Integral Safety Management System at Schiphol

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Abstract

Several investigations of accidents and serious incidents show that the risks at the interfaces between organizations are an important factor in the further improvement of safety. At Schiphol airport, airlines, ATC, ground handlers, refueling services and the airport itself, joined forces to manage these risks together. In this way, they followed up on recommendations of the Dutch Safety Board to strengthen co-operation on safety. The joint sector Integral Safety Management System (ISMS) applies the safety management principles of ICAO Annex 19 and EASA to the management of interface risks. The main difference compared to a 'normal' SMS is that there is no accountable executive for the sector as there does not exist a hierarchical relation between the participating organizations. This paper describes the way the ISMS is organized and how the lack of hierarchy has been overcome. Finally, the effectiveness of the ISMS is demonstrated by a number of results.

Introduction

Since the early years of aviation, safety has been the top priority. Over the decades, technological advancements, human factors and organizational improvements have led to a reduction of accident risks to a fatal accident rate of one accident per 2 million flights in 2019 [aviation safety]. One of the more recent developments is the mandatory introduction of safety management systems (SMS) for aviation service providers in 2013 [ICAO Annex 19]. In [ICAO Annex 19] safety is defined as *'The state in which risks associated with aviation activities, related to, or in direct support of the operation of aircraft, are reduced and controlled to an acceptable level.'* The assurance that the conditions of a safe operation are met is provided by safety management systems within the organization of the aviation service provider. The aviation safety providers operate within the context of a state safety program which provides legislation and oversight of the safety of aviation activities.

Since each aviation service provider has its own SMS, the natural focus of these management systems is the scope of the individual organization. However, certain risks are not completely within the scope of an individual organization but involve the interaction between organizations as well. For example, the risk of runway incursions involves the lay-out of the airport infrastructure, the handling of traffic by ATC and the execution of flight operations by airlines. Hence runway safety does not only depend on the performance of each individual organization but also on the way the organizations interact.

ICAO and EASA have recognized the importance of interfaces and provide standards and recommended practices with respect to interface management. EASA prescribes that aerodrome operators carry out safety programmes and ICAO gives guidance on the establishment of runway safety teams for example. Furthermore, interfaces are made explicit in the safety regulation concerning changes to the functional system of air navigation service providers [EASA, 2017].

A useful concept for describing interface risks is that of the so-called bow-tie. A 'bowtie' is a diagram that visualizes a risk in just one, easy to understand picture [cgerisk]. The diagram is shaped like a bow-tie, creating a clear differentiation between proactive and reactive risk management.

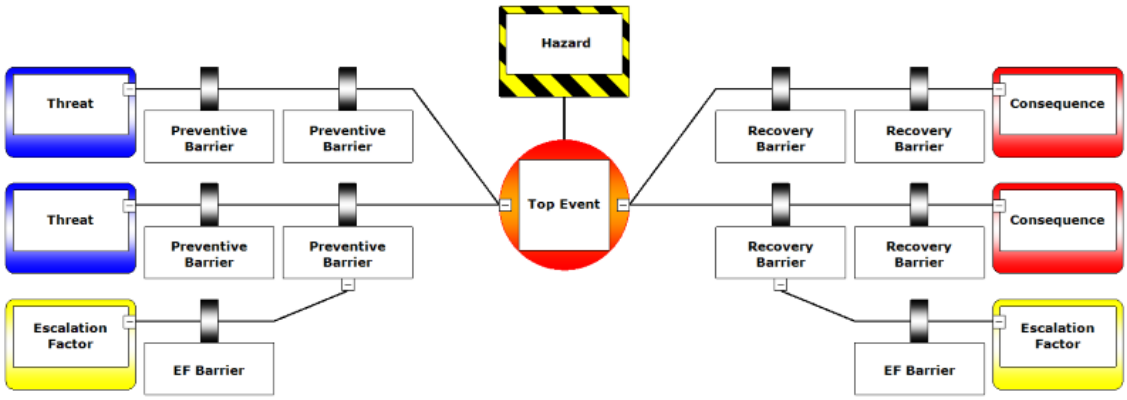

Figure 1: example of a bow-tie.

