Safety Management System

SMS in Aviation
Introduction
Air transport is a popular way of travelling – approximately 9.4 million passengers do so each day. Safety (and perceived safety) therefore influence peoples’ decision to fly or not. However, the large number of passengers, unpredictable circumstances such as weather, dangerous air zones and the constant threat of terrorism, make ensuring the safety of all flight operations a challenging task for global commercial aviation. Aircraft condition and maintenance are also variables that have to be taken into account. To succeed, a properly-implemented Safety Management System (SMS) is essential. This system can analyse every aspect of safety to minimise operational risk. SMS’s help organisations reach and maintain maximum safety over a long period of time.

Safety Management System
The need for improved safety handling has been obvious since the first accidents in aviation. The more complex aircraft became, the more complex their associated safety topics became. This factsheet describes the aviation industry’s Safety Management Systems as they address the needs of modern day flight operations.

A Safety Management System is a systematic approach to managing safety, including the necessary organizational structures, accountabilities, policies and procedures (ICAO, 2013). The objective of an SMS is to improve safety performance through a structured management approach that reduces the risk of accident.

An SMS consists of four main activities – pillars that consist of multiple elements as depicted in Figure 1. They are: Policy and Objectives; Safety Risk Management; Safety Assurance; and Safety Promotion (CASA, 2016).
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Safety Policy and Objectives

The first pillar of a SMS is Safety Policy and Objectives. This pillar consists of three elements: management commitment, safety accountabilities, and the appointment of key safety personnel. The ICAO Safety Management Manual (SMM) states that the coordination of emergency response planning and a documentation of the SMS are part of the Safety Policy and Objectives (ICAO, 2013).

Management commitment

The management of an organization must commit to safety if the SMS is to work properly. This includes providing the necessary resources for the SMS and its implementation, following procedures for reporting incidents and accidents, and supplying employees with information regarding behaviour standards for aviation activities (as well as stating the kinds of risk deemed acceptable and unacceptable). Management commitment should be signed by a ‘responsible executive’ and then communicated throughout the entire organisation. The management or responsible executive should also ensure that the document stays accurate and relevant.

Safety Accountabilities

An executive should be appointed with final responsibility and accountability for the SMS’ implementation and maintenance. They should be supported by a line of safety-accountable managers, with a pre-determination of which managers (and at what level in the organisation) have the authority to make decisions regarding safety risk tolerability.

Appointment of key safety personnel

Aside from accountable managers, a safety manager is also needed to implement the SMS and keep it up to date. This safety manager should have direct access to the responsible executive, and a position above the line managers in the organisation – see Figure 2 (ICAO, 2013).

Safety Risk Management

The second pillar of a SMS is Safety Risk Management. This part consists of hazard identification and risk assessment.

Hazard identification

A hazard is defined as a condition or an object with the potential to cause death, injuries to personnel, damage to equipment or structures, loss of material, or reduction of the ability to perform a prescribed function (ICAO, 2013).

Ideally, hazards should be detected before they lead to accidents or incidents. Reporting systems, inspections and audits are used to achieve this. However, some hazards can be identified from the study of accident investigation reports. There are three methodologies for hazard identification: the reactive way (an analysis of past events); the proactive way (an analysis of real-time situations); and the predictive way (the use of data gathering to identify possible negative future events).

Risk assessment

Safety risk is the projected likelihood and severity of the consequence or outcome from an existing hazard (ICAO, 2013). Due to the endless number of
of different hazards, a wide variety of risks emerge. Not every risk can be mitigated or excluded, so safety risk has to be categorised. These categories are specified in the Safety Policy, which assesses the broad range of risks in aviation, their probability, and their severity. There are five different grades of likelihood, ranging from extremely improbable to frequent (see Figure 3). Every grade has its own number, from 1 → extremely improbable to 5 → frequent. These numbers are used in the risk assessment matrix (see Figure 3).

<table>
<thead>
<tr>
<th>Likelihood</th>
<th>Meaning</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequent</td>
<td>Likely to occur many times (has occurred frequently)</td>
<td>5</td>
</tr>
<tr>
<td>Occasional</td>
<td>Likely to occur sometimes (has occurred infrequently)</td>
<td>4</td>
</tr>
<tr>
<td>Remote</td>
<td>Unlikely to occur, but possible (has occurred rarely)</td>
<td>3</td>
</tr>
<tr>
<td>Improbable</td>
<td>Very unlikely to occur (not known to have occurred)</td>
<td>2</td>
</tr>
<tr>
<td>Extremely improbable</td>
<td>Almost inconceivable that the event will occur</td>
<td>1</td>
</tr>
</tbody>
</table>

Figure 3: Risk probability table according to the ICAO Safety Management Manual

There are five different grades of severity, ranging from negligible to catastrophic (see Figure 4). Every grade has its own letter, from A → catastrophic to E → negligible. These letters are also used in the risk assessment matrix (see Figure 4).

