Classroom Companion: Business

Andreas Wittmer
Thomas Bieger
Roland Müller *Editors*

Aviation Systems

Management of the Integrated Aviation Value Chain

Second Edition

Springer

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Preface

Globalisation has led to a strongly growing demand in international air transport. This growth was fuelled by deregulation of the airline sector. The industry has been challenged by downturns every decade and at the time of finalising this book, by COVID-19, the biggest global aviation downturn in history. The aviation industry is facing huge challenges, especially with respect to its impact on the environment and new technologies to solve those challenges. More than ever, policy makers, business leaders, but also the whole society need a deeper understanding of the aviation sector and the connections between its benefits and costs.

This book targets industry managers as well as policy makers, institutional customers of the sector, and in particular students in the field of transport and tourism. It provides an overview on the aviation sector with a special focus on value creation and strategies based on industrial economics. The consequent application of a system view makes the book unique in its field. The book draws on the rich tradition of integrated management approaches and the use of system models in management research and teaching of management at the University of St. Gallen. The system view and the use of system models help to understand interrelated and interdependent developments, like the consequences of technical progress on regulation, supply and demand.

The authors were fortunate enough to be able to draw on research results of many years at the Center of Aviation Competence at the University of St. Gallen. Therefore, the editors thank all colleagues who contributed to this book by discussions, research contributions and administrative support, and especially the co-authors René Puls, Adrian Müller, Erik Linden, Jan-Christian Schraven, Mark Roth and Philipp Boksberger. Special thanks go to our assistant Christopher Siegrist, who did the language editing and supported with different works along the development of the book.

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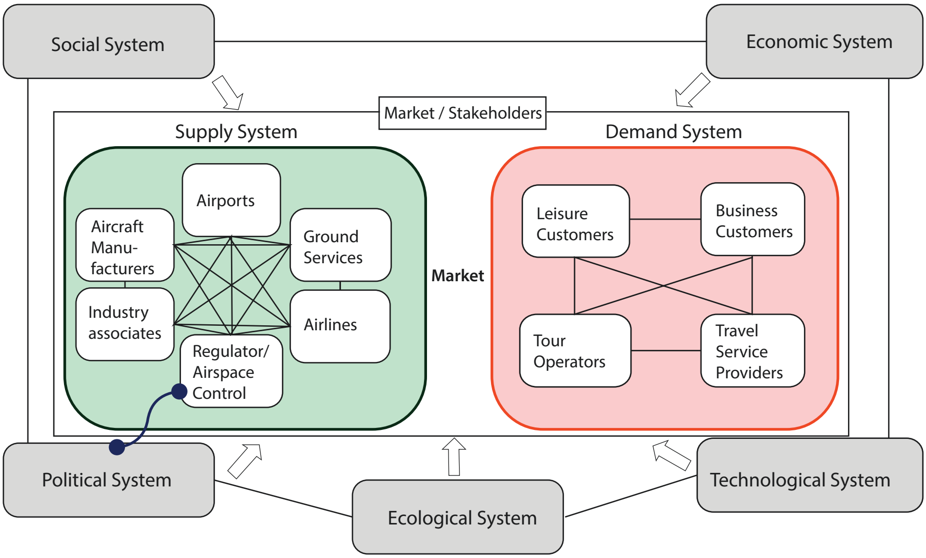
1 April 2021

Aviation Systems Management Summary

The liberalisation of markets, rapid technological changes and the establishment of new businesses in air transportation constantly raise new questions for theory and practice. Current and future developments in aviation are thereby shaped by the industry actors and structures, in short, the aviation system. The textbook *Aviation Systems* addresses these questions by providing a detailed picture of major management aspects in the field of air transportation. Directed at students, researchers and practitioners alike, the book deals with the three major stakeholder groups in aviation: the air transportation industry itself (supply side), the customers (demand side) and the regulatory bodies and organisations (institutional side). The book follows a superior system approach in the field of aviation economy and creates the big picture of the aviation industry. The following figure shows the aviation system as a fundamental framework underlying the chapters of this book.



Source: Wittmer & Bieger, 2006

► Chapters 1 and 2: Fundamentals and Structure of Aviation Systems

► Chapter 1 starts with an overview of trends, especially mobility trends, which will shape the aviation industry.

► Chapter 2 provides an overview on the fundamental industry structures, the industry's importance, its size and historical development. The author introduces the air transportation industry as a highly dynamic and complex industry, characterised by high cyclicality and a great vulnerability to external shocks and volatile commodity prices.

While on several levels of the value chain the industry is characterised by duopolistic (aircraft manufacturers) or oligopolistic (airports) market structures, on other levels of the value chain, companies act in a polypolistic market and face fierce competition (airlines). Main stages of the aviation value chain, however, face the problem of a high fixed cost structure characterised by specific and capital-intensive investments in long-term assets. This creates high exit barriers, but at the same time there is an oversupply and a very competitive market, which leads to low prices demanded by the market.

► Chapter 3: The Environment of Aviation

The economic relevance of aviation includes direct, indirect, induced and catalytic effects. Apart from its economic relevance, air transportation leads to social benefits by contributing to global welfare as well as improved living standards, and supports and increases cultural understanding as well as multicultural cooperation. The authors also show within this chapter that these benefits come at the cost of negative ecological impacts. The textbook gives an overview on major negative externalities of aviation, both on a local and a global level.

► Chapters 4–7: The Supply Side of Aviation

► Chapters 4–7 covers the supply side of aviation. It presents the path from the aviation value chain to the aviation system (► Chap. 4) as well as the theoretical basics of network management and its application to air transportation. By introducing major strategies for network management – such as the hub-and-spoke system vs. the point-to-point system – the authors analyse the prerequisites for the operation of these systems and their usage in the different business models that exist in aviation, whilst providing a new framework for analysing airline business models (► Chap. 5). The major business models in aviation are also introduced: the full-service network carriers, regional (niche/wet lease) airlines, point-to-point carriers, leisure airlines and business aviation. A view from an airline planning and operations perspective is added in ► Chap. 6. In a further step, the focus is moved from the air to the ground. ► Chapter 7 provides an introduction to the "landside" of air transportation, including airports and the respective ground infrastructure.

► Chapters 8 and 9: The Demand Side of Aviation

The demand side of the aviation industry can be classified into people flying for business and leisure purpose. Business travellers usually seek quality services and demand frequent flights to a wide range of destinations, and they are willing to pay a premium for these benefits. Leisure travellers, by contrast, often seek the lowest available price, but are less concerned with service offerings, flight frequency or the number of destinations served. Generally, it can be observed that the heterogeneity of passengers is increasing. The authors discuss marketing, segmentation, pricing (revenue management) and customer value of air transport (► Chap. 8). Furthermore, passenger behaviours are discussed to better understand the behavioural issues of passengers (► Chap. 9).

► Chapters 10–15: Steering and Controlling the System

Steering aspects (e.g. influence of regulatory institutions, aviation law), safety provision and human factors, long-term planning as well as controlling aspects in aviation (e.g. corporate governance, risk management) are analysed in detail to show how the aviation industry is shaped by its institutional surroundings. Regulations cover all elements of the air transportation value chain, from the construction of aircraft to customer contacts specifying how contract conditions of tickets are shaped.

The book distinguishes between public and private institutions on the one side, as well as between national and supranational institutions on the other side (► Chap. 10). While public organisations generally serve as norm-setting and monitoring institutions, private organisations often serve as a platform for member exchange and advocacy and are not allowed to set binding norms and rules. Important institutions, such as ICAO and IATA, are introduced and their specific roles and competencies are discussed. It is also shown how the industry is shaped by the norms and regulations set by these bodies. In this respect, the ► Chap. 10 elaborates on how international institutions influence competition structures in air transportation and thus may cause potential distortions among states and individual companies, such as airlines and airports.

► Chapter 11 provides an overview of risk, safety and security in aviation from a consumer and also air service provider perspective and leads to the discussion of an organisational cultural understanding in relation to human factors. Human factors (► Chap. 12) deal with the human–machine interface and all factors which influence humans when operating planes with respect to safety. The book investigates an increasingly intercultural industry, where cultural differences and languages become an increasing issue. Furthermore, the just culture concerning how we deal with failures, e.g. blame or no blame for failures, is addressed.

Aviation governance (► Chap. 14) deals with corporate governance of aviation companies. Corporate governance includes corporate risk management. The book shows how corporate risks (► Chap. 13) and the integration of all risks, not only safety risks, are highly important for sustaining an aviation company in the long run.

Furthermore, the aviation industry is exposed to regular external shocks, which is challenging for management. During an environmental shock, there are high levels of uncertainty, which can lead to unproductive long-term decisions. ► Chapter 15 addresses how to strategically prepare for external shocks in management.

► Chapter 16: Future Technologies and Development of Aviation

The book picks up three developments, which are linked to new technologies and might influence the future of air travel.

Supersonic travel was possible in the past until the famous Concorde crashed and supersonic travel came to a halt. Since then, new developments of supersonic air transport failed to enter the market for technical, economic and environmental reasons. Nevertheless, there are certain concepts, and some of them may make it to the market in the coming years.

Space tourism is a new potential market for travellers. While the first companies are already trialling their products, the technological implementation and the price of space travel make it unclear as to when and how the market will develop.

There are many different fields for the application of drones and urban air mobility. One of them being passenger transport. Despite the many obstacles in place, there are many opportunities for drone taxis. It will take some time until obstacles are overcome and trust in automated air vehicles will allow them to enter the market. The market entry will most likely be seen in markets where time versus cost efficiency gains are possible. This will most likely be in city transport, intercity transport and airport shuttle services.

Andreas Wittmer

Contents

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The Future of Mobility: Trends That Will Shape the Mobility and Aviation Industry in the Future

Andreas Wittmer and Erik Linden

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The Future of Mobility: Trends That Will Shape the Mobility…

Summary
- Digitalization is a gigatrend.
- Individualization, urbanization, ecology, globalization, new life, new work, security and mobility are eight megatrends to have on your watchlist.
- Autonomous vehicles, sustainable mobility and mobility sharing will reshape the mobility system.
- These trends have a global character, even if they are not pronounced everywhere at the same time with the same characteristics and the same magnitude.
- Be aware that these trends have a fundamental impact on supply and demand. Thus, introduce a culture of openness towards dynamic change and introduce uncertainty and curiosity as standard factors to embrace these trends.

Mobility is set to change in the future and this chapter maps these changes as well as the potential outcomes. It starts by exploring giga- and megatrends that will influence and shape the future of mobility. Technical innovations around autonomous vehicles, sustainability and mobility sharing will form part of the change in the mobility system. Although the shape and impact of these phenomena will differ across various geographical regions, they will have a global impact. The impact of these trends will shape the supply and demand sides of our economy. It is recommended that decision makers follow a culture of openness towards dynamic changes, which result from these trends. Furthermore, curiosity and uncertainty are standard factors that should be accounted for when working with these trends. This is not to be seen as an extensive list of trends, nor as a scientific piece on these trends. The chapter is rather based on our ongoing exchange with various societal, economical and political actors on these trends. It is a piece of opinion, which shall allow decision-makers to get curious about these trends, get involved in discussions on these trends, and/or exchange ideas and thoughts with their stake- and shareholders on this piece. It is further ought to be used as initial piece for long-term planning and thinking processes in for-profit and non-for-profic organizations.

1.1 Gigatrend Digitalization

1.1.1 Trend Management in General

Many researchers, scientists and also private institutes and companies are addressing the topic of the future and trying to analyse the effects of current trends for the future. Megatrends serve as early warning systems in corporate circles and highlight possible bottlenecks and shortages in life. They thus the future more plannable. This holistic view, with which we proceed to observe these deep currents of change, is not primarily technology-centred, but is always socio-technical, i.e. an evolutionary perspective on the interface of society and technology.

Trend research is increasingly reaching its scientific limits. Only a few methods and standards have been developed yet which reliably describe the changes in systems. By combining quantitative methods (e.g., updating past developments through mathematical-statistical procedures) and qualitative methods (e.g., Delphi method, in-depth interviews, etc.), futurology does justice to the level of abstraction of a trend and the different knowledge types humans possess and are able to handle. Nassim Nicholas Taleb describes an essential limit of trend research in his book *The Black Swan* (2015). He shows that highly improbable events (called black swans) can occur, which are very difficult to measure and have a significant impact on the future of systems (e.g. earthquakes, economic and social revolutions, wars, etc.). The relevance of the factor of uncertainty has risen sharply as a result of scientific debate and the consideration of future or trend worlds. Trend research is thus currently in a paradox to explore the impossible to strengthen the validity of its own trend research.

1.1.2 Definition Gigatrend

Joseph. A. Schumpeter already assumed that in a cycle of at least 50 years, a trend will develop, which will then transform into the economy, ecology and society and thus influence the lives of all people on earth (Schumpeter, 2008).

The term *gigatrend* has been used very little in science and practice so far. The term *megatrend* strongly predominates. The term gigatrend merely describes the next higher prefix of the term megatrend. To put it simply, the word *giga* here means a "gigantic" change and the word mega a huge change in our society. When talking about a gigatrend in the following, this type of trend includes the following prerequisites:

- The trend must have an impact on all existing megatrends and other trend forms as well as on all areas of life, whereby this impact can be different.
- The trend is international and can be observed in all soecietal and economic systems.
- The trend has a half-life of at least 30 years.

Gigatrends, therefore, not only have an impact on all current megatrends but also on systems of industries or sectors due to their holistic nature. They considerably influence supply and demand and have different characteristics depending on the system, country and region.

Gigatrends are not intended to show what is already discernible today, but instead move on the borderline of what can be known and, through this level of abstraction, provide added value for the investigation of a future in more than 30 years, which is very difficult for people to imagine today (Kreuzer, 2003).

> Imagination is more important than knowledge. For knowledge is limited, whereas imagination embraces the entire world, stimulating progress, giving birth to evolution. It is, strictly speaking, a real factor in scientific research. (Einstein, 1931)

Gigatrends are to be distinguished, among other things, in their cycles and characteristics from megatrends (20–30 years), technology (15–20 years), society (10–15 years), consumption (5–10 years) and product trends (2–5 years).

1.1.3 The Gigatrend Digitalization

According to the Gartner Glossary (2020), *digitalization* is "the use of digital technologies to change a business model and provide new revenue and value-producing opportunities; it is the process of moving to a digital business."

> » The digital revolution currently affects all areas of the economy and society and will have similar disruptive effects as the industrial revolution in the 19th century. (Zukunft Mobilität, 2016)

> » Digitalization will be the main driver for the future of mobility. (Sommer, 2016)

What a few years ago was considered fictional, visionary thinking and represented the maximum level of abstraction, has now become everyday life: AI, the Internet of Things, Big Data, wearables and many other digital forms of products are influencing the future worldwide (Linden & Wittmer, 2018). The mobile, digital life will replace the classic computer. Digital products, such as smartphones, tablets or wearables, can be carried conveniently either directly on the body or in the trouser pocket. Humans and technology are growing together (more on this under connectivity). For Generation Z, it will be a crucial to be very mobile. A further development of information technology, sensor technology (Heinrich et al., 2015; Tille, 2016) and robotics (Haun, 2013; Molzow-Voit et al., 2016), as well as miniaturization of technical components, can be observed (Sánchez, 2008; Wiechert, 2015). The leaps in innovation are increasing as a result of advances in nanotechnology (targeted manipulation of matter at the atomic and molecular level) (Ahmed & Jackson, 2015; Schneider, 2016; Wolf & Freudenstein, 2015) and bionics (Küppers, 2015; Steinbuch & Gekeler, 2016) as well as the increasing semantics and intelligent algorithms up to a so-called Web 3.0 (Stachowicz-Stanusch & Wankel, 2016) or the much-discussed Industry 4.0 (Brettel et al., 2014; Lee et al., 2015). Besides, the technologies are networking with each other, which is leading to increasing consolidation effects in many industries and in some cases, across industries (Zukunftsstark, 2016). This is giving rise to new digital and internet-based business models that take computer support into different areas of life, new forms of communication and participation, increasing real-time information processing, and start-up and beta culture as models (Zukunftsstark, 2016). Through gamification (Mitzscherling, 2015; Wood & Reiners, 2015) and other applications, such as artificial intelligence, companies can change customer behaviour (Watson, 2014). The gigatrend of digitization will certainly, in the long term, lead to automation and technologization of the world of work, life and transportation. Digital and global subcultures are emerging, which also promote the digital participation of users from developing countries.

> » Every part of the UK economy and our lives has been digitized – from how we shop and entertain ourselves to the way we travel to work and manage our health. (Vaizey, 2015)

This often raises the question of the legal protection of both newly created and already existing generated data. Specifically, this concerns data, operational and, in the context of the digitalization of motion, vehicle safety (more on this in the megatrend of safety). According to experts, the right to privacy is an obsolete model. The increasing use of data will lead to a democratization of data in the future. The sub-trend of open-source redefines privacy. The individual is given more personal responsibility but also more freedom (Zukunftsinstitut, 2016). Thus, the democratization of public data also leads to the unleashing of private information. In the coming years, a new awareness of data rights will form and be reflected in socially sanctioned rules. However, this also leads to a demand for more transparency; with transparency becoming an increasingly important attribute of every economy and various public and private organizations (EY, 2016).

> » The Internet of Everything is the connection of people, data, process and things. It is revolutionizing the way we do business, transforming communication, job creation, education and healthcare across the globe. (Chambers, 2014)

Computer-based avatars and brain-computer interfaces are the latest technologies (Diego-Mas & Alcaide-Marzal, 2015; Myers et al., 2016), which make the interface between products and humans even more fluid – whether by replacing the human with a machine (already commonplace in the industry today), an assistance function with avatars or only by better connecting the human brain to digital or material end products. The future of digitalization will certainly not depend on whether things are possible, but on whether people are willing to trust. This fact describes the failure factors to date of, for example, autonomous driving (more on this in the section on autonomous vehicles) or other fully autonomous products in the industry. Many expert opinions show that the entire world, all other trends, systems of industries and their value chains are fundamentally changed by digitization. Experts, therefore, no longer speak of digital industries, but of industries that operate in a digital world.

> » We should no longer be talking about "digital marketing", but "marketing in a digital world". (Weed, 2015)

Moreover, the term digitalization also includes the connectivity of people and things. Connectivity refers to the organization of humanity in networks in the context of digitalization. Via new digital products, not only people but also machines communicate with each other. According to Evans (2011) of Cisco, around 50 billion "things" are connected to the Internet by 2020. The interaction of these systems is crucial. Everything is then interdependent. Connectivity, therefore, has not only a technical impact but also a social one. The partial trend towards Big Data (Fasel & Meier, 2016; Hu, 2016) and open source (Anthes, 2016; Watters & Layton, 2016) allows companies and administrative structures to the outside world (Deek & McHugh, 2008). It is driven by the demand for transparency, which is transforming society as a whole. Data should, thus, be freely accessible. Due to the new availability of data, increasing networking and communication between devices can be observed. This, in turn, is making the partial trend of connectivity increasingly dynamic.

Whether it is a home cinema, lighting, everyday objects such as the refrigerator or other types of terminal equipment, they can increasingly be used in networks with other products. Digital and analogue realities are increasingly merging into a holistic one (Zukunftsinstitut, 2016). Life as a whole becomes more connected. Modern communication technologies give connectivity a breath-taking dynamic, where change, disruption and innovation are the results. New forms of national economies are emerging in the shape of new social, economic and collaborative communities. Through digital interface management, infrastructures can increasingly be networked and function, especially in the field of mobility, with intelligent contact points between hardware, software and humans. Vehicles will become parts of smart grids (Eberl, 2013; Mouftah & Erol-Kantarci, 2016; Stephens et al., 2015). Not only do they consume energy, but they also store energy or return it to the environment when required. Parked vehicles, for example, can act as interactive elements in urban space and interact with people (e.g. as city guides or through interactive advertising). The trunks and interiors of parked vehicles, for example, can be made accessible and thus usable.

> » Infrastructure is already in place today. It is important how this infrastructure can be networked and used in a more digital way. (Beckmann, 2016)

The trend becomes more critical when one considers that there are different mobility requirements in different areas (urban, suburban and rural) and that different technologies or products are and will be attractive. One can certainly not fundamentally assume that explorations on the scale of the gigatrends will be made. However, one should sharpen the senses for such elementary changes in society and extend trend research through this giga level, also due to the cycle and the holistic view. To this end, this short report should provide added value, stimulate critical reflection and focus on future discussions.

? Key Questions for Digitalization

- *What does digitalization really mean? What does it not mean?*
- *How can I use digitalization in a beneficial manner?*
- *Do we need digitalization for the sake of digitalizing or rather because of increasing efficiency or effectivity?*

1.2 Megatrends

> » Megatrends (…are) large social, economic, political, and technological changes (…), they influence us for some time. (Naisbitt, 1982)

> » A megatrend influences our social world view, it influences our values and our thinking. (weiterdenken.ch, 2010)

> » Megatrends are the result of complex interactions between many different social, cultural, economic and technological systems. (Frick, 2016)

“[A megatrend] must play a role in ALL areas of life and show effects (economy, consumption, politics, everyday life, etc.). In principle, megatrends have a global character, even if they are not pronounced everywhere at the same time” (Horx, 2014). A megatrend has a fundamental impact on supply and demand and varies

Fig. 1.1 Illustration of the megatrends described in this chapter. (Author's own figure)

by country, industry and organization. The effect can have different characteristics in each case. If we speak of a megatrend in the following, this trend form has a half-life of at least 20 years.

The summary presented here is intended to provide a basis for discussion of the megatrends. It is important to note that the following list by no means covers all megatrends, but only those that have a central impact on future mobility. Therefore, the megatrend mobility is also listed separately at the beginning. Also, the megatrend of mobility will be given special attention in all megatrends. However, a compilation of megatrends, and therefore this chapter, is never final and conclusive. The megatrends examined in this chapter are shown in Fig. 1.1 (Frick, 2016).

However, there is one significant limitation to be made when it comes to the topic of megatrends. So-called wild cards (events not foreseeable in the future) are not to be considered here. Trends can develop into various extremes or be eliminated by the influence of other megatrends or other externalities.

> » Anyone who thinks into the future must always take into account that everything will be different from what we think today. (Maas et al., 2015)

1.2.1 Individualization

Individualization describes the process of replacing industrial and social forms of life with post-industrial values of self-determination and self-realization. Decentralization is a decisive factor in this respect. The megatrend is developing as a result of an improved standard of living, extensive social security and new, digital ways of life and opportunities. There is a pluralism of lifestyles and the traditional family image is changing (see megatrend New Life). However, in this society, which is to be shaped freely by the individual, also known as a "multi-option society" (Cachelin, 2009; Heufers, 2015), there is also pressure for individuals to make decisions. This pressure to make decisions is changing values and attitudes and with them the economy, in which "do-it-yourself cultures"

(Reed, 2016; Suh et al., 2016) along with “free economies” (Andrews, 2013) are forming, and niche markets are established. Cultures of LOHAS (Helmke et al., 2016), LOVOS (McGouran & Prothero, 2016; Rich et al., 2016) and service clubs are emerging, which promote co-housing (Labit, 2015; Tummers, 2016) and strive for work-life balance (Maas et al., 2015). Social awareness, open-source, sharing, independence and renunciation as well as modesty, simplicity, voluntariness, hope and slowness define this new kind of “self-determination” (Maas et al., 2015, p. 63ff). Traditional restrictions and norms are overcome; class orders, caste systems and religions partly converge. Individualization processes are spreading worldwide and, thus, additionally promote multi-optionality. The trend towards sharing, for example, is closely linked to the megatrend of individualization. In the future, individualization can, therefore, make an essential contribution to increased mindfulness (Zukunftsinstitut, 2016). At the very least, however, it fundamentally changes interpersonal relationships (Sauter-Servaes, 2016; Schuldt, 2016).

As a result of this development, people are often “spoilt for choice” and sometimes find it challenging to deal with this heterogeneity and multiculturalism. Thus, they make irrational decisions. The result is that people look for orientation and support. The megatrend is thus also nurturing its opposite, with individualists seeking community or social groups to find more individual solutions. This corresponds more or less to the frequently used term “cocooning.” Communities (real and virtual), shared flats and closed societies give the individual the security and safety needed through coaching.

Digitization dynamizes individualization and enables new forms of it. We can, for example, put together products ourselves via the Internet and thus tailor them to our individual needs. Schuldt (2016) describes mobility as a practice of individualization: “People want to be able to move freely and independently, to organize their lives flexibly.” This has been observed for years, particularly in the area of mobility. New, multi-layered segments are emerging and are confronting government organizations and companies with the task of finding new, more individual solutions. Managers of companies with established business models have to adjust these old models to this trend and consider analyzing customer’s demand and value drivers in more detail.

1.2.2 Urbanization

The United Nations (2015) estimates that by 2050 two thirds of the world’s population will live in urban areas. The trend towards *urbanization* is already very distinct today. The degree of urbanization is particularly high in less developed countries (Ushakov, 2015). These urban centres are becoming engines of innovation in modern urban development, as planning often does not take place with existing infrastructures but with new, previously undeveloped infrastructures. The reason for this is the development problems of rural areas. But even in more developed countries, this megatrend – contrary to the expectations of many demographers – is unbroken (EY, 2016). On a global scale, urbanization has very different characteristics. These characteristics are broken down according to the economic and demographic bases of the countries (Watson, 2014).

The cities of the future will be more diverse, networked, livable and in every respect "greener" than we have experienced for a long time (Eberl, 2013; Watson, 2014); they will become smart cities (Albino et al., 2015). This megatrend is also highly connected to the subsequently introduced megatrend of ecology, with people in well-developed countries seeking opportunities for the interconnection between digitalization, urbanization, and ecology for concepts of, e.g. urban farming. These future megacities are thus developing great innovation potential. The borders between town and rural areas are blurring. The cities of the future will be made more attractive through urban farming and through leisure activities, which are now also possible in the city (e.g. city golf). Urban spaces thus change the relationship to their inhabitants. Mobility and aviation customers, especially the younger generation, are therefore changing their behaviour already today and will do so in the future. Climate movements are just one of the many accelerators of this development.

> The fully networked city becomes an interactive marketplace for mobility customers. (Schönduwe, 2016)

These cities of the future are no longer just competing nationally, but must also strive and position themselves internationally for new industries and talented, mobile people. Cities must be more than just a centre of activity for their inhabitants. They must enhance the quality of life and thus contribute to the well-being, comfort, convenience, safety and satisfaction of the broadest possible range of needs. Particularly in the area of mobility and aviation, new technologies will increase the differences in urban and rural living. This requires the establishment of more efficient infrastructures to ensure sustainable urban life, but also the connectivity and accessibility of suburban areas.

However, the urban trend is also subject to multi-layered geographical-spatial, financial and ecological growth limits (Camagni et al., 2015; Dijkstra et al., 2015; Duncan & Wang, 2015). The impact of this development on mobility and quality of life in mega-cities is already taking on dramatic forms. Concepts for higher-level spatial planning must be introduced. If these complex solutions cannot be guaranteed across the board, or if the benefits of city life are minimized by new trends such as autonomous driving, the counter-trend towards more rural or suburban living will be reinforced. Rural regions become more attractive as a result of such new, digital developments, and urban sprawl occurs unless countermeasures are taken early on by spatial planning measures. These rural areas might be more accessible and reachable in the future, with mobility concepts being introduced on a rapid scale to foster rural living, working and commuting (for example through drones. To find out more about these new developments for rural mobility concepts, see the chapter on the megatrend *mobility*).

1.2.3 Ecology

Progressive global warming, a noticeable power shift, increasing pollutant emissions due to inefficient products, scarcity of raw materials and the increasing sensitization of people to environmental issues are making this megatrend more dynamic and impactful. As a result of environmental problems, some of which are highly visible and measurable (Beijing, Stuttgart, Sao Paulo, etc.), rising food consumption and increasing consumption of energy and raw materials, especially in the rapidly growing emerging and developing countries, an increasing tightening of laws and market interventions can be observed - especially in urban areas. However, despite the sometimes apparent limitations and the increasing environmental awareness and sense of responsibility of people, especially in the automotive industry, there are still few dependencies in mobility behaviour due to significant pollutant emissions and sometimes enormously inefficient products, contrary to many expert opinions. Consumers often do not view this megatrend in a reflected and detached manner, but always in the context of economy, ecology and social commitment. This is right on the one hand, as this development shifts people's values towards the term LOHAS: Lifestyle of Health and Sustainability (Helmke et al., 2016; Pittner, 2014). Environmental protection, resource conservation, CO_2 reduction, corporate social responsibility and urban and vertical farming are, therefore, also fundamentally changing people's attitudes and values. On the other hand, there are still substantial differences in actual behaviour. In this context, science (mainly on sustainability issues) often speaks of the attitude-behaviour gap (Aschemann-Witzel & Niebuhr Aagaard, 2014; Caruana et al., 2016). Although customers feel a sense of responsibility based on ethics, values and attitudes, they still do not act on them due to economic and restrictive factors. For example, sustainability plays a minimal role in the choice of a mobility offer, since restrictive factors such as time and money predominate, and systematic misjudgements are made in the case of these inefficiencies.

It is noticeable that the customer thoroughly checks many products for their respective carbon footprint – "eco is in." This offers great potential for new technologies in the field of mobility, for example. The demand for post-fossil mobility is becoming increasingly popular as a result of the developments described above (Brake, 2009; Hehn, 2015; Knoflacher, 2013). Politics, societal actors and business must increasingly take this megatrend into account (Bilyk, 2015). In the context of other megatrends, the customer no longer wants to consume only in the classical sense but wants to control consumption himself due to his new, ecological values and attitudes. Digitalization and connectivity will ensure alternatives to the old throwaway society. New markets for environmental protection technologies and "fair trade" as well as concepts for saving resources and energy are emerging. In addition, there is an increasing demand for regional and seasonal products, and new business models are emerging in the area of recycling and by-product electricity use. For countries such as Switzerland, it will be valuable in the future to guarantee liberal electricity and energy markets, to "depoliticize" or privatize markets in order also to give new technologies and innovative solutions in the field of ecology a chance (possibly based on a measurable green premium), and to separate the market from the interests and behaviour of suppliers (Meister, 2013).

Attention

Be aware that introducing an ecological strategy or single products or services might backfire. Embrace this megatrend, create a culture of ecological relevance, empathically care about this topic, not only for your marketing campaigns, and incorporate with main stakeholders or even outsiders to strategically tackle this megatrend for the long-term.

? Key Questions for Ecology

- *What does ecology really mean? What does it not mean?*
- *How can I use the megatrend ecology for good in aviation without being criticized for greenwashing?*
- *Do we need ecology for the sake of an external push for environmental sustainability or because of increasing long-term competitive advantage instead?*
- *How can we use the megatrend of ecology to develop a culture of sustainability alongside long-term thinking and acting?*

1.2.4 Globalization

Supported by gigatrends such as digitalization and increasing automation, the dynamics of mobility are proliferating and becoming increasingly global. Migration movements of population groups and individuals can be observed worldwide. Contrary to numerous forecasts, this means that developing and newly industrializing countries will be able to participate more in world trade and, thus, in prosperity and economic growth (Eberl, 2013). The Internet, and in the future the Internet of Things, promotes a culture based on global challenges in a sometimes highly virtual space (Derven, 2016; Zaugg et al., 2015). Trade and innovation flows are changing. The influence of large emerging markets is increasing due to growing innovative power and positive social changes. Countries rich in raw material are developing a growing self-confidence and self-image (Eberl, 2013). Also, new technologies and speeds of travel, as well as the global spread of these factors, have led to a weakening of global production differences and a declining relevance of labour costs as a location factor (Lejpras, 2015). Many experts already speak of a multipolar world due to the megatrend globalization (De Keersmaeker, 2015; Dee, 2015). The role of the state and state organizations is changing (Fischer et al., 2016). Autonomy is being surrendered because of global interests and demands for transparency and participation.

In addition to economic factors, social factors are also playing an increasingly important role in this megatrend. The megatrend is changing education systems and consumption. Private life and relationships are changed via global mass media. Cultures change and converge. However, globalization affects not only urban but also rural areas. This does not necessarily mean that existing traditions will be dissolved. These are only made globally accessible and, thus, possibly more comprehensible.

Due to the pressure to legitimize established political and economic systems, a counter-trend towards more nationalization and the elaboration of local characteristics has emerged in the recent past. Covid-19 fostered this development even further. Experts speak of the increasing impotence of regional legislation. This can be observed mainly in regions that are highly dependent on other regions or show increasing competitive disadvantages. As a result of this development, remote areas are trying to detach themselves from the global challenges and reduce their dependence to become competitive again or to differentiate themselves from other regions or nations. Reshoring and nearshoring are just two of the many buzzwords in this context.

1.2.5 New Life

1.2.5.1Demographic Change

Due to the megatrend of globalization, also caused by migration, as well as due to the health trend (considered separately) and medical developments, a demographic change can be observed, especially in markets in Western Europe and North America. As a result of rising life expectancy worldwide (Watson, 2014) – according to United Nations forecasts, 9 billion people will already be living on Earth by 2043 (depending on the birth rate, wars, pandemics, accidents, etc.) – and due to the falling birth rate and population decline in general, an aging society emerged (Maas et al., 2015; Naumann et al., 2015). It can be observed that people are not only getting older but that developments or behaviour can also be observed across generations (Morgan & Kunkel, 2016). Experts refer to this as down aging, the process of stepping out of traditional-age roles (Beckmann, 2016; Dill & Keupp, 2015; Schuldt, 2016). Older people are simply no longer satisfied with classical everyday activities but want to reinvent themselves and realize their dreams in old age. Volunteering, working life and further education are the results. Age groups are blurring (Geithner et al., 2015). These new older generations are changing existing structures and creating new, different markets and more heterogeneous segments. Age no longer plays a decisive role in many decisions and is no longer a central differentiating factor for companies. Multigraphic CVs are the consequence.

This demographic development has a particularly significant impact on the area of mobility. The over-65s will account for a much larger share of the total mobility market in Western countries. These segments will have different mobility requirements or abilities to move within the mobility system. Experts even describe it as the most heterogeneous and complex segment in the mobility sector.

In addition to demographic change, an increase in population can be observed worldwide, despite the decline in births. Nevertheless, shortages of skilled labour and poverty among the elderly are evident in many regions. For many nations, the question is how this sub-trend can be financed and how these new needs and requirements can be met.

Case: Ageing Airline Passengers

Although airlines are relatively good at catering for the needs of infants and children through the provision of colouring books, dedicated nanny services and food options, it is only recently that they have started to address the needs of older travellers systematically. Demographic aging has already become apparent and will increase rapidly in the coming decades. Older air travellers show different behaviour, beliefs, needs and values compared to younger travellers. In particular, they differ concerning their propensity to fly, travel purpose, destination choice, access modes, airport dwelling time, perception of the travel product and the use of airport facilities. This demographic has a particularly strong impact on airlines. The over-65s will account for a significantly larger share of the overall mobility market.

The physical and mental conditions of people change with age. Eyesight, hearing, and general physical health decline, mobility decreases, and mental changes such as anxiety may be potential side effects. These changes affect the business and operating model of airlines and the global transport system. Older travellers may be less agile, require mobility aids, take longer to board, are not familiar with automated systems and may find it difficult to lift bags into overhead lockers.

Also, in this context, it can be observed that people are not only getting older, but behavioural changes can also occur across generations. Experts refer to this as down aging, i.e. leaving traditional-age roles and changing traditional activities. The result is multigraphic CVs and travel characteristics. Older people are no longer satisfied with traditional everyday activities but want to reinvent and fulfil themselves. This results in changing behaviour, beliefs, needs, and values, for example, voluntary working, traveling more frequently and to a greater range of destinations. Age groups are becoming blurred. These older generations change existing structures and create new, different markets and more heterogeneous segments. Researchers and transport experts describe older travellers as the most heterogeneous and complex segment. They will have a significant impact on the business models of airlines, but also on the design of transport systems and the underlying infrastructure.

Stop and Think

Why is an understanding of aging important for airlines? What does the demographic change mean for my own business?

1.2.5.2 Gender Shift

In many regions and countries of the world, gender is increasingly losing its significance and social commitment. Contrary to many forecasts by experts, the change can also be observed in emerging and developing countries (Eberl, 2013; Otten & Wittkowske, 2014; Zukunftsinstitut, 2015). In the future, gender will no longer determine how a biography develops and what overarching gender role an individual assumes (Zukunftsstark, 2016). Career models dissolve; new cultures are formed (Blair-Loy et al., 2015). The increasing equality of men and women in professional, private and social life creates enormous potential and disruptive changes in the economy and society of national economies.

This sub-trend, in turn, dynamizes the trend of individualization, as it enables more individuals to realize their own potential and satisfy individual needs. Millions of women from all over the world start their own businesses. Most of them do so because of the reason of possibility and less because of the aspect of necessity (EY, 2015). They, thus, provide new career opportunities. Female entrepreneurs also tend to expand. However, women are also increasingly striving for leadership positions, while men act as family organizers (Zukunftsstark, 2016). New and different family models are emerging, which places higher demands on the compatibility of family and career (more details in the chapter on the megatrend *new work*). The family thus plays a more significant role in general life. This also poses new challenges in the field of mobility. The changing needs and demands for mobility are developing an enormous potential for new business models and service structures, which are very different from today's offerings.

On the other hand, a trend towards single lifestyle has been observed for many years. Driven by the changing image of the family, almost 34% of all people in the United Kingdom already live alone (Watson, 2014). Due to the changed role of women in working and leisure life, marital alliances will no longer be decisive in the future.

? Key Questions for Gender Shift

- *What does Gender Shift really mean? What does it not mean?*
- *How can I use the megatrend Gender Shift for my aviation organization?*
- *What are the benefits of a more gender-diverse culture in aviation?*
- *How can I, as an organization, benefit from a more gender-diverse culture?*

Case: Switzerland and Gender Diversity in Top Management Positions

Fifteen years ago, in Switzerland, only a few organizations had gender diversity on their agendas. At that time, the percentage of women on executive boards of the largest 100 companies in Switzerland was at 4%. Today, the quota is at 10%, which means that it has reached the double digits for the first time. Since 2010, the percentage of women on supervisory boards has even increased from 10% to 23%. The trend has remained consistent for years, which is why experts anticipate a 30% quota by 2024.

What one would not think of is that the public sector is paving the way in terms of gender diversity on the board level. The proportion of women employed as top executives in the public sector steadily rose by two percentage points and for the first time reached the 20% mark in 2020. The public sector confirmed its efforts of the previous year and again filled 38% of the vacancies in the top positions with a woman. The proportion of women in top positions is, therefore, twice as high as on executive boards of the private sector. The greater gender diversity in the public sector is due to the better reconciliation of career and family. These aspects are vital to balance gender diversity.

Despite this, there is much room for improvement. Only 53% of the largest companies employ one or more women on executive boards. 47% of the companies still do not have one single woman on their executive board. In contrast, only 11% of the surveyed companies are without women on their strategic board – the supervisory board.

This case is based on the Schilling report of 2020 (Schilling, 2020).

1.2.5.3Health

Due to rising standards of hygiene and living as well as the transparency of conflicts with food, work and consumption, a partial trend of New Life exists today. Growing health expenditure and increasing cost pressure in medicine can be observed (Zukunftsinstitut, 2015). Health is seen as a desirable goal, also because is offered more individually and technologically. Psychology and physiology are growing even closer together. This offers enormous potential for new medical services, as they are now seen less as a necessary means and more as a service for achieving general prosperity. Detoxing, self-tracking, wearables and other technological products for measuring the health of an individual are, therefore, in high demand (Bruno, 2015; Ernst, 2016; Neff & Nafus, 2016; Tiller, 2015; Zukunftsstark, 2016).

> » Right now, we are struggling to realize what wearable technology is. It will not be just on the body, but in the body. (O'Reilly, 2014)

In this health society, the customer sees himself as a "health prosumer" (based on the term prosumer: the consumer who makes professional demands on a product). The marketing potential seems almost inexhaustible. This trend is also making itself felt in working life. Experts call this phenomenon "corporate health" (Moussu & Ohana, 2016; Schuldt, 2016).

However, the mobility market has not yet really become aware of this trend. Health offers, in combination with mobility offers, are the exception, although there would be an enormous synergy potential here, as the customer would feel this not only psychologically but also physically. Personalized genomics, regenerative medicine, remote monitoring, organ printing and user-generated medicine through medical data mining will lead to an additional dynamization of this trend (Watson, 2014). In the future, it will be possible to generate user-specific data, monitor it and treat it in a more personalized, resource- and cost-efficient manner.

> » The digital world has been in a separate orbit from our medical cocoon, and it's time the boundaries be taken down. (Topol, 2014)

On the other hand, the shift in the focus of clinical pictures, the more important information and self-treatment of the customer and the emergence of ethical questions are creating new demands on the partial trend of health and medicine in general.

1.2.6 Knowledge Culture

Due to the increasing speed of innovation, growing technological change, new individualized concepts for lifelong learning, the globalization of educational opportunities and the worldwide increase in education and qualification levels, enabled the emergence of a knowldge culture. The demands on the type of competencies are changing. New competencies are in strong demand.

This trend will be reinforced by an increase in open access and open source solutions in the field of education (Eberl, 2013). Bionics, creativity and creation are increasingly promoting this trend (Maas et al., 2015). The liberalization of the education system leads to considerable potential for efficiency and innovation (Schellenbauer & Walser, 2013). There is an increasing number of educational opportunities. Besides, access to these new and more varied educational opportunities is increasing. Educational institutions act as multipliers. Through new technological educational opportunities (also due to the gigatrend digitalization), individuals are able to access knowledge more autonomously. Digital education is the key to success (Eberl, 2013).

> » Think about learning and education with all the new tools that are being built. We are on the cusp of the acceleration of that and it's almost overwhelmingly good. (Schmidt, 2015)

This, in turn, supports the trend towards individualization. A culture is emerging around the knowledge and education of individuals in a society (Zukunftsstark, 2016). This development is further supported by new forms of work (see megatrend New Work) such as part-time work, homeoffice and third places (Maas et al., 2015). In turn, the future viability and competitiveness of individuals, societies and entire nations depend on the development of a knowledge culture (Schellenbauer, 2013).

On the other hand, there is also great danger in this. If individuals and societies do not succeed in establishing this knowledge culture, industries and societies will come under increasing pressure to be uncompetitive in the "war for talents" due to faster and more disruptive phases of change. For this reason, a gap in the level of education can be observed increasingly worldwide. Ghettoization, social inequality and two-tier societies are the result (Maas et al., 2015).

Attention

Really challenge and reflect your own thinking and your respective organizations'. Do not stick to the same mental models and rationales, but try to learn continuously. Foster different views from different people through open sources and open dialogue and develop into a learning organization or a learning individual.

? Key Questions for Knowledge Culture

- *How can I use the megatrend knowledge culture for my aviation organization?*

- *What might be possible partners for my organizations to cooperate with to create a knowledge culture?*
- *How can I create a learning organization that benefits my employees and the capabilities of my organization in the long-run?*

1.2.7 New Work

The softening of the traditional image of the employee, the changing role of men and women and the automation of increasingly complex work tasks are creating a megatrend that can be described as a new way of working. Companies are faced with the challenge of combining concentrated work and increasing employee demands. They are increasingly being held responsible for solving social challenges. As a result, new and more open work structures and management concepts are developing, which result in more flexibility for employees. In recent years, the megatrend of digitalization has made it possible to develop new, intelligent production processes that increasingly relieve employees of physical labour. The megatrend of globalization is also fundamentally changing from an industrial to a knowledge and service society. Service, information and creative work form the foundation of modern economies. Different industries are growing together and are increasingly consolidated. Mobile working, autodidactic, new workplace designs as well as part-time work, home office and so-called third places are the characteristics of this new work. Creativity and identity are the critical skills required to manage the polarization of work content and quantity. New forms of mobility enable mobile workers to work and eliminate the need for a fixed job. It is not a scarcity that this trend promotes, but the complexity of the type of work that will challenge organizations in the future.

On the individual side, the megatrend new work is leading to an increasing merge of professional and private life. The professional world is taking on a new role in the life of an individual. Work-life balance, home office and flexible working hours are already standard today. Collaborative concepts and co-working allow the new, creative workers to exchange ideas and take on different jobs. This gives the employee the possibility (and sometimes just the feeling) of being self-employed, even though being employed. The boundaries between work, living and movement become relative. Work is changing and with it mobility as well. Leisure and work paths are becoming blurred, as is general leisure and working life.

However, collective labour agreements, minimum wages and sector-specific wages have created inefficiency in many industrialized countries that limit this flexibility, liberal wage formation and new concepts (Schellenbauer, 2013).

1.2.8 Security

Due to the insecurity of society concerning uncertain events (described at the beginning as wild cards), new technologies and the usability of data as well as the vast and diverse demands on the state, military and sovereinty, a megatrend of security exists. This trend is caught in the dichotomy between monitoring or prevention and protection or precaution.

Many experts even call this a new culture of security, with the megatrend moving away from established structures and responsibilities. Due to the increased threat of cyberterrorism, natural disasters, data theft and forgeries, individuals are subjectively insecure and the complexity of the situation overburdens the state. For this reason, the state and public organizations will no longer play a central role in the security megatrend in the future. New technologies also result in an increase and change of type of safety issues, such as in the case of autonomous driving and flying. The new types of safety issues in this specific fields are issues of liability and vehicle safety. But also, in operational and data security, new questions arise in the context of security due to new and different final products and different interfaces (Eberl, 2013). In the future, there will generally be more regulation and incentive systems instead of hard regulation.

> In the digital era, privacy must be a priority. (Gore, 2013)

Due to increasing digitalization, connectivity, individualization and new demands about living and working, the understanding of security values is changing from superordinate organizations towards individual designs. In the context of mobility, for example, previous national efforts often neglected issues such as the intermodality of transport and overestimated safety issues. Experts argue that governmental organizations are only responsible for a framework and are guaranteed by regional institutions (private or state), some of which are highly adapted and individualized (Lyons & Davidson, 2016). In this new security world, people and companies are increasingly security and not just risk carriers because in the future security world, “nothing is private” (Watson, 2014). If the new security is not dynamic, adaptable, flexible and changeable, security can fundamentally no longer be guaranteed. Transparency plays a vital role in this process, to build trust with users and society.

> Trust is a serious problem; we have to get to a new level of transparency – only through radical transparency will we get to radical new levels of trust. (Benioff, 2015)

1.2.9 Mobility

> Economies, states and cultures have always depended on transport and the spatial exchange of people and goods for their existence, security and progress. For this reason, transport and its history form a fascinating cross-cutting theme with numerous far-reaching references, both within the historical sciences (political, economic, social, environmental and technological history) and within other sciences (geography, sociology, economics and ecology). (Merki, 2008)

▪▪ Mobility:

No other term embodies the hopes, wishes, needs and problems of people and their impact on economic cycles. The term describes the movement, speed and agility of persons (origin in Latin: *mobilitas*). The term transport, in turn, describes the instrument with which mobility is perceived and executed.

The forms of mobility today are at least as heterogeneous as the needs, lifestyles, work forms and networks of the mobility customers themselves (Hunecke, 2015). The mobility of the future, therefore, depends on many premises. Mobility stands for the freedom of movement of individuals (Weihrauch, 2014), strongly observable in times of the recent COVID-19 crisis. Since mobility is expressed in various areas of life (work, leisure, tourism, etc.), mobility has been characterized by a steady increase in demand and simultaneous acceleration (BFS, 2016). The volume of traffic and the number of trips per person will further increase in the future, experts say – especially in urban areas (ARE, 2016b) with transport modi being available in the future, such as urban air travel. In the future, home becomes a relative concept. Being mobile will become a social obligation and, thus, a matter of course for the customer (Zukunftsinstitut, 2016).

The value of mobility is changing in the perception of the customer precisely because many experts already describe mobility as a "commodity" or "basic supply." The megatrend mobility will also play a central role in everyday life of every individual in the future (Buckley et al., 2015). The car is still considered a general right of ownership today. Today, mobility also means activity, freedom, change and heterogeneity, both individually and socially. Future customers want even faster, more frequent, more, cheaper, safer and more female-friendly mobility (Wittmer & Linden, 2017). Soon already, mobility will increasingly unite working and living spaces. The needs become even more heterogeneous due to individual demands. Central mobility points (mobility hubs) are the key to an efficient, networked and mobile mobility lifestyle. The car is no longer just a status symbol and the central vehicle for everyday mobility but is being developed into an autonomous, high-tech data tool for the new, more mobile worker. Multimodality becomes even more system-critical and -important in the multi-option society that can be observed today. This also increases the search for possibilities to implement mobility requirements, rules, infrastructure and needs in an economical, comfortable, individual and ecological way. The consequence is that more and more areas of politics, business and society are being influenced and made dependent on the megatrend mobility. Mobility affects everyone and sometimes to a very considerable extent.

> » In 2040, mobility will be greener, safer, more automated, multimodal, shared and individual. Mobility will thus become people-friendly, post-fossil and climate compatible. At the same time, mobility customers want 100% safety, punctuality and predictability as well as emission-free, eco-friendly, multimodal and time-independent services. (Linden & Wittmer, 2018)

Social change with new forms of living and working will further dynamize this megatrend. The increase of flows of people, goods and information on an international scale as well as growing tourism, changing interplay between different forms of mobility, mobility substitution through digitization, new logistics concepts and the emergence of horizontal mobility concepts are essential criteria for the relevance and nature of this megatrend (Zukunftsstark, 2016). The combination of social and environmental change combined with new technological possibilities has a major impact on the future of mobility. This is one of the reasons why the megatrend mobility is so dynamic and its development incredibly difficult to measure (Canzler & Wittowsky, 2016; Knie, 2016).

How can we react to this dynamic development, one might ask. The central challenge will be to eliminate inefficiencies in the mobility market and to make transport policy dependent on external costs such as congestion, noise, emissions, etc. (ARE, 2016a) to charge actual costs and promote the polluter-pays principle (Müller-Jentsch, 2013). One term that is particularly relevant is a controversial one: "mobility pricing" (Kryvobokov et al., 2015; Nash & Whitelegg, 2016; Pronello & Rappazzo, 2014). According to experts, it is also necessary to promote a rethink in the area of mobility (Knoflacher, 2013) to do justice to the digital mobility revolution (Canzler & Knie, 2016). Without this rethinking, the critics will grow in the following direction: "*Besides smaller innovations, it is above all the past that is being perpetuated: The sale of private cars remains at a high level, congestion hours are increasing, and the number of kilometers traveled and passengers on trains and buses are rising steadily. Although goods traffic on the last mile is becoming increasingly small, it is also continuing to grow.*"

1.2.9.1 Autonomous Vehicles

> The revolution in mobility comes with autonomous vehicles. And these are coming sooner than many experts suspect. (Thomsen, 2016)

> In 2040, autonomous vehicles will mundane. (Kelkar, 2016)

> Autnomous vehicles is the biggest revolution in the mobility industry since the invention of the car. (Röhrleef, 2016)

■■ Back to the Future:

Strictly following this motto, today's mobility players are trying to shape the future of the industry. They try to integrate phenomena observed in nature into intelligent, autonomous vehicles of the future (Watson, 2014). One of the most exiting examples for this is FESTO's Smart Bird, which is inspired by the herring gull. The ultralight flying model has state-of-the-art aerodynamics and agility, and is able to take off, fly and land without an additional drive. Vehicles of the future are to scan their surroundings with multi-layered sensory organs, communicate with other vehicles, act autonomously and also learn from past events.

Many researchers and experts, therefore, describe the introduction of fully autonomous vehicles in transport as a turning point for mobility as a whole. The potentials and effects of this sub-trend are very complex. Not only other modes of transport but also new ways of life and work of mobility customers depend very much on this sub-trend of mobility. Many megatrends, such as urbanization, ecology, globalization and security, can be suddenly changed or dynamized by this sub-trend. If autonomous vehicles are successfully introduced, the vehicles' system(s) exist mainly in acting as intermediaries between "automotive users" and third-party products. Thus, mobility vehicles will develop into data collectors and storage devices. These vehicles allow the provider to collect, analyse and use essential data and information to further improve their system, networks and resilience as well as understand customer needs. These customer needs can also change significantly through autonomous vehicles. The customer can be presented with new, more flexible and individual offers. The pyramid of needs can thus shift considerably. The autonomous vehicle eliminates both the price advantage of public transport and the flexibility advantage of MIV.

