Management for Professionals

Roland Müller · Andreas Wittmer
Christopher Drax *Editors*

Aviation Risk and Safety Management

Methods and Applications in Aviation Organizations

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Preface

This book closes a gap as there is no literature currently in circulation that specifically addresses risk management issues in the aviation industry. The aim of this book is to show the theoretical background and implementation phases of a multifaceted risk management system, to gain a gradation for smaller operators who do not have the complexity of large operators for whom the system was initially developed. This approach illustrates the leeway available to adapt processes and reveals the interfaces between risk management and safety management. The book describes how to approach corporate risk management, with reasonable effort, appropriate to the size and complexity of the specific operator. It provides an idea of what the key considerations are and how to effectively operate such a system with the various interfaces. Furthermore, it provides an indication about the time investment needed in the set-up and the continuous process of corporate risk management from a cost and benefit perspective. Specifically, a safety management system (SMS), fatigue risk management and air traffic control risks are provided as specific practical cases of risk management.

An empirical study shows the level of implementation of corporate risk management in the aviation industry in practice. Based on the comparison of theory and practice, and the knowledge provided by the empirical study, different checklists and samples for the optimization of risk management are provided. Documents illustrating risk policy, the job description of a risk manager, a questionnaire for an SMS gap analysis, emergency director checklist, master risk list, hazard reporting procedure, air safety report, safety manager evaluation sheet, SWANS report, etc. are provided in appendices for the particular chapters. Furthermore, a time/cost table for the implementation and continuous development of corporate risk management is included.

This book addresses all actors in the aviation industry, such as aviation companies, consultants, and educators. It provides the opportunity for all actors to build and optimize their risk management systems/procedures. For the strategic management level, this publication makes clear why risk management has to be established as a culture in a company and must be fully supported by top management.

Finally we would like to thank everyone who supported us during the process of writing this book, especially the authors Ernst Kohler, Stefan Becker and Heinz Wipf who provided additional content. Furthermore, many thanks go to Nicole

Denk who helped with translations and supported us administratively, and to David Roberts who supported us with the final editing. We are grateful for all the support we have received and which helped to finalize this book that fills a void in the current literature.

Sankt Gallen, Switzerland — Roland Müller
Lorsch, Germany — Andreas Wittmer
January 2014 — Christopher Drax

Abbreviations

A/C	Aircraft
AEMS	Airplane Emergency Medical Services
ALARP	As low as reasonable practicable
AMC	Acceptable Means of Compliance
AOC	Air Operator Certificate
ArG	Arbeitsgesetz
Art.	Artikel/Article
BAZL	Bundesamt für Zivilluftfahrt
BCMS	Business Continuity Management System
BIA	Business Impact Analysis
BoD	Board of Directors
CAA	Civil Aviation Authority
CEO	Chief Executive Officer
CFIT	Controlled Flight into Terrain
CFO	Chief Financial Officer
COSO	Committee of Sponsoring Organizations of the Tradeway Commission
CRM	Corporate Risk Management
CRM	Crew Resource Management
CRO	Chief Risk Officer
CS	Certification Specification
DME	Distance Measuring Equipment
DOT	Department of Transportation
EASA	European Aviation Safety Agency
EBITDA	Earnings before interest, taxes, depreciation and amortization
EC	European Convention
EEG	Electroencephalogram
ERM	Enterprise Risk Management
EU	European Union
FAA	Federal Aviation Administration
FMEA	Failure Mode Effects Analysis
FOCA	Federal Office of Civil Aviation
FPM	Fellow Program in Management
FRMS	Fatigue Risk Management System

GM	Guidance Material
HAZID	Hazard Identification
HEMS	Helicopter Emergency Medical Services
HSG	Hochschule St. Gallen
IBAC	International Business Aviation Council
ICAO	International Civil Aviation Authority
ICS	Internal Control System
IFR	Instrumental Flight Rules
ISO	International Organization for Standardization
JAA	Joint Aviation Authorities
KSS	Karolinska Sleepiness Scale
LFG	Luftfahrtgesetz
LFV	Luftfahrtverordnung
LOFT	Line Oriented Flight Training
LVA	Luftverkehrsabkommen
MCTOM	Maximum Certified Take-off Mass
MDA	Minimum Descent Altitude
MSAWS	Minimum Safe Altitude Warning System
NPA	Notice of Proposed Amendment
OM	Operational Manual
OPS	Operations
Pax	Passenger/s
PF	Pilot Flying
PNF	Pilot Not Flying
QMS	Quality Management System
QRA	Quantitative Risk Analysis
RIMS	Risk & Insurance Management Society
RVOG	Regierungs- und Verwaltungsorganisationsgesetz
SAG	Safety Action Group
SARPS	Standards and Recommended Practices
SEC	Securities and Exchange Commission
SMM	Safety Management Manual
SMS	Safety Management System
SPS	Samn Perelli Scale
SRB	Safety Review Board
USD	United States Dollar
VAS-F	Visual Analogue Scale to Evaluate Fatigue Severity
VFR	Visual Flight Rules
VOR	Very High Frequency Omni Directional Radio Range
WOCL	Window of Circadian Low

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1 Management Summary

Andreas Wittmer

The aviation industry faces a variety of risks. For this reason, risk management is self-evident in this industry. But the aviation industry also faces a greater density of regulations concerning risk management than other industries. For example, the implementation of internal control systems (ICS) and safety management systems (SMS) are often required depending on specific activities, complexity and size of the company. The International Civil Aviation Organization's (ICAO's) decision to require aviation organizations to adopt safety management systems (SMS) has clearly focused attention on the concept of SMS. These requirements for safety and risk management represent a huge problem, especially for small and medium sized aviation companies because the majority is not able to appropriately deal with the subject in order to gain advantages. The different systems are interrelated and should be linked to the culture of companies. In fact, aviation companies need to have risk management as a core competence if they want to operate according to regulations and remain sustainable in the market.

Part I: Introduction The introduction provides the reader with the background and the motivation of the authors to write about the topic of risk and safety management in aviation. The objective and methodological approach are explained, with all the relevant definitions, to build the scientific basis for the further understanding of the topic. Furthermore, the introduction outlines the limitations of the book to define the scope of the following chapters.

Part II: Theoretical Background of Risk and Safety Management Part II provides theoretical background on risk and safety management. It deals with the necessity to develop risk management and internal control systems, as well as highlighting the importance of implementation and a continuous risk management process. The costs and benefits of risk management reveal major differences in the

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different implementation efforts based on the complexity and size of individual companies. It demonstrates that the implementation of risk management is also possible for small companies; although the cost of maintaining an effective risk culture does influence the sustainable development of a small company more than it does a big one. The check list and files in the appendix should help small companies especially to implement risk management with limited costs.

Operational risk management is an integrated part of safety management systems which have an impact on corporate governance and internal control systems in organizations.

Part III: Practical Implications of Risk and Safety Management An empirical study analyses the level of risk and safety management implementation in the aviation industry. The analysis of the survey shows that almost half of the respondents were from organizations with a workforce greater than 500 employees. Small firms with less than 50 employees were underrepresented with only 15%. However, this is still a very interesting segment to study as most of the regulations are developed specifically for larger organizations, and small organizations are increasingly struggling with the implementation and monitoring of regulatory compliant management systems.

Risk management in air traffic control highlights how operators deal with risks and their consequences, such as accidents. In an aviation transport system value chain, it can be argued whether every entity has to perform risk management in its safety activities. Instead, it is proposed first to analyze where the risk bearers are located.

There is evidence that the aircraft operator bears the final risks. Although other entities like airports and air navigation service providers are part of a hazardous operation, they have a limited impact on the exposure to safety risks. They suffer only limited effects from safety risk. It is therefore necessary for the aircraft operator to have a risk-based safety management system. Risk assessment is part of risk management and should be done only by the most influential entity, while still collaborating with the other entities that support the addressed flight operation. The need and necessity to assess the risk of flights seem best to remain with the operator. This is because it seems to be the only entity that can predetermine the scenarios, estimate convoluted likelihoods and control incurred damages and losses when deciding on the type of aircraft to be used. The influence of the other entities on likelihood, damage and loss are unevenly allocated.

The case of fatigue risk management is addressed by a risk assessment study. When implementing a company-wide safety culture and the related programs, managers or supervisors form an integrative link between the senior management and the employees. Corporate culture is the sum of the behavior, habits, shared history and anticipated future within a company. Supervisors are correspondingly important, as they act as role models who uphold the corporate culture in the various spheres on a day-to-day basis. It is essential that they are aware of the key role they play, and that they carry it out voluntarily. Otherwise, they fail to come across as authentic and are thus more likely to damage a healthy safety culture than enhance it. Supervisors should also integrate the fatigue factor into their daily mission discussions, in order to regularly address the problems involved. Changes may need to be made to the duty roster to prevent acute or cumulative sleep debt or other fatigue-promoting factors. For this purpose, superiors are continually informed about new findings gained from the Fatigue Risk Management process and also involved in further developing company-wide anti-fatigue programs, for which they can draw on their everyday experience. Finally, two aircraft accident investigation cases highlight the importance of continuous risk and safety management in practices.

Part IV: Implementation and Optimization of Risk and Safety Management Part IV deals with implementation and optimization of established risk and safety management and adds four phases, namely "organization", "risk collection and assessment", "risk mitigation" and "continuous improvement and change management". A general problem within the SMS literature is that the majority of implementation structures and recommendations are tailored to large enterprises. When following these plans, an enterprise might take months until they come to the point where they can start identifying their first risks. Our philosophy is to immediately start with the collection of risks in order to gain an overview of the main risks an organization is facing and to work on mitigating them as soon as possible. We therefore compressed the following implementation structure down to the essentials to quickly move to risk collection. The following SMS implementation process is divided into four different phases to split up the workload and to provide a convenient structure to follow when implementing the safety management system. The time horizon of four years should also allow the adjustment of the culture within a company in order to create a positive safety culture. Each corresponding SMS topic will be addressed in this chapter with a brief explanation including the required deliverables. Thus, Part V provides tools as practical examples and guidance for the implementation.

Appendices The appendices in the different chapters provide check-lists and documents which can be used directly by companies implementing and optimizing their risk and safety management. The following documents are provided:

- Sample risk manager job description
- Types of risk
- Accident definitions
- Joint probability distribution of aircraft weight and total fatalities
- Decision layer and influence
- Kinetic and chemical potential energy of aircraft
- SMS gap analysis
- Sample safety policy
- Master risk list examples
- ASR/hazard reporting procedure
- Sample air safety report
- Safety manager evaluation sheet

- SWANS report
- ERP checklist emergency director
- Individual risk assessment example
- Risk management policy
- Steps in assessing risk
- Glossary
- Insurance review

Part I

Introduction

2 Essential Basics and Limitations of Safety and Risk Management

Roland Müller and Christopher Drax

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.[1]

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.

2.2 Objective of the Book

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

[1] 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.

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.

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.[2]

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.[3]

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

[2] Stolzer, Halford, and Goglia (2008), p. 26.

[3] International Civil Aviation Organization (ICAO) (2013), pp. 2–25.

events, adverse weather conditions, geophysical events, geographical conditions, environmental events and public health events.[4]

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.[5]

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.[6]

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.[7]

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".[8] 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

[4] International Civil Aviation Organisation (ICAO) (2009), pp. 4–3.
[5] International Civil Aviation Organisation (ICAO) (2009), pp. 4–4.
[6] International Civil Aviation Organisation (ICAO) (2009), pp. 4–4.
[7] International Civil Aviation Organization (ICAO) (2013), p. 5–ii.
[8] 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[9]—probability and severity.[10]

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.[11]

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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[9] According to the Safety Management Manual (SMM) of the ICAO.

[10] International Civil Aviation Organisation (ICAO) (2009), pp. 5–2–8.

[11] 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."[12] 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.[13]

2.4.6 Risk Mitigation

Risk mitigation is the process of lowering a risk to a level which is as low as reasonably practical.[14] 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.

[12] Rittenberg and Martens (2012).

[13] The Institute of Risk Management (2011).

[14] 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.[15]

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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[15] 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.

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.[16] 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

[16] 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.[17] 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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Part II

Theoretical Background of Risk and Safety Management

3 Necessity and Development of Risk Management

Roland Müller and Christopher Drax

Every company faces different types of risks. Unfortunately, risks are often detected too late, so neither sufficient time nor adequate measures are available to prevent damage resulting from the realization of the risk potential. To prevent this, farsighted management seeks to identify potential risks and, where possible, to minimize the most dangerous ones for the company through appropriate strategic and operational measures. Therefore, consciously or unconsciously, each organizational management applies Risk Management. In fact, Risk Management is an inalienable and indefeasible duty of the Board of Directors. The Swiss code of obligations specifies in Article 716a under no. 1 that the direction of the organization is necessarily assigned to the board.

This includes the duty to avoid unnecessary risks and to minimize unavoidable risks to ensure the existence and further development of the company. As a consequence of the amendment of the Limited Liability Company Law of 1.1.2008,[1] the annex to the financial statements must state information about the implementation of a risk assessment.

If the risk assessment and risk mitigation is to be more than an occasional and coincidental event, the organizational structures, responsible personnel and the applicable processes have to be defined. In order to compare the efficiency of Risk Management between different companies, a certain standardization of the following points is necessary[2]:

[1] Also Article 663b OR is added that according to No. 12.

[2] AIRMIC, ALARM, and IRM (2002).

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- Terminology related to the words used
- Risk management process
- Organizational structure for Risk Management
- Objectives of Risk Management

Such a risk management standard was created in England after extensive consultations with various professional associations such as the Institute of Risk Management (IRM),[3] the Association of Insurance and Risk Managers (AIRMIC)[4] and the National Forum for Risk Management in the Public Sector (ALARM).[5]

The Federation of European Risk Management Association (FERMA) is trying to implement this standard in practice, so that organizations and companies can measure themselves against it. Where applicable, the definitions of the International Standard Organization (ISO) will be used.

3.1 Importance of Risk Management

Risk is considered as an essential element of strategic management and is currently discussed in many empirical industry studies and is prominent in connection with firm and business unit performance. Especially in times of crisis, the strategic importance of Risk Management becomes quite clear. The massive increase in forecast uncertainty leads to a competitive advantage for companies that can interpret and manage risks better than others. As companies are usually only able to achieve higher returns by simultaneously taking additional risks, Risk Management in particular has to decide what kinds of risks are acceptable for an organization.[6] Ruefli et al. argued that we lack a generally accepted model of strategic risk taking which is based on the various connections within firms and the interplay among decision makers, organizational processes, and market and industry factors that have an influence on the judgment of risk and strategic risk taking in an organized way.[7]

Strategic Risk Management can be described as a process for identifying, assessing and managing risk anywhere in the strategy, with the goal of protecting and creating shareholder and stakeholder value. Strategic Risk Management is the primary component and basis of enterprise Risk Management and is affected by boards of directors, management and others. A strategic view of risk is required in order to understand how external and internal events or scenarios will affect an organization in the pursuit of reaching its strategic objectives. Furthermore,

[3] The Institute of Risk Management, Lloyd's Avenue 6, London EC3N 3AX, www.theirm.org.

[4] The association of Insurance and Risk Managers, Lloyd's Avenue 6, London EC3N3AX, www.airmic.com.

[5] The National Forum for Risk Management in the Public Sector, Queens Drive, Exmouth, Devon EX8 2AY, www.alarm-uk.com.

[6] Speckbacher, Asel, and Posch (2010).

[7] Ruefli, Collins, and Lacugna (1999).

Strategic Risk Management can only work if an organization defines tolerable levels of risk, or risk appetite, as a guide for strategic decision making. Finally, it is an ongoing process which needs to be embedded in strategy definition and strategic management.[8] The current financial and economic crisis has put financial management and controlling in affected companies under intense pressure. Plans and budgets abruptly lost their basis and companies had to deal with unexpected and completely new scenarios. While performance management, value generation and growth for many businesses had, for decades, stood in the foreground, the focus shifted suddenly towards Risk Management, liquidity assurance and business preservation. Emphasis is now placed on increased communication, particularly relating to the desired handling of risks. The focus is on the creation of awareness for company-wide, acceptable risks, as well as on what kind of risks are unacceptable and have to be avoided. In connection with this, the link between risk and performance has to be communicated to the employees in order to achieve awareness of that specific interdependency. In this context, the aspect of trust plays an important role.[9]

In addition to Ruefli et al., Frigo and Anderson also argued that Strategic Risk Management is still a relatively undeveloped activity in many companies, and that managers are reluctant to invest in risk functions. Even though Risk Management has become quite prominent in many companies, no significant financial investment has been made during recent years. The study further revealed that less than one-half of companies invested in risk processes; whereas, less than one quarter allocated funds for the training of employees with central risk functions. Constant cost pressures and budget cuts are limiting investments, but companies have to be careful not to compromise the effectiveness of a working risk management system/approach.[10]

When systems increase in size and become more connected, the complexity increases as well. Furthermore, large systems become unmanageable and irretrievable failures are more likely to happen. Without a doubt, with the complexity of organizations today and, to a greater extent those of the future, all institutions will face huge challenges when managing that situation. The chance of accidents is high and managers have to be able to respond in an appropriate way.[11]

Given the fact that Risk Management in Austrian companies is mainly understood as a top management task, 83 % of Austrian CFOs indicated they were responsible for Risk Management. The survey further showed that there is a relatively weak agreement on the question of whether there is a need for Risk Management primarily through regulatory/corporate external authorities/systems (for example, law or Corporate Governance Code). This may be an indication that companies don't see Risk Management as a regulatory obligation, but rather a process for active value creation.[12]

[8] Frigo and Anderson (2011).

[9] Speckbacher et al. (2010).

[10] Frigo and Anderson (2011).

[11] Ford et al. (2003).

[12] Speckbacher et al. (2010).

The global financial crisis has revealed that strengthening Risk Management and corporate governance are major challenges for organizations. A lesson learned is the necessity to clearly link the corporate strategy and Risk Management, and to identify and manage risk in a highly uncertain environment.[13]

On average, companies are reasonably satisfied with their Risk Management. However, companies across all industries see significant potential for improvement in risk management systems, in particular the link between Risk Management and strategic planning.[14] Certainly, Risk Management is not a new concept to businesses and managers, but the growing complexity and speed in the business environment have increased the necessity of a structured approach towards managing risks. Risk management systems and processes have evolved especially for enterprise wide, risk facing organizations. The growing awareness of risks is reflected in the fact it is now a central topic for boards and audit committees. Nevertheless, until a few years ago, there was still no accepted standard available to structure the company wide risk management activities.[15]

In the aviation industry, risks can be broken down into two different levels, namely the strategic and process levels.

Risk at the strategic and process levels is comprised of the following sub categories described in Fig. 3.1.

Recent discussions have shown that there is an ongoing conflict between the operational and strategic levels within various aviation organizations. Operational stakeholders feel increasingly patronized by financial controlling when carrying out risk assessments. Further communication and harmonization efforts have to be initiated in order to solve these internal discrepancies.

3.2 Regulation of Risk Management

Law has been the main driving force for better Corporate Governance practices in Switzerland and therefore also a main driver for Risk Management. Since 1936 there have only been minor changes to the law, with reforms in 1968 and 1992. The Stock Exchange Act, which was implemented in 1996, had a strong influence on Corporate Governance practices. The code of obligations triggered many developments, such as increased transparency, auditing and compensation disclosure along the lines of the Sarbanes Oxley Act (SOX).[16]

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[13] Frigo and Anderson (2011).

[14] Speckbacher et al. (2010).

[15] Frigo and Anderson (2011).

[16] The Sarbanes-Oxley Act of 2002 (often shortened to *SOX*) is legislation enacted in the US in response to the high-profile Enron and WorldCom financial scandals to protect shareholders and the general public from accounting errors and fraudulent practices in the enterprise. The act is administered by the Securities and Exchange Commission (SEC), which sets deadlines for compliance and publishes rules on requirements.

Fig. 3.1 Risk model for the aviation industry. *Source*: IATA (2013)

3.2.1 Regulation in Air Law

There are several regulations in Air Law concerning risk management and safety management. The following overview may help to find the relevant regulatory framework.

3.2.1.1 Overview International Regulations

- ICAO Annex 6 Operation of aircraft
  - Part 1: International commercial air transport, 9th edition 2012 (3.3 Safety management and 4.10 Fatigue management)
  - Part 2: International general aviation, 7th edition 2012 (3.3.2 Safety management system)
- ICAO Annex 19 Safety management, 1st edition 2013 (Transfer of existing provisions)
- ICAO Doc 9859 Safety management manual, 3rd edition 2013 (Support roll-out of Annex 19)
- Regulation (EC) No 300/2008 Civil aviation security, 11 March 2008
  - Art. 4 Common basic standards
  - Art. 6 More stringent measures applied by Member States
- Regulation (EC) 8/2008 Establishing a European Aviation Safety Agency
  - 1.037 "An operator has to establish a risk awareness program"
- EU-VO 185/2010 (Grundstandards in der Sicherheit)
  - 1.3.1.5 Stichproben bei Pax-Kontrollen nach Risikobewertung
  - 1.5.2 Geländeüberwachung auf Grund Risikobewertung
  - 4.3.2 Unterrichtung der Behörden über Risikobewertung
- EU-VO 1178/2011 (EASA FCL & MED)
  - Art. 4 Sicherheitsrisikobewertung von Flugschülern
  - FCL.820 lit. (d) Testflugberechtigung

3.2.1.2 Overview National Regulations

- Art. 103a LFV Sicherheitsmanagementsystem
  - Art. 122h LFV Einsatz Sicherheitsbeauftragter nach Risiko
  - Art. 122k LFV BA für Polizei zuständig für Risiko-Analyse
  - Art. 122m LFV Mitwirkung Airline bei Risiko-Analyse

A few regulations in Air Law have to be pointed out in order to understand the regulatory framework of risk management in the aviation business.

3.2.1.3 International

The ICAO describes, with its Fatigue Management SARPs in Appendix 8 of Part I to Annex 6, the components that must be in an FRMS. In addition, the associated guidance material provides further information on how an FRMS should function.

Part II of Annex 6 describes the operations of Aircraft in International General Aviation (GA) and provides standards and recommended practices (SARPs) for international GA operators.

Regulation (EC) 300/2008 on common rules in the field of civil aviation security specifies, under Art. 4, the local risk assessment through the local authorities and lays down more stringent measures that have to be applied by Member States after the risk assessment under Art. 6.

Commission Regulation 8/2008, the so called (EU-OPS), regulates common technical requirements and administrative procedures applicable to commercial transportation by aircraft. It states under 1.037 that an operator shall establish and maintain an accident prevention and flight safety program, which may be integrated with the quality system.

Commission Regulation 185/2010 states detailed measures for the implementation of the common basic standards on aviation security. More specifically under 1.3.1.5,where persons other than passengers and items carried have to be screened on a continuous random basis and under 1.5.2, the frequency and means of undertaking surveillance and patrols shall be based on a risk assessment undertaken by the appropriate authority. Paragraph 4.3.2 describes that an air carrier will be notified in writing and in advance by the competent authority about their risk assessment of individuals and of their plan when embarking a potentially disruptive passenger on board its aircraft.

Commission Regulation EU 1178/2011 (EASA FCL & MED) lays down technical requirements and administrative procedures related to civil aviation aircrews. Art. 4 (c) specifies that student authorizations will be issued on the basis of an individual safety risk assessment carried out by an instructor following a concept safety risk assessment carried out by the Member State. In addition, FCL.820 lit. (d) specifies the flight test rating requirements.

3.2.1.4 National

The Swiss Verordnung über die Luftfahrt (Luftfahrtverordnung, LFV) points out the obligation to implement a SMS under Art. 103a LFV. Furthermore, Art. 122h LFV regulates the deployment of a security officer in conjunction with the federal risk analysis. Art. 122k LFV illustrates the responsibility of the federal police for the risk analysis and the associated use of security officers. Finally, Art. 122m LFV regulates the obligations of airlines to participate during certain scenarios.

3.2.2 Swiss Code of Obligations

In the Swiss Code of Obligations (CO) under article 716a No. 1 the ultimate direction of the company is assigned to the Board of Directors (BoD) which has the duty to avoid unnecessary risks and minimize unavoidable risks in order to assure the existence and progression of the organization. Therefore, the BoD has to specify the organization's risk appetite and the corresponding risk control policies. As explained in the previous chapter, the risk goals have to be aligned with the organization's strategic business objectives. Article 716b OR states that the BoD can delegate operational risk management to the management. Moreover, there is no requirement for a Chief Risk Officer (CRO) for organizations smaller than 500 employees.

As mentioned in the introduction, the amendment of the Limited Liability Company Law of 1.1.2008 made it mandatory that organizations state, within their annex to the financial statements, information about the implementation of a risk assessment.

For specific types of companies, for example the limited liability company (GmbH) and the cooperative, explicit reference is made in connection to the accounting rules and the rights and obligations of the corporation. Thus, the requirement for the publication of information on the implementation of a risk assessment has to be annexed to the financial statements for these companies. Consequently, risk management must ultimately be considered as a necessity on the list of responsibilities of the strategic management level for all types of companies, including associations and foundations.

3.2.3 Bank Regulations

The Swiss Banks and Saving Banks Regulation (SR 952.02) defines, under Article 9, the fundamental regulations of risk management for the banking sector. Banks have to implement and document procedures for the inclusion of business risks in internal guidelines and regulations. In addition, banks are required to seize, limit, and supervise market, credit, loss, transactions, liquidities and image risks in particular, as well as operational and legal risks.[17] Furthermore, the Swiss Bankers Association adopted guidelines for Risk Management in their trade and derivatives business in 1996.

[17] Die Bundesbehörden der Schweizerischen Eidgenossenschaft (2013).

3.2.4 German Law for Control and Transparency (KonTraG)

The German Law for Control and Transparency (KonTraG) has been in force since May 1998 and calls for the implementation of an adequate risk management system for publicly listed companies. In particular, it focuses on the Board of Directors and the initiation of appropriate measures to set up a monitoring system which detects hazardous developments that could threaten the existence of the organization (§91 para 2 AktG). The main reasons for the legislative initiative were, on the one hand, spectacular business failures in the nineties (Metallgesellschaft, Sachsenmilch, Balsam, KHD, Bremer Vulkan, etc.) and, on the other hand, the increasing internationalization of capital markets and the increasing globalization of shareholder structures.[18] Many of the discussions about including risk disclosures in Swiss law have been influenced by this German precedent, including Art. 663b E-OR and amendment 728A E-OR.

3.2.5 Institutional Investors

With the focus on better corporate governance and on safeguarding shareholders' interests, (i.e. Risk Management) institutional investors, especially pension funds have historically been very influential and were one of the first forces in Switzerland to become vocal on the subject. A forerunner in that field is the Swiss Investment Foundation for Sustainable Development (also known as Ethosfunds) which was founded in 1997 by amalgamating two pension funds based in Geneva, and which now comprises more than 90 pension funds from all over Switzerland. Their goal is to promote sustainable development and to invest in companies that contribute to positive market developments in that direction. Furthermore, they enable members to exercise shareholder rights in a responsible way and to foster good corporate governance practices. Traditionally, pension funds have a very conservative way of managing investments because the invested funds are the pension savings of the ageing population; therefore, the margin for error is very low and these funds mainly invest in companies which manage their risk in an exemplary way and provide accurate and transparent risk-related information.

3.2.6 Impact of US Developments

Given the fact that some of the world's largest corporate disasters in the past years have happened in the US, shareholders of large companies want increased assurance and better predictability for the performance of their investments. Consequently, public-listed companies are under growing pressure to implement effective risk management and predictability mechanisms. In 2002, the Security and

[18] GLP (2008).

Table 3.1 Comparison of SOX and Swiss Law

Sarbanes Oxley and NYSE rules	Swiss rules
Sarbanes Oxley Act Section 301	Swiss Code of Best Practice for Corporate Governance, par. 23
NYSE Section 303 A(7)(d)	Mandatory for banks (Swiss Federal Banking Commission Circulars 95/1) Swiss Code of Best Practice for Corporate Governance, par. 19
NYSE Section 303 A(7)(c) (iii) (D)	Draft article 663b Ziff12 CO Swiss Code of Best Practice for Corporate Governance, par. 19
Sarbanes Oxley Act Section 404	Article 716a CO new article 728a CO

Source: Kalia and Müller (2006)

Exchange Commission (SEC) and the US government responded to these disasters, and to the growing need for security, by enacting new acts and regulations, most significantly the Sarbanes Oxley Act (SOX). SOX had an enormous impact on Swiss Corporate Governance Law as some elements of SOX were incorporated in Swiss requirements made by Basel II type regulations. Table 3.1 shows how Swiss rules and regulations have been affected by SOX and New York Stock Exchange regulations.

3.2.7 Press

The press plays a significant role in bringing issues to the attention of the public, thus supporting the worldwide interest in corporate governance that has grown in the light of so many corporate scandals. Issues such as Severe Acute Respiratory Syndrome (SARS), Mad Cow disease (BSE), the September 11 terrorist attack and corporate scandals like Swiss air and Enron, have initiated political debates and created an increased awareness among society and business towards risks and risk management.

In addition, there are various other sources which have an influence on corporate governance and risk management in Switzerland which are illustrated in Fig. 3.2.

3.3 Milestones in Risk Management History

The development of risk management can be divided into five different stages. Each stage has its own characteristics and different focus.

The 1930s marked stage one with the beginning of new concepts and discussions, a preliminary stage of Risk Management.

Stage two evolved during the 1970s with formal Risk Management which mainly focused on dealing with credit risks.

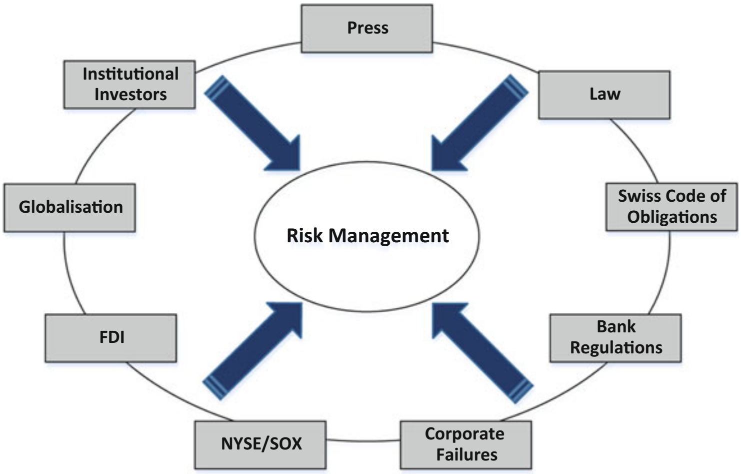

Fig. 3.2 Forces fostering better risk management in Switzerland. *Source*: Kalia and Müller (2006)

In the 1980s the focus was on financial risk management (i.e. market risk management), in addition to credit risk management, and can be classified as stage three.

During the 1990s operational risk management emerged, enlarging the field to operational risks which can be considered as stage four.

The final stage of the development of Risk Management has evolved during recent years and is called corporate risk management. It takes a 360° view of Risk Management by integrating Risk Management across functions and divisions within a company.[19]

3.3.1 New Concepts

With the beginnings of Risk Management, the subject only dealt with isolated security measures, including some loss prevention and a bundle of largely uncoordinated insurances.[20] In the 1930s, the Glass-Stegall Act prohibited common ownership of banks, investment banks, and insurance companies. In 1945, Congress passed the McCarran-Ferguson Act, delegating the regulation of insurance to the various states.[21]

[19] Kalia and Müller (2006), p. 39.

[20] Haller (1999).

[21] Kloman (1999).

3.3.2 Credit Risk Management

During the 1970s stage two evolved with the focus on insurance management, i.e. the co-ordination of pure insurance, which could be considered as traditional risk transfer.[22] Important milestones in risk management during these years were the foundation of a few associations with a strong focus on Risk Management, for example the International Association for the Study of Insurance Economics or the "Risk Management Circle" of Sweden's Statsföretag. The American Society of Insurance Management was renamed Risk & Insurance Management Society (RIMS). Fortune magazine published the article "The Risk Management Revolution"[23] suggesting co-ordination of formerly unconnected risk management functions within an organization, and acceptance by the Board of Directors (BoD) of responsibility for preparing organizational policies and supervision of the risk management functions.

3.3.3 Financial Risk Management

In the third stage, the 1980s, the development of Risk Management diversified in two directions: One was risk financing, including concerted deductibles, captives, and various mixed forms; the second was risk control in the sense of comprehensive risk engineering, partially in close co-ordination with insurance coverage. At the end of the 1980s, Risk Management experienced an expansion in the direction of risk communication, primarily as a consequence of a loss of trust after large-scale accidents in the concerned insurance sectors.[24]

3.3.4 Operational Risk Management

Stage four began in the 1990s. In certain industrial insurance markets, crises affected relationships between industrial insurers and big clients.[25] The term Chief Risk Officer (CRO) was used for the first time by James Lam at GE Capital, who described the function of the CRO as managing all aspects of risk. Operational risk management plays an important role when talking about aviation safety. The operational side of aviation is a hazardous environment with many factors contributing to unsafe situations. Therefore, special attention has to be placed on that area.

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[22] Haller (1999).

[23] Kloman (1999).

[24] Haller (1999).

[25] Kalia and Müller (2006), p. 39.

3.3.5 Corporate Risk Management

The 9/11 terrorist attacks on the World Trade Centre, New York[26] gave a new dimension to the magnitude of volatility and risk. The New York Stock Exchange (NYSE) lost trillions of USD in a day. This had an enormous impact on the perception of risk management worldwide.[27] Today, companies embrace the concept of enterprise risk management which takes an overall view of all internal and external risks affecting the organization, and aims to provide an integrated approach to managing risks across divisions and functions. This has given rise to concepts of business continuity management where companies make sure that they survive even extreme events, such as terrorist acts, natural disasters, epidemics, and major failures.

3.3.6 Compliance Management

A significant, current trend is the increasing regulation in the risk management and safety management sector which can be considered as a real challenge, especially for the aviation industry. These regulations require additional resources to set up and implement different obligatory mechanisms or systems and require on-going compliance monitoring and audits. Figure 3.3 provides a graphic illustration of these developments and also shows how risk management has evolved during the past decades.

3.4 General Risk Management Models

The following risk management frameworks illustrate a structured approach towards the management of risks.

3.4.1 COSO Enterprise Risk Management—Integrated Framework

The COSO model can be considered as the oldest risk management framework. It was initially developed to improve the quality of financial reporting within ethically aware companies, in combination with an effective internal control system. In 1985 the Committee of Sponsoring Organizations of the Treadway Commission (COSO) was established as a platform for the National Commission on Fraudulent Financial Reporting. The system was approved in 1992 by the SEC (Securities and Exchange Commission) as standard for the internal control system and was constantly developed further throughout the following years.[28]

[26] Kalia and Müller (2006), p. 40.
[27] Kalia and Müller (2006), p. 40.
[28] Häsch and Müller (2009).

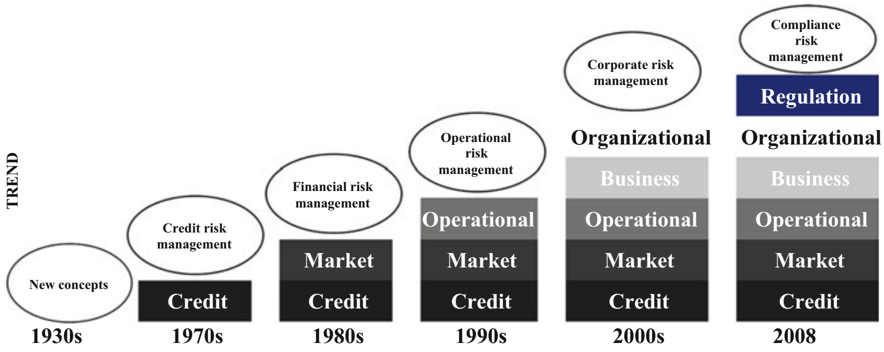

Fig. 3.3 Development of risk management. *Source*: Adapted from Kalia and Müller (2006)

The COSO Enterprise Risk-Management Framework comprises three interrelated dimensions which are illustrated in Fig. 3.4.

The first dimension shows the main components which are common to the managerial level and are integrated within the overall management process.

1. **Internal Environment**: The internal environment describes how managers, employees and the whole organization views and addresses risks including Risk Management philosophy and risk appetite, integrity and ethical values, as well as the environment in which they operate.
2. **Objective Setting**: An organization should follow clear objectives. It is vital for the organization to identify the associated risks which should be in line with the risk policy, and consistent with the risk appetite of the organization.
3. **Event Identification**: Internal and external events affecting the achievement of the organization's objectives must be identified. Moreover, having distinguished risks from opportunities, the opportunities should be channeled back into management strategy or objective-setting processes.
4. **Risk Assessment**: The identified risks are classified according to their likelihood and impact. Likelihood and impact are assessed in order to obtain a solid basis for the risk response.
5. **Risk Response**: Management is responsible for the initiation of risk responses. These include, but are not limited to, avoiding, accepting, reducing or sharing risks and encompass the development of an appropriate set of actions to align risks with the entity's risk tolerances.
6. **Control Activities**: In order to track that the risk responses are effectively carried out, specific policies and procedures have to be established and implemented.
7. **Information and Communication**: Relevant information has to be identified and communicated in order to enable employees and management to carry out their responsibilities. Effective communication occurs horizontally as well as vertically in modern organizations.

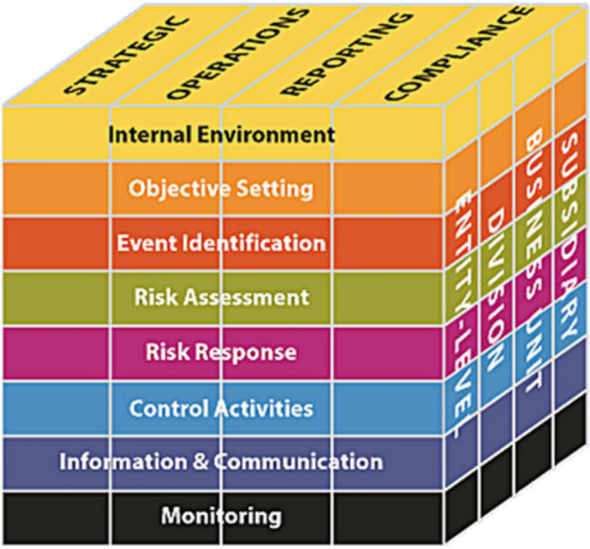

Fig. 3.4 COSO framework. *Source*: Enterprise risk management—integrated framework

8. **Monitoring**: Enterprise Risk Management is illustrated and documented throughout the organization. Monitoring is accomplished through ongoing management activities, separate evaluations, or both.

The second dimension, on top, classifies the different types of risks or the entity's objectives within an organization. COSO distinguishes between strategic, operational, reporting and compliance risks.

The third dimension illustrates risk management in relation to the entirety of an organization's enterprise risk management. This comprises the entity level, division, business unit or subsidiary.[29]

3.4.2 ISO 31000:2009 Risk Management—Principles and Guidelines

The ISO 31000:2009 Risk Management Principles and Guidelines is the worldwide available standard for risk management. The purpose of the ISO 31000 standard is to integrate and adapt the risk management process to already available management systems, in order to optimize and tailor the risk management process to the needs of organizations and not to just fulfill compliance issues.

The system is based on the following core principles:

- Top Management is accountable for Risk Management, which has to be constantly monitored and controlled.

[29] Committee of Sponsoring Organizations of the Treadway Commission (2004).

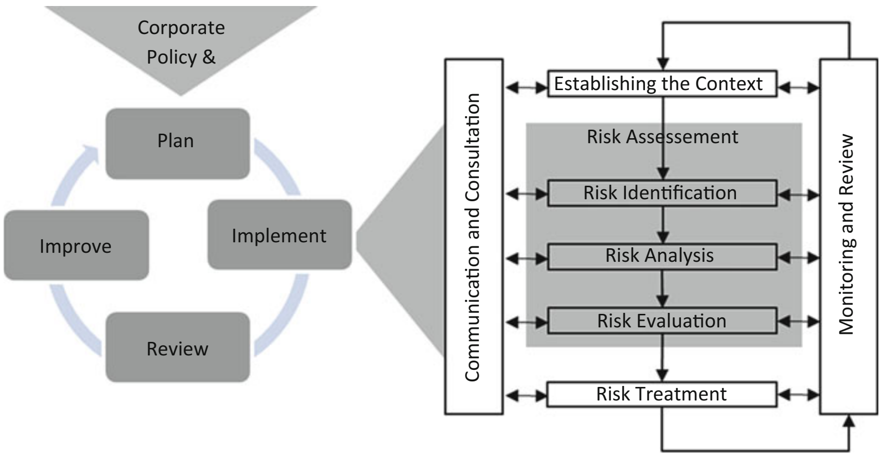

Fig. 3.5 Systemic approach to Risk Management according to ISO 31000. *Source*: ISO 31000:2009

- Risks have to be communicated throughout the organization on all operational management levels and not just on a strategic level. The initiation of the risk management process has to be communicated top down through all management levels.
- Finally the ISO standard tries to identify all the different internal and external risks throughout an organization. These identified risks influence the overall implementation of the risk management system.

Figure 3.5 illustrates the systemic approach of the ISO 31000 which combines the risk management process, and integration into the risk management system. The risk management process defines the procedure of identifying risks, analyzing and evaluating them including the application of appropriate mitigation measures and the final communication throughout the organization. The risk management system includes all measures like planning, implementation, evaluation and continuous improvement in terms of the Deming Circle[30] and should be understood as a vital part of the strategic management of an organization.

3.4.3 ISO 22301 Business Continuity Management

A Business Continuity Management System (BCMS) aims to make public and private organizations more resilient in times of extreme events. This standard supports organizations of any size to proactively prepare for managing disruption which might endanger the survival of a company. Typically, incidents can disrupt the business environment or even directly affect an organization negatively. ISO

[30] Morris and Pinto (2010), p. 141.

2203 prepares organizations for disruptive events and ensures that they can respond in an appropriate manner and protect and continue their operations.[31]

The ISO 22301 structure focuses on specific key areas which are crucial for business continuity planning.

- Part 4: Context of the Organization
- Part 5: Leadership
- Part 6: Planning
- Part 7: Support
- Part 8: Operation
- Part 9: Performance Evaluation
- Part 10: Improvement

Part 4 of the standard focuses on the context of the organization and determines the external and internal issues which could have an effect on the organization. This part especially focuses on the potential impact a disruptive event might have on the organization's activities, functions, services, products, relationships with interested parties, supply chains, and partnerships. It makes the link between the business continuity policy and the organization's objectives, policies and risk management strategy. Furthermore, it takes the legal, regulatory and additional requirements of the organization into account.

Part 5 concentrates on the leadership aspect, which requires ongoing commitment to the BCMS by top management. Here it is important that the BCMS is compatible with the strategic organization which requires the integration into established business processes, and the provision of the necessary resources. Responsibilities and areas of authority have to be clearly delegated and have to be constantly assessed. In addition, the communication of the significance of the BCMS and constant monitoring, direction and support are required in order to ensure efficient implementation.