<table>
<thead>
<tr>
<th>Severity</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catastrophic</td>
<td>Equipment destroyed</td>
</tr>
<tr>
<td>Hazardous</td>
<td>A large reduction in safety margins, physical distress or a workload such that the operators cannot be relied upon to perform their tasks accurately or completely</td>
</tr>
<tr>
<td></td>
<td>Serious injury</td>
</tr>
<tr>
<td></td>
<td>Major equipment damage</td>
</tr>
<tr>
<td>Major</td>
<td>A significant reduction in safety margins, a reduction in the ability of the operators to cope with adverse operating conditions as a result of an increase in workload or as a result of conditions impairing their efficiency</td>
</tr>
<tr>
<td></td>
<td>Serious incident</td>
</tr>
<tr>
<td></td>
<td>Injury to persons</td>
</tr>
<tr>
<td>Minor</td>
<td>Nuisance</td>
</tr>
<tr>
<td></td>
<td>Operating limitations</td>
</tr>
<tr>
<td></td>
<td>Use of emergency procedures</td>
</tr>
<tr>
<td></td>
<td>Minor incident</td>
</tr>
<tr>
<td>Negligible</td>
<td>Few consequences</td>
</tr>
</tbody>
</table>

Figure 4: Risk severity table according to the ICAO Safety Management Manual

Figure 5 shows the risk assessment matrix, combining probability and severity in one graph. This leads to three different regions: the intolerable region (red), the tolerable region (yellow) and the acceptable region (green). Risks assessed in the red region are unacceptable under any circumstances, and operations associated with them have to stop immediately. Risks assessed in the yellow region need appropriate mitigation strategies. Risks assessed in the green region require no further action.
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SAFETY ASSURANCE

Safety Assurance is the third pillar of the SMS, and is the part that shows whether an organisation is safe. This is done by monitoring the identified risks and measuring safety performance in the organisation.

Safety Assurance also contains a feedback system for the SMS when processes change or new hazards are identified. In such cases, this new information is incorporated into the SMS to keep it complete – and the organisation safe.

SAFETY PERFORMANCE MONITORING AND MEASUREMENT

Safety must be measured and monitored to know if the SMS is working. This can be done by:

- Introducing a reporting system for hazards and occurrences. The reporting system can be made mandatory or voluntary (mandatory reporting systems tend to collect more information about high consequence technical failures than other operational activities). In all cases, it is advised to educate personnel on the needs of the reporting system, as well as on how the reporting system is to be used.

  - Using safety studies that are conducted mostly by large organisations or government institutions, which provide information to improve safety.

  - Conducting safety reviews when a new technique or procedure is introduced, to show how they might influence safety in the organization.

  - Conducting safety surveys to create an expanded view of an organisation’s safety, and where potential problems may lie.

  - Conducting audits for the assurance of safety management functions, such as training or staffing.

  - Conducting internal investigations when serious (or minor) incidents or accidents happen. (ICAO, 2013)

SAFETY PROMOTION

The fourth pillar of the SMS describes Safety Promotion. A safety culture must always exist in an organisation, and it should be promoted with positive supporting practices. Safety Promotion includes training, education and communication to create a safety culture across all levels of an organisation.

TRAINING AND EDUCATION

A written SMS policy in an organisation is not enough for success. Management should convey, enhance, and emphasise the organisation’s safety policy by exemplifying it in their daily work and in their one-on-one leadership styles (FAA, 2015). Managers must make sure that the safety policy is continuously promoted and enhanced. Employees must be provided with training and education to promote safety awareness, and safety information systems accessible to all employees should form part of the educational approach.

SAFETY COMMUNICATION

Figure 5: Risk assessment according to ICAO Safety management manual
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A good safety culture depends on effective communication of the SMS policies, existing processes, tools and other related information. The SMS aims to ensure that all employees in an organisation have sufficient SMS awareness and that important information is transferred. Clear explanations regarding specific actions and safety procedures must be conveyed.