Besides autonomous ground transportation, drones have been experiencing an immense push in recent years. When precisely the history of drones began depends on what exactly is considered to be a "drone." Both the first flight of an unmanned balloon in 1782 and the first quadcopter created in 1907 can be regarded as the beginning of the drone era. For many years, drones were developed and used mainly for military purposes. However, over the past 10 years, there has been a steady development towards commercial and private uses. The global drone market is expected to generate 43.1 billion USD in 2024, with growth projected to be at 16.8% CAGR (DroneII, 2019). Further, drones are set to disrupt different areas, from agriculture, arts and entertainment, to energy, logistics, real estate as well as mobility in more general. In many cases, it is expected that drones can carry out their mission independently without the intervention of a pilot, which makes the operation of drones very attractive from a technological and economic perspective. This automation of air mobility is expected to be implemented first for early use-cases, such as search and rescue, transport of medical goods or logistics, before even introduced in the passenger transport segment.

What drones clearly show is that the sub-trend of autonomous vehicles is mainly dependent on digital solutions, technological development in the entire mobility system and the provision of a network of intelligent infrastructures. Sommer (2016), for example, says that "autonomous vehicles will not be possible without digitalization." Nevertheless, for many experts, the question is only when and not whether this sub-trend will become a reality:

However, the smart vehicle of the future must increasingly be embedded in its environment to increase safety, ecology and connectivity. Today, due to the lack of implementation of these aspects, there is often speculation about public acceptance of such vehicles. If the public does not trust these products due to safety or other aspects, this sub-trend will only be observed as a selective phenomenon or utopia. However, if acceptance can be guaranteed, this will have "fundamental effects on the way people understand mobility" (Thomsen, 2016).

? Key Questions for Autonomous Vehicles

- *What do autonomous vehicles really mean for the system of mobility?*
- *How do autonomous vehicles change customers' perception?*
- *How do autonomous vehicles change the way the mobility industry will function?*
- *What are showstoppers for autonomous vehicles and what and when are tipping points for them?*
- *What do new technologies, such as drones, mean for my business in the long-term?*

1.2.9.2 Sustainable Mobility

e-Mobility

> The crisis in the automotive industry is putting on the agenda what has long been a certainty: The departure from oil is drawing nearer and with it the need to further develop our current form of mobility and make it fit for the future. (Brake, 2009)

The environmental discussions in politics and society are omnipresent and inevitable. In current discussions, the electric car seems to be a promising way to reduce emissions and allow environmentally friendly driving in the future. Although this sounds promising and there is a lot of media interest in it, the handling and the high acquisition costs prevent many people from seriously considering the purchase of an electric car. It still frequently fails to be integrated into the existing mobility concept of many companies, regions and mobility ecosystems. Furthermore, the negative energy balance of the manufacturers as well as the need of and impact on natural resources. At present, customers do not yet have sufficient confidence in the technology. They doubt that the range is sufficient to meet their needs and think that not enough charging stations are available yet (Henkel et al., 2015). However, fundamental issues of the automotive industry, such as the VW exhaust gas scandal, clearly show the advantages of regenerative drives. Therefore, despite the relatively adverse developments in electric mobility today, many researchers consider the trend towards post-fossil drives to be inevitable (Augenstein, 2015; Monheim, 2012). At the latest when the internalization of external costs (noise, congestion, emissions, etc.) (ARE, 2016a), which many experts have called for becomes a reality, the price of non-electromobility mobility will increase significantly and lead to an efficiency disadvantage (cost-benefit) compared to electromobility - also called green premium. Many of these external costs can be minimized and, in some cases, even eliminated by electric vehicles. Many experts, therefore, conclude that price parity will be achieved soon:

> » Price parity will be achieved by 2022 at the latest. (Randall, 2016; Wenzel, 2016)

> » We will have almost exclusively electric mobility, with a few exceptions that will not get away from fossil fuels until then (gravity, infrastructure). (Weiss, 2016)

Also, laws and regulations provide this sub-trend towards mobility with a critical framework in which it can develop further. The state must inevitably promote post-fossil transport to achieve its sustainability goals. E-bikes already demonstrate very well today the enormous impact that an electric motor can have on mobility in general (see also e-load wheel). The mindset of humans will inevitably adapt (Gebauer et al., 2016).

Very exciting is also the combination of different mobility sub-trends, such as a combination of sustainable mobility and autonomous vehicles. A ground-breaking field is, e.g. eVTOLs (an acronym for electric vertical take-off and landing vehicles). eVTOLs highlight the incredible promise and progress of electric and hybrid-electric powered vertical take-off and landing aircraft, focusing on non-helicopter VTOL aircraft large enough to carry passengers without conventional helicopter flight controls. They are said to change regional air mobility, inter-city travel, city-countryside as well as countryside-countryside and, most importantly, urban air mobility. There are more than 500 concepts worldwide working on a solution to integrate autonomous and electric vehicles into airspace, mostly for urban centres with highly congested road traffic and with rotor-lift or wing-lift technologies. The market for eVTOLs could amount to $1.5 trillion by 2040 (Morgan Stanley Research, 2019).

However, the challenges of eVTOL companies are often not given adequate attention in the media. The VTOL pioneers act “in a largely and so-far unregulated and non-certified space. It is unclear if there will ever be a product achieving economic viability and social acceptance - despite billions of dollars being invested in this sphere already and several SPAC-deals being concluded in 2021 alone. Air travel is highly regulated, and aircraft are required to be authority-certified for passenger safety. Also, main issues to be solved are in the area of infrastructure, technological development, safety, social acceptance, economic viability, and emissions of these aircraft. Even if a concept could be technologically, ecologically, socially, and economically successful, regulators might not allow its widespread use, due to regulatory and/or safety concerns.

Further, a main disclaimer for eVTOLs needs to be made here. One needs to highlight that there might be radical innovation from a technical development standpoint; they might disrupt the helicopter market and they might be a valid addition to the already existing transport modi, but they will always serve a small niche in the broader mobility system.

? Key Questions for e-Mobility

- *What does e-Mobility really mean for the larger system of mobility?*
- *What is the real impact of e-Mobility on the system of mobility?*
- *How do autonomous vehicles change customers' perception?*
- *How do autonomous vehicles change the way the mobility industry will operate?*
- *What are showstoppers for e-Mobility?*

Case: Dufour Aerospace as an eVTOL Manufacturer

Dufour Aerospace is an eVTOL start-up, based in Visp, Switzerland. Thomas Pfammatter and Dominique Steffen, both aerospace experts, started working on an electric aerobatic aircraft, the aEro1, in 2016 (Dufour Aerospace, 2016). Building on this experience, they founded Dufour Aerospace in 2017 with Jasmine Kent to further explore the possibility of electric aviation. So far, most work has been done remotely by the leadership team or outsourced as project work. They have raised 2.2 million CHF in funding until March 2019 and raised another 10 million CHF to develop and produce the aEro 3.

The leadership team of Dufour Aerospace consists of Thomas Pfammatter, co-founder and CEO, Dominique Steffen, co-founder, Jasmine Kent, co-founder and CTO, and Damian Hischier, chief test pilot and head of certification. They are the core team with the vision and the motivation to develop and market the aEro 3, a 7-seater version of their tilt-wing eVTOL concept. The current goal is to first introduce the aEro 3 as an emergency medical service (EMS) aircraft, because such a use case will most likely face the least resistance from the public and can provide a solid cost advantage, compared to traditional helicopter emergency services. The company is cooperating with academic institutes in Switzerland to refine their concepts. So far, Dufour Aerospace has worked on three concepts. The aEro1 was their first electric acrobatic aircraft that first flew in 2016 as proof of concept for electric aviation (Dufour Aerospace, 2016). The aEro2 concept was designed as an eVTOL and was the original concept Dufour Aerospace planned to bring to market, based on their understanding of the certification requirements at the time. Due to the regulation "Special Condition for Small Category VTOL Aircraft" (EASA, 2020), this focus shifted as all passenger-carrying eVTOLs up to the weight limit of 3175 kg are treated equally under the regulation. Therefore, it makes sense to directly develop a passenger aircraft with more seats instead of developing a two-seater with a much more limited scope of application. Dufour Aerospace aims to develop the aEro3, while testing with a half-sized aEro2 prototype, that could potentially become a cargo drone, and simultaneously looking to develop the aEro1 into a standardized product to be manufactured on a small scale.

Dufour Aerospace is approaching the development of products with a strategically planned phased approach, hoping to stay as lean as possible and utilize their time and products efficiently to develop the capabilities to be a successful eVTOL manufacturer. This approach is a mirror of the eVTOL concept selection, trying to reduce the risk and cost whilst positioning themselves as an early follower, hoping to leave the majority of development and certification costs to the pioneers, entering with a mature product in an already established market.

Nevertheless, success is uncertain as many factors are beyond Dufour Aerospace's control, and its assumptions might be faulty. The eVTOL market may develop quicker, technologies might be more successful than anticipated, business models might diverge and the willingness of the EMS market to adopt eVTOLs over helicopters may be lower than expected. Also, the acceptance of society and the public of eVTOLs on an autonomous basis might be slower than expected. Additionally, Dufour Aerospace might be outpaced by competitors, such as Joby, Lilium, Volocopter and others, which have far-exceeded Dufours' funding amounts and are far-ahead in terms of certification and public sentiment.

1.2.9.3 Sustainable Aviation

Climate change and increasing air pollution are among the most significant challenges facing humanity in the coming years and decades. One industry that is increasingly appearing in the spotlight of public debate on reducing greenhouse gas emissions is the mobility industry, with specific emphasis on the aviation industry in recent months and years. Why is this so? Commercial aviation is responsible for about 2% of global carbon emissions. Reducing these emissions is a serious global challenge for the aviation system and every player involved. In 2009, IATA put in place an ambitious and robust carbon emissions strategy, which targets a four-pillar action plan: (1) improved technology, including the deployment of sustainable low-carbon fuels, (2) more efficient aircraft operations, (3) infrastructure improvements, including modernized air traffic management systems and (4) a single global market-based measure, to fill the remaining emissions gap (IATA, 2020a).

Further, by establishing a multilateral approach to the "Carbon Offsetting and Reduction Scheme for International Aviation" (short CORSIA) in 2016 at the General Assembly of ICAO, the industry tries to stabilize and reduce emissions from international aviation continuously. CORSIA's obligations have already started. As of 1 January 2019, all carriers are required to report their CO_2 emissions on an annual basis, whereas they have to compensate for a part of their CO_2 emissions by purchasing and cancelling CO_2 emission units as of 2021.

Today, the substantial societal and political call for more sustainable travel has already resulted in the first movements, such as "flight shame," which regard flying as one of the top environmental sins and therefore call for renunciation. Despite and maybe even because of the unprecedented industry crisis brought by

COVID-19, aviation players reconfirmed their commitment to their global environment strategy (IATA, 2020b). Thus, the commitment, also established through CORSIA, is yet more critical than ever before. Combating climate change remains a top priority. Cutting CO_2 emissions by half by 2050 with innovative technologies, sustainable aviation fuel and improved operations and infrastructure will be a considerable challenge, but also an immense opportunity for aviation players to position themselves as leaders in this critical but relevant area for society and politics.

Since the social and political pressures on the industry will continue to grow in the future, sustainability and the path to it are currently at the top of the strategic agenda for all players of the aviation system. In addition to numerous measures that can be implemented in the short term, a complete transformation is needed in the long term in addition to pollutant-neutral and sustainable flight services. For example, airlines need to rethink their business models (Rossy et al., 2019) and look for opportunities to embrace sustainable aviation. One solution might be a controversially discussed topic of eco-labels (Wittmer et al., 2019). Even if the necessary technologies are not yet available, players of the aviation system are well-advised to plan the transformation process as early as possible, to define a roadmap and milestones, and to plan the required resources as well as the internal change management.

? Key Questions for Sustainable Aviation

- *What are the main concerns of society and politics when it comes to sustainable aviation?*
- *What might be hidden agendas of stakeholders that demand sustainable aviation and how do I cope with that?*
- *What is my long-term plan for sustainable aviation?*
- *How can I sense and use the strong societal and political call for sustainable aviation to develop a long-term competitive advantage for my organization?*

1.2.9.4 Mobility Sharing

> Sharing is good, and with digital technology, sharing is easy. (Stallman, 2012)

Due to the emergence of “peak car use” in numerous countries, a trend toward less ownership can be observed. This might be due to cars not being used 96% of the time. They are one of the most expensive goods that private households own. This makes cars incredibly inefficient, not to mention that in some cities up to 30% of the area is dedicated to car infrastructure. Sharing could reduce this inefficiency to a smaller extent. “Using instead of owning” is the motto of this sub-trend of mobility. Through the trend of mobility sharing, it is possible to combine public and private mobility offers even better. The development of membership figures for such sharing offerings is rising by 600% in some cases (e.g. China), with a nationwide increase observable for years. Bike, ride and especially car sharing are the characteristics of mobility sharing today (Laporte et al., 2015; Shaheen, 2016). The sharing concept is clearly on the advance: 20% of all car routes worldwide today run via Uber. A study by Deloitte (2015) has shown that 55% of Swiss consumers will purchase a sharing service in the next 12 months. Also, in aviation, many exciting start-ups popped up in recent years, such as WeeShare, Wingly, Simplyfly, to name only a few.

Travis Kalanick, the former CEO of Uber, even described sharing as "the future of human-driven transportation." If two or more people share a car, total mobility costs are reduced. For example, there is one fewer car on the roads, which can reduce emissions. An study by APTA of 2016 came to the same conclusion:

> » The more people use shared modes, the more likely they are to use public transit, own fewer cars, and spend less on transportation overall. (APTA, 2016)

Today, mobility sharing fails going mainstream already passing the first hurdle: actual testing and first-using vehicles. Mobility sharing is mainly used based on recommendations from friends and acquaintances. However, since there are still relatively few experiences and offers, many models fail already due to the lack of awareness of these models. Though, the dynamics of the sub-trend and new offers could increasingly accelerate it in the short term. The problem today is that the sharing models are still too little integrated into the existing infrastructure and receive little legal support. Despite this, there are some promising examples, also in niches of the mobility industry, which serve as appetizers for more innovative ways of sharing instead of owning in the future (see Case Fractional Aircraft below).

Further, megatrends such as urbanization, digitization and ecology, but also spatial boundaries, are making the partial trend of mobility sharing increasingly dynamic (González, 2015). It is, therefore, not only a trend with an urban impact but also an essential basis for rural and suburban areas to participate in modern life. For many experts and researchers, it is therefore already taken for granted. For the future, however, the development of attitudes and values and, thus, the mobility behaviour of mobility customers will continue to be neccessary to boost its acceleration.

? Key Questions for Mobility Sharing

- *What are main aspects that need to be introduced to enable mobility sharing?*
- *What are the pitfalls of a mobility sharing concept?*
- *How do mobility sharing concepts change the way the mobility industry will operate?*

Case: Mobility as a Service and MaaS Global with Its Whim-App

Mobility-as-a-Service (MaaS) describes a shift away from personally owned modes of transportation towards mobility provided as a service. This is enabled by combining transportation services from public and private transportation providers through a unified gateway that creates and manages the trip, which users can pay for with a single account. Users can pay per trip or a monthly fee for a limited distance. The key concept behind MaaS is to offer travellers mobility solutions based on their travel needs. Travel planning typically begins with a journey planner. For example, a journey planner can show that the user can get from one destination to another by using a train/bus combination. The user can then choose their preferred trip based on cost, time and convenience. At that point, any necessary bookings (e.g. calling a taxi, reserving a seat on a long-distance train) would be performed as a unit. It is expected that this service should allow roaming, that is, the same end-user app should work in different cities, without the user needing to become familiar with a new app or to sign up to new services.

MaaS has many benefits that can improve ridership habits, transit network efficiency and societies that adopt MaaS as a viable means of transportation. MaaS could decrease costs to the user, improve utilization of MaaS transit providers, reduce city congestion as more users adopt MaaS as a primary source of transit and reduce emissions as more users rely on public transit component, autonomous vehicles in a MaaS network. MaaS equally has many benefits for the business world – understanding the total cost of business mobility could help travel decision-makers in the corporate world save hundreds of thousands. By analysing data and costs attributed to "business mobility" (e.g. vehicle rental costs, fuel costs, parking charges, train ticket admin fees and even the time taken to book a journey), businesses can make informed decisions about travel policy, fleet management and expense claims. Business MaaS companies such as Mobilleo suggest that in journey planning alone, it can take up to nine steps before a simple travel arrangement is booked.

Maas Global soft-launched its MaaS application Whim in Helsinki, Finland, in late 2016, followed by a full launch in November 2017. The first-ever MaaS operator interconnected many of the city's mobility options under one subscription and within a single app. With the Whim app, the user can combine, plan and pay for public transport, taxi, car rental, car sharing and city bike trips. The data of a study by Ramboll in 2018 on MaaS Global suggests that public transport is the backbone of MaaS users' travel habits, MaaS users excel in multi-modality and the MaaS platform is potentially facilitating first/last mile choices that lead to greater access to public transport. As MaaS lets users access alternative modes more quickly when they need to, it may attract those users who are thinking of either buying a car or give up a car. MaaS, therefore, allows a more holistic use of the existing transportation system. MaaS is, therefore, not changing the transport system itself; rather, it facilitates more effective and inclusive use of the existing one.

Through MaaS platforms, such as Whim, users can access a variety of different transport modes, which covers an individual's mobility needs. Platforms not only could combine the different modes but also could be the "distribution channel" for new mobility services. This has been the case in other industries, such as new content creators in social media, shopkeepers in internet retail and so on.

Case: The Fractional Aircraft

Today, many business travellers are criticized for taking a private jet or leasing a jet to travel for short business meetings. Most probably, you will never justify the cost of a business jet by how much you save in airline tickets. It comes down to how much the value of time and the opportunity to take trips that you could not otherwise is, as well as how important it is to run on your own schedule. Further, business jets reduce the lack of stress, being able to work or relax, meet with associates in privacy and the feeling of freedom from the misery of mega hubs. What price is that worth? Whether to acquire a business jet often comes down to an act of faith – an entrepreneurial rather than a spreadsheet decision. Fractional aircraft is a novel compromise, used by many managers, athletes or generally busy or luxury-seeking people today.

Fractional aircraft is a collective term for fractional ownership of aircraft where multiple owners share the costs of purchasing, leasing and operating an aircraft. There are already several commercial programs for fractionally owning a large aircraft, such as NetJets, Flexjet, PlaneSense and AirSprint, to name only a few. With fractional aircraft, customers (or "owners") buy a share of an aircraft, rather than an entire one. The price is pro-rated from the market price of a full aircraft. Owners then have guaranteed access (the magnitude of usage depends on the model) to that aircraft or a similar one in the operators' fleet – with as little as 4 hours' notice in some models. Fractional owners pay a monthly maintenance fee and a pay-per-use hourly operating fee. Usually, the latter is charged only when an owner or guest is on board, not when the plane is flying to a pick-up point or returning to its home base after completing a flight. Owners have access to the full fleet of aircraft and may upgrade or downgrade for specific flights when they need to. At the end of the contract, the owner can sell his or her share either back to the company or to another owner waiting for a position, though most companies charge a re-marketing fee to do this. In most cases, typically, after 5 years, you have a guaranteed buy-back of your capital asset at "fair market value."

After 20 years of fractional ownership, it is unclear if the model works in its current form. The original fractional model anticipated selling planes in 1/4 fractions, rather than the 1/16 or 1/32 fractions that have emerged recently. Each additional partial owner creates more demand and scheduling complexity for each plane, particularly during peak periods, such as holiday seasons. Further, the theory that a growing customer base will reduce empty-legs has proven limited. While there have been some improvements, the best-case "floor" of empty traffic is still above 20% of total traffic. The worst-case for new operators can approach 50%. One strategic boost has been the introduction of efficiency incentives to align client behaviour with operating efficiency better. Some companies have resisted these programs: if fractional's appeal is the simplification of flight, that appeal is reduced when accompanied by a host of individual pricing adjustments and incentive programs. Despite this marketing challenge, cost concerns have resulted in numerous efficiency-driven programs, while many models still struggle to offer cost-efficient ways of fractional aircraft.

The case shows that such niche mobility sharing models are exciting but challenging. These models might offer customers innovative solutions that increase variability and options. At the same time, flexibility and individualism challenge such models – true for many sharing models in the sector of mobility and especially in air travel today.

1.3 Summary

In recent years, one can observe a hype in trend research. Many researchers and scientists are addressing this topic and trying to analyse the effects of today's trends for the future. Megatrends should make the future more predictable due to their long-term nature and overarching effects. In the course of the work at the Center for Aviation Competence at the University of St. Gallen (CFAC-HSG), it was found through empirical work that one central trend fundamentally influences all megatrends, i.e. *digitalization*. This is why one can refer to digitalization as so-called gigatrend.

In this chapter, we discussed the gigatrend and eight other megatrends, always emphasising their relation and importance for the mobility and aviation industry. Through our dedicated work on the matter and intense exchange with experts, we found that the megatrends *individualization*, *urbanization*, *ecology*, *globalization*, *new life*, *new work* and *security*, in turn, also have a substantial impact on mobility and the aviation industry in specific. Also, we identified three central sub-trends for the the megatrend *mobility*: autonomous vehicles, sustainable mobility and mobility sharing. We described the gigatrend and each of these mega- and sub-trends briefly and highlighted their impact on mobility and the aviation industry.

This chapter is ought to ensure a discussion of the criteria for planning the future of mobility and the aviation industry and, at the same time, to show the dependence of mobility and aviation on various external factors of the environment, influenced by trends that are already possible to be sensed today. Further, it is not to be seen as an extensive list of trends, nor as a scientific piece on these trends. Hence, the chapter could be a first starting point for a strategic exercise or planning process.

Hint

A transformation towards embracing these trends will not happen overnight. Introduce a culture of openness towards dynamic change and introduce uncertainty and curiosity as standard factors. This will take time. But be aware of the immense power of being a role model as management team and introduce quick wins to increase motivation and commitment to the topic.

? Key Questions Overall

- *What do these specific mobility trends mean for my organization?*
- *How can I use these mobility trends to shape my own organization in the long run?*
- *How can I sense developments, like the ones described above, continuously to do proper long-term planning?*
- *How can I personally and proactively shape the future that was described above?*
- *What role do we, as an aviation organization, play in the future described above?*

? Key Questions for Digitalization

- *What does digitalization really mean? What does it not mean?*
- *How can I use digitalization for good?*
- *Do we need digitalization for the sake of digitalizing or rather because of increasing efficiency or effectively?*

? Key Questions for Ecology

- *What does ecology really mean? What does it not mean?*
- *How can I use the megatrend ecology for good in aviation without being criticized for greenwashing?*
- *Do we need ecology for the sake of an external push for environmental sustainability or instead because of increasing long-term competitive advantage?*
- *How can we use the megatrend of ecology to develop a culture of sustainability and long-term thinking and acting?*

? Key Questions for Gender Shift

- *What does gender shift really mean? What does it not mean?*
- *How can I use the megatrend gender shift for my aviation organization?*
- *What are the benefits of a more gender-diverse culture in aviation?*
- *How can I, as an organization, benefit from a more gender-diverse culture?*

? Key Questions for Knowledge Culture

- *How can I use the megatrend knowledge culture for my aviation organization?*
- *What might be possible partners for my organizations to cooperate with to create a knowledge culture?*
- *How can I create a learning organization that benefits my employees and the capabilities of my organization in the long run?*

? Key Questions for Autonomous Vehicles

- *What do autonomous vehicles really mean for the system of mobility?*
- *How do autonomous vehicles change how customers perceive mobility?*
- *How do autonomous vehicles change the way the mobility industry will function?*
- *What are showstoppers for autonomous vehicles?*
- *What do technologies, such as drones, mean for my business in the long term?*

? Key Questions for e-Mobility

- *What does e-Mobility really mean for the system of mobility?*
- *What is the real impact of e-Mobility on the system of mobility?*
- *How do autonomous vehicles change how customers perceive mobility?*
- *How do autonomous vehicles change the way the mobility industry will operate?*
- *What are showstoppers for e-Mobility?*

? Key Questions for Sustainable Aviation

- *What are the main concerns of society and politics when it comes to sustainable aviation?*
- *What might be hidden agendas of stakeholders that demand sustainable aviation and how do I cope with that?*
- *What is my long-term plan for sustainable aviation?*
- *How can I sense and use the strong societal and political call for sustainable aviation to develop a long-term competitive advantage for my organization?*

? Key Questions for Mobility Sharing

- *What are main aspects that need to be introduced to enable mobility sharing?*
- *What are the pitfalls of a mobility sharing concept?*
- *How do mobility sharing concepts change the way the mobility industry will operate?*

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2

Fundamentals and Structure of Aviation Systems

Andreas Wittmer and Thomas Bieger

Contents

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Summary

- The history of aviation beginning with the first drawings and flying items goes back to the fifteenth century.
- The aviation industry has grown to a remarkable size over the last century and is one of the important industries of economic growth today.
- The aviation industry is structured along the aviation value chain.
- Air transport is characterised by high fixed costs, low profit margins in a growing market and by its dependence on external factors.
- The stakeholders of aviation profit from the economies and drivers of aviation.
- The aviation system model includes different environments, such as the economic, ecological, social, technological and political environments, which are impacted by and influence the aviation market.

The history of aviation and the dream of flight dates back many centuries and includes pioneers such as Leonardo da Vinci, Otto Lilienthal and the Wright Brothers, who contributed to this quest. The last century brought along a remarkable growth of the aviation sector and resulted in considerable economic importance of the industry. The aviation industry can be projected along the aviation value chain and comes with its own special characteristics. Whilst aviation creates a high value for customers and other stakeholders, the profit margins are typically low due to high fixed costs and its dependence on external factors. The benefits of aviation to the economy as well as other drivers create positive effects for many stakeholders who are directly or indirectly involved in the system. The aviation system is surrounded by different environments: the economic, ecological, social, technological and political environments. Each environment exerts influence on the aviation system and is simultaneously affected by it.

2.1 Introduction

The aviation industry is characterised by constant change. The ongoing liberalisation of markets, technological progress, environmental challenges and the establishment of new business models including intermodal transport options, but also the increasing awareness of climate change and CO_2 are just a few examples that illustrate the dynamic development of air transportation within the last years. The fact that there are various fields of development indicates that the industry development is not only influenced by the industry actors themselves, but also by its institutional surroundings and the different spheres of its environment, economic, social/political and natural environments. In turn, the development of the industry shapes its actors and competition structures. It also has significant impact on its environment as an economic and social factor, but also through its effects on the natural environment, of which CO_2 is a significant issue today. The interdependencies among the different stakeholders in aviation and the continuous industry development thereby constantly raise new questions for both theory and practice.

Due to the industry's importance as a provider of employment and as an enabler for social exchange and international trade, its ongoing development is of high relevance for the society and economy. Air transport is a driver of international trade, globalisation and global economic prosperity. The aviation industry as a whole is worth over USD 1300 billion whereof USD 1000 billion are direct, indirect and induced effects, employs about 65.5 million people whereof 10.2 million people work directly in the aviation industry (ATAG, 2020), and transports and services about 4.5 billion passengers a year (ATAG, 2020). In 2019, 915 million tonnes of freight was transported by air (ATAG, 2020), being responsible for global just in-time production chains. About 35 percent of the global trade (by value) reaches their markets by air, whilst covering less than 1% in volume (Shepherd, Shingal, & Raj, 2016), making air transportation an important part of international trade. Today, air transportation is an essential component of leisure and business-related travelling, and thus of human connectivity and worldwide economic integration (Sterzenbach & Conrady, 2003). Aviation is also at the heart of travel and tourism, the world's largest industry, supporting 36.7 tourism jobs, to equates to one in eight tourism jobs (ATAG, 2020).

The aviation industry today also is in the focus because of its environmental impacts. Most important factors to be mentioned are CO_2 emission, although there are other gases and compounds with an impact on the environment. The aviation industry in the last decades made significant progress regarding noise reduction and fuel efficiency of engines. Whereas in the 1960s around 12 litres per 100 km per seat were consumed today only around 2–3 litres are used per 100 km per seat (loaded seats are assumed) (Pompl, 2007). But the tremendous growth of the demand for air transport and the growth of the industry overcompensated these gains. Today around 8% (Planète Energies, 2019) of worldwide consumption of fossil fuel and 2–3% of CO_2 emission (International Energy Agency, 2020) can be attributed directly to flying. The use of alternative sources of energy is limited because fuel still is the densest form of energy (Joule per Kg) (not taking into account fuel for nuclear power). The aviation industry, therefore, must optimise the maximum in the framework of the existing technologies and at the same time venture new frontiers like maybe in a first-stage renewable fuel and later on new flying technologies based on new forms of engines. Environmental issues, therefore, on the forefront of aviation management and long-term competitive advantages may arise from this field. The importance of sustainable management will even grow as financial markets define sustainability as a key investment quality (Eccles & Klimenko, 2019).

From a theoretical point of view, there are two aspects that justify the selection of the aviation industry as a research subject. First, the industry's complexity and its dynamism constantly raise new questions and open up fields that have hardly been investigated by academia. It is a typical VUCA (volatile, uncertain, complex, ambiguous) industry (Mack et al., 2015). Secondly, theoretical findings about the aviation industry may be applied beyond this context to other industries. In regard to various developments (e.g. dynamic pricing, global network development and alliance formation, customer value applications and today even sustainability management etc.), aviation serves as an industry precursor, making the research results valuable for broader application, e.g. in other industries.

2.2 Historical Development of Air Transport

This section provides an overview about the history and development of the aviation industry. It is split into different stages of development:

- 1783–1917 Technical development
- 1918–1928 Pioneer stage
- 1929–1944 Political development, bilateral flights and technical stage
- 1945–1970 Internationalisation, development of quality and cost
- 1971–1990 Networks, alliances and low-cost operations
- 1991–2005 Deregulation and customer value
- 2006–2018 Consolidation, new materials and technologies
- 2019 + Environment concerns and new technologies (fuels)

Aviation history deals with the development of mechanical flight. It ranges from earliest attempts at flying kite-powered devices or gliders to person-controlled and -powered flying.

Humanity's desire to fly possibly first found expression in China, where flights by humans tied to kites (as a punishment) are recorded from the sixth century AD (Anno Domini, After Christ). Subsequently, the first hang-glider was demonstrated by Abbas Ibn Firnas in Andalusia in the ninth century AD. Leonardo da Vinci's (fifteenth century) dream of flying found expression in several designs, but he did not attempt to demonstrate that flying was possible. It was in post-industrial Europe, from the late-eighteenth century onwards, that serious flight attempts were made, with progression from lighter-than-air flight (hot-air balloons, 1783), to unpowered heavier-than-air flight by Otto Lilienthal, 1891, and finally, to powered sustained flight by the Wright Brothers 1903.

The dream of flying is fuelled by the observation of birds and is illustrated in myths across the world (e.g. Daedalus and Icarus in Greek mythology, or the Pushpaka Vimana of the Ramayana). The first attempts to fly often drew on the idea of imitating birds, like Daedalus did building his wings out of feathers and wax. Attempts to build wings of various materials and jump off high towers continued well into the seventeenth century.

Systematic attempts began with hot air balloons and kites in China. The Kongming lantern (proto hot air balloon) was known in China from ancient times. Its invention is usually attributed to General Zhuge Liang (180–234 AD, honorific title Kongming), who is said to have used them to scare the enemy troops. The balloon was made of a large paper bag, below which an oil lamp was installed. Due to the lamp heating the air below the bag, the bag floated in the air. According to

Joseph Needham,[1] hot-air balloons in China were known since the third century BC (Before Christ). During the Yuan dynasty (thirteenth century), under rulers like Kublai Khan, it became popular to use rectangular lamps at festivals where they would attract huge crowds. In 559 AD, human flight using a kite was documented during a dispute over succession in the Northern Wei kingdom. In 852 AD, first parachutes and gliders were flown in Spain and England. Some five centuries later, Leonardo da Vinci came up with a hang-glider design in which the inner parts of the wings are fixed, and some control surfaces are provided towards the tips. While his drawings still exist and are deemed flight worthy in principle, Leonardo da Vinci himself never flew such a hang-glider.

The first published paper on aviation was the "Sketch of a Machine for Flying in the Air" by Emanuel Swedenborg published in his periodical 1716. This flying machine consisted of a light frame covered with strong canvas and equipped with two large oars or wings moving on a horizontal axis, arranged in such a way that the upstroke met with no resistance, while the down stroke provided lifting power. Swedenborg knew that the machine would not fly, but he thought of it as a good starting point and was confident that the problem of flying would be solved. He said, "It seems easier to talk of such a machine than to put it into actuality, for it requires greater force and less weight than exists in a human body. The science of mechanics might perhaps suggest a means, namely, a strong spiral spring. If these advantages and requisites are observed, perhaps in time to come someone might know how better to utilize our sketch and cause some addition to be made so as to accomplish that which we can only suggest. Yet there are sufficient proofs and examples from nature that such flights can take place without danger, although when the first trials are made you may have to pay for the experience, and not mind an arm or leg." Swedenborg would prove prescient in his observation that powering the aircraft through the air was the crux of flying.

2.2.1 Technical Development 1783–1917

The first generally acknowledged human flight took place in Paris in 1783. Jean-François Pilâtre de Rozier and François Laurent d'Arlandes went 5 miles (8 km) in a hot air balloon invented by the Montgolfier brothers. The balloon was powered by a wood fire. Ballooning became a major "rage" in Europe in the late-eighteenth century, providing the first detailed understanding of the relationship between altitude and the atmosphere. Work on developing a steerable (or dirigible) balloon (today called an airship) continued sporadically throughout the 1800s. The first powered, controlled, sustained lighter-than-air flight is commonly believed to have

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[1] Joseph Terence Montgomery Needham (9 December 1900–24 March 1995) was a British biochemist, best known for his work on the history of Chinese science. He was elected a fellow of both the Royal Society and the British Academy. In China, he is known mainly by his Chinese name Li Yuese.

taken place in 1852 when Henri Giffard flew 15 miles (24 km) with a steam engine driven craft in France ("History of aviation,", n.d.).

During the last years of the eighteenth century, Sir George Cayley started the first rigorous study about the physics of flight. In 1799, he exhibited a plan for a glider which, except for its form, was, from today's perspective, already completely modern. It showed a separate tail for control and provided for the pilot to be suspended below the centre of gravity to ensure stability. Cayley flew it as a model in 1804. Over the next five decades he worked on the problem, inventing most of basic aerodynamics and introducing such terms as "lift" and "drag." He used both internal and external combustion engines, fuelled by gunpowder, but it was left to Alphonse Penaud to make powering models simple, using rubber power. Later, Cayley turned his research to building a full-scale version of his design. First, he flew it unmanned in 1849; in 1853, his coachman made a short flight at Brompton near Scarborough in Yorkshire.

First test flights with gliders began in the middle of the nineteenth century when several pioneers made short flights or jumps. Scientists started to publish more papers about aerodynamics and the subject of flying in general. In the 1880s, first advancements were made in the construction of gliders which led to the first truly practical gliders. Otto Lilienthal was one of the particularly active researchers who flew with and controlled his glider. He produced a series of good gliders, and in 1891, was able to make flights of 25 meters or more routinely. He rigorously documented his work, including photographs, and therefore is one of the best known of the early pioneers. He also promoted the idea of "jumping before you fly," suggesting that researchers should start with gliders and work their way up, instead of simply designing a powered machine on paper and hoping it would work. Lilienthal knew that once an engine was attached to the plane, it would be difficult to further study the laws of aviation. Finding and describing many of those laws was the greatest heritage he made to his successors. By the time of his death in 1896, he had made 2500 flights on a number of different designs of gliders. His death was caused by a gust of wind that broke the wing of his latest design. He fell from a height of roughly 56 ft. (17 m) fracturing his spine. Lilienthal died the next day, his last words being "sacrifices must be made.." Up to his death, Lilienthal had been working on small engines suitable for powering his designs.

Picking up where Lilienthal had left off, Octave Chanute took up aircraft design after an early retirement and funded the development of several gliders. In the summer of 1896, his troop flew several of his designs a number of times at Miller Beach, Indiana, eventually deciding that the best was a biplane design that, from today's point of view, looked surprisingly modern. Like Lilienthal, he documented his work meticulously, using also photographs, and was busy corresponding with like-minded hobbyists around the world.

Chanute was particularly interested in solving the problem of natural stability of the aircraft in flight; birds did this by instinct, but humans would have to do it manually. The most disconcerting problem was longitudinal stability because as the angle of attack of a wing increased, the centre of pressure moved forward and made the angle increase more. Without immediate correction, the craft would pitch up and stall.

On the basis of the research documented by Lilienthal and Chanute, several other researchers worked on better controllable aircrafts with engines. At the same time that non-rigid airships were starting to have some success, rigid airships were also becoming more advanced. Indeed, rigid body dirigibles would be far more capable than fixed-wing aircraft, in terms of pure cargo carrying capacity, for decades. Dirigible design and advancement was brought about by the German count Ferdinand von Zeppelin.

Between 1900 and 1902, the Wright brothers built and tested a series of kite and glider designs before attempting to build a powered design. The gliders worked, but not as well as the Wrights had expected, based on the experiments and writings of their nineteenth-century predecessors. In 1903, the first sustained flight with a powered controlled aircraft took place successfully. Flyer I and II were used for several test flights; a number of crashes happened. When rebuilding the flyer, calling it Flyer III, after a severe crash on 14 July 1905, the Wrights made radical changes to the design. They almost doubled the size of the elevator and rudder and moved them further away from the wings – about twice the distance than before. They also added two fixed vertical vanes (called "blinkers") between the elevators and gave the wings a very slight dihedral. They disconnected the rudder of the rebuilt Flyer III from the wing-warping control and, as in all future aircraft, placed it on a separate control handle. When testing of Flyer III resumed in September, the results were almost immediate. The bucking and veering that had hampered Flyers I and II were gone and the Wrights experienced no more minor crashes, which had happened frequently with the two previous models. The flights with the redesigned Flyer III started to last over 20 minutes. Thus, Flyer III became a practicable as well as dependable aircraft, flying solidly for a consistent duration, bringing back its pilot to the starting point safely, and landing without causing damage to itself. On 5 October 1905, Wilbur flew 24 miles (38.9 km) in about 40 minutes. In 1908, the Wright brothers conducted the first passenger flight in the United States.

Several researchers built and tested powered planes within the following years. On 25 July 1909, Louis Blériot flew the Blériot XI monoplane across the English Channel, winning the *Daily Mail* aviation prize. His flight from Calais to Dover lasted 37 minutes. On 22 October 1909, Raymonde de Laroche became the first woman to pilot and solo a powered heavier-than-air craft. She was also the first woman in the world to receive a pilot's licence. The first seaplane was invented in March 1910 by the French engineer Henri Fabre. Its name was *Le Canard* ("the duck"). The plane took off from the water and flew 800 metres on its first flight on March 28, 1910. His experiments were closely followed by the aircraft pioneers Gabriel and Charles Voisin, who purchased several of the Fabre floats and fitted them to their Canard Voisin airplane. In October 1910, the Canard Voisin became the first seaplane to fly over the River Seine, and in March 1912, the first seaplane to be used militarily from a seaplane carrier, *La Foudre* ("the lightning").

2.2.2 Pioneer Stage 1918–1928

In World War I, planes were used for the first time for military purposes. During that time the military supported the development of planes strongly. These were mostly double decker planes produces in wood and cloth. They were weather dependent and could not fly in wet conditions.

Aircraft evolved from being constructed mostly of wood and canvas to being constructed almost entirely of aluminium. Engine development proceeded apace, with engines developing from in-line water cooled gasoline engines to rotary and radial air-cooled engines, constituting a commensurate increase in propulsive power. All of this development was pushed forward by prizes for distance and speed records. Charles Lindbergh, for instance, took the Orteig Prize of $25,000 for his solo non-stop crossing of the Atlantic in 1927. He was the first person to achieve this, although not the first to carry out a non-stop crossing. Latter was achieved 8 years earlier when Captain John Alcock and Lieutenant Arthur Brown co-piloted a Vickers Vimy non-stop from St. John's, Newfoundland, to Clifden, Ireland, on 14 June 1919, winning the Northcliffe prize worth GBP 10,000 (USD 50,000).

Mail and single-passenger transport became more popular, but it was an adventurous mode of transport, which was dependent on weather. The Warsaw Convention for limitation of liability was reached in 1929.

2.2.3 Political Development 1929–1944

In the 1930s, development of the jet engine began in Germany and England. In England, Frank Whittle patented a design for a jet engine in 1930 and started building an engine towards the end of the decade. In Germany, Hans von Ohain patented his version of a jet engine in 1936 and began developing a similar engine. The two men were unaware of each other's work, and both Germany and Britain had developed jet aircraft by the end of World War II.

World War II saw a drastic increase in the pace of aircraft development and production. All countries involved in the war stepped up the development and production of aircraft and flight-based weapon delivery systems, such as the first long-range bomber. Fighters were critical to the success of the heavy bombers, as they ensured that the number of losses was lower than it would have been without fighter protection. A number of technological advances that were remarkable for its day are the following: The first functional jet plane was the Heinkel He 178 (Germany) flown by Erich Warsitz in 1939. The first cruise missile (V-1), the first ballistic missile (V-2) and the first manned rocket Bachem Ba 349 were also developed by Germany; however, the small number of jet fighters did not have a significant impact. The V-1 was not very effective, as it was slow and vulnerable, and the V-2 could not hit targets precisely enough.

With the emergence of longer flights and the possibility to fly over other countries, some international regulation was needed. The central convention in the field of international air law is the agreement concerning international civil aviation reached on 7 December 1944 (Chicago Convention – CHI) (SR 0.748). Due to its universal character the Chicago Convention is the fundamental policy for the post-war development of international civil aviation. Following the agreement, the International Civil Organisation (ICAO) was built.

Art. 1 CHI states that "The contracting States recognize that every State has complete and exclusive sovereignty over the airspace above its territory". The claim of every state having a sovereign power over the airspace above its territory contradicts the nature of aviation, which is, by definition, international. To allow international aviation, states need to negotiate for multilateral agreements and/or bilateral aviation conventions. Therefore, the preamble of the CHI states that "the undersigned governments [have] agreed on certain principles and arrangements in order that international civil aviation may be developed in a safe and orderly manner and that international air transport services may be established on the basis of equality of opportunity and operated soundly and economically."

The preparations for the conference of Chicago had started when the ending of World War II was conceivable. On 1 September 1944, the United States invited to a diplomatic roundtable in Chicago to discuss the future of the aviation industry. Before the negotiations had started a multilateral system of traffic rights was aspired (Wenglorz, 1992).

The United States disposed of an extraordinarily strong military aviation force (300,000 aircrafts) after World War II – including countless transportation aircrafts. Those, they could easily convert into a civil armada. With this in mind, the US delegation argued in favour of open skies. Britain, in contrast, wanted an orderly market development (Larsen et al., 2006), meaning a contract that regulates all aircraft transport services. In bilateral aviation agreements, important factors in the competitive environment should be negotiated – the number of seats, the type of aircraft, the frequency of flights, the routes, the rights to land, etc. In contrast to this British scheme was the idea of a worldwide opening of the aircraft transportation market (open skies) (Larsen et al., 2006).

Due to the differing positions, long-lasting and difficult negotiations about the "eight freedoms of the air" were necessary (refer to ▶ Chap. 11 of this book) (Wenglorz, 1992).

2.2.4 Development of Quality and Cost 1945–1971

Commercial aviation took hold after World War II, using mostly ex-military aircraft in the business of transporting people and goods. Within a few years many companies existed, and flight routes criss-crossed North America, Europe and other parts of the world. This development was accelerated by the glut of heavy and super-heavy bomber airframes, like the B-29 and Lancaster, which could easily be converted into commercial aircraft. The DC-3 also permitted easier and longer commercial flights. The first North American commercial jet airliner, the Avro C102 Jetliner, flew in September 1949 shortly after the British Comet. By 1952, the British state airline BOAC had introduced the De Havilland Comet into scheduled service. While it represented a technical achievement, the plane suffered a series of highly public failures. The shape of its windows led to cracks due to metal fatigue which was caused by cycles of pressurisation and depressurisation of the cabin, and eventually led to a catastrophic failure of the plane's fuselage. By the time the problems were overcome, other jet airliner designs had already taken to the skies.

The USSR's Aeroflot became the first airline in the world to operate sustained regular jet services with the Tupolev Tu-104 on 15 September 1956. Boeing 707, which established new levels of comfort, safety, and passenger expectations, ushered in the age of mass commercial air travel as it is enjoyed today.

Even after the end of World War II there was still a need for advancement in aircraft and rocket technology. Not long after the war had ended, in October 1947, Chuck Yeager took the rocket-powered Bell X-1 past the speed of sound. Although anecdotal evidence exists that some fighter pilots may have crossed the sound barrier while dive-bombing ground targets during the war, this was the first controlled level flight to achieve this. Further barriers of distance were overcome in 1948 and 1952 as the first jet crossing of the Atlantic was conducted.

In 1961, the sky was no longer the limit for manned flight, as Yuri Gagarin orbited the planet within 108 minutes. His achievement heated up the space race, which had started in 1957 with the launch of Sputnik 1 by the Soviet Union, even further. The United States responded by launching Alan Shepard into space on a suborbital flight in a Mercury space capsule. With the launch of the Alouette I in 1963 Canada became the third country to send a satellite into space. The space race between the United States and the Soviet Union would ultimately lead to the current pinnacle of human flight, the landing of men on the moon by Neil Armstrong in 1969.

However, this historic achievement in space was not the only progress made in aviation at this time. In 1967, the X-15 set the air speed record for an aircraft at 4534 mph or Mach 6.1 (7297 km/h). This record still stands as the air speed record for powered flight, except for vehicles designed to fly in outer space.

An important driver of the future economic development of the industry was the development of wide body aircraft like the Boeing 747 (first flight 1969) or DC 10 (1970) or the Lockheed Tristar (also 1970). These planes allowed to transport up to 500 passengers instead of 150 which allowed significant economies and reduced cost but also required new markets and business models to fill the planes. In 1975, commercial aviation progressed even further when the Soviet Aeroflot started regular service on Tu-144 – the first supersonic passenger plane. In 1976, British Airways inaugurated supersonic service across the Atlantic, courtesy of the Concorde. A few years earlier the SR-71 Blackbird had set the record for crossing the Atlantic in less than 2 hours, and Concorde followed its footsteps with passengers in tow.

At the same time commercial aviation became more reliable and the industry grew. Airlines were established and route networks were set up. The following figures (◘ Figs. 2.1 and 2.2) show the development of Swissair as an example for a flag carrier of a neutral state and its route networks from the 1930s to the 1970s. The network evolved from a European point-to-point network to a hub-and-spoke network with connections through the hub Zurich Airport. First, some European destinations were served.

The following figure (◘ Fig. 2.1) illustrates the development from a point-to-point network to a raster network. As the planes became bigger, they allowed for more passengers to be transported. This development enabled the airlines to offer several destinations on one route by "milk can flights" landing and (un)loading

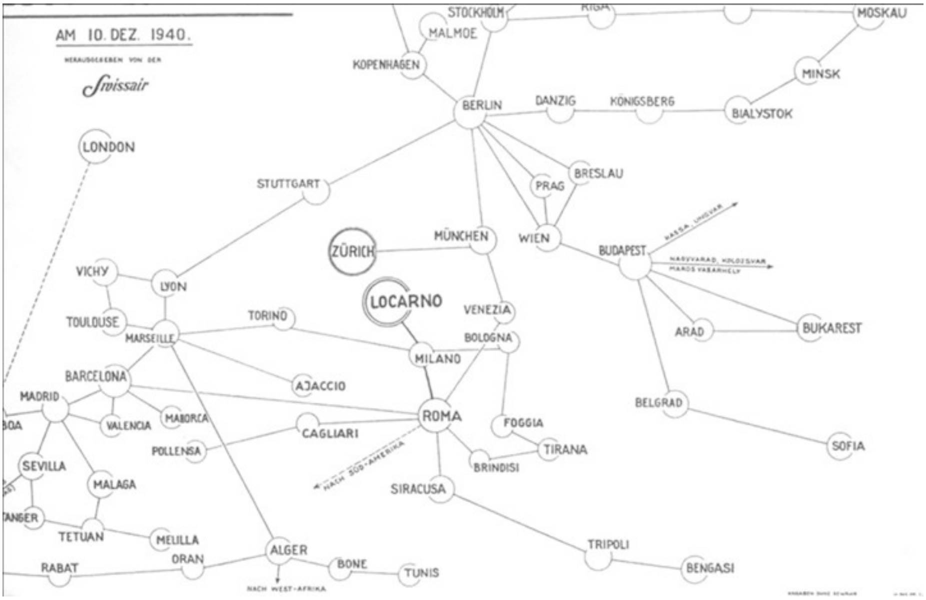


Fig. 2.1 Swissair routes in the early 1940s during World War II. (Schroeder, 2002)

Fig. 2.2 Swissair routes in the 1980s. (Schroeder, 2002)

passengers, which meant that they could serve more passengers in a small market and thus finance their operation.

Figure 2.2 shows the hub Zurich located in the centre and European domestic connections going through the hub Zurich to long-haul destinations. With the establishment of the long-haul market, it became important for airlines to have enough passengers to fill the large long-haul planes. Therefore, short- and long-haul flights were connected.

The route development of Swissair, as illustrated in the following route network figure (▣ Fig. 2.2), was a consequence of deregulation. The competitive environment changed and led to competitive prices and more efficient network management in the airline business.

2.2.5 Deregulation, Networks, Alliances and Low-Cost Operations 1974–1990

2.2.5.1 Deregulation of American Air Transport

The regulation of aviation was questioned strongly in the 1970s and 1980s. On the one hand, this was based on the general critique concerning the regulation policy of the government stemming from new economic approaches like the "contestable markets" approach (Baumol et al., 1982). On the other hand, the aviation industry found itself in a serious crisis: the oil crises lead to higher fuel costs; simultaneously there was a low demand for flights due to the recession and airlines had considerable debts from investments in wide-bodied aircrafts.

At this time, countless government regulations existed which aimed at securing an area-wide supply and avoiding too strong a competition that would ruin the aviation market. However, these regulations led to a favouritism of large airlines and a slackening of competition (Grundmann, 1998). Although flight prices were high, airlines did not achieve returns. As a consequence, and to meet the rising political pressure, the Airline Deregulation Act was signed in 1978 (Pompl, 2007). This was the beginning of the deregulation of the inner-American air traffic between 1979 and 1983 (Schäfer, 2003), in which the regulations concerned with market access, capacities and prices were abandoned.

This was an important development because, from then on, the United States actively aimed at deregulating the aviation market. The so-called Open-Sky policy of the United States strived for the signing of agreements with other states which then got the permission for the third, fourth and fifth freedom: opportunity of code-sharing, capacity for free tariffs, freedom in the appointment of capacities and frequencies (Schäfer, 2003).

The impacts of deregulation on the American market have been assessed in countless studies and have been discussed controversially. In the following, the decisive effects for the airlines (supply) as well as for the consumers (demand) are presented.

2.2.5.2 Supply

Especially the deregulation of prices in conjunction with the reduction of entry barriers led to fierce price pressure through new market entries for existing airlines. Therefore, in the first 8 years after the abolition of regulations, 200 new airlines were founded. Many of those newly founded airline companies quickly became victims of the strong competitive pressure. Approximately two thirds of the newly founded airlines disappeared from the market because they ceased business, were absorbed or involved in mergers (Pompl, 2007). Consequently, the concentration within the aviation industry rose. Prior to the deregulation, the eight biggest airlines possessed 81 percent of the domestic market, which shifted to 95 percent by 1991 (Dempsey & Goek, 1992). The rise in economic pressure from competition and the high number of mergers during that period show that economies of scale, scope and density had been idle and could be fully utilised after the deregulation of the market.

Altogether the first 5 years of deregulation were characterised by bad revenues in the airline industry. The American airlines lost USD 900 million and suffered from the worst profit situation the aviation industry had ever experienced (Pompl, 2007). In this context, it is important to remember that the general economic climate was marked by a recession and the second oil crisis. Therefore, the situation for the aviation industry was difficult worldwide.

The airlines confronted with competitive pressure reacted by massively cutting costs, mainly labour costs. As a result, the real unit labour costs fell by more than 50 per cent in the period between 1978 and 1984. In contrast, the decline in Europe only amounted to 15 percent (Card, 1996).

Besides introducing cost cuts, airlines also adapted their business models and strategies towards the new competitive environment. In particular the new competitors were forced to position themselves in niches. The "no frills" concept and the introduction of low-cost carriers are supply strategies which have developed into a widely spread concept among airlines.