Part 6 is the planning phase where the objectives are developed on how to treat the identified risks and how to comply with organizational requirements. The objectives have to be measurable and consistent with the business continuity policy, and have to assess the minimum level of products and services that is acceptable for the organization to survive.

Part 7 deals with the assignment of the appropriate resources for each task. Only competent staff with relevant training is qualified to perform the implementation and maintenance of a BCMS. Furthermore, the creation, update and control of the required documentation is specified in this part.

Part 8 deals with the operation of the BCMS. By performing a Business Impact Analysis (BIA) an organization can identify critical processes that support its key products and services and their interdependencies between each other. Moreover, an organization can identify the required resources to operate the processes at a minimally-acceptable level. In addition, a solid risk assessment is the key to a solid Business Impact Analysis. These points have to be considered when documenting

[31] Towards a Safer World (2012).

the business continuity procedures which aim to minimize the consequences of disruptive events through the implementation of appropriate mitigation strategies.

Part 9 specifies the performance evaluation and the permanent monitoring of the systems to improve their operation. This will be assured by constant monitoring of compliance, historical evidence, internal audits and ongoing management reviews.

Part 10 emphasizes the continuous improvement of the effectiveness of the system, its inherent processes, and objectives.[32]

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[32] St-Germain, Aliu, Lachapelle, and Dewez (2012).

Internal Control System (ICS) 4

Roland Müller and Christopher Drax

Companies that are subject to regular audits must continue to confirm the existence of an internal control system (ICS). To date, auditors assess the internal control system only to obtain an understanding of the entity to be audited for consideration in the preparation of the ICS audit strategy and the audit approach.

This chapter provides an overview of:

- The concept and objectives of an Internal Control System
- The different components of an Internal Control System
- Tasks and responsibilities and
- Minimum requirements for an Internal Control System

4.1 Concept and Objectives of the Internal Control System (ICS)

An internal control system encompasses all processes, methods and measures arranged by the directors and the senior management that serve to ensure the proper, ongoing conduct of a business. The organizational measures of the internal control are integrated in the operational processes, which means they are part of the work execution.

In this case, a current state is determined and compared with a target value (target state). The Internal Control is supportive of:

- The achievement of business objectives through effective and efficient management
- Compliance with laws and regulations (compliance)

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- The protection of business assets
- The prevention, reduction and detection of errors and irregularities
- Ensuring the reliability and completeness of the accounting
- Timely and reliable financial reporting

The main tasks of an internal control system (ICS) are, on the one hand, to improve the reliability and completeness of the accounting and external financial reporting (accounting), and, on the other, the prevention and detection of errors and irregularities including fraud in accounting and financial reporting.

4.1.1 Components of an ICS

The design and the implementation of an ICS depend on the size of the business, the business risks and the complexity of the organization. Smaller companies can more easily achieve the objectives of an ICS with less formal means and simpler processes and structures.

Based on COSO, the components of an ICS are subsequently divided into the following five categories:

Category	Description
Control Environment	The design of the control environment of a company comprises various components and the way management influences the processes in the company. These include regulations for the delegation of tasks and responsibilities, communication and enforcement of integrity and ethical values, commitment to competence, the involvement of those responsible for the management and supervision, leadership principles and management style, organizational structure and, finally, interaction with employees and customers.
Risk Assessment	Every organization needs to be aware of the risks that it is exposed to and how to manage these risks. The risk assessment typically involves: • Specification of corporate objectives and risk management objectives (safety objectives), Department of Risk Management Policies • Risk identification (identifying the principal risks that could result in a misstatement in the accounts, and the accounting and business risks that could affect the financial reporting) • Risk assessment (assessment of the importance of a risk, and assessment of the likelihood of occurrence) • Information/communication (defining who, when, what is to be informed) • Risk Management (decisions about possible measures) • Monitoring of the control measures
Control Activities	Each company must define and implement instructions and procedures to ensure that those activities which have been considered as necessary targets by the BoD and the Executive Board are actually executed. Examples of control activities are the processes of authorization (authorization levels, signature policies), work instructions, performance monitoring, entry rights in IT processes, physical controls and segregation of duties/4-eyes principle.

(continued)

Category	Description
Accounting relevant information systems	Information and communication channels must be defined so that the board and the employees have the right information at the right time in order to perform the required activities/controls. Information systems that ensure that all relevant information is reliable and timely collected, processed and distributed are a prerequisite.
Monitoring of the internal control system	The ICS is only effective if the control measures are reliable in the long term. Therefore, the ICS must be constantly monitored so that it remains effective. This includes a timely review of the structure and function of the controls by supervisors and the implementation of necessary corrective measures.

4.1.2 ICS Tasks and Responsibilities

The responsibility for the implementation of an ICS is with the Board of Directors; respectively it's the Audit Committee. Primarily, the BoD has to make sure that the appropriate control measures are taken so that misstatements of transactions and the related statements are prevented, detected or can be corrected. The management, however, is responsible for the operation and maintenance. The tasks and responsibilities in the area of the ICS can be illustrated as follows:

Board of Directors resp. its Audit Committee	Implementing and maintaining a functioning internal control system as the core of the monitoring function of the BoD in relation to the accounting of the company. In particular, the set-up of the processes in relation to: • Targets • Scope and expansion level of the ICS • Documentation requirements • Reporting requirements Ensuring the implementation of the measures to be taken by the management related to the framework of the ICS Maintaining an adequate monitoring of the effectiveness of the ICS. This requires: • Regular consultation with management (effectiveness of the ICS) • Evaluation of reviews by the management of the ICS • Initiation and monitoring of measures to correct deficiencies • Use of Internal Audit for the monitoring and evaluation of the ICS
Management	Implementation of the principles defined by the BoD: • A systematic approach to the collection of an adequate control structure • Development of appropriate processes for the identification, assessment, monitoring and control of identified risks • Identification of key controls and their monitoring, and ensuring that corrective measures are taken • The maintenance and documentation of an organizational structure that clearly functions in line with all assigned responsibilities, skills and information flows

(continued)

	• Documentation and verifiability of the ICS regarding the reliability of financial reporting, and for ensuring the fulfillment of delegated tasks • Ensuring the necessary technical and human resources and quality of staff (training, experience)
Auditors (**based on Article 727 OR**)	• Verification of the existence of the ICS • Reporting to the General Assembly • Detailed reporting to the Board of Directors regarding the audit of the ICS

The Board has to periodically deal with the following fundamental issues in relation to the ICS:

1. Are all significant risks in the operational business processes known?
2. Are there measures that reduce these significant risks to an acceptable level for the company?
3. Do BoD and Management receive the guarantee that the ICS is actually effective and operating efficiently?
4. Do organization and corporate culture allow for continuous improvement of processes and controls?

4.1.3 Minimum Requirements for an ICS

The Fiduciary Chamber, as a professional organization for accountants in Switzerland has issued a position paper, which states that the degree and the requirements for an ICS have to be adapted to the complexity and size of the organization. In particular, the size and activities of the company, the number and complexity of transactions, the ownership structure and financing play a role. In determining the requirements of the ICS, the Board of Directors considers the principle aspects of effectiveness, accountability and efficiency:

Aspect	Meaning/content/expression
Effectiveness	• Compliance with the corporate culture • Clearly defined responsibilities • Controls are aligned to risks • Controls are integrated into processes and are monitored • Sufficient tested controls • Well trained employees • A clearly defined information and escalation process
Traceability	• ICS objectives and degree of expansion are documented • Business risks are documented • Processes and controls are recorded in writing • Control activities are clearly documented • The quality of the ICS is regularly assessed and reported
Efficiency	• ICS is an integral part of the enterprise-wide risk management • Use of internal audit and coordination with auditors • Focusing on key risks • Possibility to automate the controls

There are no statutory regulations on the scope and the minimum requirements for the ICS.[1] However, the ICS must meet certain requirements to ensure that the auditor can confirm its existence:

- The ICS must be documented
- The ICS has to have the size relevant to business risks and be appropriate to the scope of the business
- The ICS must be communicated to the employees
- The ICS must be applied and has to be implemented
- The company must have a control consciousness

An internal control system, like the company, has to develop itself further and further. The adaption to changing environmental conditions is of central importance. Globalization, competitive pressures, new technologies and legal changes have, therefore, always to be included into business processes. In addition, the ICS must be continually reviewed and the responsible manager has to react immediately if adjustments are needed. The costs, however, have to always be kept in mind. The costs of establishing and maintaining the ICS are, in the medium term, certainly expected to be offset by the following benefits:

- Clear organization, roles and responsibilities within the company
- Identified business risks associated with controls, a step towards Enterprise Risk Management (ERM)
- Identification of efficiency potential in business processes
- Reduced amount of error corrections (since errors are detected more quickly)
- Development of control consciousness of employees at all levels
- Increased confidence in the financial report (stakeholders)
- Improved corporate monitoring
- Eliminated redundancies in the controlling processes
- Reduced risk of fraud
- Fewer error corrections during the audit

Such an ICS almost automatically satisfies the requirements for auditability; the compliance can be regarded as a "by-product".

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[1] Atteslander and Cheetham (2007).

Fundamentals and Structure of Safety Management Systems in Aviation

5

Roland Müller and Christopher Drax

To understand the fundamentals and the structure of a Safety Management System the developments and the basics have to be explained. This chapter provides an overview of:

- The general development of safety and accidents
- The organizational accident causation by James Reason
- The regulatory environment
- The structure and objectives of a Safety Management System

5.1 Development of Safety and Accidents

As having an acceptable air safety record is an important indicator of an airline's success, improving safety has constantly been a major focus for the aviation industry. Over the past years there has been a constant increase in the reliability of machines and software in the aviation industry. Unfortunately, the reliability of humans and organizational systems has not improved at the same speed.[1]

The early years of commercial aviation were notorious for underdeveloped technology and inadequate infrastructure, where limited oversight by the authorities, and almost no regulation, was common practice. The aviation business was driven by production demands and there was no understanding of safety management measures, like hazard identification and Risk Management. Aviation developed very quickly with ambitious production objectives which lacked the

[1] International Civil Aviation Organisation (ICAO) (2009).

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necessary means and resources for safety management and was characterized by a high frequency in breakdowns and accidents.

The former principals of accident prevention and investigation were driven by reactive processes. Outcomes only became visible after an accident had already happened. With increasing regulation during the 1950s, advanced technology and the fast development of infrastructure, accident rates declined steadily. The common thinking in those days was as long as rules were followed, there should be no safety violation.

The belief was that only if rules are disregarded, could eventual breakdowns be considered. It was possible to minimize risks by introducing regulatory limitations, but with the increase in aviation complexity it became impossible to cover all operational scenarios in such a dynamic environment. Accident investigations mainly had the focus on technological breakdowns with less focus on human or organizational factors.

The typical approach for the identification of the cause of an accident was to ask what, who and when. This ignored the why and how an accident happened, which are of real importance to fully understanding the safety breakdowns or hazardous conditions. Recent years have shown that the perception has changed towards understanding why and how accidents happened. When looking at the development of safety thinking, the first years of aviation until the 1970s can certainly be seen as the “technical era” where safety violations and concerns were typically linked to technical factors.

Given the fact that technology was not fully developed to cope with mass transportation demand, technological failures were a recurring factor. Therefore, the main focus in those days was put on the investigation and improvement of technical issues. During the 1970s major technical improvements like radar, jet engines, autopilots, flight directors, improved navigation and performance enhancing technologies, both on the ground and in the air, were introduced and radically minimized technical failures.[2]

These changes introduced the “human era” and the safety efforts shifted focus to human factors. With the introduction of crew resource management (CRM) and line oriented flight training (LOFT), massive efforts were made to try to control human error. However, human error continued as a frequent factor in safety violations. From the early 1990s on it was recognized that individuals can’t be seen as “stand alone” within the operational context.[3] The causal sequence of accidents—from organizational factors, to local workplace conditions, to individual unsafe acts, to failed defenses and negative outcomes—has to be taken into consideration; those elements reveal the contributing factors of potential failures.

For any accident, the focus must be on the organizational factors, for example the safety culture of an organization and what local conditions could have shaped or provoked it.[4]

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[2] International Civil Aviation Organisation (ICAO) (2009), p. 2–3.

[3] International Civil Aviation Organisation (ICAO) (2009), pp. 2–2, 2–5.

[4] Reason (2004), p. 18.

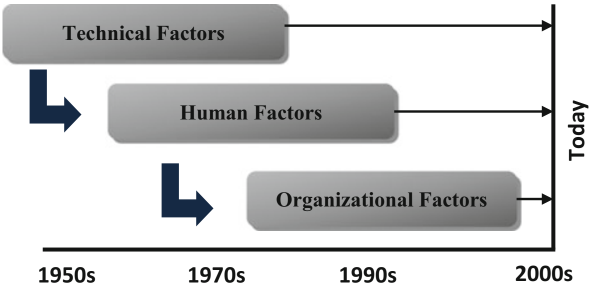


Fig. 5.1 Evolution of safety thinking. *Source*: ICAO SMM

Figure 5.1 illustrates the timeline of the evolution of safety thinking and encloses the above mentioned contributing factors.

5.2 The Organizational Accident Causation

By taking a closer look at what causes an accident it is not possible to simply point out one factor which is responsible. Accidents require a chain of enabling factors where each together has to be present to cause an accident, but individually has insufficient power to breach the system's defenses. This underlines the complex and well protected aviation system where single point failures are rarely consequential because they are protected by various defenses such as regulations, training and technology.[5]

By looking at Fig. 5.2 it should become clear that operational errors or disregarded procedures are delayed effects which have been missed by managers, workplace conditions or organizational processes. Those errors will continue to emerge until organizational or workplace conditions are changed towards better safety awareness. Operational failures act as triggers of latent conditions where people in complex systems make mistakes or violate procedures for reasons that usually go beyond the scope of individual psychology.[6] Those latent conditions doze in the system and become apparent once the defenses of the system are breached.[7]

Other contributing factors to an organizational accident are active failures. These failures are errors or violations committed by front line personnel such as ground staff, pilots, and air traffic controllers which have a direct impact on the safety of the aviation system and which may result in a damaging outcome.[8]

Summarizing the cause of an organizational accident reveals the different stages which are required to generate an accident. Most of the latent conditions start with the decision makers and organizational processes which are often subject to human

[5] International Civil Aviation Organisation (ICAO) (2009), p. 2.4.1.

[6] Reason (2004), p. 10.

[7] International Civil Aviation Organisation (ICAO) (2009), pp. 2.5–2.6.

[8] Reason (2004), p. 10.

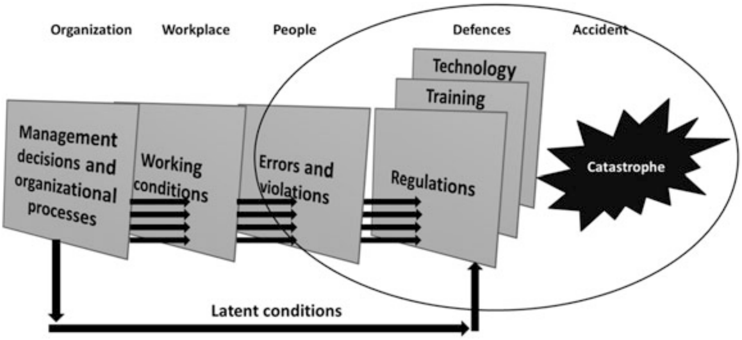


Fig. 5.2 Stages involved in an organizational accident (James Reason 2003, p. 90). *Source*: Reason (2004)

biases and limitations, such as budgets and politics. Internal processes must be established to detect those threats and neutralize them. The decisions made by line management may lead to inadequate training, violation of maximum working hours or protective workplace measures.

The result will generate a workforce which has inadequate knowledge and skills or is not able to apply the right operating procedures. The consequence of generating errors and violations will lead to active failures and potential accidents which, in total, reflect a poor safety culture.[9]

5.3 Regulation of Safety Management Systems

With amendment 30 to ICAO Annex 6 Part I, the International Civil Aviation Organization introduced a new paragraph, 3.3 which addresses safety management, and under paragraphs 3.3.4–3.3.8 set standards which require that states, as part of their safety program, have to ensure that an air operator implements an acceptable safety management system (SMS).[10]

5.3.1 ICAO Regulations[11]

Relevant for the implementation of an SMS are the standards and recommended practices (SARP). They can be found in the ICAO annexes 6, 11, 14 and the ICAO Safety Management Manual. Furthermore, ICAO Annex 19, 1st edition is applicable from the 14th November 2013. All of the safety management provisions in

[9] International Civil Aviation Organisation (ICAO) (2009), p. 2–6.

[10] International Civil Aviation Organization (ICAO) (2010), p. 3–3.

[11] Further guidance material can be found at http://www.icao.int/safety/ism/ICAO%20Annexes/Forms/AllItems.aspx.

Annex 19, 1st edition, were transferred or duplicated from safety management provisions previously contained in the six different Annexes, with the exception of:

1. The Safety Management System (SMS) framework now applies to organizations responsible for the type design and manufacture of aircraft;
2. The four components of the State Safety Program (SSP) framework are elevated to the status of Standard in Chapter 3;
3. The State Safety Oversight is applicable to the oversight of all product and service providers; and
4. The Safety Data Collection Analysis and Exchange (Chapter 5) and the Legal Guidance for the Protection of Safety Information from Safety Data collection and processing systems (Attachment B) complement the SSP.[12]

ICAO regulations are categorized into primary and secondary ICAO-law.[13]Primary ICAO-law is everything that is part of the Convention of Chicago,[14] which was signed by Switzerland on the 6th February 1947 and has been effective since the 4th April 1947.

The secondary ICAO-law consists of 18 annexes containing standards, recommended practices, procedures for Air Navigation Services (PANS), and Regional Supplementary Procedures (SUPPS).[15]

In contrast to the EU (EASA) the ICAO has no sovereign powers. Normally, the application of ICAO regulations and annexes in Swiss law is implemented through the adoption or amendment of an already existing statute or the creation of a new one. The recently added article 6a LFG explicitly foresees the possibility of a direct application of the ICAO annexes.[16] This reference to and delegation of a piece of legislation established by organizations which are not subject to international law (i.e. ICAO, and JAA) can be problematic (see 3.2.4). Nevertheless, as long as the treaty's clauses are self-executing, no transformation into national law is required. US-Courts decided that article 5, 8, 15, 20, 24, 29, 32, 33 and 36 CHI are directly applicable. There has been no decision, so far, about whether the annexes of the convention are directly applicable.[17]

5.3.2 EASA Regulations

EASA regulations are divided into recommendations (soft law) and standards (hard law). Hard law is binding for all member states and established by the EU Commission, EU Parliament or the EU Council; whereas soft law [Acceptable Means of

[12] International Civil Aviation Organization (ICAO) (2013).

[13] Müller and Schmid (2009).

[14] International Civil Aviation Organisation (ICAO) (1944).

[15] Müller and Schmid (2009), pp. 26–27.

[16] The federal council has made use of this reference for example in art. 138 & 103a LFV, art. 3bis VIL.

[17] Müller and Schmid (2009), p. 27.

Compliance (AMC), Guidance Material (GM) and Certifications Specifications (CS)] are not binding. Acceptable Means of Compliance (AMC) illustrate a means, but not the only means, by which a requirement contained in an EASA airworthiness code or an implementing rule of the Basic Regulation, can be met. An applicant correctly implementing an AMC issued by EASA is assured of acceptance of compliance.[18] The soft regulations are established directly by EASA itself.[19]

5.3.3 CAA

Even though aviation is internationally regulated with the ICAO regulations on the one side and with EU laws, based on the EASA regulations on the other side, there are still Civil Aviation authorities in each country. Their purpose is not only to transfer these regulations into national law, but also to identify country specific amendments.

As Switzerland is not part of the EU, regulations have to be accepted in a special procedure which is determined in the bilateral agreement on air transportation with the European Community (Luftverkehrsabkommen, LVA[20]). For an EU-Regulation to be transformed into Swiss law there has to be a decision by the aviation committee which, if accepted, becomes the equivalent to a bilateral treaty. The Swiss Federal Counsel or, in special cases, the Swiss Parliament[21] need to then give their consent. In this context, it is important that every amendment needs approval again. [22]

So far no European regulation concerning the introduction of SMS exists. However, the EASA stated its intention to translate the SMS related provisions in ICAO Annex 6 into upcoming rulemaking proposals.[23] Until now, only the EU-OPS 1.037 exists which defines an “accident prevention and flight safety program” consisting of a risk awareness system, reporting system, evaluation of accident information and a flight data monitoring program for airplanes heavier than 27,000 kg MCTOM.

Furthermore, every organization needs to have a person accountable for managing the program.[24] Despite EASA concluding that EU OPS-1 is consistent with the major principles of the ICAO SMS,[25] it has already placed a notice of proposed amendment (NPA).[26] The NPA-2008-22c mainly contains the ICAO standards with

[18] European Aviation Safety Agency (n.d.).

[19] Bundesamt für Zivilluftfahrt (BAZL) (2007, p. 6.

[20] European Union (2002).

[21] See art. 184 paragraph 2 Cst. respectively art. 7a RVOG in connection with art. 3a LFG.

[22] Article 22 paragraph 4 LVA.

[23] EASA, NPA AR/OR.

[24] European Union (2008), p. 6.

[25] European Aviation Safety Agency (EASA) (2007), p. 1.

[26] For detailed information and content of the NPA see NPA-2008-22a Appendix II N.26 ff., and NPA-2008-22c especially OR.GEN.200 and AMC’s to OR.GEN.200.

much more detailed requirements for small operations.[27] Swiss aviation service providers should therefore closely track EASA developments. However, a delay of 6 months has to be expected.[28]

5.4 Importance and Objectives of a Safety Management System

Given the complexity of the aviation system with its rapidly changing operational environment and demanding authority regulations, the air operators are facing increased pressure on the financial as well as operational side. These underlying characteristics of complexity and rapid change in the aviation industry demand a systematic approach towards managing safety.

The key to success is a safety management system, which can be described as a set of processes or components that combine operational and technical systems with financial and human resource management. Those processes are present in every activity of an air operator, airport or an approved maintenance organization. It is a methodical approach to safety with the focus on goal setting and a clear definition of accountability throughout the operator's organization.

An 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.[29]

The implementation of an SMS requires processes which allow the control of safety risks, and introduces the concept of an acceptable level of safety.

In order to describe the basic components of a safety management system, a look at the structured elements is necessary. These elements are presented as the "four pillars" and illustrate the principles and basic concepts of the SMS structure. The structured elements must exist and have to be robustly executed in order to make the SMS effective.[30]

5.4.1 Pillar One: Policy

The policy of an air operator's management is a written expression of the company's intentions, philosophy and commitment to safety. It generally describes the accountabilities and responsibilities of the personnel involved. Furthermore, it focuses on achieving safety goals or safety performance targets, with the corresponding measures to achieve those targets.[31] The policy should focus on the

[27] See AMC to OR.GEN.200 in NPA-2008-22c.

[28] Bundesamt für Zivilluftfahrt (BAZL) (2007), p. 19.

[29] Department of Transportation Canada (DOT) (2002), p. 6.

[30] FAA (AFS-800) (2006), p. 9.

[31] Stolzer, Halford, and Goglia (2008), p. 25.

continuous improvement of the overall level of safety through the management of safety risks and establishment of clear standards for behavior. The commitment of senior management is the key success indicator for a successful safety management system. Therefore, it must be a high level statement signed by senior management and should provide assistance to everyone who is in direct or indirect contact with safety performance. Fundamentally, it should also provide a specific roadmap so that all safety management activities are efficient and shared among the company.[32]

5.4.2 Pillar Two: Risk Management

The risk management process is the fundamental task to control risks at an acceptable level and can be seen as the key task in safety management. The process consists of identifying hazards, assessing the risks, developing mitigation measures, controlling safety risks and monitoring the effects of safety actions. The underlying plan of risk management is that the severity and likelihood of an event occurring can be minimized. Risk management is a basis for decision making concerning how to handle occurrences which affect aviation safety. In addition, it is a basis for incident assessments, their implications and evaluating the results. A key to success is constant and direct communication throughout the organization.[33]

A detailed understanding of operational systems is a prerequisite for risk management. These systems encompass the organizational structures, processes and procedures, people, equipment, and facilities which have a contribution to the organization's productivity. An in depth systems engineering analysis will emphasize the interactions between hardware such as aircraft, software, people and the environment. It points out weaknesses in the identification of hazards and associated risks.[34]

5.4.3 Pillar Three: Safety Assurance

> Safety assurance shall mean all planned and systematic actions necessary to afford adequate confidence that a product, a service, an organization or a functional system achieves acceptable or tolerable safety[35]

Having policies, processes, measures, assessments and controls in place, an operator has to put emphasis to the following processes to assure the highest level of safety.[36] Aviation organizations must develop safety performance monitoring and measurement processes in order to maintain the means to validate the safety

[32] Department of Transportation (DOT) Canada (2004), p. 10.

[33] Stolzer et al. (2008), p. 26.

[34] Stolzer et al. (2008), p. 26.

[35] The Commission of the European Communities (EC) No 2096/2005 (2005), p. 335/16.

[36] Stolzer et al. (2008), p. 27.

performance of their operations in relation to the safety policy, and to confirm the efficiency of safety risk management. Safety performance and safety monitoring must have structured reporting processes where it is clear which types of operational behavior are acceptable or unacceptable.

It must be explicitly defined under which conditions immunity from disciplinary action has to be considered. The aviation service provider must constantly apply the management of change and develop and maintain formal processes to identify deviations within the operational environment which may have an effect on the established processes and services. Operational changes have to be implemented and documented to modify the safety risk controls that are no longer needed or effective. Management must constantly identify causes of deviations in safety standards and procedures of the SMS and work on continuous improvement of the SMS with regular safety audits and management reviews to eliminate such deviations.[37]

An important instrument for safety assurance is the Safety Review Board (SRB). The SRB should normally comprise the Accountable Executive, Safety Manager and different managers from their corresponding field of duty (ground ops, flight ops, etc.). The Safety Review Board should meet monthly in order to assess the submitted safety reports of the employees. This review and assessment process should deliver monthly reports which can be processed internally and also be forwarded to aviation authorities.

These reports should include SMS performance indicators which illustrate quantifiable attributes from analyzed events. The performance indicators should have concentrated expressiveness, the ability to allow internal and external comparisons, and should point out developments and tendencies. Safety performance indicators on their own only provide stimulating information for further analysis. Therefore, securing comparability is essential for internal and external analysis. Safety performance indicators are generally data based expressions of the frequency of occurrence of some events, incidents or reports. There is no single safety performance indicator that is appropriate for all organizations.

The indicators chosen should correspond to the relevant safety goals. Examples of possible safety indicators are as follows:

- Number of in-flight incidents per 1,000 flight hours/cycles
- Number of findings per audit (or other measurable audit performance criteria)
- Number of hazard/safety reports received, etc.
- Number of incidents in daily operations

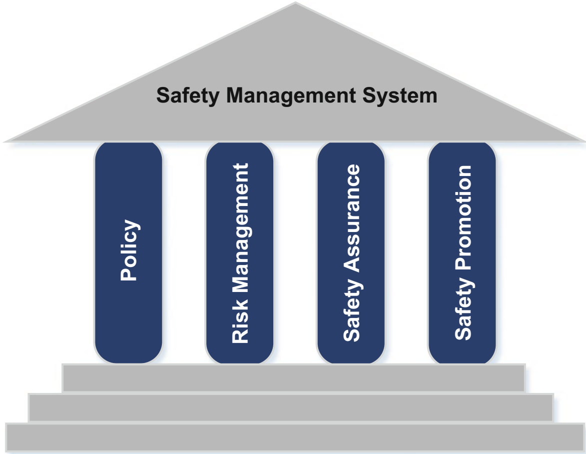
5.4.4 Pillar Four: Safety Promotion

To boost a sound safety culture, an organization must constantly strive for safety excellence and promote safety as the core value.[38] The organization should have

[37] International Civil Aviation Organisation (ICAO) (2007), p. A6.

[38] Stolzer et al. (2008), p. 28.

Fig. 5.3 Four pillars of a safety management system. *Source*: Own illustration



clearly defined arrangements to ensure that the work achieved by the Safety Manager and committees (e.g. SAG or other), as well as line management, is transmitted to all those involved in the relevant activities (Fig. 5.3). The lessons learned must be communicated effectively in order to promote system achievements.

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Costs and Benefits of Risk Management

6

Andreas Wittmer

This chapter provides an overview of:

- Different sources of risk from a microeconomic perspective
- The conflicting nature of risk perception: managers vs. shareholders
- Different risk perceptions of shareholders and stakeholders
- Systemic risk in network industries
- Implications of risk management on an operational level
- The cost and benefits of implementation and optimization of risk management for the company

6.1 Introduction

The representatives of the strategic management level of companies have the perception that risk management causes too high costs. In reality, this perception can be ignored if all relevant consequences of risk management are taken into account. An example of this comes from the experience of the authors with a large overhaul and maintenance company, employing about 5,000 people, where the insurance fees were reduced by 25 % due to the implementation of Risk Management. Before the company had its own Risk Management, the insurance firm would create its own risk assessment of the company, coming up with a risk list including 50 risks. After the implementation of the risk management process by the company itself, 250 risks were found internally and added to the risk list. With this the company was able to show that it recognized the risks and that risks were constantly measured and reduced, which lead to an insurance premium reduction of 25 %, as mentioned above, and really added value to the company.

Risk is the shadow of business opportunities. Different literature often links risk to financial risk. The worst that can happen is if a risk comes true and places the

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company in a situation of cash shortage. Enterprise risk management aims to manage risk at a level of detail that has been decided upon by the board of directors.[1] The attention to detail depends on the costs the board of directors is willing to allocate for Risk Management. At the beginning, one of the major unknowns is the benefit that risk prevention and management can bring to a company.

Much literature about risk is found in the field of modern financial theory and is based on three rationales[2]: risk/return trade off, rational wealth maximization, and the no-arbitrage principle. Risk Management is understood within the context of these rationales in the financial literature. The focus of this chapter, with respect to financial theory, is on the risk/return trade off, where it is argued that by implementing a simple process, the monitoring of risks is not very costly in comparison to the occurrence of a non-identified risk, which can be deadly for a company. This chapter does not only follow a financial rationale. Hence, risks are not only addressed from a financial perspective; business, strategic, structure, and systemic risks especially play a relevant role when dealing with risk assessments and management. One issue of the implementation of risk management processes is their costs and benefits though. If risk management were costless—meaning allowing companies to reduce risk without any cost—managers would implement it in great detail, as it also reduces their own risk based on their responsibility. As risk management is costly, it is important to find the most efficient way to keep transaction costs low and limit expended resources, while also ensuring risk monitoring results in a maximum of risk reduction.[3]

Risk, as it is understood in this chapter, is a corporate approach or philosophy used to create risk intelligence within a company by utilizing internal and external knowledge and measures. The goal of a continuous risk management process is to create a risk adverse corporate culture and, by this, create a great benefit for the company. In the context of this book, Risk Management is focused on in the aviation industry. Figure 6.1 highlights the development process of efficient Risk Management. There is a shift from organization, which through the development of processes leads to a culture.

6.2 Sources of Microeconomic Risks

In general, enterprise risk can be divided into six sources: business or operating risk, strategic risk, financial risk, structural risk, change risk and systemic risk. Each of the risk dimensions influences the overall corporate risk. The broadness of the risks indicate the importance that Risk Management has in affecting all sources and levels of risk, and dictates the importance of achieving a risk averse culture in an

[1] FERMA and ECIIA (2010).

[2] Fatemi and Luft (2002).

[3] Tufano (1996).

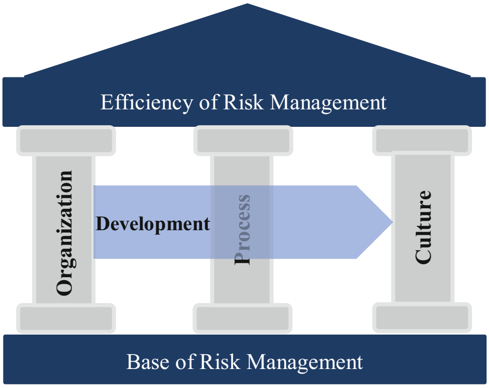

Fig. 6.1 The development of a risk-averse culture. *Source*: Related to Müller CFAC-HSG (2012)

aviation organization. The following paragraphs explain the different sources of risk.

6.2.1 Business Risk (Operating Risk)

Business or operational risk is fundamental to a company. It comprises technological, distributional, and informational risk sources.[4] These risks are assumed to have an impact on the competitive positioning of a firm. Moreover, these risks can mostly be controlled by management conducting regular, internal risk analyses, and choosing the correct follow-up operating decisions. If a firm takes operating risks and management is fully aware of them, the firm aims at a competitive advantage, for which it will be rewarded financially. If this is not the case, it is not worth taking that risk. So if firms are not able to mitigate their operational risk for their own advantage, they may fail in the market as this implies that costs would be greater than benefits.[5]

6.2.2 Strategic Risk

Strategic risk includes all macro factors which affect a firm. Furthermore, it encompasses the value to its shareholders.[6] Strategic risk can be economic or political on a domestic or international level. Typically, increased regulation and regulatory structures are examples of domestic economic events. Fundamental governmental changes, such as the inclusion of a country in the European Union or the weakening of financial security in a country, illustrate strategic political risks. These risks are commonly long term factors and affect a firm's value over many

[4] Fatemi and Luft (2002).

[5] Fatemi and Luft (2002).

[6] Fatemi and Luft (2002).

years. Hence, strategic risk factors are longer term oriented than business or operational risk factors, and the awareness of them in a risk culture of a company creates benefits and a sustainable development of the company within its economic environment.

6.2.3 Financial Risk

In general, financial risk appears in the short term, due to adverse changes of interest rates (e.g. airplane leasing rates), commodity prices (e.g. jet fuel), equity prices (e.g. share price development, value of own equity) and exchange rates (e.g. CHF-EUR exchange rate). Adverse changes of these factors translate into real losses for the company and shareholders. In the worst case, such impacts can quickly lead to low cash positions, which is especially the case in the airline business where airlines have small margins and can easily run into debt. Management can deal with such risks by using financial instruments—which themselves incur other risks. A popular example in the airlines industry is fuel hedging which can be seen as a failure after 2008 when fuel prices dropped significantly and airlines paid higher prices for fuel than the market price due to their hedging contracts.

6.2.4 Structural Risk

Structural risks are related to company internal risks over different hierarchical levels. The largest structural risk stems from the situation that many members of the supervisory board of directors are experts in their fields (such as finance, regulation, marketing, etc.), but unfortunately do not understand the specifics of their company's industry. An example of this situation is the aviation industry with many different regulatory limitations and a much diversified business structure with pilots, administrators, technologists, etc. Network management and yield management of airlines is especially crucial knowledge that one has to have about the industry in order to be successful. The small margins in aviation also lead boards to make decisions differently to those they might make in other industries. It is in an industry with such small margins, and due to these rather high risks it becomes very important to be aware of the structural risks for the benefit of the sustainable existence of the company. Risk management processes which incur costs are often related to specific benefits, without explicitly acknowledging that the core benefit, in many cases, is the sustainable survival of the company.

6.2.5 Risk of Change

Change risk addresses the risks that occur when changes happen in a company. Let's assume an airspace control company changes its supervisory system. There is the risk that it fails to work properly from the beginning, which would lead to a closure of all national airports and a grounding of all airplanes within its supervisory area. Furthermore, the market changes continuously. This leads companies to adjust constantly to the market and therefore being confronted with ever changing corporate risks. Change risks have to be dealt with specifically, and risk assessments have to be made for each change process so alternatives can be planned, just in case the change does not work according to plan.

6.2.6 Systemic Risk

Systemic risks are risks that appear in networks which can be more or less formalized, for example very formalized alliances. There are two kinds of systemic risk, namely internal and external. Internal systemic risk addresses structural issues (structural risks) within the company. They appear due to routine which leads to systemic behavior and less awareness of specific activities which may include risks. For example, if processes have become routine, there is a systemic risk of making mistakes by becoming reluctant to deviate from the given procedures, or if the supervisory board does not prioritize and allocate the necessary resources for risk assessment.

External systemic risk refers to the risk of dependencies in networks, the environment and the market risk in general. Issues such as the risk of losing a major partner in a network, e.g. the major partner in a global alliance, arises with the increasing dependency on that partner in the network. What would happen to Swiss if Lufthansa went out of business? What is the risk that such a scenario could come true? Such questions address external risk that can only partly be steered by individual companies. Typical types of risks in networks can be the following[7]:

- Too low or inappropriate demand
- Problems in fulfilling customer deliveries
- Cost management and pricing (yield management)
- Weaknesses in resources, development and flexibility (e.g. in route networks of airlines).

Figure 6.2 summarizes the two kinds of systemic risks.

Alliances are a common form of cooperation in the airline industry. They can create great economic value and might even be responsible for the success or failure of some small companies. But it also creates risk for entities in such alliances. Small firms especially are faced with higher levels of risk in alliances. Large firms are usually able to gain access to a smaller, entrepreneurial firm's new technology or

[7] Hallikas, Karvonen, Pulkkinen, Veli-Matti, and Tuominen (2004).

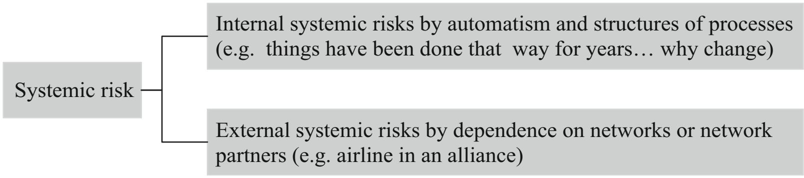

Fig. 6.2 Internal and external systemic risks

core resource through an alliance, whereas the long-term success of the smaller, entrepreneurial firm might actually suffer from the alliance with large firms.[8]

Das and Teng (1996) discuss the relational and performance risk of alliance partners. Relational risk deals with the probability that partner firms lack commitment to the goal of the alliance. Their opportunistic behavior could have a negative influence on the success of the alliance, due to their prioritizing of self-interest by focusing on their own benefits from the alliance at the cost of their partners.[9] Such opportunistic behavior includes shirking, distorting information, delivering unsatisfactory products or services, appropriating the partner's resources and following hidden agendas.[10] The result is suboptimal outcomes,[11,12,13] Performance risk deals with the opportunity that an alliance might fail, although all partners fully commit themselves to the alliance. Despite their best efforts, reasons for such failure may be a result of internal and external factors. External factors can be environmental factors such as governmental policy changes, economic recession and war. Furthermore, there are market factors such as demand fluctuations and fierce competition. Internal factors can be a lack of competence in critical areas or just plain old bad luck. Performance risk can be related to most strategic decisions, whereas relational risk is only present in alliances,[14,15] For example, Bombardier, which competes in the field of business jets and small airliners, uses partners in many countries to control development costs, thus sharing about half of the costs for the production of new jets. Boeing has, for example, similar deals with engine producers such as Rolls Royce, Pratt & Whitney and GE to share the risk and development costs of airplanes. These risks related to costs are clearly performance risks, which are present in addition to relational risks that might occur in the alliance.[16] Risk (and/or cost) sharing has been identified as an important motive for entering such alliances,

[8] Alvarez and Barney (2001).
[9] Willianson (1993).
[10] Das and Teng (1996).
[11] Parkhe (1993).
[12] Rugman (1982).
[13] Brouthers (1995).
[14] Das and Teng (1996).
[15] Ring and Ven (1994).
[16] Das and Teng (1996).

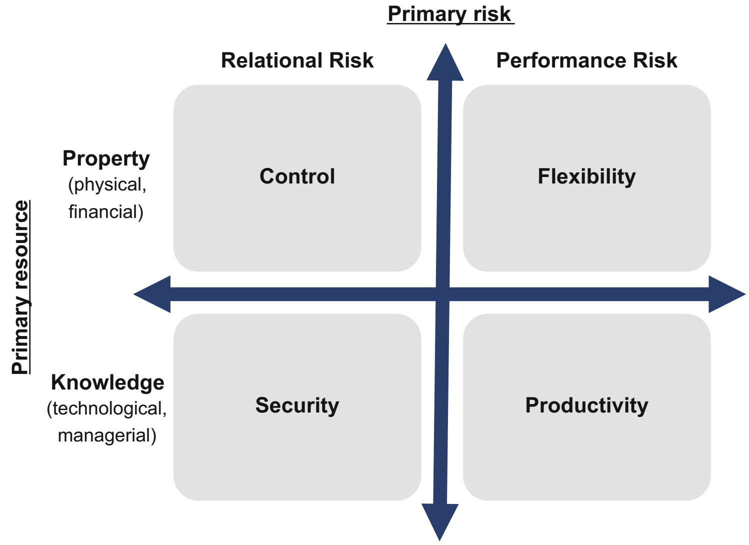

Fig. 6.3 Strategic alliance orientations for primary risks and resources. *Source*: Related to Das and Teng (1996)

as stated in the previous example.[17,18,19,20,21] Figure 6.3 summarizes the different orientations of primary risks and resources in alliances.

Relational and performance risks[22] for smaller firms in alliances can be reduced if larger partners are continuously monitored. When entering an alliance with a bigger partner the following actions will reduce risk and increase the knowledge about the larger firm,[23,24]

- Perform due diligence on the large firm
- Be cautious to prevent excessive appropriation of the alliance benefits by the large firm
- Protect own primary resource
- Form alliances with entrepreneurial firms that have managers capable of understanding what is required to make the alliance successful

[17] Badaracco (1991).
[18] Kogut (1991).
[19] Murray and Mahon (1993).
[20] Oliver (1990).
[21] Powell (1987).
[22] Das and Teng (1996).
[23] Alvarez and Barney (2001).
[24] Das and Teng (1996).

- Be aware of competition issues (cooperation and competition) which are preserved in an alliance. A sense of competition should be combined with the spirit of cooperation
- Keep it flexible enough to minimize sunk costs, adapt to new situations, and recover more investment if the alliance fails

6.3 Cost Factors of Corporate Risk Management

The goals of a corporate risk management project must be that all employees have the chance to provide their list of risks the company faces. For this reason one is well advised to first make sure the goal of the risk management project is clear for all participating employees in the company, and not only for top management. Furthermore, financial and time resources need to be allocated and approved by the top management for a successful finalization of the project. The risk management project needs to be on the agenda of the board of directors. Once this is the case, a detailed project plan with a specific time schedule for the risk management process is required. It is important that bigger risk management projects are not just running parallel to "more important" daily business. Last but not least, project controlling must be in place to guarantee the quality, time and budget allocation for the project. The following list is a general risk management project guideline for the implementation of a risk project split into four phases (see Part IV of the book):

1. Phase 1: Organization: Planning and implementation of the risk project
2. Phase 2: Risk collection and assessment: Collect the risk and create report
3. Phase 3: Risk mitigation: Investigation, determination and documentation
4. Phase 4: Continuous improvement and change management: Internal and external audits, and safety training

Nevertheless, risk management projects can be implemented in different ways, either internally or externally. Internally means that the project is handled by the company itself, which means that the company assigns a risk manager to the project. Externally means that a risk consultant is hired who implements and runs a risk management project in the company. Figure 6.4 summarizes the different internal and external procedures towards risk assessments.

