoroughly. This also underscores the need to use additional incident data from such sources such as employee reporting and flight data analysis programs.

Tier 2 SPIs address the behavior of aviation service providers (including, for example, operators, maintenance organizations, manufacturers etc.). This level can be distinguished between three different types of SPIs such as:

- Data-driven performance and process indicators take Tier 1 SPIs as a starting point, but are developed further down the causal chain from the main outcomes. The approach aims to identify the main accident scenarios and related safety issues to identify targets for risk management.

- Scenario-based indicators identify hazards derived from potential accident scenarios and apply them to development of safety performance indicators where no accident or major incident has ever happened. These affect both Tiers 2 and 3.

- Indicators measuring the effectiveness of risk mitigation measure the service provider level (“safety management effectiveness”) Examples of this approach are implementation of Commercial Aviation Safety Team, Aviation Safety Information Analysis and Sharing and European Strategic Safety Initiative recommendations.

Tier 3 indicators look at the effectiveness of the mitigation measures put in place by the regulator. They measure how well the safety measures, actions and initiatives of the regulator achieve their safety objectives. Safety outcomes and the behavior of service providers all reflect on the regulator and, moving up the chain, effective regulator activities should motivate service provider behaviors that, in the aggregate, result in overall improvements in outcomes.

5. THE SAFETY MEASUREMENT MATRIX – INDICATOR USAGE

This pillar defines what the SPIs in the three tiers will be used for. The actual usage can then inform and drive the discussion on how the indicators have to be formulated.

SPIs at Tier 1 are largely for strategic planning and public information. They describe the overall outcome of the system, which is the main concern for the public.

SPIs at Tier 2 are used to guide service providers and regulators in their actions to mitigate safety risks as part of their (SMS/SSP). Thus they also have an impact on resource allocation.

SPIs at Tier 3 provide regulatory authorities with feedback on the performance of their SSP with which to guide on-going and future decision making. They also support the processes of measuring and monitoring the performance of the SSP under the CMA.

6. THE SAFETY MEASUREMENT MATRIX – RESOURCE REQUIREMENTS

At each level, resources provided by the regulator or the service provider must be made available in order to manage safety. This pillar addresses resource allocation and prioritization relative to their influence on the safety behavior and performance at each tier.

7. THE WAY FORWARD

The members of the SM ICG felt that safety performance indicators be specified by each State both for their SSP and their service provider's SMSs that are relevant to each organization. These measures and indicators should be developed in accordance with the safety matrix described above.