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## 2.1 Background

To improve the currently existing levels of aviation safety, especially when considering the continuing growth of the industry, additional measures are required. One such measure is to encourage individual aircraft operators to introduce their own safety management system. Such a safety management system is as important to business survival as a financial management system and should be regarded as the core value and process of a company. One of the main purposes of an SMS is to improve the safety performance, and therefore reduce exposure to the risk of having an accident or suffering bankruptcy.

The implementation of a safety management system should lead to an overall improvement of the processes of a company, and should contribute to one of civil aviation's key business goals: enhanced safety performance, aiming at best practices and moving beyond full compliance with regulatory requirements.

With Amendment 30 to ICAO Annex 6 Part I, the International Civil Aviation Organization introduced requirements for air operators to implement an acceptable safety management system. This obligation is similar to EC 8/2008 EU OPS 1 paragraph 1.037 which requires the establishment and maintenance of an accident prevention and flight safety program in order to improve aviation safety.

Another crucial part of risk management, namely security, is defined in regulation (EC) No 300/2008 of the European Parliament and of Council of 11 March 2008 on common rules in the field of civil aviation security. In order to be more flexible in addressing evolving risk assessments, adopting security measures and processes and to introduce new technologies in the civil aviation framework, this

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**Fig. 2.1** Risk management components. *Source:* Own illustration



regulation was designed to illustrate the basic principles of what has to be done in order to safeguard civil aviation against acts of unlawful interference without going into the technical and procedural details of how they are to be implemented.<sup>1</sup>

Although many companies and operators already use a form of safety/risk management, this is often a long way from being designed effectively. Often operators restrict themselves to risks on the operational level, or risk management is considered only as prevention management. Risk management has to cover all company areas and has to be communicated across all business functions in order to be effective (Fig. 2.1).

There are many aviation companies that have extremely good safety records while still operating with risky behavior characteristics or inadequate organizational structures. Fortunately, they have just not had an accident yet. However, a good safety record does not guarantee future safety—a fact that is yet not clearly understood by the various aviation stakeholders. Safety does not happen by chance.

In addition, small aircraft operators lack the required resources and knowledge to implement an effective, integrated management system into their business processes.

Sample checklists and guidance material (provided in this book) should serve as a guideline for an appropriate way of dealing with the implementation of a suitable SMS.

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## 2.2 Objective of the Book

The objective of the book focuses on the illustration of several aspects of safety and risk management.

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<sup>1</sup> European Union (2008).

First of all the necessary scientific basis has to be explained in order to gain an understanding of the examined subject. In relation to this, the interdisciplinary aspects of international regulations and organizational requirements are explained.

The regulatory basics and requirements are demonstrated in a theoretical way in order to build the foundation for a practical approach. It should serve as a guide to how an organization, affected by safety management system requirements, can adapt to the regulations in a size-appropriate manner and with a corresponding suitable approach, in order to implement a safety management system in practice.

A further objective is to highlight that safety and risk management are essential parts of an organization and vital for day to day business.

Finally, it demonstrates how safety management can be implemented by the various aviation stakeholders. Samples and checklists serve as the guideline for a basic SMS implementation.

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## 2.3 Methodology

The methodological approach of the authors can be explained as follows:

1. Evaluation of the existing literature on the subject risk management and safety management systems
2. Analysis of studies and reports
3. Results from a survey about risk management
4. Experience based on past implementation projects and seminars
5. Development of specific tools based on (solutions to) practical problems

The different disciplinary backgrounds of the authors have repeatedly led to exciting discussions during the preparation of the book. It became clear that the issues about risk management and safety management systems can only be usefully worked on in practice when different perspectives are taken on board, and if they are consciously applied in an aviation context.

The introductory chapter indicates which concepts for the in-depth understanding of safety management systems and risk management are essential, and how they are/should be interpreted. Definitions provide the foundation for further reading.

Part II provides the theoretical background of risk and safety management. In detail, it combines the scientific basis of regulatory requirements and basic law on the one hand and, on the other hand, creates a basis for the understanding of the subject. In relation to this, the relevant legal, management and aviation specific literature is incorporated.

Part III explains the practical implications of risk and safety management. Due to this, a survey was conducted and the results have been evaluated to illuminate current trends. The chapter closes with two aircraft accident examples.

Part IV deals with the concrete, practical implementation and optimization of the previously explained theoretical models concerning safety and risk management approaches. Therefore, it explains the most important implementation steps in four different phases with specific, practical examples.

Part V includes appendices with checklists and samples for implementation. They should serve as guidance material for planning and implementing a SMS. Furthermore, the samples can be enhanced and adapted to each organizational need.