6.3.1 Internal

Two internal risk management processes can be implemented: asking all employees to state all the risks they have identified within the company during their yearly personnel talk with their supervisor, and sending out a questionnaire to all employees on a regular basis to collect risks for a master risk list. By doing this, the master risk list is constantly changing and shows the current highest risks as perceived by the employees. Furthermore, the analysis of existing cases that occurred in the company and externally can help identify risks and improve sensitivity to risks.

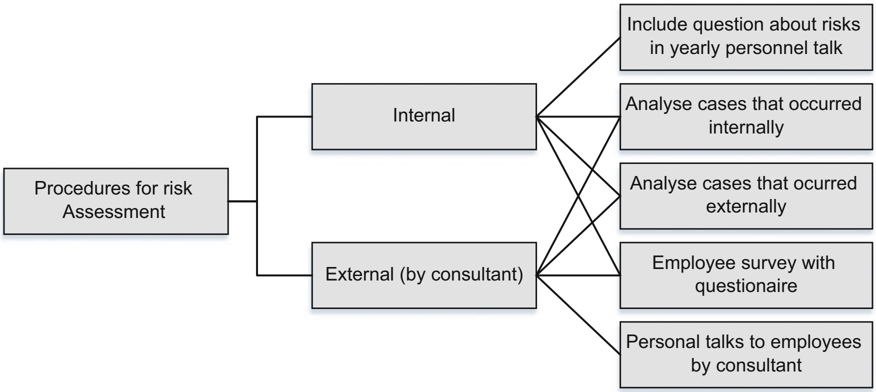

Fig. 6.4 Procedures for risk assessment

The following list summarizes four different internal procedures to create a high quality determination of risks:

- Determine risks after the yearly management talk with employees
- Questionnaire to employees
- Analysis of cases that occurred internally
- Analysis of cases that occurred externally

6.3.2 External

External risk management procedures differ from the internal ones, mainly as they are outsourced to a risk management consultant. The goal is not only to draw on internal knowledge, but also to take external expertise about risks from others into account when assessing one's own risk.

Such external risks that hit others, might hit one's own company as well. This begs an analysis of such cases in order to learn from them and improve one's own position to reduce that risk. External risks are determined the same way as internal risks, but often there are consultants involved who bring their cross-industry risk management skills as an asset into the risk analysis.

The following list summarizes the different external procedures used towards a high quality determination of risks:

- Determine risks through personal talks of employees with the consultant
- Questionnaire given to employees by consultant (anonymously if needed)
- Analysis of cases that occurred internally by consultant
- Analysis of cases that occurred externally by consultant
- Input of knowledge across industries by risk management consultant

6.4 Risk Management Costs

One reason why risk management is not conducted thoroughly by some companies most likely lies in the provision of resources. As long as a company runs well, the search for possible risks seems almost paranoid, like if people ran to a doctor every time they sneezed. Resources for proper corporate risk management are needed in the form of time and money and they have to be placed on the top level agenda of the board of directors.

The general benefits of corporate risk management can be explained as a reduction of the different risks threatening an organization. However, the financial benefit is difficult to derive if a risk has not previously resulted in a crisis. For example, in the operation of an airline one of the biggest risks is losing a plane in a crash. The costs of such a loss can be calculated financially. But it is not always the financial loss that counts most. It might rather be an image loss. But what is the value of image for an airline? No manager would argue that it does not matter, but no manager would be able to provide a specific financial value for image. So the benefit of the image is hard to measure and, for this reason, it is hard to measure the benefits of risk management. Concerning incidents that could lead to airplane crashes, the industry is now regulated in this area, meaning most of the safety management processes need to be in place.

Costs of risk are simpler to calculate than benefits. Table 6.1 shows the costs of the set-up of Risk Management in the first year. The time (days) spent by representatives of the company and external consultants are included in the calculation. The calculation on a working day level is provided with examples for companies with 20, 100, 250, 500 and 1,000 or more employees. The numbers provided are subject to some volatility based on the different complexities of companies depending on what specifically they are offering, whether they are producing for the aviation industry as suppliers or whether they are also involved in work in the air. The volatility level of plus/minus 25 % allows the numbers to be interpreted for different cases. Furthermore, only the corporate risk management activities are included within the day calculation. This excludes costs for internal control systems (ICS) and safety management systems (SMS).

Table 6.1 shows the costs of risk management for different company sizes.

Table 6.2 shows different time investments in Risk Management, dependent on company size and based on the authors real life experience. Furthermore, it is seen in practice that small companies do the absolute minimum to just fulfill the requirements. Some reasons for the increasing time needed related to size, are based on the fact that large companies:

- need to deliver a situation report
- need to include investor relations into risk management
- need to deal with insurances
- are more complex and have more diversified product portfolios
- need to inform, educate, etc. more employees
- are confronted with bigger difficulties to create a corporate risk culture

Table 6.1 Costs of implementation of risk management in year 1

Position	Number of working days used dependent on company size				
	20 empl.	100 empl.	250 empl.	500 empl.	1,000+ empl.
Phase 1					
Supervisory board of directors	0.5	0.5	0.5	0.5	0.5
Executive management	1	1	2	3	4
Project leader	5	10	20	25	30
Others (administration, accounting, ext. experts)	2	4	7	10	15
Phase 2					
Supervisory board of directors	0.5	0.5	0.5	0.5	0.5
Executive management	1	1	2	3	4
Project leader	2	3	4	6	10
Others (administration, accounting, ext. experts)	2	3	4	8	15
Total	**14**	**22**	**40**	**56**	**79**

Table 6.2 highlights the number of working days needed to continuously work on Risk Management. Continuous improvement and adjustment related to new regulations, structures and market situations is important. Again, these numbers are based on the authors' expertise in practice. A comparison of the first year implementation and the continuous risk management process demonstrates that the risk manager needs less time for phase one and two than the project leader. The reason is that the project leader has already created all the templates and described the risk management process in the first year which just has to be followed by the risk manager in year two and after. Appendix shows a sample job description of a risk manager for Aviation Company Ltd.

6.5 Summary

There are different sources of risk that play a role from a microeconomic and managerial perspective. One of those risks is systemic risk, which is of upmost importance in the aviation industry. It is an industry that depends strongly on networks and partly on alliances, whether in the airline industry or in the aviation supply chain. There are internal risks related to internal structures and behavior, as well as external risks, especially for smaller partners in bigger networks or alliances. It is important for companies entering networks to ensure they keep their crucial knowledge in house and, at the same time, aim at flexibility and productivity in the alliance.

When implementing risk management it is important to have the supervisory board support the project and follow clear time schedules, regularly controlling achievements and financial resources within the risk project. Risk management has

Table 6.2 Costs of implementation of risk management after year 1

Position	Number of working days used dependent on company size				
	20 empl.	100 empl.	250 empl.	500 empl.	1,000+ empl.
Phase 1					
Supervisory board of directors	0.5	0.5	2	3	3.5
Executive management	3	4	4.5	5	6
Risk manager	0	2	3	4	6
Others (administration, accounting, ext. experts)	0	1	3	4	5
Phase 2					
Supervisory board of directors	0	0.5	0.5	0.5	1
Executive management	1.5	2	4	6	8
Risk manager	0	3	6	8	10
Others (administration, accounting, ext. experts)	0	3	6	8	10
Phase 3					
Supervisory board of directors	0	0.5	0.5	1	2
Executive management	2	4	6	8	10
Risk manager	0	4	8	12	20
Others (administration, accounting, ext. experts)	1	5	10	20	30
Phase 4					
Supervisory board of directors	0	0.5	0.5	0.5	0.5
Executive management	2	4	6	8	10
Risk manager	0	3	7	10	15
Others (administration, accounting, ext. experts)	2	10	20	30	50
Total	**12**	**41**	**87**	**128**	**185**

to move from an initial project to a continuous risk assessment. There are several internal and external solutions about how to achieve this goal either by assigning internal resources or employing a consultant.

It is difficult to calculate specific costs and benefits arising from risk management as long as no failure that could have been prevented by proper risk management materializes. Costs for implementing and for the continuous improvement of risk management play an important role. Depending on the size, complexity of the company, the business framework and industry the company is in, risk assessments will affect financial resources to a greater or lesser extent. As a part of this chapter an assessment of time spent for setting up a proper risk management in a company and for a long term development of risk management has been provided. From the number of working days spent on different functional levels of management, costs can be estimated individually for companies. This is a new concept and should help managers to better financially plan their risk management process.

Appendix: Sample Risk Manager Job Description

Sample Company

Risk Manager Job Description

1. **General Information**

Job Title	Risk Manager
Appointed by	Executive Committee (EC)
Supervisor	Chief Executive Officer (CEO)
Starting date	1 April 2014
Percentage	30 percent
Deputy	Chief Financial Officer (CFO)
Subordinates	None
Additional function	Head of Quality
Signatory rights	None
Competencies	Right to inspect all business documents, legal right to inform all employees, reports directly to the Chairman of the Board

2. **Duties**
   - Monitoring and optimization of the risk management process
   - Ongoing mitigation of the key risks of the sample company
   - Ensuring adequate insurance coverage
3. **Requirements**
   - Social and interpersonal skills
   - Independent, accurate and structured way of working
   - Flexible and resilient, solution-oriented
   - Optimization focus
   - Openness to new ideas and changes
   - Loyal and discreet
   - Planning and organizational ability
   - Expertise in Risk Management
   - Basic training in Risk Management
   - Interdisciplinary understanding
   - Networked thinking
   - Organizational strengths
   - Willingness to participate in ongoing training in Risk Management
4. **Key Activities**
   - Risk analysis:
     – Preparation of annual risk analysis (as part of the annual operational risk analysis) for submission to the CEO and BoD

- Ongoing identification of risks, proposals for the definition of measures and reporting of significant changes in the risk environment
- Ensuring that all employees are also asked about new or worsened risks in connection with the annual employee interview

- Definition and monitoring of risk-mitigating measures:
  - Preparation of the definition of risk-mitigating measures for submission to the CEO and BoD (as part of the individual risk assessments)
  - Coordination with the respective risk owners and, if necessary, coaching of the risk owners
  - Monitoring the implementation of the risk-mitigating measures by the risk owners
- Creating appropriate reports for the submission to CEO and BoD
  - Quarterly reporting to the CEO on the development of key risks and the status of risk-mitigating measures (risk radar as part of the quarterly reporting)
  - Annual report on Risk Management to the BoD
- Coordination of the risk management function with the measures of the ICS
- Preparation of annual insurance overview
- Advice to the CEO regarding relevant risk management issues

5. **Special Tasks**

After consultation with the BoD the incumbent may be given special additional tasks, particularly in relation to specific projects.

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Zürich, ...

The incumbent:	For the sample company
______________________	______________________
XXX	XXX

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Operational Risk Management as an Integrated Part of Safety Management Systems

7

Roland Müller and Christopher Drax

Operational risk management is a central part of the safety management system and has to be further outlined. This chapter provides an overview of:

- Hazard Identification
- Operational Safety Risks

7.1 Hazard Identification

The identification of hazards is the fundamental activity within safety management. Each risk analysis starts with the hazard identification process. It aims at identifying any condition with the potential to cause injury to personnel, damage to equipment or structures, loss of material, or reduction of the ability to perform a prescribed function. In particular, this also contains any conditions that could contribute to the release of an un-airworthy aircraft or to the operation of aircraft in an unsafe manner. Hazard identification is performed in order to identify the hazards in the organizational systems and the operational environment of companies and to assist in controlling these hazards.[1] Such a process can be implemented through internal reporting instruments like flight data monitoring including the constant monitoring of the processes defined for specific operations and business processes. For safe operations, it is vital that an ongoing assessment of the operational functions and processes is performed to apply changes which contribute to the proactive management of safety. The core processes in safety management are regularly safety

[1] Skybrary (2009).

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assessments which immediately track trends and changes in order to provide essential information for maintaining the system's safety health.[2]

The traditional approach of air operators towards hazard identification only focuses on the monitoring and assessment of operational areas. These areas include trend analysis and safety relevant occurrences of aircraft operation. The method is called the reactive approach because operational data is used to understand the environment, equipment status and cultural milieu in order to identify the hazard. Just being reactive and only responding to incidents and accidents, is a clear indicator of deficiencies in the aviation safety system of a company.[3]

With modern hazard identification the focus is directed towards process analysis finding weaknesses as well as identifying potential failures. The overall goal is to fix or eliminate those weaknesses before they turn into an incident or even an accident.[4] This new thinking is a proactive approach to the identification of hazards and risk analysis. Upon being able to understand the hazards and associated risks within daily operations, a company must work on minimizing hazardous conditions and respond proactively. This can be achieved by analyzing processes, conditions and working environment to improve the overall level of safety. Those processes and conditions include departments like training, budgeting, planning, marketing, procedures and organizational factors that might have a contribution to operational accidents. Here it becomes obvious that hazard identification should be regarded as a core-business function and not as an extra management task.

It is a fundamental step for a company to transform from a reactive culture to a proactive reporting culture where everybody actively tries to address safety related issues before they turn into catastrophic events.[5] The way to safety superiority is through the additional predictive approach where confidential reporting systems monitor real time flight data and provide information which might identify future problems. The focus is on emerging safety risks and how to intervene in order to minimize the risks to an acceptable level.[6]

A combination of reactive, proactive and predictive methods will lead to effective hazard identification and will provide fundamental information for risk management.

7.2 Operational Safety Risks

Given that a hazard may involve any situation or condition that has the potential to cause adverse consequences, the scope for hazards in aviation is widespread.

The following list provides some examples for hazards:

[2] International Civil Aviation Organisation (ICAO) (2009), pp. 4.4–4.6.

[3] Stolzer, Halford, and Goglia (2008), pp. 120–121.

[4] Stolzer et al. (2008), p. 121.

[5] Department of Transportation Canada (DOT) (2002), p. 32.

[6] International Civil Aviation Organisation (ICAO) (2008).

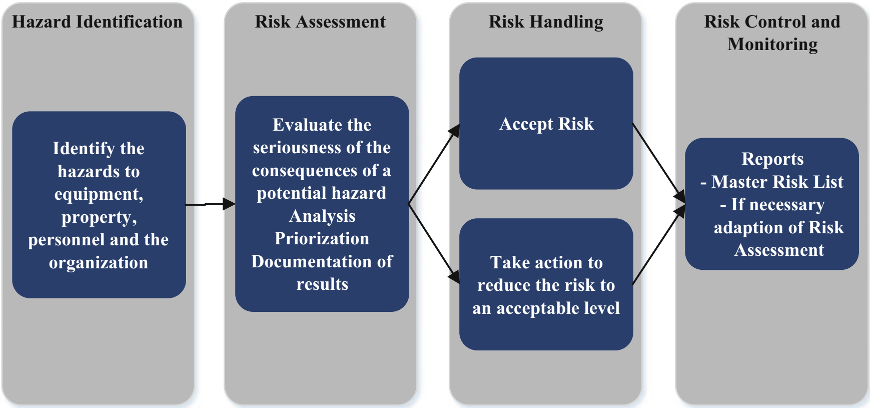

Fig. 7.1 Operational risk management process. *Source*: Adapted from various sources (ARMS Working Group, 2007–2010; Skybrary, 2013)

- Equipment or task design
- Procedures and operating practices
- Communication
- Human factors
- Organizational factors
- Work environment factors

Operational risk management is the identification, analysis and elimination of those hazards, as well as the subsequent risks, that threaten the viability of an organization.

The first goal of Risk Management is to avoid hazards. The proactive identification and control of all major hazards is fundamental. Successful operations depend on the effectiveness of the hazard management program. Figure 7.1 illustrates the risk management process[7]:

The following example should provide clarification to help understand the difference between corporate risk management and the safety management system.

Four pilots found a business aviation company and want to operate their aircraft on a commercial basis. According to state obligations they are required to show efficient Risk Management during their first annual financial statement for the acquisition of the aircraft. In parallel they acquire their AOC, where they are required to implement a safety management system for the company, with a strong focus on the operational and organizational sides.

The four pilots hold an equal share in the company, but the CFO has single signature rights because they decided to speed up the signature process and trust their partner. This fact illustrates a very common mistake in corporate governance and completely neglects Risk Management.

[7] Skybrary (2010).

After 2 years, the CFO depredates the accounts and the company has to declare bankruptcy. How could this scenario have been avoided and how could the risk have been identified?

Corporate risk management integrates the whole organization, including accounts and management, and provides an in depth analysis of corporate risks and their mitigation in order to manage the business on a sound economic basis.

A safety management system approach during that stage would not have incorporated the shown risk above. While disclosing the yearly financial statements, a company which is buying aircraft has to clearly demonstrate a corporate risk management, whereas air operations require the implementation of a safety management system.[8]

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[8] Own example.

Management Implications

8

Roland Müller and Christopher Drax

The aviation business is one of the harshest business environments managers can think of. Tight profit margins, frequent business cycles, governmental regulation, safety requirements and the direct interdependency to the world economy are just a few factors which cause immense headaches for top management. Maneuvering a company through this environment requires the right management strategies and skills.

This chapter provides an overview of:

- Corporate Governance
- The Internal Control System with its connection to different standards
- The balancing act between production and protection

8.1 Corporate Governance

Corporate Governance touches different areas within a company. It basically defines the processes, structures and the framework for the leadership, management and monitoring of companies.[1]

Successful companies have classically similar characteristics which set them apart from less successful companies. The key areas comprise an effective, competent board of directors, with clearly defined responsibilities, and a skilled CEO who is eligible to run the business with integrity and great vigor. Additionally, the business concept has to be executed effectively and profitably utilizing the right

[1] Töpfer (2007), p. 213.

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resources in order to compete in the market environment and to meet the customers' expectations in an outstanding way. Moreover, prosperous companies apply the right tools and systems which ensure the efficient implementation of processes and compliance with applicable laws and regulations.[2]

There are three main objectives which are addressed by Corporate Governance:

1. Establishing, with regard to content, the timely preparation and **distribution of information** about all important business processes within the company to the management across all decision levels.
2. Ensuring **transparency** of all essential processes, decisions and results in order to illustrate a clear picture for all involved stakeholders.
3. The **control** by the advisory board ensures that companies do not act against laws or ethical codes, and that all decisions made by the shareholders are implemented.

Figure 8.1 illustrates the main objectives of Corporate Governance.

Corporate Governance in the aviation industry is not specifically the primary objective when looking at the composition of the board. Authorities like EASA, BAZL, etc. have positioned structural rules and regulations for air transportation which have to be followed by AOC holders. These regulations already contain guidelines concerning transparency, control and information systems which target managerial leadership.[3]

8.2 Internal Control System

Overall Risk Management in the context of corporate governance has to be distinguished from the focused operational risk management in the aviation business. It is therefore helpful to speak of "Corporate Risk Management" if the overall approach in the sense of corporate governance is intended. A part of corporate risk management is the Internal Control System (ICS). The ICS is one of the key management instruments and is defined by the Committee of Sponsoring Organizations of the Treadway Commission (COSO) as a process affected by an organization's structure, work and authority flows, people and management information systems, designed to help the organization accomplish specific goals or objectives.[4]

The challenge for the aviation industry is to combine corporate governance risk management with the safety management system. The SMS includes the process of hazard identification (HAZID) based on the standards and recommended practices (SARPS) of ICAO. The experience of successful aviation companies leads to the conclusion that the SMS should be based on the corporate risk management without touching the aspects of internal controlling, as visualized in Fig. 8.2.[5]

[2] Colley, Stettinius, Doyle, and Logan (2005), p. 4.

[3] Jermann (2011), p. 13.

[4] Committee of Sponsoring Organizations of the Treadway Commission (2004).

[5] Müller (2012).

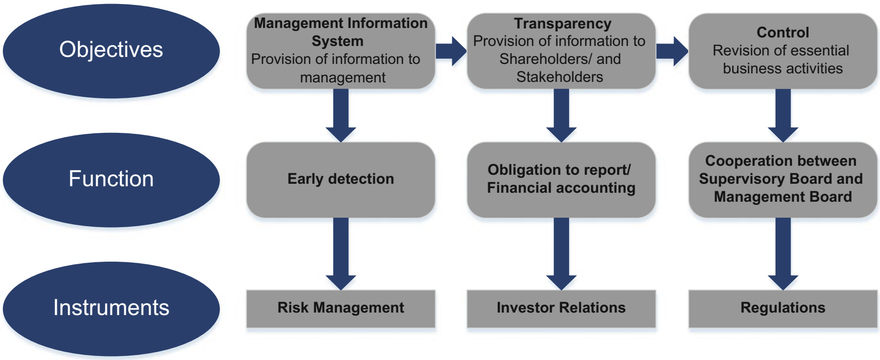

Fig. 8.1 Main objectives of corporate governance. *Source*: Töpfer (2007)

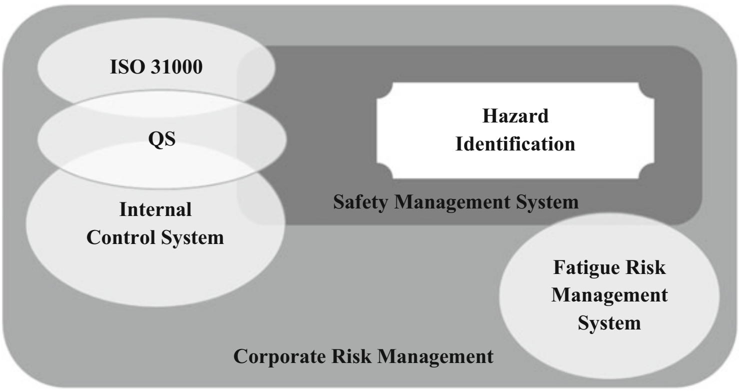

Fig. 8.2 Connex of risk management and the safety management systems. *Source*: Own illustration

Research by the I. FPM Centre for Corporate Governance, at the Institute for Leadership and Human Resources Management at the University of St. Gallen showed that one of the main mistakes made by the Management Board was insufficient or non-existent Risk Management. That is why risk management assumes a key significance in the area of corporate governance.[6] The ten most common and important mistakes and deficiencies at board level can be listed as follows:

[6] Müller, Lipp, and Plüss (2007).

Box 1: Challenges and Deficiencies at Board Level[7]

1. Below satisfactory qualifications of the Board of Directors (BoD), especially the function of the Chairperson in connection with the absence of the non-executive board members, and incorrect structure of the board
2. Poor preparation and lack of overview by board members
3. Conflicting interests influence board decisions due to inadequate internal regulations
4. Lack of clear strategies and strategy control
5. Non-existent or inefficient risk management, especially regarding liquidity planning or regulatory compliance
6. Very reactive rather than proactive approach by the Board of Directors to changes, due to the low frequency of board meetings
7. Unsatisfactory provision of information and information evaluation, in particular due to insufficient or delayed reporting to the Board of Directors.
8. Poor or delayed decision making, especially with incomplete decision documents
9. Lack of cooperation between Executive Management and Board of Directors, in particular lack of clearly defined responsibilities
10. No existing evaluation of Executive Management and Board Members; inefficient Managers and Board Members are replaced too late

8.3 Balancing Act, Production vs. Protection

Coming to the question of production and protection, the management constantly faces a “management dilemma” (Fig. 8.3).

The commercially competitive environment puts a lot of pressure on the overall cost basis. Frequently, being safe is perceived as an expensive, intangible and never ending obligation imposed by the aviation authorities that has unclear returns on investment.

There is an inherent conflict between protection and production goals. On the one hand, the overall protection (safety) must be kept at a high level to avoid any catastrophic events but, on the other hand, production goals must also be at a high standard to avoid bankruptcy. Whilst the productive aspects are commonly well understood and their related processes are comparatively transparent, the protective functions are far more diverse and more subtle.[8] Since production generates the resources which are vital for protection, its needs will always be prioritized within an organization. Air operators are always driven by production goals, where the

[7] Kalia and Müller (2006), p. 15.

[8] Reason (2004), pp. 3–5.

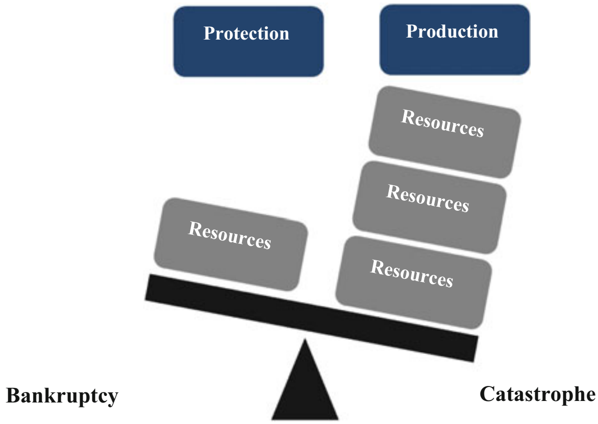

Fig. 8.3 The management dilemma. *Source*: International Business Aviation Council (IBAC) (2008), p. 15

primary objective is the timely and efficient delivery of services. This objective often contradicts operational safety considerations, because the need to meet a schedule and land at a particular airport at a particular time often has priority, regardless of weather conditions or airport limitations.[9] Often such sacrifices have no negative effects or generate no negative outcomes and can become a common practice in daily business and routine work practices. Unfortunately, becoming used to reduced system safety margins provides an increasingly vulnerable combination of accident-causing factors.[10]

But looking at the consequences, it must be recognized that accidents, incidents or even single safety violations can put the lives of staff in danger and might damage customer relationships, not to mention the damage to the reputation or the morale within the company. The balancing act within safety management is about finding the perfect balance between the production of services and products and the protection of human, financial and technical resources.

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[9] International Civil Aviation Organization (ICAO) (2009), pp. 14–17.

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Part III

Practical Implications of Risk and Safety Management

9

Study of the Level of Risk and Safety Management System Implementation in Practice

Andreas Wittmer and Christopher Drax

9.1 Introduction

The presented risk management survey was conducted in winter 2012/13 with the aim to gain an insight into corporate risk management procedures, and the level of implementation of such procedures in aviation companies and organizations. The survey was set up online and was distributed among small, medium and large Swiss enterprises in the aviation industry. A sample of 27 companies participated in the survey. This is a small sample which allows an insight into the implementation level of Risk Management, but does not provide statistically significant and completely representative conclusions. The examination of the topic follows a qualitative research approach and the findings meet the expectations of the researchers, providing a valid base for discussion and further research.

9.2 Research Findings

The analysis of the survey shows that almost half of the respondents are from organizations with a workforce greater than 500 employees where Risk Management is already implemented. Small firms with less than 50 employees are under-represented at only 15 %. However, smaller firms are still a very interesting segment to study as most of the regulations have been developed specifically for larger organizations, and small organizations are increasingly struggling with the implementation and monitoring of regulatory compliant management systems.

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The functions of the respondents within the organizations are all, at least, middle to top management. Furthermore, at least 85 % of the respondents hold an academic degree.

An interesting finding is that approximately 60 % of the respondents perform a double function within their organizations, meaning they are responsible for a minimum of two different areas within their organization.

Only 41 % of organizations surveyed employ a risk manager in their Corporate Risk Management. This leads to the assumption that in some organizations, Risk Management is still a side function which does not require a dedicated position within the organization and is thus not properly executed.

Usually, executive management, supported by a specific risk manager, would be involved in the Corporate Risk Management, and would bear the overall responsibility and authority for the risk management process. According to the survey, only 60 % of the organizations involve executive management within their Corporate Risk Management. In addition, only 33 % have a specific risk management committee which should jointly evaluate and mitigate the risks for the organization. Furthermore, the low percentage of 22 % regarding the involvement of an audit committee indicates that corporate risk management is not regularly monitored for effectiveness or regulatory compliance.

The individual identification of risks by every employee within an organization is crucial for the exposure of safety risks. Still, 30 % of the respondents have never conducted a survey with all the employees to reveal inherent safety risks within their organization and processes. Instead, the survey showed that the organizations make use of various types of data/information sources for the Safety Management System, e.g. operational factors, flight data and air safety reports.

When taking a closer look at the connection between Corporate Risk Management and other management systems, the majority of the organizations link Corporate Risk Management with their Safety Management System. Nearly half of the respondents identify a link with the Quality Management System. Only 22 % have a connection to the Internal Control System. There is still a minority of 19 % of the organizations which use their Risk Management as a stand-alone process without any further connection to other management systems.

Even though the aforementioned analysis is not ideal from a solid risk management process perspective, 89 % of the respondents classify their operational safety level within a range of fair to excellent, with 60 % classifying their operational safety level as excellent.

In order to reach this excellence and to effectively manage and improve their Safety Management System, organizations are dependent on industry specific information and guidance. Most of the organizations follow the Civil Aviation Authority guidelines and/or directly the ICAO SMS framework which shows that best industry practices and regulatory parameters are the most commonly used form of obtaining information for the improvement of the Safety Management System. Forty-four percent of the organizations use seminars as a source of information, whereas only 25 % rely on the expertise of consultants. This importance of seminars contributes to the fact that sharing of safety relevant information within the industry is a common approach to improving each organization’s SMS.

In addition, most of the organizations make use of internally developed tools or buy software to help them with the implementation, monitoring and running of their SMS. Therefore, Safety Policy, with the safety management manual, is the least challenging module to implement. In contrast, 42.3 % regard the safety risk management module as the most challenging. This is in line with recent discussions during industry forums and workshops. Operators increasingly face issues to identify and properly manage risks within their organizational and operational processes and environment. Approximately 20 % are not challenged by the implementation of any of the four modules. On average, the respondents estimate their total spending on Safety and Risk Management at around 2.4 % of their total revenues.

9.3 Results

The majority of respondents are from large organizations or parts of an organization with more than 500 employees where Risk Management is implemented. Around 70 % of the respondents are from organizations larger than 250 employees, which shows that the majority of the answers are based on more complex organizational structures and organizational challenges. Small organizations are only represented by 15 % of the respondents (Fig. 9.1).

The educational level shows a high academic concentration with around 85 % of respondents at least with an undergraduate or postgraduate degree (Fig. 9.2).

The respondents of the survey have the following functions which are spread from middle management to top management.

- Captain
- 2 × Safety Management Systems Manager
- CEO
- Chairman of the Board
- Chief Engineer
- CO
- Commander Flying Training
- CSO
- Deputy CEO
- Director, Corporate Safety Policy, Planning and SMS Audits
- Head of Division Safety Development and Support
- Head of Safety
- Maintenance Manager
- Managing Director
- Member of the Board
- National Air Navigation Services Provider
- Project Coordinator, Aircraft Maintenance Engineer and SMS Instructor
- Safety and Environmental Compliance Manager
- Safety Manager
- Safety Projects Coordinator
- Senior Director
- Type Rating Instructor

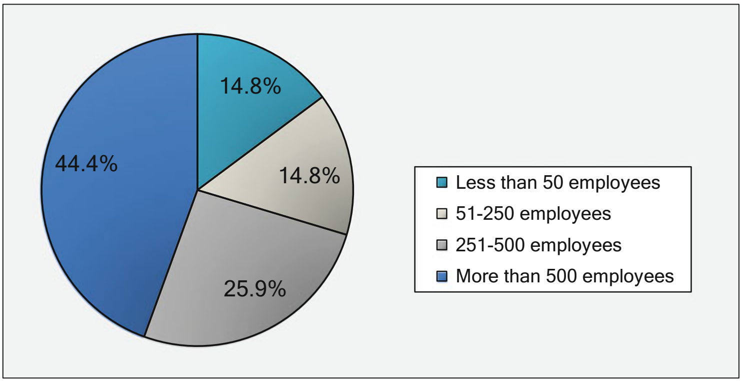

Fig. 9.1 What is your organization size? (Organization where your Risk Management is implemented)

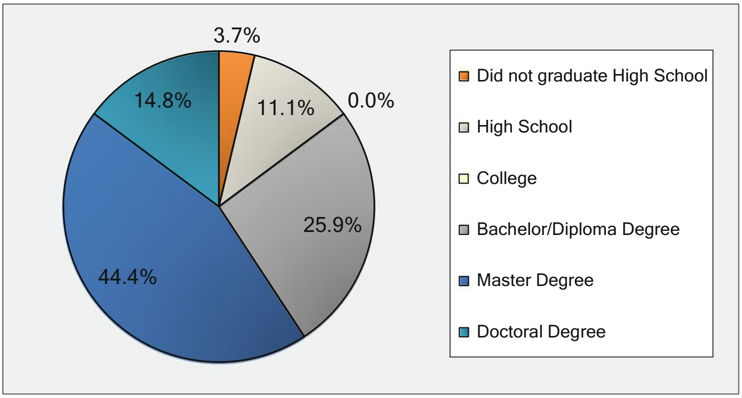

Fig. 9.2 What is the highest level of education you have completed?

- Underwriter
- Vice President EU Affairs

Two thirds of the respondents are responsible for Risk Management within their respective organization. As expected by the authors, at least 60 % of the respondents hold double functions in their organizations.

Around 60 % of the organizations involve Executive Management within their Corporate Risk Management and at least 41 % have a specific Risk Manager, which verifies the responses made in question three that at least 60 % of the respondents hold a double function . Only 33 % have a specific Risk Management Committee which should jointly evaluate and mitigate the risks for the organization. Only 22 % involve an audit committee in their Corporate Risk Management (Fig. 9.3).

Seventy percent of the organizations have, at least once, conducted a survey concerning safety and risks within their organization. Nevertheless, 30 % have still

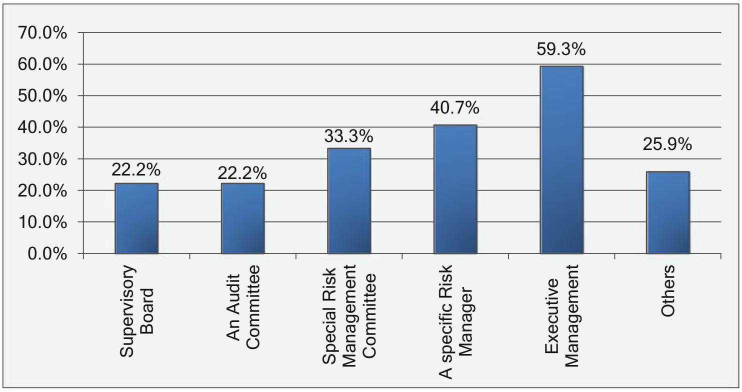

Fig. 9.3 Who is involved in your Corporate Risk Management?

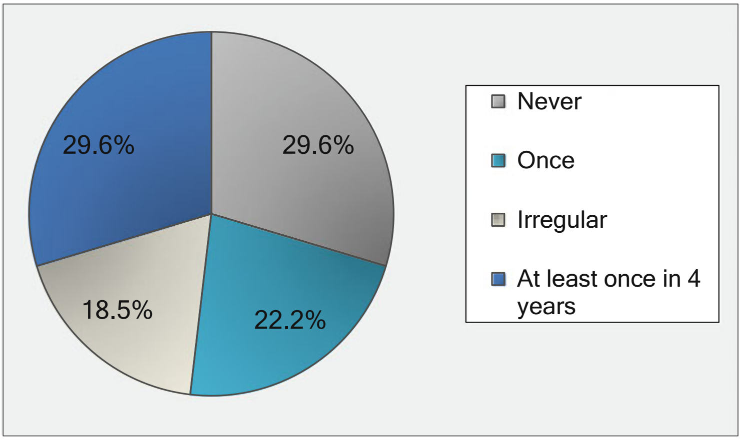

Fig. 9.4 Have you ever conducted a survey concerning safety and risks in your company with all employees?

not conducted a survey concerning safety risks despite this being crucial for identifying risks throughout the organization (Fig. 9.4).

As anticipated by the authors, the majority of the organizations link their Risk Management with Safety Management, and nearly half with the Quality Management System. The empirical evidence still shows that there is no link in some companies to other management systems. This fact shows that there is further implementation effort needed to create the required links between the management systems (Fig. 9.5).

Eighty-nine percent of the respondents classify their current safety level within a range of fair to excellent, with even 60 % rating their current safety level as excellent (Fig. 9.6).

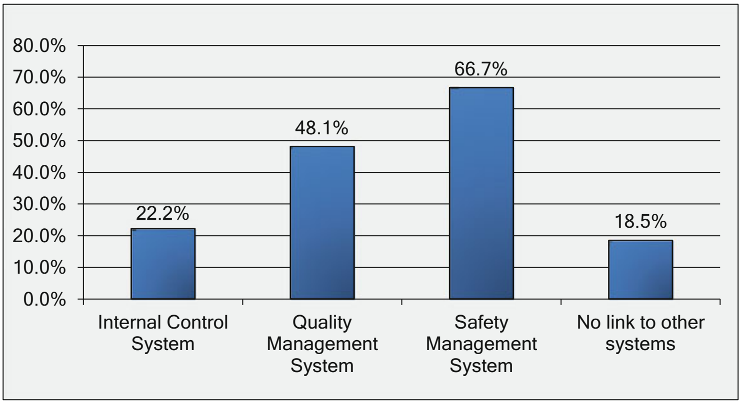

Fig. 9.5 Do you link your Corporate Risk Management with other systems?

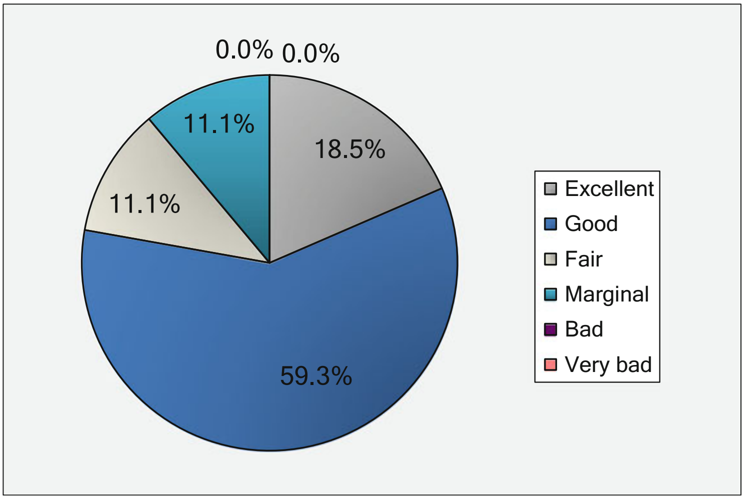

Fig. 9.6 Regarding the operational situation, how would you personally classify your current safety level within your company?

The following answers show that best industry practices and regulatory parameters are the most commonly used form of obtaining information for the improvement of the Safety Management System. The open answer option also reveals that the sharing of safety information within the industry is a common approach to improving each organization's SMS (Fig. 9.7).

Most of the organizations have concrete and specific strategic objectives in either their safety- and/or risk policy. Almost all organizations have documented strategic objectives in a specific policy (Fig. 9.8).

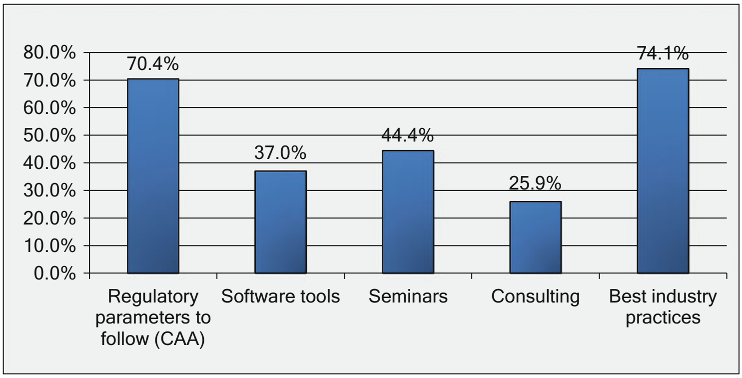

Fig. 9.7 Where do you get your information from in order to improve your Safety Management System?

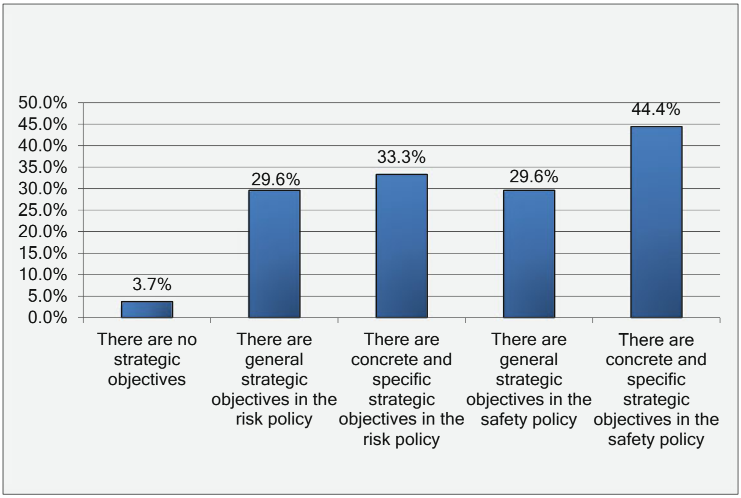

Fig. 9.8 Which strategic objectives for Risk Management and Safety Management do you have?

The survey also shows that the different organizations make use of various types of data/information sources for the Safety Management System (Fig. 9.9).

The majority of the organizations use self-developed tools or buy software to help them with the implementation, monitoring and running of the SMS. Only 8 out of 27 make use of external consultants to help them with the implementation. This leads to an interesting question about the market availability of the appropriate consulting services concerning Safety Management (Fig. 9.10).

The following question revealed interesting facts about the implementation of the different SMS modules. It demonstrates that the Safety Policy module is the easiest to implement, which shows that writing a static manual and policy was not a

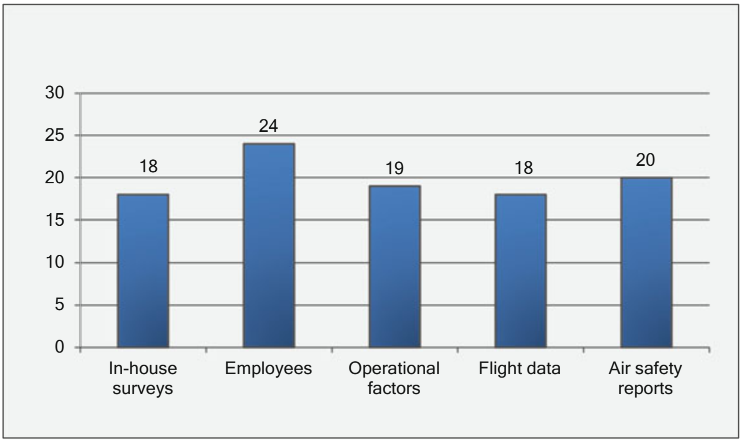

Fig. 9.9 What are your data/information sources for your Safety Management System?