Within organizations, bow-ties are used to identify the barriers available to prevent top events from occurring (preventive barriers) and the barriers available to reduce the impact of top events (recovery barriers). On this basis the risk associated with the top event can be systematically assessed and managed, for example by interpreting the results of audits and incident reports in the bow-tie structure and next giving priority to improving relatively weak (strings of) barriers. In this way, an integral understanding of the available risk controls is achieved.

In the case of interface risks, not all barriers are within the managerial control of an individual organization. Moreover, the barriers may be distributed over several actors. In order to properly manage such risk, an integral view of the risk as a whole is necessary. Based on such integral view, the most effective measures to reduce the interface risk may be identified. Therefore, integral management of safety goes a step beyond properly managing the interfaces. Rather it is about getting an integral picture of the risk involved including the safety barriers of the relevant organizations, which is the basis for taking the necessary and most effective measures to control the risk to an acceptable level.

In 2018, the aviation parties at Schiphol airport started a new initiative to jointly manage their interface risks in a structure which mimics the structure of a safety management system of an individual organization. This initiative is named the joint sector Integral Safety Management System (ISMS). With the ISMS, the aviation parties are following up recommendations of [Dutch Safety Board, 2017]. This paper describes this new approach to managing interface risks. In particular the following topics are described: the setup of ISMS, the way joint decision-making takes place, and a number of results obtained thus far, are given. Finally, conclusions are drawn.

Set-up of ISMS

Scope and structure

The scope of ISMS has been defined (geographically) as extending from the façade of the airport terminal facilities towards and including the Schiphol Terminal Manoeuvring Area (TMA) airspace. This implies that platform safety as well as flight ops safety are within the scope. Within the geographical scope, the safety risks of the relations and interactions between the individual organizations operating at Schiphol Airport (interfaces) are considered. For practical reasons, a distinction is made between flight ops risks and ground handling risks.

The organizations involved in ISMS are:

- Amsterdam Airport Schiphol;
- Air Traffic Control The Netherlands;
- Royal Dutch Airlines;
- EasyJet;
- Swissport;
- Gezamenlijke Tankdiensten Schiphol (GTS);

The latter three have a representative role: easyJet represents the homebased carriers (except KLM), Swissport represents the ground handlers (except KLM), and GTS represents the refueling services.

The approach to work with representation instead of inviting all organizations was motivated by the experience with earlier safety improvement programs, where meetings sometimes became less effective because of the large number of people at the table. In preparation of meetings, the representatives consult their collegues at beforehand and bring in a consolidated position.

The organizational structure of ISMS follows the guidance given in [ICAO Doc 9859]. In the figure below the structure is shown schematically.