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## 2.4 Definitions

Below, the most important concepts are explained to serve as a basis of understanding for the following content.

### 2.4.1 Hazard

A hazard is a condition or an object with the potential of causing injuries to personnel, damage to equipment or structures, loss of material, or reduction of ability to perform a prescribed function.<sup>2</sup>

Looking at an example from the ICAO Safety Management Manual, will make it clear how a hazard should be understood.

Consider, for example, wind, a normal component of the natural environment. Wind is a hazard: A fifteen-knot wind, by itself, does not necessarily hold potential for damage during aviation operations. In fact, a fifteen-knot wind blowing directly down the runway will contribute to improving aircraft performance during departure. However, when a wind blows at fifteen knots across a runway used for intended take-off or landing, it becomes a crosswind. It is only then, when the hazard interfaces with the operations of the system (take-off or landing of an aircraft) aimed at service delivery (the need to transport passengers or cargo to/from the particular aerodrome while meeting a schedule) that its potential for damage becomes a safety concern (a lateral runway excursion because the pilot may not be able to control the aircraft as a consequence of the crosswind).

A hazard should not necessarily be considered as a “bad thing” or something with a negative connotation. Hazards are an integral part of operational contexts, and their consequences can be addressed through various mitigation strategies to contain the hazard’s damaging potential. Hazards can be divided into three different sub categories and can be found in all operational, natural and maintenance aspects which have a direct influence on aircraft operations and have the potential to cause harm. Therefore, it is of high importance to identify those hazards and keep them controlled.<sup>3</sup>

The three categories are classified as follows:

**Natural hazards** can be described as an unforeseen or uncontrollable natural event of unusual intensity which has a negative effect or possibly threatens a safe aircraft operation. Natural hazards are classified as severe weather and climatic

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<sup>2</sup> Stolzer, Halford, and Goglia (2008), p. 26.

<sup>3</sup> International Civil Aviation Organization (ICAO) (2013), pp. 2–25.

events, adverse weather conditions, geophysical events, geographical conditions, environmental events and public health events.<sup>4</sup>

**Economic hazards** can occur at any time within an organization, whether it is currently in a growth period or suffering from a recession. During growth periods, organization and safety is lacking behind the operations, while during a recession a company tries to reduce costs and wants to avoid wasting money, especially on costs for material and equipment. Therefore, sacrifices towards safety might be accepted to save costs.<sup>5</sup>

**Technical hazards**, in general, perpetuate in all maintenance and operational environments where humans interact with technological systems. Some examples where technical hazards might occur are in the operational environment with aircraft and aircraft components, systems, subsystems and corresponding equipment.<sup>6</sup>

## 2.4.2 Safety Risk

Risks are disruptions resulting from the unpredictability of the future caused by accidental derogation possibilities of planned targets. Therefore, talking about risks also means the dispersion around an expected value.

The assessment, expressed in terms of predicted probability and severity, of the consequence(s) of a hazard taking as reference the worst foreseeable situation.<sup>7</sup>

This statement is the official definition of safety risk by ICAO; it takes into consideration the identified hazard and classifies it into two categories—“probability” and “severity”. The term “safety risk” is the continuance of a hazard in terms of a scenario that follows due to accepting the hazard. Since it is not only of importance to identify hazards and then engage a mitigation process, it is also “necessary to evaluate the seriousness of consequences, so as to define priorities for the allocation of resources when proposing mitigation strategies”.<sup>8</sup> A hazard is only the condition or circumstance that can lead to physical damage or loss. It is not to be confused with the associated safety risks. For example, an obstacle at the end of a runway composes a hazard. This obstacle could lead to at least three safety risks. The first safety risk would be that an aircraft might hit the obstacle while landing or taking off. The second safety risk would be that the pilot knows the obstacle is there and may carry out a steeper approach than normal, in order to avoid the obstacle and arrive at the end of the runway “hot and high”, continue with the landing and overrun the runway. A third safety risk could be

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<sup>4</sup>International Civil Aviation Organisation (ICAO) (2009), pp. 4–3.

<sup>5</sup>International Civil Aviation Organisation (ICAO) (2009), pp. 4–4.

<sup>6</sup>International Civil Aviation Organisation (ICAO) (2009), pp. 4–4.

<sup>7</sup>International Civil Aviation Organization (ICAO) (2013), p. 5–ii.