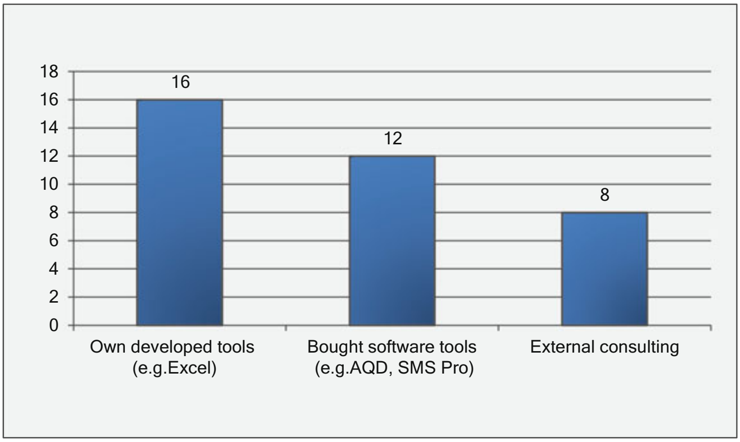

Fig. 9.10 Which tools/advice concerning the Safety Management System is your company using?

real challenge during the implementation process for most of the respondents. What is quite interesting though is that approximately 20 % were not challenged by the implementation of any module. As anticipated by the researchers, the most challenging module, with 42.3 %, was the Safety Risk Management module as it requires connecting many different interfaces within the organization (Fig. 9.11).

The survey further reveals that the majority of the organizations follow either Civil Aviation Authority guidelines and/or directly the ICAO SMS framework (Fig. 9.12).

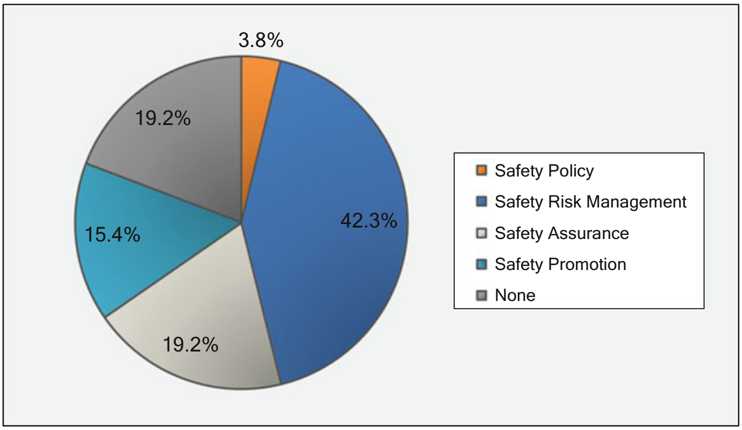

Fig. 9.11 Which Safety Management System module is the most challenging to implement within your company?

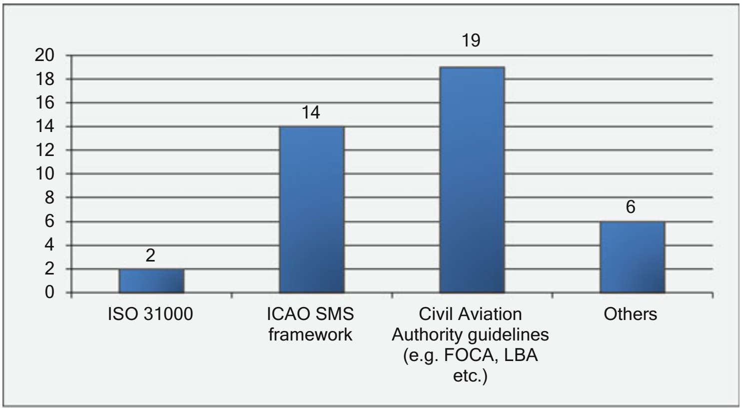

Fig. 9.12 Which standards concerning Risk and Safety Management is your company following?

Risk Management in Air Traffic Control "Operator's Risk – Back to Basics"

10

Heinz Wipf

Air traffic is a relatively safe means of transport compared to others. One of the reasons for this fact is the way air traffic has made safety a priority in its operations.[1]

As mentioned earlier, all productive entities[2] in civil[3] aviation are obliged to set up a Safety Management System, and the International Civil Aviation Organization (ICAO) or other accepted bodies[4] recommend or try to enforce them.

Interestingly, the same ways and means concerning how to implement such a Safety Management System (SMS) seems to apply to all entities.[5] Without doubt, one could call the material at hand a standard way of introducing a SMS.

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[1] See Perrow (1999), p. 123. He claims that there are structural explanations for the high level of safety. Most importantly, experience is accumulated for the vast number of flights carried out daily. Another reason is that aircraft accidents have an immediate impact on the demand side.

[2] See ICAO's Safety Management Manual 3rd Edition 2013 § 3.1.2 "…safety management standards and recommended practices provide the high-level requirements States must implement to fulfil their safety management responsibilities related to, or in direct support of, the safe operation of aircraft. These provisions are targeted to two audience groups: States and service providers. . . . the term service provider refers to any organization required to implement a safety management system . . . . (and) include: approved training organizations that are exposed to safety risks during the provision of their services; <u>aircraft and helicopter operators</u> authorized to conduct international commercial air transport; approved maintenance organizations providing services to operators of airplanes or helicopters engaged in international commercial air transport; organizations responsible for type design and/or manufacture of aircraft; <u>air traffic service providers</u> and <u>operators of certified aerodromes</u>".

[3] The scheme has even been adopted by military aviation in certain countries.

[4] For example Eurocontrol ESARR (see ESARR 4 – Risk Assessment and Mitigation in ATM, 2001; Felici 2006, p. 1483) or EASA.

[5] See Rose (2008): The scheme has even been adopted by military aviation in certain countries, e.g. Swiss Air Force.

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This chapter takes a closer look at whether this approach is supportive in promoting and enhancing safety in aviation.

Analyzing the recommended method reveals that a risk-based approach[6] is promoted. It is therefore correct to ask which of the three entities—aircraft operators, air traffic service providers, and operators of airports[7]—are risk bearers.

To this end a more formal definition of risk and eventual safety is unavoidable. Most people are conscious of the fact that in today's world and even more so in the air transport system, risks are manifold.[8] This, however, is amplified, because many parts of the system have become privatized firms where the variety of risks has vastly increased (see Appendix: Types of Risk).

In accordance with aviation practice, the remainder of this chapter concentrates on the risk of an aircraft accident as the ultimate hazard on a flight from A to B. While it is, in principle, irrelevant whether a flight is under visual or instrument flight rules,[9] the remainder of the text treats only the more instructive case of a flight under instrument flight rules. This is because an additional entity besides aircraft operator and airport come into play, namely the air navigation service provider and its full service range. For any flight of an aircraft operator, an airport is most often necessary.[10]

10.1 Security Risks

Security is often mentioned in the same breath as flight safety. Nevertheless, security risks will not be addressed in this chapter, because security breaches concerning unlawful acts would have to be treated differently. The reason is that at least two[11] parties with their proper strategies are involved. This article assumes stochastic processes on the one side and a possible strategy on the other. Security risks would ask for a game theoretic approach. It remains an open question, however, whether a game theoretic approach would have to be taken into consideration for the situation where a group of risk bearers inside a firm are confronted with

[6] See ICAO's Safety Management Manual 3rd Edition 2013 § 5.1.1 "An SMS is a system to assure the safe operation of aircraft through effective management of safety risk. This system is designed to continuously improve safety by identifying hazards, collecting and analysing data and continuously assessing safety risks. The SMS seeks to proactively contain or mitigate risks before they result in aviation accidents and incidents. It is a system that is commensurate with the organization's regulatory obligations and safety goals."

[7] Maintenance organizations are thought to be part of the operator and service providers while manufacturer's of aircraft declare the reliability of their products to the aircraft operators; training organizations exposed to safety risks would most probably belong to aircraft operators.

[8] See Appendix: Types of Risk.

[9] Abbreviated VFR or IFR.

[10] Especially for flights with fixed wing aircraft.

[11] Or more.

organizational decisions, whereby the strategy from the group differs from the one management has imposed.[12]

10.2 The Notion of Risk

A generally valid definition of risk is difficult.[13] In the remainder of this text the focus is on operational safety risks[14] and the suggested method for operational risk assessments is a quantitative risk analysis[15] (QRA). A first reason for this is because the three considered entities—aircraft operators, air navigation service providers and airports—are organizations,[16] and therefore base their choices on rationality.[17] The second one is the number of important enough realizations with uncertain outcomes, namely flights or movements. A third one is the practitioner's and engineer's view that numbers warrant a certain rigor and allow for comparisons.

In most definitions of risk, an adverse or negative outcome of a realization appears to generate a damage or loss.[18]

The occurrence of such an outcome, however, is not certain; but, there is a likelihood that goes with it.[19] For certain categories of risk takers, there exists some control over space and time, of where and when this adverse outcome may take place. If the outcome is negative, the question arises why risks are being taken at all. This is answered by the utility theory.[20]

Regarding quantitative risk analysis the statement, "A risk is deemed to be large if either the loss is severe, if the probability is high or both together. Similarly, a risk is deemed to be small if the loss is small, if the probability is low or both together," is broadly accepted.

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[12] So called "organisational factors" see also Gephart, Maanen, and Oberlechner (2012), Marais et al. (2004), p. 12 and Hollnagel (2008), p. 9.

[13] See Kaplan (1997), p. 407, Haimes (2009), p. 1647, Gephart et al. (2012), p. 141 also Aven (2011a), p. 28.

[14] Some of the different risk categories are intertwined with safety. For example, availability is connected to business risk while reliability is connected to safety risk, while in addition the two are analytically related.

[15] Often also probabilistic risk analysis PRA, which evaluates and quantifies risks associated with complex systems. In respect to consequences and likelihood see also Apostolakis (2004) and Aven and Zio (2011), p. 66, §2.1, also Alverbro, Nevhage, and Erdeniz (2010), p. 6 and Shyur (2008), p. 35.

[16] Made up of groups of individuals—see also Sage and White (1980), p. 440 $C.

[17] Even more so because all three should be high reliability organisations, notwithstanding the fact of bounded rationality by H. Simon; see also Sage and White (1980), p. 435 §IV, for a summary of definitions (Cookea and Rohledera (2006), p. 216.

[18] Risk is the expected value of loss. See Kahneman and Tversky (1979), p. 263.

[19] Haimes (2009), p. 1648 § 2.

[20] In Adams Richard and Payne (1992), p. 263 introduces the expectations of the total utility as the product of probability times gain; see also Sage and White (1980), p. 433.

Going a step further in defining quantitative risk, Kaplan and Garrick (1981) introduced a proposition, where risk is defined as a set of triplets.

$$R = \{\langle s_i, p_i, x_i \rangle\} \quad \text{where } i = 1, \ 2, \ \ldots, N+1$$

R: risk
s_i: a scenario identification or description
p_i: the likelihood of that scenario
x_i: is the consequence or evaluation measure of that scenario, i.e., the measure of damage.

The scenario s_0 is the scenario of success and N + 1 is the sum of the scenarios nobody has thought of. With these definitions the set of triplets is complete, and so are all the risks.

It is obvious that the variables p_i, x_i, themselves are uncertain. This fact is taken care of by having p_i and x_i described by probability density functions. Although this extension of Kaplan and Garrick towards what they call level 2 is necessary, for the argument at hand it is not strictly needed.[21]

Furthermore, the following objective function for the expected risk[22] for a given operation is defined:

$$\overline{R} = \sum_{i=1}^{N+1} p_i \cdot x_i$$

Given the number of realizations, this product allows an entity to decide, whether the risks taken are acceptable and commensurate with the ones expected or planned for a certain type of IFR operation. The function also supports the statement on quantitative risk assessment above.

$\overline{R}$ has to be distinguished from the total risk taken. The total risk taken is expressed in the risk curve[23] based on the cumulative likelihood of all the scenarios.

10.2.1 Scenarios

For simplicity[24] the following general categories of scenarios are developed as an example (Fig. 10.1).

The occurrences in Table 10.1 are the prominent scenarios thought to lead to aircraft accidents. To define the set of triplets for R the s_i are to be complemented by

[21] See also Coolen et al. (2010), S. 1.

[22] See also Haimes (2009), p. 1652 §7.

[23] Or survivability curve.

[24] It is a fact that accidents also happen, while the aircraft is standing or manoeuvring on ground. For the complete list see the taxonomy of ECCAIRS 4.2.6 based on ICAO's ADREP 2000.

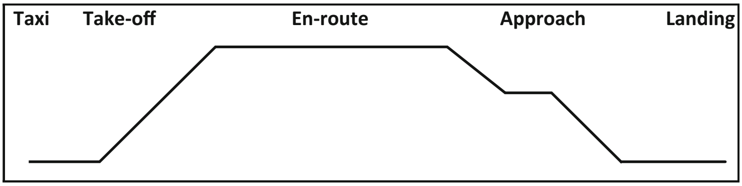


Fig. 10.1 Phases of flight

Table 10.1 Scenarios $N = k \cdot j + 1 = 4 \cdot 4 + 1 = 17$ where $i = k + j$ for a Flight from A to B

Scenario	Occurrence[a] k			
	Collisions			
Phases of flight[c]	Obstacle	Terrain	Aircraft	In-flight damage[b]
Take-off	s_{11}	s_{12}	s_{13}	s_{14}
En-route	s_{21}	s_{22}	s_{23}	s_{24}
Approach	s_{31}	s_{32}	s_{33}	s_{34}
Landing	s_{41}	s_{42}	s_{43}	s_{44}
Unknown	$s_{5.}$[d]			

[a]ECCAIRS 4.2.6 "Occurrence classes"
[b]The airframe structure render it not flyable
[c]ECCAIRS 4.2.6 "Event phases"
[d]$s_{5.}$ than matches the scenario N + 1

p_i and x_i. Any flight is thought to evolve along the above phases.[25] It is obvious that more detailed phases of flight and a finer occurrence scheme lead to a polynomial increase in scenarios.

10.2.2 Likelihood

Empirical values for $p_{i,}$ the likelihood of a scenario for a given type of operation are often known from experience. Where empirical data is missing and a stationary process is identified, a Bayesian approach is usually suggested to estimate the likelihood.[26] Bayesian[27] theory is also used when the likelihood of an occurrence for a sequence of events leading to an aircraft accident is to be estimated. The most general start then is the computation of the conditional probability to estimate the likelihood for the scenario. The frequency of such a scenario is then quantified as a product of probability terms of the individual events in this sequence.[28]

[25] Operational reality can be more closely modelled in state space. A Markov process would then describe the changes from one phase of flight to any another. For example, if a landing is aborted and a missed approach is initiated without passing through an en-route phase. See also Aven (2011b), p. 516.

[26] See Aven (2011a), p. 28; more general (Der Kiureghian & Ditlevsen, 2007, p. 13; Helton, Johnson, Oberkampf, & Sallaberry, 2008).

[27] See Netjasov and Janic (2008), p. 215 §3; also Brooker (2011), p. 1142.

[28] See Zimmerman and Bier (2002), S. 6.

The advantage of a Bayesian approach comes into full effect when no occurrences are available. A prior assumption, often based on expert judgment,[29] is then gradually modified whenever empirical data from operation is available. Such an evidence-based approach is of considerable practical relevance, especially if a new technology or new procedure is introduced.

10.2.2.1 Hazards

In conjunction with the above set of risks a corresponding set of hazards[30] is introduced.

$$H = \{\langle s_i, x_i \rangle\}$$

The hazard H_i out of the set of hazards H is related to scenario s_i and consequence x_i. It can result in damage or loss and is a major hazard to the aircraft in flight. For the remainder of the text the focus is on risks related to those hazards, meaning loss of property or lives.[31]

10.3 Consequences: Accidents

A general definition of an accident is an event that is unintended; causes untoward damage to persons, objects or the environment, and affects the functioning of the system.[32] Aircraft accidents are safety occurrences.[33]

According to ICAO three main categories of such safety occurrence are distinguished:

(a) Accidents and serious incidents
(b) Incidents and
(c) Other safety occurrences.

Aircraft accidents, for the most part, are thoroughly analyzed and extensively documented.[34] Although results are ex post and the official publication of the

[29] See also Lambert et al. (1994), S. 733.

[30] For a definition see ICAO's Safety Management Manual 3rd Edition 2013 § 2.13.2 "… 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. For the purpose of aviation safety risk management, the term hazard should be focused on those conditions which could cause or contribute to unsafe operation of aircraft or aviation safety-related equipment, products and services."

[31] Conscious of the fact that all loss of property or life may eventually turn into a monetary or financial risk, hazards may be insured. In this case the insurance premium maps the insurable safety risk onto a cost dimension, which is to be compared to the average risk above.

[32] See Perrow (1999), pp. 64–66.

[33] Events that are or could be significant in the context of aviation safety.

[34] See ICAO Annex 13.

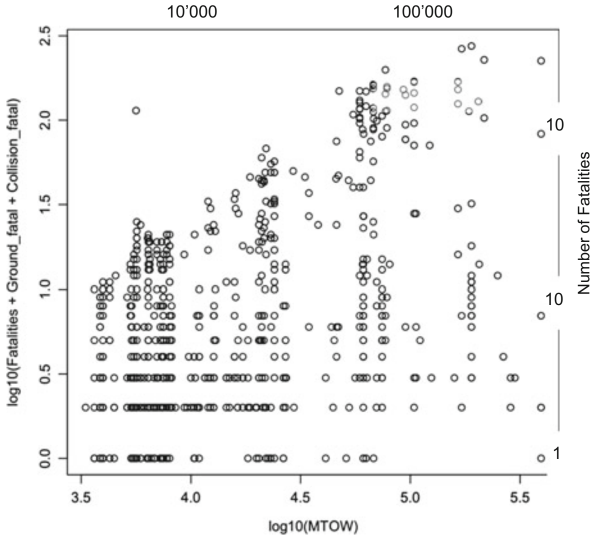


Fig. 10.2 Scatterplot showing the variability in number of fatalities in aircraft accidents in relation to the maximum take-off weight in kg. See Flage and Aven (2012)

reports often has a substantial time lag,[35] the range of damage and loss x_i incurred for a given type of operation is accessible in detail.

Given this empirical data, it is thus also possible to quantify x_i in probabilistic terms for a particular scenario.

Figures 10.2 and 10.3 show the available statistical information of empirical evidence of x_i, namely the loss of life. The loss is the logarithmic[36] number of fatalities in aircraft accidents from 1st Jan 2000 to 23rd Aug 2013 for occurrences with one fatality or more. The graph shows the losses grouped as a function of the weight class (see Table 10.2) of the aircraft. The data is publicly accessible from the "Aviation Safety Network Database" (Courtesy of H. Ranter). The sample size is 808.

The median, indicating expected loss, clearly rises[37] as the weight of the aircraft increases and so does the variability. Damage, in monetary terms is somewhat more intricate to calculate. Part of the reason lies within ICAO reporting schemes. However, accident reports and the service age of the aircraft involved will allow for reasonable estimations.

ICAO defines an aircraft accident (see Appendix: Accident Definitions) rather extensively.[38] This has an impact on the variance and the expected value of the probability distributions for x_i. It does make sense to assume a central tendency in the distribution (see Appendix: Joint Probability Distribution of Aircraft Weight and Total Fatalities). Still a bias towards the lower end of damage and loss cannot

[35] Due to the intricate accident investigation.

[36] log10.

[37] Lower losses in class 5 may be due to limited occurrences available, indicated also by the reduced surface of the boxplot, which is a function of sample size (width proportional to the square-roots of the number of observations in the groups).

[38] ICAO's accidents therefore do not necessarily always translate into catastrophes.

Fig. 10.3 Boxplots showing empirical evidence of the consequences x_i

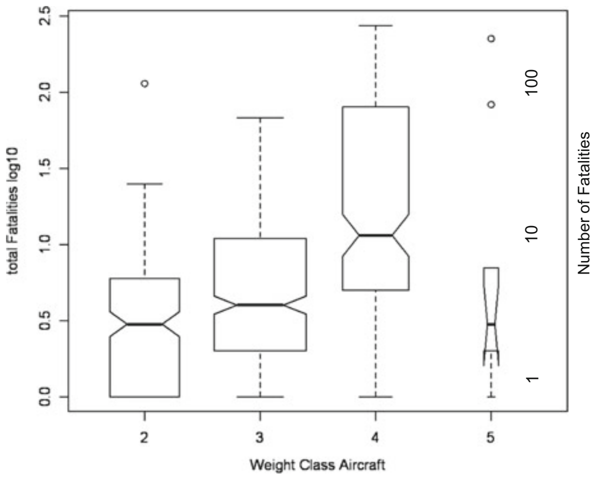


Table 10.2 Weight classes of aircraft

Weight class	MTOW min in kg	MTOW max in kg
1	0	2,250
2	2,251	5,700
3	5,701	27,000
4	27,001	272,000
5	272,001	∞

be ruled out. The ICAO's definition in Appendix: Accident Definitions with the taxonomy under ECCAIRS, does not concur when using simple count data. The ECCAIRS suggested method is towards using categories, an approach leading to Kaplan and Garrick's multidimensional approach.[39]

The distinction between final accidents and ones where a sequence of events leads to an adverse outcome is of importance when estimating the likelihood of an aircraft accident. These are occurrences such as a sudden structural failure or extreme weather phenomena (in Table 10.1). However, aircraft accidents most often do develop in sequences of mishaps and are thus called system accidents.[40] When applying conditional probabilities to these sequences, some caution has to be exercised.[41] This is because a tight coupling renders prediction of the system reaction difficult. This leads to the question whether the air transport system is tightly or loosely coupled. It is tightly coupled in certain microscopic[42] aspects

[39] See also Kaplan and Garrick (1981), S. 14.

[40] "System accidents involve the unanticipated interaction of multiple failures." From Perrow (1999).

[41] System accidents start with the failure of a part and are characterized by the progression of the accident involving multiple failures and those failures interacting in ways that are not anticipated by nor are they comprehensible to the designers and properly trained operators (Perrow, 1999).

[42] On a per flight basis.

which depend on the phase of flight. Interactions occur on the flight deck and with air traffic control[43] or on the ground with airport facilities. Albeit, the system operators are aware of the fact that they have the obligation to provide enough resources in order to assure a running system,[44] there may be times such as peak-hours on an international hub airport, where resources become constrained. General statements on tight or loose coupling (Marais et al., 2004, p. 3) should be avoided. In any case, the scenarios (Table 10.1) would allow for a qualified decision on whether the application of conditional probabilities to estimate likelihood is justified. The transport system on a macroscopic[45] level is inherently decentralized.[46] Therefore, tight coupling is not really an issue. However, recent developments in air traffic management[47] have shown efforts in concentration and centralization, and this will cause an increase in complexity.[48] Large international hubs are just another example on the airport entity side.

10.4 Risk Bearers

Individuals and organizations bear risks in aviation. But not all individuals are free to choose the risks they want to bear. Therefore, it makes sense to classify risks in different categories. From now on, neither societal nor individual risk will be the focus; instead, the emphasis will be on group risk.

Persons exposed to risk are risk bearers and possible victims. They may be a part of the system in the sense of carrying out a crucial function. A classification is necessary because the appreciation of risk is different regarding voluntary and involuntary exposure. Voluntariness in risk exposure is, for all but the fourth party (see Fig. 10.4), of varying importance. There are always personal choices involved. According to Slovic,[49] the perceived benefit of air transport technologies is more than four times higher than the perceived risk. Furthermore, individuals tend to be more positive towards taking risks if they expose themselves voluntarily. Perrow suggests a suitable categorization.[50]

Examples of a trade-off between voluntary exposure and involuntary exposure are aircrews. They have chosen to work for an airline and by earning an income the

[43] Part of air traffic services (ATS).

[44] See provisions for air traffic flow management positions (ATFM).

[45] For example a flight region.

[46] Although the system is tightly coupled on certain aspects like cockpit interactions, flight deck and aircraft or ATC-aircraft, but in general stays a decentralised loosely coupled overall system (Perrow, 1999).

[47] For example the Single European Sky (SES) and the creation of Functional Airspace Blocks (FAB).

[48] In agreement with Perrow's arguments on efficiency, complexity and coupling (Perrow, 1999, pp. 87–96).

[49] "The perception of risk" Slovic P. ed. London 2000.

[50] See Perrow (1999), p. 67.

Category	Characteristics	Description	Risk exposure
1st party	Operators of the system	Persons with explicit control responsibility as well as other workers who are on-site.	Involuntary / voluntary
2nd party	Non-operating personnel or system users	Passengers or the users of the system and those who exercise no control of its operation.	
3rd party	Innocent bystanders	Persons on the ground where an accident happens.	
4th party	Future generations	Persons confronted with the future consequences of the accident.	

Fig. 10.4 Categories of risk bearers (Perrow, 1999, p. 66). *Risk exposure* (*4th column heading*): qualitatively, for in depth view (see Kahneman & Tversky, 1979)

risk exposure is only partially voluntary. For the population living or working near airports[51] that are located close to metropolitan regions, it is difficult to argue that they could simply choose to live elsewhere. So to them the risk is almost completely involuntary.

The first party risk takers are the ones that staff the three entities that run the air transport system. This group, depending on which entity they belong to, is thus the one that influences or controls, to a varying degree, the triplets determining risk R. This group is obviously heterogeneous across and within the three entities, i.e. implying operation and maintenance personnel or managerial staff. Although the cited sources claim that the overall responsibility lies with the top management position, it is understood that decisions are taken on all levels in the organizations. It is a matter of on-going research what the responsibilities and decisional powers are that have an impact on safety.

It is, however, clear from the description in Table 10.2 that the possibilities to manage risk are with the group of first party risk bearers.[52] The focus of interest for the remainder of the chapter is therefore on them.

10.5 Managing Risk

In managing risk it is generally understood that the risk should be reduced to an acceptable level. Clearly, the operation of flying an aircraft from A to B is hazardous.

[51] Vrijling et al. (2004).

[52] Second and third parties have only indirect power to influence risk, mostly through legal action or politically via impositions of rules and regulations. An example in this case is the population near to airports in metropolitan areas. Direct actions by third party risk bearers against air transport to reduce risk would be unlawful acts.

Returning to the quantitative risk analysis the question to be answered is which of the first party risk bearers, grouped by entity, has the capacity to manage the risk of an aircraft accident and to what extent?

Therefore, managing risks means an entity must be in a capacity to influence the triplet defined above—namely scenario, probability and consequences.

For the sake of argument, the interaction between an aircraft and air traffic control[53] under IFR is taken as an example.

While the phase of flight is a planned act of the flight crew, entering a new flight phase under IFR needs a request and is entered only with clearance from air traffic control. The reverse is only exceptionally true. The flight crew requests a change to a new flight phase as part of the planned flight from A to B. Due to efficiency, air traffic control is in the position to deny the flight crew's request. Naturally, given the constraint of the aircraft's fuel reserves, the granting of the request cannot be postponed indefinitely.

The semaphored interaction by air traffic control assures that separation is established (note part of the set under "Collision") in (Table 10.1).

Now the likelihood that a certain scenario takes place is, in this case, governed by the flight deck and air traffic control decisions. However, it can be shown that under certain assumptions the layers of influences (see Fig. 10.5) diminish from top to bottom (for a more formal explanation, see Appendix: Decision Layer and Influence).

If the en-route flight phase is taken as an example, four outcomes (as in Table 10.3) become possible.

The diagonal probabilities p_{aa} and p_{bb} are part of normal operations. The off-diagonal elements though are of interest. While p_{ab} is part of the safety risk under consideration, flight operations would consider p_{ba} a business risk.[54] The probability p_{ab} is itself a random variable having a probability density function and a possible dependence on space and time,[55] e.g. traffic density.

While the aircraft operator has to endure the damage to the aircraft plus the possible loss of lives, the air navigation service provider seems to have merely some influence. The damage and loss of its own assets would be limited.[56] Since the magnitude of damage and loss is positively correlated with the weight of an aircraft (Fig. 10.1 and Appendix: Kinetic and Chemical Potential Energy of Aircraft).[57] The operator, by choosing the type of aircraft and the amount of fuel carried, has almost[58] exclusive control over damage and loss.

[53] Provided as part of air navigation services or more precisely air traffic services. From ICAO Annex 11 July 2001 §2.2 "..objectives of the air traffic services shall be to: a) prevent collisions between aircraft; b) prevent collisions between aircraft on the manoeuvring area and obstructions on that area; c) expedite and maintain an orderly flow of air traffic; d) provide advice and information useful for the safe and efficient conduct of flights; e) notify appropriate organizations regarding aircraft in need of search and rescue aid, and assist such organizations as required."

[54] Leading to additional fuel burn and unwanted delay.

[55] Subject to data analysis e.g. regression.

[56] Except if an airport tower or other air navigation facilities were damaged by an aircraft.

[57] See Freitas (2012).

[58] Airports may add to damage and loss when exposing assets like buildings.

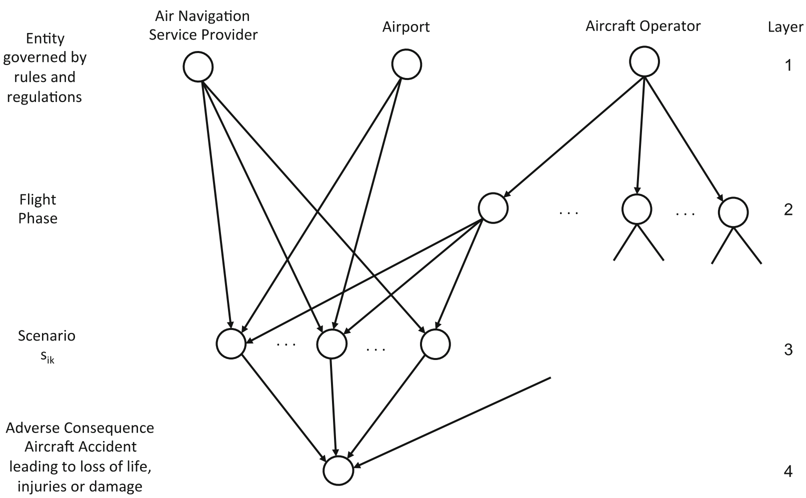


Fig. 10.5 Interactions amid entities on different layers resulting in distinctive influence

Table 10.3 Probabilities resulting from an air traffic control clearance

		If separation	
		Assured	Not assured
Clearance	Issued	p_{aa}	p_{ab}
	Not issued	p_{ba}	p_{bb}

The opposite holds for an airport. It has little to no influence over the flight phases and limited impact on the likelihood of most of the scenarios, but could suffer damage and loss of its own assets as a result of an aircraft accident on its premises. The only measure to reduce risk in operations is to reduce the maximum weight and size of aircraft it can accommodate.[59] That obviously correlates with the officially published airport reference code (Table 10.4).[60]

Not only air transportation, but also the services industry in general is known for producing their goods between service provider and client in a convoluted way. Nevertheless, it is worthwhile to approach the processes in a structured way. The likelihood of a scenario may serve as an example. The different entities (Fig. 10.4) contribute to the final likelihood. The resulting probability density that allows an estimate of the likelihood is the convolution of the individual ones.

$$p_i\langle\phi_i\rangle = p_{iOp}\langle\phi_{iOp}\rangle * p_{iATC}\langle\phi_{iATC}\rangle$$

[59] This is not unlike a regulatory authority which can limit the use of certain aircraft.
But restrictions interfere with economics and in conjunction with a quasi-monopoly of an airport will lead to inefficient solutions.

[60] See ICAO Annex 14: Table 1-1.

Table 10.4 Summarizing different entity's influence on risk

	Scenario S_i	Likelihood, probability P_i	Damage, loss x_i
Aircraft Operator	Through the choice of the flight phase the scenario is predetermined. The influence is high	The likelihood is governed by multiple causes like equipment reliability and human factors. The influence on probability density function of p_i is high	Through choice of the aircraft type and fueling connected to the mass. The influence on the potential damage and loss is high
ANSP	Acting on a second layer in Fig. 10.1 the influence through clearances (and information) on the scenarios is limited	The likelihood is governed by multiple causes like equipment reliability and control of the airport environment (e.g. temporary obstacles). The influence on probability density function of p_i is high	Influence on the damage and loss is limited, because all sizes of aircraft in the controlled airspace have to be serviced
Airport	Influence on the scenario is almost nonexistent, because the very function of an airport as a transportation node is landing and departing aircraft	The likelihood is governed by multiple causes like equipment reliability and the control of the airport environment (e.g. temporary obstacles). The influence on probability density function of p_i is high	Influence on the damage and loss is given through the classification and layout of the airport

10.6 Regulatory Authorities and Risk

So far, little has been said about the accepted bodies and regulatory authorities.

The question can be posed whether a regulatory authority, typically a civil aviation authority, has any safety risks to bear. As they indirectly intend to limit the risk exposure of the four categories in Table 10.2 that obviously gives any regulation a high influence on Risk Management. In the context of an adverse scenario a regulation would turn out to be a sort of a prohibition,[61] reducing the likelihood of occurrence to virtually nil. To avoid these scenarios, conservative regulation of system design and operation has to be imposed. Often, an identified worst-case scenario or a worst credible accident serves as a guideline.[62]

Such an approach, however, given the different variables and probabilities involved, will turn out to be sub-optimal. Moreover, the identification of worst-cases often implies subjectivity[63] and arbitrariness in the definition of the scenarios.

[61] See also Kaplan (1997), p. 416 § 8.2.

[62] "Risk assessors usually call for less regulation and are severe in their criticism of the agencies" (Perrow, 1999, p. 307).

[63] ". . .we should never ask an expert for his opinion. What we want from an expert is, his experience, his information, his evidence" (see Kaplan, 1997, p. 416 § 8.2).

In principle that leads to the imposition of unnecessarily severe regulatory burdens.[64]

Is it possible instead that regulatory activity—through oversight, the collection and dissemination of empirical data to let first and second party risk takers make qualified decisions, and limit the risk exposure for third party risk bearers—could be sufficient?

Conclusion

In an aviation transport system value chain it can be argued whether every entity has to take Risk Management into consideration in its safety activities. Instead, it is proposed first to analyze where the risk bearers are located.

There is evidence that the aircraft operators bear the final risks. Although other entities like airports and air navigation service providers are part of a hazardous operation, they have a limited impact on the exposure to safety risks. They suffer limited impact from safety risks.

It is therefore necessary for the aircraft operator to have a risk-based Safety Management System. Risk assessment is part of Risk Management and should only be performed by the most influential entity in collaboration with the others that support the addressed flight operation. The necessity to assess the risk of flights seems best to remain with the operators. This is because it appears to be the only entity that predetermines the scenarios, can estimate convoluted likelihoods, and control incurred damages and losses when deciding on the type of aircraft used. The influence of the other entities on likelihood, damage and loss are unevenly allocated.

When taking a macroscopic[65] view of an air transport operation, it is recommended to leave the risk-based safety management with the aircraft operator.

Furthermore, when employing quantitative risk assessment, the lead for assessing safety should be with the aircraft operator in conjunction with the other two entities—air navigation service providers and airports. The operator is the one to ultimately decide whether to fly through a given airspace or take off and land at a specific airport and the one entity that must ask the questions “What can happen? How likely it is that it will happen? And if it does happen, what are the consequences?”

While setting the likelihood[66] as a standard value makes sense for the air navigation service provider, it is doubtful whether it will also be applicable for every type of flight operation. For the average risk[67] of a realization it must be compatible with the aircraft operator’s way of conducting its flight operation. Given different acceptable risks and the considerable variability in the

[64] See also Aven and Zio (2011), pp. 64–74.

[65] That is group not individual risks, and many realizations and not a single flight.

[66] See also level of safety or target level of safety (TLS).

[67] The product of likelihood times consequences see above.

consequences, the likelihood for a given type of flight operation[68] cannot be a standard value.

Different risk management activities in general increase the complexity of a system and lead to the creation of incompatibilities.

This is especially true in air transport, where we see an increase in system complexity; thus, care must be taken that the creation of incompatibilities is avoided, not only globally but also locally.

Acknowledgements The author would like to thank Harro Ranter for the accident data sets, Jules Hermens Eng Civil Aviation Authority the Netherlands and John Dyson Eng NATS for a critical review and discussions on various topics, Prof. Dr. Wolfgang Kröger of the Risk Centre at ETH Zürich for the advice regarding industrial risks, and several other peers from air navigation.

Appendix: Types of Risk

Risk	Manifestation
Strategic	– Consumer behavior – Policy changes – Regulation changes – Marketing
Financial	– Loan management – Fraud – Capital management
Operational	– Products, projects, design – Labor force problems – Political demonstrations – Property
Commercial	– Parts delivery – Joint venture partners problems with management – Legal
Technical	– Default of technical infrastructure – Fire – Explosions – Flood – Natural catastrophes
Environmental	– Activities of green activists – Change in regulations – Unintended pollution – Public perception

[68] For example Adams Richard and Payne (1992), p. 39.

Appendix: Accident Definitions

ICAO[69]

An occurrence associated with the operation of an aircraft which, in the case of a manned aircraft, takes place between the time any person boards the aircraft with the intention of flight until such a time as all such persons have disembarked, or in the case of an unmanned aircraft, takes place between the time the aircraft is ready to move with the purpose of flight until such a time as it comes to rest at the end of the flight and the primary propulsion system is shut down, in which:

(a) a person is fatally or seriously injured as a result of:
  – being in the aircraft, or
  – direct contact with any part of the aircraft, including parts which have become detached from the aircraft, or
  – direct exposure to jet blast, except when the injuries are from natural causes, self-inflicted or inflicted by other persons, or when the injuries are to stowaways hiding outside the areas normally available to the passengers and crew; or

(b) the aircraft sustains damage or structural failure which:
  – adversely affects the structural strength, performance or flight characteristics of the aircraft, and
  – would normally require major repair or replacement of the affected component, except for engine failure or damage, when the damage is limited to a single engine, (including its cowlings or accessories), to propellers, wing tips, antennas, probes, vanes, tires, brakes, wheels, fairings, panels, landing gear doors, windscreens, the aircraft skin (such as small dents or puncture holes), or for minor damages to main rotor blades, tail rotor blades, landing gear, and those resulting from hail or bird strike (including holes in the radom); or

(c) the aircraft is missing or is completely inaccessible.

Dataset from the Aviation Safety Network Database[70]

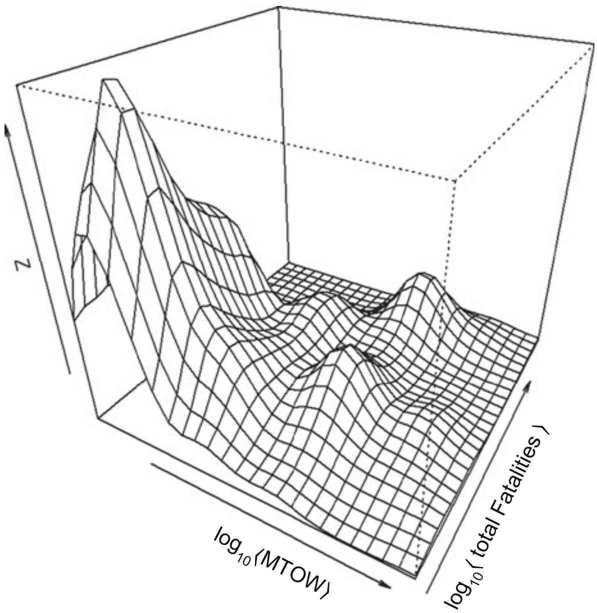
– Accidents (no incidents, hijackings or sabotage)
– Fatalities (at least one among the plane's occupants)
– Aircraft model certified to carry 12 passengers or more
– Aircraft damaged beyond repair
– Data from 1st January 2000 until 23rd August 2013

[69] From ICAO Annex 13 2010 p. 1-1.

[70] http://aviation-safety.net.

Definition: Massgroup nr. as used in ECCAIRS
1: <2,250 kg
2: 2,251–5,700 kg
3: 5,701–27,000 kg
4: 27,001–272,000 kg
5: >272,000 kg
Maximum Take-Off Weight (MTOW) in kg.[71]

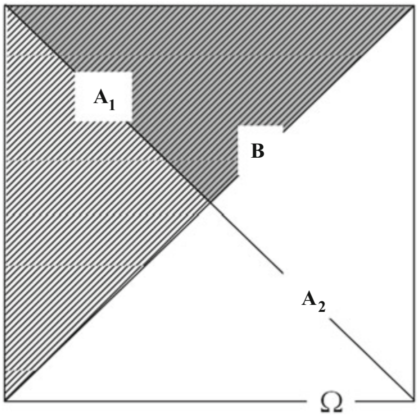
Appendix: Joint Probability Distribution of Aircraft Weight and Total Fatalities



The 3d Graph shows central tendencies supporting arguments for expected values.

[71] Maximum certificated for the entire model range, not of the accident plane in question.

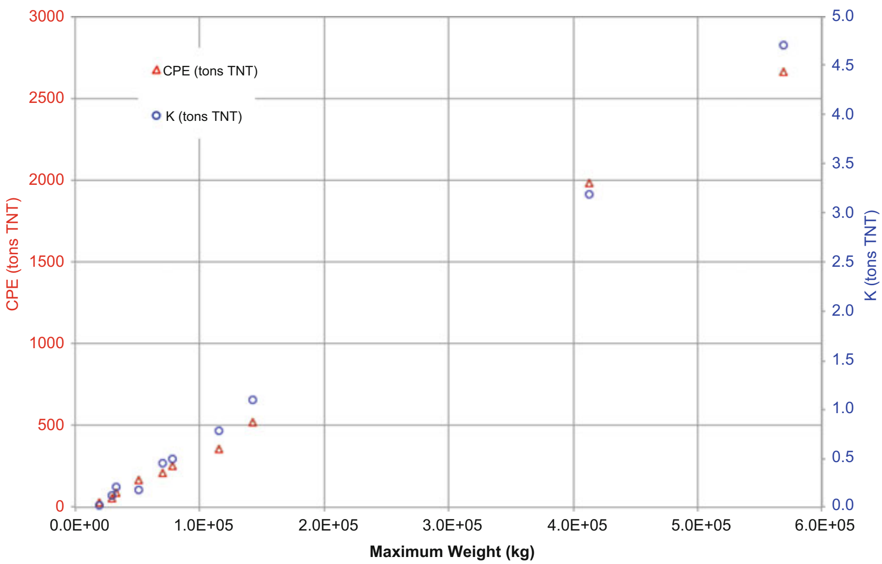
Appendix: Decision Layer and Influence



Source: Own illustration

With respect to the layers in Fig. 10.5, this Gauss-Venn diagram shows the influence of decision B, given decision A_1 under the assumption of an equal decision space distribution. For example, if the decision space of A is extended while the one of B remains, the growing impact of A is obvious

Appendix: Kinetic and Chemical Potential Energy of Aircraft[72]



Kinetic K and Chemical Potential Energy CPE under full fuel load

[72] Freitas (2012), p. 12 Table II, p.13 Table III.

The difference in potential energy between take-off and landing reaches two to three orders in magnitude.[73]

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[73] Freitas (2012).

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Importance of Fatigue Risk Management 11

Stefan Becker and Ernst Kohler

11.1 The Relevance of Fatigue in Aviation

Fatigue is caused by sleep deprivation. Sleep is a basic human need. When you are thirsty you drink; when you are hungry you eat. And when you are tired, only sleep will prevent fatigue and its almost inevitable and, sometimes, extremely serious consequences. For the aviation industry, the question how far fatigue poses a risk of accident for crews, patients,[1] passengers, the public at large and, in the end, also companies needs to be addressed.