The pressure, however, also opened up new opportunities for increased flexibility which led to an augmentation of productivity. The flight routes could be restructured and adjusted to better suit customer needs. Since price regulations had been abolished, price differentiation became possible. The newly founded airlines in particular profited from the fact that their employees were not unionised and that they could, therefore, cut costs thanks to more flexible conditions of employment and lower wage levels (Baltagi et al., 1995). The emergence of hub-and-spoke networks was also a development promoted by the deregulation. The canalisation of routes through hub-and-spoke networks allowed for cost cuts, while the mounting of hubs also led to a natural monopoly for certain airlines at the different locations. These airlines could avoid the price pressure up to a certain degree (Card, 1996). Except for three cases, all hubs were controlled by airlines that generated at least 60 percent of all flights, gates and passengers (Dempsey & Goek, 1992).

In the air passenger market, the competition among national airlines increased. National airlines charged high amounts for tickets and were supported by their governments. They operated in a controlled environment, where they had monopolies in their countries. With the deregulation in the United States, prices started to decrease and the first low-costs carrier (Southwest Airlines) was founded in the United States in 1971. In Europe, the deregulation process took much longer. Price competition started in Europe in the 1980s. Several low-cost carriers commenced their operations in Europe following the start of the price competition and new business models emerged with different cost allocations. New pricing schemes were introduced which followed new booking behaviours using internet booking services.

The large airlines adopted computer-based reservation systems as an entry barrier for new suppliers. They used these computer-based reservation systems as a marketing instrument and paid commissions to travel agencies for using the systems prohibiting the use of competing systems. The travel agencies could request price information and capacities, as well as carry out bookings in these systems. These developments increased the concentration on only a few airlines (Kennet, 1993). Frequent flyer programs also emerged during that time – another measure of customer loyalty which boosted big airlines.

In general, the supply developed positively with rising demand. Between 1978 and 1988 the number of passengers increased by 88 percent and the kilometres flown by passengers rose by 62 percent. The supply, in the form of available seat kilometres, rose by approximately 65 percent during the same period (Kennet, 1993).

2.2.5.3 Demand

The consumers are often considered the real beneficiaries of deregulation because it resulted in lower flight prices and flying as a former luxury good becoming a commodity. In fact, the prices sank by 22 percent on average between 1978 and 1993 (Morrison & Winston, 1997). In addition, a large number of passengers was able to benefit from lower prices. In the year 1989, for instance, 89 percent of all passengers benefited from an average price reduction of 89 percent (Pompl, 2007). Prior to the deregulation a decrease of flight prices would already have been possible through technical advances, i.e. the introduction of large capacity aircrafts, but it was forwarded further by the deregulation.

The increased number of flights and air connections after deregulation also meant that customers had a greater choice of offers to choose from (Pompl, 2007). Additionally, the hub-and-spoke systems were established and increased connectivity of travellers for lower prices. The hub-and-spoke system, however, also led to higher prices at the hubs. In 1988, the average prices at the 15 most frequently passed hubs were 27 percent higher than the prices at the 38 not-concentrated airports (Dempsey & Goek, 1992). One reason for this is the market power of the dominant airlines at different locations. As a consequence, prices for air travel which ended at hubs became more expensive in comparison with prices for connecting flights towards hubs. The major competition and, consequently, the decrease in prices happened on those routes that were direct connections with much traffic (Button, 1996).

Overall, the service offering has increased because of the differentiation of performance; however, a distinction has to be made between hubs and remote areas. Although at large, the number of offered flights has increased, since the deregulation, smaller towns are generally only serviced by one airline and, therefore, the availability of flights is worse for those regions. However, the number of hubs has increased and thus the number of non-stop connections has also risen.

Then again, the increase of the total number of flights has also led to a capacity overload and consequently, the number of delayed flights and the noise exposure in the area surrounding the hubs have increased. Furthermore, passengers have to cope with having to spend more time on aircrafts and airports.

In general, studies on deregulation conclude that, on average, consumers have benefited distinctively from lower flight prices and higher service offerings. It is estimated that consumers saved up to USD 11 billion in the year 1986 alone (Kahn, 1988).

2.2.5.4 Deregulation of the European Air Transport

In Europe, the same development happened with a time lag of 15 years. Since 1993 freedom of services has existed in European aviation, and since 1997 full cabotage has been allowed in the framework of the third liberalisation package. Since that year there is an actual domestic market for aviation among the members of the European Union (EU). The delay of the deregulation development in Europe is due to the heterogeneous structure of the European Union which did not allow for an implementation at the same pace as in the United States.

Besides the harmonisation of the law and the deregulation, accompanying measures were implemented. Therefore, in view of the higher number of flight delays and cancellations, passenger rights were strengthened. Furthermore, a number of regulations concerned with flight noise emissions were implemented and flight security was further Europeanised (O'Reilly & Stone Sweet, 1998).

Still, the European market cannot be referred to as a liberalised market. There are still countless regulations which have an impact on the aviation industry. In particular, the following are significant (Heitmann, 2005):

- The regulation of extra-European routes and extra-European airlines.
- The regulation of the access to lean airport capacities.
- The hindrance of pan-European fusions.
- The payment of open and hidden subsidies.

Because of the structure of the European aviation, deregulation was implemented over a longer period of time and has different impacts compare to the impacts deregulation has had in the United States. Those differences are explained in the following.

2.2.5.5 Differences Between the European and American Markets

Unlike the US aviation industry, which was affected by private companies from its very beginning (Grundmann, 1998), the European aviation industry was always heavily influenced by governmental interventions and governmentally funded companies.

The liberalisation of the European civil aviation industry was an evolutionary process, whereas the Deregulation Act constituted an abrupt change in policy. Incremental developments give advantages to small companies entering a market, as they may provide a chance for consistent development (Martinez et al., 2001).

As mentioned before, the political process of deregulation is significantly different to the one in the United States. The European Union is a collective of sovereign states which makes deregulation to a process of negotiation. Due to differing interests of various states, deregulation was only slowly implemented. The majority of states had a governmentally funded flag carrier and an infrastructure they wanted to protect. These national interests were reasons for the gaps in deregulation pointed out earlier. These regulations lead to an inefficient deregulation process.

The structure of airlines in different nations and the state funding scheme of those states differ significantly. The company culture, the terms of employment and the claims of the environment differ between the US and EU regions. A further difference may be noticed in the structure of customers. Customers in the US market are relatively homogenous, whereas European airlines have to cope with customers that have heterogeneous demands and differ in their cultural backgrounds.

A significant difference also exists in the hub-and-spoke systems. In contrast to the US system, in Europe these systems are nationally coined. Although since 1997, when cabotage has been permitted, the possibility exists to establish hubs at optimal locations outlying the home market, this possibility is strongly limited by the stringency of slots.

Strong network carriers with big home markets strengthened their hub-and-spoke networks searching for economies of scale, scope and density by growing organically or by mergers and acquisitions. Instead of merging with other airlines, the national airlines in Europe in the 1990s went for alliance systems Lufthansa, for example, decided to start loose alliance networks by founding the Star Alliance. Wide-body planes, such as the Boeing 747, the DC 10 and the MD 11, were generating profits on long-haul routes.

At the same time the growing leisure market charter airlines became more popular and were more and more integrated into tour operators. The latter offered the tourist the whole value chain, from the transportation to the holiday destination, to the stay in the destination as well as the transportation back to his/her home.

2.2.6 New Perspectives – Customer Value 1991–2005

During the 1990s, especially in Europe further deregulation took place. Today, online sales channels have become more efficient and are very popular. Under the pressure of an increasing number of low-cost carriers on short-haul routes as well as international threats such as wars, epidemics and terrorism, network carriers had to become more efficient to be able to survive in a liberalised market which is dominated by prices. Network management was intensified. Alliances grew independently, while mergers started even across borders. The path through alliances towards mergers seems to be a successful one. Best examples for this are the integration of Swiss International Airlines into Lufthansa in 2005 and KLM into Air France in 2004. The trend moves towards continental hubs.

More and more the legacy carriers in the traditional western countries running on a hub business model see competitors from new countries especially in the Middle East. Emirates with Dubai or Qatar with Doha, but also Turkish with its newly opened big airport in Istanbul operate intercontinental hub models drawing on their excellent geographical location between Europe and Asia. Based on the strong economies (economies of scale and networks) it can be expected that in future the hub business model will see an even stronger consolidation into a system of so-called mega carriers like Emirates Airlines, Lufthansa, British Airways, Air France/KLM with their "satellite" airlines. Or they become niche players with smaller networks focusing on specific routes or a specific group of travellers (e.g. La Compagnie, Peoples Airlines, Helvetic Airways).

Low-cost airlines developed an anti-network model, a so-called point to point model, which has been successful on the domestic and continental markets around the globe for several years and enticed away passengers from existing network carriers. In addition, this business model managed to attract new target groups for low-cost trips within continents, consisting partly of those persons who had never flown before. Developments indicate that there even might be a market for long-haul low-cost travel as Norwegian has launched low-cost long-haul routes from Europe to North and South America and Asia. However, the sustainability of the long-haul low-cost market is yet unclear, as Norwegian has repeatedly reported losses, partly attributable to problems with their long-haul operations (Norwegian 2019). Long-haul low-cost operations seem to work fine with flight times up to 8 hours, so in the case of Norwegian for the routes between Europa and the eastern part of North America. Longer flights to Asia and South America cannot achieve the cost structure needed and passengers needed to be successful. Reasons for this might be that up to 8 hrs passengers can cope with reduced board service and smaller, cheaper aircrafts like the A321neo can be used, which have a limited fuel capacity and range.

Due to high numbers of new low-cost airline entries in the market, consolidation is becoming an issue among low-cost airlines. In recent years, takeovers have occurred more frequently than they used to. Also mixed business models (between point-to-point and hubbing) proved difficult as carriers such as Air Berlin have failed.

2.2.7 New Materials and Technologies 2006–2018

In commercial aviation, the early-twenty-first century has seen the end of an era with the retirement of the Concorde. Supersonic flights turned out not to be commercially viable, as the planes had to fly over the oceans if they wanted to break the sound barrier. Furthermore, the Concorde featured high fuel consumption and could only carry a limited number of passengers due to its highly streamlined design. New developments in the area of supersonic flight can be recognised; however, for an airline, they are not yet at a sustainable level for implementation. The end of the supersonic period in commercial aviation might be considered a symbol for a move to more sustainability and pragmatism in the industry.

After Open Skies Agreements had been relaxed in the United States, they also have been further relaxed in Europe. This had an impact on connectivity and pricing of airline tickets. In the future, new pricing schemes are likely to be evaluated and implemented. As prices are increasing due to overfilled airspaces and airports and also due to high fuel costs, a seamless customer service becomes a highly relevant issue. A new level of quality is required in premium classes (business and recently also premium economy) which are growing in their popularity and represent the business field of network carriers which is most profitable. Consequently, some airlines introduced new aircraft, even all-business class aircraft, to the market. Together with rising environmental awareness and for some periods high fuel prices lead to a focus on fuel efficiency and environmental quality.

This was possible due to new technologies produced by Airbus and Boeing. Airbus brought the A380 flagship on the market which can realise huge economies of scale in a full economy-class configuration with over 800 seats on board. Boeing produced the Boeing 787 Dreamliner, which is the first commercial airplane produced to a great extent with lightweight carbon material. Due to its lower weight the rather small Dreamliner can operate new routes point to point in a long-haul market to competitive prices and by this compete with better direct connections also from secondary hub airports, whereas the A380 is the plane for the big mega hubs and large transfer passenger numbers. Both concepts support different business models and come along with significant fuel efficiency.

Mini Case: easyJet and the Implications of Brexit

By Andreas Wittmer

Since its inception in 1995, easyJet has grown to become one of Europe's leading low-cost airlines carrying over 96.1 million passengers p.a. using a fleet of 331 aircraft throughout Europe. Initially launching operations in the United Kingdom, easyJet rapidly expanded beyond its London Luton hub into the European market, operating from 30 bases across Europe (easyJet, 2019).

The access to the European market was provided by the basis of the airline's ownership by EU nationals which afforded them the 9 freedoms agreement giving them the allowance to fly anywhere within the EU without restrictions. This free market access forms part of the European Common Aviation Area (ECAA) together with standardised regulations, e.g. air crew licensing or air traffic management. Furthermore, easyJet benefitted from the bilateral agreements signed between the EU and third countries. All these privileges are currently at stake with the impending Brexit, the United Kingdom's departure from the EU (KPMG, 2016).

These are the primary problems that easyJet is facing, besides a recession in the United Kingdom or other smaller aspects such as slot management (easyJet, 2019). After Brexit, easyJet's ownership would consist mainly of non-EU nationals, thus eliminating these traffic rights. As such, easyJet would be dependent on the United Kingdom government re-negotiating the United Kingdom's access to the European aviation market such as re-applying for an ECAA membership or signing bilateral agreements. Another option for easyJet is transferring its European operations to a separate entity with an EU operating license, thus granting them the traffic rights with the EU as well as to other countries covered by agreements (KPMG, 2016).

For easyJet, the latter option proves to be viable, with the airline opening a subsidiary in Austria to secure traffic rights in the event of a "no-deal Brexit." This includes the transfer of aircraft, pilots and cabin crew to the new subsidiary. Additionally, they created a second spare parts hub in the EU to prevent any supply chain issues (Kaminski-Morrow, 2019). Regarding the ownership issues, easyJet is prepared to use its right to force non-EU shareholders to sell their shares in order to achieve the 50% plus one EU-national ownership requirements (easyJet, 2019). As such, the company has implemented several measures to maintain the fundamental aspects of their business model challenged by the impending Brexit.

2.2.8 2019 + Environment and New Fuels

Further development, in the beginning of the twenty-first century, until the Corona Crisis in 2020 has been driven by a strong economic development with growing demand and, also because of new entrants like the Gulf carriers, supply. There is now a clear picture of the long-term consequences of the Corona Crisis. The short-term lock down effects which lead to a quasi-complete stop in passenger traffic (with the exception of repatriation flights) for several months already lead to bankruptcies of mainly smaller airlines and a need for state support (with growing influence of governments on airline management) even for large and strong airlines like Lufthansa. In the long-run most forecasters see a reduction of business traffic but a close to complete come back of leisure traffic (IATA, 2019, own research, 2021).

Together with the Corona Crisis awareness of the climate crises grew. Many governments introduced new environmental taxes to reduce carbon effects of aviation (e.g. Swiss government CO_2 charges between CHF 30 and 120, Austrian government, minimum price) also in summer 2020. The combined effect of coping with a transition stage until a new normal and a new normal with possibly less business traffic and an increased environmental awareness will affect the business models of airlines and the whole aviation industry. Important elements of this change might be made possible by new technologies.

Aviation has focused on remotely operated or completely autonomous vehicles. Several unmanned aerial vehicles or UAVs have been developed. In April 2001, the unmanned aircraft Global Hawk flew from Edwards AFB in the United States to Australia non-stop and without being refuelled. It took 23 hours and 23 minutes and was the longest point-to-point flight ever undertaken by an unmanned aircraft. In October 2003, the first completely autonomous flight of a computer-controlled model aircraft occurred across the Atlantic. In Switzerland, post offices have started using quadrocopters to transport blood samples between laboratories in 2019, hoping to eventually use the technology to deliver mail.

The Airbus A380 will not be produced anymore from 2021 as it has proven not to be successful with its cost and emission perspectives. Markets are not big enough to generate the needed load factors in line with the needed prices. Furthermore, the plane technology and the engine technology are not up to date and too expensive to be upgraded in a saturating market in the United States and Europe. Furthermore, limited airspace, airport infrastructure and climate awareness and policies will have an impact on demand of air travel. Whereas limited airspace and airport space are arguments for bigger planes such as the A380, the market and environment aspects are countering strong and airlines moved to order more of the new technology planes such as the Boeing 787 Dreamliner and the Airbus A350.

The main topic in society of this time period will be the climate impacts of aviation. Aviation is a significant and growing contributor to the environment by its emissions. It has become heavily under pressure by especially younger generations blaming aviation for climate change. In research there is a high pressure on the development of new engine technologies using electricity (electric engines) and new carbon-neutral fuel. Furthermore, the society less and less accepts short-haul flights, which can be substituted by trains. Airlines start to cooperate with railway companies to replace direct or feeder flights by railway options, e.g. Swiss and Swiss Federal Railways operate the transport from Lugano to Zurich by train. Emirates has gone into a partner agreement with the French TGV railway company to transfer its passengers by TGV from Paris to the different destinations in France.

The more intramodality will become normal, the more challenged will be the point-to-point airlines (low-cost Carriers). Their business case only works on short-haul routes. In Europe many of these short-haul routes can be assessed by rail and high-speed rail. Due to more and more airspace and airport congestion, travel time by rail is not longer for rail travel of up to 4 hours. With state policies increasing travelling cost by plane (e.g. Austria introduced a minimum price of EUR 40 from Vienna, Switzerland introduces a CO_2 charge of min CHF 30 for short haul flights), and subsidies for railways (e.g. Austria supports newly very cheap rail travel passes) the competitive disadvantage of trains versus planes will be reduced and as research shows that the most important decision factor for travellers is the price or total travel cost, it can be assumed that short-haul growth of air travel in Europe will come to an end. Additionally, some governments and companies have made new rules about minimum travel times by air for their employees (e.g. Swiss government up to 6 hours travel time by train).

By the year 2050, one can expect to live in a world with carbon-neutral aviation operation, but most likely not carbon neutral footprints including production and recycling planes and airports.

2.3 Size of the Aviation Industry

This section provides an overview and some statistics of the aviation industry based on different data sources. The largest airlines in the world can be found in the Unites States. Operating over 330,577 million revenue passenger kilometres (RPK) each year (IATA, 2019), American Airlines is the largest passenger airline in the world. Federal Express (FedEx) is the largest scheduled freight transporter with almost 17,499 million freight ton kilometres. The second and third largest passenger airlines are also American airlines; Emirates ranks fourth. Southwest Airlines ranks fifth, China Southern Airlines ranks sixth and Ryanair ranks seventh, being the biggest European Airline with respect to RPK. The ranks and passengers carried are presented in ▣ Table 2.1.

Table 2.1 Top 10 passenger and cargo airlines in 2018

Total revenue passenger kilometres flown			Total freight tonne kilometres flown		
Rank	**Airline**	**Millions**	**Rank**	**Airline**	**Millions**
1	American Airlines	330,577	1	Federal Express	17,499
2	Delta Air Lines	330,034	2	Emirates	12,713
3	United Airlines	329,562	3	Qatar Airways	12,695
4	Emirates	302,298	4	United Parcel Service	12,459
5	Southwest Airlines	214,561	5	Cathay Pacific Airways	11,284
6	China Southern Airlines	200,239	6	Korean Air	7839
7	Ryanair	170,900	7	Lufthansa	7394
8	China Eastern Airlines	166,282	8	Cargolux	7322
9	Air China	161,199	9	Air China	7051
10	Lufthansa	158,986	10	China Southern Airlines	6597

IATA (2019)

When airlines are ranked according to the group revenues, a different picture emerges. American Airlines is top of the ranking ahead of Delta Air Lines, Lufthansa Group and United Continental. This emphasises the structure of the airline industry around the world with revenue being considerably higher in the American (because of an earlier consolidation) as opposed to the European and Asian markets. In contrast, the growth in revenue is low for American airline groups as opposed to their European or Asian counterparts. European airline groups are currently going through a phase of consolidation, thus enhancing growth. ◘ Table 2.2 shows the revenue of the top 20 ranked airlines in the years 2017 and 2016.

However, airlines and freight forwarders are not the only important partners of the aviation industry. Airports handle all passengers and represent the key infrastructure for the industry. Atlanta, which is the largest airport in the world, handles over 107 million passengers each year. Beijing, the second largest airport, handles almost 101 million passengers and Dubai being the third largest airport, handles more than 89 million passengers each year. ◘ Table 2.3 provides an overview of the 20 largest airports in the world. A new player in the European arena is Istanbul with its new airport opened in 2019 capable of handling 90 million passengers and up to 200 million passengers once all future phases are completed by the year 2028.

The size of airports can also be looked at from the perspective of total movements per year. Ranking airports according to this perspective shows that Atlanta handles almost one million movements, which represents the largest number of departures and landings of all airports worldwide. Considering the perspective of movements, Amsterdam, which ranks ninth on the world ranking list, is the largest

Table 2.2 Top 20 airline groups based on revenue 2017

Ranking	Airline group	Revenue US$m		% Change
		2017	2016	
1	American Airlines	42,207	40,180	5.0
2	Delta Air Lines	41,244	39,639	4.0
3	Lufthansa Group	40,449	34,912	16.2
4	United Continental	37,736	36,556	3.2
5	FedEx	36,172	27,358	32.2
6	Air France-KLM Group	29,313	27,398	7.0
7	Emirates Group	27,882	25,779	8.1
8	International Airlines Group	26,116	24,885	4.9
9	Southwest Airlines	21,171	20,425	3.7
10	China Southern Airlines	18,987	17,272	9.9
11	Air China	18,425	17,297	6.5
12	ANA Holdings	17,805	16,298	9.2
13	China Eastern Airlines	16,335	15,679	4.2
14	Air Canada	12,534	11,094	13.0
15	Japan Airlines Group	12,490	11,900	5.0
16	Cathay Pacific Group	12,480	11,950	4.4
17	Qantas Group	12,103	11,777	2.8
18	Singapore Airlines	11,693	10,737	8.9
19	Qatar Airways Group	11,597	10,816	7.2
20	Turkish Airlines	11,185	9871	13.3

Table compiled by the author based on Flightglobal (2017, 2018)

European airport. American airports take seven of the first ten positions. ◘ Table 2.4 shows the movement rankings of the largest airports worldwide.

These data all present the historical development of the airlines and airports mentioned. However, for economists and managers an important question is "how the future will develop." Airbus, for example, has looked at the scheduled world air traffic today and compared it to forecasts made in regard to the year 2038. In 2018, the big air transport market has recently shifted from the United States to the Asia-Pacific region. By 2038, it is expected to move even more towards other continents. Throughout all of the continents, a general growth trend can be expected. Of all these, the Asia-Pacific region is expected to experience the highest growth, where in future over 50% of the world's biggest traffic flows will be involved in. Other emerg-

Table 2.3 The largest airports in the world based on total number of pax handled 2018

Rank	City	Code	Total passengers	% Change
1	Atlanta GA	ATL	107,394,029	3.3
2	Beijing	PEK	100,983,290	5.4
3	Dubai	DXB	89,149,387	1.0
4	Los Angeles CA	LAX	87,534,384	3.5
5	Tokyo Haneda	HND	87,131,973	2.0
6	Chicago O'Hare IL	ORD	83,339,186	4.4
7	London Heathrow	LHR	80,126,320	2.7
8	Hong Kong	HKG	74,517,402	2.6
9	Shanghai Pudong	PVG	74,006,331	5.7
10	Paris Charles De Gaulle	CDG	72,229,723	4.0
11	Amsterdam	AMS	71,053,147	3.7
12	New Delhi	DEL	69,900,983	10.2
13	Guangzhou	CAN	69,769,497	6.0
14	Frankfurt/Main	FRAU	69,510,269	7.8
15	Dallas/Fort Worth TX	DFW	69,112,607	3.0
16	Seoul Incheon	ICN	68,350,784	10.0
17	Istanbul Atatürk	IST	68,192,683	6.4
18	Jakarta	CGK	66,908,159	6.2
19	Singapore	SIN	65,628,000	5.5
20	Denver CO	DEN	64,494,613	5.1

Airports Council International (2019)

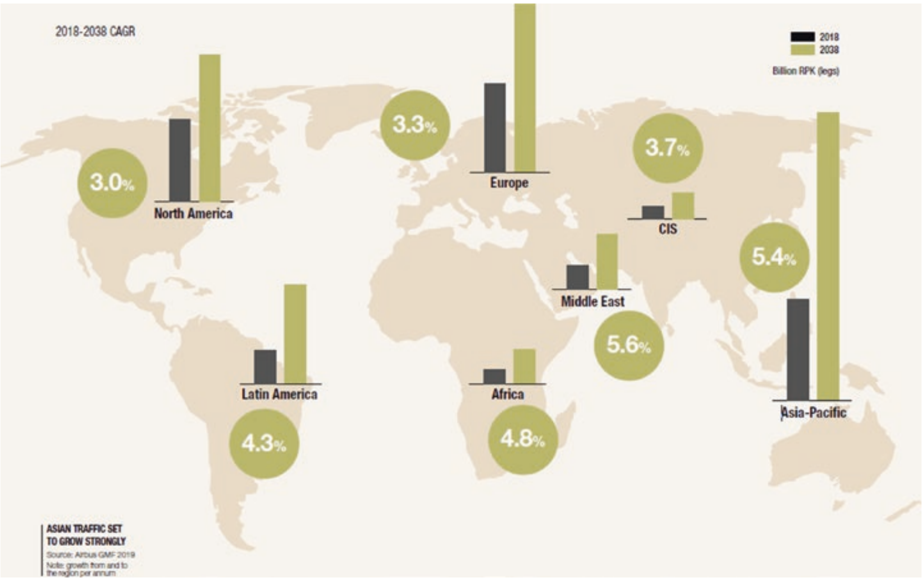
ing markets such as Latin America and Africa are also expected to experience higher growth rates. In addition, the Middle Eastern area is expected to realise an increase in the volume of passengers carried and movements in the next few years. This is particularly evident in the growth forecasts for the world traffic flows, where the highest growth rates are either within or between these highest growing markets. On the other hand, Europe, North America and CIS will be experiencing slower growth. ▣ Figure 2.3 illustrates the compound annual growth rate per region in regard to the number of revenue passenger kilometres (RPKs) between 2018 and 2038. ▣ Figure 2.4 illustrates the shares of RPK between different areas of the world in the year 2000 and the year 2020. RPKs are the revenues per passenger per kilometre.

Table 2.4 The largest airports worldwide according to the number of movements in 2017

Rank	City	Code	Total movements	% Change
1	Atlanta GA	ATL	879,560	(2.1)
2	Chicago IL	ORD	867,049	(0.1)
3	Los Angeles CA	LAX	700,362	0.5
4	Dallas/Fort Worth TX	DFW	654,344	(2.7)
5	Beijing	PEK	597,259	(1.5)
6	Denver CO	DEN	574,966	1.7
7	Charlotte NC	CLT	553,817	1.5
8	Las Vegas NV	LAS	542,994	0.3
9	Amsterdam	AMS	514,625	3.6
10	Shanghai Pudong	PVG	496,774	3.5
11	Paris Charles De Gaulle	CDG	482,676	0.7
12	London Heathrow	LHR	475,915	0.2
13	Frankfurt/Main	FRA	475,537	2.7
14	Toronto Pearson ON	YYZ	465,555	2.0
15	Guangzhou	CAN	465,295	6.9
16	Istanbul Atatürk	IST	460,785	(1.2)
17	San Francisco CA	SFO	460,343	2.2
18	Tokyo Haneda	HND	453,126	1.0
19	Houston TX	IAH	450,383	(4.3)
20	Mexico City	MEX	449,664	0.3

Airport Council International (2019)

Airports and airlines are not the only representatives of the aviation market. Further suppliers play a significant role in the aviation industry along the supply chain: manufacturers, e.g. Boeing and Airbus, which depend on orders of airlines, maintenance, leasing, ground handling, reservation system providers, catering and fuelling organisations and travel agents. All those suppliers generate their incomes entirely or at least to some extent from the aviation industry. The Aviation Ecosystem (Rencher, 2019) reaches far beyond with companies in the finance, consulting, engineering, furniture and service sector influencing innovation and development of the industry. The indirect, catalytic effects like enabling transport and contribution to the attractiveness of places (Littorin, 2015) highlights the relevance of the aviation industry for the whole economy.



ASIAN TRAFFIC SET TO GROW STRONGLY

Source: Airbus GMF 2019

Note: growth from and to the region per annum

Fig. 2.3 World air traffic flow in the year 2018 and 2038. (Airbus, 2019)

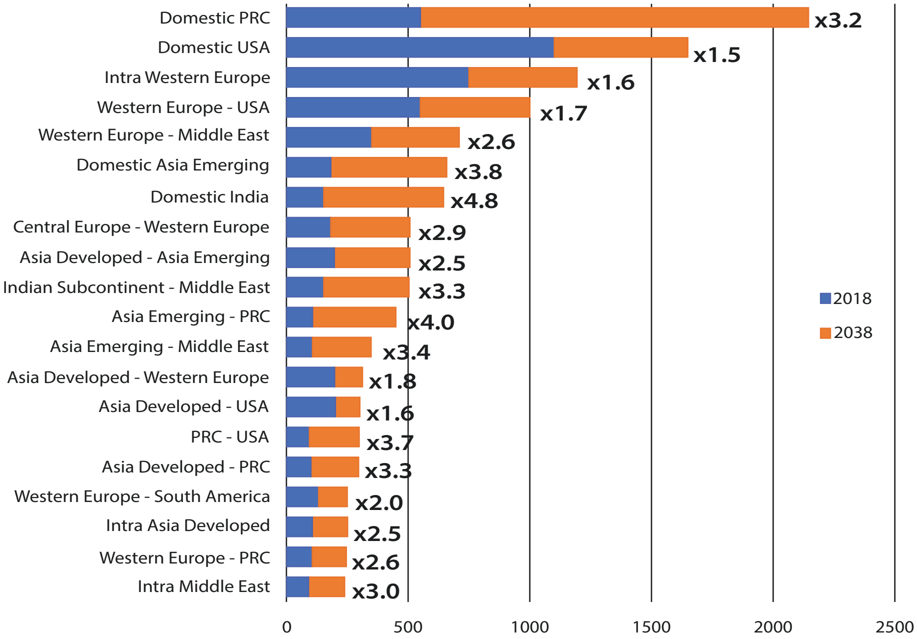


Fig. 2.4 World air traffic flow forecast from 2018 to 2038. (Airbus, 2019)

2.4 Structure of the Aviation Industry

The aviation industry is a service industry providing transport services. Air transportation shows many characteristics which are typical for service industries, e.g. the intangibility and perishability of the product and the high importance of personal contact to the customer (Benkenstein et al., 2017).

As mentioned before, airlines and airports are the two main actors in the industry. Airlines offer the actual transport service; airports provide the ground infrastructure to handle aircraft movements. The manufacturing industry and aviation suppliers assemble aircrafts and provide spare products. As a provider of supplementary processes, the industry relies on general service providers such as air traffic control. Figure 2.5 illustrates the core value chain in the aviation industry.

This section provides an overview about the overall supply chain and industry competition structures. Each group of actors will be then be described in the following chapters.

Concerning the *general service providers*, the airline industry is characterised by monopolies for air traffic control services. The aircraft *manufacturing industry* forms an oligopolistic structure regarding small- and mid-sized aircrafts and a duopoly regarding the market for wide-body aircrafts. Manufacturers of smaller aircraft like Embraer or Bombardier merge (or try to) with these big manufacturers. New developers of medium haul planes have now come up in China (COMAC).

The *airline industry* is characterised by fierce competition. Airlines compete on a polypolistic market. On the one hand, the latter is characterised by low entry barriers and a variety of different business models. On the other hand, the airline industry is extremely capital intensive and comprises specific investments in long-term assets that create high exit barriers. While information technology (IT), maintenance, repair and overhaul (MRO) and catering providers are usually located nearby the respective airlines (commonly large airlines), the airline leasing market is dominated by two companies (duopoly). Oligopolistic structures occur in regard to airports, usually one or a few of them dominating whole regions or nations. At airports, often only limited competition exists concerning ground handling services. Fuel companies are structured in an oligopoly.

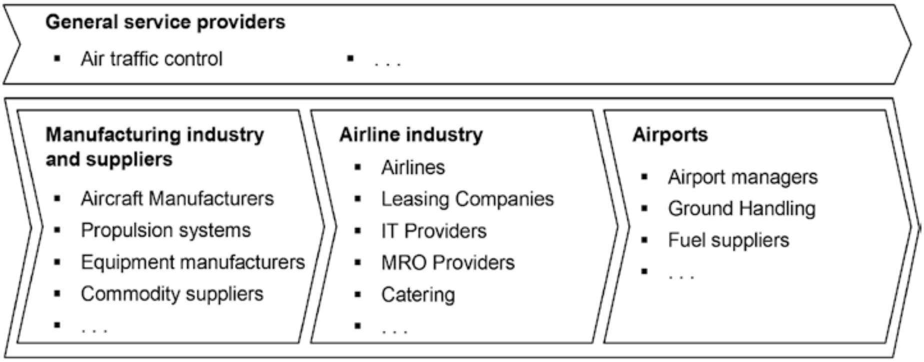


Fig. 2.5 The aviation industry value chain. (Author's own figure)

While airlines and airports are enclosed by the manufacturing and supplying industry on the upstream side, the final customer is located at the downstream side of the value chain. With the ascent of online booking and the decline of packaged travels and the role of tour operators, demand for air transport is fragmented.

2.4.1 New Competitors

As the airline market is characterised by low entry barriers and increasing market liberalisation, new competitors are a constant threat to existing airlines. However, not all new entrants are successful in building a permanent market position and thus may exit the market after some time (such as all-business carriers or long-haul low-cost carriers). The most important market barrier today seems the establishment of hubs and the limited slot capacities of the big airports. The allocation of slots, therefore, is an important factor of competition policy in the aviation sector. Finances today in the age of zero to negative interest rates are not a significant hurdle anymore. Leasing companies enable the establishment of new airlines. The establishment of "low-cost" airlines in the 1990s is an example for successful market entries.

Market entrance barriers of airports are much higher than the ones of airlines, due to extremely high initial infrastructure investments and even more the space and rights needed. As a consequence, the number of newly established airports remained rather low during the last years. In Europe, notable exceptions are the conversions of former military airfields into low-cost airports, whereas in Asia and the Middle East an exception is the emergence of all-new airports in the strongly growing traffic regions.

2.4.2 Substitutes

High-speed trains offer transportation alternatives and have an impact on airlines – and consequently on airports. On the one hand, high-speed trains may pose a threat to airlines, particularly on short-distance routes. On the other hand, however, they may also provide an opportunity for airlines and airports to alleviate air- and landside airport congestion and gain new customer groups. Thus, rail transport cannot be considered being a substitute for air transportation per se. A further potential threat to air transportation is the increasing usage of telecommunication technologies as a means for communication (such as videoconferencing). This technology might reduce the volume of passenger movement which was made possible by air transportation in the first place.

2.4.3 Customers

The demand side of the aviation industry can be distinguished between persons who are flying for business purposes (those passengers, who demand frequent flights to a wide range of destinations, seek service quality and are willing to pay a premium for these benefits) and leisure travellers (who seek the lowest prices and are less concerned about the service being offered, frequency of flights or the number of destinations being served). However, the group of airline passengers is becoming increasingly heterogeneous (Huse & Evangelho, 2007). The competition in aviation results in a high customer persuasion as consumers have the choice between different options for travelling and transportation providers.

In regard to the product, an extraordinary high transparency exists, as customers may compare prices and thanks to various internet platforms the quality of almost all products is available (e.g. Seatguru, to check for leg room). Even though the customer may choose from a large variety of sales channels (such as travel agencies, internet, telephone), the air transportation market is characterised increasingly by online distribution. The majority of sales will be direct sales, mostly via the airlines' digital channels such as websites and/or mobile apps. IATA's new distribution capability (NDC) is an example and shows the pressure the airline industry puts on global distribution system providers (e.g. Amadeus, Sabre, etc.).

Air freight in general is booked over the forwarder, who in turn reserves cargo capacity at an airline. Since key freight forwarders usually make the largest bookings, cargo airlines typically deal with a very small client base, which therefore disposes of a high bargaining power (Becker & Dill, 2007).

As mentioned, the air transportation industry's core value chain is part of the aviation ecosystem which itself is encompassed by a number of stakeholders. As the "outer-circle" shows, the air transportation industry as a whole is embedded in its environment (stakeholders). Major linkages exist to its ecological environment, to institutions and organisations, to its technological and economic environment as well as to its social system (see ► Chap. 2).

2.5 Special Characteristics of the Air Transport Market

The aviation industry features a number of characteristics which make it unique and distinguish it from other industries. As these peculiarities are fundamental to the industry and have implications on competition structures, the most important characteristics are introduced briefly:

- *Cyclicality of the industry development:* The aviation industry is characterised by a highly cyclical development of passenger and freight transportation. Years of high profits and strong demand are regularly followed by years of substantial losses. In general, the development of air transportation is coupled to the overall economic situation. Nevertheless, the cyclical up- and downturns in aviation appear to be amplified, i.e. more volatile than the overall economic development. The development of air cargo thereby is often found to feature a trend which is slightly ahead the development of the general economy. Therefore, it can be used as an indicator for the overall development of the economy (◘ Fig. 2.6).

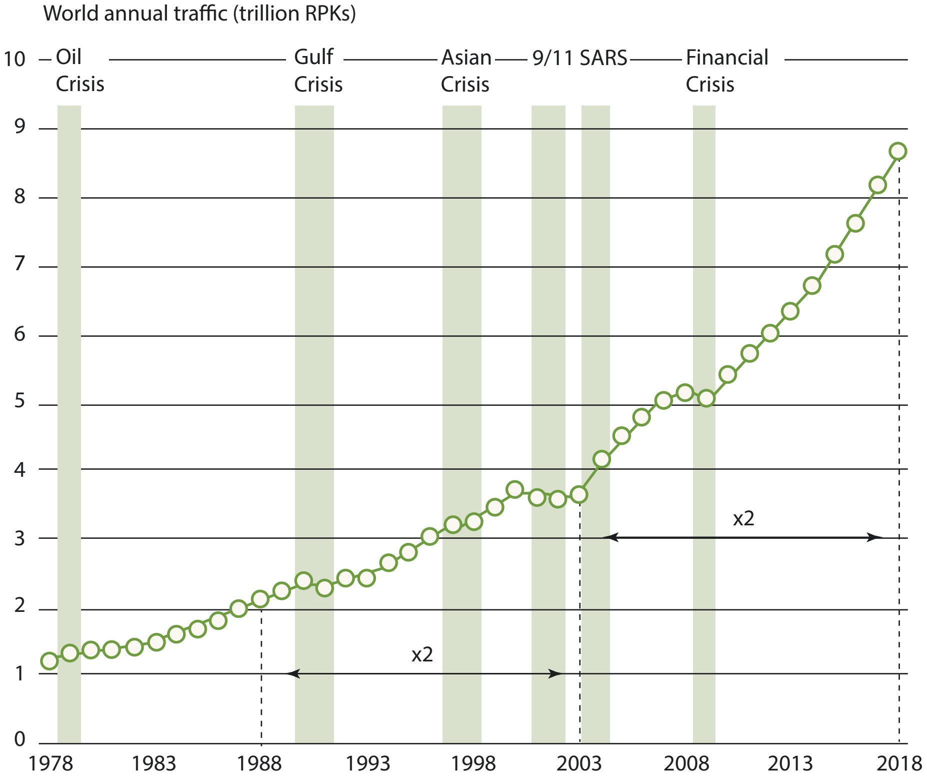


Fig. 2.6 Influence of external shocks on air travel in the long term. (Airbus, 2019)

On the one hand, the reasons for the high cyclicality in aviation lay in its external surrounding, with air transportation only reacting and following the overall state and development of the economy. On the other side, long supply chains and procurement cycles often lead to over- and under capacities. The time between the order of an airplane and the actual start of operations can take up to several years. Thus, an aircraft which has been ordered in an economic upturn often arrives in a recession and may even worsen this downturn. Inversely, intended capacity growth due to increasing demand might not completely be met, as there is only little possibility to respond quickly to increasing demand if airplanes, which have been ordered, are not delivered in time. Therefore, profit cycles are even more extreme than revenue cycles and are forerunning.

- *High fixed cost structure:* When compared to other industries, air transportation is characterised by a high fixed cost structure and rather low variable costs. Air transportation is an extremely capital-intensive industry with very specific investments in long-term assets that create high exit barriers.

  The reasons for this cost structure are high – and often very specific – investments at either manufacturers (development of new aircraft), at airlines (financing of new aircraft) or at airports (provision of ground infrastructure such as runways and terminals). Consequently, for airlines marginal costs are important, regarding a possible implementation of lower price limits which may be offered over a short period of time. This peculiar cost structure often leads to fierce price competition, in which, e.g. airlines are selling their seats close to variable costs (as a marginal return to the fixed costs) (see ▶ Chap. 3). This structure also can lead to a fast financial problem and the need for state support in a severe downturn like the Corona Crisis.

- *Strong growth coupled with low profit margins:* The airline industry has always been characterised by strong growth numbers. In the past 50 years, global aviation has grown at an average rate of about 5% per annum. The reasons for this strong growth are the on-going industry liberalisation and the resulting opening up of new markets as well as the decreasing costs of flying. Nevertheless, growing passenger numbers are accompanied by ever decreasing margins. Doganis (2005) describes the latter as the "paradoxon" of aviation. Historically, returns in the airline business have been low and can be compared to those in commodity industries. Airlines in particular are characterised by rather low profit margins that regularly fall short of those realised at airports, caterers, aircraft manufacturers and ground service providers (Doganis, 2005). Overall, many airlines do not earn their cost of capital. However, in terms of profitability, there are high variances among airlines.

  The reasons for the low margins, particularly at airlines, can partly be found in the specific industry cost structure introduced before. A further reason is the high competition within the airline industry. Moreover, airlines often claim that their low profitability arises from a "hostile" environment in which airlines are caught in a "sandwich position" in the value chain between monopolistic or oligopolistic providers that are able to generate much higher profit margins at the expense of the airlines.
- *Dependency on external input factors and shocks:* Aviation is highly dependent on and, thus, vulnerable to external input factors. This is especially true in regard to fuel prices. At airlines, kerosene bills alone regularly sum up to approximately 25–50% depending on fuel prices of the overall costs. Sharply decreasing or increasing prices for input factors can, therefore, either foster or slow down industry growth.

Mini Case: The Impact of COVID-19

By Andreas Wittmer

COVID-19 hit the aviation industry, especially airlines, in the beginning of 2020. Within 2 months, the virus spread rapidly across the globe. As a consequence, international transport came to a halt. Many airlines had to park their planes and went through cost cutting programs and demanded financial aid from governments.

World trade decreased significantly and different organisations forecasted the economic and international trade impacts of COVID-19 (◘ Fig. 2.7).

IATA forecasted that it may take until 2024 for the global air network recover to a similar level as 2019. Eurocontrol produced air traffic scenarios for 2021 showing

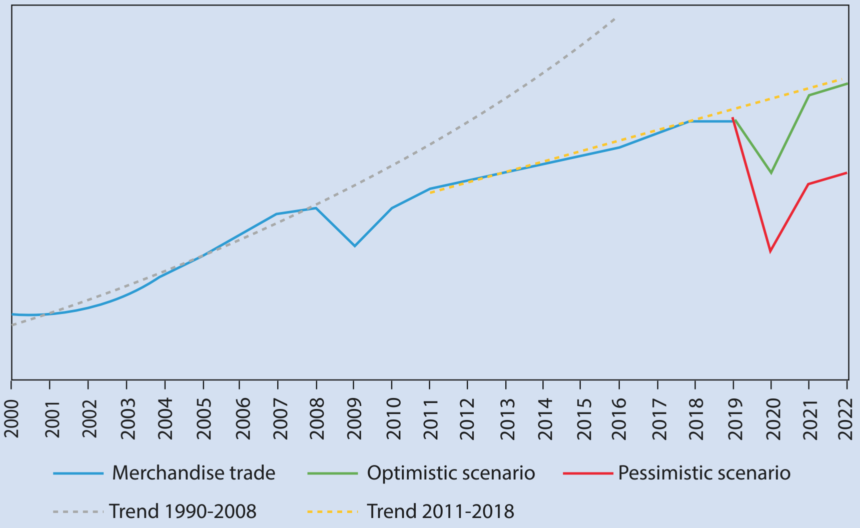


Fig. 2.7 Scenarios of world trade volume 2020–2022. (World Trade Organisation, 2020)

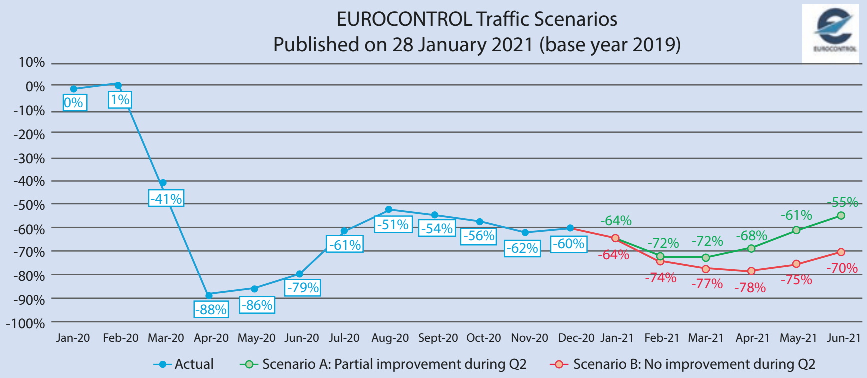


Fig. 2.8 Air traffic scenario forecasts for first half of 2021. (Eurocontrol, 2021)

less than 50% of air traffic movements for the first half of 2021 compared to 2019 (Fig. 2.8).

Governments provided financial help to airlines all around the world. Still some bankruptcies were inevitable. Especially global network airlines were struggling in contrast to regional point-to-point airlines, which were less impacted as domestic markets still had some demand for air travel.

Some governments demanded concessions from airlines in return for the financial support. It was interesting to recognise that deregulation and privatisation activities, which dominated the last decades, were suddenly overstepped by adding government control mechanisms. The German and Austrian governments, for example, took action by defining some requirements for Lufthansa and Austrian Airlines:

Lufthansa:

- Cut short-haul flights <3 h (excl. Hub connectors).
- Reduce emissions of domestic flights (inner-German) by 50% until 2024.
- Reduce CO_2 per RPK by 50% by 2030, compared to 2005 levels.
- Source 2% of fuel from sustainable sources by 2025.

Austrian Airlines:

- Cut short-haul flights <2.5 h (including hub connectors).
- Reduce emissions from domestic flights by 50% until 2030.
- Reduce total CO_2 emissions by 30% until 2030, compared to 2005 levels.
- Minimum ticket price of EUR 40.

2.6 Stakeholders in Aviation

In the aviation industry, three main groups of actors can be distinguished: the aircraft manufacturing industry, airlines and airports. These stakeholders are briefly introduced in the subsequent paragraphs.

2.6.1 Manufacturing Industry and Suppliers

The aircraft manufacturing industry is characterised by two dominant manufacturers: Boeing and Airbus. These two companies represent the main manufacturers of wide-body aircrafts. These two players as well as smaller manufacturers such as Embraer play a role for small- to medium-sized aircrafts (up to about 150 seats). Profit margins of aircraft manufacturers are commonly higher than those of airlines and airports; however, when compared to the total manufacturing industry, they are below average.

The characteristic features of the aircraft manufacturing industry are extremely high capital requirements, high entry and exit barriers, dynamic economies of scale, a high research and development (R&D) intensity and relatively long periods between initial investment and returning cash flows resulting from aircraft sales. As a consequence, prices for aircrafts must be calculated long time before the sale the aircraft on the basis of sales forecasts. Furthermore, due to dynamic economies of scale, production costs vary greatly depending on the output. Thus, an exact prediction of production levels is critical. Overall, the high investment needs, the long planning horizon and the dependence on the cyclical demand for aircraft significantly enhance the manufacturers' business risks. Launch costs for new aircraft such as the Airbus A380 or the Boeing 787 can amount to more than USD 25 billion (A380)/USD 32 billion (B787) (Wells & Wensveen, 2004). Mostly, a large part of the construction is sourced out to a network of international suppliers. While this measure aims to reduce the business risk for aircraft manufacturers, today it is considered as one of the main reasons for delays in the delivery schedule of new aircrafts (Pritchard & MacPherson, 2004). Because of the long investment cycles and the high amount of investment, the role of the state as co-owner (Airbus) or core customer (Boeing) is crucial.

Suppliers to aircraft manufacturers mainly constitute of propulsion systems manufacturers (a market dominated by General Electric, Rolls-Royce, Pratt & Whitney), equipment manufacturers (e.g. avionics, cabin, electrical and hydraulic systems) as well as commodity suppliers (e.g. metallic and composite assemblies). Nowadays, up to 70 percent of the added value of aircrafts may stem from the supplying industry (Pritchard & MacPherson, 2004).

2.6.2 Airlines

In the aviation industry, airlines represent the most visible group of actors. Even though every airline offers the same core service (the transport of passengers or cargo from one destination to another), by no means the group of airlines is a homogeneous one. Between airlines, fundamental differences exist in regard to the underlying business model, i.e. the service level offered, the regional reach and the main functions.

The business model of the *international full-service network carriers* or *flag carriers* is largely based upon the operation of a hub-and-spoke network with a strong focus on transfer traffic. By carefully synchronizing inbound and outbound flights, passengers can optimally transfer and connect to different flights at an airport hub and by this has the opportunity to reach a greater number of destinations. Direct services between the major cities (mainly national) complement the network. In the main international traffic regions, important international network carriers can be found, for example, in North America (carriers such as Delta Airlines, American Airlines or United Airlines), in Europe (e.g. Air France-KLM, Lufthansa and British Airways), and in the Asia/Oceania region (e.g. Emirates, Singapore Airlines and Qantas Airways). As the main source of revenues in this group of airlines is the actual transport fare, the majority of traditional airlines still offer all-inclusive prices (including return flights, luggage handling, etc.). However, traditional airlines have shifted towards one-way basic fares with less frills due to the advent of low-cost carriers. They unbundled especially their short-haul flights and offer different price-based packages with more or less services included and by this offer a basic transport option where services have to be extra paid for, like point-to-point low-cost airlines do. On the long-haul flights full-service network carriers offer a highly service-intensive product. On the one hand, this allows them to attract business traffic and to realise a price premium. On the other hand, it leads to highly complex and expensive network designs and operational structures.

Network niche carriers represent a modification of the traditional network carriers. Due to their smaller size, network niche carriers merely operate regional networks with a few connections to major international hubs (e.g. SAS, Austrian Airlines, SWISS). Often, niche carriers are a subsidiary of the so-called "mega-carriers" such as Lufthansa or Air France/KLM and operate partly as wet lease operations for them.

Smaller *regional carriers* (e.g. Helvetic) pursue a different business model. They focus on linking remote areas with thin flows or on feeding into the hubs of network carriers often in wet lease contracts.

Further relevant business models are the point-to-point low-cost carriers (e.g. Southwest, Ryanair, easyJet, AirAsia) and charter airlines (e.g. TUIfly). In contrast to traditional network carriers, *low-cost carriers* (LCC) concentrate on a high volume short- to medium-haul point-to-point traffic based on a minimum service approach ("no frills") and lean operations (no seat reservation; no frequent flyer programs, narrow seating). The carriers either use smaller (and cheaper) secondary airports (e.g. Ryanair) or fly into major airports and thus, directly compete with established airlines (e.g. easyJet). LCCs heavily rely on ancillary revenues, which are generated, for example, from offered catering as well as from luggage fees. Ancillary revenues can make half of the carriers' revenues (*Financial Times* 19.9.2017). LCCs usually pursue unbundled pricing strategies which are in contrast to the ones pursued by traditional carriers.

Charter airlines service tourist markets. Their strategy is a combination of service quality, low-cost structures and their integration of the passengers' travel chain. However, charter airlines are more and more substituted by low-cost carriers on highly frequented traffic routes (e.g. from the United Kingdom to Southern Spain).

Air cargo carriers are a special form of an airline business model. The network carriers introduced above generally have their own cargo fleets (e.g. Korean Cargo, Lufthansa Cargo) whereas in the field of air cargo carriers, some airfreight-only carriers exist (e.g. FedEx, Polar Air, Cargolux). These companies ship cargo in their freighters as well as in the cargo compartments of their passenger fleet (belly freight).

2.6.3 Air Taxi Services

In the United States, air taxi services have been existing for many years and they are growing remarkably in the European market. Operators like NetJets are at service for individual travellers and companies who prefer to travel on business jets. They operate partly as feeders to mega-carriers regarding first class passengers. The saving of travel time and the direct reachability of all regions in the world are some of their main advantages. By means of significantly lower air fares, new very light jets (VLJ) are supposed to change the air taxi business. In the business jet service, there also exist network effects (e.g. NetJets). Bigger providers operating more jets can offer more flexibility and, thanks to better average usage of their jets, lower rates.

2.6.4 Airports

Airlines are dependent on airports, which are providers of ground infrastructure (e.g. runways and terminals). Airports have an extremely high specificity of their infrastructure investment. A large number of national and international airports still are under public ownership; noteworthy privatisation trends have only recently been observed and ownership and operation are often separated. In many cases the concession to operate the airport does not belong to the owner of the airport, but rather to the operator. There are different airport ownership structures such as state-owned airports, public private partnerships, privately owned airports, international airport groups, etc.