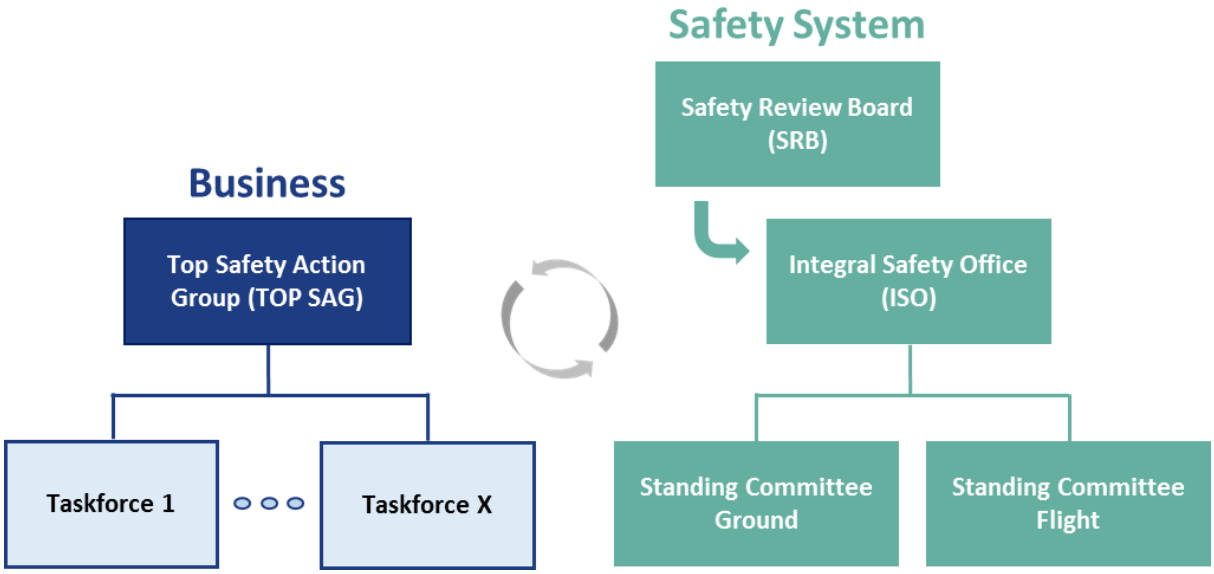

Figure 2: Organizational structure. The number of Task Forces may vary over time.

The elements of the ISMS structure are briefly described below.

Safety Review Board (sector SRB)
The SRB is a high-level committee, which sets the safety policy and strategic safety goals. The SRB is staffed by the Accountable Executives of the organizations involved plus the Director of the Integral Safety Office (ISO). The sector SRB is chaired by the accountable executive of Schiphol airport.

TOP Safety Action Group (TOP SAG)
The TOP SAG is a high-level management group that assesses analysed risks and ensures timely mitigating actions, if necessary. The TOP SAG consists of the Accountable Executives and a number of Operational Executives plus the Director of the Integral Safety Office. The scope of the TOP SAG are safety risks of the relations and interactions between the individual organizations operating at Schiphol Airport (interfaces). The TOP SAG is chaired by the accountable executive of Schiphol airport.

Task Forces
Task Forces prepare and direct risk reduction measures on specific topics, e.g. runway safety, ground movement safety, bird hazards etc. The Task Forces can be described as working groups on actual themes and report to the TOPSAG. The Task Forces can be initiated, augmented, cancelled, etc. according to necessity. Taskforces are chaired by executives or senior management of one of the organizations and sponsored by a TOPSAG member.

Integral Safety Office (ISO)
The Integral Safety Office is the operational function of the ISMS. The ISO i.a. advises the sector SRB, TOP SAG, analyses risks, takes safety initiatives and assesses the effectiveness of risk reduction measures.

The Integral Safety Office consists of the Core Team (Managers HSE office of Amsterdam Airport Schiphol, Air Traffic Control The Netherlands, Royal Dutch Airlines and a Ground Handler), a pool of safety analysts from the participating organizations and programme management support staff. Furthermore, services of consultants are contracted to execute specific tasks such as risk analysis or programme management support of a taskforce. The ISO is led by a Director who is employed by Amsterdam Airport Schiphol and who reports to the sector SRB.

Standing Committee Ground & Standing Committee Flight
The Standing Committee Ground & Standing Committee Flight have the following responsibilities with respect to ground handling risks and flight ops risks respectively:

- Identify safety concerns related to the flight / ground process at Schiphol airport.
- Provide input to the Integral Safety Office related to joint safety investigations;
- Advise on the sector top 5 flight / ground risks;
- Share information about the ISMS activities;

The Standing Committees consist of representatives of all organizations within the scope, and are open to all stakeholders. The standing committees are chaired by a member of the ISO Coreteam.

Decision-making

In contrast to an SMS of an individual service provider, the ISMS does not have a single accountable executive with final responsibility. The safety accountabilities in aviation are defined by regulations, most of which originate in European law and worldwide standards. In this context, it seemed legally impossible to give the ISMS formal authority over safety decisions, as parties are not allowed to transfer safety responsibilities. Decisions are instead made by consensus.