<sup>8</sup>International Civil Aviation Organisation (ICAO) (2009), p. 5.

that the pilot in the second scenario recognizes that he or she is “hot and high” and executes a “go around”. In order to know the outcome of the hazard, where this might lead and what actions need to be taken, the safety risk has to be assessed. This is done by classifying the safety risk into two categories<sup>9</sup>—probability and severity.<sup>10</sup>

### 2.4.3 Risk Management

Risk management is generally understood as the holistic process involved in recognizing possible risks, and the measures undertaken to reduce and monitor them. It thus comprises a modular cycle of communication, documentation, control, early warning mechanisms, and advancement.

This general definition of risk management as a comprehensive process can be further concretized:

Risk Management means the permanent and systematic recording of all kinds of risks with regard to the existence and the development of the enterprise. It involves analyzing and prioritizing recognized risks as well as defining and implementing adequate strategic or surgical measures to minimize non-tolerable risks.<sup>11</sup>

In this definition, the following important elements are united in connection with risk management:

- Risk management comprises not only a unique action, but a steady process which must be implemented in the enterprise.
- In order to not merely recognize the obvious risks, a structured procedure, aimed at investigating and listing all risks within all ranges, is necessary.
- Each risk is to be judged individually and to be evaluated by the same yardsticks to establish interconnections as regards the degree and kind of risk potential involved.
- Within the scope of its risk policy, company management has to decide which risks must be accepted, avoided or managed on the basis of their consequences and the suitable measures that would need to be undertaken.
- The logical conversion of agreed strategic or mitigation measures to manage or reduce potential risks.
- And finally, risk management can only be successful if newly emerging risks and claims are communicated in a standard form on all enterprise levels (so-called Risk Reporting) and if a suitable organization exists to ensure on-going process optimization (so-called Risk Controlling).

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<sup>9</sup> According to the Safety Management Manual (SMM) of the ICAO.

<sup>10</sup> International Civil Aviation Organisation (ICAO) (2009), pp. 5–2–8.

<sup>11</sup> Wittmer, Bieger, and Müller (2011).

### 2.4.4 Operational Risk Management

Operational risk is defined by the Basel Committee as “The risk of loss resulting from inadequate or failed internal processes, people and systems or from external events”. Operational risk management and line management together assess and monitor these risks and prepare risk mitigating strategies and actions. The Business Continuity Plan is a response prepared to react to a subset of operational risks, defined by the scope and size of events: The focus of Business Continuity Management is not on risks to the core-business objectives, but on external risks that lie outside the competencies of the business and cause significant business disruption that might threaten the survival of the company.

### 2.4.5 Risk Appetite

“Risk appetite is the amount of risk, on a broad level, an organization is willing to accept in pursuit of value. Each organization pursues various objectives to add value and should broadly understand the risk it is willing to undertake in doing so.”<sup>12</sup> No organization can achieve its objectives without taking risks but the level and amount of risks an organisation has to take, cannot be clearly specified. The biggest challenge is to manage the taken risks continuously.<sup>13</sup>

### 2.4.6 Risk Mitigation

Risk mitigation is the process of lowering a risk to a level which is as low as reasonably practical.<sup>14</sup> Risks have to be identified and classified in order to develop and apply the right mitigation measures. The process of risk mitigation makes it possible for air operators to accept certain risks in daily operations and classify them according to company policies and procedures. It ensures that changes or new situations are assessed according to their safety significance, and classifies them according to their safety severity. Risk mitigation measures often incorporate a cost benefit analysis. This analysis has to determine whether risk mitigation makes economic sense, or whether the organization has to accept the risk, or if it has to cancel the operation.

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<sup>12</sup> Rittenberg and Martens (2012).

<sup>13</sup> The Institute of Risk Management (2011).

<sup>14</sup> International Civil Aviation Organisation (ICAO) (2009).

### 2.4.7 Safety

The term safety has different meanings and depends on perspective and context. The International Civil Aviation Organization (ICAO) considers safety as:

The state in which the risk to harm to persons or damage to property is reduced to, and maintained at or below, an acceptable level through a continuing process of hazard identification and risk management.<sup>15</sup>

Often, safety is understood as the condition of zero incidents. When being familiar with the hazardous environment in aviation, it becomes clear that the risk of incidents is always present. The question is not about how safe a company is, but more how safe a company wants to be and what measures have to be taken to reach this defined goal. Safety must be interpreted as a result of efficient review and management behavior of organizational processes, with the target to control safety risks and hazards in the operational environment.

### 2.4.8 Safety Management System

A safety management system can be described as a set of processes or components that combines operational and technical systems with financial and human resource management. Those processes are present in every activity of the aviation stakeholders. It is a methodical approach to safety with the focus on goal setting and a clear definition of accountability throughout the operator's organization. The intention of a safety management system is to develop and sensitize the company away from a reactive to a proactive generative safety culture in order to identify hazards and possible incidents before they can occur.