Airports are not a homogeneous group. Among others they differ in their size, function and regional reach. Airports like Chicago O'Hare, London Heathrow or Singapore Changi are international hubs ("mega hubs"). They concentrate on intra-regional and international transport and serve as starting and end point for intercontinental long-haul services. Secondary airports focus on intra-regional services (e.g. intra-European or intra-American air transportation). Regional airports, which habitually are only served by smaller aircrafts, focus on feeder flights to international or national hubs. Overall, there is a high degree of concentration among passenger flows at airports, for example, in North America 72 percent of all passenger enplanements are accounted for by 30 hubs (FAA, 2018). Furthermore, the highest growth in traffic flows in the two upcoming decades will be between so-called aviation mega-cities (AMC), where most aviation connectivity/international passengers can be found, as well as between AMC and secondary airports (Airbus, 2019). In numerical terms, small airfields represent the largest group of all airports. Small airfields serve general aviation like private business aviation and leisure/sports flying.

Airports pursue different business models that depend on their sizes, functions and locations. Particularly at major international airports, traditional revenue sources, e.g. landing fees, merely represent a small part of all income sources. Non-aviation income sources, such as parking and real estate, often represent more than half of the total revenues. Usually, the service level provided at these airports (e.g. infrastructure connections to other modes of transportation, lounges) is relatively high. Airports that mainly serve low-cost airlines, however, only provide a minimum of services. Due to their remote locations, ground infrastructure connections are usually poor. In contrast to the group of airports introduced above, these airports often generate losses and thus operate at the taxpayers' expenses.

2.7 Main Drivers and Economies

The potential market of airlines depends on the extent of economic growth and the internationalisation of economies. Furthermore, a country's regulation and international global regulation create boundaries of the air transport market. Technical developments have a great impact on cost structures of airlines and air transport companies which, in turn, influence the air transport market. The most important economies in the air transport market are presented in the following paragraphs.

Economies of Technology

- New planes have lower costs per available seat/km (CASK) (e.g. Airbus A350).
- Smaller planes are able to fly longer distances (e.g. Boeing 787).
- New engines with lower fuel consumption and carbon-neutral fuel as perspective.

Economies of Scale

- Bigger planes have lower costs of available seat/km (CASK) (e.g. Airbus A380).
- Bigger airports are cheaper per passenger.

Economies of Scope

- Bigger airlines provide more origin and destinations with comparably fewer legs (e.g. alliances like Star Alliance).

Economies of Density

- Airlines dominating hubs show comparably higher market shares.

Further Economies of Networks

- Airports have two sided markets (airline customers and passengers; aviation and non-aviation market).
- Network effects of the hub business model (scale, scope and density effects).

2.8 Approach Towards an Integrated Aviation System

The aviation system can be seen in a framework where social, economic, technological, ecological and political factors create an integrated system, the aviation system. The social and political systems profit from aviation. Moreover, they profit from the opportunity to getting to know new cultures and, thus, to create a mutual understanding between cultures. However, there are negative factors as well, such as safety and security and noise emission, which are perceived by the society. The economic system deals with demand and supply in the air transport market. A demand growth contributes to the growth of direct economic factors like jobs and revenues of air transport companies but also indirect and induced economic factors along the supply chain. Furthermore, catalytic effects such as accessibility (e.g. for international companies or tourism) play an important role for a country's international attractivity compared to other countries. On the other side, factor cost and the absorption of resources are compared to positive economic effects in the economic system. The technological system focuses on a better performance of, for example, engines and aerodynamics. New innovations that help the aviation industry to perform more economically and ecologically are of great importance in the technology system. Technology puts pressure on aviation operators to reinvest in new innovation in order to become more efficient in the market. Safety and security also play a very important role in the technology system. The environmental system mainly deals with natural resources and the fact that resources are for free (e.g. oxygen, CO_2 emissions, airspace, etc.). The natural environment is mainly

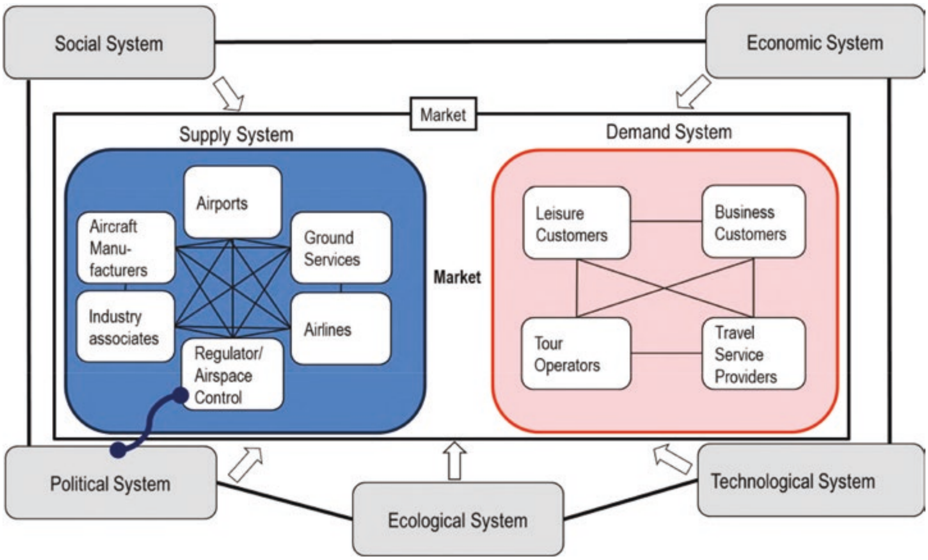


Fig. 2.9 The aviation system. (Author's own figure)

impacted by gas emissions (to a great extent CO_2), volatile organic compounds and microparticles (dust) and noise. The development of sensitivity for natural beauty and on the negative side pollution in high altitude and pollution at airports are dealt with in the environmental system.

In summary, this system represents the framework in which the air transport companies and organisations operate. The core system consists of a supply system and a demand system. The supply system consists of all partners along the supply chain that deliver to airlines and airports and the surrounding ecosystem. On the demand side, there are consumers, like leisure and business customers, tour operators and travel sources that pay for an air service. Airlines generate their revenues from the market. The whole supply system is being paid from these revenues, e.g. airport taxes are collected by airlines. By this the airlines are the most important factor in the supply system, in the aviation market and for whole aviation system. Figure 2.9 illustrates the aviation system.

In the following chapter, the aviation system will be looked at in detail.

Review Questions

- Who are the main players in the aviation industry value chain?
- Who are the main stakeholders of the aviation industry?
- What are the special characteristics of air transportation?
- How are economic development and the aviation industry linked?
- What is the problem of industries with high fixed costs?
- What are the economies of technology of airlines?
- What are the economies of scale of airlines?
- What are the economies of scope of airlines?
- What are the economies of density of airports?
- What are the environments of the aviation system?

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The Environment of Aviation

Andreas Wittmer and Adrian Müller

Contents

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Summary

- The political history in aviation has a great impact on the rather politically dependent aviation industry.
- Major technological innovations have shaped developments in aviation.
- The airline industry is of high economic relevance with its direct, indirect, induced and catalytic economic impacts.
- Aviation is especially important for social development.
- Ecological effects of air transportation have an impact on a global, regional and local level.

Politics have a considerable impact on the aviation industry, which again depends on politics itself. This ranges from conventions concerning air traffic rights to regulatory affairs that govern aspects such as safety or market conditions. Beyond the political sphere, technology has provided a major boost to innovations and developments in the aviation industry, thus improving the economic and ecologic efficiency of air travel. From an economic perspective, aviation creates considerable economic effects, may it be directly at the airports or beyond the aviation system. Aviation has also shaped our society by raising living standards and promoting cultural understanding. Nevertheless, the environmental impacts of aviation, such as pollution and noise, cannot be neglected and will provide an important topic for the years to come.

3.1 Introduction

While the first chapter gave an overview on the basic industry structures and the main drivers of air transportation, this chapter introduces in detail the five environmental (political, technological, economic, social, ecological) perspectives of the aviation system. Our goal is to give an overview on the importance of each of these fields, its respective development in the course of time and the interdependencies among the different perspectives.

Overall, the aviation industry is heavily dependent on technical developments, such as aerodynamics or engine technology, which in turn strongly impact the economic and ecological development of the industry. Furthermore, in aviation, the political system through its regulations and recommendations is directly included in the system, both on the national and on the global levels. This chapter covers issues such as safety and liberalisation, which again, have a substantial influence on the economic development of the air transport industry. While each of these perspectives may provide valuable insights in the field of air transportation, the complexity and the interdependencies among the different aspects require a more integrated view on the industry development. Therefore, for each of these aspects cross-references to the other perspectives are given. Consequently, the term *aviation system* includes all those perspectives, which – in the traditional framework – are treated separately (▣ Fig. 3.1).

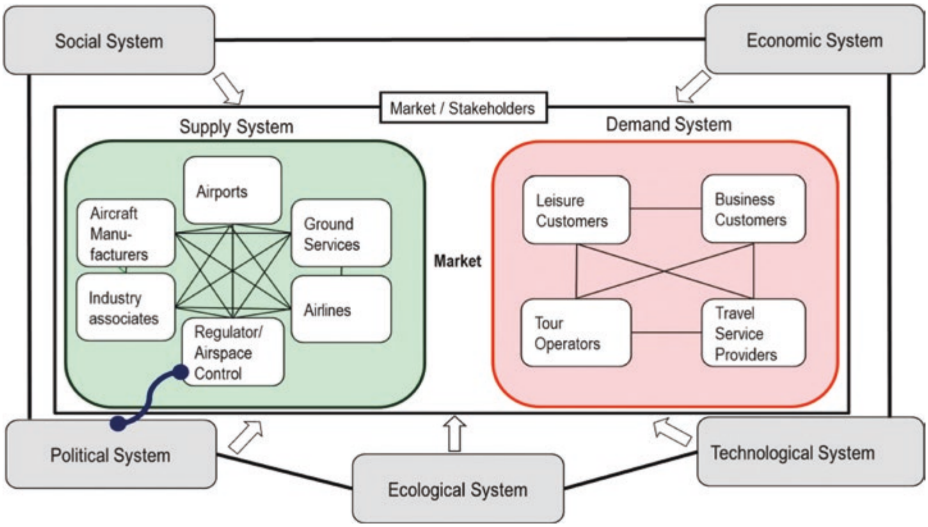


Fig. 3.1 The aviation system. (Author's own figure)

Due to the multi-dimensionality in aviation, there is a close interconnection among political, technological, economic, social and ecological issues. The next section will introduce the political development of aviation.

3.2 Political Development of Aviation

Besides airlines, airports and aircraft manufacturers, a number of institutions and organisations, which together form the political environment in aviation, influence air transportation. Since these institutions constitute the legal framework for air transportation, they are particularly influential with respect to the economic and the ecological industry development.

Aviation has developed from its early beginnings in a strongly regulated market environment to a more liberalised market as we find it today. An important step for the political development in aviation was taken at the Convention on International Civil Aviation (Chicago Convention) in 1944. At this convention, a number of regulations and recommended practices were agreed on that still shape the industry today and, for the most part, have become universally accepted standards. Another important step was the US Airline Deregulation Act in 1978. While the main purpose of this act was to remove government control over fares, routes and market entry of new airlines, it immediately spurred a more dynamic economic development in air transportation (Joppien, 2006).

The political environment of aviation is shaped by different bodies, both on the international/supranational and on the national level. Due to the nature of flights, which often include trans-border traffic, the political development of aviation has largely been a development that was shaped by international political decisions.

The increase in the number of international co-operations (e.g. airline alliances) and cross-border mergers (e.g. Air France/KLM) has added to the importance of the international political bodies. Nevertheless, contrary to its international nature, the industry is still building on many national regulations and bilateral agreements. Overall, the political development in aviation covers a wide range of different areas such safety, autonomy, liberalisation and aviation law (Maurer, 2006). While these different aspects will be covered in detail in ▶ Chaps. 11 and 12, the remainder of this chapter will provide an overview on the political environment of aviation, with a particular emphasis on the influence of political changes on the economic and ecological developments in air transportation.

One common classification distinguishes between public and private institutions on the one hand, as well as between national and international/supranational institutions on the other hand. Within this classification institutions can further be distinguished with regard to their primary functions. National public institutions (e.g. Federal Aviation Administration) act primarily as norm-setting and monitoring organisations. The main task of national weather service providers and air traffic control is to offer services for an efficient and safe operation of air traffic. They audit all providers in the supply chain of the aviation industry. Private institutions, such as the International Air Transport Association (IATA) or the Airport Council International (ACI), act as interest groups. Their main functions are member advocacy and the creation of a platform for its members. Private institutions are not allowed to set binding norms and rules.

Similarly, it can be distinguished between institutions at the international and supranational levels. International public institutions (e.g. International Civil Aviation Organization – ICAO; European Aviation Safety Agency – EASA) focus on norm-setting and regulation in air transportation. Air traffic providers, like Eurocontrol, by contrast, are primarily service providers. International private institutions (e.g. International Air Transport Association – IATA; Association of European Airlines – AEA; Airport Council International - ACI) offer a forum for exchange of information between its members. These institutions represent their members and lobby for their interests towards stakeholders in the entire aviation industry.

International political decision making often collides with national concerns, particularly if aspects such as self-determination and national autonomy are affected. International policies, however, in almost all cases shape the further development of the industry, both economically and ecologically.

The so-called Single European Sky (SES) project is one example of a political development affecting further developments in air transportation. It was proposed by the European Union (EU) with the intention to harmonise and simplify air traffic control within the EU (European Commission, 2009). In this case, a change initiated at the political level is intended to lead to altered industry structures that have both economic and ecological impacts. It is assumed that a redesigned air traffic structure will lead to shorter and, thus, more efficient flight routes. This change would not only lead to lower traffic management costs and lower costs for airlines, but also reduce the environmental impact of aviation, since overall emissions would be reduced by 10% according to IATA estimates (IATA, 2013).

Political bodies can also have a direct effect on competition, sometimes even specifying who is "allowed to take part in competition". The "blacklists" for airlines published by IATA and the European Union, for example, suspend airlines that fail to meet safety standards from landing at airports within member states' territories. While this example illustrates how political decisions may enforce industry safety, it also demonstrates well that political developments and political bodies may pursue diverging approaches; IATA strongly opposes the blacklist published by the European Union and instead recommends its own Operational Safety Audit (IOSA) program (IATA, 2006). The resulting lists are not harmonised and the risk assessment for certain airlines can be contradictory, however in the European Union only the EU Air Safety List is binding.

The political developments in aviation often open up market opportunities, like the introduction of an EU-US open skies agreement in 2008. In this case, a political change immediately stimulated industry reactions, as a new airline called Open Skies was founded. Further, several of the established carriers were partly reconsidering their network structure as well as their destination mix.

Contrarily, political developments may also close market opportunities. German regulatory authorities, for example, continually refuse to give additional landing rights to the Gulf States which would allow carriers, such as Emirates Airlines or Etihad, to serve new destinations in Germany (Vespermann et al., 2007).

A particular issue concerning the further political development in aviation are ownership rules. These rules specify cross-border mergers and equity holding and may be fundamental for the further industry consolidation. Today, international mergers are still widely forbidden and international equity holding is often limited (e.g. to 49 percent or less). This is again another example where political structures in the air transport industry have been shaping its economic structures and its further development.

The high relevance and interdependence of policy measures demand for national aviation strategies. In Switzerland, the Federal Council analysed the situation in the Swiss civil aviation as part of the *Luftfahrtpolitik* (*Lupo*) *2016* report on aviation policy and defined the following political priorities: Switzerland's connection to global air traffic, infrastructure, safety and security, organisation of air navigation services, education and research and new technologies. Within the framework of the analyses, the Swiss government comes to four conclusions, which deserve special attention.

1. **Safety**

For the Swiss government, the existence of effective safety management systems in aviation companies is key to a high safety level. In the Swiss approach, the intensity of state supervision should depend on the safety performance of the respective companies. Nowadays, national governments have only little regulatory flexibility, as in civil aviation an international set of rules and regulations is almost entirely authoritative for the safety requirements.

Aviation can only take place safely and under the same competitive conditions if international regulations exist. The International Civil Aviation Organization

(ICAO) and the European Aviation Safety Agency (EASA) are responsible for the said regulations. Switzerland is involved in this international regulatory framework and is actively engaged in its development. The task of the Federal Office of Civil Aviation is essentially limited to enforcement and supervision. The Federal Council brings the specific interests of the Swiss aviation industry to bear at the international level.

The report recognises several challenges that will arise for the safety of Swiss civil aviation. On the one hand, the operation of the national airports of Zurich and Geneva is becoming more and more demanding, namely because of the high capacity utilisation and dense traffic. Flight routes have become more complex, also because of efforts to protect airport regions from noise. The system of intersecting runways in Zurich is a particular source of danger.

On the other hand, the overall use of Swiss airspace is very dense and intensive. The heterogeneity of users – scheduled and charter traffic, the Swiss Air Force, general aviation, non-powered aircraft such as hang gliders and gliders, and increasingly drones – places the highest demands on the organisation and management of airspace.

Finally, new technologies (e.g. drones) and new air traffic control and navigation procedures require new regulatory approaches and additional know-how on the part of air traffic control and the supervisory authorities (e.g. Swiss U-Space, Flight Information Management System for Drones – FIMS).

2. **Access of a Country to Global Air Traffic**

As a landlocked country, for example, the Swiss economy is heavily dependent on international air traffic connections for passenger and freight transports. Today, these connections are ensured by private airlines, since Switzerland has adopted European law, which largely rules out the support and control of airlines by states. Nevertheless, Swiss International Airlines is of special importance for Switzerland's access to the world as it maintains a network of feeder and long-haul routes, which creates direct connections to important global centres.

An important political question is whether the international connections should be direct or indirect and whether a national airline is required to maintain the access to the global air network. For the Swiss government this means a trade-off between keeping the independence of other airlines and countries by protecting the home carrier and being an open economy with a liberal traffic law policy which is discussed in the next paragraph.

3. **Fair Markets (Competition vs. Monopolies, Basic Conditions)**

The liberalisation of global aviation has led to an intense competition. With the emergence of new airlines from the Middle East and (Southeast) Asia, markets have changed. While Swiss customers can take advantage of cheaper prices, Swiss and European Airlines were confronted with a different competitive environment.

Several Ricardian competitive advantages of the Gulf region led to the perception of an “unlevel playing field” by European airlines (also see Mini Case).

In the report, the government assumes that under the existing market conditions, Swiss and European Airlines will continue to lose market share. The Federal Council believes that without Swiss International Airlines serving Zurich as a hub carrier, the network of air traffic connections from Switzerland would be thinned out and, particularly, the number of intercontinental direct connections would be significantly reduced.

To counter this trend, Switzerland is taking various measures – in compliance with EU regulations – to improve the basic conditions for airlines based in Switzerland. Examples include efficient airports with competitive operating hours, low fees for the use of airports, the examination of a partial coverage of security fees by the state and lean administrative procedures. Also, the government wants to prevent non-EU companies from exercising de facto control over Swiss companies and thus gaining access to the liberalised European internal market. A general abandonment of the liberal traffic law policy would have negative consequences for companies operating from Switzerland as well as for the economy as a whole and is, therefore, not an option.

4. **Negative Effects**

The federal council recognises two major categories of negative effects of aviation: noise and greenhouse gas emissions. Noise is a very emotionally discussed topic, especially in the vicinity of national airports. The government wants to continuously reduce the noise emissions from flight operations. Various measures are taken to ensure this, namely the consideration of noise protection in the definition of flight procedures and approach and departure routes, the establishment of immission limits and the implementation of steering measures which contribute to the use of the quietest possible flight material. The noise charges implemented in Zurich contain a mechanism that reduces the financial burden on Swiss International Airlines in order not to jeopardise its international competitiveness, while still being effective overall.

The federal council also acknowledges that aviation must make an appropriate contribution to climate protection. The emissions of harmful pollutants caused by aviation, specifically nitrogen oxides (NOx) and particulate matter (PM), must be further reduced. International developments in the implementation of the Framework Convention on Climate Change and the development of aviation-specific measures by ICAO must be taken into account.

There are two main examples. One is the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) which includes market-based mechanisms to monitor and compensate CO_2 emissions, which have to be adopted by Swiss aviation companies from 2020. The other is the inclusion of Swiss aviation into the Swiss emissions trading system, which since 2020 is linked to the EU emissions trading system (ETS).

Mini Case: Unlevel Playing Field?

(De Wit, J. G. (2014). Unlevel playing field? Ah yes, you mean protectionism. *Journal of Air Transport Management*, 41, 22-29.)

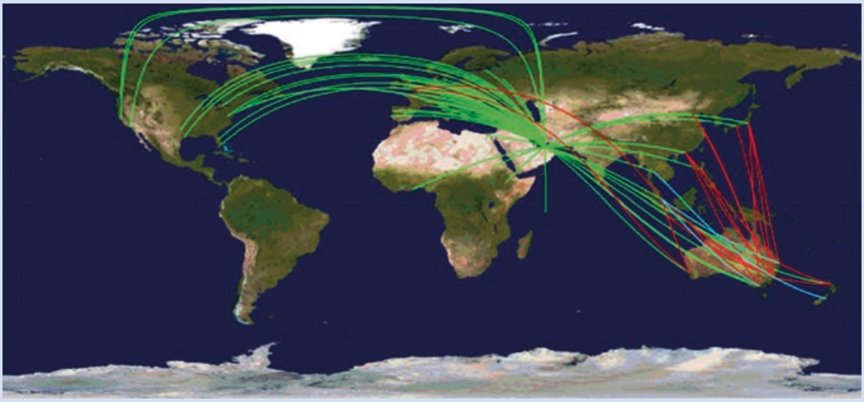
The fact that the German government is resorting to protectionist measures and restricting the landing rights of Gulf airlines is presumably attributed to the lobbying efforts of German airlines, especially Lufthansa. It is a popular argument by European carriers to accuse the gulf carriers of market distortions and to criticise an "unlevel playing field." The following six alleged market distortions are highlighted in this context: cheap oil, low airport charges, capacity dumping, financial state aid, favourable fiscal regime and low labour costs.

A level playing field means having the same rules for everyone. However, even then there might be comparative advantages on a global scale, which have an impact on the playing field and mainly result out of the geographical pre-conditions. In general, four significant comparative advantages exist:

1. Concentration of population around the home base of a national carrier
2. Location of the hub
    (a) Within the continental market
    (b) In relation to important intercontinental passenger flows
3. Long-haul flights to and from an "hourglass hub" (◘ Fig. 3.2)
4. Distance advantages and technological economies of scale of aircraft for long haul flights

All the comparative advantages above can be observed with the Middle Eastern carriers.

It is, however, not only the geographical pre-conditions that tilt the playing field, but also market distortions caused by the EU and its member states. European home carriers are competing under the five following disadvantages: green taxes, restric-



◘ **Fig. 3.2** Emirates (green) and Qantas (red) joint-venture route map. (Cyan routes are operated by both airlines). (Great Circle Mapper, n.d.; Emirates, n.d.)

tions for aircraft financing, capacity constraints, ATC costs and passenger compensation laws.

It becomes obvious that the alleged unlevel playing field is mainly caused by Ricardian comparative advantages of states in the Gulf region. The playing field is further tilted by EU policy measures to the disadvantage of the European network carriers. Any calls for protectionist measures thus become even more problematic and raise the questions whether the industry lobbying should focus on different policy topics.

Mini Case: B737 Max 8

by Adrian Müller and Andreas Wittmer

Policy measures have to account for the various interdependencies within the aviation system. Failures in supervision and enforcement of regulatory matters can lead to a failure of the entire safety system and have catastrophic consequences. This can be illustrated with the case of the Boeing 737 Max 8.

Background

The Boeing 737 had its maiden flight in 1967 and is - after several modifications over the years - the best-selling passenger jet in the world. Its direct competitor is the Airbus A320. Since 2016, the European aircraft manufacturer has delivered this type with new and more efficient engines as A320NEO (new engine option). Financial and environmental considerations have led many airlines to choose the more efficient engines. The aircraft was so successful that Boeing lost market share. Although Boeing had originally planned to design a completely new aircraft, the group opted for a faster upgrade of the existing 737 model with more efficient engines to respond to the immediate competitive pressure. However, the new engines were larger and could not be mounted in the same place as the old ones due to the small distance between wings and ground. They had to be moved forward and upwards, which changed the centre of gravity and the flight characteristics of the aircraft, as it was not designed for the larger engines. The new configuration, combined with the greater thrust of the engines, gives the jet too much lift during climb, so that a dangerous stall may occur because the flight position is more difficult to control. To minimise the risk, Boeing engineers have developed the MCAS (manoeuvring characteristics augmentation system), which presses the nose of the aircraft downwards in critical situations. The system should then automatically intervene in the attitude control if the sensors determine that the aircraft is in an elevated angle of attack (AOA) state. The fact that Boeing managed to convince the FAA and other regulators not to describe MCAS in the pilot's manual and that therefore no re-qualification to attain a new type rating from the old B737 to the new B737 MAX was necessary provided a key selling point for the company. The 737 MAX became the fastest-selling airplane in Boeing history with about 5000 orders from more than 100 customers worldwide. The airlines with the most orders were Southwest Airlines with 280 orders, Flydubai with 251 orders, and Lion Air with 201 orders. It looked like

Boeing had managed a turnaround with their decision to only slightly modify the existing aircraft.

Accidents

On October 29, 2018, a brand-new Lion Air Boeing 737 Max 8 crashed near Jakarta, Indonesia, killing all 189 passengers. On March 10, 2019, a recently delivered Boeing 737 Max 8 from Ethiopian Airlines hit the ground shortly after departure. There were 157 fatalities. In response to the accidents, a worldwide grounding order was issued in March 2019 for all aircraft of this type already delivered.

Cause

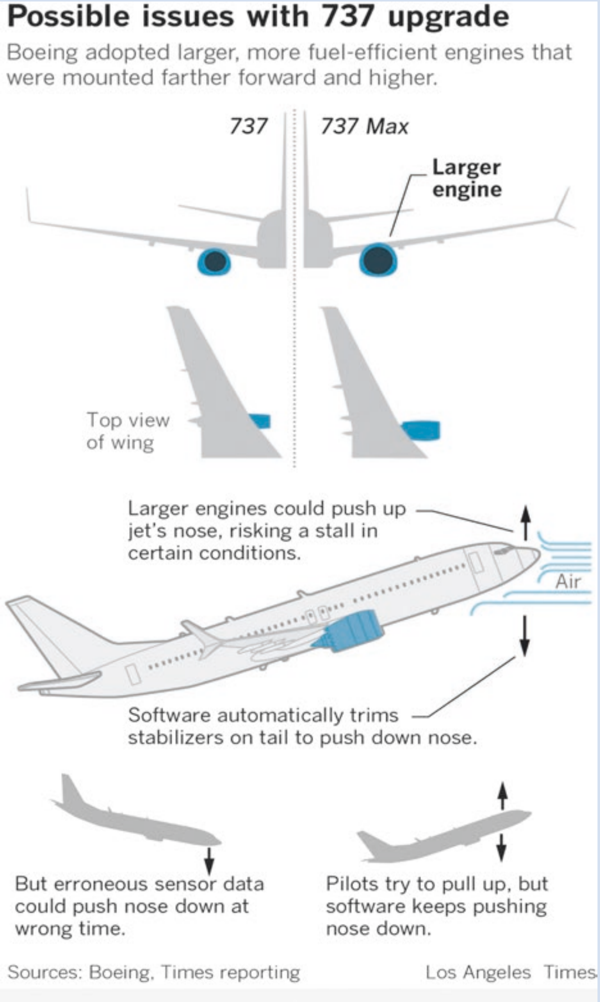
The accident reports show that unquestionably MCAS was the cause of both accidents. Flight-data recordings unveiled that the immediate reason for the Lion Air accident was a sensor failure caused by insufficiently performed maintenance work. The dependence of MCAS on a single AOA (angle of attack) sensor was considered appropriate by Boeing, thereby ignoring the redundancy principle. This decision made it vulnerable to false sensor inputs. Furthermore, the lack of MCAS guidance in the pilot's manual and training material made it impossible for the inexperienced and underqualified crew to respond appropriately to uncontrolled trimming by MCAS. Initial results of the Ethiopian accident investigation indicate that their crew followed the procedures set by FAA and Boeing in the Airworthiness Directive which was released in the aftermath the Lion Air crash and still were unable to solve the issues fast enough to prevent the accident (◘ Fig. 3.3).

Analysis

The 737 Max 8 accidents are a prime example for a failure of the entire system, as explained in the "Swiss Cheese Model" of accident causation by Reason (1990, 2016). The model compares safety systems with several slices of Swiss cheese stacked next to each other, where the risk of a threat becoming a reality is reduced by the different layers and defence systems that are "layered" one behind the other. Thus, gaps and weaknesses in a protection measure do not theoretically allow the occurrence of a risk, as there are other protection measures to prevent a single point of failure. In this specific case multiple aspects of the system failed (◘ Fig. 3.4).

Society's demand for unlimited mobility and cheap prices causes overall aviation demand growth and a fierce price competition among **airlines**, especially in the low-cost point-to-point segment, and drives down margins for the companies. Consequently, airlines demand for efficient planes and low prices in their supply chain. Cost savings may also include training of flight personnel and maintenance. New technologies are not sufficiently scrutinised.

Externally, the de-facto duopolistic **market structure** put immense pressure on **Boeing** to meet customer requirements (cost-efficient technology) and to fulfil the expectation of investors. Internally, the alleged lack of a safety culture and poor corporate governance due to the personal union of CEO and Chairman of the Board of Directors created a fertile soil for undesirable outcomes like the rushed and



Possible issues with 737 upgrade

Boeing adopted larger, more fuel-efficient engines that were mounted farther forward and higher.

Larger engines could push up jet's nose, risking a stall in certain conditions.

Software automatically trims stabilizers on tail to push down nose.

But erroneous sensor data could push nose down at wrong time.

Pilots try to pull up, but software keeps pushing nose down.

Sources: Boeing, Times reporting Los Angeles Times

Fig. 3.3 Possible issues that could have facilitated the accidents (Elebee, 2019)

deficient technology development. This resulted in a market entry with an unsafe product as well as the presumed deliberate exploitation of systematic errors in the approval process.

The most severe failures happened in the **political/regulatory system** where the FAA allegedly failed to fulfil its supervisory obligations. The lack of public funding caused the design and implementation of a flawed approval process, where a large part of the tasks is delegated to the manufacturer on a trust basis. Due to the duopolistic OEM market, Boeing is considered too big to fail and likely received favourable treatment by the US government. The political system could have prevented this

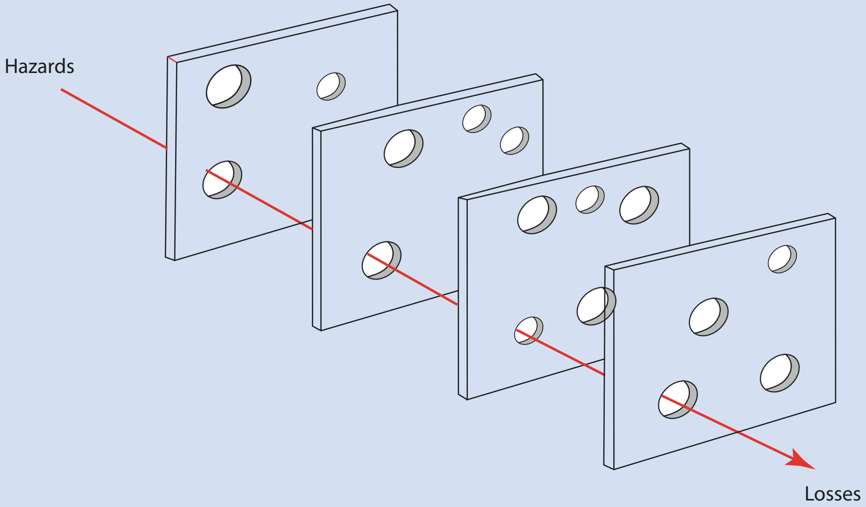


Fig. 3.4 The Swiss Cheese Model (Reason, 1990, 1997)

catastrophic outcome if the regulatory authorities had diligently fulfilled their intended duties and acted as a final safety layer, thus preventing the system failure.

Responsibility

Boeing was charged with 737 Max 8 fraud conspiracy and agrees to pay over $ 2.5 billion composed of a criminal monetary penalty of $243.6 million, compensation payments to Boeing's 737 MAX airline customers of $1.77 billion, and the establishment of a $500 million crash-victim beneficiaries fund to compensate the heirs, relatives and legal beneficiaries of the 346 passengers who died in the Boeing 737 MAX crashes of Lion Air Flight 610 and Ethiopian Airlines Flight 302. The tragic crashes exposed fraudulent and deceptive conduct by employees of one of the world's leading commercial airplane manufacturers Boeing's employees chose the path of profit over candour by concealing material information from the FAA concerning the operation of its 737 Max airplane and engaging in an effort to cover up their deception. The misleading statements, half-truths and omissions communicated by Boeing employees to the FAA impeded the government's ability to ensure the safety of the flying public (► www.atn.aero 2021).

Sources: Boeing, n.d.; KNKT, 2019; Reason, 1990, 1997; Schürpf, 2021.

3.3 Technological Development in the Aviation Industry

Nowadays, most passengers board an aircraft without even realising the progress that has been made in aircraft technology and the technological sophistication that surrounds them. Yet, from the first attempts of launching hot air balloons in China in the third century AD and successful balloon rides by the French Montgolfier brothers in the eighteenth century, the aviation industry has gone a long way. Major steps in the early development of aviation were the gliding flights by Otto Lilienthal 1891 and the first successful manned airplane flights by the Wright brothers near Kitty Hawk in 1903.

It was not until the end of World War II, though, that the development of civil aviation started to accelerate. Up to that point, civil flights were mainly national or cross-border mail flights that only carried a limited number of passengers. Furthermore, in the 1930s and 1940s, developments in aviation were largely driven by military usage.

The late 1940s mark the beginning of the development of large-scale commercial aviation. While the first flights connected major continental routes, particularly within North America and Europe, bigger aircraft with longer ranges allowed for a successful and faster development of the industry. Passenger numbers were constantly increasing, and new destinations were continuously added to the route maps of the airlines. The introduction of innovative airplanes, like the Lockheed Constellation as the first aircraft that was widely equipped with cabin pressurisation (maiden flight: 1943), the Boeing 707 as the first long-haul aircraft (1958), and the Boeing 747 as the first wide-body aircraft (1969), have left a lasting footprint on the development of aviation. Thus, it was technological changes that allowed for a successful development of aviation. In turn, the fast industry development required bigger and safer aircraft, and hence promoted technological progress. The beginning of the jet aircraft century with cruising at higher altitudes allowed for a comfortable travel among continents at prices that were affordable for an increasing number of people.

As a consequence, more aircraft were entering the market, representing the whole range from large aircraft used for intercontinental routes to smaller aircraft mainly used for regional traffic. The first supersonic aircraft, such as the Concorde or the Russian Tupolev TU-144, was introduced to the market in the mid-1970s. Although the planes were later taken off the market for commercial reasons, they have shown that the current techniques allow travelling at speeds faster than sound. One of the latest major innovation on the aircraft market is the Airbus A380, a plane that seats about 550 passengers in its standard configuration. Further recent innovative aircraft developments are the Boeing 787 (Dreamliner) and the Airbus A350. These aircraft are lighter, feature new design elements and are, therefore, more efficient than previous aircraft.

In the course of time, aircraft have undergone a lot of technological changes, which can be categorised into visible to the passenger as well as "hidden" innovations. This has had effects on the economic as well as on the ecological development in air transportation. Today's commercial airliners use far less kerosene than older aircraft thanks to technological progress (e.g. more efficient fans, changes in aircraft design such as the installation of winglets) and operational changes (more passengers). It could be observed that the efficiency of an airplane increases with increasing size due to reduced fuel consumption per passenger ("specific fuel consumption"). Also, today's aircraft produce far less noise than older aircraft. While this progress has had its positive effect on the ecological development of aviation, the economic success of the aviation industry and its growth has largely cancelled

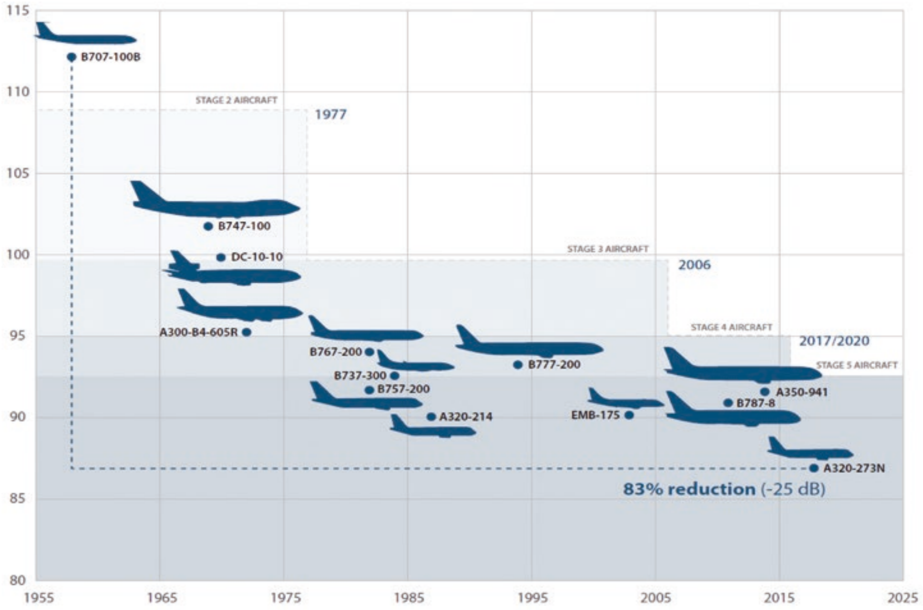


Fig. 3.5 Aircraft effective perceived noise in decibel (EPNdB) levels (San Francisco Airport, n.d.; based on FAA, 2012)

out these environmental benefits. The following paragraphs highlight three examples of technological development with impacts on the economy and ecology of airlines.

- Noise of planes has been reduced in the past years. According to technical research, noise waves appear in front and behind the engine. The noise waves move away from the airplane like a funnel. This means that the further away the noise waves are from the airplane, the bigger the geographical area which is impacted. But the level of noise decreases significantly, if the distance to the plane is more than 600 meters (Fig. 3.5).
- Ageing aircraft lead to higher maintenance costs for airlines. For example, 20-year-old aircraft cause 50%–60% higher maintenance costs than new aircraft. There are often problems with the supply of spare parts for older aircraft which decreases their reliability and increases the maintenance time. Old planes must be checked more often than new planes and spend more time in maintenance. Therefore, they have lesser availability for the airline. Some maintenance companies do not even want to work on aircraft older than 18 years for liability reasons. Furthermore, older aircraft need more fuel due to older, less efficient engines and hence have a significant impact on the cost structure due to higher fuel costs.
- Fuel is one of the highest cost factors for airlines. The following Fig. 3.6 shows the development of a plane's fuel consumption from 1950 to 2010. In the 1950s, an aircraft used 12 litres per 100 km per passenger. In the end of the 1990s the Airbus A340 used less than 4 litres per 100 km per passenger. The

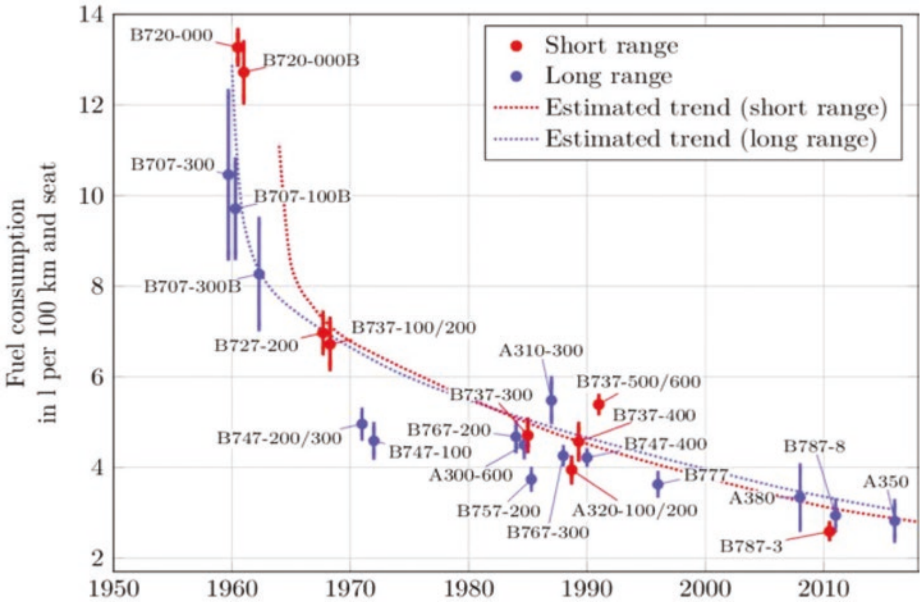


Fig. 3.6 Fuel consumption of commercial aircraft (Knoblach, 2015, p. 1, based on Internal Energy Agency, 2009)

newest planes, such as the Airbus A380 or the Airbus A350 and Boeing 787 Dreamliner, consume less than 3 litres per 100 km per passenger. Behind this decrease of fuel consumption are technological improvement of engines, lighter construction materials, such as carbon fibre, the greater size of aircraft and improved aerodynamics, for example, through new winglets that reduce the turbulence at the wing tips.

The industry will continue to develop technologically. Concerning the outer aircraft appearance, more fuel-efficient aircraft designs could be imagined. A possible development is the single wing design and a slide delta shape with canard for planes. Wing sizes of 100 meters and aircraft that seat up to 1500 passengers are seen as a possibility. The integration of passenger cabins and cargo room in the wing is another possible development. Also, fly-by-wire technologies and electronic CG (centre of gravity) control are potential changes that could shape the future of the air transport industry. As the aviation industry is still highly dependent on kerosene and thus on fossil fuels, a further focus is on using substitutes for powering the aircraft. In this context, the use of thermoelectric power and hydrogen can be a future development. Furthermore, purely synthetic fuel, which is obtained from carbon dioxide in the air, has been developed and can be scaled up as a solution. One could also imagine several large fan blowers generating the power to lift the aircraft. Also, hybrid systems where electric propulsion and combustion engines are combined are being tested.

The development of fully electric aircraft is also being pursued. While long-haul use currently seems rather unlikely, application in the area of urban air mobility in particular is already realistic, at least from a technological point of view. Numerous companies are currently developing fully autonomous aircraft for the urban air mobility use case. Boeing and Airbus are designing self-flying air taxis, which would be used for flights of about 30 minutes and have a passenger capacity between two and four people (Rice & Winter, 2019). Generally, air taxi concepts rely on vertical take-off and landing (VTOL) and resemble existing public transport options such as metros, trains or buses with pre-determined routes, schedules and stops in high traffic areas throughout the cities. Globally, NASA (2018) estimates 740 million passenger trips annually by the year of 2030, with a total of 23,000 vehicles and an average price of $30 per trip. Many of the projects being discussed are in their initial stages and still have to prove themselves in a real societal environment, but there is a clear willingness on the part of aerospace manufacturers to take society into the next era of aviation.

Mini Case A380 – Size Does Matter

by Adrian Müller and Andreas Wittmer

Background

The Airbus A380 Superjumbo project is considered one of the most ambitious in aviation history. When the aircraft's development was initiated, the market of wide-body aircraft was dominated by Boeing with its incredibly successful "Jumbo Jet", the Boeing 747. Airbus was under strong pressure to introduce an ultra-high-capacity airliner (UHCA) itself to complete its fleet offering and, therefore, reduce the supremacy of Boeing. Airbus launched the €9.5 billion A380 program on 19 December 2000. The first superjumbo with 471 seats was delivered to Singapore Airlines in October 2007. The plane was very well received by the customers, especially by business class passengers.

Failure

Despite being loved by the airlines' customers, demand for the A380 never picked up. In 2019 Airbus announced that the production would end by 2021 after the most important customer Emirates reduced its remaining 39 orders in favor of the A330neo and the A350. Considering that Airbus had delivered only 234 out of the predicted 1200 airframes and thus had never made a profit, this decision was no surprise to experts.

The failure of the A380 can be pinned down to three major reasons:

- Airbus **overestimated the demand** for very large aircraft (VLA). Retrospectively, the Airbus A380 was developed for a market which was going to be a niche. There are essentially only two business models in which superjumbos strive: use in mega-hubs and on high-density routes.

- The global **aviation market shifted** from hub-and-spoke networks to point-to-point connections. Passengers prefer higher flexibility and more flights per route per day; in consequence, an increase in direct flights and ultra-long-haul routes can be observed. This shift away from network models leads to the requirement of higher frequency instead of higher average seat capacity.
- High upfront**, operating and maintenance costs** make it difficult for the A380 to be commercially successful. Globally there is only a limited number of routes on which the plane can operate efficiently. Compared to other two engine wide-body airplanes there is an efficiency disadvantage, as pointed out by Dr Tony Weber, Qantas' former chief economist:

> » You can fly two Boeing 787s between Sydney and Los Angeles with the same fuel consumption as the A380. Qantas has tried to justify its fuel consumption by saying its aircraft can allow more passengers on board. But the jet fuel price hovers above \$80 to \$90, so it just becomes uneconomic and unsustainable.
>
> *Dr Tony Weber – Former Qantas chief economist*

The ▪ Table 3.1 below shows the cost comparison between the A380 and two of its the major two engine competitors.

Implications and Future Developments

The end of the A380 will have numerous consequences for a myriad of stakeholders. Not only the supply chain with OEMs, airlines and airports, but also the social and political systems will be affected. Airbus itself will not suffer a major financial loss but with the company's announcement that as many as 3500 jobs might be at risk, the impact on the production countries Germany, France, Spain and UK is significant. The governments could also be left with more than 600 million Euros of outstanding credits (Roubanis, 2019).

Despite the initial economic failure of the Airbus Superjumbo, a new case for the plane could arise in the future. According to IATA estimates, **the global demand for air travel will grow significantly**. By 2037 they forecast 8.2 billion air travellers, that is, a compound annual growth of 3.5% which doubles the passenger numbers compared to 2018 levels (IATA, 2018). Increasing global **urbanisation** will further impact

▪ **Table 3.1** Cost Comparison (Table compiled by author)

Airbus A380-800	Airbus A350-1000	Boeing 787-9
List price per unit:465m USD Cost per flight hour:26,000 to 29,000 USD Typical number of seats:510	List price per unit:366.5m USD Cost per flight hour:11,000 to 15,000 USD Typical number of seats:384	List price per unit:292.5m USD Cost per flight hour:11,000 to 15,000 USD Typical number of seats: 330

aviation traffic flows. While today there are 58 megacities with more than 50,000 daily long-haul passengers, Airbus expects 98 such centres in 2036 (Halsey III, 2018). The global increase in demand clashes with an infrastructure whose growth cannot keep pace with these trends. Airports around the world continue to be under pressure to create more capacity. Particularly in Europe, restrictive political environments and a lack of space are barriers to growth. **The increasing congestion of airports**, coupled with global demand growth, could one day again be an argument in favour of superjumbos. Lastly, also the global **sustainability** discussion is relevant for the A380, which – when operated at full capacity – is already one of the most efficient airplanes. Technological advancements could also help an A380neo to make its comeback.

Sources: Roubanis, 2019; IATA, 2018; Halsey III, 2018

Mini Case VTOL – Lilium

by Adrian Müller and Andreas Wittmer

"We believe in making urban air travel affordable and accessible." The vision of the Bavarian air-taxi start-up "Lilium" is a promise that it shared by many companies who are working on developing innovative mobility concepts.

Manufacturers promise fast, fully electric VTOLs for point-to-point connections without the need for additional infrastructure, with zero operating emissions and potentially fully autonomous that thus have the potential to revolutionise aviation and urban mobility in general.

By 2020, Lilium has raised more than $100m in funding and 300+ employees work for the company which was founded in 2015 by the young German engineer Daniel Wiegand.

Unlike other concepts, such as Volocopter, Lilium is a tilt jet aircraft with 36 engines mounted on its flaps. The company promises a range of 300 km – significantly more than its competitors – thus suggesting that "the Lilium Jet would be able to connect not just urban and suburban areas, but also cities to each other" (Lilium, n.d.-b).

To this date it remains unclear, however, whether the Lilium engineers can deliver what their marketing department has promised. In 2020, several independent engineers sought the public to cast doubt on Lilium's claims with their own calculations. Their concerns can be pinned down to the following three problems:

- The low energy density of lithium-ion batteries
- Hovering efficiency losses of propeller, motor, power electronics and power lines
- Distinctive noise from the electric motors

While efficiency losses and battery issues cause the experts to doubt the maximum range of the aircraft, the noise raises concerns about the acceptance of VTOLS in

▣ **Fig. 3.7** The Lilium jet (Lilium, n.d.-a)

inhabited areas. Both aspects are not only decisive for customer acceptance, but ultimately also for the approval of such concepts by the regulator.

The vision of VTOLs, to be autonomous and pilotless, further reinforces these concerns. It is not yet clear whether the visions of resourceful engineers can actually become reality. In addition to technical aspects, legal and social questions must first be addressed (▣ Fig. 3.7).

Sources: Lilium, n.d.-b; Evers & Seidler, 2020; Schelling, 2020

3.4 Economic Impacts

The aviation industry has grown at enormous rates of about 5 percent per annum over the past 60 years. Today, the world's airlines carry about 60 million tons of freight and more than 4 billion people each year (World Bank, 2020; IATA, 2020). While some air transportation markets in Africa and the Asia Pacific region are expected to continue to grow strongly, at annual rates of above 5 percent respectively, other, more saturated markets, particularly in North America and Europe, are expected to develop only at reduced rates between 2.0 and 4.0 percent a year. The growth in international aviation, however, is estimated to remain a global phenomenon, despite the climate challenges, with an average projected growth rate of 4.6 percent annually until 2038 (Boeing, 2019). By size, the Asia-Pacific market will be the world's largest aviation market (44.8 percent of world traffic) followed by Europe (21.3 percent) and North America (13.8 percent) (▣ Table 3.2).

Overall, the economic development of aviation shows very close connections to its political development. Liberalisation and deregulation developments have initiated the strong growth of the air transport industry. These developments allowed, in particular, for new and better air services and the emergence of new business

Table 3.2 Forecast of traffic numbers and airplane fleet (Boeing, 2019)[a]

	Revenue passenger kilometre (bn)				Airline traffic growth rate (RPK) CAGR	Total airplane fleet			Economic growth rate (GDP)
	2008	**2018**	**2028**	**2038**		**2018**	**2038**	**CAGR**	
Asia-Pacific	1′264	2′857	5′232	8′138	5.5%	7′880	19′420	4.6%	3.9%
North America	1′406	1′900	2′680	2′503	3.2%	7′550	10′930	1.9%	1.9%
Europe	1′252	1′898	2′814	3′880	3.6%	5′260	9′340	2.9%	1.6%
Middle East	213	552	999	1′564	5.1%	1′550	4′030	4.9%	3.2%
Latin America	290	530	922	1′523	5.9%	1′580	3′380	3.9%	2.9%
Africa	117	189	338	576	5.9%	740	1′620	4.0%	3.4%
Total	**4543**	**7925**	**12,985**	**18,183**	**4.6%**	**24,560**	**48,720**	**3.4%**	**2.7%**

[a]Numbers are rounded; the data may contain small deviations of about 3% due to rounding and allocation of the traffic flow data to consolidated regions

models and airline alliances. These new business and network models led to a growth in air traffic, which resulted in economic growth and consequently in increased employment.

Aviation contributes significantly to the welfare of nations and is of high importance for the economic development around the world. Economic benefits of aviation can be split into direct, indirect, induced and catalytic effects which can, to a great part, be defined by income and employment generated by the aviation system (Whitelegg & Cambridge, 2004).

A systematic comparison of the methodological approaches used to evaluate the economic effects of airports shows that a methodologically similar approach is increasingly being used. In the majority of studies (Bauer et al., 2019; Aéroports de Paris, 2017; Bertschmann et al., 2017; Baker et al., 2015; Wittmer & Bieger, 2011; Sellner & Nagl, 2010), the economic effects of airports are calculated on the basis of the methodology of the Airports Council International (ACI, 2000; ACI, 2004). With this methodology the employment and income effects resulting from the operation of a regional airfield are divided into direct, indirect, induced and catalytic effects (Klophaus, 2006; Maibach et al., 2006) (Fig. 3.8).