Fatigue does not pose a risk in itself, but is rather a physiological condition caused by a number of factors. The following are contributing factors:

- Individual sleep need, including existing cumulative sleep debt,
- Sleep quantity,
- Sleep quality,
- Circadian rhythm,
- Length of current and preceding duty periods,
- Exposure of the body to the environment (e.g. solar radiation, light, noise, vibrations, heat, changes in air pressure),
- Absolute and relative physical and mental effort,
- General physiological constitution, including previous medical conditions,
- Nutrition,
- Stress (in both professional and private life) and,
- Where appropriate, time zone adjustments (long-haul flights).

[1] As per its deed of foundation, Swiss Air-Rescue Rega conducts aeromedical flights only.

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It is the impact of fatigue or over-tiredness on a person's performance, and the resulting error frequency and severity that pose potential critical risks. These risks need to be managed.

11.1.1 Fatigue: A Measurable Factor?

First, it is necessary to establish the scientific definition of fatigue. The ICAO defines fatigue as follows:

> A physiological state of reduced mental or physical performance capability resulting from sleep loss or extended wakefulness, circadian phase, or workload (mental and/or physical activity) that can impair a crew member's alertness and ability to safely operate an aircraft or perform safety-related duties.[2]

As far as measurability is concerned, two different approaches need to be taken into consideration: subjective and objective fatigue.

The challenge posed by subjective measurement values is their comparability and applicability with regard to objective physiological states. In practice, for subjective evaluations the following scales are used, which enable physiological conclusions to be drawn:

- Karolinska Sleepiness Scale (KSS),[3,4]
- Visual Analogue Scale to Evaluate Fatigue Severity (VAS-F)[5]
- Samn Perelli Scale (SPS)[6]

In order to correlate the findings with the above-mentioned scales, study participants are generally also asked to keep a sleep logbook.

Objective measurement results relating to fatigue and sleep can be achieved by means of invasive polysomnography together with electroencephalograms (EEG), electro-oculography or body temperature measurement, or by non-invasive actigraphy. In practice, however, only actigraphy is generally used in an operational setting. The actigraphs currently on the market, usually in the form of a wristwatch-like device, have the necessary sensitivity and specificity. Thanks to their non-invasive application, the measurement results are also less influenced by the device itself, as it is generally not perceived as a "foreign body".

11.1.2 Fatigue: An Overestimated Safety Risk?

Fatigue is without doubt one of the most frequently underestimated risks connected with error making.[7] This is particularly due to the fact that without appropriate

[2] International Civil Aviation Organization (ICAO) (2012).

[3] Putilov and Donskaya (2013).

[4] Shahid, Wilkinson, Marcu, and Shapiro (2012a)

[5] Shahid, Wilkinson, Marcu, and Shapiro (2012b).

[6] Samn and Perelli (1982).

[7] Akerstedt (2000).

training, people find it difficult to accurately assess their own level of fatigue. Even as working time progresses, they continue to subjectively assess their fatigue level as low, although from an objective point of view it has increased.[8,9] Correspondingly, the potential risk is also underestimated.

During long-haul flights, particularly long periods of wakefulness and little sleep give rise to acute sleep debt, of which the crew member is more conscious, and can thus more easily assess the fatigue-related risk. However, with regular, shorter overall duty periods, crew members build up, over a period of days, a cumulative sleep debt, of which they are generally much less aware. Assuming that an individual requires 8 h of sleep a day, but only obtains 7 h each night over a period of a working week (Monday to Friday), at the end of this period he has accumulated a sleep debt of 5 h. As a result, the operational risk can increase to the same degree as if he had slept normally for the first four working days but had had just 3–4 h of sleep during the night from Thursday to Friday.

On long-haul flights, when the circadian body clock is desynchronized due to changing time zones, this gives rise to so-called jet lag. Common symptoms are fatigue due to sleep disruption, exhaustion and a feeling of being unwell, as well as confusion and digestion problems.

Without special training, crew members often underestimate the impact of sleep debt and the ensuing risks. Already a sleep debt of 3 h is comparable to an increased level of alcohol in the blood that would preclude the person concerned from driving a car, and certainly from flying an airplane.

This also applies to situations where, for example, crew members sleep for 10 h but then have prolonged periods of wakefulness with sleep restrictions. Despite the preceding lengthy period of sleep, after the 12th hour of being awake, the average performance degrades, and by the 16th hour the cognitive performance deficit is comparable to that of a person with a blood alcohol concentration of approx. 0.04 %.[10] Being awake for more than 20 consecutive hours impairs reaction times to a level similar to those found with a blood alcohol level of 0.1 %.[11,12] Already with a blood alcohol concentration of 0.06–0.09 % there is a 1.36–3.3 times higher risk of an accident (in the 95 % interval).[13]

Sleep deprivation and prolonged periods of wakefulness have immediate effects.[14,15]

- Up to 50 % degradation in reaction speed
- Reduced memory

[8] Sasaki, Kurosaki, Mori, and Endo (1986).

[9] Van Dongen, Maislin, Mullington, and Dinges (2003).

[10] Dawson and Reid (1997).

[11] Lamond and Dawson (1999).

[12] Rajaratnam and Arendt (2001).

[13] Compton et al. (2002).

[14] Van Dongen, Belenky, and Krueger (2011).

[15] Williamson and Feyer (2000).

- Impaired vigilance
- Reduced hand–eye coordination
- Reduced situation awareness
- Impaired decision-making ability
- Increased micro sleeps (momentarily nodding off)
- Prolonged sleep inertia immediately after waking up
- Increased irritableness
- Increased apathy

Moreover, the long-term health effects of chronic fatigue, such as cardiovascular diseases, diabetes and metabolic disorders, should also be taken into consideration.

11.1.3 Fatigue: An Individual or Systemic Factor in Accident Causation?

Although fatigue is an individual physiological reaction on the part of crew members, systemically promoting or inhibiting framework conditions should also be taken into consideration. Ultimately, a fatigue-related incident or even a fatigue-related accident is the end of a causal chain of events, or "error trajectory", where the fatigue risk was insufficiently considered at various points in the process, or where the mitigation strategies were not effective. Naturally, the chicken and egg question can be posed in this respect—that is, whether the cause was purely an individual error resulting from fatigue, or whether a system had facilitated it.

In the field of aviation, fatigue is a risk that, like all other risks related to flight operations, must be addressed within the framework of a Safety Management System (SMS). As it is a complex risk, a fatigue-specific sub-SMS, known as a Fatigue Risk Management System (FRMS), is necessary.

However, Risk Management does not come to an end on completion of the last flight of the day/shift. In accordance with the duty of care, the journey home after work by a potentially overtired employee should also be taken into consideration.[16]

11.2 Rega's Fatigue Risk Assessment Study

11.2.1 Aim of the Study

For a number of years, Swiss Air-Rescue Rega has been aware that fatigue on the part of its crew members can have consequences. For this reason, Rega decided to evaluate this risk as precisely as possible on a scientific basis, and to develop risk-based mitigation strategies. To this end, an independent company was entrusted with the following tasks:

[16] Scott et al. (2007).

- General identification of fatigue risks within the scope of Rega's flight operations and other framework conditions, such as the duty roster model and its potential impact on safety
- Personal interviews with pilots relating to fatigue and sleeping habits
- Investigation and analysis of sleep and fatigue relating to pilots and other crew members, both during and outside official duty periods
- Support in the development of effective mitigation strategies, e.g. by designing new duty roster models and introducing a company and operation specific Fatigue Risk Management System (FRMS).

Rega carried out several sub-studies on fixed-wing and helicopter missions, relating to each of the two operations—helicopter emergency medical services (HEMS) and airplane emergency medical services (AEMS)—separately.

These studies also aimed at increasing staff awareness of the risks relating to lack of sleep, prolonged periods of wakefulness and the ensuing physiological and psychological effects.

The results of the studies were also intended to form a base for establishing a Fatigue Risk Management System (FRMS).

11.2.2 Materials

Basically, all flight crew members were made available to participate in the studies and were guaranteed absolute anonymity. In order to measure the individual fatigue levels objectively, each crew member was given a "ReadiBand" actigraph. ReadiBand is a highly sensitive wristwatch-like device that accurately monitors fatigue and sleep by means of movement and acceleration sensors. Preliminary studies, with the aim to validate the design, showed that this actigraph provides 92 % of the accuracy of laboratory sleep testing without using invasive and complex polysomnography methods. The device is waterproof and indestructible. The only function it has for the wearer is that it indicates the time, so it can be worn instead of a watch. The study participants were then required to permanently wear an actigraph for a period of two weeks (helicopter crews) or 3–4 weeks (fixed-wing crews).

In addition to the actigraphs, all study participants kept a personal logbook in which they recorded both the subjective level of fatigue and any accompanying circumstances, which was then correlated with the objective data. To this end, the crew members evaluated their level of alertness in accordance with the Samn–Parelli scale (SPS),[17] both before and after periods of sleep and naps. They also noted down the quality of their sleep and their subjective sleep need.

In order to assess the effects of sleep debt and circadian influences on performance, the study participants were required to carry out so-called psychomotor vigilance tasks (PVT), in the form of reaction tests, at predefined times before, during and after flights for the entire duration of the study. These involved standard

[17] Samn and Perelli (1982).

tests, developed by the Walter Reed Army Institute of Research,[18] which were performed on an electronic Palm Pilot organizer provided to each study participant.

During the study, each participant was contacted twice by telephone by the independent research institute. The purpose was, on the one hand, to ensure that the data collection was functioning properly and, on the other, to ask participants about social or other environmental factors that could affect the quantity and quality of their sleep in order to integrate these findings into the study.

After this data collection phase, the actigraphs and logbooks, as well as the PVT test devices, were directly sent by the study participants to the independent research institute so that the data could be read and evaluated. In order to also be able to compare the results at an international level, the Fatigue Avoidance and Scheduling Tool (FAST®) was used, which is also used by the US Department of Defense, the US Department of Transportation and the Federal Aviation Administration (FAA). FAST® was specially developed for the aviation industry and allows continuous fatigue risk monitoring, even when high volumes of data are involved. The tool produced a precise sleeping profile for each of the participating crew members (Fig. 11.1). This sleeping profile had been influenced by such factors as activities, time zone changes, rest periods and sleep periods in the aircraft, and was also documented by the study participants in their personal logbook.

The effects of sleep quantity and quality on the study participants' individual performance in their daily work was evaluated by means of the Sleep, Activity, Fatigue & Task Effectiveness (SAFTE™) model (Fig. 11.2). To achieve this, besides fundamental factors such as circadian rhythm, sleep history and time spent awake, SAFTE used a host of other data delivered by the actigraph (ReadiBand) (Fig. 11.3). This data was then compared with the personal logbooks and conclusions were drawn relating to increased sleep need and sleep debt, as well as successfully and unsuccessfully applied mitigation strategies.

After collecting and evaluating the data, the next step was to assess the risk. For this purpose, the mission risk was portrayed in the form of key risk indicators (KRI), by means of matrix evaluation. Here, the overall risk is indicated on a 5×5 risk matrix, with the likelihood of occurrence shown on the Y-axis and the mission safety that is compromised by fatigue on the X axis. The following risk rating applies:

- Low risk: KRI 1–4
- Medium risk: KRI 5–11
- High risk: KRI 12–25

11.2.3 Results

The predictions relating to the cognitive effectiveness of the flight crew members provided by the FAST method proved to be very reliable. The deviation between

[18] Thorne et al. (2005).

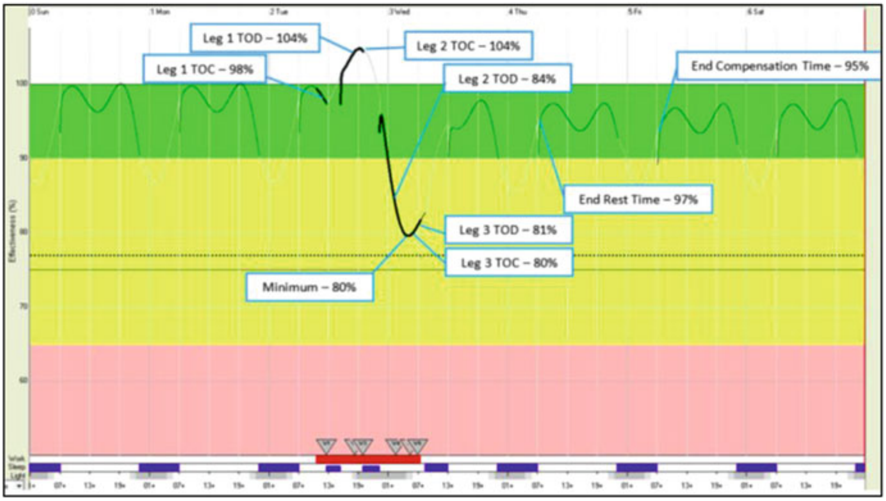

Fig. 11.1 Example of the FAST program results

the forecasted and the actual effectiveness amounted to between −4 % and +3 % based on 172 block hours.

In individual situations, flight crew members were found to be suffering from higher levels of fatigue than allowed by Rega's own safety standard. It was discovered that without the corresponding training and experience, the crew members were not able to optimally apply and evaluate the risk factor of fatigue in their work planning.

After training, the crews showed an increased awareness of fatigue as a risk factor. However, the fact that crew members with sleep debt were not able to accurately assess their own level of fatigue was also confirmed.[19]

The following individual mitigation strategies were used by the flight crews in accordance with their training:

- Food
- Planned in-flight rest (bunk/cabin) in accordance with the crew members' circadian rhythms and potentially fatiguing mission phases
- Changed in-flight rest structure
- Caffeine
- Increased use of SOPs
- Fatigue taken into consideration during briefings
- Flight crew member (FCM) notified of fatigue
- Increased use of automation
- Enhanced use of crew resource management (CRM)

[19] Clockwork Research Ltd. (2011), pp. 178 and 220.

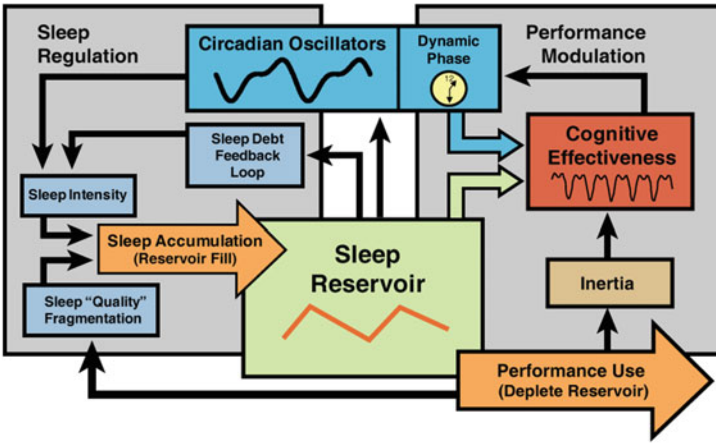

Fig. 11.2 FAST/SAFTE model components. *Source*: Clockwork Research at EASA, Cologne

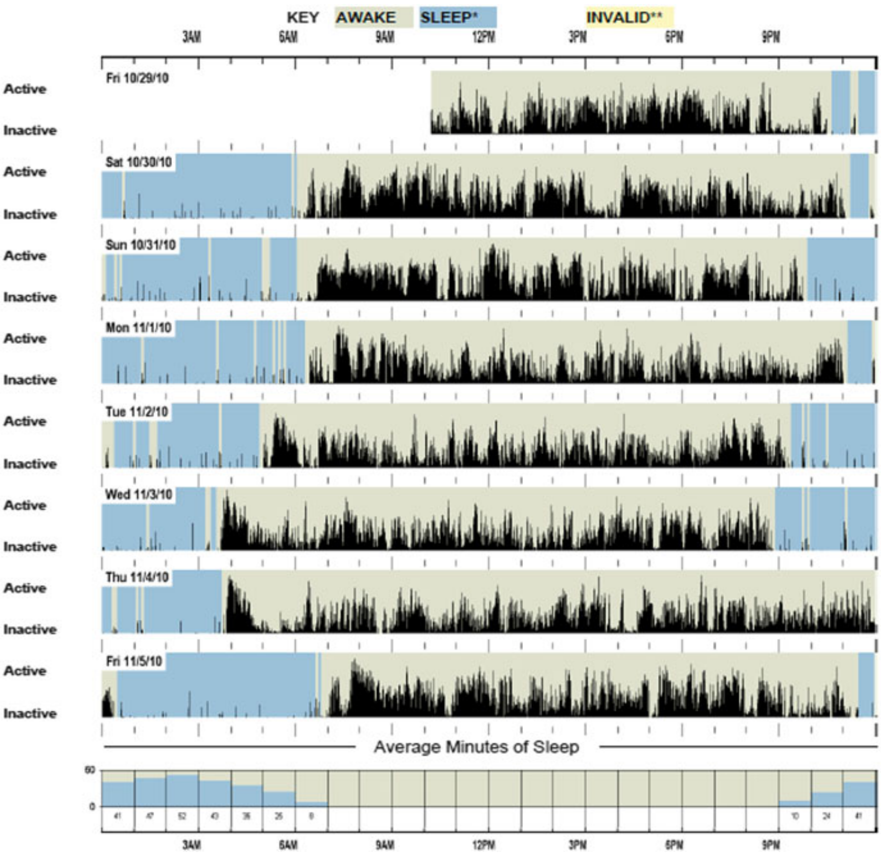

Fig. 11.3 Example of the ReadiBand data analysis by the SAFTE program. *Source*: Workshop presentation

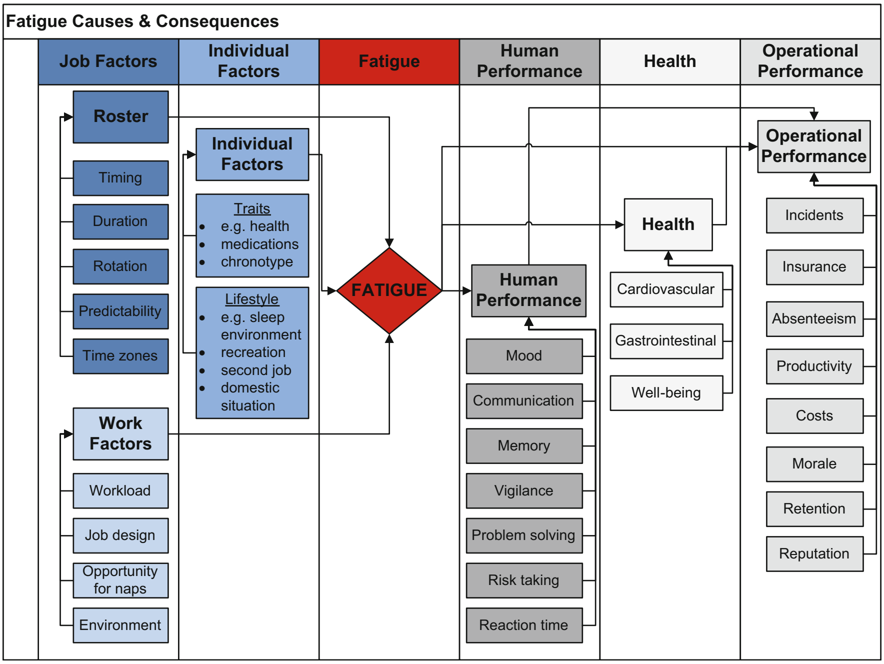

Fig. 11.4 Example of Fatigue causes and consequences. *Source*: Clockwork Research

- Controlled rest in the cockpit[20]
- Targeted advance sleeping at the Rega Centre before early-start duties[21]
- Naps in the afternoon before starting a night duty[22]
- Naps during ground patient transfers at airports
- Use of cockpit iPad
- Use of ear plugs and sleep masks
- Use of own sleeping bags and pillows

Thanks to these comprehensive studies and the clear commitment on the part of the management to establish fatigue as an officially recognized safety risk in the corporate culture, it was possible to achieve a change in mentality, as well as conscious consideration of this factor when drawing up the duty rosters (Fig. 11.4).

At an operational level, the following risk factors were taken into account:

- Duty hours
- Cumulative duty
- Basic maximum flight duty period
- Night, early and late duties

[20] Rosekind et al. (2009).

[21] Rupp, Wesensten, Bliese, and Balkin (2009).

[22] Rupp et al. (2009).

- Duty extensions
- Duty extensions due to in-flight rest
- Positioning and travelling
- Extension of on-ground break
- Pilot-in-command discretion
- Airport standby
- Standby other than airport
- Basic rest
- Basic rest-reduced rest
- Extended and recovery rest
- Time zone crossing

To allow for the above-mentioned risks, among other things, the following operational mitigation strategies were implemented:

- Predicting the expected level of fatigue during the mission phases by means of FAST and, where necessary, scheduling additional crew members
- Activating the crew as early as possible
- Pre-positioning with night stop ideally in the same time zone
- Planning missions in accordance with circadian principles, in particular avoiding starts and landings during the window of circadian low (WOCL)

In this way, it was possible to significantly reduce the mission risk on 11 ultra-long-haul missions. Predicting the fatigue levels played a significant role in this respect. Here, the FAST program provides a reliable calculation base, as the studies showed:

> These findings indicate that, for this mission, FAST is a reasonably accurate tool for predicting mission effectiveness.[23]

Initially, a high risk was registered in three cases, and a medium risk in eight cases. In all cases in which initially a high overall risk (Key Risk Indicator KRI > 11) existed, this dropped to a substantially reduced medium residual risk after applying operational mitigation strategies. Thus, on all the ultra-long-haul flights there was only a moderate residual risk.

In the sphere of helicopter flights, it was found that overall the fatigue factor was well managed by Rega thanks to the existing operational framework conditions (corporate culture, OM, SOP). It emerged, that night missions in particular are very tiring for flight crew members. On the Karolinska Sleepiness Scale (KSS),[24] the value for night flights increases by one point per mission flown. Moreover, when using night vision goggles (NVG), the impact is doubled.[25] Of additional relevance was the length of the mission. The reasons for this are cumulative and acute sleep debt, physiologically unfavorable circadian night phases, short phases between waking up and taking off in the helicopter, as well as the considerable strain and

[23] Clockwork Research Ltd. (2011), p. 58.

[24] Shahid et al. (2012a).

[25] Clockwork Research Ltd. (2012).

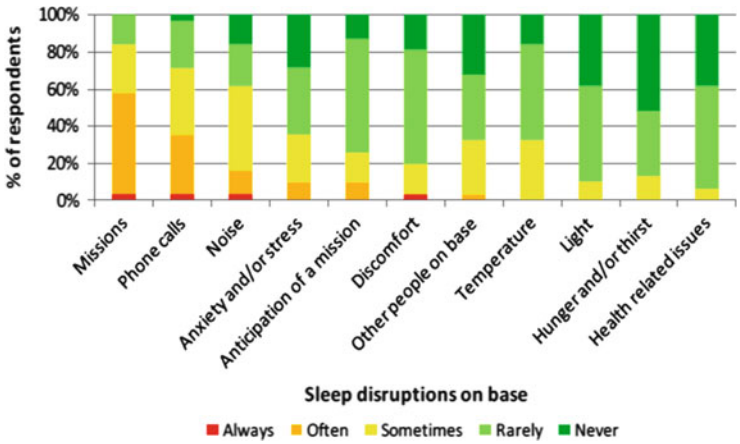

Fig. 11.5 Rega fatigue risk study

exertion of performing a night mission. In this connection, with primary missions, the type of mission (winch operation, search flight, etc.) is not important. Equally, no significant differences were found between the fatigue experienced by pilots and by HEMS crew members (HCM).

Nevertheless, the existing mitigation strategies could be implemented even more effectively. For example, although the 3-h break specified in the Operations Manual (OM) was evaluated as being beneficial, it was not used nearly as much as it could have been. The 6-h break, also provided for in the OM (temporary closure of helicopter base) with the aim of limiting working at night, was also not always correctly implemented by the crews. After closing the base, crew members continued to perform technical and administrative tasks, and stopped only to sleep after these had been completed. This resulted in an unplanned and avoidable sleep deficit.

The existing rest and sleeping facilities at the helicopter bases were rated as very good.

The comparative study of the duty time model, 24 h versus 48 h, examined the levels of fatigue and performance of the flight crews in the course of 76 periods of duty with a total of 226 missions using the 48 h model, and 138 duties with a total of 366 missions using the 24-h model. No advantages relating to operational safety could be identified in connection with the 24-h model,[26] thus reconfirming the results of the preceding HEMS main study (Fig. 11.5).

11.2.4 Conclusions

Despite the fact that Rega voluntarily permits its flight crews breaks that go far beyond the legal requirements, before the Fatigue Risk Management System

[26] Clockwork Research Ltd. (2013).

(FRMS) was introduced states of fatigue that posed a potential safety risk were identified. It was only after collating data and analyzing and evaluating the risks relating to both fixed-wing and helicopter operations that it was possible to develop specific mitigation strategies. Raising awareness among flight crew members relating to fatigue as an operational risk factor has resulted in it now being managed in a professional, scientifically based and responsible manner.

However, there is no such thing as an error-free mission; every operator will repeatedly make mistakes. Whilst errors of a purely technical nature can be increasingly reduced by continually making improvements, cases of human error are on the rise—not least due to the increasingly complex technology and the ensuing increasingly complex: man–machine interface. Added to this is the fact that in recent years the legally prescribed Crew Resource Management (CRM) training has resulted in creating greater awareness of human error, as well as delivering effective identification methods and mitigation strategies. Consequently, in absolute terms, more errors caused by human factors are being identified, communicated and avoided. Also, in the case of fatigue, the aim is to teach employees to recognize the human factors and the resulting error trajectories in good time, and to try to avoid them and, subsequently, their consequences. For this purpose, Rega has drawn up a Rega Fatigue Guide for use by the employees.

At an operational level, Rega has now integrated the fatigue factor into the overall risk assessment for missions. Here, it is possible to predict the risk of fatigue and where necessary make adjustments to avoid it occurring (Sect. 11.3). To this end, the FAST prediction provides a reliable basis on which to calculate the lowest mission risk relating to various operational scenarios in terms of both time and staff.

Apart from compromising safety, sleep debt and fatigue also lead to a drop in productivity and with it, unnecessarily high costs for the company concerned.[27]

11.2.5 Discussion

A Fatigue Risk Management System (FRMS) must form an integral part of a company's Safety Management System (SMS).

In addition to identifying risks, a FRMS assesses risks and introduces effective countermeasures at the earliest possible point of the error trajectory. Solely focusing on flight operations would be insufficient, with the result that the fatigue-related risk for the operator would be underestimated. Even the best and most rested pilots cannot totally counteract technical errors made by fatigued maintenance staff. Forgotten lock pins, nuts tightened at a too high or too low torque or even the classic error of leaving bolts or tool parts inside critical aircraft components are all potential causes of serious malfunctions which are physiologically related due to cognitive impairment on the part of overtired maintenance and service staff (Fig. 11.7).

[27] Rosekind et al. (2010).

The identified potential error development trajectories must be continually re-evaluated within the framework of dynamic Risk Management and necessary modifications made to the mitigation strategies, in order to counteract the development of potentially severe errors as early as possible. This principle is not FRMS-specific and applies to the framework of quality management in general and safety management in particular. It is also not necessary to establish FRMS as a parallel structure to SMS. On the contrary, FRMS is optimally applied when fatigue on the part of staff flows into the company SMS as an error occurrence source (Fig. 11.6). Overall safety largely depends on the frequency and quality of such re-evaluations (Fig. 11.8).

Explicit reference should be made to the considerable risk of a single action bias. This is an infinite management process. Anyone for whom this seems rather expensive is recommended to calculate the potential financial, reputational and legal costs and consequences of a technical incident (e.g. exceeding the rotor mast moment of a helicopter, hydraulic failure, FOD in the engine) or even worse, of an accident.

The results of the Rega studies are based on particular operations and are therefore company-specific. Simply transferring the detailed results to other operators would be inappropriate and potentially dangerous. The results relating to one company could lull another company into a feeling of false safety. For this reason, Rega refrains from publishing any specific measurement results.

All flight operators must comply with the appropriate national and supranational laws, as well as international legal provisions, such as the Chicago Convention (ICAO annexes), EU law, European Rules for Air Operations (Commission Regulation (EU) No. 965/2012), Swiss Code of Obligations (OR), Luftfahrtgesetz (LFG) (Swiss aviation law), Arbeitsgesetz (ArG) (Swiss labour law), Luftfahrtverordnung (LFV) (Swiss aviation directive), Verordnung für Betriebsregeln im gewerbsmässigen Luftverkehr (VBR I) (ordinance governing the operation of aircraft for commercial air transport) and the Verordnung über die Verkehrsregeln für Luftfahrzeuge (VVR) (ordinance governing the operating regulations for commercial civil aviation). All the above-mentioned regulations are, concerning individual points, relevant to FRMS. Added to this are collective or company employment agreements. Companies that apply the principles of good corporate governance also take account of circumstances that are not governed by law, but that are of benefit to their company and employees. This includes not permitting staff suffering from fatigue to drive home themselves or scheduling more rest time than prescribed by law. Rega offers its employees rest facilities at all its bases that are designed based on the latest sleep research findings. This not only provides flight crew members with sleeping accommodation, but also enables high quality sleep. At the company headquarters and at all of the helicopter bases, there are several apartments that can be used at short notice and free of charge. It also pays for travel by public transport, so that fatigued crew members do not have to drive themselves home. Furthermore, Rega has introduced so-called “compensation time”, in addition to the statutory rest time. Compensation time, approximately the same length as the official rest time, aims to ensure that flight crews are well rested

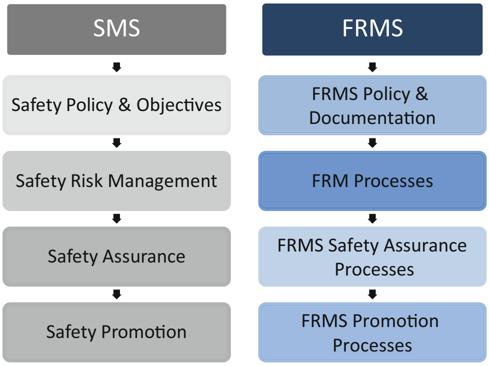

Fig. 11.6 FRMS is an integrative component of a SMS. Implementation guide for operators. *Source*: IFALPA/ICAO/IATA

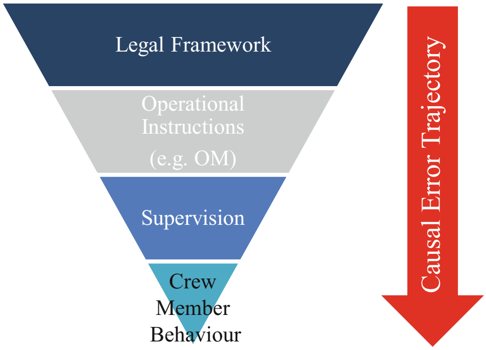

Fig. 11.7 Error levels and error trajectory

Fig. 11.8 FRMS components

when they commence their period of duty. As all studies show, great emphasize should be put on ensuring that staff have sufficient sleep before commencing a period of duty as existing sleep debts can no longer be compensated during the mission, and therefore represent a correspondingly increased risk.

11.3 Countermeasures Against Fatigue

11.3.1 Regulatory Recommendations

In the past, legislators have taken a regulatory approach to fatigue prevention by regulating the duration of work and non-work periods. In the sphere of aviation, this is known in many countries as "flight time limitations and rest requirements". However, it is not always clear which legislation actually applies.

For example, if a Swiss pilot-in-command with a FOCA license flies together with an Austrian co-pilot with a EASA license in an aircraft registered in the USA on behalf of an Egyptian aviation company over Russian territory, the question arises as to exactly which regulations apply. In Appendix 2 to ICAO Annex 6, the ICAO defines the organization and contents of the Operations Manual (OM) and under Para. 2.1.2, part (a) explicitly requires flight and rest times to be specified within the framework of Fatigue Risk Management. In Europe, the framework conditions that are prescribed by law are specific to the operator and are defined by the operator in accordance with Appendix 1 to EU-OPS 1.1045, Para. A.6.1 part. j, in the General/Basic section of the Operations Manual (OM-A). The competent supervisory authority is responsible for approving the OM to ensure compliance with the applicable laws and regulations. The AOC is decisive for the flight and rest times. In the above-mentioned hypothetical case, this was issued by Egypt. As far as the approval of the OM is concerned, Egypt lies outside the EASA's jurisdiction. However, as Egypt has signed the Montreal Convention, and thus recognizes the ICAO, it is bound by the international ICAO guidelines. Nevertheless, these only regulate the organization of the OM, but not the length of the flight and rest times themselves. In the above example, the organization of the OM could, and most probably would, comply with the statutory standards. However, hypothetically, it is possible that a flight time of 18 h without a break could be approved by the Egyptian authorities. Thus a flight time for both pilots of 15 h without a break would be formally legalized, despite the fact that this would be imprudent due to the risk of fatigue.

11.3.1.1 Hard Rule

Generally speaking, legislators and authorities have a high interest in promoting safety. However, they are equally interested in their regulations being monitored in a simple and straightforward way. Until now, legislators have addressed the risk of fatigue simply by applying blanket regulations relating to maximum working times and minimum number of resting times and breaks, despite the fact that in Switzerland alone, working time regulations in the sphere of aviation is a very complex topic.[28] Such limits were primarily intended to protect the employee. Legislators are faced with the challenge of satisfying the needs of all operators as well as all situations, both predictable and unpredictable. This "one size fits all"

[28] Neuhaus and Buholzer (2013).

philosophy only functions when minimum safety standards, including all possible deviations, can be precisely defined or, in the absence of potential concrete identification of risks for all the companies, when the safety buffer is large enough. In many technical areas, this kind of so-called "hard rule" can be adopted and applied in an efficient manner (cf. EASA Certification Specifications, European Standards).

However, it is difficult to understand why a model that is successful and efficient for technical matters should be used to respond to the potential risk-related consequences of multifarious human behavior. It must be possible to implement laws and directives in such a meaningful and safe way that they neither compromise safety nor place a burden on the market through overregulation or even bureaucracy. This calls to mind the former Commission Regulation (EEC) Nr. 1677/88 – the so-called "Cucumber Regulation"—where the EU regulators in Brussels even specified the curvature of a cucumber as a quality standard. This standard has now been rescinded as the legislators recognized, in this particular case, management by direction and control was not expedient (Fig. 11.9).

11.3.1.2 Soft Rule

The counterpart of the rigid flight and rest time regulation (hard rule) is a result-oriented risk management process. This allows fatigue-related risks to be regularly identified and assessed. It also enables operational processes to be actively adapted and mitigation strategies to be drawn up by all flight operators that are required to implement them. Here the legislator determines the safety goals, which must then be achieved by the operators through their in-house risk management process.

> The acceptable level of safety expresses the safety goals of an oversight authority, an operator, or a services provider. From the perspective of the relationship between oversight authorities and operators/services providers, it provides the minimum safety objective (s) acceptable to the oversight authority to be achieved by the operators/services providers while conducting their core business functions.[29]

A result-oriented process with a safety objective, including a goal for the level of safety, also promotes readiness for technical innovation. Innovations make it possible to achieve or even exceed an existing safety level more easily and cheaply in the future. For decades, the speed limit for trucks has been 80 km/h. This hard rule is based on the braking performance of a truck fitted with old-style drum brakes and without ABS, as was the norm several decades ago. When it was introduced, this maximum speed was without doubt appropriate, as it prevented the braking distance of the truck, including in adverse driving conditions, from being exceeded and thus protected other road users. In the meantime, however, most trucks are equipped with modern disc brakes and ABS. Their braking capacity is significantly better than the originally prescribed distance. However, this development has taken a very long time, because there has been very little incentive for the manufacturers to improve the system. Theoretically, it would be more sensible to define the maximum stopping distance, as well as other safety and environmental criteria. If the required safety

[29] International Civil Aviation Organization (ICAO) (2009).

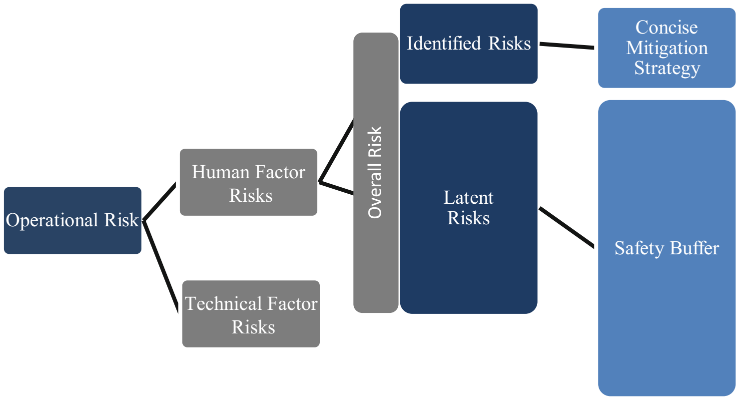

Fig. 11.9 Concept of so-called hard rules. *Source*: Own illustration

level is complied with, it could lead to a model-related maximum speed of 90 or 100 km/h.

In the sphere of aviation, a result-oriented process would result in hitherto unidentified risks being actively reduced by means of legal regulations with an acceptable safety level and active, comprehensive Risk Management by the operator. The active Fatigue Risk Management process would also identify potential risks that are not immediately associated with fatigue. This would achieve a positive collateral effect. Thus the claim, "Safety is worthwhile" is true on two counts. Furthermore, by means of innovation management, the corporate culture could be decisively improved regarding safety.

Consequently, it is difficult to understand why, for example, a pan-European hard rule specifies a maximum duty time of 12 h. At some helicopter bases, 12 h is already too long because by this time, the crew members have long been showing significant cognitive impairment due to fatigue, resulting from, for instance, the number and length of the missions performed at unfavorable circadian times. On the other hand, other helicopter bases might not have carried out any missions at all, with the result that the crew members are by no means suffering from fatigue. In remote regions, it can happen that only four or five missions are flown within a period of 96 h. In normal circumstances that would be equivalent to around one mission per day. With such a low frequency, the flight crew members are unlikely to suffer from fatigue due to an uninterrupted period of duty, and a prescribed safety level can be complied with. In fact, a frequent change of flight staff would result in a loss of mission experience which would instead have a negative impact on flight safety. In addition, the crew members would be exposed to greater risk on the roads—which is also completely unnecessary, as such a rigid measure would not increase flight safety anyway (Fig. 11.10).

Legislators should encourage companies to assess the risk of fatigue actively and at their own initiative. However, this will only happen when operators are given an incentive to continually optimize their processes while at the same time maintaining or improving safety.

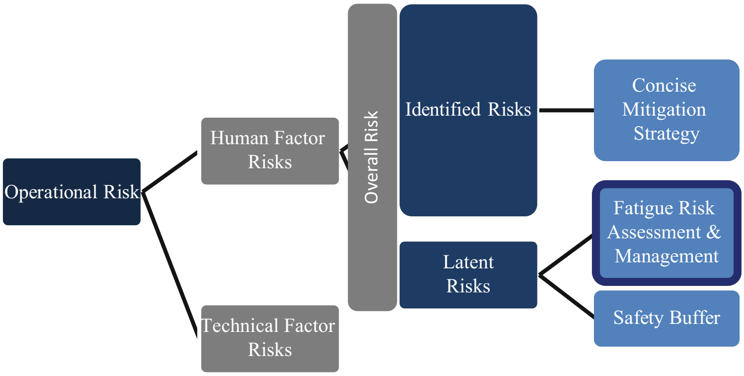

Fig. 11.10 Concept of soft rules. *Source*: Own illustration

11.3.2 Organizational Recommendations

It is quite clear that some companies need to change their way of thinking and to realize that simply completing checklists and complying with legal provisions do not guarantee safe flight operations. Even if the laws are complied with, serious accidents involving fatalities are still also possible, as unfortunate cases all over the world continually demonstrate. In the end, independent of laws, ordinances and standards, it must be in the interests of each and every flight operator to perform its services with the highest possible level of safety, and to successfully and proactively reduce the high potential risk posed by fatigue. Naturally, this applies to all other risks, too.

This responsibility—vis-à-vis passengers, crew members and maintenance staff—must be actively assumed. The supposed “passing on” or “delegation” of this fundamental responsibility to a third party, including the legislator (Sect. 11.3.1), is not in line with good corporate governance. A clear, on-going commitment by the company management to introducing a proactive, company-wide safety culture is absolutely essential. Even the best strategy can be rendered ineffective by a misguided corporate culture that neglects safety. This falls in line with the management maxim, “Culture eats strategy for breakfast” (Peter Drucker).

A non-punitive corporate culture is necessary if companies want their employees to deal with their own mistakes openly and honestly, and to discuss them internally in order to prevent the same mistakes being made again by other crews. People make mistakes, and instead of sparking off a destructive tirade of “name–blame–shame–claim”, accidents and, even more, incidents can be regarded as valuable, constructive elements for a learning and increasingly intelligent organization.

Fatigue can be triggered by a host of factors over which employees do not always have an influence, such as lack of sleep through night noise. It is of key importance that staff develop an awareness of the risks associated with fatigue, and are correspondingly prepared to address and manage the problem proactively for the good of both themselves and their work colleagues.[30] For this purpose, operators should publish possible countermeasures in the form of a guide (e.g. Rega Fatigue Guide).

This also includes the fact that flight crew members should, at any time, be able to report in as "unfit to fly" before commencing a period of duty, without being subjected to reproach, criticism or "interrogation". It also comprises employees notifying each other of impairments, such as those due to fatigue in a constructive manner, in order to avoid safety risks and to seek suitable resolutions in good time. Naturally, it should not be possible for this kind of system to be misused, such as by giving overall, systematic, non-punitive absolution for willfully or grossly negligent violations. Investigations carried out by the European Helicopter Safety Team (EHEST) show that only 16 % of all unsafe acts concerned violations or willful disregard of rules and regulations. The vast majority (84 %) were the result of human error. Of these errors, 72 % were attributable to fatigue (judgment and decision-making errors 60 %; perceptual errors 12 %).[31] The remaining errors were skill-based (28 %), which could only partly be attributed to fatigue because the skill impairment was already evident beforehand. Instead, in the case of qualification errors, fatigue has a detrimental effect on the compensation mechanisms (Fig. 11.11).

The European Helicopter Safety Team (EHEST) also discovered that regarding the causes of unsafe acts, the current condition of the individual (60 %) coupled with environmental factors (17 %) made up a large proportion of the factors that were influenced by fatigue (77 %). In addition, general personnel factors (23 %) played an important role (Fig. 11.12).

Circadian aspects should be taken into consideration already at the mission planning stage and, for example with elective missions, be avoided from the very outset by wisely choosing the best time to begin the period of duty (early or late). Poor mission planning is the greatest supervisory problem, rating even higher than faulty supervision,[32] which is why this topic is examined in more detail under Sect. 11.3.3.

Even the best safety culture needs explicit programs. In the field of aviation, the Safety Management System (SMS) is the core program for company-wide safety. This should integrate the Fatigue Risk Management System (FRMS) as an essential process relating to fatigue-related risks. With the FRMS, just as with the SMS, a holistic approach is desirable, and maintenance and service should also be taken into account alongside flight operations (Sect. 11.2.5).