Decision-making in networks of mutually dependent actors has received ample attention in the literature [Daams, 2011], [de Bruijn, ten Heuvelhof 2017], [Mandell and Steelman 2003, p203], [Scharpf, 1997]. Because hierarchical relations are lacking, actors need to agree before joint actions can be taken. As agreement is not obvious in the light of different views and interests, attention is paid overcoming potential hurdles for effective joint decision-making. In general, the main impediments[1] for effective co-operation are:

A. Incongruent goals;
B. Disagreement about the facts;
C. Absence of an effective working process;
D. Lack of sound working relations;

Within ISMS these potential impediments have been resolved while respecting the individual accountabilities of the actors involved. Below, the solutions found are discussed per impediment:

Congruence of goals

The main goal of ISMS is to improve safety, which has priority in aviation. The organizations involved in ISMS are represented by their accountable executive, who has final responsibility for safety in the own organization according to aviation law and who has a position in the board of the own organization. Therefore, the individuals who participate in the sector SRB and the TOPSAG have 1) a shared personal commitment to safety and 2) the mandate of the own organization to set strategic goals and accept the consequences thereof. The members of the sector SRB have stated the priority of safety and their commitment to ISMS in a policy statement which is compliant with ICAO Annex 19.

Agreement about the facts

Within ISMS, joint decision making with respect to risks is based on shared information. The ICAO definition of safety risk is used, being 'The predicted probability and severity of the consequences or outcomes of a hazard'. By gathering facts from occurrence reporting systems, databases with operational data (such as radar-data, FMS data), expert judgement, and using safety models to evaluate accident probabilities, a common estimate of the probability of occurrence is arrived at. Here consultants such as the Netherlands Aerospace Center make a significant contribution with their specialized expertise in safety modelling.

[1] These factors are derived from the theoretical framework which is described in [Daams, 2011].

For the assessment of risks, a common risk matrix was developed in which the organizations plot the aggregated assessment of an interface risk. The application of the common risk matrix is shown in Figure 3 below.

Figure 3: application of common risk matrix.

The following steps are taken:

1. Identification of safety issues for assessment including a fact-base per safety issue (likelihood and severity of the event);
2. Assessment of the safety issue against the individual risk matrices of the involved organizations;
3. Discussion about the individual assessments, leading to an aggregated plot in the common risk matrix. The aggregated plot may reflect differences between organizations by drawing a box rather than a point in the common risk matrix.

Steps 2 and 3 are performed in a dedicated workshop where several safety issues can be assessed.

Effective working process

The working process of ISMS strictly adheres to EASA and ICAO safety management principles, which are shared by all ISMS participants. In this way, many often theoretical discussions about the process are avoided. Within the EASA and ICAO framework, the working processes are detailed via a 'learning-by-doing' approach: by starting to work together, the people involved develop effective working methods based on practical experience. Once a year, the developed ways of working are consolidated in an update of the ISMS manual.

The ISMS manual also contains the terms of reference of the sector SRB and the TOPSAG. In order to facilitate effective decision-making, the following terms were agreed upon:

- There are no replacements;
- Documents are distributed 2 weeks before the meeting;
- Meeting minutes are distributed within 2 workdays after the meeting.

These terms ensure that the right mandate is at the table and allow for thorough preparation and adequate follow-up of the meetings.

Finally, the ISMS partners signed a covenant with the Minister of Infrastructure and Water Management about the development of ISMS, including a milestone planning and yearly external evaluations of the functioning of ISMS.

Sound working relations

The parties at Schiphol are used to co-ordinate their operations in order to manage the airport. In the development of ISMS, the safety departments of the different organizations involved have become acquainted and learned to act as a team rather than as representatives from the own group. Within the taskforces, a similar development takes place, where it becomes 'normal' to work together on the basis of a joint mandate of senior management of different organizations. With the growth of aviation the interdependencies between the aviation actors have increased. Therefore, the competence to establish productive working relations with other aviation parties has become increasingly important for the staff involved. This trend from 'working within the own organization' to 'working within the sector' both supports and is reinforced by developments such as ISMS.