The following Fig. 3.9 illustrates these impacts:

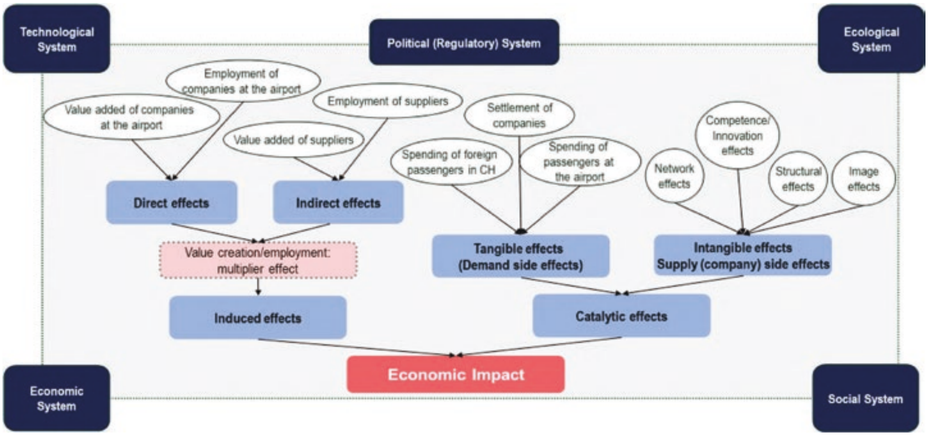


Fig. 3.8 Economic impact of aviation. (Author's own figure)

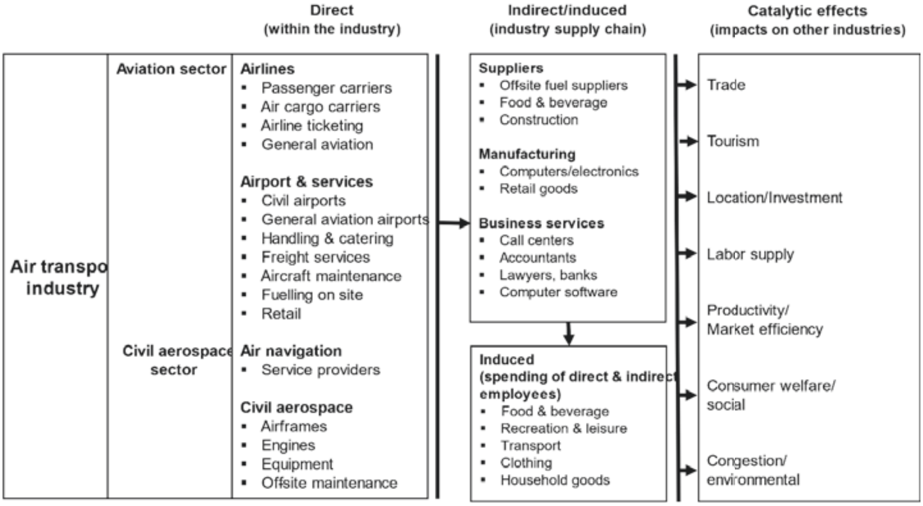


Fig. 3.9 Economic impacts of aviation. (Author's own figure based on ATAG, 2005)

Direct Effects

All institutions directly involved in air traffic operations – such as airlines, airports, service providers and manufacturers – have a direct impact on economic activities. Together they form the most obvious impact of aviation (Button, 2004). The group of airlines comprises various different business models, such as passenger airlines and all-cargo carriers. The three broad areas of employment generated by airports are airline-related employment (catering, fuel services and maintenance), airport-related employment (police, immigration and customs) and retail/commercial related employment (shops, restaurants and car park companies) (ATAG, 2020). Service providers that contribute to national economic growth are air navigation or weather forecast providers. Manufacturers comprise the whole range from airframe and engine to the flight equipment production.

Because not all these activities take place directly at the airports, one can further distinguish between on-site and off-site generated employment, with on-site employment generated directly at the airport and off-site employment generated, for example, at office building locations in city centres (ATAG, 2020).

Direct effects are estimated to represent almost 11.3 million direct jobs and contribute about USD 961.3 billion to global gross domestic product (GDP) (ATAG, 2020).

■ *Indirect Effects*

Services closely related to air transportation, like aviation fuel suppliers, travel agencies or IT providers, have an indirect economic effect (Intervistas, 2015). They generate revenues and employment because they supply the air transport industry. The indirect effect is estimated to generate overall another estimated 13.5 million jobs worldwide and contribute about USD 816.4 billion to the global GDP (ATAG, 2020).

■ *Induced Impacts*

As illustrated in the figure above, the buying power of direct or indirect air transport employees is defined as the induced impact (Graham, 2018). This includes consumption expenditures and investments on local goods and services, such as retail, food, transport and housing (Graham, 2018). Induced impacts may result in the settlement of businesses and enhanced personal mobility, and in a higher quality of life (see catalytic effects) (Intervistas, 2015). Thus, there is also a social effect to the economic impacts. Induced impacts are estimated to support another 13.5 million jobs around the globe, accounting for about USD 692.8 billion of the global GDP (ATAG, 2020).

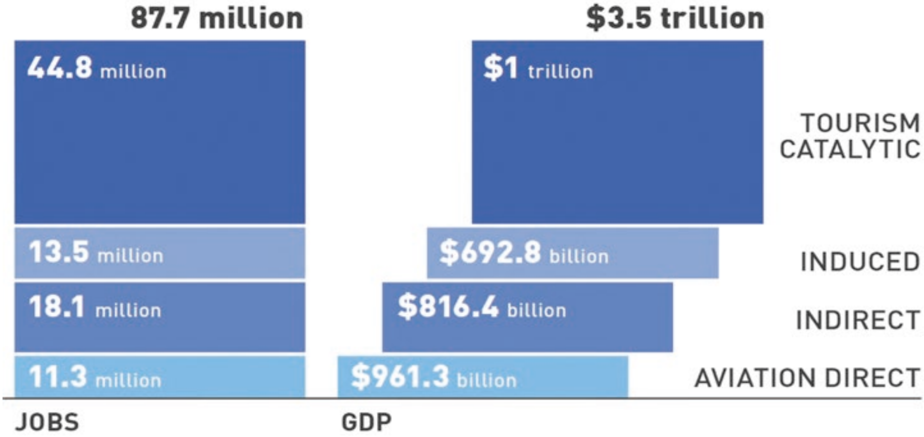
■ *Catalytic Effects*

An additional industry impact is generated through catalytic or spin-off benefits, which refer to economic activities of other industries whose development and growth depends on air transport operations. The catalytic impact is described as the employment and income resulting from the settlement of businesses of various industries due to the attractiveness of an airport and its surroundings. These effects are location effects which do have an impact whether a location is an interesting location for a business or not. High-tech businesses and corporate headquarters are regularly influenced by air transportation opportunities in their choice of locations (Pompl, 2006). An increase in productivity and generated revenues is a resulting benefit for the businesses within the catchment areas of the airport (Peter et al., 2006). Catalytic effects also impact the development of tourism. The presence of an efficient air transport system encourages people to travel. In turn, air transport itself also derives demand from an increasing international tourism market. Air traffic provides accessibility to islands and other long-distance destinations. Hotels, restaurants, exhibitions and recreation centres are those facilities that may benefit from international aviation. Tourism may even generate interlinks to other industries, such as agriculture, fishing or craft production. Tourism is the major supplier of economic growth and development in developing countries (ATAG, 2005).

Starting with a resource-based approach, catalytic effects can be divided into tangible and intangible effects (Bieger and Frey, 1999). Intangible effects are those effects that cannot simply be explained by number of workplaces or income created, but that can still have an impact on how attractive a region's location is. This practical approach is implicitly being used by airport representatives and politicians when they talk about image, accessibility of regions, travel time savings for top managers, the possibility to hold premium events, the social understanding for aviation, leisure- and meeting opportunities for societies, aviation education, a relieving function for national airports, etc. Intangible effects can be classified as structural, competence and network effects. Knowledge and targeted use of these effects hold great potential, and thus have the possibility of positively and sustainably shaping the economic effects of a public activity. The intangible effects in particular, however, do not necessarily make only positive contributions to the economic development of a region; they can also be restrictive, hindering economic developments in the direction of economic growth by assuming, for instance, an infrastructure that makes other development impossible.

Catalytic effects are estimated to generate another 36.7 million jobs worldwide. The following ◘ Fig. 3.10 illustrates the effects introduced above:

In total, aviation is estimated to account for around 65.5 million jobs worldwide and contribute to around 3.6 per cent of global gross domestic product. As a capital-intensive business, the productivity per worker in the air transport industry is very high. It is estimated to be 4.4 times the average of other sectors.



◘ **Fig. 3.10** The global employment and GDP effects of aviation (ATAG, 2020)

Determining the Economic Significance of Aviation

By Adrian Müller and Andreas Wittmer

There are various methods of analysis to determine the economic benefits of aviation. Three of these approaches will be presented below.

1. **Input-Output Model**

Input-output analysis (I-O) assumes that there are mutual interdependencies between different industries or sectors. This macroeconomic analysis method is often used to analyse the impact of positive or negative shocks on the economy. The I-O analysis was developed by Nobel Prize winner Wassily Leontief (1905–1999).

In the resulting so-called inter-industry matrix, the column entries usually represent inputs for an industry sector, while the row entries represent outputs from a specific sector. This matrix, therefore, shows how dependent a specific sector is on all other sectors, both as a purchaser of outputs from other sectors and as a provider of inputs. Each column of the input-output matrix displays the monetary value of the inputs for each sector, and each row represents the value of the outputs of each sector. The sum of all values in a row must equal the sum of the values in the corresponding column.

The input-output analysis models three types of impacts: direct impacts, indirect impacts and induced impacts. These economic impacts are determined by changing certain input levels.

2. **General Equilibrium Model**

Instead of presenting a collection of individual market phenomena, the general equilibrium theory (or Walrasian General Equilibrium) attempts to explain the functioning of the macroeconomy as a whole. The theory was developed by Leon Walras in the late nineteenth century. It contrasts with the theory of partial equilibrium (or Marshall's partial equilibrium), which only looks at selected markets or sectors.

The general equilibrium theory views the economy as a network of interdependent markets and attempts to prove that all free markets ultimately move towards a general equilibrium. The general equilibrium shows how supply and demand interact and tend towards a balanced state in an economy with several markets functioning simultaneously. The balance of competing levels of supply and demand in different markets will ultimately lead to a price equilibrium. Walras' law says that each individual market is in equilibrium if all other markets are also in equilibrium.

In aviation, the general equilibrium theory is, for example, applied for regulatory purposes such as climate policy or airport pricing, where it views aviation as an industry consisting of different subsystems. The analysis can also be used to quantify the economic consequences of disruptions (natural hazards, pandemics, terrorism, etc.) in the aviation system. This will show the impact of a change in the equilibrium of the aviation industry on the equilibria in other industries.

3. **Cost-Benefit Analysis**

A cost-benefit analysis (CBA) is the procedure used to measure the benefits of a decision or action minus the costs associated with that action. The concept of the CBA goes back to Jules Dupuit (1848) and was formalised in later works by Alfred Marshall.

A CBA includes measurable financial indicators such as revenue generated, or costs saved as a result of the decision to pursue a project. A CBA can also include intangible benefits (e.g. image or reputation) and costs (e.g. environmental impacts or externalities) or effects of a decision.

CBA is often applied in public policy making, such as transportation investment. The guiding principle of benefit assessment is to list all stakeholders affected by an intervention and add the positive or negative (usually monetary) value they attribute to the effect of an intervention on their well-being. The cost-benefit analysis always includes a number of forecasts, and if one of these forecasts is inaccurate, the results may be questioned.

3.5 Effects on Society

Next to its economic relevance, air transportation leads to social benefits (Brueckner & Girvin, 2008). Employment opportunities contribute to social welfare on local and regional levels, improving living standards and lifestyles (Janic, 2007). Mobility is seen here as a factor that increases the quality of life and opens different countries. Thus, as a means of mass transportation, the industry supports the connection of different countries and cultures. In doing so, it also supports cultural understanding and increases multicultural cooperation. Air transport often provides access to otherwise inaccessible places, delivering necessary goods and services. On the negative side, noise related impacts on the well-being of people living near airports should be mentioned. Noise can have different medical and psychological impacts on the health of individuals. Yet, since people have the choice to move away from or not move to noisy regions around airports, these negative effects can be overcome more easily than the loss of positive social effects can be compensated. While both economic and social effects of air transportation contribute significantly to global prosperity and social welfare, these benefits come at the cost of negative ecological impacts (Janic, 2007). The next section will introduce these effects.

3.6 Impact on the Environment

Besides its economic and social impacts, aviation also has ecological effects. While the previous sections have illustrated that technological progress has improved the overall efficiency of the industry, the strong growth in aviation has largely cancelled out these developments. Today, aviation is a minor contributor to worldwide emissions, particularly when compared to other industries. It is believed that aviation contributes 2–3 percent to the global CO_2 emissions, if all anthropogenic emissions are taken into consideration (Sims et al., 2014). Looking at the emissions of air transportation within the transport sector, international aviation accounts for about 6.5 percent and domestic aviation for about 4.1 percent of all emissions. Road based transport accounts for 72 percent, international and coastal shipping for 9.2 percent, domestic waterborne for 1.9 percent, rail transport for 1.6 percent and all others for about 5 percent. The indirect emissions from electricity generation account for an additional 2.11 percent.

With the continuing growth in aviation, however, the main question for the future will be how to tackle the climate change impact of the air transport industry and allow for a more sustainable industry development.

When analysing the ecological impacts of the aviation industry, the main operators in air transportation, particularly airlines, airports and airspace control, need to be considered. We, therefore, organise this section as follows: First we introduce the concept of sustainability, followed by an in-depth analysis of environmental effects of the aviation industry, both on a global and a regional/local level. We conclude by giving an overview on potential solutions to decrease the negative effects of aviation.

The term *sustainability* was first used by the mining engineer Hans Carl von Carlowitz for the thoughtful usage of resources.[1] A generally accepted definition of sustainability defines sustainability as “Sustainable development is development that meets the needs of current generations without compromising the ability of future generations to meet theirs” (European Commission, 2019). For non-renewable resources this term implies the efficient use of resources and the ability to replace them for renewable resources. Renewable resources, in turn, should be used in a pace that allows a natural regeneration (European Environment Agency, 2020). Conveying the term sustainability to the transportation industry, there is a lot of discussion concerning the definition of sustainable mobility. Berger, Feindt, Holden and Rubik (2014) point out that it is important to focus on the main dimensions of sustainability, such as the triple-bottom-line, and implement these in a transport context.

Since it is believed that the internalisation of all external costs is a prerequisite for a sustainable industry development, the (long-term) sustainability of aviation can only be achieved, if improvements to the environmental performance of air transport operations outweigh the external effects of growth. While external effects (both negative and positive) are generally considered to be “economically relevant impacts that one agent imposes on another agent without recognising or accounting for them” (Wit et al., 2005), in aviation, negative external effects mainly comprise the costs of noise pollution and climate change introduced above.[2] Even

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[1] Von Carlowitz tried to ensure that the forest remained a reliable provider of lumber by not felling more trees than could re-grow, and thus he shaped the term “sustainability.”

[2] For a detailed overview of environmental externalities in air transport markets, see Fahey et al. (2016) and Lee et al. (2009).

though these costs are difficult to quantify, most studies agree that the environmental impacts of aviation are largely uncompensated, concluding that the costs of air transportation are not reflected by current prices (Pentelow & Scott, 2011; Chapman, 2007). While this represents a market failure and leads to sub-optimal activity levels, it would also result in low investments in new technologies and more efficient operational procedures (Wit et al., 2005).

The *global ecologic impacts* of aviation comprise impacts on the atmosphere, and consequently on the entire world. Regional and local impacts relate to environmental effects at specific airports and the surrounding communities (Graham, 2018; Janić, 2017). While scientific research has made significant progress in examining the impacts of emissions, reliable figures and forecasts – particularly with respect to the global ecologic impact of aviation – are still rare and difficult to make (Olsen et al., 2013). This is partly because aircraft emissions occur directly in upper spheres where they act differently than on the ground. Nevertheless, it is widely recognised that the impact of emissions depends on the altitude and on climate conditions (Brasseur et al., 2016).

Emissions are generally generated through the combustion process of the aircraft engine in which a mixture of many different hydrocarbons is burned. The most well-known pollutant stemming from this combustion process is carbon dioxide (CO_2), which is created by the reaction of carbon oxide (CO) and atmospheric oxygen (O_2). CO_2 is a trace gas with a long residence time in the atmosphere (about 100 years), thus becoming relatively evenly distributed over the atmosphere after emitted by aircraft.

Nitric oxide (NO) and nitrogen dioxide (NO_2) (which form together NO_x) are emitted to a lower degree (Schumann, 2000). NO_x is a greenhouse gas which simultaneously triggers the production of ozone (O_3) and the reduction of methane (CH_4) in the atmosphere. The latter implies a cooling effect in the atmosphere (Fahey et al., 2016), but ozone is a greenhouse gas which has positive as well as negative implications. On the one hand, its appearance in the stratosphere helps to filter out harmful ultraviolet (UV) radiation from the sun, thereby protecting life on Earth. On the other hand, an increased concentration of ozone in the troposphere fosters the greenhouse effect.

Water vapour (H_2O) is another relatively short-lived greenhouse gas, usually disappearing within one to one and a half weeks, although this is found to be increasing (Hodnebrog et al., 2019). Emitted in the stratosphere it may support the reduction of ozone, and therefore contribute to global warming. Condensation trails, also called contrails, are line-shaped icy clouds that form from water emitted by aircraft preferentially in cold and humid air in the upper troposphere (Lee et al., 2009). Contrails contribute to the warming of the earth's surface. NO_x, water vapours and other emitted particles have the highest concentration close to their source of release (Chapman, 2007).

The combustion of 1 kg of kerosene and 3.4 kg of oxygen generally results in 3.15 kg carbon dioxide (CO_2) and 1.24 kg of water vapour (H_2O). Depending on the construction and condition of the engine, it further emits 6–20 g nitrogen oxides (NO_x), 0.7–2.5 g carbon monoxide (CO), 0.1–0.7 g unburned hydrocarbons (C_xH_x), and 0.01–0.03 g of soot.

To identify the exhaust emissions induced by aircraft at the *regional and local levels*, the International Civil Aviation Organization (ICAO) defined the so-called landing and take-off cycle (LTO) embracing landing, alighting, taxiing, take-off and climb of 3000 feet. Aircrafts enter this cycle about 20 km in advance to landing and exit it approximately 7 km after take-off.

On a regional and local scale, smoke may play a role. Smoke originates from particles emitted by the engines' operations during take-off and climb of the aircraft. Unburned hydrocarbons (UHC) are a mixture of hydrocarbons remaining from partial combustion. Close to the surface UHC in combination with NO_x, CO and smoke may even contribute to smog by reducing air quality through the production of secondary organic aerosols (Miake-Lye et al., 2016; Pompl, 2006). UHC and carbon monoxide (CO) emissions occur primarily during the aircraft's lower power engine phase. The aircraft's surroundings are also often affected by airborne dust, containing toxic heavy metals and soot aerosols, as well as suspended sediments able to evoke allergies. The local impact of emissions influences local political decision making, and therefore should not be underestimated.

However, only a small share of all emissions in airport proximity stems from aircraft operations; the majority is generally caused by automobile feeder traffic, machines and engines on the ground.

Another local impact of aviation is its land use, often causing conflict between aviation stakeholders, neighbouring communities and their respective population who try to hinder expansion plans.

Another major concern of communities in the airports' proximity is noise. Generally, noise originates from air transport operations and occurs particularly at airports and within their vicinity, thereby representing a local problem. According to ATAG (2020), more than 4.2 million people of the European population is exposed to aviation induced noise levels exceeding 55 dB. One reason for this is the location of airports in densely populated areas. Noise is defined as unwanted sound that interferes with intended activities and encompasses an objective and subjective component, with the latter being more difficult to assess (Basner et al., 2016; Janic, 1999). Besides the direct impacts of noise, such as disturbance and annoyance of the population, there is also a monetary consequence – the decline in value of properties, houses and apartments, at least in the direct airport proximity (Mahashabde et al., 2011). Although this cannot be generalised as around some airports property prices even increase due to positive connectivity, entertainment and shopping effects.

The area affected by noise can be defined and visually expressed with help of the so-called noise footprint, which are areas encountering the same noise level emitted by aircraft (Filippone, 2014). This area has been reduced with newer aircraft types such as the Boeing 737 MAX having up to 40% lower noise footprints than current comparable aircraft (Boeing, 2017). Aircraft currently entering into service are estimated to be about 20 dB quieter than those aircraft that entered into service about 30 years ago (Airbus, 2020). The strong growth in aviation, nevertheless, has partly offset these noise reductions.

A number of different *solution approaches*, namely policy options and measures, could serve to limit or reduce greenhouse gas emissions, and these have been discussed both by practitioners and in academia. These solution approaches include operational practices to raise the efficiency of the air traffic system, such as improving descent planning (Jopson, 2016), lowering cruise altitudes (Schumann, 2011), reducing cruise speeds (Lovegren & Hansman, 2011), using alternative fuels and altered aircraft design (Richter et al., 2018; Okonkwo & Smith, 2016) or changing air traffic management (SESAR, 2015). Additionally, regulatory approaches can be considered, including measures to restrict the usage of auxiliary aircraft engines for electricity and air conditioning at airports (Padhra, 2018). For example, some airports have implemented noise surcharges depending on noise levels of individual planes and time of the day. The noise fee model of Zurich Airport is an example of a levy system that determines the noise fee based on the noise class of the aircraft and time of day. In addition, the concept includes a relief mechanism for so-called hub-relevant flights, i.e. those flights of particular economic importance for the airport (Wittmer, 2018).

Explanation of Decibel Levels

By Adrian Müller and Andreas Wittmer

Noise is disturbing sound. The physical measure of sound is the decibel (dB). The decibel is a logarithmic measure. In concrete terms this means:

- An increase of 10 dB corresponds almost to a doubling of the perceived volume.
- If two equally loud noise sources come together, the level increases by 3 dB.

In Switzerland, the legislator distinguishes between immission limits (exposure limit values) and emission limits. The exposure limit values define how high the sound level at the place of impact (e.g. in an apartment) may be. The emission limit values define the maximum amount of sound that e.g. a vehicle may emit into the environment.

The immission limit values (exposure limit values) can only be compared with the sound levels of the individual noises to a limited extent, since the corrected, so-called assessment level is decisive for the assessment of a noise situation.

The subjective evaluation of the sound as an undesirable disturbance depends on the volume, frequency, tonality, impulse content, time of occurrence and duration of the sound. The perception of noise also depends on personal factors such as individual and social attitudes and value judgements about the noise source or the psychological situation as well as current activity of the person affected.

Sensitivity level		**Immission limit value In dB(A)**		**Alarm value In dB(A)**	
		Day	Night	Day	Night
I	Relaxation	55	45	65	60
II	Residential	60	50	70	65
III	Residential/commercial	65	55	70	65
IV	Industrial	70	60	75	70

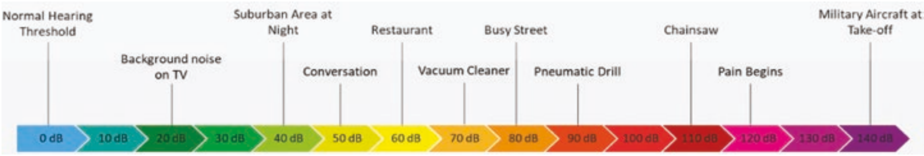

Fig. 3.11 Decibel scale. (Author's own figure based on ScienceDirect, n.d. and decibel-level comparison chart, n.d.)

Immission limits define the threshold above which noise significantly disturbs the well-being of the population. They apply to existing noise-generating installations and to building permits for noise-sensitive buildings (apartments).

Alarm values are a criterion for the urgency of renovations and the installation of sound-proof windows (Fig. 3.11).

Source: BAFU, 2019

Market-based regulatory options, such as environmental levies or emissions trading schemes, are a third possibility to mitigate the climate impacts of aviation. These options in particular have the potential to provide economic incentives for technological innovation and encourage efficiency improvements (Larsson et al., 2019). Since 2012, for example, all flights departing from or arriving at airports within the territory of the European Union (EU) are covered under an emissions trading scheme which is intended to reduce emissions.

Furthermore, a reduction of emissions can be achieved by implementing new technologies (e.g. new fuels, new engine technologies, aerodynamic improvements, etc.). In order to develop new technologies, it is important to increase budgets for research and development. By implementing a cost on emissions, the financial pressure on airlines and the aviation supply chain as a whole is increased. This might have a positive effect on new developments, since countries that are operating under a scheme, in which emissions have to be paid for, might improve their research and development more than others. This could create a competitive advantage for these countries in the future (Andreoni & Miola, 2016).

In addition to introducing tools related to pricing of emissions, there is the idea to reduce growth of aviation and so to reduce emissions of the industry. In order to reduce growth consumer behaviour has to be changed and new technologies (e.g. video conferencing), which reduce the need for travelling, need to be enhanced (Denstadli et al., 2013).

Mini Case: Sustainable Aviation Fuel (SAF)

By Adrian Müller and Andreas Wittmer

Aviation is coming under increasing social pressure due to the use of fossil fuels and the associated emissions. Renewable fuel for aviation has been identified by the International Civil Aviation Organization (ICAO) to play a critical role in decarbonising the industry and cutting CO_2 emissions. The industry is, therefore, conducting intensive research into alternative fuels.

Approximately 300 Mt of kerosene was consumed by civil aviation in 2019. Despite other revolutionary aircraft technologies, such as propellers electrically powered by photovoltaic cells, fuel cells or ultracapacitors, large commercial aircraft to date have little to no alternatives to liquid fuel for the near- to mid-term. In the following, we will briefly introduce various potential alternative energy sources for aviation and their potential advantages and drawbacks.

Electric Propulsion

Similar to the automotive industry, electrification of aviation could also largely eliminate GHG emissions. However, despite various successful applications of smaller electric aircraft, it is hardly foreseeable in the near future that passenger aircraft will be completely electrically powered. The main unsolved problem lies in the storage of the required energy and the associated weight. A sample calculation[3] is used to illustrate the problem.

Assumptions:

► Jet A fuel contains…	…100× the specific energy of today's Tesla Model S batteries …>20× the specific energy of the best predicted future batteries
► Aircraft engine thermodynamic efficiency	ca. 50% (today's best aircraft engines)
► Electrical systems efficiency	up to 95%
► Example Aircraft: A320neo	*Fuel Capacity:* 24 t
	Max. Take-off mass: 78 t
	Range: 4800–6150 km

Based on the above assumptions, we calculate the impact on the weight of a short-range aircraft if the amount of energy contained in paraffin is to be completely replaced by electrical energy.

Calculation:

Stored energy in fuel:	24,000 kg * 43.1 MJ/kg = 1,034,400 MJ
Battery would need to provide 1/2 of the energy *(→ 50% efficiency of aircraft engine*)	1,034,400 MJ * 0.5 = 517,200 MJ
Today's Tesla Model S batteries:	517,200 MJ at 0.4 MJ/kg = **1293 t** (>78 t)
Tomorrows projected best batteries:	517,200 MJ at 1.8 MJ/kg = **287 t** (>78 t)

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[3] Calculation conducted by Dr Philipp Furler, Synhelion AG. 2020.

The same amount of stored energy would exceed the maximum take-off weight many times over, even assuming more advanced batteries. The main reason is that kerosene stores much more energy per kilogram as well as per litre and, therefore, needs less space and weight than batteries. Therefore, while hybrid concepts are conceivable; a complete electrification of commercial aviation in the coming years is considered unrealistic by many experts.

Hydrogen

A similar problem occurs with hydrogen: even if it can be produced directly from electricity and water, the storage volume required per kWh of energy is much larger and, therefore, the main problem for carrying large amounts of energy in an aircraft. Due to the low volumetric energy density cryogenic H_2 would have to be stored in cylindrical tanks. For aerodynamic reasons, current airframes provide no space for bulky tanks.

Production and supply are further challenges, as the H_2 supply chain infrastructure is quasi non-existent and aviation certification for pressurised or cryogenic H_2 will likely pose a great challenge. It will, therefore, take a long time for the newly required aircraft to enter service, which means that the impact on emissions reduction will come late.

Sustainable Aviation Fuels

Based on a brief overview of the two most frequently mentioned alternatives to conventional fuels, it seems clear that chemical fuels can hardly be replaced in the near future. They have a high gravimetric and volumetric energy density, can be stored easily thanks to their long-term stability and the supply and fuel infrastructure exist. These are the three most important arguments in favour of sustainable aviation fuels (SAF) which as so-called drop-in fuels can be used as a direct replacement for the existing fossil fuels. Compared to fossil fuels, sustainably produced, non-conventional aviation jet fuel leads to a reduction in carbon dioxide (CO_2) emissions over its entire life cycle. SAF contains fewer pollutants (such as sulphur), which means that sulphur dioxide and particulate emissions can be reduced even more than is possible with current technology.

Biofuels

Biofuels usually refers to fuels manufactured from biological resources (plant or animal material). Current technology, however, allows the production of fuels from other alternative sources, including non-biological resources. Various raw materials can be used to produce SAF: municipal solid waste, recycled oils (used cooking oil), animal fats, algae, sugar crops, cereals, plant waste and cellulosic or oil-producing plants.

The carbon dioxide absorbed by the plants during the biomass growth corresponds approximately to the amount of carbon dioxide that is produced during the combustion of the fuel in a combustion engine and is simply returned to the atmosphere. This means that SAF would be nearly carbon neutral over its life cycle. However, the production of SAF generates emissions that are caused by the equipment required to grow the plants, transport the raw materials, refine the fuel, etc. If these elements are considered, it has been shown that the use of sustainable aviation fuel leads to a significant reduction in total lifecycle CO_2 emissions compared to fossil fuels, which in some cases can be as much as 80%.

Biofuels have some disadvantages. In particular, the "food vs. fuel" debate, which deals with the risk of using agricultural land for fuel production at the expense of the global food supply. Similarly, the planting of crops for biofuels can have negative effects such as deforestation and soil erosion, as well as increasing pressure on water resources through agriculture and refineries. There are also some technical challenges that have not yet been fully resolved. One major problem that needs to be solved also relates to SAF's economic viability; currently, sustainable fuels are significantly more expensive than fossil fuels. Also, within biofuels there are significant differences between the different types.

Power-to-Liquid/Sun-to-Liquid fuels

The term power-to-liquid refers to various technical processes, all of which aim to produce liquid fuels. Starting materials for the entire process are water, carbon dioxide and electrical energy. A promising further development is the so-called sun-to-liquid process, which uses solar energy instead of standard electrical energy from potentially non-renewable sources. Unlike biofuels, solar energy is scalable to meet any future demand and is already used on a large scale to generate heat and electricity. Solar energy can also be used to produce hydrogen, but the transport sector cannot easily replace hydrocarbon fuels as discussed earlier.

Concentrated solar energy is used in the sun-to-liquid approach to synthesise liquid hydrocarbon fuels from H_2O and CO_2. Such a reversal of combustion is achieved by a high-temperature thermochemical cycle based on reactions that convert H_2O and CO_2 into high-energy synthesis gas (syngas), a mixture of mainly H_2 and CO which is subsequently processed to so-called Fischer-Tropsch hydrocarbon fuels.

Solar conversion efficiency and the cost of a sustainable CO_2 supply are key factors in the competition with fossil and biomass-based fuels. The supply of carbon dioxide (CO_2) for the synthesis process can potentially be achieved by CO_2 extraction from the air, but some technological challenges remain.

Mini Case: Sustainability in Air Transportation

By Adrian Müller and Andreas Wittmer

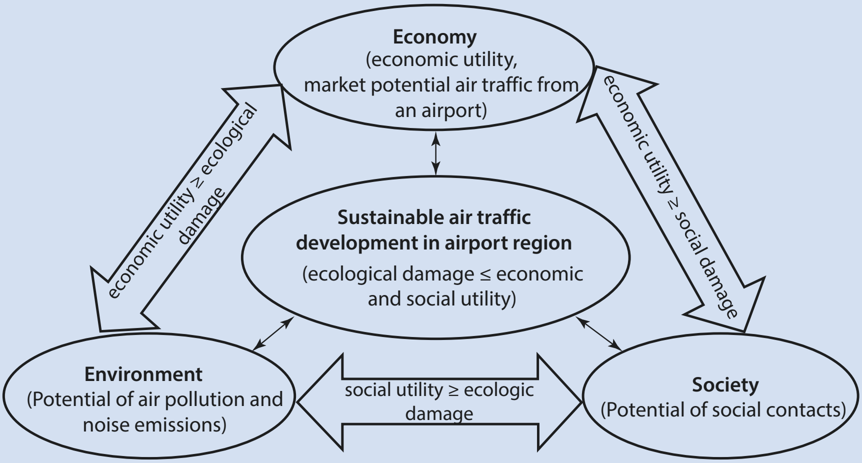
The case of sustainability exemplifies the multi-dimensional impacts of issues in air transportation. Sustainability, in particular, not only covers the five perspectives introduced above, but also illustrates that these different aspects may interact on several impact layers, namely on a global, national and local level.

There is, overall, a global and an ecological perspective of aviation sustainability with respect to worldwide anthropogenic climate change, which is the greatest global challenge of our time. Since the Paris Agreement 2015 and the 1.5°Celsius target, there is a broad global consensus on this issue. With the climate strikes of 2019 initiated by the so-called climate youth, the issue has reached civil society worldwide and thus finally arrived on the agendas of policy makers and executives. This development has also influenced customer needs and especially in Northern Europe "flight shame" became a new phenomenon.

These environment-driven changes are causing increasing conflict with the other two dimensions of sustainability. Economically, the competitiveness of nations and international companies is a major factor and governments are reluctant to implement environmental regulations that could weaken their own position in international competition. From a social perspective, mobility needs and impacts on the quality of life are of relevance. It is, therefore, difficult for a large part of the population in Western countries to imagine doing without or with less international mobility, and regulation faces resistance. At the same time, it is problematic to demand that less developed regions abstain from growth in mobility, which goes hand in hand with greater prosperity and increased quality of life.

On a national level, air transportation provides trade opportunities and increases the attractiveness of a nation. However, CO_2 emissions and noise are important negative factors in the airport proximity and under flight paths. The opportunity to meet people, to travel, and to create personal networks are factors which, from a social perspective, increase the quality of life of inhabitants in a country.

On a local level around airports, economies profit from increased employment opportunities and attractive living locations with good public transport networks. Ecologically, challenges concerning noise pollution and bad smell due to emission may arise around airports. From a social point of view, air transport connections create high living standards, reflected, for example, by increasing land prices and construction activities around international airport hubs (▪ Fig. 3.12).



▪ **Fig. 3.12** Sustainability framework. (Author's own figure)

Review Questions

- What are major influencing factors and milestones in the political development of the aviation industry? What is the Chicago Convention about?
- What are major technological impacts and inventions that have shaped the air transport industry? How does technological progress impact the economic and ecological development of the aviation industry?
- Explain the economic relevance of the air transportation industry. What do direct, indirect, induced and catalysed effects stand for?
- What is meant by the “social impact” of aviation?
- What are the ecological impacts of aviation and what effects can be distinguished on a global and a local level? Quantify these impacts!

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4

From the Aviation Value Chain to the Aviation System

Andreas Wittmer and Thomas Bieger

Contents

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Summary

- The aviation value chain consists of sub-industries, most importantly, aircraft manufacturers, leasing companies, airports, ground services, technical support, reservation systems and airlines.
- Within this value chain there are pull and push effects at work, e.g. technical push effects from aircraft manufacturers or demand-pull effects in form of customer requirements.
- Because of these interdependencies, but also due to the interrelations of the whole aviation value system with its different environmental spheres (economic environment, political environment, technical environment, social environment and ecologic environment) and the market structure, the aviation sector can be ideally modelled with a system approach.
- The profitability of the different sub-industries varies and depends on entry barriers and on natural market power. Therefore, reservation systems, airports and leasing companies are more profitable.

The aviation value chain is made up of different sub-industries that range from aircraft manufacturers over technical support to airlines. Each of these sub-industries face different pull and push effects which are interdependent and influence their decisions and actions. Coupled with the interrelations of the different spheres within the aviation value system, and the market environment, a system approach is useful to map the aviation industry. Each sub-industry faces different degrees of profitability which depend on the entry barriers and the natural market power. This explains why airlines see narrower profit margins while airports or leasing companies face higher profits.

4.1 Introduction

This chapter gives an overview on the different sub-industries in aviation, e.g. airports, airlines and aircraft manufacturers. Based on historical development, strategic success factors of different sub-industries are derived. The profitability of the different sub-industries in the aviation value system is discussed, and thereby, the chapter provides a deeper understanding of the aviation system model introduced in the previous chapter.

Mini Case: Zurich Airport

By Andreas Wittmer and Christopher Siegrist

Zurich Airport is a publicly traded company. The majority of the shares, however, are still owned by the Canton of Zurich. The airport has three terminal concourses and three runways which allow for simultaneous movements on two runways (two of three runways intersect). The airport can currently handle a maximum of 66 movements per hour (Zurich Airport, 2019). This is due to politically motivated approach and departure procedures, as well as unilaterally imposed regulations by Germany, which needs to be flown over in order to get to the airport. Furthermore, noise abatement procedures cause complex routings, further reducing capacity. This poses a problem, as newest forecasts require a capacity of up to 70 movements per hour to meet future growth (BAZL, 2017). As the government is forced to take action to reduce impacts as soon as a certain level of noise is measured, the maximum number of aircraft movements permitted by law depends on the noise that aircraft produce and on how many people reside in the immediate vicinity of the airport. Zurich Airport may, in the future, be able to accept a higher number of flights, if technical progress leads to quieter aircraft. However, the airport may also lose capacity, if more people move into the vicinity of the airport (AfV, 2008).

Zurich Airport serves the business hub and economic capital of Switzerland (a large number of international company headquarters are located in Zurich). In addition, it is also the main Swiss airport, and thus the gateway to Switzerland, especially to the northern part of the country. Together with Southern Germany and Western Austria the airport serves a market of roughly 10 million people in one of the most prosperous regions of Europe.

Zurich Airport is served by 77 airlines from 5 continents and it is also the hub of Swiss International Airlines (Zurich Airport, 2020, p. 14). Swiss International Airlines runs a comprehensive international and intercontinental hub out of Zurich based on a wave structure, which dominates the operation of the whole airport. As a subsidiary of Lufthansa, Swiss International Airlines operates the third major hub of the Lufthansa multi-hub system. “Hubbing” provides growth opportunities for the airport beyond the local market. Additionally, a number of suppliers and service companies depend on the airport, such as Swissport as an airport handler, SR Technics in the airplane maintenance business or LSG Sky Chefs in the catering sector.

Zurich Airport is one of the most expensive airports in Europe, but also one of the most efficient and qualitatively outstanding ones. Politicians and businesspeople from the region care about the development of the international connectivity of Zurich Airport, since they want Zurich to remain an important hub. Easy accessibility by air from all over the world is considered to be a major ingredient of the attractiveness of Zurich as an international business centre.

Questions for Discussion:

Which are the most important elements of the aviation system in Switzerland, and which factors determine the competitiveness of Switzerland as an aviation hub?

Would you personally rather invest in the Zurich hub by buying shares of Zurich Airport or by buying shares of Lufthansa or Swiss Airlines? Why?

How can the interdependence between the Zurich Airport and its major customer, Swiss International Airlines, and respectively between Swiss International Airlines and its most important infrastructure, Zurich Airport, be organised? What type of market structure is this relation based on?

4.2 The Aviation Value Chain

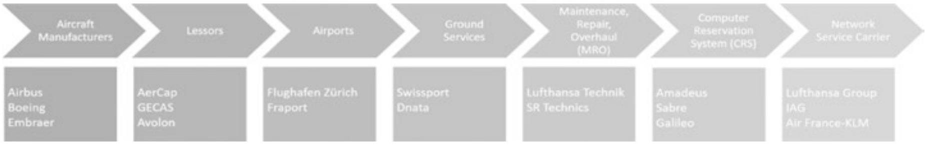
Like in any other industry the value chain in the aviation sector can be structured into different industries. Typically, the aviation value chain consists of the following industries (◘ Fig. 4.1):

- Manufacturers which produce aircraft
- Lessors which buy aircraft and lease them to the airlines
- Airports
- Airport ground services, such as catering, baggage handling services, etc.
- Computer reservation systems which organise distribution within the industry
- Travel agents representing the face of the aviation industry to the customers in the distribution system
- Freight forwarders to the customers in the airfreight sector
- Airlines which provide air flight services

This value chain can be illustrated in different forms (for example from the perspective of an airline as shown in ◘ Fig. 4.2). It seems clear that the central element of the value chain are the airlines, which provide, in form of passenger or freight services, the core product to the final customers.

The airline is the most important of the various actors in the aviation value chain because it functions as the integrator of all the products in the system. The

◘ **Fig. 4.1** Return on invested capital (ROIC) excluding goodwill in the period 2004–2011, by sector (McKinsey & Company (n.d.) as cited in IATA, 2020)



◘ **Fig. 4.2** The aviation service chain. (Author's own figure) airline buys all the other products in the supply chain and delivers them to the aviation industry customers.

The picture is quite different, however, if the return on capital investments in each sub-industry of the aviation systems value chain is analysed. In the long run, airlines always seem to be losing money – there are some exceptions like Southwest Airlines or Singapore Airlines, which can look back at a long history of profitability. However, service providers, such as computer reservation system providers or lessors, have much higher profit margins. Even some airports and service providers at the airports show a respectable profit which is due to their (regional) monopoly power. In the airport sector, there are pronounced barriers to new entrants. Especially in well developed markets, today, it is practically impossible to develop a new airport. The profitability of the aircraft manufacturers depends very much on the technology cycle. In times when new investments are undertaken profit rates tend to be smaller. This applies, for instance, to recent developments like the launch of new aircraft such as the Airbus A350, Boeing 747-8 or Boeing 787 Dreamliner.

For countries like Singapore or Dubai, in which aviation is strategically developed as an important element of the economy, an integrated view on the whole aviation value chain is taken. The aviation system is treated as an integrated entity. The local airport is very often developed according to the needs of the home carrier, e.g. the new airport in Dubai. Also, aviation clusters are developed. A cluster (or industrial district) (Scherer & Bieger, 2003) is a theoretical concept in regional economics. It describes a network of suppliers and institutions within value systems. Within a cluster, supplier-buyer-relations can be organised optimally and, even more importantly, mutual learning and competence development can take place (Scherer & Bieger, 2003). A similar concept in management science is the "business ecosystem" (Rencher, 2019) that describes the far-reaching ecosystem into different business areas and the supply or customer value chain in connection to aviation. If a cluster provides optimal conditions for mutual learning, a so-called learning region can develop (Florida, 1995). Singapore implements this strategy. It aims to provide a good development perspective for airline suppliers, maintenance companies and aviation service companies, e.g. by expanding the runway and terminal area for its maintenance- and service-orientated airport (Urban Redevelopment Authority, n.d.).

Mini Case: Singapore Changi's "The Jewel" and Terminal 5

By Andreas Wittmer and Christopher Siegrist

To further develop the country's aviation sector, Singapore's Changi Airport designed a new complex within the airport perimeter called "The Jewel." This extension provides an upgrade to convert the airport and Singapore itself into a lifestyle destination, featuring a wide range of shops, a cinema or even a jungle for passengers to discover during their layover in Singapore. The aim of this project is to mix industrial design with natural elements to create a tourist attraction in its own right for travellers flying in and out as well as through Singapore (Changi Airport, n.d.).

Furthermore, additional capacity needs to be built to strengthen the location and make it future proof. As such, the airport authorities are seeking to extend the airport with the world's largest terminal, the new Terminal 5, by 2030. This will involve building one main terminal and two satellite terminals to provide for more passenger capacity and aircraft parking. Furthermore, the military runway will be converted to civilian use, whilst being extended simultaneously. This would up the total number of runways to three and would facilitate the increase in aircraft movements.

Both projects demonstrate how countries like Singapore continuously develop their infrastructure to maintain a strategic advantage. The Jewel improves passenger experience for passengers travelling through the hub, whilst the planned terminal and runway extension act as an infrastructure upgrade to maintain the required capacity for the future.

4.3 The Development of the Most Important Elements in the Aviation Value Chain

4.3.1 Airlines – Swiss International Airlines as an Example

Taking a look at the development of Swiss International Airlines helps to understand how airlines in general often develop. It shows that the combination of technological advances and airline regulation combined with economic development provides an excellent explanatory pattern for the development of airlines like other network infrastructures. Understanding airline development is also the first step towards a deeper understanding of the development and dynamics of the whole aviation system.

Based on the Swiss Airline development case and its history of aviation in Switzerland and the example of Swissair some important success factors for airlines can be derived:

- Early adoption of new technologies. New technologies seem even more important in today's business environment considering ever rising fuel prices and emission, increasing noise sensitivity and fees and airspace and airport space limitations.
- Early adaptation to changes of the business model to the regulative environment. It is necessary to observe and forecast these changes, to develop scenarios for different regulatory regimes and to design strategies and adaptation processes even if they involve totally redesigning a company's business model. This is especially challenging in a dynamic industry which operates under regular impacts of external shocks.
- An operational basis of business, operational reliability and successful service and marketing are key to successfully develop an airline business. A solid base for business means also an appropriate anchor airport and home market.

4.3.2 Airports – Zurich Airport as an Example

Based on the case study of Zurich airport the following main success factors for the development of an airport can be derived:

- Early adaptation of the infrastructure to the needs of airlines and modern aircraft (e.g. the construction of a new gate to accommodate the A380 or provide infrastructures for new alternative fuels, etc.).
- A combined business model which takes maximum advantage of the traffic generated and the people attracted through retailing, but also through entertainment and service companies/activities.
- Strategic outsourcing of services. Airports are infrastructure providers and as such "landlords." In such a set-up it is important to ensure certain services in house to have the necessary impact on quality perception by business partners and air passengers.
- Safe and sound financing which allows to navigate through the cycle and to survive even difficult economic times.
- The proactive corporate affairs assure the acceptance and legitimacy of the airport in its environment and to avoid severe restrictions of its operation.
- A balanced business model with commercial revenues (in Zurich accounting for about 40% of total revenues).
- A good mix of carriers (with a strong home carrier but also a diversified structure of other carriers serving the airport).

4.3.3 Aircraft Manufacturers

Generally, aircraft manufactures rely heavily on suppliers, particularly regarding technological sensitive parts. This is for instance true with respect to airline engines (produced and supplied for example by General Electric, Rolls Royce or Pratt & Whitney), or aviation electronics, so called avionics, and cockpit equipment, like Honeywell (Rockwell Collins etc.). The previous paragraphs have illustrated that the main success factors for aircraft manufactures are:

- Reasonable and sustainable development which, on the one hand, involves the constant adaptation and implementation of new technologies, but on the other hand, avoids premature investments in new fields that are commercially not viable (many new aircraft developments were never economically successfully, like, in 1920 – in the early days of aviation – the big water plane Do X).
- Adoption of platform and family concepts which allow for efficient production and operation within the airline companies. Pilots can be used for several different aircrafts of the same family, which increases flexibility of airline operational planning and the number of staff needed.
- Good cooperation with the suppliers of technologically intensive components (Ecosystem). Supply chain management is centrally important also with respect to ensuring a constant production flow. Hence, oversight over suppliers' financial situation, business models and compliance is key for success and demanded by regulation.

Mini Case: Development of Swiss National Airline

By Andreas Wittmer and Christopher Siegrist

Like many other airlines, Swissair was the result of a merger of two start-up mini-airlines in the first years of aviation history. Ad Astra Aero, founded in 1919, and Balair Airlines, founded in 1925, merged to form a new company called Swissair in 1931 (von Schroeder, 2002). At that time, the company operated a fleet of two planes with piston-driven propeller engines. Later, regulations required for passenger aircrafts to have at least two engines which meant that a major investment in the fleet became necessary. Typical “milk-can flights” were operated during that time, e.g. from Zurich via Basel and Frankfurt to Amsterdam and later even to London. Aviation was still quite unreliable. The propeller airplanes departed from grass-strip airports and in most cases, airports did not even have designated runways, since the airplanes had to lift off straight into the wind because of their weak engines. Very often there was just a circular area at the airport to be used for landing and take-off. If there was fog, for landing the pilots opened the windows and listened to the bells of the airport. For a long time after passenger cabins had become enclosed pilots would continue their work in open cockpits.

The introduction of modern aircraft, which allowed winter operations and the operation of flights under reduced visibility, was a crucial development for airlines. As one of the first airlines Swissair bought US aircraft for this purpose and was one of the first to introduce the Douglas DC-2 and Douglas DC-3. Due to this technological supremacy the airline was able to gain market share and to operate relatively profitable.

After World War II, which almost completely stopped civil airline operation in Europe, the two drivers of aviation development, regulation and technical development, worked their magic. As a result of the preparation of post-war economic development in the Chicago Conference in 1944 the scheme for airline regulation with the eight traffic rights emerged (International Civil Aviation Organization Chicago Conference [ICAO]) (see also ▶ Chap. 11). Due to World War II, high investments in the development of aviation technology took place. Radar, night and instrumental flight systems, as well as land-based long-haul planes were developed. After World War II, many planes formerly used in the military were bought by airlines for use in civil aviation.

Swissair had a relatively good starting position after World War II. First of all, the airline could rely on an intact infrastructure with aircraft that were in serviceable condition. Second, thanks to the neutral position of Switzerland, it was very easy for Swissair to get traffic rights. For a long time, Swissair was one of the only European airlines flying to certain destinations. The first long-haul operation to New York took place on 2 May 1947.

After a short period of recovery, the countries affected by the war, especially the ones with an own aircraft industry, invested heavily in the development of their airlines. As a result, Swissair, being a relatively small company, had to compete with international airlines who profited from considerably larger financial backing. These companies introduced new generations of propeller-driven long-haul planes with advanced pressurised cabins, such as the Douglas DC-6 or the Lockheed

Constellation. For the first time Swissair had to ask for government aid. The Swiss government bought two Douglas DC-6B for use by the airline in 1951. Thanks to this technological boost, and the fact that Switzerland has been a neutral country, which made traffic rights very easy to come by, Swissair started to thrive by developing a unique and – for a relatively small country – quite extensive intercontinental network.

Towards the end of the 1950s, relatively large and advanced long-haul planes, like the Boeing 707 and the Douglas DC-8, were launched. Swissair ordered the Douglas DC-8 and introduced commercial jet services in 1960. Different factors supported the development of Swissair into one of the leading European airlines, including the company's sound financial situation, the good market position based on superior service, the fast adoption of new technology as well as the swift change from propeller to an all-jet fleet. In the early 1970s, the next major technological developments followed. The first wide-body airplane, the Boeing 747, was introduced and, as always, Swissair tried to take advantage of a "first-mover strategy." It bought two of these large airplanes and started wide-body services in 1971.

However, these latest technological developments had a major impact on the economics of aviation and consequently also on the regulative environment of the airline industry: The huge increase in seats offered – the previous generation of long-haul aircraft like the 707s had roughly 140 seats, the Boeing 747 now suddenly offered 400 seats – led to a rapid decrease in airfares. In order to fill their planes, airlines had to accept customers paying lower fares. Unfortunately, IATA regulation dictated the price for each route, and the airlines were unable to freely adjust their fares. Price regulation, on the one hand, provided the advantage that airline tickets were exchangeable between different companies because on a given route every airline offered the same price. It was, therefore, easy to transfer passengers between airlines. On the other hand, price regulation limited the possibility to use the price as a marketing instrument. Airlines became creative in order to circumvent this industry regulation. "Grey-market tickets" were introduced – tickets were sold in other markets at lower prices and were then re-imported in order to offer more competitive prices to customers (Yenckel, 1987). Due to this practice, prices fell slowly and steadily, and price regulations were eventually abolished. As a consequence of the increasing range of prices within a certain service category, there was a need for product differentiation. In the economy class there were passengers paying 800 or 900 US dollars for a transatlantic flight sitting right next to passengers paying 4000 and more US dollars. An innovation in the class system was needed. As a result, business class service, positioned between economy and traditional first class service, was introduced throughout more and more airlines. As a result of the introduction of wide-bodied aircraft, airlines had to rethink their marketing practices. They had to consider service, pricing and distribution again.