At the end of a shift, operators can offer flight staff members suffering from fatigue various options for returning home safely.[33] This could be, for example, the

[30] Caldwell (2005).

[31] EHEST (2008).

[32] EHEST (2008).

[33] Scott et al. (2007).

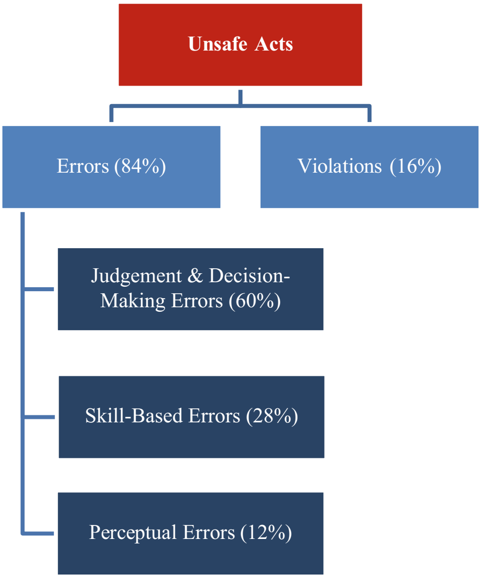

Fig. 11.11 Causes of unsafe acts (EHEST, 2008). *Source*: Own illustration

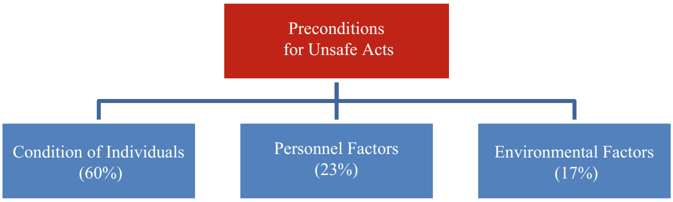

Fig. 11.12 Preconditions for unsafe acts (EHEST, 2008). *Source*: Own illustration

possibility of having a sleep before going home, or of the company paying for travel by public transport.

In the long-term, companies can also profit from more alert staff by providing health-promoting facilities and activities for its staff, such as ergonomically designed workplaces, healthy food, subsidized fitness club memberships, company sports teams and general health education.

11.3.3 Supervisory Recommendations

When implementing a company-wide safety culture and the related programs, managers or supervisors form an integrative link between the senior management and the employees. Corporate culture is the sum of the behavior, habits, shared history and anticipated future within a company. Supervisors are correspondingly important, as they act as role models who uphold the corporate culture in the various spheres on a day-to-day basis. It is essential that they are aware of the key role they play, and that they carry it out voluntarily and unconditionally. Otherwise, they fail to come across as authentic and are thus more likely to damage a healthy safety culture than enhance it.

Supervisors should also integrate the fatigue factor into their daily mission discussions, in order to regularly address the problems involved. They know "their" staff and can ensure that the possibilities offered by the company are used in order to avoid fatigue. Changes may need to be made to the duty roster to prevent acute or cumulative sleep debt or other fatigue-promoting factors. For this purpose, superiors are continually informed about new findings gained from the Fatigue Risk Management process and also involved in further developing company-wide anti-fatigue programs, for which they can draw on their everyday experience.

11.3.4 Individual Recommendations

In the error trajectory, the last "line of defense" lies primarily with the active operative staff, such as the pilots, HEMS crew members (HCM), emergency doctors, paramedics, flight nurses, mechanics and avionics engineers. Signs and symptoms of fatigue include:

- Lapses in attention and vigilance
- Slowed reaction time
- Poor decision-making
- Decreased psychomotor coordination
- Frequent yawning
- Restlessness
- Moodiness
- Inadequate or lack of response when addressed
- Frequent blinking and/or lengthy phases of eyelids being closed
- Unintentional and uncontrolled micro sleeps

Staff should have a high sense of responsibility in relation to fatigue-related risks, and should only go about their daily work if their actions will not be impaired by fatigue at any time during their duty period or if the risk lies within the prescribed, acceptable scope. In this respect, possible intervention activities aimed at mitigating fatigue may also be taken into account (Sect. 11.2.3). The following measures could be considered (Fig. 11.13).

Within the aviation industry, flight staff members are strongly dissuaded from using sleep-inducing substances to increase sleep quality and quantity. Such drugs and medicines cannot be dosed precisely enough and it could occur that a relatively high level of the substance is still present in the body at the planned start of the duty period. Moreover, the targeted intake of drugs to increase alertness or lengthen the period of wakefulness is advised against. Quite apart from the effectiveness and the physical side effects for employees, a more rapid degradation of the active

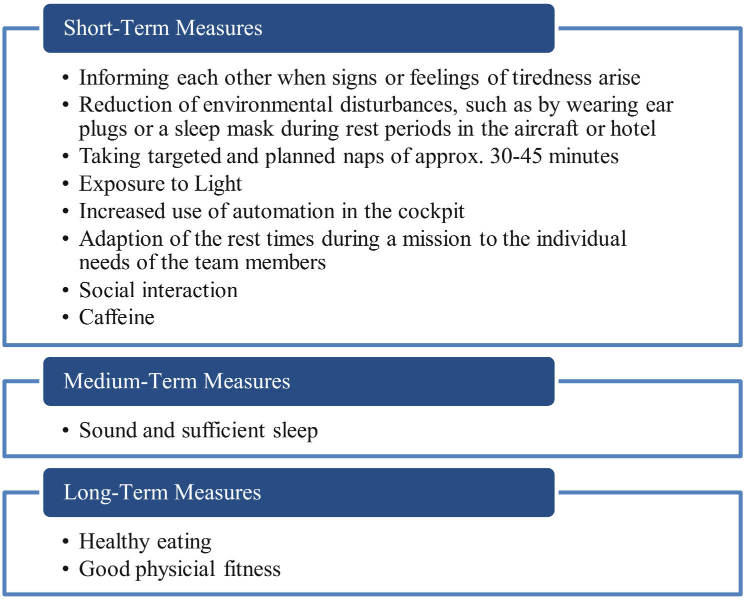

Fig. 11.13 Individual compensation measures

substance could lead to premature acute fatigue and thus render the individual concerned unfit for duty.[34]

Furthermore, employees involved in support processes, such as mission coordinators, dispatch staff or logisticians, should not only observe and assess their own level of fatigue, but also pay attention to signs of fatigue on the part of crew members and, where necessary, offer them the appropriate constructive feedback or suggest an alternative course of action.

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[34] Dawson and McCulloch (2005).

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Aircraft Accident Investigations 12

Roland Müller and Christopher Drax

Besides all the national and international regulations and proactive safety measures, also the findings of the accident investigation authority are of central importance in the combined effort to make aviation safer.

The accident investigation authority (Schweizerische Unfalluntersuchungsstelle—SUST) examines aircraft accidents and issues recommendations to the Board of FOCA which later proposes measures to increase safety in aviation.

12.1 Case Airbus A300-203, Flight AF 447

The following aircraft accident case has been partially extracted from the final investigation report of the Air France A330-203 flight AF 447 from Rio de Janeiro to Paris in 2009. The aircraft was destroyed upon crashing in the Atlantic Ocean, killing all 216 passengers and 12 crew members. This case serves as an example to illustrate a general safety relevant trend. Pilots continuously fail to apply their most expedient knowledge and skills for manual flight operations by following standard operation procedures. It should be clearly understood that in this accident case details of the investigation are discussed as examples only and in a simplified manner to fit the scope of this section.

"On 31 May 2009, the Airbus A330 flight AF 447 took off from Rio de Janeiro Galeão airport bound for Paris Charles de Gaulle. The airplane was in contact with the Brazilian ATLANTICO control centre on the INTOL–SALPU–ORARO–TASIL route at FL350. At around 2 h 02, the Captain left the cockpit. At around

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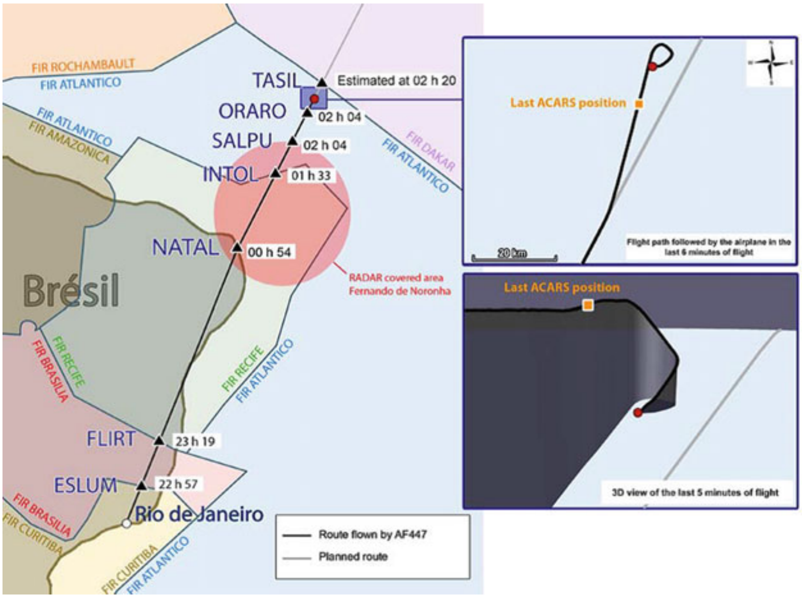

Fig. 12.1 Flight routing from departure to accident. *Source*: Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile (BEA) (2012)

2 h 08, the crew made a course change of 12° to the left, probably to avoid returns detected by the weather radar (Fig. 12.1).[1]

At 2 h 10 min 05, the autopilot and then the auto-thrust disconnected and the PF said "I have the controls". The airplane began to roll to the right and the PF made a nose-up and left input. The stall warning triggered briefly twice in a row. The recorded parameters showed a sharp fall from about 275 to 60 kt in the speed displayed on the left primary flight display (PFD), then a few moments later in the speed displayed on the integrated standby instrument system (ISIS). The flight control law reconfigured from normal to alternate. The Flight Directors (FD) were not disconnected by the crew, but the crossbars disappeared.

At 2 h 10 min 16, the PNF said "we've lost the speeds" then "alternate law protections". The PF made rapid and high amplitude roll control inputs, more or less from stop to stop. He also made a nose-up input that increased the airplane's pitch attitude up to 11° in 10 s.

Between 2 h 10 min 18 and 2 h 10 min 25, the PNF read out the ECAM messages in a disorganized manner. He mentioned the loss of auto-thrust and the reconfiguration to alternate law. The thrust lock function was de-activated. The PNF called out and turned on the wing anti-icing. The PNF said that the airplane was climbing and asked the PF several times to descend. The latter then made several nose-down

[1] Schneider (2012).

inputs that resulted in a reduction in the pitch attitude and the vertical speed. The airplane was then at about 37,000 ft and continued to climb.

At about 2 h 10 min 36, the speed displayed on the left side became valid again and was then 223 kt; the ISIS speed was still erroneous. The airplane had lost about 50 kt since the autopilot disconnection and the beginning of the climb. The speed displayed on the left side was incorrect for 29 s.

At 2 h 10 min 47, the thrust controls were pulled back slightly to 2/3 of the IDLE/CLB notch (85 % of N1). Two seconds later, the pitch attitude came back to a little above 6°, the roll was controlled and the angle of attack was slightly less than 5°. From 2 h 10 min 50, the PNF called the Captain several times.

At 2 h 10 min 51, the stall warning triggered again, in a continuous manner. The thrust levers were positioned in the TO/GA detent and the PF made nose-up inputs. The recorded angle of attack, of around 6° at the triggering of the stall warning, continued to increase. The trimmable horizontal stabilizer (THS) began a nose-up movement and moved from 3 to 13° pitch-up in about 1 min and remained in the latter position until the end of the flight. Around 15 s later, with the ADR3 being selected on the right side PFD, the speed on the PF side became valid again at the same time as that displayed on the ISIS. It was then at 185 kt and the three displayed airspeeds were consistent. The PF continued to make nose-up inputs. The airplane's altitude reached its maximum of about 38,000 ft; its pitch attitude and angle of attack were 16°.

At 2 h 11 min 37, the PNF said "controls to the left", took over priority without any callout and continued to handle the airplane. The PF almost immediately took back priority without any callout and continued piloting.

At around 2 h 11 min 42, the Captain re-entered the cockpit. During the following seconds, all of the recorded speeds became invalid and the stall warning stopped, after having sounded continuously for 54 s. The altitude was then about 35,000 ft, the angle of attack exceeded 40° and the vertical speed was about −10,000 ft/min. The airplane's pitch attitude did not exceed 15° and the engines' N1's were close to 100 %. The airplane was subject to roll oscillations to the right that sometimes reached 40°. The PF made an input on the side-stick to the left stop and nose-up, which lasted about 30 s.

At 2 h 12 min 02, the PF said, "I have no more displays", and the PNF "we have no valid indications". At that moment, the thrust levers were in the IDLE detent and the engines' N1's were at 55 %. Around 15 s later, the PF made pitch-down inputs. In the following moments, the angle of attack decreased, the speeds became valid again and the stall warning triggered again.

At 2 h 13 min 32, the PF said, "[we're going to arrive] at level one hundred". About 15 s later, simultaneous inputs by both pilots on the side-sticks were recorded and the PF said, "Go ahead you have the controls".

The angle of attack, when it was valid, always remained above 35°.

From 2 h 14 min 17, the Ground Proximity Warning System (GPWS) "sink rate" and then "pull up" warnings sounded.

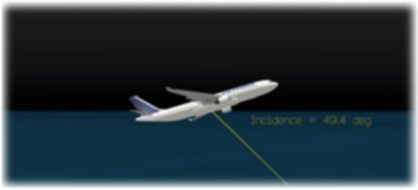

Fig. 12.2 Airplane attitude in the final seconds of flight. *Source*: Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile (BEA) (2012)

The recordings stopped at 2 h 14 min 28. The last recorded values were a vertical speed of −10,912 ft/min, a ground speed of 107 kt, pitch attitude of 16.2° nose-up, roll angle of 5.3° left and a magnetic heading of 270° (Fig. 12.2).

No emergency message was transmitted by the crew. The wreckage was found at a depth of 3,900 m on 2 April 2011 at about 6.5 NM on the radial 019 from the last position transmitted by the airplane.[2]

- The examinations of the wreckage undertaken showed that there was no depressurization and that on impact:
  - The airplane was intact;
  - The airplane struck the surface of the water with a pitch-up attitude, a slight bank and a high vertical speed;
  - The flaps were retracted;
  - The engines were at high RPM ;
  - The stabilizer was near to its maximum pitch-up position.
- This information was confirmed by the analysis of the data from the flight recorders.
- The blockage of the Pitot probes by ice crystals in cruise was a phenomenon that was known, but misunderstood, by the aviation community at the time of the accident. From an operational perspective, the resulting loss of all airspeed information was an identified malfunction. After initial reactions involving basic airmanship skills, this blockage should have been diagnosed by the pilots and managed, if necessary, by precautionary inputs on the pitch attitude and thrust as detailed in the associated procedure.
- The occurrence of the failure in the context of flight in cruise completely surprised the crew of flight AF 447. The apparent difficulties of handling the airplane in turbulence at high altitude resulted in over-handling in roll and a sharp nose-up input by the PF. The destabilization that resulted from the climbing flight path and changes in pitch attitude and vertical speed therefore added to the incorrect airspeed indications and ECAM messages that did not help any diagnosis. The crew, whose work was becoming disrupted, probably never realized they were facing a "simple" loss of all three airspeed sources.
- In the first minute after the autopilot disconnection, the failure of the attempt to understand the situation and the disruption of crew cooperation had a multiplying effect, inducing total loss of cognitive control of the situation. The behavioral assumptions underlying the classification of a loss of airspeed

[2] Schneider (2012).

information as "major" were not validated in the context of this accident. Confirmation of this classification therefore requires additional work in terms of operational feedback in order to modify, where necessary, crew training and the ergonomics of the information made available to them, as well as the design of procedures.

- The airplane went into a sustained stall, signaled by the stall warning and strong buffet. Despite these persistent symptoms, the crew never understood they were in a stall situation and therefore never undertook any recovery maneuvers. The combination of the warning system ergonomics, and the conditions under which pilots are trained and exposed to stalls during their professional and recurrent training, did not result in a reasonably reliable, expected behavior patterns.
- At present, recognition of the stall warning, even when associated with buffet, assumes that the crew assigns a minimum degree of "legitimacy" to the alarm. This in turn assumes sufficient prior experience with stall conditions, at least some cognitive availability and understanding of the situation, as well as knowledge of the airplane (and its protection modes) and its flight physics. A review of pilot training did not provide convincing evidence that the associated skills had been correctly developed and maintained.
- More generally, the dual failure of the expected procedural responses shows the limits of the current safety model. When action by the crew is expected, it is always assumed that they will have the capacity to initially control the flight path and to rapidly diagnose and identify the correct entry in the dictionary of procedures. A crew may encounter an unexpected situation causing a momentary but profound loss of understanding. If, in such cases, the assumed capacity to initially control and then to diagnose is lost, the safety model is in "common failure mode". In this occurrence, the inability to initially control the flight path also made it impossible to understand the situation and find the appropriate solution.
- The accident resulted from the following succession of events:
  - Temporary inconsistency between the measured airspeeds, likely following the obstruction of the Pitot probes by ice crystals that led in particular to autopilot disconnection and a reconfiguration to alternate law,
  - Inappropriate control inputs that destabilized the flight path,
  - The crew not making the connection between the loss of indicated airspeeds and the appropriate procedure,
  - The PNF's late identification of the deviation in the flight path and insufficient correction by the PF,
  - The crew not identifying the approach to stall, the lack of an immediate reaction on its part and exit from the flight envelope,
  - The crew's failure to diagnose the stall situation and, consequently, the lack of any actions that would have made recovery possible (Figs. 12.3/12.4)."[3,4]

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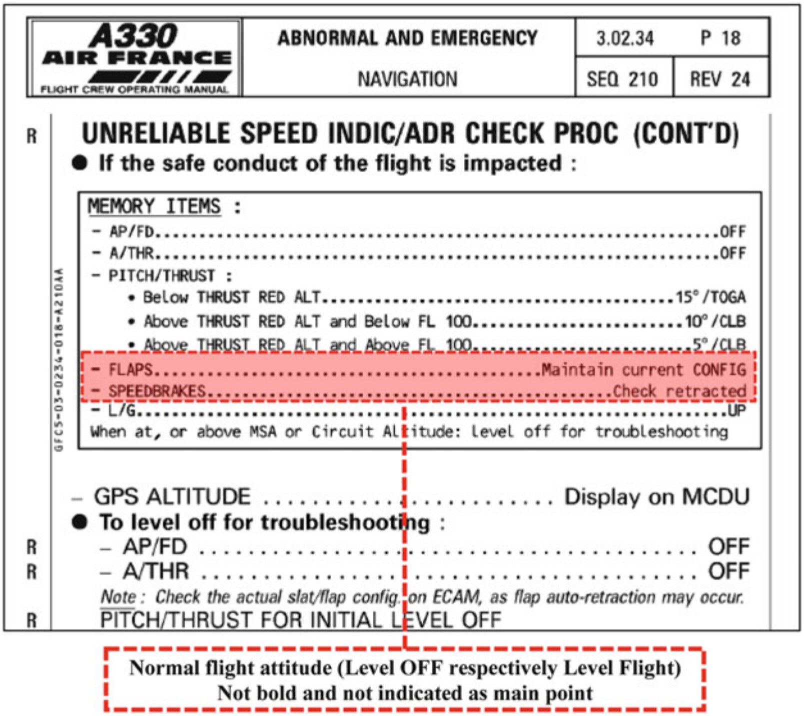
[3] Schneider (2012).

[4] Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile (BEA) (2012).


A330 AIR FRANCE FLIGHT CREW OPERATING MANUAL | ABNORMAL AND EMERGENCY | 3.02.34 P 18
NAVIGATION | SEQ 210 | REV 24

R UNRELIABLE SPEED INDIC/ADR CHECK PROC (CONT'D)
● If the safe conduct of the flight is impacted :

MEMORY ITEMS :
- AP/FD.....OFF
- A/THR.....OFF
- PITCH/THRUST :
• Below THRUST RED ALT.....15° /TOGA
• Above THRUST RED ALT and Below FL 100.....10° /CLB
• Above THRUST RED ALT and Above FL 100.....5° /CLB
- FLAPS.....Maintain current CONFIG
- SPEEDBRAKES.....Check retracted
- L/G.....UP
When at, or above MSA or Circuit Altitude: Level off for troubleshooting

GFCS-03-0234-018-A210AA

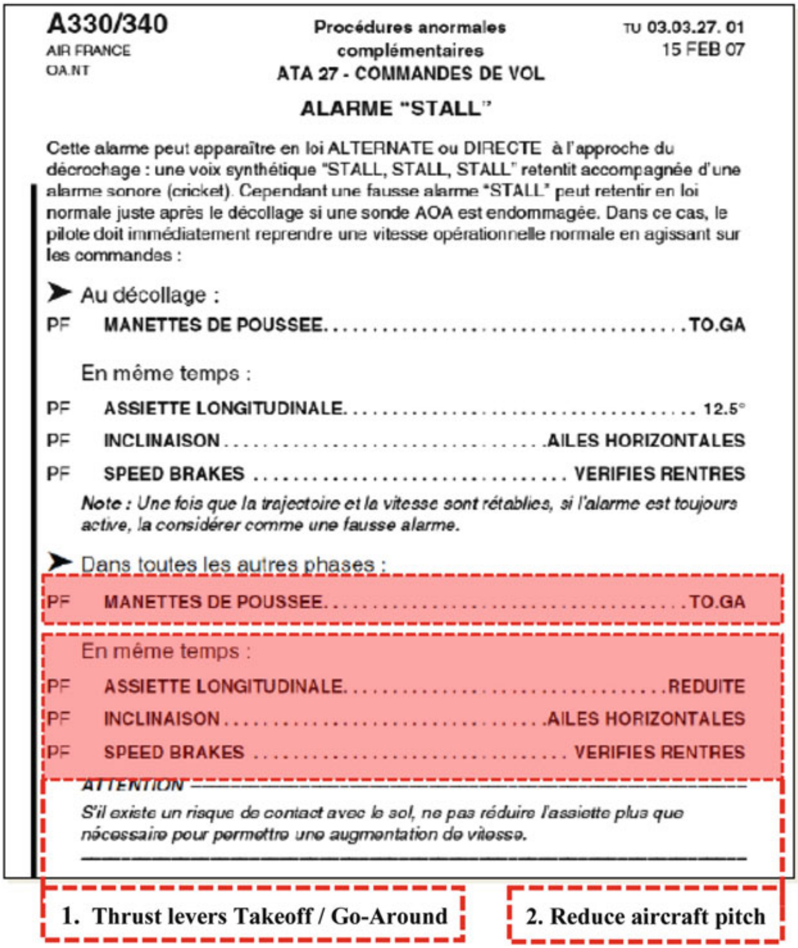
- GPS ALTITUDE ..... Display on MCDU
● To level off for troubleshooting :
R - AP/FD ..... OFF
R - A/THR ..... OFF
Note : Check the actual slat/flap config. on ECAM, as flap auto-retraction may occur.
R PITCH/THRUST FOR INITIAL LEVEL OFF

Fig. 12.3 Airbus FCOM supplied to Air France. *Source*: Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile (BEA) (2012)

It must be noted that the pilots were not the sole factor behind the crash, but also various factors which already start at the stage of the pilot training play a part. As already mentioned, there was no convincing evidence that the required stall recovery skills had been correctly developed; nor had they been maintained through constant training on the type of aircraft by the flight crew. Each flight crew member trained stall recovery on the A320 model, but had no specialized stall recovery procedural training on the A330. Additional A330 and A340 type ratings deal only with the differences in relation to the type ratings already issued on other types (A320, A330, and A340).

The accident investigation report shows that the pilots reacted according to the standard operational procedures. Neither false system indications nor a stall should lead to an accident; however, pull and full throttle during a stall will lead to an accident.

It must be understood that accident prevention starts with the pilot training and should include Stall & Spin awareness and basic aerobatic maneuvers. In an emergency, the systems provide only limited support to the pilot, and simulator training is not sufficient for a basic understanding of flying. Swiss Aviation Training leads by example and uses an Extra 300 for stall, spin and recovery



A330/340 | Procédures anormales complémentaires | TU 03.03.27. 01

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OA.NT

ATA 27 - COMMANDES DE VOL

ALARME "STALL"

Cette alarme peut apparaître en loi ALTERNATE ou DIRECTE à l'approche du décrochage : une voix synthétique "STALL, STALL, STALL" retentit accompagnée d'une alarme sonore (cricket). Cependant une fausse alarme "STALL" peut retentir en loi normale juste après le décollage si une sonde AOA est endommagée. Dans ce cas, le pilote doit immédiatement reprendre une vitesse opérationnelle normale en agissant sur les commandes :

➤ Au décollage :

PF MANETTES DE POUSSEE.................................TO.GA

En même temps :

PF ASSIETTE LONGITUDINALE.................................12.5°

PF INCLINAISON.................................AILES HORIZONTALES

PF SPEED BRAKES.................................VERIFIES RENTRES

Note : Une fois que la trajectoire et la vitesse sont rétablies, si l'alarme est toujours active, la considérer comme une fausse alarme.

➤ Dans toutes les autres phases :

PF MANETTES DE POUSSEE.................................TO.GA

En même temps :

PF ASSIETTE LONGITUDINALE.................................REDUITE

PF INCLINAISON.................................AILES HORIZONTALES

PF SPEED BRAKES.................................VERIFIES RENTRES

ATTENTION

S'il existe un risque de contact avec le sol, ne pas réduire l'assiette plus que nécessaire pour permettre une augmentation de vitesse.

Fig. 12.4 TU (Technique Utilisation—Technical Standards) Air France. *Source*: Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile (BEA) (2012)

training during their MPL training. The integration of stall, spin and recovery training concepts, and carefully selected aerobatic maneuvers during flight training, which provide upset recovery procedures, are critical to the development of a properly aware and self-confident pilot.

At the beginning of April 2013, the Federal Aviation Administration issued a Safety Alert where it encouraged operators to take an integrated approach by incorporating emphasis on manual flight operations into both line operations and training (initial/upgrade and recurrent). Where applicable, the operators should develop operational policies or review them to ensure there are appropriate opportunities for pilots to exercise manual flying skills, such as in non-RVSM airspace and during low workload conditions.

Furthermore, the FAA recommends developing or reviewing company policies to ensure that pilots understand when to use the automated systems, such as during high workload conditions or airspace procedures that require use of autopilot for precise operations. Augmented crew operations may also limit the ability of some pilots to obtain practice in manual flight operations. Finally, airline operational policies should ensure that all pilots have the appropriate opportunities to exercise the aforementioned knowledge and skills during inflight operations.[5]

12.2 Case Avro 146-RJ100 Flight CRX3597[6]

This second accident case has been extracted partially from the final investigation report of the Crossair Avro 146-RJ100 flight CRX3597 in 2001 from Berlin-Tegel to Zürich.

The aircraft was destroyed during the impact, killing all 21 passengers and 3 crew members. This case serves as an example to illustrate how fatigue can contribute as a factor to an aircraft accident. Also here, it should be clearly understood that in this accident case, details of the investigation are discussed as examples only and in a simplified manner to fit the scope of this section.

On November, 24th, 2001, at 20:01 UTC (21:01 lcl) the airplane AVRO 146-RJ 100, registered HB–IXM, took off from Berlin-Tegel airport as CROSSAIR CRX 3597 bound for Zurich/CH.

At 20:58:50, after an undisturbed flight, CRX 3597 was cleared for a VOR-DME approach into rwy 28 at ZRH. Preceding traffic CRX 3891 (Embraer EMB 145) landed on rwy 28 and reported to the control tower that the weather conditions found on approach and landing were quite close to the minimum required.

At 21:05:21, CRX 3597 reported on the tower frequency. At 21:06:10, when the flight reached the minimum descent altitude for this approach, the commander stated “some ground visibility” to the first officer and continued the descent towards the runway.

At 21:06:36 UTC the aircraft collided with treetops and subsequently crashed into the ground. The aircraft caught fire on impact. Twenty-one passengers and three crew members died from their injuries at the site of the accident; seven passengers and two crew members survived the accident.

12.2.1 Main Reason for the Crash

The accident was caused by the flight crew’s descent below the published minimum descent altitude for the VOR-DME 28/ZRH approach even though the requirements

[5] Federal Aviation Administration (FAA) (2013).

[6] Aircraft Accident Investigation Bureau (SUST) (2006).

for such a course of action had not been fulfilled. A go-around maneuver was initiated too late.

The commander continued below the MDA without having established visual contact with the landing runway or runway lighting. The first officer did not make any effort to prevent such an action by the commander.

12.2.2 Contributing Factors

The following contributing factors (among others) were identified:

- Lack of crew performance records
- Lack of crew duty and rest-time records and responsibilities
- Selection of landing runway by established procedures
- Unavailability of MSAW for rwy 28
- Unsuitable recording and publishing of meteorological data
- Lack of air traffic control personnel
- Unsuitability of designed approach procedure
- Unsuitability of depiction of obstacles in approach charts
- Flying and corporate culture in the company

The accident is attributable to the fact that on the final approach, in own navigation, of the standard VOR/DME approach 28, the aircraft flew in a controlled manner into a wooded range of hills (controlled flight into terrain—CFIT). This was caused by the fact that the flight crew deliberately continued the descent under instrument flight conditions below the minimum altitude for the approach, without having the necessary prerequisites. The flight crew initiated the go around too late.

The investigation has determined the following causal factors in relation to the accident:

The commander deliberately descended below the minimum descent altitude (MDA) of the standard VOR/DME approach 28 without having the required visual contact to the approach lights or the runway.

The copilot made no attempt to prevent the continuation of the flight below the minimum descent altitude.

12.2.3 The Following Factors Contributed to the Accident

- In the approach sector of runway 28 at Zurich airport there was no system available which triggers an alarm if a minimum safe altitude is violated (minimum safe altitude warning—MSAW).
- Over a long period of time, the responsible persons of the airline had not made correct assessments of the commander's flying performance. Where weaknesses were perceptible, they did not take appropriate measures.

The final report of the accident investigation shows that the commander had clearly exceeded the maximum allowable operating times in the 2 days before the accident. Through his work as a part-time flight instructor before the scheduled service time, he was more than 13.5 h on duty at the time of the accident. A prolonged break from work, for relaxation or sleep, was missing. The commander was thus clearly exhausted, leading to impaired concentration and decision-making skills. He was, as well, error-prone. The SUST concluded from the events that the observed fatigue met the criteria for an impairment of fitness to fly and classified fatigue as a factor behind the accident. The SUST turned to the FOCA with a recommendation to check how to control flight duties and rest times.[7]

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[7] Neuhaus and Buholzer (2013).

Part IV

Implementation and Optimization of Risk and Safety Management

13 General Remarks and Overview

Roland Müller and Christopher Drax

A general problem within the SMS literature is that the majority of the implementation structures and recommendations are tailored to large enterprises. If you follow these plans, it might take months until you come to the point where you can start identifying your first risks. Our philosophy is to immediately start with the collection of risks in order to gain an overview of the main issues the organization is facing, and to work on mitigating them as soon as possible. We therefore compressed the following implementation structure down to the essentials, to quickly move to the risk collection. The following SMS implementation process is divided into four different phases, in order to split up the workload and to provide a convenient structure to follow when implementing the Safety Management System. The time horizon of four years will also allow leeway to adjust the culture within a company and to create a positive safety culture. The following section will give an overview of the different phases with their corresponding implementation subjects, as well as providing tools as practical examples and guidance for the implementation. Each topic will be addressed in this chapter with a brief explanation including the required deliverables.

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14 Organizational Challenges and Phases of Implementation and Optimization

Roland Müller and Christopher Drax

In a competitive environment organizations have to constantly adapt and change in order to preserve and to increase financial returns. The dynamics of adaption and change include risks which can create internal resistance to change. For that reason, creating and sustaining substantive strategic changes can only be achieved by those organizations that foster a risk seeking culture with the willingness to change the future position of the organization.[1]

A successful strategy is always connected to the right planning and effective implementation. For that reason, the implementation requires simple, consistent, long-term goals, a profound understanding of the competitive environment and an objective appraisal of the required resources.[2] According to Dong, Neufeld, and Higgins (2009), organizations are challenged by the implementation of large scale information system (IS) projects—only 35 % of companies in the United States completed their IS implementation on time. In 2003, KPMG conducted a survey among 230 of the largest global companies discovering 57 % had written off at least one IT project in the previous 12 months, and of those experiencing an implementation failure only 41 % were able to calculate how much costs were incurred for their company.[3]

Top management support during new management system implementations is crucial, as we expect top management to influence and shape the behaviors of others in the organization. The appropriate provision of resources is necessary for a

[1] Fiegenbaum and Thomas (2004).

[2] Grant (2010).

[3] Dong, Neufeld, and Higgins (2009), p. 55.

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management system implementation, but appears not to have a positive influence on user satisfaction. Top management actions should not be static—it is important that the management can adjust behavior throughout an implementation process.[4] The study of Dong, Neufeld, and Higgins (2009) further showed that supportive behavior, rather than just expressed support, ultimately determines the implementation outcomes. This implies that top management need to actively engage with supportive actions to ensure that the strategic visions are internalized and appropriately implemented.[5]

In addition, Olsen and Boxenbaum (2009) examined organizational barriers which hindered the implementation of a new management system within an organization. These organizational barriers posed a significant obstacle to the implementation in general and required a shift in the implementation strategy from a decentralized to a more centralized approach. They identified three types of organizational barriers, namely a cognitive barrier of conflicting mindsets, a process-related barrier of radical change of routines, as well as a structural barrier which was based on diverse project evaluation criteria.[6]

The first type of organizational barrier can be connected to the dominant mindset of key actors in the operational area who are reluctant to change and do not embrace new projects. The fundamental problem lies in the contradictory aims concerning the relationship between an organization's financial performance and its commitment to sustainability.

The second identified organizational barrier was the difficulty to change organizational processes which required a complete reorientation of the existing work processes in the operational environment. In principle, obstacles of this kind could be overcome by organizational learning and training programs.

The third barrier relates to different evaluation criteria employed by the strategic planning groups and the operations department to assess new market opportunities. Olsen and Boxenbaum (2009) found that there is a fundamental difference between the Net Present Value (NPV) evaluation method and the business risk evaluation method employed by operations. The NPV technique is a common financial metric often used by companies when evaluating the value of new market opportunities. In contrast, business risk evaluation is similarly used to assess the risks associated with new projects.

Furthermore, McFadden and Hosmane (2001) argued that in the field of operations management, improving safety has become a growing area of interest. Operations managers in the aviation industry, e.g. Boeing or Honeywell, have specified safety as their top operating priorities. Even before all regulatory pressures, the total quality movement, technological changes, cost-saving objectives and customer expectations of social responsibility, just to mention a few, can be named as motivating factors for considering safety as the core priority

[4] Dong et al. (2009), p. 72.

[5] Dong et al. (2009), p. 74.

[6] Olsen and Boxenbaum (2009).

for the operating environment. Safety management has become crucial for companies, as an aviation accident can be viewed as the ultimate service failure. Passengers of airlines expect 100 % accuracy when it comes to safety.[7]

14.1 Phase: Organization

In Phase I of the Safety Management System implementation, the basic structure should be developed and a compliance document has to be issued which identifies the Accountable Executive and the person within the organization who is responsible for the implementation of the SMS. To show how the SMS requirements will be met, a gap analysis has to be conducted which identifies the variations between the company's policy and the authority regulations, and states which components are in place and which elements have to be added or modified. This phase mainly focuses on basic planning and the assignment of responsibilities, where the core priority is a clear roadmap which should serve as a reference. The company's organizational chart should clearly illustrate the roles, responsibilities and safety accountabilities which are the basis for effective safety violation handling. Therefore, all levels of management and supervisory levels are encouraged to define, communicate and document their individual and shared responsibilities for safety performance. Senior management is accountable for safety within the company. It must clearly ensure that everyone has a responsibility for safety, and should emphasize that it is essential to facilitate safety management as an integral strategic aspect of the organization's business.[8,9]

The key deliverables comprise the following:

- Gap analysis
- Safety objectives of the organization approved by accountable executive
- Safety Policy signed by accountable executive
- Safety Policy distributed across entire organization
- SMS organizational structure in place
- Lines of safety accountability established
- Approval of SMS implementation plan and initial training
- Emergency response planning implementation process

14.1.1 Project Planning and Implementation

During the project planning phase, an implementation project plan has to be developed which serves as a basis for a structured approach to the Safety

[7] McFadden and Hosmane (2001).

[8] Safety Regulation Group Civil Aviation Authority (CAA) (2008), p. 5.

[9] ICAO (2008).

Management System implementation. It guides the organization through the different implementation phases and provides a structure to assess the progress.

- The start of the SMS implementation should be initiated by appointing the person, or establishing the planning group, responsible for the development of the SMS implementation project plan.
- All applicable documents that contribute to the SMS implementation plan should be collected.
- The costs associated for training and planning of the implementation must be identified, so that the budget for SMS implementation can be drafted and approved.
- Establishing the allocation of time for the development and deployment of the SMS implementation plan among the different management layers of the organization is the next step.
- Then the organization must allocate resources for the SMS implementation and generate a draft budget.
- Finally, submitting the SMS implementation plan for endorsement by senior management and conducting regular meetings to assess progress are the last steps.

14.1.2 Gap Analysis

First of all, to start the SMS implementation process, it is essential to perform a gap analysis to identify already existing safety management measures within the organization and those parts that are missing in the organizational context. Based upon the results of the gap analysis, the responsible individuals for the implementation should be able to develop a SMS implementation plan. At the beginning of the planning process, the identification of potential gaps that may hinder the SMS implementation phases have to be accounted for, and the development of strategies to address such gaps have to be developed in advance. An example of a gap analysis can be found in Appendix: SMS Gap Analysis.

During the gap analysis it is advisable to identify, collect and store the SMS-specific records and documentation and to develop guidelines for SMS record management.

14.1.3 Policy and Principles

A Safety Policy, signed by the accountable executive and which is communicated throughout the organization has to be developed. The safety policy is a high level statement of desired corporate safety performance. The Safety Policy serves as guidance regarding who has a direct or indirect impact on safety performance and should provide specific directions to ensure that any safety management activity targeted has an impact on the improvement of the safety level within the organization. A Safety Policy generally describes high level accountabilities and responsibilities of the organization and the personnel involved in the operation. It prescribes measurable standards, and should be constructed so that short and long-term safety goals and objectives (or safety performance targets) are accounted for. A sample Safety Policy can be found in Appendix: Sample Safety Policy.

To assure that the Safety Policy and operational safety is followed, it is recommended to establish measurable targets which are monitored on a regular basis by a safety committee.

Each aviation organization should conduct their business according to the following key safety principles:

- Safety is considered as the core value of the company
- Everyone is responsible for the identification, reporting and management of risks
- Always operate in the safest manner practicable
- Never take unnecessary risks
- Recognition that familiarity and prolonged exposure without a mishap leads to a loss of appreciation of risk
- Safe does not mean risk free

14.1.4 Accountabilities

In order to have a precise overview of the accountabilities, clear lines of communication between the Safety Manager, the Accountable Executive, the Safety Action Group (SAG) and the Safety Review Board (SRB) have to be established. In connection to this, it is mandatory to appoint a Safety Manager as the responsible individual and focal point for the development and maintenance of an effective SMS. The assessment of functional lines of communication should be commensurate with the size of the organization and complexity of the services provided.

- Firstly appoint senior managers, including line managers responsible for functional areas, to the SRB.
- Then, assign the SRB appropriate strategic and tactical functions in order to process safety relevant information and lessons learned.
- Finally, develop a schedule of meetings among the safety service office with the SRB and SAG as needed.

Looking at the key success factors of a safety culture and clear safety accountabilities, it becomes obvious that executive management involvement leads to a vital basis for Safety Management. Without the commitment and support of executive management, a Safety Management System will not work effectively. The Accountable Executive must emphasize the company's dedication to safety, enforce safety as one primary responsibility off all managers, and inform all personnel about the plan to achieve the highest safety standards.

No initiative or plan started by staff will have any effect if executive management is not fully dedicated to an SMS implementation. Employees need support from the executive management, and the supply of all appropriate resources to run an SMS efficiently. Types of resources include time for meetings, as well as information gathering and planning. Managers must decide on a person who will attend seminars and training courses. Managers must also decide to involve people who already have the expertise and can improve the Safety Management System's practicality e.g. consultants.[10] In order to make a full commitment and support Safety Management, the executive must have an understanding of Risk Management and the corresponding processes. Consequently, executive management must ensure that all policies and safety objectives are understood, applied and maintained at all levels.[11]

14.1.5 Safety Requirements and Accountabilities of Subcontractors

The management of subcontractors is something that has to be thought about when implementing Safety Management System processes. The primary purpose of safety requirements and accountabilities for subcontractors is to include them in your risk management process. Subcontractors provide goods or services and often also operate in the same environment, e.g. at an airport. Some incidents or accidents can be directly caused by subcontractors, e.g. by a ground handling provider for an airline. Therefore, it becomes important to define safety requirements, accountabilities and interfaces between your organization and the subcontractors. There have to be processes in place which assess the subcontractor's operations, to identify associated hazards and to check the quality of the service they provide.

14.1.6 Safety Management Manual

Draft a Safety Management Manual (SMM) to communicate the organization's approach to safety across the whole organization. The SMM is a living document and its contents may be expanded, reviewed and amended as the phased approach of the SMS evolves. The Safety Management Manual serves as a basis guide for all personnel involved in the safety of an organization's flight, maintenance or general operations. Such a manual should define the policy that governs the safety of operations of an aviation company. A Safety Management Manual should deliver a reactive and pro-active, integrated approach to safety management. Safety Management should be seen as a part of an overall management process that the organization should adopt in order to ensure that the goals of the organization can be accomplished. Hazards should be identified and dealt with systematically through a hazard identification program that facilitates continuing improvement and professionalism.

[10] International Business Aviation council (IBAC) (2008), p. 16.

[11] Stolzer, Halford, and Goglia (2008), pp. 25–26.