Roadmap safety improvement

In the ISMS structure, safety risks are systematically identified, quantified and resolved. The resulting safety improvement measures constitute the Roadmap for Safety Improvement at Schiphol, which is published on www.integralsafetyschiphol.com. The way the measures address the [Dutch Safety Board, 2017] recommendations and a safety analysis performed by the Netherlands Aerospace Centre (NLR) is presented on separate pages as well.

The Safety Improvement Roadmap is a working document that aligns all parties on shared goals. It is also a working document, which means that new items will be added and statuses changed based on joint sector ISMS decisions and achievements. Roadmap items can be in different stages of development:

- Study phase: the measure is studied with respect to effectiveness of risk reduction, costs, duration, possible unintended consequences etc. The result of this phase is a go / no go decision by the TOPSAG on the implementation of the measure;
- Planning phase: the implementation plan of the measure is made, taking into account the dependencies with other developments;
- Implementation phase: the measure is being implemented;
- Evaluation phase: after implementation, the effects of the measure are determined and assessed.

Status updates of the roadmap are published every half-year. The first version of the roadmap contains studies and measures resulting from existing and new sector initiatives; that originate in the recommendations of the Dutch Safety Board; and measures proposed by the NLR.

Results

Since the start of ISMS, a number of results have been obtained. In June 2019 an evaluation of ISMS with the EASA Management System Assessment Tool [EASA MSAT, 2017] was conducted by Baines Simmons safety consultants [Baines Simmons, 2019]. The assessment concluded that:

"The overall performance of the management of safety within the ISMS, measured against PRESENT, SUITABLE, OPERATING, EFFECTIVE, as defined by the EASA Management System Assessment Tool (MSAT), is currently assessed as being at OPERATING, which is above the global aviation industry average of high SUITABLE, assessed by Baines Simmons with 22 assessments completed within the last 3 years. In the view of Baines Simmons, the current regulatory requirement (based on EASA Organisational General regulation) is at OPERATING; however, few regulators are yet mature enough in their Performance Based Oversight programmes to assess this accurately. Given the short amount of time that the ISMS has been in place to achieve an assessment of OPERATING already is remarkable and furthermore, there are already some EFFECTIVE indicators in the ISMS which shows promise for the future development."

Examples of results obtained within ISMS are:

- Joint incident investigations. Currently, 6 incidents or accidents were investigated in ISMS. Here not only outcomes of individual investigations are shared, but also the fact-finding and underlying analysis is carried out together. For example, in one case an airline human factors specialist made a situation awareness analysis of air traffic control in relation to a runway incursion. The joint investigations show that the involved organizations obtain a much richer understanding of the occurrence and that the investigations provide a common view on necessary improvements which may take place across organizations. Furthermore, it appeared possible that the organizations involved sign a non-disclosure agreement which i.a. precludes that shared information is used for other purposes than improving safety. This is particularly important in the cases where damages occurred which may lead to claims between organizations involved.
- Joint risk analysis of flight operations and ground handling. For two large infrastructural investments at the Schiphol maneuvering area a joint risk analysis was carried out. This led to the initiation of two sector taskforces to further reduce identified risks. In these risk analyses, several aspects are considered, such as workload for ground control, the complexity of the infrastructure for pilots and options and limitations in the airport lay-out. As a result, safety issues are identified during the initial design stage which would normally become apparent when the project is in its implementation phase. This enables optimization of the design from an integral perspective rather than mitigating individual risks within constraints set by earlier design choices.
- Publication of more than 30 safety improvement measures at Schiphol airport. Some of these measures have been realized already, others are being implemented or under investigation. Examples are:
    - Schiphol is equipped with a circumferential double-lane taxiway system, except for the current Quebec taxiway on the A4 highway. Schiphol and its partners will increase operational predictability, uniformity and ground capacity by doubling the Quebec taxiway. This will reduce the likelihood of on-ground safety occurrences.