In the face of increasing globalisation, internationalisation and the need for cheap air transport, initiatives were launched to deregulate the sector. In 1978, the airline industry was fully deregulated in the United States. The European Union followed in 1983. Consequently, more and more intercontinental open sky agreements were signed, e.g. between the European Union and United States. These agreements led to increased competition between airlines. Airlines were no longer protected by air traffic rights. Also, new forms of airlines and business models, like the low-cost model, were introduced. Eventually, another transformation and consolidation happened: alliances were formed, later on mergers of whole airline systems took place and the differentiation of business models was introduced.

In the process of competing in an increasingly deregulated environment Swissair also had to redefine its strategy. As one of the first airlines it headed for a major breakthrough, a mega merger with KLM, SAS and Austrian Airlines in 1993. Due to political pressure in Switzerland and due to unresolved issues between the partners, the merger had to be abandoned (Ernst & Young, 2002). Swissair knew that a carrier of its size could not survive in a more loosely regulated market in which bigger carriers profit significantly from network effects. It decided therefore to embark on a "hunter strategy," which consisted of buying minority shares of other airlines and developing an own airline group through part-ownership and alliance mechanisms. This strategy, however, drained the financial and management resources of the company (Ernst & Young 2002). In the aftermath of 9/11/2001, the airline went bankrupt and operated under government protection and finances until end 31 March 2002.

Based on the legal structure of its former daughter Crossair a new airline was founded financed by the Swiss government, the canton and the Swiss Business world, Swiss International Airlines. The newly founded company was not able to survive in the very competitive environment in the post-regulation era. After severe losses, Swiss International Airlines was sold to Lufthansa in 2005; and it is now operated as a wholly owned subsidiary and as a member of Star Alliance. Lufthansa committed to maintaining Swiss as an independent brand with a hub in Zurich within the Lufthansa system and to taking advantage of access to Star Alliance traffic streams. This arrangement was among other instruments safeguarded by a special foundation with representatives of the government and the canton of Zurich.

Thanks to the flexibility of a newly founded airline, the access to a strong alliance, the operational synergies with a strong mother company and the strong business market of Switzerland, Swiss International Airlines flourished and was even able to be profitable in the economically very difficult years of 2008 and 2009. This growth and profit trend continued thereafter and Swiss has positioned itself as the premium carrier within the Lufthansa Group, as well as becoming "The Airline of Switzerland" (Swiss, n.d.). Through cabin refits, new aircraft types such as the Airbus A220 or the Boeing 777-300ER, Swiss has strived to maintain its competitiveness and premium product proposition (Lufthansa Group, 2019, pp. 45–46). With over 18m passengers a year and a fleet of 90 aircraft, the company posted a total operating revenue of over CHF 5bn in 2018, thus making it Switzerland's largest airline (Swiss, n.d.). However, the expansion also poses new challenges as cost reduction or capacity constraints at their main hub in Zurich (Voigt, 2019, p. 21).

Mini Case: Development of Zurich Airport over Time

By Andreas Wittmer and Christopher Siegrist

Zurich airport was opened in 1946 as the future national airport to enable easy access to Switzerland from all over the world. Its location was selected based on in-depth topographical studies. A relatively flat and remote area outside the town of Zurich was eventually chosen. At the time, it was very important to provide a runway system which allowed take-off and landing according to the prevailing wind directions.

The original runway system of Zurich airport comprised three runways, all leading in different directions. During the post-war era an airport was considered as a public infrastructure providing services necessary for aviation. Therefore Zurich Airport was owned and operated based on a federal concession by the canton of Zurich.

In 1960, a major expansion took place to prepare the airport for the jet age. The main runway was renewed and expanded to a length which allowed for safe landing and take-off of intercontinental jet planes. Operation of the airport still remained the same as did the capacity of its infrastructure. Another significant expansion took place in 1970. In that year, a third runway, which did not intersect with any other runway, was built. The expansion allowed for a considerable increase in aircraft movements, which was important, since the introduction of long-haul planes led to a substantial rise in traffic and “hubbing” became necessary. Consequently, the terminal structure needed to be enlarged as well. In short succession two terminal buildings were constructed.

Loop Mini Case: Runway Concept at Zurich Airport

Being a commercial airport, Zurich Airport operates on a concession by the Federal Department of Environment, Transport, Energy and Communications (DETEC). Based on the sectoral aviation infrastructure plan (SAIP) and the operations regulation, this concession outlines the goals and responsibilities that Zurich Airport and its operational concept have got to meet. It specifies that the airport has got to serve the needs of the Swiss business hub by meeting the demand for air travel and meeting the resulting operational requirements. These requirements are expressed in more detail, covering several aspects such as the number of aircraft movements per hour or the obligation to implement environmental protection measures (e.g. noise).

Accordingly, the airport authorities have created operational concepts in accordance with the conditions outlined in the SAIP and the concession. These operational concepts define the use the airport’s three runways, which are allocated to take-offs and landings depending on several factors. Each runway possesses two runway designators which are assigned according to their heading on the magnetic compass in degrees, whilst omitting the last digit. Using all the runways and their respective directions, the airport has derived three operational concepts: the North concept, the East concept and the South concept. Each of them is used according to several variables such as time of the day, wind or public holidays in Switzerland and

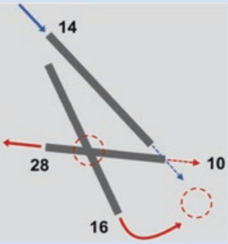
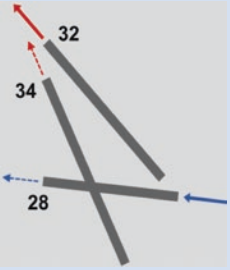
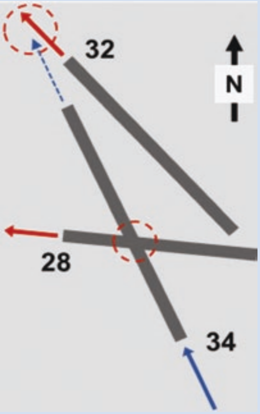
Southern Germany. Whilst each concept allows take-offs and landings, the aircraft movement capacity varies considerably between each one of them due to available runway length, intersecting runways and/or political reasons. An overview of each concept can be found in ▣ Table 4.1.

Looking at the illustrations of each concept, the take-offs (red) and landings (blue) rotate between the concepts. The dashed line arrows show potential flight paths such as occasional take-offs or aborted landings; often leading to so-called "hot spots," which are shown using red dashed circles. Such hot spots can greatly affect the aircraft movements per hour by creating a bottleneck for traffic. As an example, in the North concept hot spots can be found at the intersection of runway 28 and runway 16, preventing simultaneous take-offs from both runways. Furthermore, due to noise abatement procedures, take-offs from runway 16 need to perform a left turn right after take-off which can cause a collision, should a landing aircraft on runway 14 abort their landing and continue straight ahead. This means that a

▣ **Table 4.1** The runway usage concept at Zurich Airport (Zurich Airport, 2019)

North concept	East concept	South concept
Description Landings from the North Take-offs direction West Take-offs direction South with a turn to the East During bise: Ttake-offs direction East	**Description** Landings from the East Take-offs direction North	**Description** Landings from the South Take-offs direction North and West
Runway usage Landing: Runways 14 and 16 Take-off: Runways 28 and 16 Runway 10 (only during bise)	**Runway usage** Landing: Runway 28 Take-off: Runway 32 (and occasionally 34)	**Runway usage** Landing: Runway 34 Take-off: Runways 32 and 34, occasionally runway 28
Operational hours 07.00–21.00: Mon to Fri09.00–20.00: Sat, Sun and public holidays in Baden-Württemberg	**Operational hours** 21.00–23.30: Mon to Fri 20.00–23.30: Sat, Sun and public holidays in Baden-Württemberg Also used during westerly winds	**Operational hours** 06.00–07.00: Mon to Fri 06.00–09.00: Sat, Sun and public holidays in Baden-Württemberg Also used if the East concept cannot be used in the evenings due to weather (bise, bad visibility etc.) or if neither the North or East concept can be used during the daytime.

Table 4.1 (continued)

North concept	East concept	South concept
Current capacity Approx. 66 movements per hour During bise approx. 44 movements per hour	**Current capacity** Approx. 60 movements per hour	**Current capacity** Approx. 50 movements per hour
		

take-off from runway 16 cannot be performed whilst a landing on runway 14 is imminent. The demonstration of these concepts illustrates how the current political environment creates a challenging situation for Zurich Airport to operate in. Whilst they need to meet the demand for air travel (70 movements per hour according to the SAIP), their concession imposes noise regulations that prohibit them from meeting their movements target. This leads to a reduced capacity when the East or South concepts are in use or the bise (northeastern) wind is blowing, thus causing considerable delays. This severely limits the future growth potential of Switzerland's main hub; therefore, the airport needs to engage with politicians to find a solution, which improves the concept and increases the total amount of aircraft movements per hour. (Source: Zurich Airport, 2019)

Due to the growth of traffic and the increasing importance of "hubbing" and transfer passengers, terminal space had to be expanded continuously (▪ Figs. 4.3 and 4.4). Runway capacity could be expanded thanks to new electronic navigation equipment and increased efficiency of air traffic control. In the year 2000, another terminal building – Dock E – was opened and the runway capacity was increased through a new taxiway system. At that time, a major source of income for the airport was

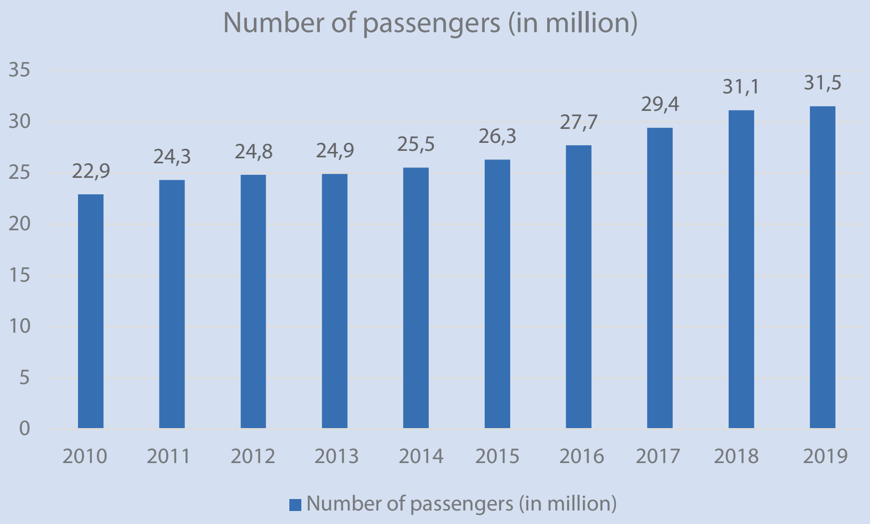


Fig. 4.3 Total passengers (2010–2019). (Author's own figure based on Zurich Airport, 2020)

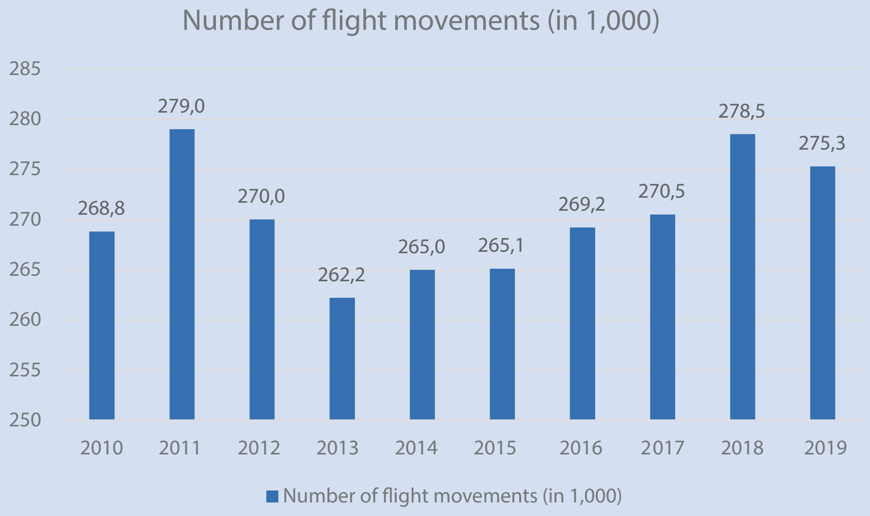


Fig. 4.4 Total movements (2009–2018). (Author's own figure based on Zurich Airport, 2020)

already retail trade (i.e. parking fees and ancillary revenues from conference services, etc.). The financing of the new terminal infrastructure was mainly based on predicted revenues from non-flight-related income sources like revenues from retailing.

Due to the impacts on the aviation industry caused by the terrorist attack in New York on September 11, 2001 and due to the bankruptcy of the home carrier Swissair, Zurich Airport suffered a significant decline in the total number of its passengers as well as traffic movements. This development hit the airport right at the time when it was financially very vulnerable because it had made major investments during the latest expansion step.

The airport was privatised on 1 April 2000 as a listed company with majority shareholders Canton of Zurich and City of Zurich.

Today, witnessing the excellent development of Swiss International Airlines as the new home carrier within the Lufthansa system, the airport faces capacity limitations again. The main approach route to the airport leads over German territory. As the German and the Swiss governments could not agree on a treaty regulating traffic procedures, Germany unilaterally imposed restrictions on the times when aircraft may approach from the main corridor over its territory. All other approach routes lead over densely populated areas where, according to noise abatement laws, significant restrictions apply. Based on the current scheme the noise emission is evaluated by use of the “ZFI” (Zürcher Fluglärm-Index) instrument, an index which considers the total number of people suffering from a certain level of noise (AfV, 2008). The maximum level of politically accepted impact will soon be reached. For the future expansion of the airport, it will be crucial to solve the noise issue or to define the politically acceptable and sustainable noise level based on an efficient approach and departure system for the planes. At the moment, the planes of home carrier Swiss International Airlines burn a vast amount of unnecessary flight hours because the flight path regulations are so complex (see mini case). Despite the complex regulatory frames and the restrained capacity, Zurich Airport has heavily invested in its infrastructure, to meet growing passenger numbers. This included certifying and re-adapting the airport for Airbus A380 operations, thus allowing Singapore Airlines and later Emirates to launch A380 operations, bringing more passengers to Zurich Airport. Furthermore, the renovation and re-opening of Dock B took place, thus allowing the airport to handle Schengen and non-Schengen traffic within the same terminal. This was closely followed by various projects to improve the connectivity in terms of public transport, which accounts for 44% of all passengers, employees and visitors arriving at the airport. But also, outside the airfield operations “The Circle,” a new real-estate project at Zurich Airport, has started construction offering office spaces, hotels, restaurants, etc. to increase the airport’s attractiveness. Whilst the airport is still growing in terms of passenger numbers, the Flughafen Zürich AG has also started investing and running several airports in South America to diversify their portfolio (Zurich Airport, n.d.). Evidently, Zurich Airport is continually striving to improve the airport’s capacity and proposition. However, it is only a matter of time before the regulatory framework will have to be changed to accommodate further growth at Switzerland’s main hub.

Case: Aircraft Manufacturers

By Andreas Wittmer and Christopher Siegrist

Aircraft manufacturing is dominated by two main suppliers, Airbus and Boeing. In addition, there are successful producers catering for the regional segment, such as Embraer and Bombardier. New suppliers have emerged in China (COMAC – Commercial Aircraft Corporation of China) and Russia (Sukhoi, also catering for the regional market).

Taking a look at the history of aircraft manufacturing it seems clear that every time a new technology generation is introduced, consolidation of the industry takes place. With the emergence of reliable short-haul airliners and navigation systems, Douglas, with its aircrafts DC-2 and DC-3, as well as Junkers, with the Ju 52, achieved a leading position (Fecker, 2005). After World War II, the US market was dominated by Douglas Aircraft Company and Lockheed with its successful model – the Constellation. The launch of new turboprop and jet aircraft opened up opportunities for new companies, for instance, Convair in the United States or Yakovlev in the Soviet Union.

The introduction of wide-bodied aircraft changed the market pattern again and led to further consolidation of the industry. Lockheed, producing the L-1011 Tristar, overestimated the market for wide bodies and eventually had to exit the market for civilian aircraft. McDonnell Douglas, producing the DC-10 and later the MD-11, also reached its limits leaving Boeing as the sole US producer for commercial aircraft.

In Europe, aircraft production was for a long time quite nationalised and heavily supported by governments. Especially in France and in Great Britain, innovative aircraft producers launched new categories of planes. De Havilland introduced the first commercial jet plane, the Comet. Aerospatiale launched the Caravelle, one of the first commercially successful short to medium range jet planes. Together the British and French industries developed the only commercially operated supersonic aircraft – the Concorde – which operated until 2003. In 1970, Airbus Industries, a consortium of two countries, was founded. It produced its first commercial aircraft, the A300, in 1972. Thanks to superior flight management technology, which allowed a two-man cockpit, and a consequent "family concept" of airplanes, Airbus managed to become a formidable competitor to Boeing (▣ Table 4.2). It was strategically important for Europe to be able to produce their own commercial aircrafts in a more and more global society, where global business become important for local economic development around the world. A dependency on US air plane producers would have been an issue of dependency in a global competitive environment. The same happens in China with Comac Aviation, which needs to ensure that China as a powerful region in the world keeps its independence with global connectivity.

Airbus continued to challenge Boeing even in its last dominion – the market for very large wide-bodied aircraft – with the introduction of the A380, which is the biggest aircraft in regular passenger service to date. As discussed, technological development, especially the introduction of new generations of aircraft, strongly affects the economic and regulative environments of the aviation system. Cheap and efficient regional airplanes have changed the industry. The introduction of the wide

Table 4.2 Commercial aircraft manufacturers

Rank	Company	Revenue ($m) 2018	Revenue($m) 2017	Deliveries (units) 2018	Deliveries (units) 2017
1	Boeing	60,715	58,014	808	763
2	Airbus (excl. ATR)	47,970	43,486	800	718
3	Gulfstream	8455	8129	121	120
4	Bombardier (incl. business jets)	6750[a]	7250	185	194
5	Textron Aviation	4971	4686	374	335
6	Embraer (incl. business jets)	3489	4055	181	210
7	Dassault Falcon	2600[b]	3000[b]	41	49
8	ATR	1498	1600	76	78

Table compiled by author, based on data from: Airbus (2019), Boeing (2019), General Dynamics (2019), Bombardier (2019), Textron (2019), Embraer (2019), Dassault Aviation (2019)

[a] The C-Series programme was transferred to Airbus on 1 July 2018

[b] Net sales in $m due to different accounting standards

bodies prompted the foundation of new business models based on “hubbing,” and besides affecting airlines it also influenced the development of airports, since new infrastructure was required.

4.4 The Link to the Aviation System

The value chain can be seen as the core of the aviation system (► Chaps. 2 and 3). It is often also referred to as the value system as it is partly rather organised as a network of connected suppliers or supply network which meets a demand system. In the following paragraphs, important aspects of the interdependencies in within this system are going to be discussed:

Co-contribution, co-research and development as well as co-production are enabled by the aviation ecosystem. This is of special importance in the field of aircraft manufacturing. So-called OEMs (original equipment manufacturer) are providers to, e.g. Airbus, producing equipment Airbus uses when assembling their planes (◘ Fig. 4.5).

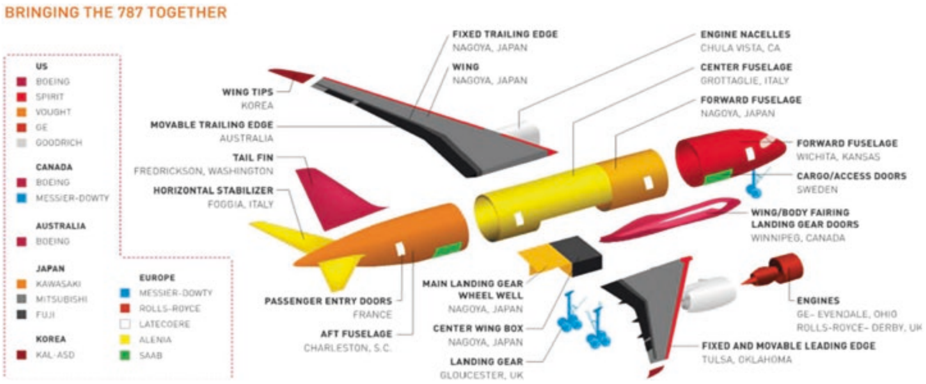


Fig. 4.5 The different parts listed by supplier and their origins (The Boeing Company)

Aircraft manufacturers drive the development of airlines by providing them with new technologies; They have got to fulfil the needs of the airlines. Additionally, aircraft manufacturers also shape the development of airports, since the introduction of a new generation of aircrafts necessitates new standards of operation. The aircraft manufacturers are heavily influenced by technological development and in this context also by the cooperation with their suppliers for engines, avionics, etc.

The development of airlines is enabled or restricted by airport infrastructure. For their part, airports respond to the needs of airlines and live off the traffic generated. Airports are typically facing a two-sided market (airlines and passengers) (for the concept of two-sided markets see Roth & Oliveria Sotomayor, 1995).

Furthermore, airports are rooted in the local environment. One of their key success factors and core competences is to manage the regional network successfully and to gain legitimacy for their operation. It is, therefore, questionable whether it makes sense for an airport to expand to other locations by buying subsidiaries in form of other airports. It can be expected that an airport, when expanding to other locations, gains bargaining power with respect to service providers, such as ground services, through cross-site synergies. Also, operational know-how might be transferred from one location to the other. However, such know-how could also be bought from consultants and service providers and bargaining power could be achieved through cooperation. It is uncertain whether knowledge about managing a local system, corporate affairs or political lobbying can seamlessly be transferred to other places, since it is very unlikely for airport management to encounter a similar culture and political system in another place.

As mentioned in ▶ Chaps. 1 and 2, the inner part of the aviation system consists of three main elements: airlines, airports and aircraft manufacturers which are all closely linked to technology providers, customers and the local environment. This inner system is surrounded by and connected with the political/legal, social, economic, technical and ecological environments (Fig. 4.6).

Aviation, in turn, has a great impact on politics in areas with high numbers of flights. In many regions around airports, issues about noise emissions or flight regulations are important political topics. As a result, aviation regulation has two

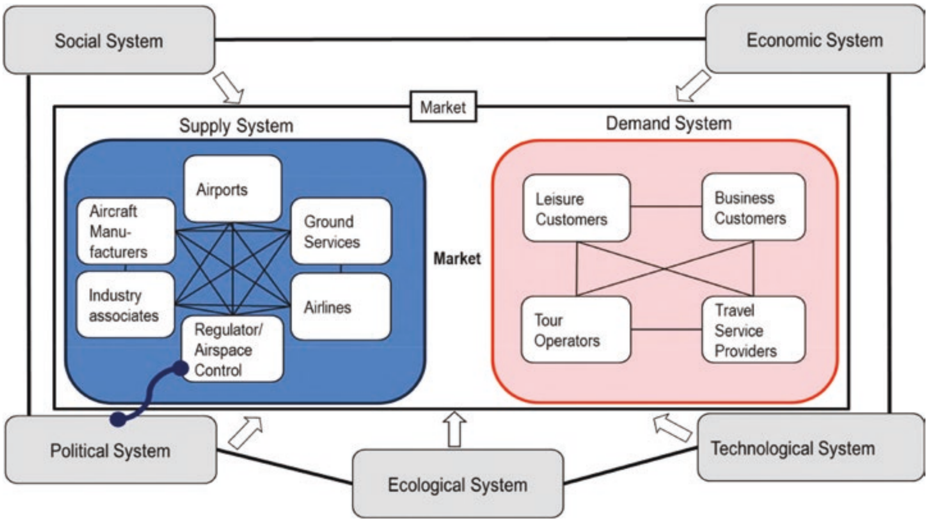


Fig. 4.6 The aviation system. (Author's own figure)

main priorities in many places: first, to assure the highest possible level of safety for commercial aviation and second, to protect the community from the negative externalities of aviation. However, policymakers should not neglect aviation as it can be an important driver of development for a particular location.

Review Questions

- Which are the most profitable sub-industries within the aviation value chain?
- Why are these sub-industries more profitable than airlines? What was the role of air traffic regulations in the development of airlines' profitability?
- What are the most important strategic success factors of airports, airlines and aircraft manufacturers?
- What are the most important interrelations within the aviation system between the different sub-industries?

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Airline Strategy – From Network Management to Business Models

Andreas Wittmer and Thomas Bieger

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Airline Strategy – From Network Management to Business Models

Summary

- The only protectable strategic resources of an airline are the brand, the customer basis and the position at a hub.
- The core of airline operations is networks and therefore network management.
- Different strategies rely on a different extent of network effects.
- The use of network effects also differentiates business models.
- Different types of planes lead to different concepts of airlines.

The core product of all airlines is rather homogenous as in selling a seat on a flight between two airports. Therefore, the only protectable strategic resources of an airline are its brand, the customer basis and its position at a hub airport. The core of its operations is shaped by its network meaning that network management is crucial. This chapter shows the different strategies as well as their typologies including point-to-point or hub-and-and-spoke. The different strategies mainly rely on network effects and are shaped by many variables. These can also be complemented by cooperation such as alliances or codeshares. Furthermore, the application of network effects creates additional value for customers which helps differentiate business models and in turn shapes the different airlines' concepts.

5.1 Introduction

The airline sector has a reputation of not being very profitable and vulnerable towards external impacts. Over time, some years with profits followed years of losses due to a strong dependency of airlines on economic development and impacts of technological progress. Since the airline sector is a commodity market, where margins are small, this is still the case. Therefore, airline managers need to look for strategies, which allow them to become more efficient, mostly by applying economies of scale either through the size of their own company or by cooperating with other airlines in networks or alliances. Networks allow to operate more efficiently and to realise net effects in bigger entities. They have an impact on the choice of airline business models which influence the profit margin and the airplane concept of an airline.

Firstly, this chapter briefly highlights the developments in aviation strategy and shows some airline strategy approaches. Secondly, it introduces the reader to network management of airline operations by defining airline net economies, the main variables of airline network design and network management processes. Thirdly, airline business models and the different concepts behind them are described.

Introductory Case: Austrian Airlines

By Andreas Wittmer and Christopher Siegrist

Austrian Airlines was founded in 1957 ("Österreichische Luftverkehrs AG"). After many years of cooperation with SAS and Swissair, which even led to a first strategic alliance – the so-called Qualiflyer group in the 1990s – Austrian Airlines joined the Star Alliance in 2000. At first it did well as an independent Airline and member of the Star Alliance. But after 2004 it turned bad. After years of losses, including a record loss of EUR 430 million in 2008, Austrian Airlines were taken over by the Lufthansa Group in 2009. The takeover posed the beginning of a successful restructuring process with a restructuring assistance of EUR 500 million granted by the European Commission. This led to product improvements and lowering the cost base, e.g. by reducing the variety of aircraft in their fleet.

Austrian Airlines operates a limited number of intercontinental connections with a comparably high share of tourist traffic which it inherited with the acquisition of the former charter carrier Lauda Air in 2004. The network focuses on links to Central and Eastern European countries. Today, the airline offers services to an impressive variety of destinations in Eastern Europe and Central Europe (▣ Fig. 5.1). At its Vienna hub, Austrian Airlines operates with a fleet of 83 aircraft to over 130 destinations, with over 35 destinations in Central and Eastern Europe providing a dense network.

Austrian Airlines has made substantial investments in its product. The Business Class is known for its top cuisine. Austrian outlines in its mission statement that their focus lies in connecting East and West through their centrally located hub in Vienna. This implies a short-haul hub between Eastern and Western Europe, which from a network strategy perspective is questionable. From a customer perspective, the airline states following credo:

- Technical reliability, punctuality and an orientation to service
- "We carry Austria in our hearts, and ever more customers into the world"
- Huge personal commitment every day by its employees

The network faced several difficulties in the past decade. With the restructuring programme taking place, Austrian Airlines' network was cut down to a handful of destinations in Asia and North America. Furthermore, with Austrian Airlines being part of the Lufthansa Group, Zurich was developed as the third intercontinental hub within the group, thus weakening Vienna's position. The long-time challenge facing Austrian Airlines' East-West network strategy in combination with the rapid expansion of low-cost carriers at Vienna airport and nearby Bratislava airport. Especially the market entry of Wizzair is challenging Austrian Airlines. Being an Eastern European low-cost carrier, Wizzair offers cheap flights between Western, Central and Eastern Europe, a strategy that Austrian Airlines has been pursuing. But also, the entry of RyanAir by taking over FlyNicki and especially the European base of Easy Jet in Vienna, made Vienna to become an airport dominated by low-cost carriers, although the airport provides a high level of service in a modern environment enabling fast connection times for the hub carrier.

The new competition is going to create a three-fold increase in seats offered from Vienna of seven million by 2020. Furthermore, Austrian Airlines is going to face low-cost competition on 60% of its routes. This has prompted Austrian to through a further phase of streamlining its operations, with staff numbers being reduced and the fleet further streamlined to remain competitive against the new threat.

Austrian Airlines business model focusing on being a connector between West and East has not worked, as Austrian early on focused on connection West and East Europe, instead of focusing on becoming a leading connector of Europe to Far East. The above-mentioned aggressive low-cost carriers took their core business, which could not have a very profitable one in any case, as stop-overs on the short-haul market are expensive and under high price pressure.

(Austrian Airlines, n.d.; Benz, 2019)

Questions:

Why did Austrian run into troubles in the mid-2000s, while Swiss recovered from the grounding?

How do you evaluate the network of Austrian Airlines?

What is the challenge with the East-West connecting model?

Fig. 5.1 **Route map of Austrian Airlines** (routes covered by Austrian Airlines: grey connection; code share routes: white connections) (Source: ► www.austrian.com)

5.2 Foundation of Aviation Strategies

Due to the strong regulation of the air transport industry, carriers, for a long time, rarely had the need to be concerned with competitive strategy. As barriers to entry and exit were high and competitors relatively weak, until the late 1970s, the level of airline competition was relatively low or non-existent. It was not until the US airline deregulation act in 1978, that new entrants entered the market, challenged the status quo and gave rise to "competitive structures" in aviation. Immediately after deregulation, new airlines with significantly lower costs – largely driven by low-cost non-union labour and the wide availability of inexpensive second-hand aircraft – entered the formerly regulated high volume point-to-point markets of the established carriers. However, the established airlines were largely able to capitalise on their size and responded with a full range of innovative strategies. They set up frequent flyer programmes (FFP) and exploited computer reservation systems (CRS). The most important strategic development was the adoption of the hub-and-spoke network which allowed the airlines to dramatically reduce the number of flights required whilst still being able to provide universal coverage throughout their networks. This in turn reduced airline costs, which were passed on to the consumers in the form of lower fares.

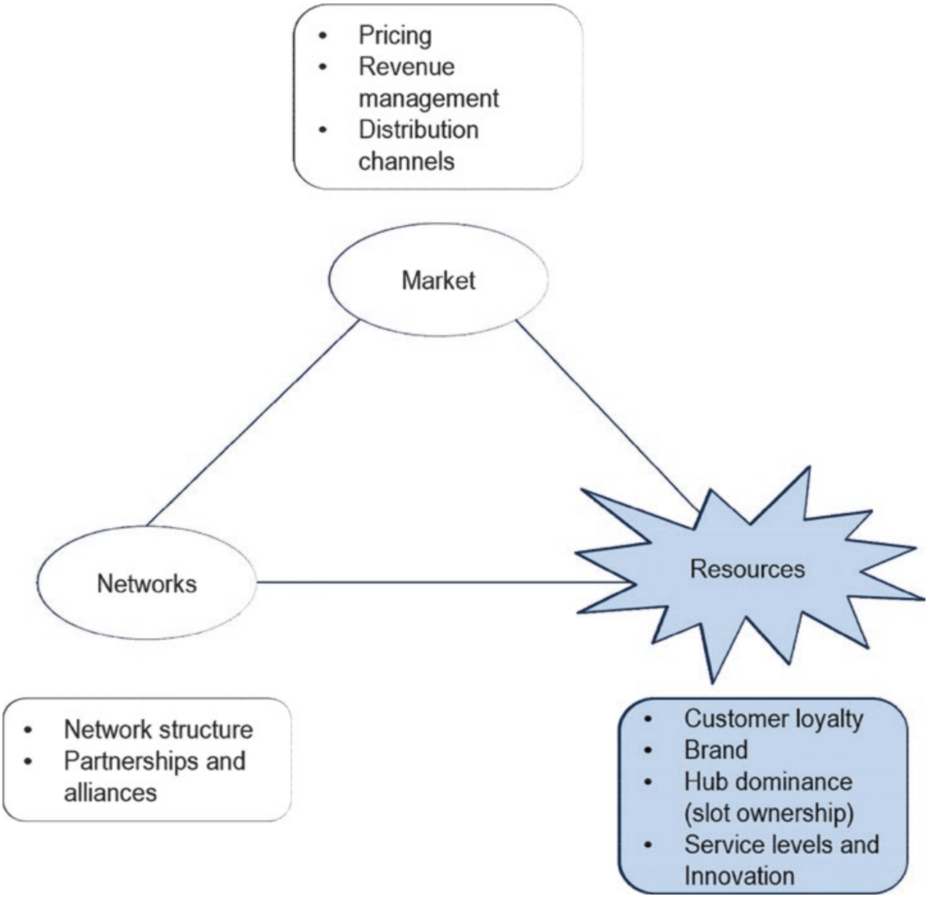
20 years after the industry deregulation began in the USA, deregulation of airline markets has been replicated in Europe and another 10 years later in many regions around the world. The airline industry has become increasingly global in its orientation and scope and much more competitive. As a consequence, all players in the industry are increasingly searching for answers on how to maintain their position in competition. Apart from the approaches introduced before (frequent flyer programmes, customer reservation system and network management), other fields of strategic orientation that have recently gained importance are the development of strategic alliances and customer relationship management.

Since the air transportation industry still is not fully deregulated, strategic management issues – including the range of strategic choices – are subject to a number of limitations which prevent the industry from developing like other industries. Mergers & Acquisitions (M&A), for example, remain a politically sensitive matter. Contrary to other markets such as telecommunication, car manufacturing or shipping, in which internationally organised enterprises develop, cross-border or global mergers and acquisitions are still limited in the aviation industry. Furthermore, the industry is often not able to act completely independently from its respective governments. While on the one hand this leads to a certain protection of individual actors, on the other hand it may limit the independence of the industry players and the range of strategic choices and ultimately harm other airlines. For instance, agreements on the number and destinations of cross-border flights can still be defined by governments in bilateral air agreements. Very often governments take positions contrary to free market beliefs whenever these are deemed to be against their national interests, thus strongly limiting competition.

5.3 Airline Strategy Approaches

Today, the airline industry is highly competitive and the various industry players constantly strive to build up and maintain a competitive advantage. Strategies can be static or dynamic. Static strategies focus on protecting existing market positions in which the brand and hub dominance play important roles. Dynamic strategies focus on market development and move forward through learning and building up of a knowledge database (e.g. about customers, markets, etc.).

Porter (1996) states that airline "strategy involves a whole system of activities, not a collection of parts. Its [the airlines'] competitive advantage comes from the way its activities fit and reinforce one another". While this quotation illustrates that airline strategy cannot be reduced to single elements but is rather a combination of three fields with several factors. They can be built on the basis of market advantages, advantages in networks and advantages with regard to resources (◘ Fig. 5.2).



◘ **Fig. 5.2** Fields of strategic advantages (author's own figure)

Network

Network structure: A network can be defined as a collection of nodes and edges (Wojahn, 2008). Airline networks generally consist of air traffic connections (edges) from one airport to another (nodes). Major characteristics that specify air traffic networks are parameters such as size, frequency and connectivity. Airline network management has important links to service attributes such as punctuality and geographical coverage. There are two basic strategies concerning the outlay of a network in air transportation: a hub-and-spoke system (single-hub or multi-hub) and a point-to-point network. Airlines that operate the former try to offer a high connectivity and many different O&D (Origin & Destination) connections. Carriers thereby build on economies of scale, scope and density that are inherent to large networks. The hub-and-spoke strategy builds on the concentration of air traffic through the hub. In general, it is possible to pursue both a multi-hub network strategy and a single-hub strategy. In any case, the concentration of airlines on hub operations leads to a situation in which individual airports often are dominated by a single airline. As a consequence, these airlines frequently control a high number of slots at individual airports. With these valuable resources they are able to build up strong hub entrance barriers. At many airports, big international flag carriers control most slots, and by not selling the latter, these flag carriers are able to maintain control over the access to the hub. In contrast, point-to-point traffic relies on strong and stable individual markets which allow for filling up the planes without feeding traffic. These networks can be operated with a much lower degree of complexity. The opening or closure of point-to-point traffic does not affect the overall network structure.

Partnerships and alliances: Given the strong limitations to M&A activities in the international airline industry, Stoll (2004) states that “the formation of alliances fundamentally reflects the airline industry’s efforts to develop its global network-based structure within the limits imposed by government regulations”. In recent years, with the trend moving towards an increasing globalisation of the airline industry, the formation of airline alliances has gathered momentum as a means to remain competitive and to gain access to a global market which is too large to be dominated by any existing airline. Today, most major airlines are involved in alliance. The three big alliances – Star Alliance, oneworld and SkyTeam – contain almost three-quarters of the worldwide scheduled air traffic (73.1 per cent as of December 2008). Besides the revenue-generating functions of alliances such as code-sharing and selling seats on each other’s flights, many alliances include service elements like mutual access to airport lounges, pooling of frequent flyer programmes and joint marketing and thus share costs.

Mini Case: Pan Am

By Andreas Wittmer and Christopher Siegrist

Pan American World Airways (short: Pan Am) was once the USA’s largest international airline, operating international flights across the globe. Initially, it was founded in 1927 and started its first flights between Key West, Florida and Cuba.

Throughout the years, it gradually expanded its international services to include South America and first transatlantic services to Europe. Later, transpacific flights to Japan, and beyond South East Asia, complemented its intercontinental route portfolio.

Whilst the airline had built an extensive intercontinental network, it hadn't built its own domestic network in the USA. As such, it sought to build its own network or acquire domestic US carriers like American Airlines. However, such undertakings were blocked by the authorities which were approached by other airlines expressing their fears over Pan Am using its monopoly to dominate the domestic market.

To cater to their transcontinental network, Pan Am had accumulated a sizeable fleet of Boeing 747s. When the oil crisis in 1973 unrolled, the demand for air travel sank internationally. Resultingly, Pan Am suffered from overcapacity with their fleet of Boeing 747s. Due to the lack of a domestic network, Pan Am were unable to reallocate the overcapacity on domestic routes. The following losses were further exacerbated by the deregulation in the USA, which opened international routes to all American carriers. This led to increased competition for Pan Am, further worsening its economic condition. Despite restructuring and attempts to build a feeder network, Pan Am failed to return to profit and eventually ceased operations in 1991. The assets were then taken over by Delta Airlines.

Mini Case: Qantas and Emirates

By Andreas Wittmer and Christopher Siegrist

Qantas was founded as the Queensland and Northern Territory Aerial Service (QANTAS) in 1920, operating regional flights within Queensland. Throughout the 20s, it grew by increasing its domestic flights and starting to operate a flying doctor service. In 1935, the first overseas flights to Singapore followed. This network eventually expanded to the Middle East, where flights connected with the British airline BOAC to London. With the advent of the jet-age, Qantas expanded outside the British Empire and continuously grew its network, eventually to Europe and the USA.

In 2004, Qantas faced increasing pressure in the Australian market from low-cost carriers Virgin Blue and TigerAir. This led to the airline launching its own low-cost subsidiary Jetstar to compete. On the so-called "Kangaroo route" between Australia and the Europe, Qantas also started experiencing strong competition from Asian and Middle Eastern carriers, resulting in increasing losses. To maintain its foothold in this market, Qantas entered a partnership with Emirates in 2013. This saw Emirates and Qantas offering improved connections between Australia and Europe by Qantas redirecting flights through Dubai, which offered passengers more connections to European destinations.

This partnership has proved successful and in 2015 Qantas returned to profit, posting a profit of USD 557 m. The partnership has proven successful so that Qantas and Emirates have extended their initial partnership until 2023 and streamlined their route networks.

Resources

Brand image: Brands serve for the identification and positioning of usually rather homogenous service products. By serving as an element of trust and orientation they help to reduce the risk perceived by customers. In general, it takes several years or even decades to build up a positive brand image. Once a brand is associated with positive attributes such as quality and reliability it may represent an important asset for airlines which can be capitalised on, for example, in the form of price premiums.

Service level and service innovation: The service product of an airline consists of a wide range of different service attributes. These comprise services on the ground (such as lounge access) and in the air (such as in-flight amenities and meals). Even though, in general, services are highly cost intensive, they allow for skimming a price premium and for a differentiation from competition and by this creating customer perceived barriers. An airlines capability to know service needs of their customers is a unique advantage. It leads to constant service innovation and the development of new services. Service innovation and introduction instead of unbundling services by copying competitors is creating strategic advantage and keeps the airline being a first mover.

Mini Case: Singapore Airlines as a First Mover

By Andreas Wittmer and Christopher Siegrist

Singapore Airlines has for many years been at the forefront of airline rankings such as Skytrax (Skytrax, 2019). The airline is best known for its Singapore Girl icon, a symbolic Singapore Airlines stewardess, which epitomises the carrier's high standards of service and customer care. As a result, new recruits undergo very rigorous cabin crew training and need to adhere to strict standards onboard to provide outstanding service.

However, Singapore Airlines' reputation stretches far beyond the excellent onboard service provided. The airline is also known for being a first mover by innovating service and the onboard product to distinguish itself from competitors. One example is the Suites which were introduced alongside the Airbus A380's entry into service and are exclusive to that aircraft type. The designer suite encompasses lie-flat seats which are enclosed by walls and offer maximum comfort. An advantage of the suites is the possibility of combining the two middle suites into one suite, thus allowing for a double bed to be set up. This was novel for a commercial aircraft and allowed couples to have a luxurious and personal journey onboard. Competitors only recently followed, e.g. Qatar Airways introduced their Qsuite which offers similar features.

Another innovation in terms of onboard service is the "book the cook" programme. The programme is available to first, business and premium economy passengers. It allows the passengers to select their main course of choice up to 24 h before departure (Singapore Airlines, n.d.-a). The menu varies by departure airport and features regional dishes too. A passenger travelling from Zurich can even choose to have an OLMA Bratwurst or "Zürich Geschnetzeltes" (sliced veal) (Singapore

Airlines, n.d.-b). This presents another innovation, providing an even more individualised service for passengers.

This is only a small selection of small innovations that Singapore Airlines have implemented as part of their first mover strategy. This has allowed them to maintain their high brand reputation and thus distinguish themselves from competitors.

Customer loyalty and relationship management: Customer loyalty does not only lead to more frequent purchases, but also has important side effects like word of mouth and reduced-price sensitivity. As the acquisition of new customers is expensive, airlines put a strong focus on the retention of existing customers. An important element of customer relationship management is the operation of reward systems. Frequent flyer programmes [FFPs] in particular represent a mechanism that allows transforming monetary value into a new "currency" which – due to its reduced transparency but increased prestige – has a higher perceived value for the customer than a pure financial reward. There are two kinds of points passengers can collect: (1) Reward points, which can be used to upgrade flights or buy a product in the airlines' shop offer. (2) Status points which allow passengers to be listed into different status levels (e.g. blue, silver, gold and platinum), which allow status holders to receive different services or service levels. While this non-monetary award leads to an increased customer value, the associated status systems also allow differentiating customers and providing them with personally identifiable services. By this, FFP can be used as effective market entry barriers.

Mini Case: Comparison of Major Airline Alliances 2019

By Andreas Wittmer and Christopher Siegrist

Star Alliance

Star Alliance is the world's largest global airline alliance. It was founded in 1997 by Air Canada, Lufthansa, Scandinavian Airlines, Thai Airways and United Airlines. New members have since joined the alliance, and 28 member carriers currently operate at over 1300 different airports within 193 countries. Star Alliance categorises its frequent flyer customers into silver, gold and (depending on the issuing airline) platinum or honorary status tiers. This is in addition to the status level that is held with an individual airline's FFP.

Star Alliance Silver Status: After reaching the premium level of one of the different airline members, the frequent flyer receives Star Alliance Silver status. This status includes a priority waitlisting and a guaranteed seat reservation if a place becomes available on a fully booked flight. Passengers also have priority standby on the next scheduled flight in the event of missing their original flight.

Star Alliance Gold Status: Gold status cardholders receive the same benefits as the Silver status members plus five additional benefits. The cardholder receives access to all Star Alliance airport lounges worldwide, regardless of the class of travel. Priority check-in is permitted at all airports and cardholders receive priority boarding and an additional 20 kg baggage. Bags belonging to Gold card members get priority handling and are among the first to be unloaded.

Oneworld

The oneworld alliance was founded in 1999 by American Airlines, British Airways, Cathay Pacific, Canadian Airlines and Qantas. It has 13 airlines and 30 affiliated partners who collectively serve over 1100 destinations in 180 countries. Oneworld offers different tier benefits to its customers. Oneworld member airlines work together to deliver a superior, seamless travel experience consistently, with special privileges and rewards for frequent flyers, including earning and redeeming miles and points across the entire alliance network. Some of the status benefits are intangible, unlike direct discount schemes such as mileage points:

Oneworld Ruby Privileges: The lowest tier status is awarded when a customer reaches the first premium level of a members' FFP. In addition to the benefits afforded by the member airline, three oneworld privileges exist. These are access to business class priority check-in; preferred or pre-reserved seating; and priority standby on fully booked flights.

Oneworld Sapphire Privileges: A Sapphire member receives Ruby benefits plus additional privileges. Sapphire members can access business class lounges at every airport, even if they are flying in economy class, and they receive priority boarding and an additional baggage allowance.

Oneworld Emerald Privileges: The benefits in the Emerald tier status include those of the Ruby and Sapphire levels and two additional privileges. If first-class lounges are available at an airport, cardholders may use them regardless of the class they are flying in. Emerald status cardholders are permitted to check-in at the first-class priority check-in desks, can access fast-track security lanes and receive an additional baggage allowance.

SkyTeam

SkyTeam was formed in June 2000 by Aeroméxico, Air France, Delta Air Lines and Korean Air and had their headquarters in Amsterdam. As of 2019, SkyTeam has 19 member airlines. SkyTeam offers different status levels and benefits, such as:

SkyTeam Elite: Elite status customers benefit from an extra baggage allowance, priority check-in, priority boarding, preferred seating and priority standby.

Sky Team Elite Plus: Elite Plus offers three additional benefits. Members have access to exclusive member lounges and may invite a guest to accompany them. They are guaranteed an economy class seat on every long-haul flight if they book more than 24 h in advance of departure, and their luggage receives priority handling.

Hub dominance: A hub must have a minimal size (minimal number of frequencies) in order to be attractive and thus be able to increase passenger market shares. With the increasing frequency of flights, especially the attraction of business passengers also increases. The dominant airline (owning the best slots) of an airport offers the best connections at the best times and makes it attractive to other airlines to use the hub if there is a good selection of connecting flights. If it becomes too big and crowded, market shares decrease again. This is the case when hub dominance and crowdedness of the airport lead to increasing waiting times at check-in and security and longer distances between gates. In such cases, passengers mind those airports as connecting airports. Hence, hub airports and hub carriers need to collaborate to make sure the efficiency won't decrease for the passengers once economies for the airline and airport increase.

Mini Case: Definition of Slots at the Example of Zurich Airport

By Andreas Wittmer and Christopher Siegrist

Slots define how many airplanes can take off or land at an airport during a certain time frame. The airport can define how many movements the airport can handle. In practice also Airspace Control needs to be involved I defining an airports capacity as there may be limitations in air space usage based on regulations, weather conditions, demands of neighbourhoods, etc.

In Switzerland, the Federal Council regulates the coordination of slots at the airports in compliance with international conventions binding for Switzerland. The Federal Office of Civil Aviation appoints the body responsible for slot coordination. Slot coordination may be entrusted to a private company. In Switzerland, it is handled by an independent association called Slot Coordination Switzerland.

The airport capacity is defined by the number of slots it can handle. Theses slots can be published by different time frames, e.g. number of slots per 5 min or 10 min, 30 min or even per hour or also per minute. Slot Coordination Switzerland, for example, offers slots at Zurich airport per 5 min, 10 min, 30 min and 60 min. There may be 60 slots per 60 min using a certain runway configuration. Furthermore, it is defined that there may be 5 slots per 5 min. But as there is no limitation below 5 min, it does not matter which of the five planes owning the five slots really takes off first or second, etc.

There are schedule slots and operational slots:

- **Schedule Slots** are take-off and landing rights that are allocated at airports, where the demand for departures or arrivals exceeds the capacity of the airport. A schedule slot entitles an airline to plan a departure (or arrival) at that time in the flight schedule. Schedule slots are normally allocated for time frames of 5 min (e.g. for 7:00; 7:05, 7:10, etc.). Schedule slots are allocated twice per year for the summer flight schedule period (end of March to end of October) and the winter flight schedule period (end of October to end of March). If any airline uses their allocated schedule slots within the flight schedule period less than 80% (due to cancelling scheduled flights – delayed flights are still regarded as operated regardless of their real departure time), it loses the right to receive the schedule slot automatically for the same schedule period in the subsequent year. These schedule slots will then be in a slot pool and will be newly allocated according to specified rules[1]. Any airline attempts to keep as many schedule slots as possible in its key times (its waves) at its hub to keep all entitlements for the next flight

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[1] For Zurich, the slot distribution is coordinated by Slot Coordination Switzerland.

schedule period. For example, the slot system at the Zurich Airport allows up to 39 departures per hour from 07:00 to 07:59 am on all days of the week. The flights can be distributed unevenly to individual time sequences of 5 min each during the window of 1 h. Up to 5 take-offs can be planned for a 5-min interval. During the summer flight schedule, SWISS and Edelweiss occupy almost all slots in its morning wave from 07:00 to 07:39 am and planned a total of 27 take-offs.

- In day-to-day operation "**operational slots**" are sometimes set when the European Airspace reaches capacity limits (due to adverse weather, air traffic controller shortages, etc.). These operational slots serve the purpose to steer the traffic and should not be confused with schedule slots described above. Operational slots define a 15-min time window, when the aircraft has to be airborne. Then the airspace is capable of handling the full routing of the plane. Operational slots are coordinated European-wide and set by the European Agency Eurocontrol located in Brussels. When an operational slot is set, it usually delays the departure as the airspace is too crowded to handle the aircraft during its originally planned time.[2] However, once an operational slot has been set for a departure, it must be met. If the plane fails to reach the slot, it will be reprioritised and receives a new slot which is usually much later.

Market

The airline industry operates in a highly competitive commodity market. Basic products (planes, seats, safety regulation, etc.) are similar. Some airlines have chosen to create value by offering the basic, unbundled product for a low price, but charge extra for ancillaries. By this the customer perceives the price of the flight as very low and does not take all extra costs into consideration, when making a travel decision. Once the decision has been made and the customer books, the willingness to pay has increased as the mind is already set for the visit of the destination and deals with accommodation etc. Other airlines provide global connectivity in a global network (alliance) and differentiate by providing supplementary services to customers. They need to charge slightly higher prices due to their higher cost structure and less utilisation of their capital (planes) due to network connectivity (higher turnaround times and waiting times for delayed passengers, etc.). Some airlines focus on specific market segments such as leisure carriers and some aim at supporting network airlines on a regional level by offering wet lease opportunities for the big network airlines.

Pricing plays, next to network management, a key role in managing an airline in a competitive market.

- *Pricing:* Due to the perishability of the product, pricing in aviation has – apart from its revenue generating and positioning function – an important task of steering demand. As a consequence, pricing is considered an important strategic component that represents one of the core functions of an airline. Generally, two main concepts of pricing can be distinguished. On the one hand, prices

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[2] In this case, the pilot usually says that the plane is delayed due to a slot.

are constantly adapted (in the sense of short term finetuning) according to the reservation curve reflecting current and projected ticket purchases. On the other hand, prices are set according to service and booking categories. As for the service category, today most airlines operate a three-class system. Airlines commonly fence service classes by service product elements (such as lounge access, ground service, seat quality and catering). Booking classes are fenced by booking conditions (such as minimum time for pre-booking, refunds and minimum stay). The general aim of pricing strategies is to target each single passenger's maximum readiness to pay. The fencing mechanisms introduced beforehand are used to separate markets in a way that somebody who would be ready to pay more cannot take advantage of a lower price category. Different pricing strategies that may be applied in the aviation industry could be the matching or penetration strategy (match or even offer prices below those offered by competitors) with the goal of gaining or preserving market shares or a skimming strategy (keeping prices higher than competitors) with the goal of skimming the market of well-paying customers.