14.2 Phase: Risk Collection and Assessment

In Phase II the focus is to correct potential deficiencies within the system and to work on key Safety Management processes. This step should be supported by conducting an analysis based on information obtained through reactive data collection measures. Just to mention a few, these data sources can comprise collected hazards, identified weaknesses in processes, audit findings and information from past incidents or accidents. The organization should demonstrate that it has certain components of the SMS in place:

- The Safety Management System elements from Phase I
- Reactive processes
- Investigation and analysis procedures
- Risk Management procedure
- Training for personnel and assigned duties within the SMS
- Documented policies and procedures of the SMS

A detailed understanding of the operational systems is a prerequisite for the risk management process. Those systems encompass the organizational structures, processes and procedures, people, equipment, and facilities which have a contribution to the organization's productivity. An in depth systems engineering analysis will emphasize the interactions between hardware such as aircraft, software, people and the environment. It points out weaknesses in the identification of hazards and associated risks.[12]

The risk management process described in this chapter is the fundamental task to control risks at an acceptable level and can be seen as the key task in Safety Management. The process consists of identifying hazards and what kind of potential risk scenarios can be derived from those hazards. Furthermore, assessing the risks and developing mitigation measures is the key to controlling safety risks and monitoring the effects of safety actions. The underlying strategy of Risk Management is that the likelihood and severity of an event occurring can be minimized. Risk Management is a basis for decision making regarding how to handle occurrences which affect aviation safety. And it is a basis for incident assessments about their implications and evaluating the results. A key to success is constant and direct communication throughout the organization.[13]

14.2.1 Risk Collection

In order to perform the systematic and efficient collection of information on possible hazards, a safety database or master risk list has to be developed and should serve as the "*corporate safety memory*".[14] Most hazards are latent conditions

[12] Stolzer et al. (2008), p. 26.

[13] Stolzer et al. (2008), p. 26.

[14] International Civil Aviation Organization (ICAO) (2009), pp. 4–8.

and are present within the company's processes and operations. Identified hazards need to be gathered and analyzed in order to avoid fatal accidents. People are rarely aware of hazards; therefore, documentation plays a key role when actively managing safety. Knowledge is an essential requirement for proactive hazard management and must be shared within the organization, especially for the management of raw data and assessment of hazard-related information. A historical data collection of hazards and safety relevant information provides a solid base for generating a quantitative analysis, thus allowing decisions to be based on facts rather than relying on personal opinions. The database has to be able to manage the raw data and to display it so that conclusions regarding hazards can be drawn. Consequently, standardizing the reporting, defining the terms (including the measurement of safety information), and management of the tracking and analysis of hazards are key prerequisites.[15]

Appendix: Master Risk List Examples show possible master risk lists, where identified and collected hazards have to be assessed according to their consequences and risks have to be prioritized accordingly. Bearing the hazards and risks in mind, control and mitigation strategies have to be developed by involving experts responsible for implementing strategies and looking at the collected data.

Consequently, the next step is to perform an operational process analysis and re-evaluate the strategies by involving this data. The outcome of the data analysis provides Safety Management information and serves to increase overall safety by issuing safety bulletins and reports, as well as helping to build up seminars and workshops for educational functions.[16] The key to success is reliable data which should be collected for each flight. This data can then be used to put emphasis on operational issues or to categorize operations according to their level of risk. The feedback of the analysis can be used to adjust the collection methods towards best practices. Hazards should be periodically reported by staff and should be identified during regular, scheduled risk identification surveys, audits and inspections, or discovered by evaluating accidents, incidents and risky situations and should be documented in the risk register.

14.2.2 Reporting Procedure and Whistleblowing

Safety Risk Management includes specifying the means of collecting, recording, acting on and generating feedback about hazards and risks in daily operations. First of all, it must be determined what form of intervention tools have to be used to collect reactive information. The next paragraph shows a common example of a reactive approach by identifying hazards in the form of an Air Safety Report (ASR). Subsequently, it has to be decided which reporting system will be required and adapted to the organization. Three different approaches are common throughout

[15] International Civil Aviation Organization (ICAO) (2009), pp. 4.7–4.8.

[16] International Civil Aviation Organization (ICAO) (2009), p. 4.8.

various aviation organizations: mandatory, voluntary or confidential reporting systems. It is also possible to directly contact the Safety Manager and provide direct feedback. The reporting of safety relevant information promotes learning from reactive information, like already encountered incidents, and prepares the organization for proactive reporting to prevent safety relevant incidents in the future. Appendix: ASR/Hazard Reporting Procedure illustrates a possible reporting procedure to collect reactive and proactive safety relevant information.

According to ICAO[17] the following key principles are to be considered when establishing a voluntary reporting system within the generic framework of an organization's SMS.

Trust—The reporting persons must be certain that the information they provide will not be used against them; otherwise, they will be reluctant to report their mistakes. A positive Safety Culture in the organization provides the foundations of a successful occurrence reporting system.

Non-punitive—The reporting person must be protected against legal, administrative or disciplinary sanctions, except in the case of gross negligence, criminal activity or intent.

Inclusive Reporting Base—The systematic approach to safety management requires that voluntary reporting be targeted at all aspects of aircraft operation, such as flight operation, cabin safety, aircraft maintenance, air navigation services, aerodrome operation, etc. Also, collecting information on the same occurrence from different perspectives provides a complete analysis and understanding of events, and consequently of the hazards and their effects.

Confidentiality—Non-punitive systems are based on confidential reporting. The person reporting an incident must be sure that his/her identity, and other information that may be used to identify other involved physical or legal personalities, will not be disclosed. In some states legislation on access to information makes it increasingly difficult to guarantee confidentiality. This could limit the safety occurrence reporting to the minimum required for mandatory reporting.

Independence—Ideally, the voluntary reporting system is operated by an organization that is separate from the state regulatory authorities. This organization collects and analyzes safety reports and feeds the results back to the regulatory authorities and the aviation community.

Ease of reporting—Submitting a report should be as easy as possible for the reporter. The reporting forms should be readily available to anyone wishing to file a report. They should be easy to compile, provide adequate space for narrative and make maximum use of a comparable format. The forms should encourage safety improvement suggestions, such as how to prevent the reoccurrence of a hazard or how to deal with it.

Acknowledgment—To encourage further submission of reports, the organization should clearly communicate to its personnel that the voluntary reports are a valuable safety asset and acknowledge the efforts made by reporting persons.

[17] International Civil Aviation Organization (ICAO) (2009).

Whenever possible, feedback on the actions taken in response to a report should be provided to the reporting person.

Promotion—The de-identified information received from the voluntary reporting system should be made available to the aviation community in a timely manner. One form of reporting is described in the Swiss Voluntary Reporting Systems (SWANS). A variety of information dissemination methods should be used to achieve maximum exposure, for example monthly newsletters, periodic summaries, safety bulletins published on the Internet, etc. Such promotional activity may help motivate people to further improve the reporting of safety occurrences.

Furthermore; another form of reporting procedure which can be closely linked with safety management is "Whistle blowing", which means "*the disclosure by any employee (former or current) of illegal, immoral, or illegitimate practices under the control of their employers to persons or organizations*."[18] Employees are, based on their insider knowledge, in the most suitable position to establish transparency and to inform about mismanagement and misconduct in the company environment.[19]

Whistle blowing, with regard to the workforce in organizations, can be split into four different components. One element is an individual who is willing to disclose company internal information and make it available outside the organization. The second element can be described as the conversion of that specific information into general information which is then available to the public. Usually, that information is about mistakes and mismanagement or scandalous material from internal sources, which is typically revealed by current or former employees of the company.[20]

A quite recent whistle blowing example is the case "Bradley Manning", an American soldier who was arrested in May 2010 in Iraq on suspicion of having passed restricted material to the website Wiki Leaks. He was accused in July 2010 of transferring classified data to his personal computer and communicating a large amount of data and US national defense information to an unauthorized source.[21]

Despite the fact of benefitting the public by revealing this secret information, whistleblowers are normally not aware of the negative consequences they have to face after their waiver of professional secrecies.[22] Colleagues and superiors may no longer welcome people who they regard as traitors. Often responsibilities will be removed or whistleblowers transferred to less interesting tasks and projects.[23]

Nevertheless, an active, implemented whistle blowing system can prevent organizations from the exposure of harmful information to external sources.

[18] Miceli and Near (1992), p. 15.

[19] Odermatt (2005), p. 1.

[20] Johnson (2003).

[21] Nicks (2010).

[22] Professional secrecy is a privilege that ensures that any information your employer provides to you is kept confidential.

[23] Devine and Maassarani (2011), p. 16.

It can serve as a shield to keep the report within the company and to reflect the concern internally. This sort of system can prevent a company's loss of reputation, especially when safety is concerned.[24]

14.2.2.1 Air Safety Report

Each aviation organization should make every effort to ensure the highest possible safety standards for its flight operations. In addition to ongoing training and education, this should also involve the analysis of events adversely affecting the safety of operations. A prerequisite is to record and analyze safety relevant events. In order to ensure the collection of data affecting flight safety, and to analyze such data based on defined criteria, an Air Safety Report (for aircraft operators) serves as the best solution to raise flight safety standards within an organization. By filing their reports, all staff members help to raise the level of safety by identifying possible hazards within daily operations. In particular, reports should include descriptions of events which affected flight safety. In addition, reporting failures or other safety-relevant situations allows operators to take a proactive approach. The Safety Manager can encourage the relevant employees to take preventive measures, thus raising the level of flight safety.

Experience gathered from accident analysis shows that the possibility of anonymous reporting should be provided. This feature, which gives the staff the option to report anonymously or officially, should be included in the reporting system. However, when employees decide to file their reports anonymously, there is no possibility to acquire more details from the reporters. When staff members prepare their reports, they can classify their information as "anonymous" by not giving their names. Appendix: Sample Air Safety Report provides a sample of an Air Safety Report where hazards or flight safety relevant information can be collected. Appendix: Safety Manager Evaluation Sheet shows the assessment of the collected hazard which has to be assessed according to the risk matrix in Fig. 14.2.

14.2.2.2 Swiss Voluntary Reporting Systems (SWANS)[25]

The Swiss Voluntary Reporting System offers, in addition to the mandatory reporting system of the Swiss Federal Office of Aviation (FOCA), the possibility of reporting occurrences and safety critical events on a voluntary and anonymous basis. This reporting system aims to encourage increased reporting of safety-related occurrences. Reports should be filed if an operational interruption, defect, fault or other irregular circumstance that has or may have influenced the safety of an aircraft, its occupants or any other person occurs. It is also possible to report occurrences which as yet present no risk, but which could, if not corrected, present a potential risk to the safety of the aviation system.

The reports are analyzed by FOCA's Safety and Risk Management office, which is independent and completely separate from the divisions responsible for

[24] Pittroff (2011), p. 64.

[25] Bundesamt für Zivilluftfahrt (BAZL) (2007).

supervisory tasks and conducting criminal proceedings. This reporting system is part of a new culture – a "just culture" as described in Part I, Sect. 4.8. Civil aviation actors are encouraged to openly report important safety-related information in a proactive way. The analysis of the collected reports helps to identify potential risks in aviation in order to learn from them by taking appropriate and proactive measures to mitigate risks to an acceptable level before they cause any harm.

However, FOCA also states that the new reporting system does not always offer protection from prosecution. FOCA only forgoes initiating criminal proceedings under two conditions:

- First, the occurrence is not a deliberate or grossly negligent breach of the applicable standards and regulations
- Second, the office learned of the occurrence through this reporting system.

The SWANS reports can be filed by anyone directly or indirectly involved in aviation, who uses aviation services or who makes safety-related observations in this field. Reports can be filed at FOCA anonymously or openly by means of a SWANS report as illustrated in Fig. 14.1.

The reporting form is available in electronic form online and can be sent to the SWANS reporting office by mail, fax or e-mail. Appendix: SWANS Report shows the SWANS report format. The submitted information is handled by FOCA using the following process flow.

14.2.3 Prioritization in the Master Risk List and Elimination of Irrelevant Risks

All collected risks are documented in a so called master risk list. Appendix: Master Risk List Examples of Sect. 14.2.1 illustrates two different examples of a master risk list. This specific list provides an overview of all the risks an organization faces at a given point in time, depending on its actual revision status. In times of budget cuts and limited resources it is not possible to manage all the risks effectively and mitigate them to an acceptable level. For this reason, a prioritization of the documented risks has to be performed with the focus on the substantial top-level risks which have to be effectively mitigated. Throughout this prioritization a thorough assessment of the documented risks has to be achieved, which is described in the next chapter. The prioritization of the risks is based on the assessment and the mapping in the risk matrix. Risks which have been classified as irrelevant are still documented, but deleted from the master risk list.

14.2.4 Risk Assessment of Relevant Risks

The Safety Manager or a pre-determined Safety Action Group (SAG), consisting of managers from different areas within the organization, are responsible for assessing all reported events and hazards on the basis of a Risk Assessment Matrix which allows determining a specific risk indicator for each occurrence. In the aviation

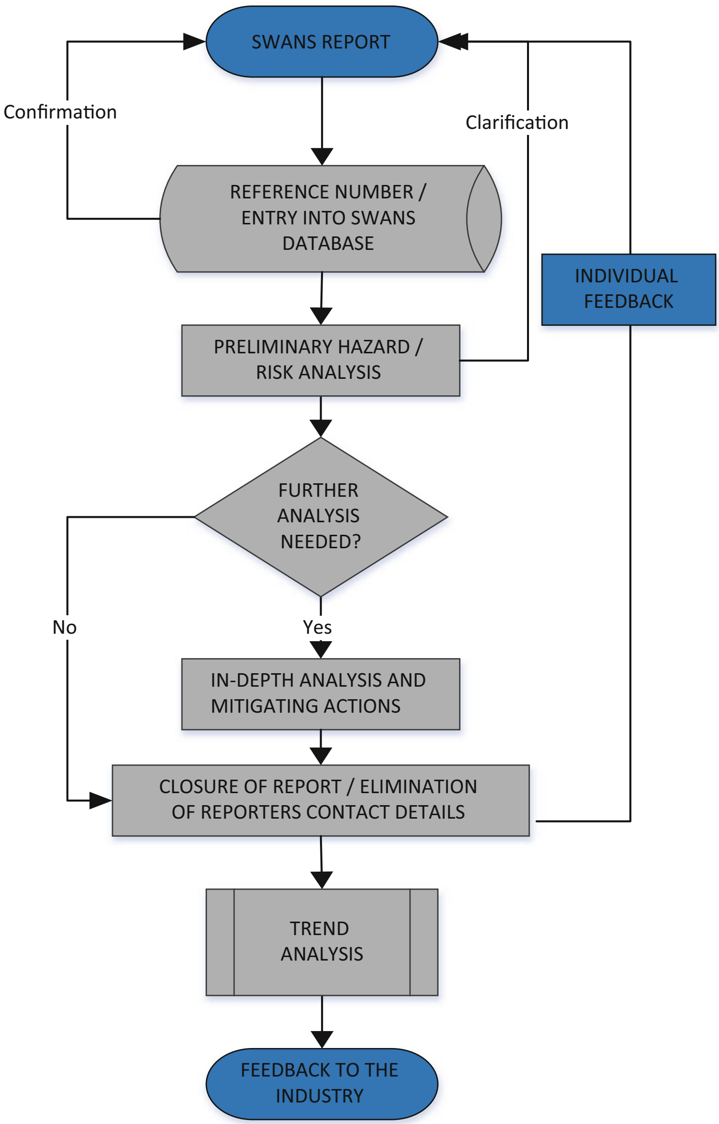


Fig. 14.1 SWANS reporting process (Bundesamt für Zivilluftfahrt (BAZL), 2009). *Source*: Adapted from BAZL

environment, not all risks can be eliminated. They are inherent in the daily operations. The Risk Assessment, however, allows the analysis of each individual hazard and identifies the level of risk to the organization. Based on these assessments, suitable mitigation measures can be implemented in order to avoid future reoccurrences.

Disaster	>50M CHF	**5**	**10**	**15**	**20**	**25**
Critical	>5 < 50M CHF	**4**	**8**	**12**	**16**	**20**
Moderate	>0,5 < 5M CHF	**3**	**6**	**9**	**12**	**15**
Low	>0,05 < 0,5M CHF	**2**	**4**	**6**	**8**	**10**
Insignificant	< 0,05M CHF	**1**	**2**	**3**	**4**	**5**
	Criteria	< 1 per 100 years	> 1 per 100 years < 1 per 10 years	> 1 per 10 years < 1 per 1 year	>1 per year <1 per month	> 1 per month
Severity / Probability		**Practically impossible**	**Unlikely**	**Possible**	**Occasional**	**Often**
Zone 1		Risk is not acceptable, immediate measures for risk mitigation required				
Zone 3		Tolerable risk, evaluate measures for risk mitigation				
Zone 4		Acceptable risk, no measures required				

Fig. 14.2 Risk matrix. *Source*: Müller, Lipp, and Plüss (2007)

The Risk Assessment Matrix is a graphic expression of risk as the product of probability on the x axis and severity of potential consequences on the y axis. The Risk Assessment Matrix shows an assigned value and has a broad application for qualitative risk determination, as well as graphically presenting the risk criteria. Each criterion has an individually tailored financial implication and a time component to make the risk assessment more structured and transparent. The evaluation consists of identifying a value from 1 to 25 (which can be tailored according to individual operational needs) for all occurrences or hazards, providing a view of the severity of consequences and the probability of each individual occurrence.

After the identification of a value for the severity and the probability of an occurrence, both values are multiplied. The result is the risk indicator for this specific occurrence. Based on this risk indicator, the risk is classified as acceptable, tolerable or unacceptable on the basis of the following risk matrix (Fig. 14.2).

In line with the risk indicators identified, the Safety Manager should initiate the measures described below:

- **Indicators 10–25: risk unacceptable.**
  Establish immediate contact and liaison with the Accountable Manager and direct initiation of appropriate mitigation measures.
- **Indicators 4–9: risk tolerable.**
  The Safety Manager briefs the team; no immediate mitigation measures are required; any suitable mitigation measures will be decided.
- **Indicators 1–3: risk acceptable.**
  No mitigation measures are required; the occurrence is included in the statistics and listed at the next scheduled safety meeting.

The financial values for the severity scenarios have to be individually tailored to each organization. It might happen that a loss of 5M CHF poses an intense threat to the survival of an organization. Therefore, each organization has to be aware of setting their individual financial risk criteria. It might be interesting to see how the criteria for assessing the financial implications can be defined in concrete terms.

A first approach is the average availability of liquidity. Exceeding liquidity, for whatever reason, leads to illiquidity and thus to bankruptcy for an organization.

A second approach is the maximum possible net financial debt to EBITDA. If this maximum leverage factor is too high, credit agreements can be terminated by the banks. Take the example when the EBITDA of a company is currently four million and external ineptness accounts for six million, at a maximum allowable leverage factor of 2.5, damage of four million would already be a disaster for the company.

It might seem logical to insure aircraft against damage. If we take a look, for example, at a commercially operated helicopter which crashes on a house, killing the crew, injuring people on the ground and destroying the house the whole scenario could be insured against. This would mean no financial loss for the company and no risk for the continuation of daily operations. Nevertheless, as we have learned from the past, the reputation of a company cannot be insured. Future customers might refuse to fly or use further services from the company again which would induce financial losses and might endanger the health and existence of that company. Without further customers the company will go bankrupt, even though they were insured against all losses. Therefore, protecting the reputation of a company by rigid safety measures and constant risk management appears to be the best and most sustainable insurance.

14.3 Phase: Risk Mitigation

Upon assessment of the safety risk in terms of severity and probability, and visualizing the safety risk in the safety risk matrix, the outcome is only an intangible product of an investigation (Fig. 14.3). In order to materialize the output from the previous assessment, the safety risk has to be further categorized to analyze its potential damage to a safe operation. This second step classifies the safety risk according to the organization's tolerability.[26]

The first category "intolerable region", matrix values 10–25, contains all safety risk criteria marked red. If a safety risk falls into this category, it is unacceptable under any circumstances. The most probable solution in this case would be to cancel the operation. If not possible, then it is necessary that "controls must be adopted so that a subsequent iteration of the risk index calculation results in the arrival at a yellow or green cell".[27] In the second category, matrix values 4–9, the safety risks which are marked yellow, are acceptable based on the mitigation processes that should follow. All remaining safety risks that fall in the area with

[26] International Civil Aviation Organization (ICAO) (2009), pp. 5–6–1.

[27] Stolzer et al. (2008), p. 141.

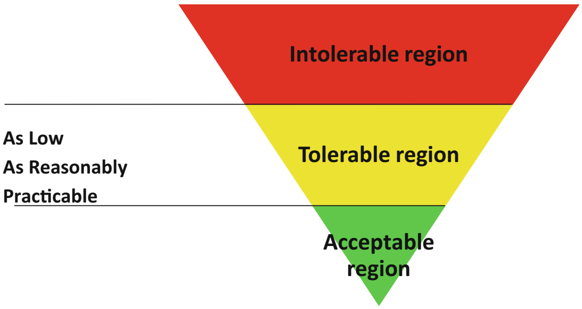


Fig. 14.3 Safety tolerability matrix (International Civil Aviation Organisation (ICAO), 2009, pp. 5–6–3). *Source*: ICAO

the green marked cells, matrix values 1–3, are acceptable without starting a mitigation process due to their unlikely occurrence or negligible severity during normal operations. The implementation of safety measures is in the hands of the Safety Manager or Safety Action Group who monitor and supervise the implementation. Results should be concurrently documented and published internally in a lessons learned library. The purpose of the risk mitigation step is to reduce the safety risk through mitigation to a level that is as low as reasonably practicable (ALARP). The underlying meaning is that the safety risk should be reduced using all available resources within the organization.

14.3.1 Investigate Possible Mitigation Measures

Not every mitigation measure leads to a favorable outcome. In Part II the concept of production and protection was introduced, which is now of great relevance. At this point possible mitigation solutions have to be found in order to manage the known hazards and associated risks. Keeping this in mind, it is also important to take an economic decision which is in line with the safety measures.

There are different ways for organizations to choose the most appropriate strategy to control a known risk associated with the provided service. The following examples provide three ways of addressing specific risks:

- **Risk avoidance**. Risky task, procedure, operation or activity is avoided if the associated risk is determined to exceed the (economic) benefits.
- **Loss reduction**. Measures are taken to reduce the frequency of occurrence of unsafe (unwanted) events or the severity of their effects (consequences).
- **Control of exposure** (by separation or duplication). Action is taken to isolate the risks or to ensure redundancy to protect against the risks (e.g. use of non-flammable insulation materials or back-up systems to reduce the likelihood of total system failure, etc.).[28]

Establishing the correct and effective risk mitigation strategies and measures is a challenging task. Often, experience and knowledge of the particular operational

[28] Skybrary (2013a, 2013b).

environment is not sufficient to apply the right mitigation strategy; it is hard to overcome the rigid mindsets and biases of those who are closest to the problem. In many cases, an open mindset and the ability to be creative and to think outside the box are of great relevance.

It is not possible to control all risks to an extent that they are no longer of relevance; in most cases it is not economically feasible to apply a certain strategy because the protection, in terms of cost, would supersede the production (benefit). As mentioned in the previous chapter, the risks have to be at the "as low as reasonably practicable" level. This requires a balance of risk against time, cost and effort to apply a mitigation measure.[29]

14.3.2 Cost–Benefit Analysis

As already mentioned in Part II in Chap. 4, most of the time, cost is the main driver influencing the reduction of a safety risk to the lowest reasonably practicable level. Therefore, it is necessary to include a cost–benefit analysis. A cost–benefit analysis is a formal technique by which the benefits of an operation are weighed against its costs.[30] In this case the technique analyses the cost and benefits of reducing a safety risk in order to find the best trade-off between the costs of reducing the safety risk and the thus received level of safety. If a safety risk reaches the status of ALARP, a further reduction of the safety risk would be outweighed by the extra costs. When reaching the status of ALARP it does not mean, for the organization, that the safety risk is eliminated. It only means that the organization accepts the residual value of the safety risk that is left because it is outweighed by the financial benefits.[31] Some factors of a cost–benefit analysis cannot be predicted exactly, especially when it comes to qualitative, less numeric figures, which also have weight in this analysis.[32] For example:

- **Managerial.** Is the safety risk consistent with the organization's safety policy and objectives?
- **Legal.** Is the safety risk in conformance with current regulatory standards and enforcement capabilities?
- **Cultural.** How will the organization's personnel and other stakeholders view the safety risk?
- **Market.** Will the organization's competitiveness and well-being vis-à-vis other organizations be compromised by the safety risk?
- **Political.** Will there be a political price to pay for not addressing the safety risk?

[29] Skybrary (2013a, 2013b).

[30] Case and Fair (2007), p. 129.

[31] International Civil Aviation Organisation (ICAO) (2008).

[32] International Civil Aviation Organization (ICAO) (2009), pp. 5–7–4.

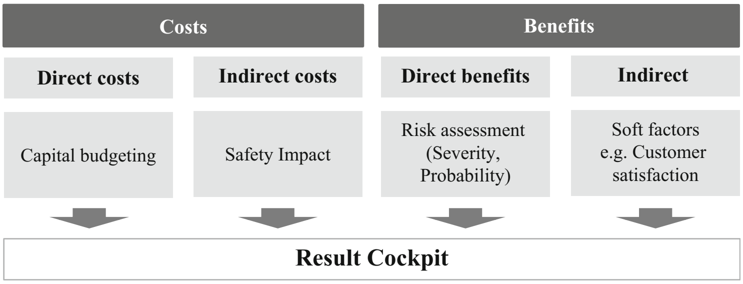


Fig. 14.4 Cost–benefit analysis. *Source*: Hecker (2012)

- **Public.** How influential will the media or special interest groups be in affecting public opinion regarding the safety risk?[33]

When applying a cost–benefit analysis, the organization has to distinguish between direct and indirect costs and what level of impact they have on the organization—including direct and indirect benefits. The cost–benefit analysis can be illustrate like in Fig. 14.4.

The results of costs and benefits can be illustrated as consolidated outcomes in the "Result Cockpit". The final result cockpit provides a summary of the collected and calculated data and serves as a basis for decision making. In general, the cost–benefit analysis should provide a numerical overview of all relevant key performance indicators, cost–benefit relations, a graphical illustration of the costs, sum at risk and damages, as well as a qualitative explanation of the indirect benefits. The goal is to present all relevant data accessible, in a comprehensible and effective way, to the decision makers.

14.3.3 Determination of Mitigation Measures

Once the mitigatable economic risks are identified, effective mechanisms have to be applied to understand the factors contributing to their occurrence. Any mechanism that is effective in reducing risk can modify one or more of these factors. Reducing the probability of occurrence or the severity of the consequences can be one mitigation measure. In order to reach the desired risk reduction level, the implementation of more than one mitigation measure may be required.[34] There are some possible approaches to effective risk mitigation outlined by ICAO[35]:

- Revision of the system design (before system implementation);
- Modification of operational procedures;
- Changes to staffing arrangements; and

[33] International Civil Aviation Organisation (ICAO) (2008).

[34] Skybrary (2013a, 2013b).

[35] International Civil Aviation Organization (ICAO) (2009).

- Training of personnel to deal with the hazard.

The importance of a proposed risk mitigation measure is that the expected safety improvement potential must be thoroughly assessed in order to exclude new risks in the system. Finally, constant monitoring will assure that the implemented risk mitigation measure is effective. Therefore, it is fundamental to verify that the mitigation measures work as initially intended.[36]

14.3.4 Publication and Documentation

All reported incidents and hazards, related findings and safety performance indicators, as well as any safety mitigation measures should be recorded and documented by the Safety Manager, and be published and made accessible to all staff members. Reports should be presented anonymously without disclosing any personal data. Publication is not aimed at assigning blame or exposing individual staff members (reports are published anonymously). Making the reports public is aimed more at raising risk awareness among all staff to achieve an ongoing improvement with a view to constantly improving safety levels and to sharing important experiences. Furthermore, the gathered data has to be analyzed. The outcome of the data analysis provides safety management information and serves to increase overall safety by issuing safety bulletins and reports, while also helping to build up seminars and workshops for educational functions.[37] The key to success is reliable data which should be collected for each flight or operation. This data can then be used to put emphasis on operational issues or to categorize operations according to their risk. The feedback of the analysis can be used to adjust the collection methods towards best practices.

14.3.5 Emergency Response Planning (ERP)

A strong process for risk mitigation is the Emergency Response Plan—the most critical test of an organization's credibility is at the time of a crisis. The danger of having the company's reputation wounded is greatest during the first hours. Therefore, disseminating information, either from a central company source or directly dealing with the media at the accident site must be a controlled process. An Emergency Response Plan should be designed to assist company personnel in fulfilling the responsibilities of the company and in responding to aircraft accident/crisis situations and incidents in the most rapid way possible. It is a structured approach to handling a crisis and is designed to assist company personnel in responding to aircraft accidents and incidents in the most rapid way possible. It characterizes response procedures for all occurrences which are not 'daily

[36] Skybrary (2013a, 2013b).

[37] International Civil Aviation Organization (ICAO) (2009), p. 4.8.

business', and requires a specific approach. The ERP acts as the guideline for the actions to be taken during the first hours after an accident or incident occurs. All procedures are written down in the form of checklists and serve as a guideline for each member of a specified "Crisis Team". These checklists ensure a standardized performance and documentation of all activities related to the crisis and must be kept readily available 24 hours a day. A company must ensure that all staff that may potentially be involved in an emergency situation are fully aware of the contents of the checklists, and that all procedures are kept up to date and all necessary arrangements remain valid. The checklists also contain necessary forms, telephone numbers and addresses for the accident response.[38]

It is of great relevance that all actions during a crisis situation are tracked. This means that a log of key events and decisions be maintained throughout the response.

The Emergency Response Plan can be made available via hardcopy folders or via an integrated software solution which can be accessed by each involved employee. The documentation can be divided into two parts.

Part I, provides all the necessary background information concerning definitions and policies which could be specified as the Emergency Response Manual. Furthermore, this part should give explanations on how to use the checklists.

Part II, should be written as different checklists in a simple "need to do" format, giving step by step actions to be taken in a crisis in and how to document the performed action. Moreover, Part II also contains telephone lists and useful addresses to facilitate communication.

In general all the planning, and identifying of external entities that will interact with the organization during emergency situations, should be made in advance. Each employee who is involved in emergency response activities should have his own checklist which should be harmonized with the corresponding internal checklists of the other crisis team members. All internal emergency response activities should be coordinated with subcontractors and suppliers in order to identify gaps in reporting procedures or possible information or data leaks. Appendix ERP Checklist Emergency Director a checklist for an Emergency Director who would be the coordinator and main point of contact in an emergency situation.

14.4 Phase: Continuous Improvement[39] and Change Management

In order to continuously improve the Safety Management System, the organization should establish and apply processes which support the investigation of the causes of deviations from the prescribed safety standards. In the case of a safety critical event, the process for the review of the SMS should be exclusively based on immediate corrections and not on a designated periodic inspection plan. These

[38] Department of Transportation (DOT) Canada (2004).

[39] Bundesamt für Zivilluftfahrt (BAZL) (2009).

safety performance reviews have to be conducted periodically and must assess the adequacy and effectiveness of the different SMS components and the effectiveness of the corrective and improvement measures. The organization should appoint a group of people—from top management levels (adjusted to the size and the complexity of the organization)—that are responsible for the safety objectives which ensure the assessment of the Safety Management System. This designated group of people has to be equipped with the necessary competencies to make decisions in the following listed areas:

- Improvement and effectiveness of the SMS
- Establishment/implementation of the safety policy in all organizational areas
- Allocation of the necessary funds to achieve the safety goals.

The assessment of SMS includes:

- Results of internal and external audits
- Observations concerning degree of fulfillment of safety goals
- Findings from hazard and event analysis
- Analysis and results from internal/external feedback
- Status of corrective and preventive measures
- Follow-up actions from previous system assessments
- Changes that may affect the SMS—recommendations for improvements
- Exchange of best processes across the organization.

A sufficient amount of data has to be available to provide the necessary traceability and reliability of the assessment system. Decisions resulting from the assessment have to be disclosed within the organization by executive management to demonstrate how the assessment process leads to new objectives which stimulate the success of the organization. In addition, the organization should compare its SMS with that of other organizations and be an active supporter of SMS within the aviation industry.

In connection with continuous improvement, Change Management has become a central buzzword in the current economic environment. Globalization and its inherent changes have shaped the managerial landscape and established the term Change Management as a fundamental process for organizations that constantly have to adapt to the fast changing business environment. Change Management can be clearly distinguished from strategic management. While strategic management focuses on adaption to the external business environment, Change Management focuses on the conversion of internal company processes to the desired organizational state. Change Management does not focus on the future result, but defines the process of moving from the status quo to a desired future condition.[40]

Prior to undergoing any significant change that could impact flight operations, a Change Management Process should be undertaken. Possible events that can indicate the need for a change management process are:

- The introduction of a new aircraft type

[40] Lauer (2010), pp. 3–4.

- Significant change in the nature of the operation (e.g., dynamic business growth, new operating environment, etc.)
- Changes in hiring or scheduling practices
- Changes to organizational structure
- Significant change in maintenance arrangements, etc.

As soon as a change event has been determined, the Safety Risk Assessment should be reviewed. On the basis of that assessment, and any other available information, the Safety Manager, or the person to whom the responsibility is delegated, should develop a Change Management Plan. The Change Management Plan should include an assessment of the changes required to items, such as:

- Standard operating, maintenance procedures and processes
- Personnel training and competency certification
- Amendment of Operational Manuals Part A–D
- Maintenance Control Manual or Maintenance Procedures Manual; and/or
- Aircraft SOPs, etc.

It should also include a plan for the development of the required changes. When the required changes have been developed, a Safety Audit should be conducted before the change is implemented. After implementation of the change, the Safety Manager should review the system performance at regular intervals. If there is any doubt about the effectiveness of the Change Management Process, a more comprehensive post implementation review or a Safety Audit should be conducted.

14.4.1 Audit

A Safety Audit is an independent evaluation of the Safety and Risk Management System. While such an audit may be done to meet an external requirement, the prime purpose of a Safety Audit is to identify areas in which safety performance may be evaluated and enhanced. Safety Audits should be held at least once a year and may be split into different modules.

A Safety Audit is used to validate the safety-risk assessment, which in turn is employed as the basis to evaluate the safety performance. It may include:

- Visits to the operating site (Home-base);
- Interviews with managers and operational staff within the company;
- Document reviews (e.g. for completeness, currency and appropriateness); and
- An evaluation of the Safety Management tools being applied

Findings from Safety Audits should be tracked in the hazard identification system, and may be used to update the safety-risk assessment.

14.4.1.1 Internal and External Audits

The aim of internal audits is the assessment and evaluation of all major internal organizational processes at least once per year. Thus, permanent and systematic target-performance comparisons of all processes and procedures should be possible. This will obtain an objective evaluation and identification of deficiencies to allow a subsequent proposal and initiation of corrective and preventive measures. The aim of external audits is to monitor subcontractors according to contractual obligations and negotiated standards.

The audit process can, in general, be divided into three steps, preparation, implementation and completion. Moreover, it focuses on the fulfillment of the legal and contractual requirements of different areas and processes. Furthermore, the roles of the designated responsible persons are monitored using specific criteria for conducting audits in the form of question catalogs. All results are logged, evaluated and reported and reconciled with previous results along with their corresponding improvement and implementation measures.

The final audit report should contain all detected faults, deviations, deficiencies and potential for improvement, with an overall evaluation of the audited area and individual evaluation of the audited processes.

Furthermore, corrective and preventive measures with responsibilities and fulfillment dates should be set, and an objective evaluation of the implementation and efficiency of these initiated corrective measures should be monitored.

14.4.2 Safety Promotion and Training

Safety promotion is a crucial part of the development and retention of a sound SMS. The promotion should guarantee that all members of staff are appropriately trained to work with the SMS and the organization's safety culture; each employee is encouraged to convey safety-relevant information and knows which actions have to be taken. The modes of promotion include safety policies and procedures, newsletters, and presentations which should harmonize and develop the organization's safety culture. The safety promotion processes must constantly be assessed by informal workplace meetings between employees and accountable managers to evaluate their impact on the organization.[41]

Safety, as the core value of an aviation organization, should underpin every activity within the company. The organization should be structured to focus on safety issues at all levels, and safety should be the first agenda item at every executive meeting. There should be a safety culture in place which positively encourages the reporting of all safety-related incidents and events. Each incident or safety critical event should be reported, no matter how minor it may seem. In order to promote safety as the core value, review, revise and communicate changes to your organization's SMS usage and standards. Use media like safety newsletters, notices and bulletins, websites and e-mail to disseminate this information. Effective methods to promote safety among others in this phase should include:

- Share "lessons learned" that promote improvement of the SMS
- Identify methods to communicate successes of the SMS (i.e. after training is completed, trends identified in the documentation submitted, changes to the safety performance indicators, etc.)

[41] Safety Regulation Group Civil Aviation Authority (CAA) (2008), p. 16.

- Review the safety policy including the reporting policy
- Promote participation by all personnel in the identification of hazards

There should be a documented process for identifying training requirements, and a validation process that measures the effectiveness of the training. An organization needs to ensure that all employees receive appropriate safety training, where the scope of the safety training is suitable to each individual's involvement in the SMS.

- Accountable Managers should have a thorough understanding and awareness of SMS roles and responsibilities, the company's safety policy, SMS safety standards and the measurements to assure them
- Senior Managers need to understand and communicate the regulatory requirements for their organization and the safety standards and assurance processes
- Managers and supervisors should be aware of the basic safety processes, like hazard identification, Risk Management and Change Management processes to learn from past events and to apply certain mechanisms to increase the safety level
- Operational employees should have a basic overview of the SMS fundamentals and the organization's safety policy.[42]

[42] Civil Aviation Authority-Safety Regulation Group (2008), p. 15.

Glossary[43,44]

Accident (Aircraft) An occurrence associated with the operation of an aircraft that takes place between the time any person boards the aircraft, with the intention of flight, until such a time as all such persons have disembarked, in which a person is fatally or seriously injured, the aircraft sustains substantial damage, or the aircraft is missing or is completely inaccessible.

Air Operator Certificate (AOC) A certificate authorizing an operator to carry out specified commercial air transport operations.

Air Traffic Control (ATC) A service provided for the purpose of controlling aircraft movement in a manner that: (a) Prevents collisions on the maneuvering area between aircraft and obstructions. (b) Expedites and maintains an orderly flow of air traffic.

Audit A structured and objective assessment that determines the level of conformity with specific standards.

Change Management A systematic approach to identifying and analyzing internal and external changes with the potential to affect the functionality of an organization, and assess and control the risks associated with such changes.

Compliance To fulfill, meet or be in accordance with requirements specified in standards or regulations.

Defenses Specific mitigating actions, preventive controls or recovery measures put in place to prevent the realization of a hazard or its escalation into an undesirable consequence.

Errors An action or inaction by an operational person that leads to deviations from organizational or operational intentions or expectations.

Emergency Response Plan (ERP) A formal plan that defines the actions taken following an accident to ensure an orderly and efficient transition from normal to emergency operations, and then safe continuation of operations or the return to normal operations as soon as possible. An ERP specifies the: (a) Delegation of emergency authority and assignment of emergency responsibilities; (b) Authorization for action by key personnel; (c) Coordination of efforts to cope with the emergency.

Fatigue A physiological state of reduced mental or physical performance capability resulting from sleep loss or extended wakefulness, circadian phase, or workload (mental and/or physical activity) that can impair a crew member's alertness and ability to safely operate an aircraft or perform safety-related duties.

Fatigue Risk Management System (FRMS) A data-driven means of continuously monitoring and managing fatigue-related safety risks, based upon scientific principles and knowledge, as well as operational experience that aims to ensure relevant personnel are performing at adequate levels of alertness.

[43] International Air Transport Association (IATA) (2012).

[44] International Civil Aviation Organization (ICAO) (2009).

Framework for Safety Management Systems (SMS) The structure of a safety management system (SMS), published in ICAO Annex 6, comprising the 4 components and 12 elements that define the minimum requirements for SMS implementation.

Hazard (Aircraft Operations) An existing or potential condition that could lead to or result in injury to or death of persons and/or damage to or loss of an aircraft in operation.

ICAO Annexes Additional sections to the ICAO Convention which are guidelines, provided for the various national aviation authorities, for use in developing civil aviation rules and regulations that govern flight operations in their respective states.

Quality Management System (QMS) The aggregate of the organizational activities, plans, policies, procedures, processes, resources, responsibilities, and infrastructure implemented to ensure all operational activities satisfy customer and regulatory requirements. A controlled documentation system is used to reflect the plans, policies, procedures, processes, resources, responsibilities and the infrastructure used to achieve a continuous and consistent implementation and compliance.

Safety (Operational) A condition in which the risk of injury or damage occurring during operations is limited to an acceptable level.

Safety Action Group (SAG) A high level tactical committee within an SMS that comprises designated line managers and representatives of front line personnel. It takes strategic direction from the SRB and addresses the implementation and effectiveness of risk control actions in operations. See *Safety Management System* (*SMS*) *and Safety Review Board* (*SRB*).

Safety Assurance The component of a Safety Management System that comprises processes for: (a) Safety performance monitoring and measurement; (b) The management of change; (c) Continual improvement of the SMS. See *Safety Management System* (*SMS*).

Safety Culture The extent, to which an organization actively seeks improvements, vigilantly remains aware of hazards, and utilizes systems and tools for continuous monitoring, analysis, and investigation. It includes a shared commitment amongst personnel and management to personal safety responsibilities, confidence in the safety system, and a documented set of rules and policies. The ultimate responsibility for the establishment and adherence to sound safety practices rests with the management of the organization.

Safety Management System (SMS) A systematic approach to managing safety within an organization, including the necessary organizational structures, accountabilities, policies and procedures. As a minimum, an SMS: (a) Identifies safety hazards; (b) Ensures that remedial action necessary to maintain an acceptable level of safety is implemented; (c) Provides for continuous monitoring and regular assessment of the safety level achieved; and (d) Aims to make continuous improvement to the overall level of safety.

Safety Promotion The component of an SMS that provides support for the processes associated with safety risk management and safety assurance, and defines: (a) Training and education; (b)Safety communication. See *Safety Assurance, Safety Management System* (*SMS*) and *Safety Risk Management.*

Safety Review Board (SRB) A strategic committee within an SMS that comprises senior management officials; addresses high level safety issues associated with an operator's policies, resource allocation and organizational performance monitoring. See *Safety Management System* (*SMS*) *and Safety Action Group* (*SAG*).

Safety Risk An assessment, expressed in terms of predicted probability and severity of the consequence(s) of a hazard to aircraft operations, with severity using as a reference the worst foreseeable or credible outcome. See *Hazard* (*Aircraft Operations*).

Safety Risk Management The component of a Safety Management System that comprises: (a) Hazard identification processes; (b) Risk assessment and mitigation processes. See *Safety Management System* (*SMS*).

State Safety Program (SSP) An integrated set of regulations and activities established by a state, aimed at managing civil aviation safety.

Organizational culture Characteristics and safety perceptions among members interacting within a particular entity. Organizational value systems include prioritization or balancing policies covering areas such as productivity versus quality, safety versus efficiency, financial versus technical, professional versus academic, and enforcement versus corrective action.

Risk mitigation The process of incorporating defenses or preventive controls to lower the severity and/or likelihood of a hazard's projected consequence.