A SMS aims at continuous improvement to the overall level of safety while measuring performance, analyzing processes and becoming an integral part of the company's business management activities and corporate culture. As a consequence, the implementation of a SMS requires processes which allow the control of safety risks and introduces the concept of the acceptable level of safety.

### 2.4.9 Safety Culture

An organization's culture is defined by what the people do and which decisions they take. This reveals the basic values of an organization. A positive safety culture will move a company forward to a maximum achievable safety level, despite business cycles and times of recession where financial pressure is evident. A positive safety culture can be split into four different components:

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<sup>15</sup> International Civil Aviation Organisation (ICAO) (2009).



- **Informed culture:** The people who manage the system have sufficient knowledge in all functional areas of human resources and maintenance, as well as environmental and organizational aspects which have a direct link to safety. They understand the hazards and risks involved in daily operations.
- **Reporting culture:** The basis for a reporting culture is an atmosphere of trust, where people are encouraged to report their errors or near misses. Those reports provide essential information which can be used to avoid the same mistakes being repeated.
- **Just culture:** Based on the reporting culture and understood as a ‘blame-free’ culture, employees are supported by providing essential safety related information. Furthermore, it is quite clear where the line is drawn between acceptable and unacceptable behavior, and when unsafe acts will call for disciplinary action.
- **Learning culture:** A company must strive for constant improvement and must share the ‘lessons learned’ to draw the right conclusions from its safety management system. It possesses the willingness to challenge its basic assumptions and should change processes when inadequacies have been identified.

Looking at the above mentioned characteristics, it becomes clear that it is not an easy task to establish a safety culture—it is more a development which takes time and commitment, and must be understood by everyone within an organization. Therefore, establishing a safety culture is one of the most challenging elements of a SMS. Creating a safety culture begins at the top level of an organization, with the incorporation of policies and procedures which establish a reporting culture (often also implied when referring to the term “just culture”).

A safety culture is characterized by structures which allow safety-related information to be identified on all organizational levels and entered into a system empowered to correct and deal with these problems.

In order to support a reporting culture, the organization must cultivate the willingness of its members to report errors. The organization has to make the commitment not to punish errors, as long as they are not reckless. Then these reports become valuable sources in the context of hazard identification and, more importantly, build the foundation for an effective SMS.

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## 2.5 Limitations

There are some topics connected to risk management which are important but are not, or only briefly, discussed in the present work. The following list provides a brief overview of the limitations.

### 2.5.1 Quality Management

This book will not describe the differences between quality and safety management. We can only highlight that quality and safety management systems both have to be

planned and managed, as neither quality nor safety happen by chance. Quality systems do not investigate incidents or accidents for risk assessment. Quality systems audit the output of a process only in terms of variance, and make adjustments. A SMS investigates events, looking for contributing factors from all influencing sources. Both depend upon measurement and monitoring, and together they encompass every function, process and member of staff, while striving for continuous improvement.

### **2.5.2 Emergency Response Planning**

In the context of risk and safety management, we don't want to focus in detail on the development and implementation of emergency response planning and crisis management. We aim to focus more on proactive and preventive measures in order to prevent crisis scenarios.

### **2.5.3 Corporate Risk Management**

The book does not focus on Corporate Risk Management or owner (leasing) risks. We will only partially describe corporate governance, with our focal point on the management level.

### **2.5.4 Aircraft Development and Testing Activities**

All development activities for aerospace products including specific verification and validation, monitoring, measuring and testing activities, and product acceptance criteria are excluded in this version. In relation to this, there is no focus on FMEA or any other design and development related processes.

### **2.5.5 Actuarial Calculation of Risks for Insurances**

Insurances are an important tool for hedging and the passing-on of risks. Companies with well-developed risk management gain cheaper access to capital; additionally, they can also negotiate favorable deals or reduced premiums with insurance providers. This is indeed an important development as risk management now makes direct financial sense, contradicting the belief of many skeptics who felt risk management was just a cost center and a bureaucratic exercise.<sup>16</sup> Furthermore, risk management has a high priority in the insurance industry and is a basic service for the insured company. The main application of insurances, from a business

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<sup>16</sup> Kalia and Müller (2006).

perspective, is the protection of property, plant and equipment, along with material items of current assets, and the consequential damages resulting from the loss of operational capabilities. In addition, liability insurance which covers third party damage, personal injury claims, property damage and financial loss are further services by insurance companies.<sup>17</sup> Despite the importance of insurance, further analysis on how to calculate insurance risks is not directly relevant to the main themes of this book.

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<sup>17</sup> Burkhalter (2011).

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