- *Distribution channels:* The choice and mix of distribution channels (both direct and indirect) are important for airlines and can be used as a market entry barrier. Indirect offline sales (such as specialised corporate client programmes and travel agencies) and online sales represent major distribution channels. On the one hand, separate sales channels can be used to target different customer groups. For example, certain tariff categories are still heavily booked merely through travel agencies. On the other hand, it may become necessary to distribute discounts and unbundled products with ancillaries and supplementary services through special channels (for example through the cooperation with retailers, or directly online over one's webpage or by using IATA's New Distribution System (NDC)) to avoid a cannibalisation of the main market. It becomes more and more important to be able to generate extra sales in combination with the ticket sale. Some airlines make up to 50% with extra sales revenue.

Competitive advantages can be achieved as a result of a focus on resources by following a combination of a static and dynamic approach. Protecting the brand and the dominant position at hub airport are static approaches, whereas creating customer loyalty by using tools such as loyalty programmes focus on developing a better position in the demand market.

Combining the different factors introduced before, it is suggested that there exist three generic airline strategies which are pursued in the airline industry. While specific factors may feature a stronger or weaker forming at individual airlines, can be proposed that a firm is able to build competitive advantages by pursuing the general outlay of one of the following three common strategies based on Porter's strategy concept (Porter, 1980). Around these generic strategies different business models have appeared on the market:

The Quality Leadership Strategy

In general, airlines that pursue a quality leadership strategy establish a sizeable worldwide network, building upon a critical mass at a hub or a dominant position in a particular geographical market. The key underlying strategy is to draw on the hub-and-spoke economies, namely economies of scale, scope and density (economies of scale, scope and density are explained in ▶ Sect. 5.1).

The sophistication in network and hub management is competitive advantage, but over the years has become a core competence of airlines and airports and by this a standard for success. It can still be used as an effective barrier against small and medium-sized airlines trying to challenge a major player's established and well-integrated network. This holds particularly true where the network's power is reinforced by infrastructural entry barriers which are caused by congestion, e.g. the non-availability of slots at key airports. Furthermore, an airline that is able to dominate a big hub is generally in the position to demand a "hub premium" with regard to both leisure and business traffic. A disadvantage of large hub-and-spoke networks is their complex and expensive operation, requiring a huge surplus of material, space and labour.

Airlines that pursue a quality leadership strategy usually build on a strong *brand,* with a special focus on attributes such as quality and service. Since airlines that focus on service-quality are able to build up a strong brand image, a special focus of these carriers is laid on the offering of services, both on the ground and in the air.

Airlines that differentiate themselves on the basis of the *service level* are able to partially reduce the need to compete on costs and prices. For business passengers, who are willing to pay more for certain amenities than leisure travellers, a superior service level is of particular importance. Services that are offered include in-flight services (e.g. catering, in-flight entertainment) and ground services (e.g. lounges, premium check-in facilities). Another important part of the service level is the successful operation of a full-size network. Through this, it is aimed to offer high frequencies and to minimise the travelling time.

Regarding *customer relationship management*, airlines that focus on a quality leadership strategy must have a clear understanding of their customers' needs and of the investments and capabilities necessary to meet those needs, e.g. sophisticated frequent flyer programmes (Stoll 2004). Customers will reward this uniqueness with a higher willingness to pay and an increased loyalty. Moreover, FFPs and substantial volume-based commissions that have to be paid to travel agents may represent an effective barrier for competitors.

Airlines that pursue a quality leadership strategy generally follow a multi-channel *distribution strategy* to reach various customer segments. In this context, indirect offline sales play an important role. In addition, however, bookings via online travel agencies and company homepages are also offered. Hub-and-spoke networks allow for a more efficient marketing and customer relationship management due to distribution advantages through agents and an increased attractiveness of the airlines' FFPs.

In general, carriers which operate in this segment are a member in one of the major international airline *alliances* and/or have close connections and financial stakes in other companies (e.g. Air France/KLM Group and Lufthansa Group).

The Cost Leadership Strategy

Airlines that pursue a cost-leadership strategy strive to outperform rivals by producing their services at a high labour and capital productivity. In this context "standardisation" is often considered the main attribute for the success of this strategy. Airlines that follow a cost-leadership strategy are often called "low-cost" or "no-frills" or point-to-point carriers.

Concerning the *network structure*, a low-cost basis is achieved by offering non-complex point-to-point transportation services on high-volume routes. The routes are served with quick turnaround times and are operated with few or one type of aircraft. Airports which are served by low-cost carriers are often dominated by one company, resulting in a high bargaining power for this carrier.

Concerning the *brand*, low-cost airlines pursue an image strategy which underlies their core value proposition of offering a low-cost product. Marketing expenditures are substantially lower than compared to those of full-service carriers and commonly are cut to a basic level.

Low-cost airlines have significantly lower input costs due to reduced *service levels*. By cutting off most frills, these carriers usually do not offer free meals, in-flight entertainment and lounges. A single-class, high density seating configuration is employed. Service attributes that are directly connected to the core of the actual transport service, i.e. punctuality, reliability and offered frequencies, however, are kept at a high level to attract passengers.

For cost-saving reasons, low-cost airlines do not maintain a sophisticated *customer relationship management*, which is linked to frequent flyer programmes. Customers of these airlines are considered to be less sensitive to service-based characteristics.

The simplicity of the low-cost business model is reflected in its simple, one-way-based *pricing* structure of fares, which only makes use of minimal fencing restrictions. Low-cost airlines generally sell their inventory on a first-come, first-served basis. In general, low-cost airlines are not members of an airline *alliance*, but put a strong focus on market dominance concerning specific routes or specific regions.

The Niche Carrier Strategy ("Focus Strategy")

Apart from the other two generic strategies, a set of niche opportunities exists from which niche carriers may take advantage. The niche or focus strategy is directed towards serving the needs of a limited customer group or market segment. Niches in air transportation can either be service related, geographically defined or to be confined for cost advantages. In this context, airlines are supposed to be able to gain a competitive advantage by better serving the needs of the chosen segment and by concentrating their efforts and activities. However, since there are a number of different approaches to operate in a niche and airlines may focus one distinctive approach, the individual carrier´s niche strategy may not be suitable for generalisations and thus might hardly be representative.

A typical *service-related* niche is focusing merely on the market of business travellers. Corporate business travellers tend to have high product expectations in terms of comfort and often are status-conscious. A focused strategy might therefore strive to satisfy these needs on the basis of exclusivity and timely implementation of processes.

Geographically defined niche carriers try to dominate a local market. Examples are island-based airlines such as Air Seychelles or Air Mauritius. The niche of low-yield long-haul services to holiday destinations could prove to be sustainable as no network carrier is able to operate these routes in a profitable way.

Regional carriers or regionally focused feeder carriers represent a further geographically defined niche. These airlines are closely linked to major network carriers as, for example, Air Dolomiti to the Lufthansa Group. These carriers often operate on so called capacity provision agreements or by available seat mile purchase agreements, under which the niche carrier is paid on a per-flight basis to operate for the major carrier. The responsibility of marketing, revenue accounting and yield management functions is typically taken over by the major carrier. Furthermore, on-board product and service-based specifications are established in cooperation with and in line with the standards of the partner.

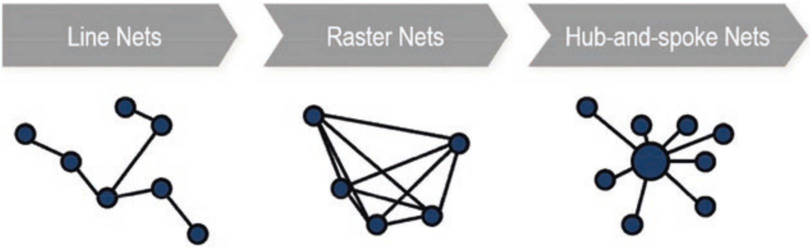
5.4 Airline Network Management

Networks and their operation define the structure of production as well as the product of commercial airlines. Thus, network management can be considered as the core function of each airline. It serves as a market activation, expanding into new and existing markets by offering flights and seats. In most modern airlines, network management is performed by a department which directly reports to the CEO. Airline networks form a part of the transport-networks within the logistics networks. Associated with them is the typology of different airline networks including line networks, raster networks and hub-and-spoke network. These range from simple point-to-point flights, "milk can flights" right through to varying degrees of hubbing, with continuous hubbing signifying the highest degree of hubs (Rossy et al., 2019; ▣ Fig. 5.3).

Since net economies imply clear and obvious key success factors for the operation of different types of airline networks, airlines need a clear strategy about:

- The role of net effects in their strategy
- Their comparative advantage (e.g. market, location, capacity and restrictions of the home airport)
- The type of network they want to offer
- The way how they want do develop and transform their networks

By considering these aspects, airlines are also defining their business models. Thus, this chapter provides an introduction into airline net economics, followed by a presentation of the main variables of the development of an airline network. Lastly, different types of airline networks and related business models will be introduced.



Line Nets

Advantages
- Simple planning
- Understandable steering

Disadvantages
- Low frequencies
- Massive station costs
- Low personnel productivity
- High marketing costs

Raster Nets

Advantages
- High personnel productivity
- Attractive for business passengers

Disadvantages
- Low frequencies
- High station costs
- High marketing costs

Hub-and-spoke Nets

Advantages
- Marketing Leverage (increase of offer)
- Dominance (strategic value)
- Production economies of scale (Production, Infrastructure)

Disadvantages
- Risk of marginal cost pricing if there is transfer traffic
- Creation of hub-concentration peaks
- High delay liability

◘ **Fig. 5.3** Network typology (author's own figure based on Jaeggi, 2000)

5.4.1 Airline Network Economies

A network can be defined as the sum of elements/objects (nodes) and their connections (edge/leg). Thus, net economics are based on net effects. The latter, in turn, can be defined as effects of consequences – economically expressed as benefits or losses – which occur due to an element's link to or its integration into a network. An airport which has one link to one hub may experience traffic growth if the respective hub strengthens its position and is able to offer more direct connections. In this case, the smaller airport is experiencing a benefit which is not linked to any own activities. The only reason for its growth is its integration into a growing network.

In general, net effects tend to get stronger with increasing network size. The example of hub effects can exemplify this (◘ Fig. 5.4). In the case of only one leg, there is one connection between an origin and a destination (in the sense of a product in form of a transport connection from an origin to a destination) which can be offered. If two legs are linked to the hub, three ODs can be offered. Ten ODs may already be offered if four links exist. Evidently, the number of ODs increases progressively.

The possibility of offering a growing number of ODs with each new leg can be considered as increasing economies of scope. *Economies of scope* are economies in the form of more variety with decreasing costs. In addition, *economies of scale*

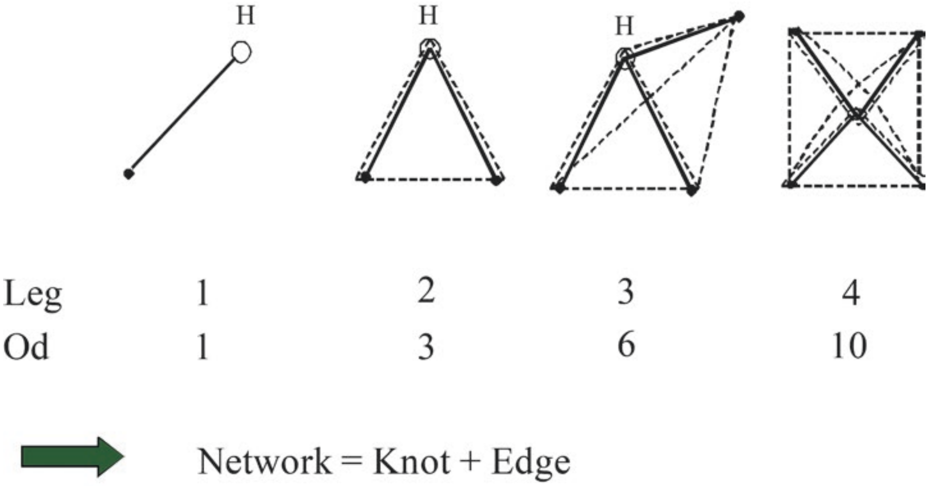


Fig. 5.4 Net effects arise through "hubbing" (author's own figure)

occur if through a bigger operation thus an increased specialisation product can be produced cheaper. This is the case at big hubs, if large maintenance or catering facilities can be operated. *Economies of density* occur, if services and activities are concentrated and thus, a higher level of productivity and quality exists. Big hubs, for example, can offer improved and optimised services such as lounges and shopping facilities thanks to a concentration of people. Overall, increasing economies in networks constantly lead to lower marginal costs.

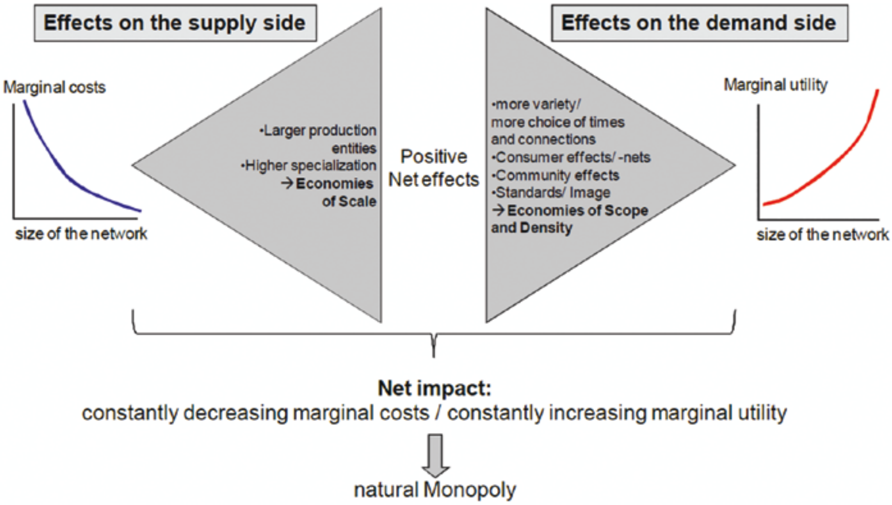
So far, the supply has been investigated. Significant economies, however, also occur on the demand side. Through the concentration of flight frequencies, more efficient and effective services can be offered to the customers (*economies of scale*). A bigger network allows for more connections. This in turn allows passengers to choose between a larger number of direct flights (*economies of scope*). Further advantages of bigger hubs and airlines are, e.g. that fellows and collaborators may use similar airlines and thus mileage programmes can be used more efficiently or meetings can be conducted at the airport or on the flight (*economies of density*).

Considering all effects on the customer or demand side, increased marginal returns or benefits can be observed. Each additional passenger allows for even more benefits. Mileage programmes with status systems, where customers may collect additional miles and may use privileges, can be regarded as examples of this marginal utility. The respective passenger gains additional benefits with every flight. Continuously decreasing marginal costs on the supply side combined with increasing marginal returns on the demand side lead to natural monopolies. Due to these powerful network effects, whenever two networks compete, the bigger network will be able to operate at lower costs and provide more benefits to its customers. In the long term, a smaller network not being able to draw on other strategic success factors (e.g. a monopoly on serving a specific route or airport, a technical advantage and the geographical location of its hub), will be pushed out of the market, if it is not subsidised. As a result, the big network will dominate all others and will be left alone as a monopolist – in line with the saying “the winner takes it all” (◘ Fig. 5.5).

However, there are some natural restrictions to the growth of hubs and their respective airlines (◘ Figs. 5.6 and ◘ 5.7). The above-mentioned economies of hubs are opposed by conflicting hub diseconomies. For example, bigger hubs with more connections typically are more sensitive to delays. Delays pile up throughout the day in the entire network, potentially leading to a reduction of perceived quality and compensation costs. Furthermore, the operation of hubs always leads to hub load peaks. If poor meteorological conditions or technical reasons, such as the closing of a runway, lead to operational restrictions, the service quality decreases and delays may occur. Moreover, the development of a hub requires high specific investments within the whole network. As a consequence, tremendous sunk costs might occur, if environmental conditions change and the structure of the hub systems has to be modified.

Since there is a tendency towards natural monopolies in all net industries, companies constantly strive for further growth. As a result, airlines try to attract traffic through their hubs, at whatever costs it may take. Thus, competition with other hubs, dominated by competing airlines, requires a constant strive for cheaper prices than competitors.

Due to this, transfer flights very often are cheaper than direct flights. For example, a flight from Prague via Zurich to New York in tendency is cheaper than a direct flight



◘ **Fig. 5.5** Natural monopoly (Shapiro & Varian 1999)

Supply Side:

- Production: Achievable Economics cause lower costs per unit
  - use of larger planes
  - reduces batch production effects
  - economics of scale of central hub facilities
- Marketing: Effects allow a better market coverage
  - higher amount of marketable O&D's
  - higher amount of frequencies
  - Diversification of the customers base
- Strategy: Dominance in the market (above the average marketshare, compared to the service share) offers sustainable competitive advantages

Demand Side:

- Economies of density, such as attractive lounges and other services
- Mileage programs
- Standardized operations

Fig. 5.6 Hub economies (author's own figure)

Supply Side:

- Tendency towards marginal cost-pricing with transfer traffic in the competition between hubs
- Production of Hub-Load-Peaks
- High delay-sensitivity
- Sunk costs when change of strategy (because of high investment into the hub infrastructure)

Demand Side:

- Time of waiting, long distances
- Partly capacity overload

Fig. 5.7 Hub diseconomies (author's own figure)

from Prague to New York. In a competitive situation between hubs, for airlines – at least for a transitional period – it can pay off to lower their prices down to marginal costs. This approach, however, may imply serious financial risks in the long term.

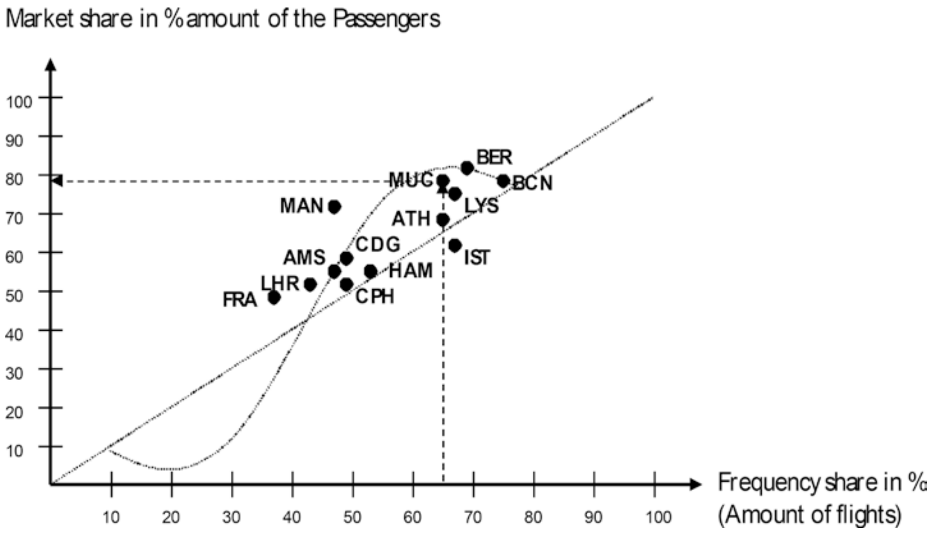
Due to these net effects, special problems and questions occur not only on a company's level, but also for aviation policy and regulation. Typical questions are: Should a smaller airline be subsidised or given special rights to assure competitiveness and to avoid a natural monopoly? How should the transformation process towards a consolidation of the industry be governed? Marginal cost pricing puts severe economic pressure on airlines, will this also affect their investments in safety and security?

An important economic effect of hubs is the so-called S-Curve or “domination effect”. The higher the share of an airline’s connection at a certain airport, the progressively higher is its market share. This effect is closely related to an increase in consumer benefits, for instance, more connections to choose from and a better ground infrastructure. As a result of this effect, there is hardly any airport in the world which is home to more than one hub carrier (see ▣ Fig. 5.8).

Considering all these effects, the optimal size of a hub is defined by:

- Its natural home market: the bigger the home market, the higher the number of sustainable flights, the higher the absolute number of transfer passengers that can be serviced; an excessive share of low revenue transfer passengers reduces the airlines yield
- The cost of operations; lower operating costs allow for a higher share of low paying transfer passengers
- The runway capacities influenced by the runway infrastructure and organisation as well as approach regulations, which define the slot capacities
- The organisation of the terminals and thus the minimum connecting time, which defines the timeframe usable for transfers

Network effects function not only in aviation networks, but also in railway or telecommunication networks. However, a difference must be made between competition within or between networks. The aviation industry can be considered as one network. Competition between airlines therefore is competition within the net. In contrast, competition between the railway and the aviation networks is a typical



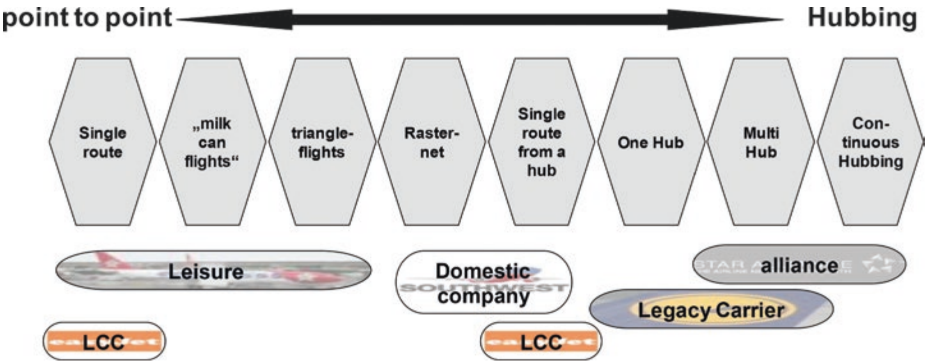
▣ **Fig. 5.8** S-Curve Effect (related to Delfmann et al., 2005) example of competition between networks. In the case of competition between networks, the larger network usually has certain advantages due to its network effects.

5.4.2 Main Variables of Airline Network Design

Due to the powerful hub economies introduced above, most airline networks are, today, constructed around hubs. However, this has not always been the case. Many airlines started their operation with *single routes*. In the 1920s, for example, Swissair offered transportation from Zurich to Basel continuing to Frankfurt, to Cologne and to Amsterdam. Today, this type of "milk can flight" can still be found in remote areas. For a long time, Aerolineas Argentinas or LATAM Chile offered this type of service along their vast coastlines. After about 1 h of flight time, the next airport was reached, and passengers, mail and cargo were loaded and unloaded. A special form of these "milk can flights" are triangle-flights. They can still be found in charter operations, for instance, flights to the Western Canadian Tourism Centres Vancouver and Calgary are often linked by triangle-flights (◘ Fig. 5.9).

The network operated by low-cost carriers (e.g. easyJet, Ryanair) or traditional carriers, like Lufthansa or SWISS, form their peripheral airports, such as Hamburg or Geneva, is based on *single routes from one centre*. Carriers assign a number of airplanes to an airport, which are used on a quite independent production basis. In these cases, rather than "hubbing" by offering transfer connections, the airlines aim to internalise economies of scale and to reduce complexity through independent production bases. Geneva airport, for example, is used by SWISS as a production centre. Several Airbus A220 are stationed at this airport to serve routes to London and other places in Europe. At the same time, easyJet has stationed aircraft at Geneva airport to provide an independent low-cost operation including connections to Barcelona and other cities mainly in Western and Southern Europe.

One hub strategy is pursued, for instance, by British Airways and Air France. Both airlines have their main hubs in the capital of the respective home country. For both countries this strategy makes sense because both, France and the UK, are



◘ **Fig. 5.9** Forms of airline networks (author's own figure) dominated by one important political, cultural and economic centre, the capital. This type of network structure requires large and efficient airports, such as, Charles de Gaulle in Paris or London Heathrow. Through one hub, the respective airlines theoretically are able to internalise a maximum of hub effects.

Hub operation concepts have already been developed into new concepts such as *multi-hub networks*; for example, the network consisting of four main hubs (Frankfurt, Munich, Vienna and Zurich) operated by the Lufthansa Group, whereas Lufthansa Airline operates two hubs no its own (Frankfurt and Munich). An advantage of that system is a good combination of the internalisation of hub economies and reduced dependency and redundancy through a multitude of hubs. If, for example, one hub must be closed for metrological reasons, passengers can be de-routed to one of the other hubs, where airlines services are fully present. Also, passengers can plan their trips according to the best travel times by combining flights through different hubs. This system is very useful for more decentralised regions with a number of strong business and political centres and the absence of a natural hub. Furthermore, it allows more growth potential, as especially big hubs run at maximum capacity – not only with respect to ground infrastructure, but also with respect to airspace capacity.

Another development is the so-called *continuous "hubbing"*. Several North American hubs are operated in this way, especially with domestic connectivity (and Dubai with Emirates aims at this level of hubbing on an intercontinental level). On airports which have high capacities thanks to an extensive runway system, like Chicago O'Hare which has four parallel runways, continuous "hubbing" can be arranged. By serving all major routes on an hourly – or at least two hourly – basis, long waiting times for transfers and other elements linked to traditional "hubbing" can be avoided. Passengers just arrive at a certain time at the airport, proceed to the gate where their connecting flight is supposed to leave from, and wait for the next available flight. This procedure reduces complexity and improves punctuality, also increasing the convenience for passengers.

The Location of a Hub

The location of hubs must be selected based on market as well as technical criteria. As mentioned above, profitable traffic with high yield results from point-to-point traffic. Hubs located in strong economic areas can, therefore, offer a larger network fuelled solely by their domestic market. Transfer passengers, by contrast, receive lower prices and discounts and may not cover the full costs of their flights. Accordingly, for profitability reasons, the share of transfer passengers that is acceptable for an airline is limited. Therefore, many airlines define strategic goals for the share of transfer passenger (e.g. 40%). This said, hubs can accept higher shares of transfer passengers if

- They are comparably inexpensive to operate. Reasons for this may be cheap labour costs, no fuel taxes, no emissions charges, 24 h opening time of airports and good geographic location for their selected network operation or low airport fees. Airports and airlines in the Middle East (such as Emirates flying out

of Dubai) can consequently accept a considerably higher share of transfer traffic than their North American or European counterparts.
- The hub is centrally located in a continent or important business area, allowing for relatively short and usually cheaper connecting flights.

Importantly, the efficient operation of a hub requires a runway and gate capacity large enough to allow for the operation of "waves". The more arrival or departure flights an airport can handle in an hour, the more efficient are the connections that can be offered in a wave.

Defining Connectivity

Connectivity is an important factor for hub-based airline networks. Generally, connectivity can be defined as the number of connections (or hits) per inbound flight. As a rule of thumb, an increased connectivity (and thus larger passenger streams) results in a higher potential to feed outgoing flights. The backbone of connectivity patterns is always long-haul connections. The long-haul planes (usually wide-bodies) have to be fed by enough incoming connecting flights. As a special form, intercontinental "hubbing" can be very profitable, particularly on those routes where long distances do not allow for direct flights, like, for instance, between Europe and Oceania (Fig. 5.10).

The "connectivity" is technically defined by the maximum transfer waiting time acceptable for passengers (normally, the shortest connections are shown first in the international booking systems; therefore, flights with short connecting times are easier to sell) – the minimum connecting time (this is the technical time defined by the airport infrastructure and services which allows a proper transfer of passengers and baggage from one plane to the other) – and the runway capacities. Today, the

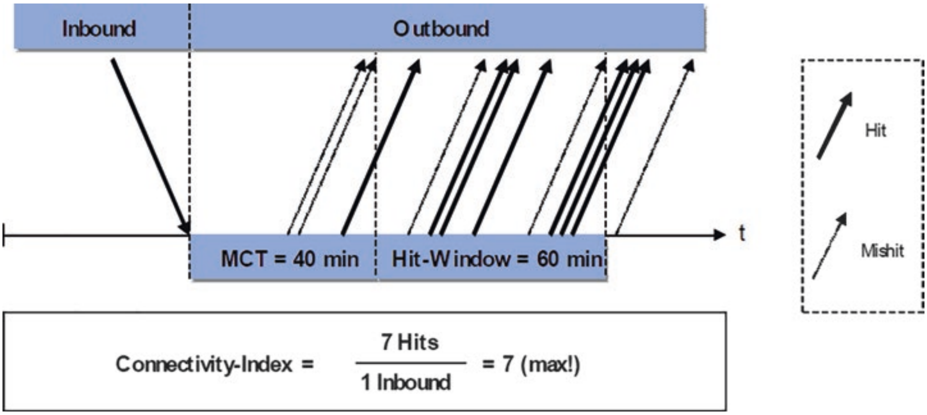
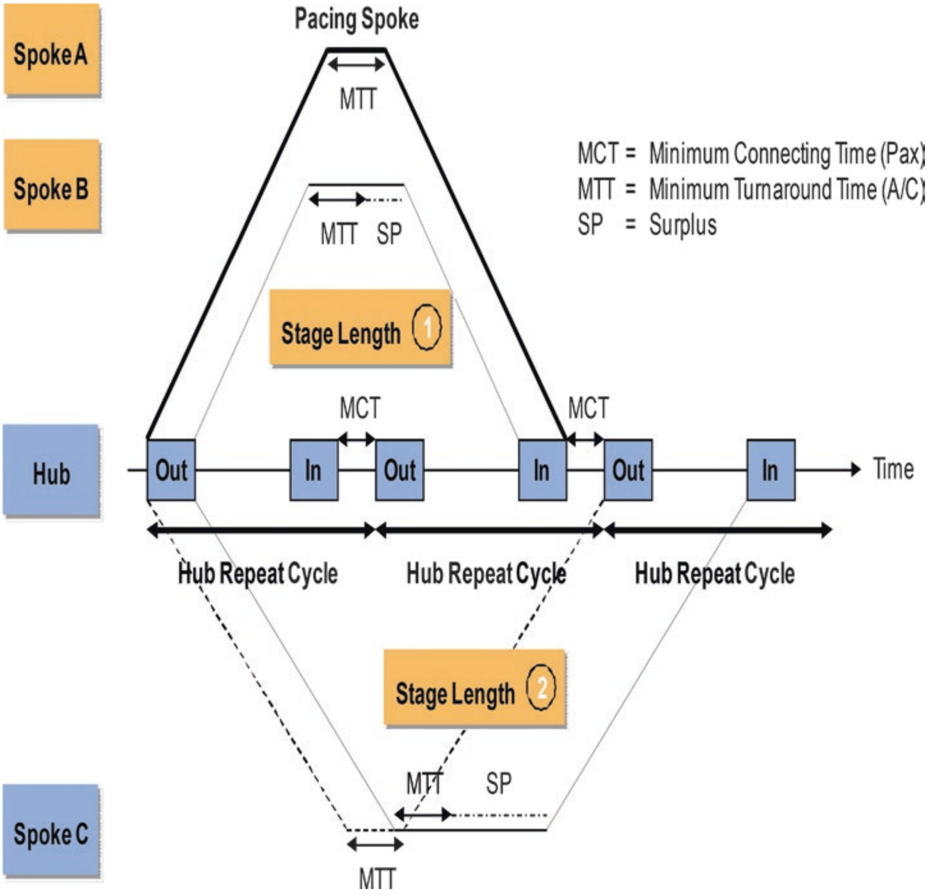


Fig. 5.10 Connectivity – key figure of "hubbing" (Jaeggi, 2000)

minimum connecting time is often around 30 min. At most big hubs it is around 35 min; at smaller hubs, like Vienna, it can be as low as 20–25 min. The maximum acceptable transfer time is believed to be around 2 h. If the runway capacity is one plane per minute, there are consequently about 1.5 h left to be shared between inbound and outbound flights. Theoretically, 45 incoming flights could feed 45 outbound flights (▪ Figs. 5.9 and 5.11).

Due to these patterns, the traffic of a typical hub is usually organised in so-called "wave structures". A wave of incoming planes is followed by a wave of outbound planes. The definition of the wave structure is crucial for the operation of an airline. Also, potential intercontinental "hubbing" has to be bundled. The



▪ **Fig. 5.11** Configuration of the hub cycles/waves (Jaeggi, 2000)

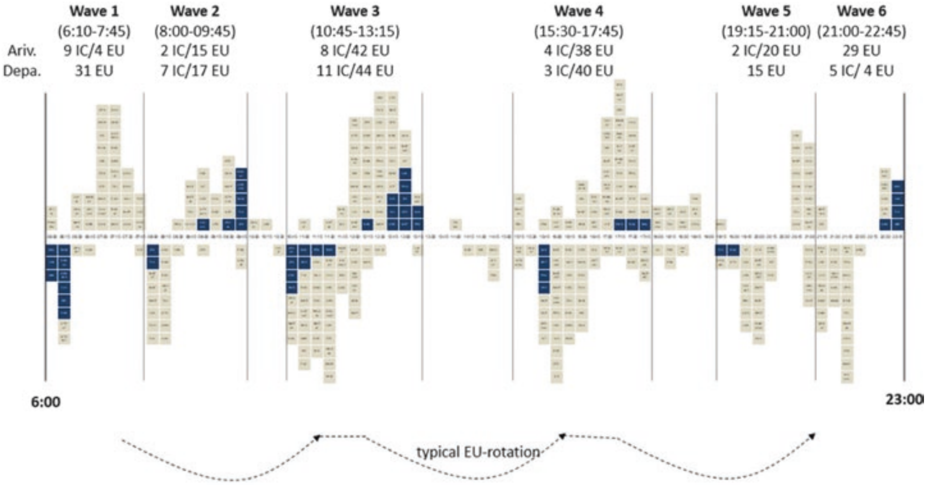


Fig. 5.12 Swiss wave structure (Tockenbürger et al., 2017)

example of the wave structure of SWISS at Zurich airport in Fig. 5.12 shows this pattern. At 6 a.m. there is an incoming wave of intercontinental planes feeding the outgoing 7 a.m. wave. In this wave, transfer passengers meet business passengers.

Wave structures in a multi-hub-system have to be coordinated. Ideally, a multi-hub-system allows for a

- Redundancy, in the sense that if one hub is affected by bad weather or technical problems (e.g. the failure of the baggage systems or airline IT systems), at least the well-paying business passengers can be transferred to other, still functioning hubs.
- Better coverage of different market segments. One hub could be developed into a more mass passenger type of hub where bigger airplanes operate, and lower ticket prices can be offered. Clearly, with this kind of operation all hubs should provide all available class types and product categories to guarantee the net effects.
- Coordinated wave structure at the different hubs which provides more time flexibility, as different departure times can be offered. On North Atlantic routes where the usable time frame for passenger flights is quite long, one plane could leave from the first hub, for example, New York, at 9 a.m., from the second airport at 11 a.m. and from a third one at 3 p.m. This would allow business travellers to choose the departure time that best suits their needs. However, such a variety of departure times cannot be offered for destinations at which the productive time slot for intercontinental flights is relatively small, for instance, flights from South East Asia to Europe. On these routes, it makes only sense to leave late at night and arrive early in the morning because of the time differences and the flying time.

Internalisation of Net Effects

Airlines can internalise net synergies by cooperating with other airlines. The degree to which airlines internalise the net effects from cooperation depends on the type of integration between airlines. These are as follows (refer also to ► Sect. 5.5 in this chapter about cooperation and alliances):

- Adjusted timetables
- Codeshare
- Integrated network structure
- Lounge access and combined frequent flyer arrangements
- Integrated pricing
- Integrated operations
- Procurement synergies
- Fleet management financing

Starting with simple cooperation, airlines can internalise first synergies from adjusting their timetables and code sharing on certain flights. This translates into airlines adjusting their timetables to complement each other, i.e. to feed each other's flights or to create a more competitive offering such as more frequency on a route. Codeshares give passengers easier access to booking flights operated by partner airlines, as they can be bought using the flight number of the airline issuing/selling their tickets.

A further measure to increase the internalised net gains can be realised by increasing the integration through an alliance structure. By integrating their network structure airlines can seek to adjust their networks with their alliance partners. Furthermore, synergies can be realised by sharing infrastructure such as lounges and combining initiatives such as frequent flyer programmes. With increasing cooperation and integration, measures such as integrated pricing and operations allow airlines to fine tune their pricing and share operational assets to improve the net income of the two partners.

The highest amount of net gains is offered by mergers. This allows airlines to realise procurement synergies such as larger aircraft orders with more discount or having uniform products such as aircraft seats. Financially, a merger improves the financial conditions through financial economies of scale when it comes to capital-intensive acquisitions such as entire aircraft fleets.

Resultingly, net effects and synergies are dependent on the degree of integration between two airlines. The degree of integration as such is a continuum between independence and cooperation. By increasing the level of integration between two airlines, they trade independence for higher net gains and vice versa. Therefore, it is important for both partners to weigh the benefits and the drawbacks of each cooperation.

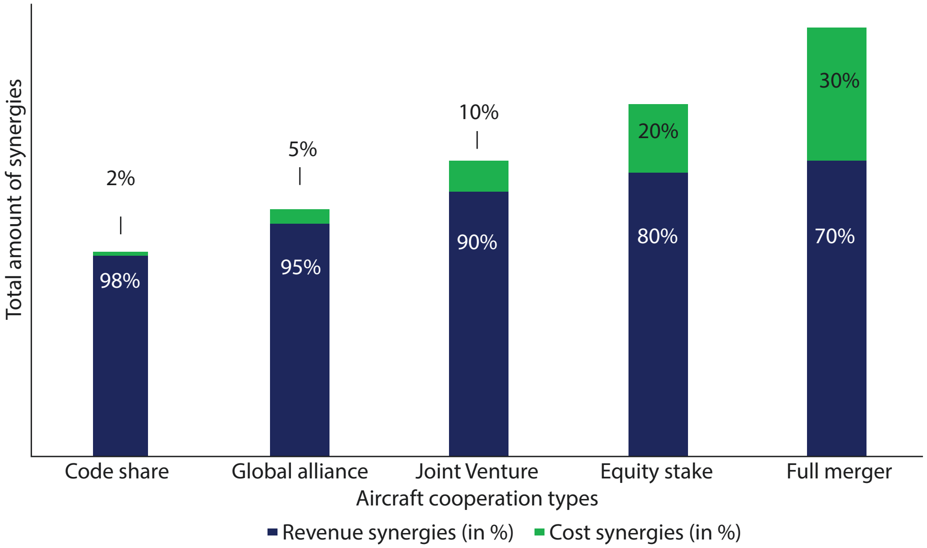
Synergies

The synergies that arise through cooperation between airlines, can generally be divided into cost and revenue synergies, which then form the total synergies. The proportion of each synergy depends on degree of cooperation.

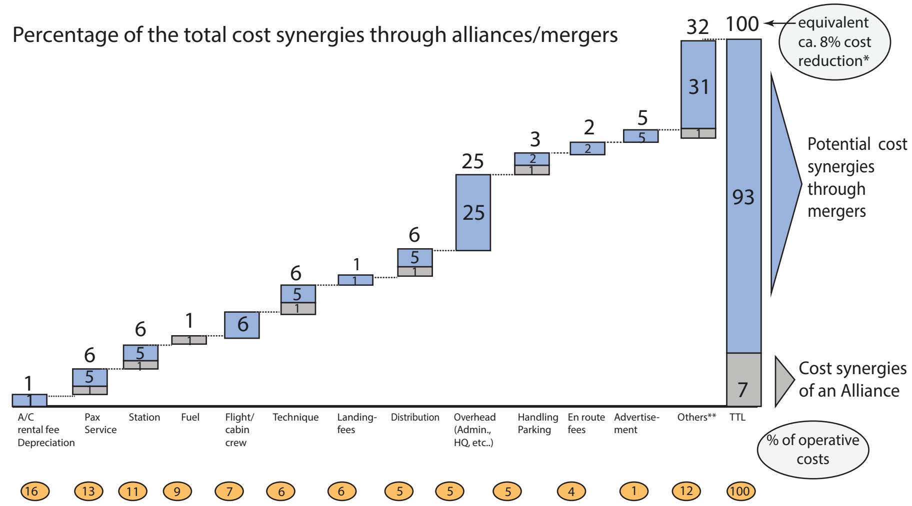
Revenue synergies tend to form the majority in every type of cooperation. However, the degree does vary considerably. Therefore, codeshares, global alliances and joint ventures tend to, almost exclusively, produce revenue synergies ranging between 90% and 98% of the total possible synergies. Whereas closer cooperation such as equity stakes or a full merger tend to have additional cost synergies of 80% and 70% of total possible synergies, respectively, as cost synergies take up an increasing part of the net effects. A majority of revenue synergies are achievable through less intensive forms of cooperation such as alliances. These include new regional and intercontinental connections, as well as S-Curve effects where the potential revenue is realised. However, measures such as network restructuring only create a feasible income synergy when a complete merger takes place (▣ Fig. 5.13).

On the cost side of net effects, alliances only produce small synergies across airport services. Over 93% of the cost synergies can only arise when a merger takes place. The main areas are overhead costs for administration, headquarters, etc. and other various cost positions. Other areas of noticeable cost synergies include passenger services, crew, maintenance and/or advertisement (▣ Figs. 5.14 and 5.15).

Cost and revenue synergies also differ geographically. Whilst European mergers and alliances create a balance between cost and revenue synergies, the North and South American counterparts realise a considerably higher percentage of revenue synergies as opposed to cost synergies.



▣ **Fig. 5.13** The more the integration, the more the synergies (author's own figure; estimation based on expert interviews)



*) regarding the weight of the cost positions

**) Other selling fees, legal, Consulting, Insurances

Fig. 5.14 Cost side of net effects (author's own figure based on Döring, 2006)

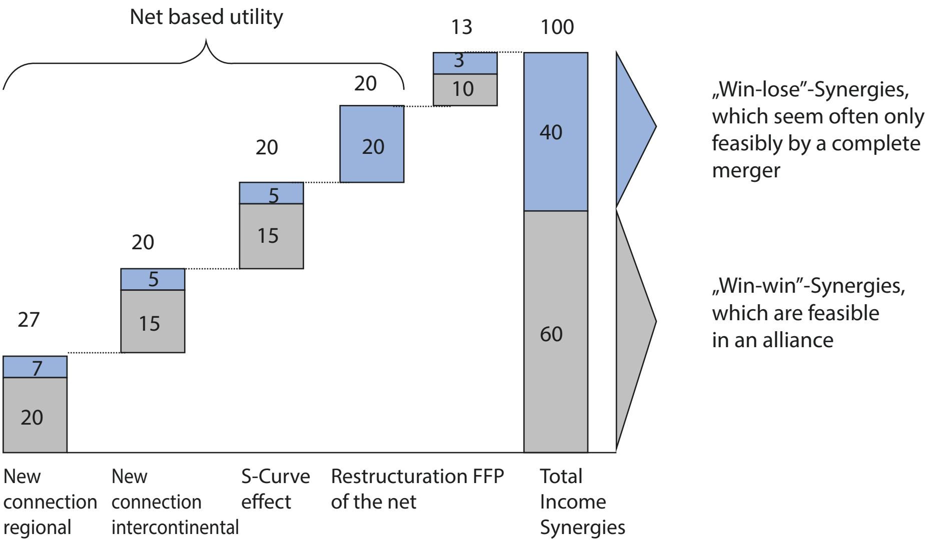


Fig. 5.15 Revenue side of net effects (author's own figure based on Döring, 2006)

5.4.3 Network Management Processes

Network management includes the analysis of markets, route planning, flight management, slot management, capacity management and demand management through sales/distribution and pricing. The goal is to plan, coordinate and manage a network at the highest possible profitability.

Network management is a process which starts 2–3 years before a new flight is introduced. At that time, decisions about routes and markets are being determined. Shortly before the actual flight mission, the plane is subject to capacity management and seat load factor optimisation (for instance through tools like price rebates and standby passengers). Each step of this integrated process consists of important decisions. At the beginning, route planning decides about the destination mix and the routes that will be operated. Next, fleet management has to decide about the optimal aircraft assignment to each route. In the long run, fleet management also has to decide about the type and number of aircraft to be purchased and operated. Scheduling has to deal with issues like slot management. This includes, for example, making necessary slots available by administrative application process or even by buying them. Based on the scheduled timetable, capacity management optimises sales and prices from the publication of the airline's timetables until shortly before the actual flight. The most important instruments of capacity management are:

- Revenue management
- Fleet assignment (for example, short-term change of aircraft size)
- Distribution and sales, e.g. special campaigns

Each airline assigns its own specific processes within network management, since all the decisions that need to be taken are interdependent. For instance, a decision about the reassignment of a smaller airplane on a specific route will have consequences on the price structure of this route. The way in which these decisions are taken, and how the process of network management is operated, is fundamental for the overall success of an airline.

5.5 Alliances and Cooperation

In the 70s and 80s most airlines were still independent airlines, mostly still state-owned, who were solitary players in mostly regulated markets. As the liberalisation started in the USA and gradually spilled over to Europe, airlines were forced to re-structure their business models and sought to optimise their networks, increase customer value and loyalty by implementing frequent flyer programmes. However, as competition increased, the need of cooperating with other airlines emerged, resulting in the foundation of the three major alliances: Star Alliance, Oneworld and Skyteam. These started to grow gradually after 2000, realising more synergies through intra-alliance mergers such as Air France & KLM within Skyteam. In recent years, the trend is shifting towards joint ventures within alliances, as well as outside of alliances as in the case of QANTAS and Emirates.

Cooperation and mergers prove to be a valuable measure from a financial but also from a network perspective. Efficiency can be increased through adjusting the network to increase loads by combining flights. Furthermore, resources such as administration or technical staff can be shared to reduce the costs. Therefore, it is possible to profit from up to 90% cost synergies through mergers as well as realising revenue synergies of up to 60% in alliances. There are different types of cooperation, all of which vary in the degree of integration (Canelas & Ramos, 2016):

Contractual arrangement: Two airlines can agree to cooperate by a simple contractual agreement covering possible cooperation regarding labour, sales etc. This could be anything from a ground handling contract to sharing lounges etc.

Codeshare: This concept involves two airlines placing their own flight numbers on the partner's flights. This allows their customers to book the partner's flights easily using the inventory of the airline they are booking with, making the booking process easier and granting the customers more options in terms of connectivity. This also allows airlines to streamline their networks by offering codeshare flights, which otherwise wouldn't be profitable to run themselves. In return, the codeshare partner profits from higher loads on their own flights.

Global alliance: As mentioned above, alliances involve a group consisting of member airlines that coordinate strategically on a bigger scale. Often this involves a variety of measures such as strategic network planning with complementing hubs or cooperation between frequent flyer programmes. The three global airline alliances are: Star Alliance, oneworld and Skyteam.

Equity stake: Taking an equity stake allows airlines to lower their capital and financing costs by investing in shares of other airlines. This is widespread in the industry such as Qatar Airways being a minority stakeholder in the International Airlines Group or Delta investing in Virgin Atlantic.

Joint venture: A joint venture involves multiple airlines closely cooperating on one or multiple areas of the business. Often a joint venture is used in route planning, for example, in the transatlantic business where several airlines form joint ventures to fortify their market share.

Merger: Airlines can cooperate by merging two entities, with the result being a group with separate brands or a full merger. This allows the highest level of synergies in all aspects of the business.

The success of a cooperation obviously depends on the process and the synergies realised. There are several factors that can be analysed to determine the success:

- Economies of scale and scope
- Cost efficiency and brand quality
- Good financial ratio
- Early adoption of new technologies
- Early adaptation to changes in the regulative environment
- An operational basis of business, operational reliability and a successful service and marketing

Mini Case: British Airways and Iberia Merger

By Andreas Wittmer and Christopher Siegrist

In 2009, the two legacy airlines British Airways and Iberia announced their intention to merge and form a new airline group named International Airlines Group (IAG). The two carriers initially signed a memorandum of understanding, which eventually concluded in the merger in January 2011.

The idea behind the merger is to use synergies and create network effects. By combining their networks out of London and Madrid, the two airlines strengthened their market share on the transatlantic market. The new network offered over 157 new destinations for either airline's customers. British Airways primarily offers North American destinations in the group, while Iberia mostly operates flights to South and Latin America. As such, both networks offer a complementary fit and allowed to optimise the two hubs by developing Madrid into a hub for Latin and South America and London Heathrow into a North America hub. Furthermore, synergies of up to €400m could be realised over the course of 5 years across several areas of the business, which corresponds to approx. 33% of the revenue. The highest synergies could be made in network and fleet planning as well as the IT and back office.

The merger not only brought synergies but also challenges. Aspects such as cultures or how to set up the management had to be considered without creating friction and/or imbalance between the two airlines. Furthermore, its systems had to be integrated to create a uniform booking platform for customers when it comes to booking flights, collecting miles, etc. The perceived differences in the service quality at the time of merger also had to be given due consideration to create a consistent group that offers a steady quality of service across its brands.

Today, IAG is the third largest airline group in Europe and posts increasing profits every year, thus indicating how synergies in the airline business can be used to create a more profitable business. In the meantime, it has strengthened its stronghold in the Western European and transatlantic market with the merger and acquisition of Aer Lingus, bmi and Vueling, whilst competing in the low-cost market with the creation of its low-cost subsidiary LEVEL.

5.6 Airline Business Models

A business model in the aviation industry can be defined as a simplified plan on how companies design and operate their networks. This plan may include different dimensions (Amit & Zott, 2001; Bieger et al., 2002). In principle, two main types of business models can be identified in the aviation industry: the traditional network model and the point-to-point model (▣ Fig. 5.16).

Most structuring approaches for business models include dimensions like

- The type of markets and production applied
- The type of revenue and pricing systems applied
- The type of coordination of the value chain or network

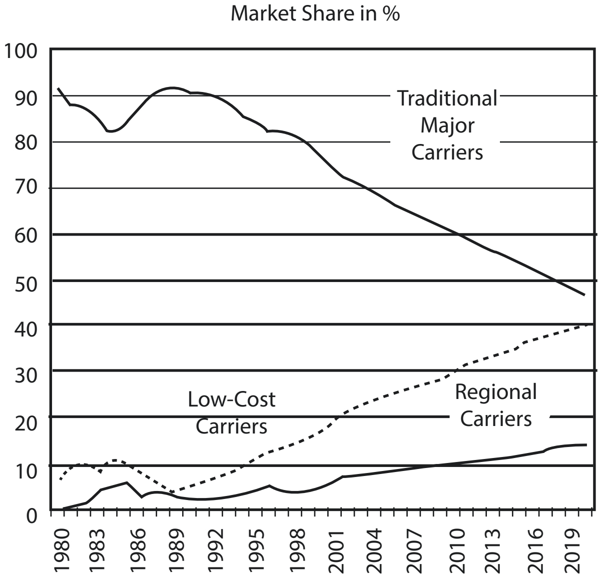


Fig. 5.16 Development of market shares between the different business models (Auerbach and Delfmann 2005)

The business model of a *network carrier* usually aims at servicing customers based on a large variety of different OD connections. Consequently, these carriers intend to take advantage of as many network effects as possible. As pointed out earlier, yield management and demand-oriented pricing are necessary to attract transfer passengers. In competition with other network carriers, the brand image and the services offered play a major role for the success of an airline. Strategic alliances, cooperation or even mergers are essential to keep up with the necessary growth of the network in the competition with other airlines and airline systems.

The *point-to-point traffic* model targets individual markets with a limited number of OD products. Network effects do not play an important role. Companies operating such a business model enter markets with an attractive – i.e. strong and stable – traffic flow, such as routes from the UK to destinations on the Spanish coast or between major cities. These companies have to be flexible enough to open up new routes where new opportunities occur or to close routes in case stronger competitors enter the market or network carriers with their brand and service quality push them out of the market. The main competitive advantage lies in the ability to reduce complexity, to save costs and to develop new sources of income (for instance additional fees for certain services).

In summary, typical airline business models as the historically established on the market include the traditional network carriers, regional carriers, leisure carriers and point-to-point (low-cost) carriers.

- *Traditional full-service network carriers* optimise network effects by designing optimal hub and network structures. They try to offer integrated products at comparably high quality in the form of attractive ODs throughout the world.

As an instrument for increasing the reach of their networks they make extensive use of alliance strategies and joint ventures (e.g. Lufthansa and United Airlines no transatlantic routes).