Appendix: SMS Gap Analysis[45]

#	*Aspect to be analyzed or question to be answered*	*Status*	*Description*
Component 1 – SAFETY POLICIES AND OBJECTIVES			
Element 1.1 – Management commitment and responsibility			
1	Is a Safety Management System with defined components established, maintained and adhered to?		
2	Is the Safety Management System appropriate to the size and complexity of the service provider?		
3	Is there a safety policy in place?		-
4	Has the service provider based its Safety Management System on the safety policy?		
5	Is the safety policy approved and promoted by the Accountable Executive?		
6	Is the safety policy reviewed periodically?		
7	Is there a formal process to develop a coherent set of safety objectives?		
8	Are the safety objectives linked to the safety performance indicators, safety performance targets and safety requirements?		
9	Are the safety objectives publicized and distributed?		
10	Is there a policy in place that ensures effective safety reporting of safety deficiencies, hazards or occurrences including the conditions under which protection from disciplinary and/ or administrative action applies?		
Element 1.2 – Safety accountabilities of managers			
11	Has the service provider identified an Accountable Executive who has ultimate responsibility and accountability, on behalf of the service provider, for the implementation and maintenance of the SMS?		
12	Does the Accountable Executive have responsibility for ensuring that the Safety Management System is properly implemented and performing as required in all areas of the service provider?		

(continued)

[45] International Civil Aviation Organization (ICAO) (2009).

#	*Aspect to be analyzed or question to be answered*	*Status*	*Description*
13	Does the Accountable Executive have full control of the financial resources required for the operations authorized to be conducted under the operations certificate?		
14	Does the Accountable Executive have full control of the human resources required for the operations authorized to be conducted under the operations certificate?		
15	Does the Accountable Executive have final authority over operations authorized to be conducted under the operations certificate?		
Element 1.3 – Appointment of key safety personnel			
16	Has a qualified person been appointed to manage and oversee the day-to-day operation of the SMS?		
17	Does the person overseeing the operation of the SMS fulfill the required job functions and responsibilities?		
18	Are the safety authorizations, responsibilities and accountabilities of personnel at all levels of the organization defined and documented?		
Element 1.4 – SMS implementation plan			
19	Has the service provider developed an SMS implementation plan that ensures that the SMS will meet the organization's safety needs?		
20	Has the SMS implementation plan been developed by a person or a planning group which comprises an appropriate experience base?		
21	Has the person or planning group received enough resources (including time for meetings) for the development of the SMS implementation plan?		
22	Has the SMS implementation plan been endorsed by the senior management of the service provider?		
23	Is the SMS implementation plan regularly reviewed by the senior management of the service provider?		
24	Does the SMS implementation plan propose implementation in phases?		

(continued)

#	*Aspect to be analyzed or question to be answered*	*Status*	*Description*
25	Does the SMS implementation plan explicitly address the coordination between the service provider's SMS and the SMS of other organizations the service provider must interface with during the provision of services?		
Element 1.5 – Coordination of emergency response planning			
26	Does the service provider have an emergency response/contingency plan appropriate to the size, nature and complexity of the organization?		
27	Have the emergency response/contingency procedures been documented, implemented, and assigned to a responsible manager?		
28	Are the emergency response/contingency procedures periodically reviewed as part of the management review of the SMS, and after key personnel and organizational changes?		
29	Does the service provider have a process to distribute and communicate the content of the emergency response/contingency procedures to all personnel?		
30	Does the service provider conduct drills and exercises with all key personnel at specified intervals?		
31	Does the service provider coordinate its emergency response/contingency procedures with the emergency/response contingency procedures of other organizations it must interface with during the provision of services?		
Element 1.6 – Documentation			
32	Has the service provider developed and maintained SMS documentation, in paper or electronic form?		
33	Is the SMS documentation developed in a manner that describes the SMS and the consolidated interrelationships between all the SMS components?		
34	Has the service provider developed a Safety Management System Manual (SMSM) as a key instrument for communicating the organization's approach to safety to the whole organization?		
35	Does the SMSM document all aspects of the SMS, including the safety policy, objectives, procedures and individual safety accountabilities?		

(continued)

#	*Aspect to be analyzed or question to be answered*	*Status*	*Description*
36	Does the SMSM clearly articulate the role of Safety Risk Management as an initial design activity, and promote the role of safety assurance as a continuous activity?		
37	Are relevant areas of SMS related documentation incorporated into approved documentation, such as Company Operations Manual, Maintenance Control/Policy Manual, Airport Operations Manual, when applicable?		
38	Does the service provider have a records system that ensures the generation and retention of all records necessary to document and support operational requirements?		
39	Is the service provider's records system in accordance with applicable regulatory requirements and industry best practices?		
40	Does the records system provide the control processes necessary to ensure appropriate identification, legibility, storage, protection, archiving, retrieval, retention time, and disposition of records?		

(continued)

Component 2 –SAFETY RISK MANAGEMENT			
Element 2.1 – Hazard identification process			
41	Does the service provider have a formal Safety Data Collection and Processing System (SDCPS) for effectively collecting information about hazards in operations?		
42	Does the service provider's SDCPS include a combination of reactive, proactive and predictive methods of safety data collection?		
43	Does the service provider have reactive processes that provide for the capture of information relevant to Safety and Risk Management?		
44	Has the service provider developed training relevant to reactive methods of safety data collection?		
45	Has the service provider developed communication relevant to reactive methods of safety data collection?		
46	Is reactive reporting simple, accessible and commensurate with the size of the service provider?		
47	Are reactive reports reviewed at the appropriate level of management?		
48	Is there a feedback process to notify contributors that their reports have been received and a process to share the results of the analysis?		
49	Does the service provider have proactive processes that actively look for the identification of safety risks through the analysis of the organization's activities?		
50	Is training provided relevant to proactive methods of safety data collection?		
51	Has the service provider developed communication processes relevant to proactive methods of safety data collection?		

(continued)

52	Is proactive reporting simple, accessible and commensurate with the size of the service provider?		
53	Does the service provider have predictive processes that provide the capture of system performance as they happen in real-time normal operations?		
54	Is training provided relevant to predictive methods of safety data collection?		
55	Has the service provider developed communication processes relevant to predictive methods of safety data collection?		
56	Is the predictive safety data capture process simple, accessible and commensurate with the size of the service provider?		
Element 2.2 – Risk assessment and mitigation process			
57	Does the service provider's SMS documentation clearly articulate the relationship between hazards, consequences and risks?		
58	Is there a structured process for the analysis of the risk associated with the consequences of identified hazards, expressed in terms of probability and severity of occurrences?		
59	Are there criteria for assessing risks and establishing risk tolerability (i.e., the acceptable level of risk the organization is willing to accept)?		
60	Does the service provider have risk mitigation strategies that include corrective/ preventive action plans to prevent the recurrence of reported occurrences and deficiencies?		
61	Are corrective and preventive actions generated in response to event analysis?		

(continued)

Component N° 3 –SAFETY ASSURANCE			
Element 3.1 – Safety performance monitoring and measurement			
62	Are regular and periodic planned reviews conducted regarding: –Company safety performance? –Internal audit reviews? –Hazard identification and occurrence investigations? –Hazard and occurrence analysis results? –Internal feedback analysis/results? –External feedback analysis/results? –Status of corrective actions? –Follow-up actions from previous management reviews? –Changes that could affect safety? –Recommendations for improvement? –Sharing of best practices across the organization?		
63	Is there a process to evaluate the effectiveness of corrective actions?		
64	Are safety reports reviewed at the appropriate level of management?		
65	Is there a feedback process to notify contributors that their reports have been received, and to share the results of the analysis?		
66	Is there a process in place to monitor and analyze trends?		
67	Has the service provider implemented self-evaluation processes, such as regularly scheduled reviews, evaluations, surveys and audits?		
68	Are corrective and preventive actions generated in response to hazard identification?		
69	Are there procedures in place for the conduct of internal investigations?		
70	Do measures exist that ensure all reported occurrences and deficiencies are investigated?		

(continued)

71	Is there a process to ensure that occurrences and deficiencies reported are analyzed to identify all associated hazards		
72	Are corrective and preventive actions generated in response to event investigations and risk analyses?		
73	Does the service provider have a process for evaluating the effectiveness of the corrective/ preventive measures that have been developed?		
74	Does the service provider have a system to monitor the internal reporting process and the associated corrective actions?		
75	Is there an audit function with the independence and authority required to carry out effective internal evaluations?		
76	Does the audit system cover all functions, activities and organizations within the service provider?		
77	Are audit scope, criteria, frequency and methods clearly defined?		
78	Are there selection/training processes to ensure the objectivity and competence of auditors as well as the impartiality of the audit process?		
79	Is there a procedure for reporting audit results and maintaining records?		
80	Is there a procedure outlining requirements for timely corrective and preventive action in response to audit results?		
81	Is there a procedure to record verification of action(s) taken and for the reporting of verification results?		
82	Does the service provider perform periodic management reviews of safety critical functions and relevant safety issues that arise from the internal evaluations?		
Element 3.2 – The management of change			
83	Has the service provider developed and maintained a formal process for the management of change?		

(continued)

84	Does the formal process for the management of change analyze changes to operations or key personnel regarding possible risks?		
85	Does the service provider identify changes within the organization which may affect established processes and services?		
86	Has the service provider made arrangements to ensure the maintenance of safety performance prior to implementing changes?		
87	Has the service provider established a process to eliminate or modify safety risk controls that are no longer needed due to changes in the operational environment?		
Element 3.3 – Continuous improvement of the SMS			
88	Does the organization have a process for the proactive evaluation of facilities, equipment, documentation and procedures through audits and surveys?		
89	Does the organization have a process for the proactive evaluation of individuals' performances, to verify the fulfillment of their safety responsibilities?		
90	Does the organization have a reactive process to verify the effectiveness of the system for control and mitigation of risks?		
Component N° 4 – SAFETY PROMOTION			
Element 4.1 – Training and education			
91	Is there a documented process to identify training requirements so that personnel are trained and competent to perform the SMS duties?		
92	Is the safety training appropriate to the individual's involvement in the SMS		
93	Is the safety training incorporated into indoctrination training upon employment?		
94	Is there emergency response/contingency training for affected personnel?		
95	Is there a process that measures the effectiveness of training?		

(continued)

Element 4.2 – Safety communication			
96	Are there communication processes in place within the organization that permit the Safety Management System to function effectively?		
97	Are communication processes (written, meetings, electronic, etc.) commensurate with the size and scope of the service provider?		
98	Is information established and maintained in a suitable medium that provides direction regarding relevant SMS documents?		
99	Is there a process for the dissemination of safety information throughout the organization and a means of monitoring the effectiveness of this process?		

Appendix: Sample Safety Policy

Our corporate culture focuses, in conjunction with corporate ethics, on the delivery of world class maintenance services. XY Maintenance provides valuable maintenance services for its customers in a safe, flexible, efficient and reliable way. We are committed to developing, implementing, maintaining and to constantly improving our processes and corporate strategy to ensure that all our maintenance activities are conducted using a balanced allocation of resources, aimed at achieving the highest level of safety performance and meeting national and international standards.

All employees are accountable for the delivery of this highest level of safety performance, starting with the Accountable Executive.

XY Maintenance's policy is to foster a generative safety culture of open reporting of all safety hazards where executive management will not initiate disciplinary action against any personnel who, in good faith, disclose a hazard or safety occurrence due to conduct not based on intention or gross negligence,

We operate according to the following key principles:

Safety is considered as the core value of the company
Always operate in the safest manner practicable
Never take unnecessary risks
Safe does not mean risk free

Our commitment is to:

1) Support the management of safety through the provision of appropriate human and financial resources that will result in an organizational culture that fosters safe practices, and which encourages effective safety reporting and communication;
2) Implement and maintain a Safety Management System;
3) Enforce the management of safety as one of the primary responsibilities of all responsible personnel;
4) Actively manage safety with the same attention to results as financial management;
5) Clearly define for all staff their accountabilities and responsibilities for the delivery of safety performance;
6) Comply with, and wherever possible exceed, legislative and regulatory requirements and standards;
7) Continually improve our safety performance and conduct safety management reviews to ensure relevant safety action is taken and is effective;
8) Ensure externally supplied systems and services that support our operations are delivered according to our safety performance standards.

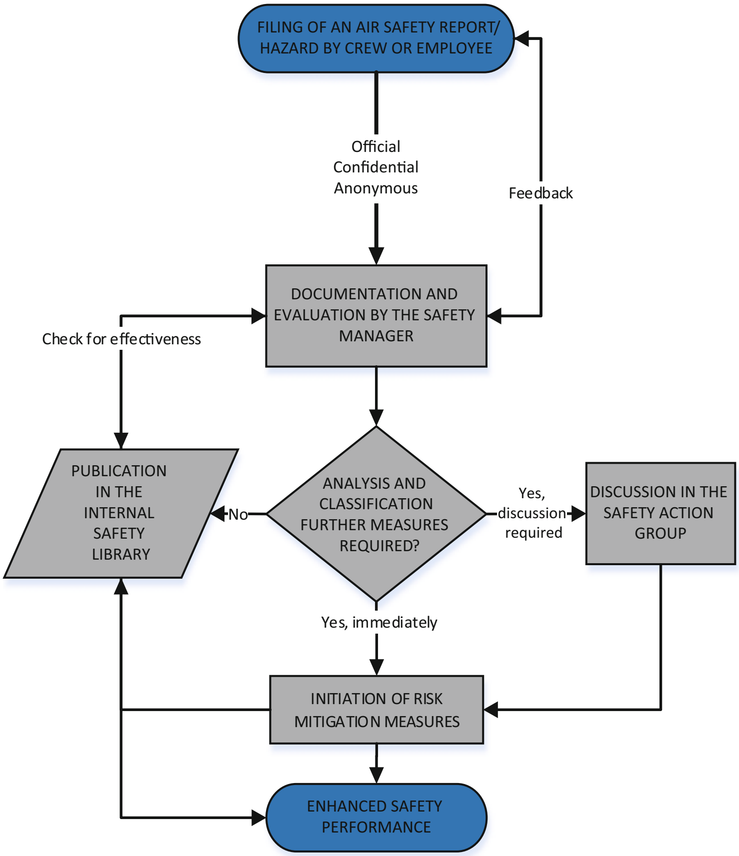
Appendix: Master Risk List Examples

Ref. No.	Risk Identifier	Risk description	Probability	Impact Financially	Risk potential Total	Priority
1	Lighting	Missing or weak lighting on taxi ways or places at the airport leads to accidents	3	3	9	3
2	Obstacle clearance	Buildings in the obstacle clearance area cannot be removed/prevented due to lack of expropriation rights	3	3	9	4
3	Static tests	Accidents as a result of static engine tests	3	3	9	7
4	Aircraft Accident	Accident of scheduled or chartered A/C	2	5	10	2
5	Attacks	Sabotage or Terror attacks	2	5	10	1
6	Market risks	Higher costs/ lower revenues	3	3	9	8
7	A/C stairs	Accident of a disembarking pax on inoperable stairs	3	3	9	6
8	Fuel mix ups	Refueling the wrong fuel	2	4	8	9
9	Towing risk	Accidents while towing large A/C or with parked A/C	3	3	9	5
10	Helipad	Helicopter collides with tank system causing an explosion	2	4	8	12
11	Water	Insufficient water drainage on RWY and Taxi way	2	3	6	18
12	Fire fighters	In the case of an accident not enough personnel or material available in accordance with regulations	2	4	8	15
13	Animals	Accidents because of animals on the RWY	2	4	8	11
14	Personnel bottlenecks	Absence of employees without substitution or without license, leads to business interruption	3	2	6	17
15	Fire	Fire in the administrative building, terminal or hangar	2	4	8	13
16	RWY surface condition	Accident due to poorly maintained RWY surface	2	4	8	16
17	BAZL regulations	Noncompliance with BAZL-regulations leads to official limitations or accidents	2	4	8	14
18	Tank system	Explosion of the tank system	2	4	8	10

(continued)

				Dec 2012				**Jun 2012**				
		Severity: 1=low, 5=high		**Risk level**				**Risk level**				
		Probability: 1=low, 5=high		**L**	**M**	**H**		**L**	**M**	**H**		
		Risk: Severity * Probability		<=3	4-9	10-25		<=3	4-9	10-25		
Ref.No.	**Department**	**Risk description**	**Impact**	**Severity**	**Probability**	**Risk**	**Tendency**	**Severity**	**Probability**	**Risk**	**Measures**	**Responsible Person**
1				5	1	**5**	□	5	2	**10**		
2				3	4	**12**	□	3	4	**12**		
3				4	3	**12**	□	4	3	**12**		
4				1	1	**1**	□	5	1	**5**		
5				3	2	**6**	□	3	2	**6**		
6				3	2	**6**	□	3	2	**6**		
7				2	1	**2**	□	5	1	**5**		

Appendix: ASR/Hazard Reporting Procedure



Appendix: Sample Air Safety Report

Air Safety Report and Hazard identification

Pilot in command	Second in command	Other Crewmember(s)
☒Flying ☐ Monitoring	--	--
Date of Event: 23.04.2013	Time (UTC): 21:45	Dep-Arr/Diversion Dep

Important Notice! The details in this grey shaded area are optional. Independent of this, the report will be made anonymously and the data will not be forwarded! Nevertheless, personal data should be stated for further enquiry.

Subject/event

Abnormal	CRM	Emergency	Pax/Cargo	ATC	Operating practices	Airport	Security
Flight planning	SOP	Charts, Maps, Nav	Dispatch	GA	Ground Handling	Technical	Weather

IAS/MACH: 150 kts Altitude: 3000 ft Fuel (lbs): 3000
No. Crew/pax: 2 Runway: 13 Geographical position: Above RW

Time of day:	Day	Night			
Aircraft:	HB-XXX	HB-XXX	HB-XXX	HB-XXX	HB-XXX
Flight phase:	Parked	Towing	Taxi	Take off	Climb
	Cruise	Descent	Holding	Approach	Go-Around
	Landing	Other			
A/C configuration:	Auto-Pilot	Auto-Throttle	Gear	Flaps	Speed brakes
Runway state:	Slush	Snow	Dry	Wet	
Weather:	Snow	Rain	Icing	Fog	Turbulence
	Hail	Wind shear	Clear	Thunderstorms	
Visibility:	more than 10 km	5 km – 10 km	1km – 5 km	Dense fog less than 1 km	
Temperature:	-30°C to -10°C	-9°C to 10°C	11°C to 16°C	17°C to 25°C	26°C to 30°C
	31°C to 40° C				

Short description: ☒**Hazard**

During takeoff, as the aircraft was climbing, at an altitude of approximately 2000 ft, the right hand engine (engine 2) ingested a bird; the flight crew immediately shut it down and returned for landing. No one on board was injured and the aircraft landed safely. The right engine suffered heavy damage.

Appendix: Safety Manager Evaluation Sheet

TO BE COMPLETED BY THE SAFETY MANAGER

The report has been identified and entered into the company database

Signature: ______________________ Date: xx.xx.xxxx

Rate the probability of the hazard recurring

Often				**Practically impossible**
5	**4**	**3**	**2**	**1**

Rate the worst-case severity

Disaster				**Insignificant**
5	**4**	**3**	**2**	**1**

What action is required to eliminate or control the hazard and prevent injury?

Raise awareness of flight crews operating at that airport, additional training regarding emerge
procedures,
Report incident to airport, harmonize with other operators and request measures from the airp

Required resources:

Responsibility for action:

Appropriate feedback given to staff.

Signed _______________________________ Date_________________

Appendix: SWANS Report[46]

In order to submit a report, please complete the online form below. Alternatively, you can download the Snapform version, which can be sent by mail or fax to the SWANS address. Complaints raised against third persons will not be filed by means of SWANS, they have to be reported to FOCA via the ordinary recourse. Nevertheless, should a complaint against a third person be filed by means of SWANS, the person filing the complaint has to take into account that his/her personal data could be disclosed to the accused person in the course of his/her right of access to records.

Top of Form

URL Homepage (do not fill please)

Date & time of the occurrence (*)

Location of the occurrence (*)

Aircraft type/ immatriculation

Occurrence reported to other parties? (*)

If yes, to whom?

Occurrence description (*)

Possible causes of the occurrence?

What could be done to avoid such an occurrence?

Last & First Name

Company

Street

Postal code/City

Phone Number

Fax Number

E-Mail

Please, fill out all mandatory fields (*)

[46] Bundesamt für Zivilluftfahrt (BAZL) (2007).

Appendix: ERP Checklist Emergency Director

Emergency Director

	Name	Department Responsibilities	Duty Phone	Fax	Mobile Phone	Private Phone
1						
2						

No	ACTIVITIES	WORK performed	TO DO / INFO	Item completed? TIME / DATE / 3LC	Comments
1	Alerting Emergency Director of corresponding Operator				
2	Gain clearance for releasing Telephone Enquiry Center Hotline and forward it to Press Office				
3	Obtain feedback about the arrival of the members of the crisis team				
4	Arrange time for initial briefing				
5	Initial briefing in the Emergency Operation Center • Current Information • Coordination of further steps • Care (Pax, Crew, NOK) • Communication (internal, external) • Data protection • Fieldwork / Field Team • Maintenance of operation • Open issues				
6	Logging of events in the Emergency Log				
7	Obtain contacts from the site of accident from Ground Ops				
8	Establish contact with the Investigator in Charge				
9	Request additional information • Pax condition • Crew condition • A/C condition				
10	Secure original business documentation, documentation of				

(continued)

	A/C, relevant audit reports, etc.				
11	Exchange of information with Investigator in Charge: • Matching of pax data • Supply of necessary data and information				
12	Information exchange with corresponding operator (broker) • Contact Special Assistance Team • Match pax data • Press activities				
13	Information exchange with local authorities • Supply of necessary data and information				
14	Check, whether notification of Civil Aviation Authorities has already occurred, respectively initiate notification via form (refer to "Forms")				

Appendix: Individual Risk Assessment Example

RISK MANAGEMENT SAMPLE COMPANY
Individual Risk Assessment
Risk No. 9 Exchange rate development

Introduction

As part of the Risk Management of the sample company, all potential sources of risk in relation to existence, operation and development of the company are systematically recorded and analyzed. The recognized and relevant risks are assessed according to standard criteria regarding financial scope, frequency of occurrence and severity. The resulting risks are then entered into a Master Risk List according to their priority and risk factor. This is the basis for the individual risk assessment in which the significant risks are presented and mitigation measures are proposed to reduce the level of risk.

Starting point: No. 9 Exchange rate risk developments

- Changes in exchange rates might not only affect income and costs, but also the assets and liabilities of the sample company extremely unfavorably. The sample company invoices in the following currencies: CHF, EUR, USD and YEN. As an exporter, the strength of CHF in recent years is, in the view of the sample company, no advantage.

- For several years, the sample company has assured the currencies CHF, EUR and USD, but not YEN, with instruments at the UBS against downward trends, with the aim of planning security. The corresponding operating margin is described in the mandatory foreign currency directive of October 3rd in 2013.
- For a natural hedging, the possibilities for the sample company are low, e.g. no production facility in the USD or YEN-area, limited ability to pay suppliers and employees in EUR.

Risk No. 9 Exchange rate development

Risk owner	CFO Karl Muster
Probability	Development (gradual) ☐ ☐ ☑ ☐ Event (unexpected)
Risk area	Finance
Hazard	Market prices (Master Risk List item 6.2)
Cause of the risk	- Negative exchange rate developments - Declining sales prices for deliveries abroad (export) - Decline in international business because foreign competitors can offer more price-favorable products (arbitrage) - Lack of currency risk hedging - Rising inflation

Goals	**Procedure / Action item**
☐ Avoid risk ☑ Mitigate risk ☐ Accept risk	Early warning indicators - Exchange rates of banks, etc.
Reduction of frequency	- Implementation of the foreign currency directive
Reduction of severity	- Ongoing completion of foreign currency exchange contracts in accordance with foreign currency guidelines - Limit holdings of unhedged currencies - Prevent opportunities for speculation with currencies, financial instruments, etc. - No additional build-up of exchange rate risks with medium and long-term investment in securities

(continued)

Risk No. 9 Exchange rate development

Measure	Responsible Person	Deadline	Status
Completed measures			
Creating a foreign currency policy	John Doe	30.06.2010	Completed
Check, if the YEN currency should also be hedged	John Doe	30.09.2011	Completed
Pending actions			
Use of hedging instruments at UBS in Zurich	John Doe	31.12.2014	In progress
Regular assessment of the currency positions relative to price limits and stocks (a currency may not exceed a certain amount)	John Doe	31.12.2014	In progress
Waiver of financial instruments and systems that include additional currency risks	John Doe	30.06.2014	In progress
Annual review of pricing arrangements with our subsidiaries regarding currency surcharge or markdown	John Doe	31.12.2014	In progress
Check if a group-wide cash pooling could be useful and practical	John Doe	31.03.2014	In progress

Appendix: Risk Management Policy

NEW AIRLINE LTD.
RISK POLICY

Table of Contents

(continued)

(continued)

RISK MANAGEMENT GUIDELINES

Phase 0: Preparation
Phase 1: Risk Identification
Phase 2: Risk Assessment
Step 1: Risk Consolidation and Classification
Step 2: Risk Prioritization
Phase 3: Risk Measures
Phase 4: Risk Re-Mapping
Phase 5: Reporting

FINAL PROVISIONS

Entry into Force
Changes and Amendments

PRINCIPLES OF RISK MANAGEMENT

Concept of the Risk Management

The Risk Management (RM) of New Airline Ltd. is a task of the Executive Management and is monitored by the Board of Directors, forming an enterprise-wide strategic framework. It is designed to identify potential events that could have a substantial negative impact on the company. Its aim is to control risks and to ensure an adequate level of certainty in relation to the achievement of corporate goals. With the early identification of risks associated with the scope of the different departments, corporate safety should be increased. The RM of New Airline Ltd. is embedded into the existing management processes of the company and should not be a parallel organization in itself.

Purpose of the Risk Management

The main objective of the Risk Management is to provide the Board of Directors (BoD) and the Executive Management (EM) with a complete and continuously updated corporate risk overview. Based on this, the most important risks can then be systematically processed according to their potential and be mitigated as far as possible. The main objectives include:

- Coordination of strategy, Risk Management and internal controls
- Optimization of decisions in response to risks
- Improvement of the reliability of forecasts
- Identification and control of enterprise-wide risks
- Improvement of risk awareness throughout the company
- Standardization of procedures and the Risk Management language at the corporate level
- Annual preparation of a Top Risks List, which is then applied across corresponding departments
- Provision of adequate insurance coverage

- Ensuring that the internal control system (ICS) is continuously implemented and optimized as far as possible.

Strategy of the Risk Management

Risk factors that may impact the ability of the company to reach its strategic objectives are detected and analyzed. The Board and Executive Management of New Airline Ltd. are convinced that risks are always associated with opportunities. Calculated risk-taking is essential for the growth of our company. Each employee should be aware of the strategic direction of New Airline Ltd. and work to achieve these goals by taking reasonable steps, outlined below, in order to effectively manage risks and opportunities.

The strategy of New Airline Ltd. is based on the following vision:

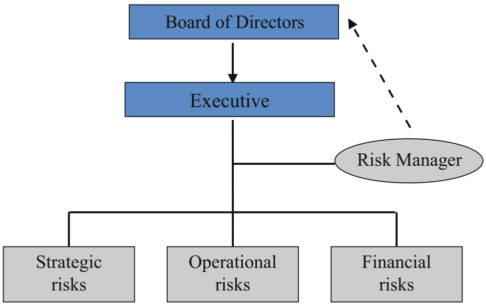
1. Take advantage of the growth opportunities in Switzerland through well-chosen market segments and service solutions
2. Market leadership in the aviation sector in Switzerland with the label Swiss Made
3. Expansion of transportation services by offering state of the art transportation services in a global network

Annual Briefings

The Board of Directors has to discuss the risk environment and the related risk exposure of New Airline Ltd. with the Executive Management at least once per annum. The findings are included in the risks list and measures. Ways to address and mitigate them are presented.

Risk Management Organization

At New Airline Ltd., the Board of Directors has the overall responsibility for Risk Management. The board may seek advice from an advisory board, if such is established and needed. In line with the law, and based on company regulations, the Board delegates the implementation of Risk Management to the Executive Management. The EM is assisted by the Risk Manager. He/she carries out activities on behalf of the EM and reports to them. In the case of urgent risks or if there is a concern that these risks are not adequately perceived and/or covered, the Risk Manager can directly communicate with the Chairman of the Board.



Roles and Responsibilities

Board of Directors (BoD)

- Definition of the risk management organization
- Defining the risk management processes
- Defining the risk management policy and the adoption of the policy
- Ensuring the effective implementation of the risk management organization, risk management policy and risk management processes
- Taking overall responsibility for Risk Management

Executive Management (EM)

- Management of all risk factors within the strategic, operational and financial framework to mitigate and to reduce risks
- Provide timely and accurate information about the risks that the company faces, as well as steps taken to ensure their effectiveness
- Responsible for the implementation and coordination of the Risk Management
- Coordination of information flow and documentation relating to the Risk Management
- Conduct sampling to ensure that all risks are identified, analyzed and, if necessary, a single risk assessment is carried out and appropriate risk-mitigating measures are defined

Risk Manager

- Preparation of annual risk analysis (as part of the annual SWOT analysis) for submission to EM and BoD
- Preparation of the definition of risk-mitigating measures for submission to EM and BoD, as well as monitoring the implementation of the risk-mitigating measures
- Quarterly reporting to the EM on the development of key risks and the level of risk-mitigating measures (risk radar as part of the quarterly reporting)
- Annual report on Risk Management to the BoD
- Coordination of the risk management function with measures of the ICS
- Ongoing identification, definition of proposed measures and reporting of significant changes in the risk environment
- Preparation of the annual insurance overview

- Ensuring that all employees are also questioned about new or worsened risks in connection with the annual staff performance review

Risk Management is the responsibility of everyone in the company, including management and employees, and is therefore explicitly or implicitly part of the job description of every member of the company. In order to allow a proper application of that responsibility by all employees, the relevant risk management information will be published with access for all employees through the intranet.

RISK MANAGEMENT PROCESS

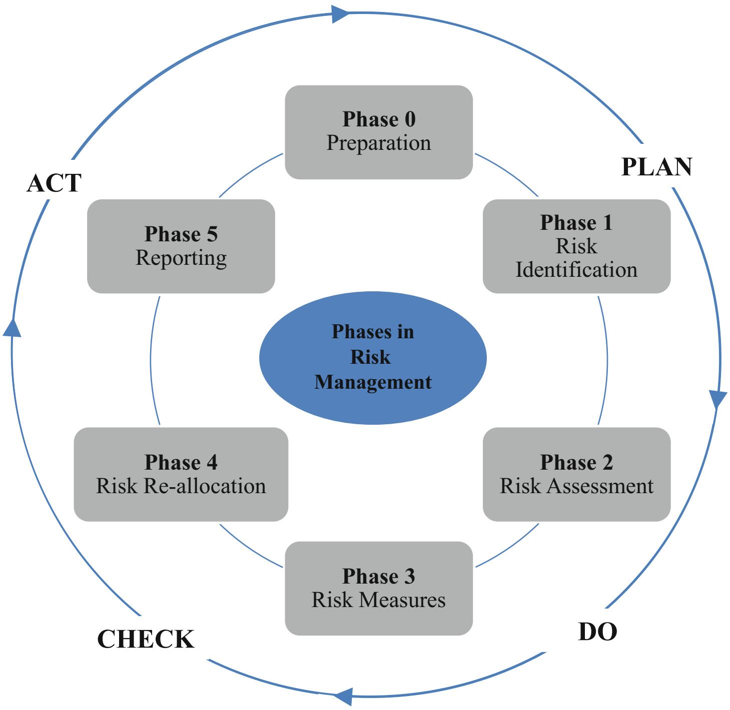
Process Phases

The overall process of risk identification, risk assessment, risk measures, risk re-allocation and reporting in the strategic environment should be carried out annually. In the case of unforeseen and extraordinary events, these processes can occur more frequently.

Six phases of the Risk Management process:

Phase 0: Preparation
Phase 1: Risk Identification
Phase 2: Risk Assessment
Phase 3: Risk Measures
Phase 4: Risk Re-allocation
Phase 5: Reporting

Overview of the Process



The RM process is standardized across the whole company. The Executive Management undertakes all the necessary efforts to raise the awareness of Risk Management amongst employees on every level.

RISK MANAGEMENT GUIDELINES

Phase 0: Preparation

The preparation phase is a long-term process and is not performed on an annual basis. It takes place over a longer period of time, and is modified and amended with changes in strategy, in cases of extraordinary events or when new information becomes available. This phase includes the following tasks

- Set up of the Risk Management Organization
- Establishment of Risk Management Processes
- Establishment of the Risk Management Policy
- Set up of Risk Management Guidelines

Milestone 0: Set up of the Risk Management Organization, approve the Risk Management Policy, implement Risk Management Processes and adopt the Risk Management Guidelines. As a result, the Risk Policy is adopted or revised by the Board of Directors.

Phase 1: Risk Identification

In this phase, all risks that confront New Airline Ltd. are identified. A risk is an incident or event that arises from either internal or external sources and could have an impact on the implementation of a strategy or the achievement of objectives. Risks can have either positive or negative effects; however, the focus of risk management activities at New Airline Ltd. is on negative events. At this stage, the Executive Management identifies and monitors all potential events, even if these events have a low probability of occurrence. This is especially relevant if the potential impact on the achievement of important objectives is high.

In order to capture all relevant risks, not just the BoD and EM members are interviewed by the Risk Manager. All the employees of New Airline Ltd. have to be questioned about possible risks, using a standardized questionnaire. Subsequently, this survey can be conducted in conjunction with the annual employee performance review.

Milestone 1: After the implementation of the risk management process all employees, as part of their annual employee performance review, are interviewed about possible new or worsened risks.

Phase 2: Risk Assessment

Step 1: Risk Consolidation and Classification

All identified risks are first consolidated by an interdisciplinary team composed by the EM, and under the direction of the Risk Manager. Similar risks will be clustered and risks without a relevant damage potential will be deleted. The risks are classified into the following three categories: strategic risks, operational risks and financial risks.

Strategic risks: all risks that endanger the existence or continuation of the company or which may cause the company to go into liquidation/insolvency are classified as strategic risks. In general, these risks relate to the long-term success and viability of the company. These include:

- Risks which arise from disasters or force majeure situations including service disruptions caused by natural disasters, uncertainties, service liabilities, etc.
- Environmental risks: Strong competitors negatively affecting the business. Incorrect, untimely or unavailable information about competitors/rivals and their products could have an adverse impact on the business.
- Management risks: In addition to having an appropriate organization, management style is one of the crucial preconditions for the success or failure of a company. Lack of leadership (unclear instructions, unclear responsibilities) may represent a risk to a company, such as overdependence on leading executives.

- Risks related to stakeholders: Ensure that the company is focused on the needs and aspirations of all stakeholders, including shareholders and business partners, authorities, suppliers and society in general.

Operational risks: Operational risks are those risks that threaten strategic goals due to inappropriate or lack of internal processes, people or systems. In general, these risks are short or medium-term risks and include the following:

- Process risks: Risks that relate to the customer value proposition process in the company.
- Operational risks: Risks that arise in the daily operation, such as insufficient resources, quality problems, illness, accidents, miscalculations, maintenance deficiencies, etc.
- Credit risks: Risks associated with the failure of important equipment for operations such as failure of the necessary IT infrastructure, etc.
- People and cultural risks: Risks that arise as a result of years of corporate culture development and the people that live and work in this culture. There are several categories of such risks, and they may take the form of resources, know-how and skills, motivation, integrity, compensation, performance, relationship with trade unions and legal problems.
- Legal risks: Potential for losses arising from the uncertainty of future regulations or legal processes, such as outcomes of litigation, bankruptcy, etc.

Financial risks: Risks that have purely financial implications for the company (short or long term) fall in this category, for example:

- Market risks: The possibility of losses arising from adverse changes in market prices and rates, including commodity prices, interest rates and exchange rates.
- Liquidity and credit risks: Liquidity risk describes a situation in which one party is not able to meet liabilities and debt obligations at a certain point in time. This may affect collection, management of liquid assets, hedging and financing.
- Taxes, regulations and accounting: The accounts are subject to a thorough examination and may be subject to substantial risks in light of existing lawsuits and legal measures.
- Capital structure: The company does not have sufficient/optimal capital, resulting in higher capital costs, lower profitability and a reduction in cash flow and liquidity.

Step 2: Risk Prioritization

A workshop should be organized in order to prioritize risks in the master risks list. Members of Executive Management from selected departments and an external advisor all take part in this workshop. The idea is to encourage an open dialogue about risks.

All identified risks are analyzed based on a risk priority number (RPN), which is based on two criteria and a weighting on a scale of 1–5. The criteria are defined as:

- The impact or severity of the event (effect of risk in financial terms)
- Probability of occurrence (frequency with which these risks occur)

The risk priority number (RPN) is obtained with the multiplication of the two risk factors. The lowest RPN is therefore 1 and the highest 25. Part of the risk assessment is also to determine whether a risk has a relevant lead time. This is considered as a surprise factor which is accounted for with the risk factor of −1. The prioritization is made in the master risk list based on the determined RPN.

The master risk list should be treated as confidential by all employees. However, it may be required to present it to insurance brokers and insurance experts in connection with the annual insurance verification. The matrix to determine the RPN is shown graphically below.

Disaster	>50M CHF	**5**	**10**	**15**	**20**	**25**
Critical	>5 < 50M CHF	**4**	**8**	**12**	**16**	**20**
Moderate	>0,5 < 5M CHF	**3**	**6**	**9**	**12**	**15**
Low	>0,05 < 0,5M CHF	**2**	**4**	**6**	**8**	**10**
Insignificant	< 0,05M CHF	**1**	**2**	**3**	**4**	**5**
	Criteria	< 1 per 100 years	> 1 per 100 years < 1 per 10 years	> 1 per 10 years < 1 per 1 year	>1 per year <1 per month	> 1 per month
Severity / Probability		**Practically impossible**	**Unlikely**	**Possible**	**Occasional**	**Often**

Zone 1	(red)	Risk is not acceptable, immediate measures for risk mitigation required
Zone 3	(yellow)	Tolerable risk, evaluate measures for risk mitigation
Zone 4	(green)	Acceptable risk, no measures required

Potential risks of more than ten RPN, according to the risk assessment, are the main risks (Top Risks) of New Airline Ltd. These risks have top priority for the following reasons:

- To keep the directed attention on the selected issues
- To allocate the available resources, human capital and finances efficiently.
- To assign risk owner(s) to each top risk

Milestone 2: Identification, development and mapping of the most important risks (Top Risks).

Phase 3: Risk Measures

The measures for each of the key risks (Top Risks) are defined in a so-called individual risk assessment. The analysis includes:

- The complete scenario of the risk occurrence
- Drivers of the risk
- The connection of this risk to other risks
- Quantification of risk (intelligent estimate)
- Identification of the "need for action" and definition of the necessary risk-mitigating measures

The detailed analysis must then be discussed with the Executive Management. Each risk is monitored by the Risk Manager along the following points:

- Clear and achievable goals and benchmarks
- Detailed planning process, including clear deadlines, important milestones and cost–benefit analysis
- Definition of Key Performance Indicators (KPIs) or Standards
- A clearly defined methodology
- Clear allocation of resources

Milestone 3: The measures for handling risks are defined, the action plan is prepared and persons responsible for each of the top most important risks are appointed.

Phase 4: Risk Re-Mapping

The action plan for responding to a particular risk is set in a specific, corresponding project. The risk mapping should be updated in the second quarter of each year, along with trends in the risks in the Top Risks List and the effectiveness of responses to these risks. The re-mapping is important for the following reasons:

- To keep the development of risk scenarios in mind
- The review of the effectiveness of measures for handling risks
- To control the risk management process

To ensure an accurate and complete understanding of all the potential risks, periodic surveys of all employees are conducted (as part of the annual performance review) to obtain their risk assessment. Where possible, the risk re-mapping should be made by a multidisciplinary team.

Milestone 4: The individual risk assessments are continually processed by the respective risk owners in coordination with the Risk Manager.

Phase 5: Reporting

The reporting is prepared by the Risk Manager and the monitoring of the risk management process is documented as follows:

- Quarterly reporting to the EM concerning the major risks
- Annual reporting of all risks according to the master risk list and the activities of the Risk Manager to the BoD
- Annual update of all documents relating to the Risk Management

In order to be able to update the Risk Management and reporting to the latest development standards, the Risk Manager should attend relevant training in consultation with the EM.

Milestone 5: Regular updates and reports on the follow up process, the effectiveness of risk responses and proposals for the next cycle.

FINAL PROVISIONS

Entry into Force

With the resolution of the Board, this risk policy will be active with immediate effect and replaces all previous provisions for risk management within New Airline Ltd.

Changes and Amendments

This risk policy has to be reviewed at least every four years and has to be amended if necessary.

****

Zürich, 1 April 2013

Chairman of the Board of Directors: Board secretary:

________________________________ ________________________________

Appendix: Steps in Assessing Risk

According to Kaplan and Garrick (1981), pp. 11–27:

> What can happen, how likely is it, that it will happen and if it does happen, what are the consequences?

According to Suddle and Waarts (2003):

1. Probability of undesired consequence.
2. Seriousness of (maximum) possible undesired consequence.
3. Multi-attribute weighted sum of components of possible undesired consequence.
4. Probability x seriousness of undesired consequence (“expected loss”).
5. Probability-weighted sum of all possible undesired consequences (“average expected loss”).
6. Fitted function through graph of points relating probability to extent of undesired consequences.
7. Semi-variance of possible undesired consequences regarding their average.
8. Variance of all possible undesired consequences regarding mean consequences.
9. Weighted sum of expected value and variance of all possible consequences.
10. Weighted combination of various parameters of the probability distribution of all possible consequences (encompasses 8 and 9).
11. Weight of possible undesired consequences (“loss”) relative to comparable possible desired consequences (“gain”)

Appendix: Insurance Review

1. Is the insurance coverage complete?

Insurance	Insurer	Insurance coverage	Insurance term
Public Liability Insurance			
Insurance of property			
Aircraft Insurance			
Personal Accident Insurance			
Comprehensive Aircraft Insurance			
Motor Vehicle Insurance			
Accident Insurance			
Collective Accident Insurance			
Sick-pay Insurance			
Loss-of-use Insurance			
Operating legal expenses Insurance			
Special Insurance (in case of blackmail)			

2.	**Are all risks associated with the master risk list covered by insurance?** □ Yes □ No Measures? ....
3.	**Are the risks insured to a significant degree?** □ Yes □ No Measures? ....
4.	**Is the time of the insurance coverage long enough?** □ Yes □ No Measures? ....
5.	**Risks are not insured twice?** □ Yes □ No Measures? ....
6.	**Was the legal standard adhered to in connection with legal risks?** □ Yes □ No Measures? ....
7.	**Is there a written assessment by the insurance broker available?** □ Yes □ No Measures? ....

(continued)

8.	**Is there a written confirmation of the insurance broker?** □Yes □ No Measures?	
9.	**Are the commissions or fees reported transparently in connection with the insurance accounts / new contracts?** □ Yes □ No Measures?	
10.	**Does transparency exists to whom and in what amount any fees or commissions in connection with insurance policies, insurance or renewals are paid ?** □ Yes □ No Measures?	

checket at ....

by ....

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