**SMS pillar interaction**

In order for the SMS to work properly, all four pillars must be stable, and more importantly, the interaction between the pillars has to be managed. A proper safety policy that defines an organisation’s commitment to safety helps ensure that risk management is conducted properly, making known which risks are deemed acceptable and which are not. The same goes for the safety assurance and the safety policy – clear safety goals must be stated. Interaction between the pillars is depicted in Figure 6.

The Four SMS Components

**Safety Policy**
Establishes senior management's commitment to continually improve safety; defines the methods, processes, and organizational structure needed to meet safety goals

**Safety Risk Management**
Determines the need for, and adequacy of, new or revised risk controls based on the assessment of acceptable risk

**Safety Assurance**
Evaluates the continued effectiveness of implemented risk control strategies; supports the identification of new hazards

**Safety Promotion**
Includes training, communication, and other actions to create a positive safety culture within all levels of the workforce

Safety Risk Management and Safety Assurance are the active pillars (see Figure 7 for their interaction). SRM starts with an analysis of the system, followed by hazard identification and risk analysis. Then a risk assessment is made: if deemed unacceptable, it must be controlled, after which the process starts over. If deemed acceptable, then safety assurance kicks in, first with the regular system operation, from which data is acquired and analysed. Then an assessment of the system is made: if it conforms to the planned safety, no further action is required and the system can continue to operate under supervision of the SMS. If it does not conform to the planned safety, corrective actions are taken, after which the system can continue to operate. If new hazards are identified, the system starts from the beginning with a new analysis for the risk management.

Without the safety promotion pillar, the workforce would be inadequately trained and would not have proper safety education. This would mean that safety is only managed from the top of the company, with less priority on the work floor, and potential hazards could be missed (FAA, 2016).

The SMS maximises organisational safety by using all pillars according to their own strengths and by making sure pillar interaction functions properly. This helps to keep air transport the safest mode of transportation.
SMS authorization

Regulatory approval from applicable authorities is necessary for companies implementing an SMS (in the Netherlands, this is the Inspectie Leefomgeving & Transport – IL&T). The acceptance and monitoring process of an SMS by the regulator will adopt the following four processes: 1) Application by the company wishing to implement the SMS at the authority; 2) Acceptance of the application by the authority; 3) Self-evaluation of the SMS by the company; and 4) On-site assessment and verification of the implemented SMS by the authority – see Figure 8 (IL&T, 2013).

Figure 8: Processes for regulatory approval of an SMS

Figure 7: Interaction between the safety risk management and safety assurance pillars
Glossary

- **Safety Management System (SMS):** a systematic and explicit approach defining the activities by which safety management is undertaken by an organisation in order to achieve acceptable or tolerable safety.
- **Crew Resource Management:** the effective use of all available resources for flight crew personnel to assure safe and efficient operation, reduce error, avoid stress and increase efficiency.
- **Maintenance Resource Management (MRM):** the application of common sense rules to everyday work environments.
- **Risk:** the predicted probability and severity of the consequences or outcomes of a hazard.
- **Hazard:** a potential source of harm or adverse health effect on something.
- **Risk assessment matrix:** a method for evaluating the probability and severity of a specific action or inaction that is expected or anticipated to occur.
- **Safety culture:** the values, attitudes, motivations and knowledge that affect the extent to which safety is emphasised over competing goals in decisions and behaviour.

References


3. No reference


Image references (top to bottom, left to right)


3. No reference

4. No reference
Dutch Summary

Om de veiligheid binnen de groeiende luchtvaartsector te kunnen waarborgen is een gestructureerd en up-to-date systeem nodig dat veiligheidsrisico's vermindert en zo streeft naar een maximale veiligheid. Een Safety Management System is nodig om de “organisatie factor” in ongelukken te minimaliseren. Een SMS bestaat uit vier onderdelen. Safety policy and objectives zorgt voor een continue verbetering en beschrijft methodes, processen en benodigde structuren om aan bepaalde safety objectives te kunnen voldoen. Safety risk management identificeert hazards en analyseert risicos. Safety assurance zorgt voor een feedbackloop in het systeem en zorgt ervoor dat de SMS blijft werken. In het safety promotion onderdeel wordt ervoor gezorgd dat alle werknemers getrained worden en op de hoogte zijn van het SMS. De onderdelen zijn onderling verbonden en zijn alle vier nodig om de SMS tot een succes te maken.