- Air Traffic Control the Netherlands redesigned the working stations in the Tower. This allows air traffic controllers to be positioned at the location most beneficial for their area of control, thereby reducing the likelihood of safety occurrences in the air and on the ground.
- Air Traffic Control the Netherlands (LVNL) and Schiphol have developed measures to further reduce the number of last-minute runway changes, and the associated risks, in order to prevent air and ground safety incidents. For instance, we maintain landing runways when an aircraft is in the Terminal Maneuvring Area (TMA) Schiphol; in addition, we use two departure runways when needed for a more stable traffic flow. We also use improved planning systems. These measures enable the percentage of last-minute runway combination changes to structurally decrease.
- Aircraft following the routing to the beginning of runway 18L (Aalsmeerbaan) pass intersection N2/E6. At that point, the traffic crosses runway 09 (Buitenveldertbaan). Schiphol and its partners are creating a runway stop bar in order to prevent aircraft that erroneously turn right from taxiing via the Buitenveldertbaan runway towards departing traffic. This will reduce the risk of runway incursions.

- The Runway Safety Team (RST) is a key component of the ISMS. The RST consists of a team of experts tasked with identifying ways to prevent runway incursions at Schiphol. A runway incursion is, according to the definition of ICAO, any occurrence at an aerodrome involving the incorrect presence of an aircraft, vehicle or person on the protected area of a surface designated for the landing and take-off of aircraft. The team continuously monitors trends to identify locations at the airport where there is a greater likelihood of runway incursions. This has resulted in a number of ongoing studies and implementation projects aimed at structurally reducing the occurrence of runway incursions and the associated risks. In 2019, no runway incursions took place at Schiphol with a potential safety consequence (2018: two, 2017: eight).

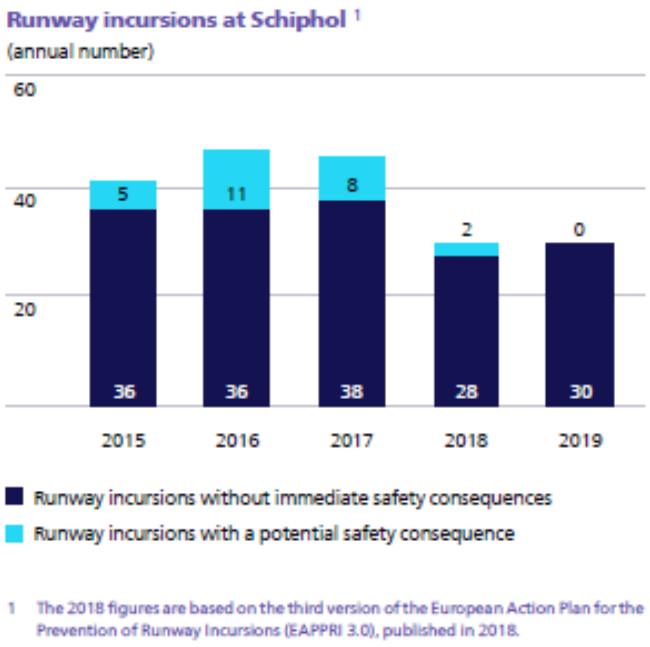

Figure 4: number of runway incursions at Schiphol [Schiphol annual report 2019].

From Figure 4 it a can be concluded that the number of runway incursions has decreased since 2017.

In 2020, a joint safety dashboard is further developed to monitor current safety performance including the effects of safety improvement measures.

Conclusions

In this paper the development of an Integral Safety Management System Schiphol is described. It was shown that the aviation organizations at Schiphol have set-up a co-operation framework to jointly manage interface risks across organizations. With respect to this co-operation, the following conclusions can be drawn:

- The ISMS takes an integral approach to the management of safety interfaces at Schiphol Airport;
- The structure of ISMS mimics the best practices for safety management systems as described in [ICAO doc 9859];
- Within ISMS, effective ways have been found to support multi-actor decision-making on the basis of consensus;
- The overall performance of the management of safety within the ISMS, measured against PRESENT, SUITABLE, OPERATING, EFFECTIVE, as defined by the EASA Management System Assessment Tool (MSAT), is currently assessed as being at OPERATING;
- ISMS has produced significant output including joint incident investigations, risk analysis, safety improvement measures and initial safety performance improvements.

Based on the above, it is concluded that ISMS is an industry leading initiative, taking aviation safety at complex airports to a next level.

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