- *Regional carriers* serve geographically limited networks within or outside alliances. They might operate regional hubs, but they mainly serve the main hubs of alliance carriers. They often also offer Wet-Lease services to full-service network carriers. An example of this type of airline is Helvetic Airways. They only serve short to medium haul routes or operate their main share of flights on this type of routes, serving or connecting to full-service carriers, and therefore face strong competition from low-cost carriers and have to try to match their cost structures. Regional carriers are somehow torn between getting integrated into large networks and developing into a point-to-point type of business model.
- *Leisure airlines* are a special form of a point-to-point and network business model and also partly known as the holiday charter model. Such airlines fly point-to-point traffic on short and long haul, but often also connect with network carriers in hubs by taking their passengers to holiday destinations they don't serve themselves. They often offer just weekly rotations with ideal timetables for leisure travellers to tourist destinations.

  According to old airline regulations, leisure airlines were traditionally not allowed to sell single seats. Seats had to be sold to tour operators, which packaged them into integrated travel products. For a certain time, beginning in the 1990s until the end of the first decade of the new millennium, the strategic success factor of leisure airlines was considered to be their integration into tour operators. Minimal transaction costs and very flexible scheduling and capacity control allowed for a higher usage and seat load factor of planes. However, with the transformation of the tour operating sector, as a result of the increasing importance of direct booking via internet, tour operators were forced to reduce their risks and capital exposure. In addition, new software systems allowed for a better inventory and capacity control. As a result, many tour operators were no longer interested in owning their own leisure airlines. Thus, nowadays leisure airlines sell flight tickets also directly to travellers. The comparative advantage of leisure airlines lies in their cheaper cost structure resulting from less complex operations and rather lower costs. Many leisure airlines were able to successfully establish a brand with a strong image in the holiday and leisure market over time and established themselves well on the market.
- Most *point-to-point airlines* (or so-called *low-cost carriers)* operate point-to-point business networks. Their main strength is their lean cost structure which is the result of less complex operations that enable short turnaround times and by this intensive aircraft utilisation. Most of them operate short-haul flights. The main savings of low-cost carriers compared to network carriers are illustrated in ◘ Figs. 5.17 and ◘ 5.18:

The gap between the low-cost airlines CASK in 2018 and Ryanair's CASK in 2006 indicates that low-cost carriers have been facing increasing costs. At the same time, network carriers were able to reduce their CASK. The latter reduction can be traced to the increasing cost pressure that network carriers faced with the advent

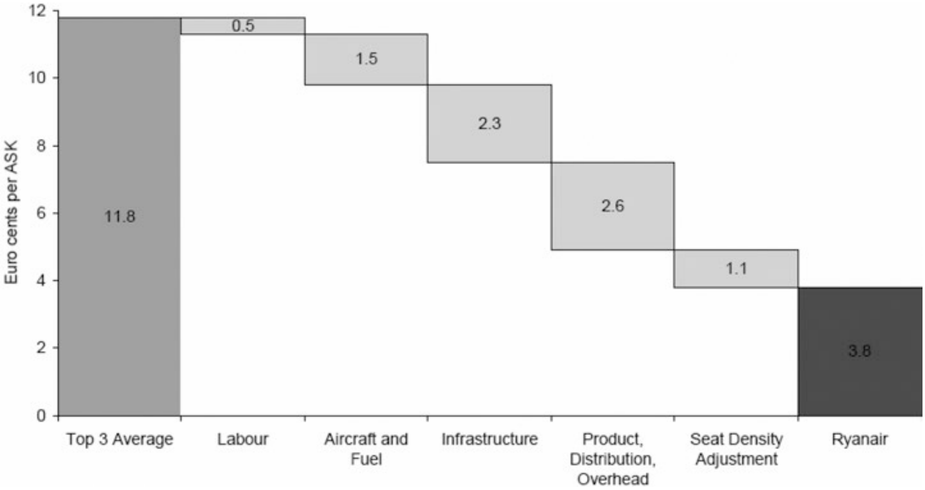


Fig. 5.17 Cost differences between legacy and low-cost carrier in 2006 (here: Ryanair) (IATA, 2006)

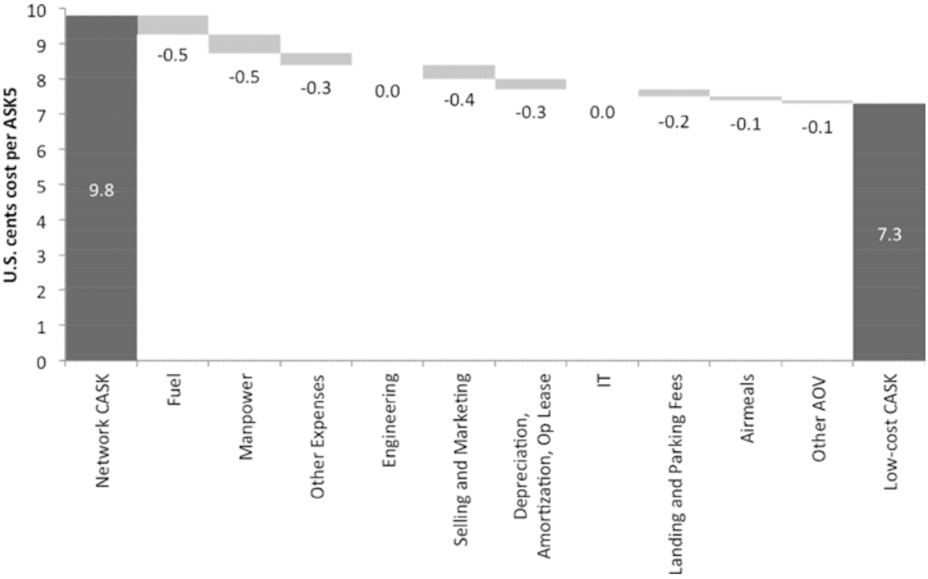


Fig. 5.18 Cost difference between network carrier and low-cost carrier in 2014 (IATA, 2014)

of their low-cost competitors. Many network carriers went into a hybridisation of their business model, by keeping packaged full service offers on the long haul but introducing new unbundled price and revenue structures for short-haul operations, offering passengers a similar buying situation like point-to-point airlines. This necessitated restructuring, increasing efficiency and productivity to gain the necessary cost savings to remain competitive. At the same time, low-cost carriers such as

Ryanair realised that, in order to grow, they would need to expand into bigger markets than the secondary airports they operate from. This led to low-cost carriers to increase their presence at busy airports, e.g. easyJet at Amsterdam or Paris and Ryanair at Frankfurt/Main. Simultaneously, business model characteristics typical for legacy carriers, such as joining GDS or airline partnerships, have been rolled out at low-cost carriers. As a result, costs have risen in the past years and the cost bases of legacy airlines and low-cost carriers are showing a tendency to converge.

Nevertheless, these strategic success factors also limit the scope of operation for these companies. Short turnaround times only play a role if a plane has to be turned around five to eight times a day. But there are also new developments into medium to long haul offers by point-to-point low-cost airlines. For example, routes from Continental Europe to the Canary Islands (e.g. Ryanair) or from Australia to South East Asia (e.g. JetStar) or from South East Asia to China (e.g. AirAsia) or even Europe (e.g. Scoot) are offered on the market by low-cost carriers. Important for long-haul low-cost operations are a flight time each way of max 8–9 h so the plane can go and come back in 24 h, be cleaned and maintained at the main hub and operations can be handled with one plane for one OD. This keeps the network structure simple. For a successful operation, such operations can work on junk routs with huge demand. As soon as long-haul planes cannot be filled at the origin and destination on a regular basis, a feeder network is needed, which increases costs and dependencies. By moving into networks, cost will increase and customers will pay a higher average price and demand more services. In such a case, an airline better focuses on a network model to be successful.

- *Business aviation* includes corporate aviation and air taxi services which represent a globally growing market. There are two models within the business aviation market: the traditional business aviation with traditional business jets, which can be operated on short- and long-haul routes, and Very Light Jet Air taxi models, which operate with smaller Very Light Jets (e.g. Embraer Phenom 100) on shorter routes. These aircraft need less runway length and thus can land on smaller airfields. Instead of the new Very Light Jets, turboprop planes (e.g. PC 12) are also frequently used today.

Airline models have further developed over time and different definitions were derived from the established business models. Wittmer, 2017 adjusted the definitions based on new developments in Pricing of network carriers and the above-mentioned changes of point-to-point airlines upgrading their offers creating packages as well. A hybridisation of products and services was seen especially in the short-haul market where competitions are very strong and customers mainly choose flights based on price, neglecting many of the other service-related factors (◘ Fig. 5.19).

In 2019 the discussion was moved forward by Rossy, Wittmer and Linden, who considered the established business model definitions of network, leisure and point-to-point airlines as unprecise. They worked on a further verification of different factors, which are used by customers when defining airline models. The rationale behind was the fact that some point-to-point airlines offer similar or even better services then full-service network carriers on short-haul operations and new

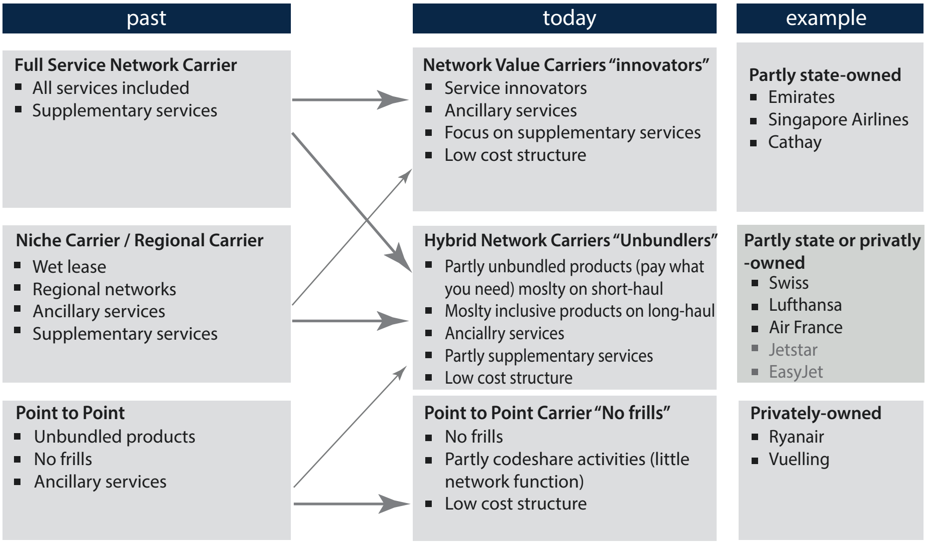


Fig. 5.19 Airline business models (author's own figure)

long-haul low-cost carriers entered the market or established low-cost airlines moved into longer distance flight offers in some areas of the world (e.g. Air Asia X, JetStar, Scoop, etc.).

They established a new framework including actual business model factors and looked at patterns (Gassmann et al., 2014) across 40 airlines. Based on this analysis, four generic business models were defined:

- No frills
- Unbundlers
- Boutique
- Connectors

Figure 5.20 shows the framework including the factors and the patterns, which show the four main models found.

Airline Business Models (Rossy et al., 2019)

By Andreas Wittmer and Christopher Siegrist

No-frills: No-frills carriers offer a minimum level of service and only a single class among their homogeneous fleet. They operate within a continental region between secondary airports as a point-to-point carrier. Typically, No-frills airlines are not collaborating with other airlines and sell their tickets solely through their airline's website. They offer à la carte tickets meaning passengers can add additional services such as luggage and food. Their customers are aware that they need to purchase any additional services besides the seat. The unbundled products, in combination with a simple cost structure, is where their financial success comes from. Additionally, the low base-line ticket prices demanded by No-frills carriers make

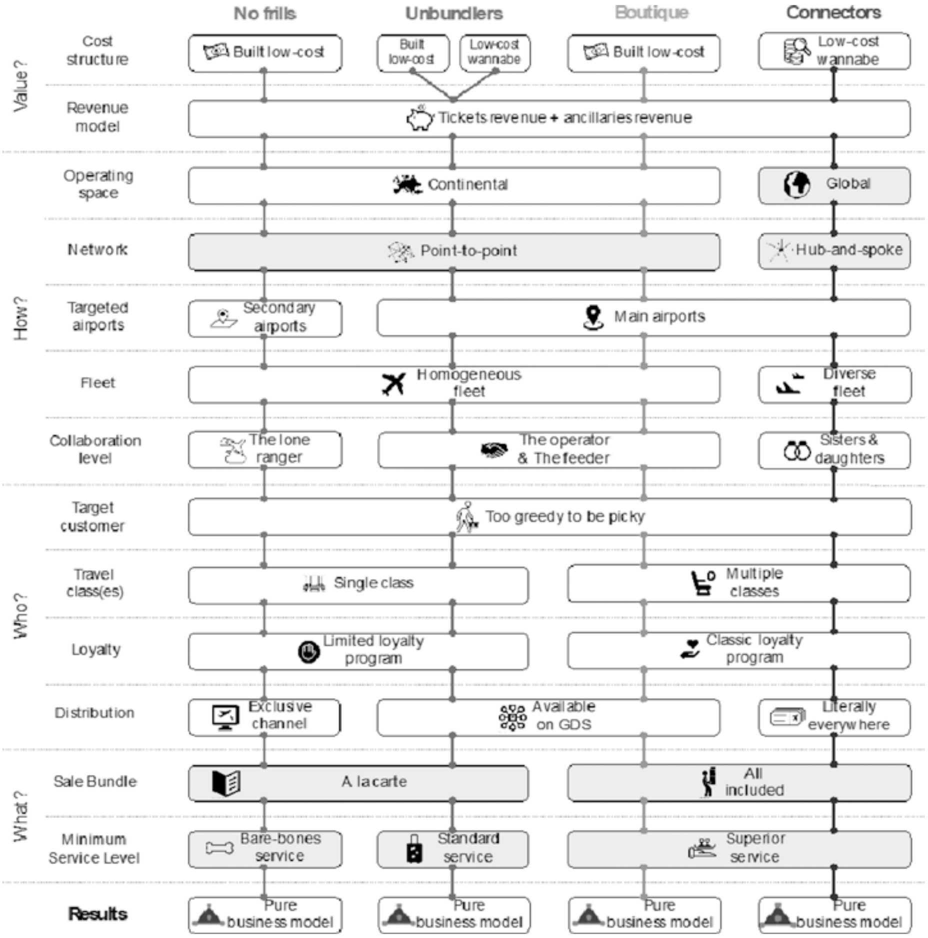


Fig. 5.20 The four generic business models of the airline business model framework (Rossy et al., 2019)

flying more affordable and therefore accessible for the general public. Examples are Ryanair, Allegiant and WOW Air.

Unbundlers: Unbundlers offer a standard service experience and a single class onboard their homogenous fleet. They predominantly operate within a continental area as a point-to-point airline connecting main airports. Nonetheless, Unbundlers can also act as feeders and operators of flights for partnering airlines. Tickets of Unbundlers can be bought through various distribution channels such as online channels as well as through Global Distribution Systems (GDS), where different bundles of services can be purchased. However, tickets are mainly purchased online as it allows customers to individualise their journey. Unbundlers, therefore, offer a steady basic service at a comparably low price, considering some included services such as carry-on luggage or free airport check-in. Nonetheless, further additional services are available for purchase. Carriers benefit from their unbundled products and the low-cost structure. Examples are EasyJet, AirAsia and Norwegian Air Shuttle.

Boutique: Boutique carriers offer a superior service, offering at least two different classes. They operate as a continental point-to-point airline among primary airports. Tickets are sold through various distribution channels. Generally, the fare includes services such as complimentary drinks and snacks. Boutique carriers also maintain a conventional loyalty programme from which travellers can benefit. Customers envisage a superior service where most aspects of the flight are included. However, certain services need to be acquired for an extra charge. Hence, Boutique carriers offer passengers more service and a higher quality compared to No-frills airlines and Unbundlers. Boutique airlines benefit from their superior service offering at a comparatively low price, which includes many additional services, as well as from cost savings by operating a homogeneous fleet. Examples are Helvetic Airways, Jet Blue and Silk Air.

Connectors: Connectors operate a hub-and-spoke network through which they offer worldwide connections. Thus, they must operate a diverse fleet of narrow-body and wide-body aircrafts. These airlines traditionally offer multiple classes onboard as well as a superior service where almost every service is included, such as food, drinks and checked luggage. Their tickets are distributed throughout all distribution channels. Connectors are part of alliances and offer a loyalty programme for their frequent flyers. Hence, customers expect a superior service where almost everything is included. The Connectors benefit from their ability to connect the passengers with the world through their primary hubs and thus from ticket purchases from all around the globe. Their advantages become apparent through their size and their ability to improve their processes and quality. Examples are Swiss, British Airways and Singapore Airlines.

A certain conversion between the three main types of business models can be observed nowadays. Some network carriers sell seat capacities to tour operators, especially on long-haul flights. Increasingly, these carriers also try to operate on a point-to-point basis – at least partially. For example, British Airways and SAS operate flights from smaller airports in their home markets to holiday destinations. Low-cost carriers also try to attract transfer passengers by making use of their "natural hub" which is the operational basis of their fleet. Furthermore, they increasingly open routes to tourist destinations. In the meantime, Charter airlines have started to sell single seats, permitted by the ongoing liberalisation of the airline sector.

Current developments concerning the emergence of new business models are:

- The competition between airports and the emergence of new airports, mainly through the transformation of former military airports towards civil airports. These airports try to attract traffic. Very often they employ active marketing in order to encourage point-to-point carriers to fly into their airports. An example for this is Frankfurt Hahn which developed into a Ryanair "hub" in Germany.
- The emergence of Light Business Jets and Business Jet traffic. Many traditional airlines, like Lufthansa, try to integrate services of these jets because they aim

to provide their customers with integrated travel products, like an intercontinental flight in First Class combined with a connecting flight to some smaller city served by Business Jets.

- The differentiation of network carriers. Many network carriers develop into so-called mega-carriers, in most cases as part of an airline alliance. The remaining carriers need to focus on specific regions; a typical example in this context is the Star Alliance: Lufthansa and Turkish Airlines are mega-carriers within the alliance and SAS with its main hub, Copenhagen-Kastrup, links Scandinavia into the alliance network.

A further convergence of airline business models is possible as network carriers (NWC) implement some of the low-cost carriers' processes and strategies while low-cost carriers start to increase service levels at an extra cost. Furthermore, LCCs and NWCs serve charter operators in high season and on weekends.

Mini Case: Air Berlin "Stuck in the Middle"

By Andreas Wittmer and Christopher Siegrist

Air Berlin was a German airline operating from its main hubs in Berlin-Tegel and Düsseldorf to destinations across the globe. Originally a charter airline operating flights to the Mediterranean resorts, Air Berlin began moving into scheduled operations at the turn of the millennium. These flights initially consisted of point-to-point flights between German cities and several major European cities. Air Berlin positioned themselves as a "semi-low-cost" carrier offering low fares with frills such as meals and seat selection, thus operating a hybrid business model.

Part of their growth strategy involved the takeover of the German charter airline LTU as well as the Austrian low-cost carrier NIKI. However, as its rival low-cost carriers continued to increase competition by lowering their costs, Air Berlin found itself unable to compete on a cost-basis due to their hybrid "semi-low-cost" model. Therefore, change was needed, which came in 2012 when Air Berlin joined the oneworld alliance, signalling a transition from a low-cost carrier to a regional network carrier. Furthermore, Etihad took a 29% stake in the German carrier. These changes reflected a turn in the carrier's strategic direction. Whilst still offering cheap point-to-point flights within Europe, it started developing a hub-and-spoke network from its long-haul bases in Berlin and Düsseldorf and therefore departed from its low-cost carrier past (Wall, 2017).

At the same time, Air Berlin started introducing various measures to evolve into a network carrier. It introduced new fare bundles for price conscious travellers and offered more codeshares with oneworld airlines and Etihad. Air Berlin hoped to position itself as a carrier offering cheap fares whilst still offering good service; a big change from its roots as low-cost charter airline (Corbo, 2016). Despite these efforts, Air Berlin continued posting losses, as it had done in the past. This required financial support from stakeholder Etihad, which continued throughout the years before eventually ending in 2017. The cessation of the funding led to Air Berlin having to file for insolvency and suspend its operations in late 2017.

Air Berlin is a useful example of an airline being "stuck-in-the-middle" as per the concept by Porter (1980). They abandoned their low-cost structure (and thus their cost leadership) by trying to turn into a regional network-carrier offering low prices, whilst not compromising on quality. This outcome was a result of years of re-adapting their business model and services to increase their revenue. However, by doing so they could neither compete on cost anymore nor be differentiated enough from their competition. Therefore, losses mounted as the revenue could not cover the rising costs, which eventually led to Air Berlin's demise.

5.7 The Fight for Concepts – A380 and B747 Versus B787 and A350

On the one hand, new extra-large airplanes, such as the Airbus A380, have been introduced to the airline market. Fuel efficiency per passenger, economies of scale and scope and mega "hubbing" are the key reasons for an airline to invest in such an airplane. On the other hand, new airplanes, such as the Boeing 787 Dreamliner and the Airbus A350, have entered the market. Efficient engines and lower weight thanks to carbon fibre construction enable a larger range of intercontinental point-to-point connections. Moreover, new technologies concerning air pressure and air humidity in the cabin lead to more comfort for passengers and will therefore increase the customer value, resulting in a readiness to pay a higher price for air travel.

The A380 is seen as an ideal plane to connect mega hubs in big markets on different continents flying on junk routes. Flights from London to Singapore, from Frankfurt to New York, from Sydney to Singapore or from Singapore to Dubai represent suitable routes for this extra-large plane. The Boeing 787 and the Airbus A350, which are smaller aircraft, are more efficient connecting hubs and secondary hubs on different continents and focusing on direct point-to-point connections, e.g. from Zurich to Atlanta or, in the future, even from a European hub airport directly to an Australian hub airport. Due to lower fuel consumption, thanks to less weight, longer distances can be flown non-stop by these aircraft. Passengers will no longer need to change planes on very long routes; they will be able to get to the final destination with just one flight. Both types of aircraft are so called wide-body airplanes. They are large airliners with a fuselage of five to six meters in diameter, two aisles and seven to ten passenger seats per row. Design considerations for widebodies include, for instance, the lower ratio of surface area compared to the volume of the fuselage. The following ▣ Table 5.1 shows the implications of the new wide-body airplanes.

Mini Case: Boeing 747

By Andreas Wittmer and Christopher Siegrist

The Boeing 747 is undoubtedly an icon and a significant milestone in the history of civil aviation. Besides its distinctive fuselage shape, Bill Gates even described it as the first World Wide Web as it connected people by removing borders and bringing countries together. Besides its symbolic appearance, the Boeing 747 also posed a remarkable engineering achievement. Comprising of over six million single parts, the Boeing 747 offered enough space to cope with the growth in travel and trade flows during the 1970s, offering unrivalled passenger and cargo capacity on the main deck by moving the cockpit to the distinctive upper deck.

What started with a gentlemen's agreement between Boeing and Pan Am, Boeing delivered the first Boeing 747, a 747-100, on the 22nd of January 1970 to the American airline Pan Am. Later that year, Boeing already rolled out the 747-200 variant featuring better performance thanks to more powerful engines and a higher weight limit. Other special versions featuring better range or more payload followed suit. By far the most popular 747 was the 747-400 variant which possessed a modern cockpit and reduced the cockpit crew to two members by eliminating the flight engineer through automatisation. Over 692 airframes were delivered to airlines around the globe. The latest model the 747-8 was unable to imitate the success of the 747-400 variant with only 107 orders placed, mostly for cargo carriers. As such, a gradual disappearance of the iconic passenger Boeing 747 looms in the coming years.

The Boeing 747 is a fundamental milestone in the history of civil aviation as the high seating capacity lowered costs for airlines and pressured them into improving their load-factor, which in turn led to lower ticket prices for passengers and a push for feeder networks. This made flying more accessible, e.g. Lufthansa and Condor operated the Boeing 747 in Germany, transporting over 30% of Germans on holidays by plane (compared to the European average of 8%). Furthermore, as discussed earlier on in this chapter, the Boeing 747 saw the rise of the hub-and-spoke networks with the aim of filling all the seats.

The Boeing 747's success is further underlined by the fact, that many airlines were and still are faithful operators of this model. Lufthansa, for example, celebrates fifty years of Boeing 747 operations in 2020.

Sources: Grossbongardt, 2019a, 2019b; Littek, 2019

Table 5.1 Implication of new wide-body airplanes (table compiled by author)

Success factors network/hub airlines	Influence of large widebodies	Influence by new small widebodies
Extensive market coverage/market share and growth (through network effects) Alliance Ability to adapt good and homogenous processes and qualities	Long range Economies of scale and scope Mega "hubbing"	Longer range Connecting hubs and secondary airports More passengers Less fuel consumption More freight Convenience Point to point Customer value Readiness to pay

Review Questions

- Explain the difference between network, regional, charter and low-cost carriers.
- What concepts exist in the business aviation sector?
- What are elements of airline strategy?
- How do airlines create value in networks?
- What are economies of scale?
- What are economies of scope?
- What are economies of density?
- How can a so-called natural monopoly appear?
- What are hub economies?
- What are hub diseconomies?
- What is the problem if a hub becomes too big?
- Is a hub constantly at maximum capacity?
- What are instruments of capacity management?
- What are success factors of large wide-body airplanes (A380) for network carriers?
- What are success factors of new small wide-body airplanes (B787) for network airlines?

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From Airline Network Development to Airline Operations

Jan-Christian Schraven

Contents

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6

From Airline Network Development to Airline Operations

Summary

- Airlines have a very perishable product in the shape of airline seats, which means once the flight takes off, the seats cannot be sold anymore. This requires careful planning on three different levels: network strategy, network management and revenue management.
- Network strategy aims to tap into markets with high demands and create a network that is diversified and thus counterbalances any fluctuations in demand across the network. The choices are a hub system or point-to-point systems, both having their advantages and disadvantages.
- To make best use of its fleet, airlines need to undergo fleet planning to build the fleet needed for its network. This includes purchasing, configuring and scheduling the aircraft.
- Routes require an economic evaluation; this is straightforward. However, in hub structures, the network profit value of feeder flights needs to be considered too, making seemingly unprofitable routes economically viable.
- In a final planning step, operational planning assigns each airframe to a set of flights, taking slots, turnaround times and block hours per day into account. The aim is to maximise the block hours flown per day.
- Once all flights have been planned and assigned to the aircraft, revenue management is tasked with selling the seats. However, this is a meticulous task that requires careful planning and thorough analysis of market conditions.

Airlines face the challenge of a perishable product as their seats can only be sold up to the time of departure, after which they cannot be sold anymore. Therefore, it is important for airlines to consider their network strategy, their network management and revenue management to ensure that the maximum number of seats are sold at the right price before a flight departs. This chapter explains the concepts behind network strategy, fleet planning, economic evaluation, operational decisions and revenue management. Beginning with network strategy to tap into unserved markets, the fleet planning is vital to ensure the right equipment is ordered in sufficient numbers. To ensure the profitability of a route, it needs to be evaluated using economic evaluation methods that take the network effects into account. Furthermore, these airframes need to be assigned efficiently, ensuring that the aircraft's daily utilisation is maximised. In a final step, the concept of revenue management is presented which aims to sell all the seats whilst maximising revenue based on the market conditions.

6.1 Commercial Basics of an Airline

Creating and developing a sustainable and profitable airline seem to be a daunting task. Too often airlines have started and failed. Too often airlines were financially dead but kept alive with funds from states fearing the loss of connection to the world or investors with emotional bonding and high-risk strategic bets. All the unsuccessful ventures too often neglected the mere basics of the airline economy such as diligently planning and managing a *high investment business* producing a *non-storable product* while facing a highly *flexible demand of end-customers*.

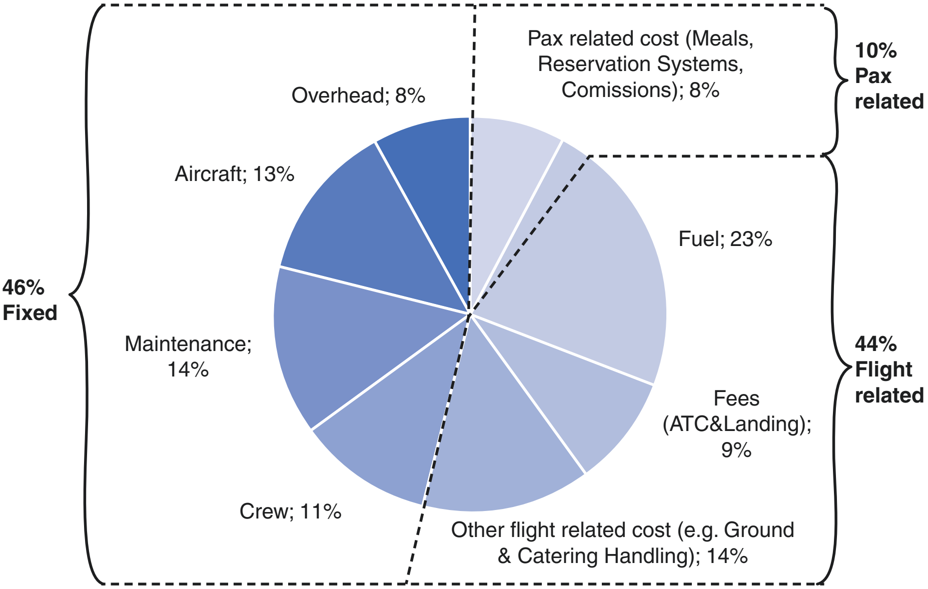
6.1.1 Nature of Airlines – High Fixed Cost

The main business of airlines remains to offer air travel by selling a ticket. Air travel is a very perishable product and cannot be stored. Once the aircraft takes off, the product cannot be sold as the seat is gone.

In contrast to that, airlines have long lead-times in making their key resources – aircraft and operational personnel – available. Aircrafts are usually ordered with lead times of about three or more years. Operational personnel need to be trained over years (especially pilots, technicians). This is reflected in the cost structure of an airline (◘ Fig. 6.1).

While 10% of the costs are directly dependent on the number of passengers transported, 44% are dependent on the flight and the remaining 46% are regardless of the number of passengers carried or flights conducted.

The latter needs more explanation. Once the fleet size and the number of aircraft are set, the operating resources are sourced. With the training schedules given, it takes about 2–3 years for an airline to adapt their cockpit crew and technical resources to a change in fleet size. Cabin personnel needs about 6 months lead time. Likewise, adapting overhead costs takes time. So the "fixed cost" for aircraft, crew, maintenance, overhead are there regardless of whether a flight is conducted or not.



◘ **Fig. 6.1** Cost structures of an airline. (SWISS, 2005–2010)

As the direct variable cost to transport an additional passenger is rather low, it usually drives the airline industry into "price-wars" if not managed correctly. Consider the following example: The cost of a short-haul flight is about EUR 12,000 (for a round trip 24,000 EUR). Let us assume that the capacity is 150 seats. The full cost per seat would be EUR 160 for a round trip. The costs could be broken down into EUR 74 fixed costs, EUR 70 flight variable and EUR 16 passenger variable costs.

If an airline has determined its fleet size and conducts the flight, each passenger paying more than 16 EUR for the round trip (plus the ticket fees for the airport) is generating a contribution margin. Therefore, when an airline is desperate to fill its seats (remember, seats on a flight are perishable), it could fall into the trap of offering super-low prices. If done in its main markets, customers will learn and take these prices granted and will adjust future price expectations accordingly. If the airline must sell more and more seats at these marginal prices, thus bankruptcy will be inevitable.

Therefore, an airline has to fine-tune its offer right from the beginning using the right planning process, applying the right metrics to judge its profitability and being very prudent in offering a sustainable price mix to its markets. To ensure a right-sized offer, airlines need to introduce a clear and structured planning process, with differentiated planning streams for sizing the company as well as creating and executing a schedule.

6.1.2 Planning Levels of Airlines

As discussed, we propose three main planning levels for an airline. To ensure economic viability, a strict separation of these planning levels is strongly recommended. The levels are:

- Fleet planning (or "network strategy").
- Schedule planning (or "network management").
- Passenger planning (or "revenue management").

By separating the planning levels, the airline planning follows the basic economic maximisation- or minimisation principle. Essentially, the principle says one has to fix one side and maximise or minimise the other side, as it is harder to work on both ends. Either the input is fixed and the output is maximised, or the output is fixed and the input is minimised to generate profit.

The construction of the different planning levels follows this principle. It is outlined in ▣ Fig. 6.2. Based on the general network strategy, the fleet size and fleet structure are determined. Once the fleet is planned, it serves as a *fixed* input for schedule planning, which aims at allocating the fleet to routes in order to achieve the best possible return. If a route is not performing as expected, it is replaced by the next route, but the fleet remains unchanged. Once the schedule is *fixed* most costs are determined. It is the task of revenue management (passenger planning stream) to maximise the revenue outcome based on the *fixed* schedule.

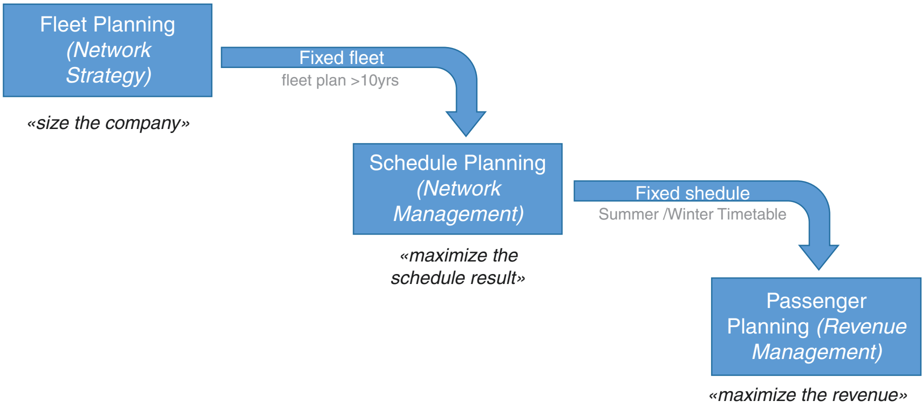


Fig. 6.2 Planning levels of an airline. (Author's own figure)

Especially in fleet and schedule planning the separation of planning streams is extremely important. At airlines where the separation is not followed, new routes often serve as an explanation to enlarge the fleet. Once the demand changes – and that can occur quickly – the route loses its profitability. Suddenly, the aircraft has no profitable routes anymore and other routes have to cover the fixed costs, or the aircraft capacity is marketed on other routes at marginal prices – driving the overall profitability down.

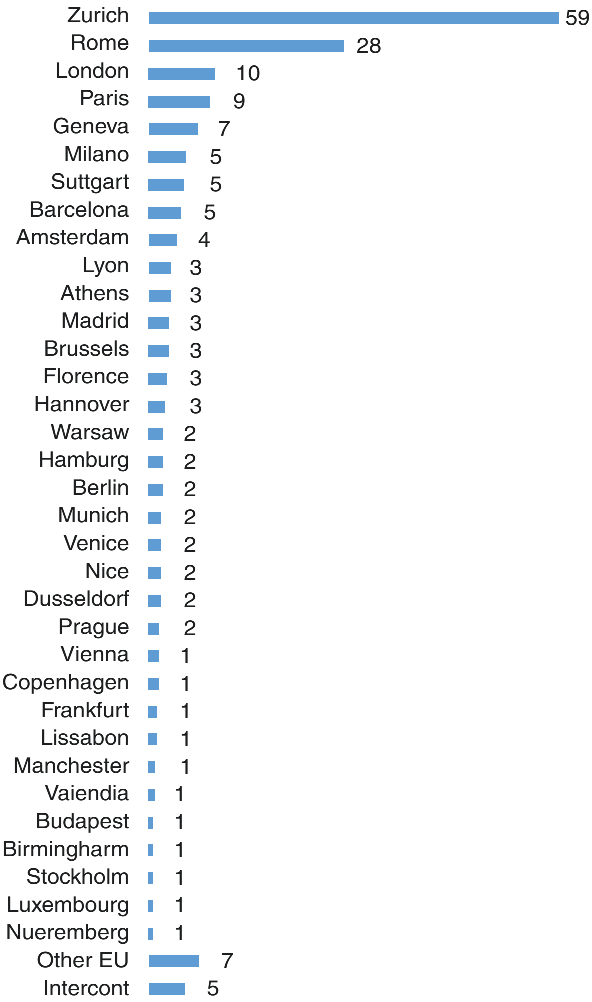
In ► Sects. 6.2 and 6.3, we will discuss the planning levels fleet planning and schedule planning in more detail as they lay the foundation for a profitable airline. ► Section 6.4 discusses how to evaluate profitability for a network airline on structural level (relevant for network strategy) and schedule level (relevant for network management). ► Sect. 6.5 explains the realisation of the schedule and its constraints. In ► Sect. 6.6, revenue management is discussed briefly.

6.2 Network Strategy and Fleet Planning

6.2.1 Network Strategy – Mitigating the Volatile Demand

Air travel is a consumer economy. It copes with a dispersed customer base. The largest "customer accounts" are big companies, but usually even the largest account makes up not more than 5–10% of total revenue. Airline revenue potential fluctuates with the overall state of the economy and development of the gross national product, but several single-market specific effects (holidays, fairs, sports events) influence revenue as well. A sound network strategy should aim at building a market base which is diversified, in order to balance variations in the single markets.

Among scheduled airlines, two major network strategies have developed over the years: the *hub-spoke strategy* of hub airlines and the *point-to-point strategy* usually adopted by no-frill airlines.



◘ **Fig. 6.3** Average number of passengers by origin of travel on Zurich-Delhi flights. (SWISS, 2005)

Hub airlines combine markets in their hub system.[1] Via feeding and de-feeding, a single flight can easily attract 100 markets. A flight from Zurich to Delhi caters for travels to Delhi sold in Zurich or Delhi. With a hub system it can serve a Paris-Delhi market sold in Paris or Delhi, Brussels-Delhi, etc. ◘ Figure 6.3 shows the distribution on the Delhi route as an example.

Point-to-point carriers are building flight networks over a geographic area (e.g. Europe) with several bases. They focus on high asset productivity, which rules out transfer traffic. When a new base or destination is added to the network, they

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[1] The word "hub" is taken as a graphic analogy to a bicycle wheel, where many spokes are connected to the hub in the middle of the wheel.

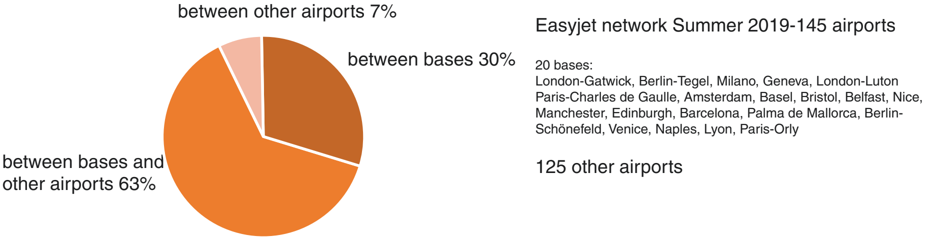

Fig. 6.4 Capacity distribution in easyJet's network in summer 2019. (Author's own figure and analysis based on OAG, 2019)

quickly connect their other bases to the new destination. In doing so point-to-point airlines move their aircraft around in the network and scale frequencies up or down, starting and stopping routes to match capacity to the fluctuating demand. Figure 6.4 illustrates the network structure of easyJet in summer 2019. About 20 bases make up for 93% of the traffic either between themselves or to the remaining airports in the network.

In common language point-to-point carriers are labelled as "low cost," leaving the notion that hub carriers are something different. We argue that all carriers are "low cost" because all airlines have to be prudent about their cost and efficiency structures. However, due to the nature of the business model, hub carriers operate with lower asset productivity and additional costs, due to the need to coordinate transfer traffic (wave structures[2] at airports, additional classes due to long-haul offering etc.).

On the other hand, the hub model opens additional revenue potential, as significantly more markets (O&Ds) can be served by each single route. Except for very few locations in the world, a sustainable long-haul operation requires hub structures, opening further revenue potentials, which a point-to-point carrier cannot attract. Up to now, profitable point-to-point offers on long-haul routes are only realisable to leisure-like destinations with low frequencies in a niche offering. It remains to be seen if point-to-point long-haul offers with high frequencies can be established with a sustainable profitability. In essence, both network strategies can be compared as shown in Table 6.1.

6.2.1.1 Selecting the Right Hub Infrastructure

The focus here is on hub carriers in Europe. For these carriers, the purpose of building a hub lies in the desire to tap into the long-haul markets. European hub systems are, therefore, built to offer good connections between European and intercontinental markets.

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[2] Wave structures describe the coordination of incoming and outgoing flights at a hub of an airline. Wave structures will be discussed in more detail in ► Chap. 3.

Table 6.1 Basic differences between point-to-point carriers and hub carriers

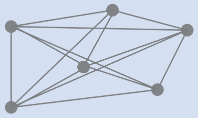
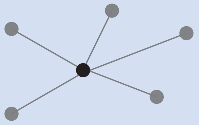
Point-to-point Carrier	Hub-Carrier
Point-to-point routes connected via bases	Hub and spoke system with a few bases
	
One class and more seats per aircraft	Business class to serve premium connex
High productivity by using full range of opening times	Lower productivity due to wave patterns
Simple complexity due to point-to- point traffic	Process complexity due to connex traffic

Table compiled by author

6.2.1.2 Key Hub Parameters: Peak Capacity and Minimum Connecting Time (MCT)

To offer sustainable year-round long-haul flights, one needs feed and de-feed from and to 30–40 and more destinations. As a consequence, a hub airport needs the capacity to enable about 30–40 arrivals or 30–40 departures in a short timeframe besides the ongoing departure or arrival traffic. Therefore, the peak capacity of an airport is one of the most relevant parameters of a hub infrastructure.

Depending on the procedures as well as approach and departure route structures a runway can deliver an hourly capacity of about 36 movements per hour (a flight every 1.5 min). Therefore, an operating hub requires more than one runway, while both runways should be operable independent from each other and mix capacity should be above 60 movements per hour. Looking at the European airport structure, this rules out many airports to serve as a hub. Table 6.2 shows the peak capacity of different airports in Europe.

Besides peak capacity, the other key parameter of a hub infrastructure is the minimum connecting time (MCT). The minimum connecting time describes the minimum time allowed between a scheduled arrival of a feeding and a scheduled departure of a de-feeding flight.

The following example should illustrate this. Take for example a schedule with two arrivals at noon: at 12:00 the flight from NCE and at 12:10 the flight from CPH. At 12:50 there is a departure scheduled to JFK. If the airport allows an MCT of 40 minutes, both connections NCE-JFK and CPH-JFK can be put on the

▣ **Table 6.2** Selected airports and their peak capacities

	Max. arrival	**Max. departure**	**Max. movements mix**
Paris – Charles de Gaulle (CDG)	63	73	111
Amsterdam (AMS)	68	74	110
Frankfurt (FRA)	60	60	104
Madrid (MAD)	48	52	100
London Heathrow (LHR)	45	45	90
Munich (MUC)	58	58	90
Barcelona (BCN)	38	40	78
Vienna (VIE)	48	50	68
Zurich (ZRH)	36	36	66
Dubai (DXB)	36	41	66
London Gatwick (LGW)	*28*	*39*	*55*
Berlin-Tegel (TXL)	*30*	*30*	*52*
Hamburg (HAM)	*31*	*31*	*48*
Dusseldorf (DUS)	*33*	*36*	*43*
Stuttgart (STR)	*32*	*32*	*42*
Hannover (HAJ)	*30*	*34*	*40*

Table compiled by author, based on Flughafenkoordination Deutschland (2020) and Schedule Coordination Austria (2019)

market and loaded into the reservation systems. If the MCT is 50′, only the connection NCE-JFK can be shown in the reservation system and the airline is not allowed to sell a connection CPH-JFK. It is obvious that a shorter MCT increases the connections, which can be offered without any additional aircraft capacity. As more connection possibilities help balance fluctuating market demands, the MCT is the second key parameter of a hub infrastructure.

The MCT depends on the layout of the airport and its terminal and baggage-sorting infrastructure. When a passenger connects from a European flight to a long-haul flight he usually has to pass border control and security control. His baggage gets unloaded, delivered to the baggage sorting system, screened, sorted and then transported to his connecting flight. All these processes need to be so efficient in order to enable a connection within the MCT. ▣ Table 6.3 shows MCTs at various European hubs.

The following example will further illustrate the importance of these two parameters. Let us assume there are departure and arrival slots available every

▪ **Table 6.3** Minimum connection times at selected European hubs

Hub	MCT (in minutes)
CDG	70 (within terminals), 90 (between terminals)
AMS	40 (within Europe), 50 (other)
FRA	45
MAD	45
LHR	60 (within terminals), 90 (between terminals)
MUC	40–45 (depending on terminal)
VIE	25 (within terminal)
ZRH	40

Table compiled by author

5 minutes and the peak capacity is 3 arrivals and 3 departures per 5 minutes (we call it a peak capacity of 3). If all possible slots are filled with flights, this would mean 3 departures and 3 arrivals every 5 minutes resulting in a total of 72 arrivals and 72 departures within a two-hour frame.

Furthermore, we assume that the airport offers a MCT of 40 minutes, meaning that for an arriving flight at 10:00, all departures at and after 10:40 can be sold as connections. The maximum number of connections within a two-hour window can be calculated with the formula below. In our example, the maximum number of possible connections is 1'224.

$$k^2 * \frac{n^2 + n}{2} = 3^2 * \frac{16^2 + 16}{2} = 1'224$$

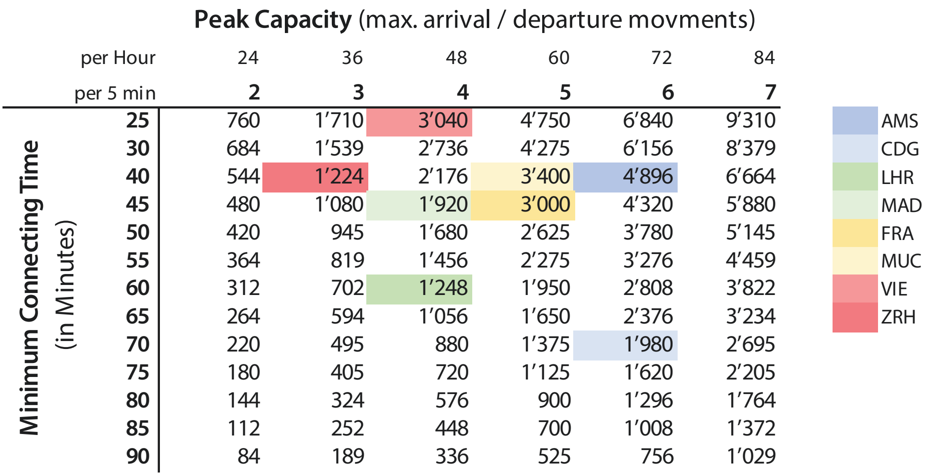
k = peak capacity per 5 minutes (in the example k = 3).

n = (120 minutes – MCT) / 5 minutes (in the example MCT = 60 and n = 16).

▪ Table 6.4 shows how the maximum amount of connection increases significantly once the peak capacity increases or the MCT decreases.

Amsterdam Airport offers the best infrastructure for a hub system with high peak capacity and short MCT. With long MCTs, London Heathrow (LHR) and Paris Charles de Gaulle (CDG) offer not more potential than Madrid (MAD) and Zurich (ZRH). As both airports are situated in catchment areas with high local traffic volume, connection traffic seems less important there. The very short MCT in Vienna (VIE) leverages the hub potential significantly and puts it on the level with Frankfurt (FRA) and Munich (MUC).

Table 6.4 Maximum number of connections within a two-hour window at different peak capacities and MCTs



Peak Capacity (max. arrival / departure movments)

	per Hour	24	36	48	60	72	84
	per 5 min	**2**	**3**	**4**	**5**	**6**	**7**
Minimum Connecting Time (in Minutes)	**25**	760	1’710	3’040	4’750	6’840	9’310
	30	684	1’539	2’736	4’275	6’156	8’379
	40	544	1’224	2’176	3’400	4’896	6’664
	45	480	1’080	1’920	3’000	4’320	5’880
	50	420	945	1’680	2’625	3’780	5’145
	55	364	819	1’456	2’275	3’276	4’459
	60	312	702	1’248	1’950	2’808	3’822
	65	264	594	1’056	1’650	2’376	3’234
	70	220	495	880	1’375	1’980	2’695
	75	180	405	720	1’125	1’620	2’205
	80	144	324	576	900	1’296	1’764
	85	112	252	448	700	1’008	1’372
	90	84	189	336	525	756	1’029

AMS
CDG
LHR
MAD
FRA
MUC
VIE
ZRH

Table compiled by author

6.2.1.3 Developing a Growth Plan

Planning the initial airline growth is quite straight forward as it is based on general passenger forecasts. IATA and aircraft manufacturers provide forecasts based on general economic factors like GDP development, import/export development, etc. The initial growth plan serves of course as a starting point, which is modified and must be justified in a full company economic evaluation.

While trend planning secures steady development, it lacks foresight when disruptive changes occur. For European airlines two changes occurred in the last 20 years, which can be labelled “disruptive” changes – first, the development of large point-to-point networks in short/medium traffic by Ryanair and easyJet – second, the establishment of Dubai as a large hub based on the A380 technology.

6.2.1.4 Disruptive Business Model of Pan-European Point-to-Point Networks

Southwest Airlines started in 1971 to offer point-to-point flights in the United States at reasonable prices. To keep its cost structure low, the airlines operates only Boeing 737 s, with short turnarounds and high productivity.

Until the 1990s, air traffic between the European states was only possible by designated national airlines. In 1992, the European Commission adopted the “third liberalisation” package, which removed the main barriers in the regulation of European air traffic (Europäisches Parlament, 2020). From then on, it was possible for a European Airline to fly between any two airports in Europe. This laid the foundation for “importing” the Southwest business model to Europe.

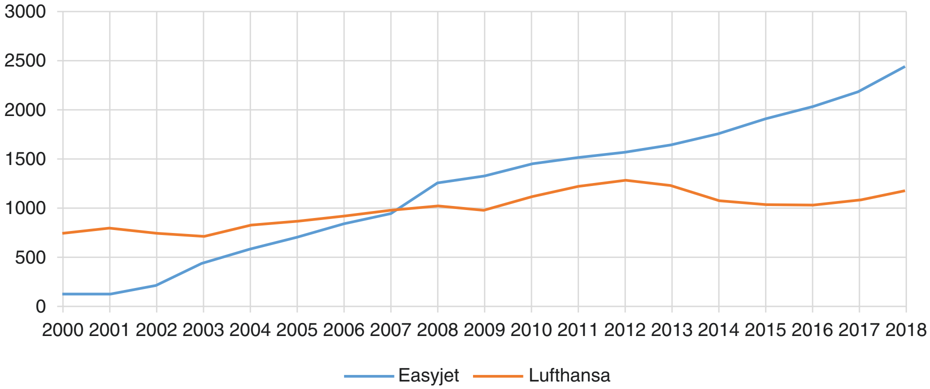


Fig. 6.5 European production of easyJet and Lufthansa (ASK in September week). (Author's own figure and analysis based on OAG, 2019)

At the end of the 90s, several carriers (Debonair, Virgin Express, Go) experimented with Southwest's business model but were not successful. easyJet and Ryanair perfected the model and were able to establish themselves in the market. With their low prices, they employed 150+ seater aircraft on routes (e.g. DUS-CDG), which were previously served by small regional aircraft. They created new passenger markets, as flying suddenly was affordable to many more people. The incumbent carriers were not aware of the dimension of this market and underestimated the growth potential. ▣ Figure 6.5 compares the development of the weekly production in Europe (measured in available seat kilometres – ASK) of easyJet and Lufthansa.

6.2.1.5Disruptive Use of Technology to Create a Mega-Hub in Dubai

Emirates was formed in 1985. Until about 2005, it was a local carrier serving the passenger demand to and from Dubai. In 2004/2005, Emirates changed its strategy to become a global airline. Emirates built its strategy on then upcoming new large aircraft (Airbus A380 and Boeing 777). In 2005 the first Boeing 777 entered to fleet. In 2008, the first Airbus A380 entered the fleet. As of 2019 the fleet of Emirates consists of 109 Airbus A380 and 148 Boeing 777 passenger aircraft.

The strategy proved successful, as major European and Asian carriers were not able to satisfy the growing demand of air travel. Additionally, the new aircraft offered range and seat capacity at a lower unit cost. As Dubai is geographically well located for the travel between Europe and Asia, Australia, Africa and likewise for travel between Asia (India) and America, Emirates was able to tap into most growing intercontinental demand.

Backed by a national strategic growth plan to establish Dubai as an economic hub for Africa, India (Asia) and Middle East, passenger demand to Dubai was growing at considerable rate.

With their financial and infrastructural limitations and their moderate growth plans, European carriers were unable to satisfy the passenger demand and opened

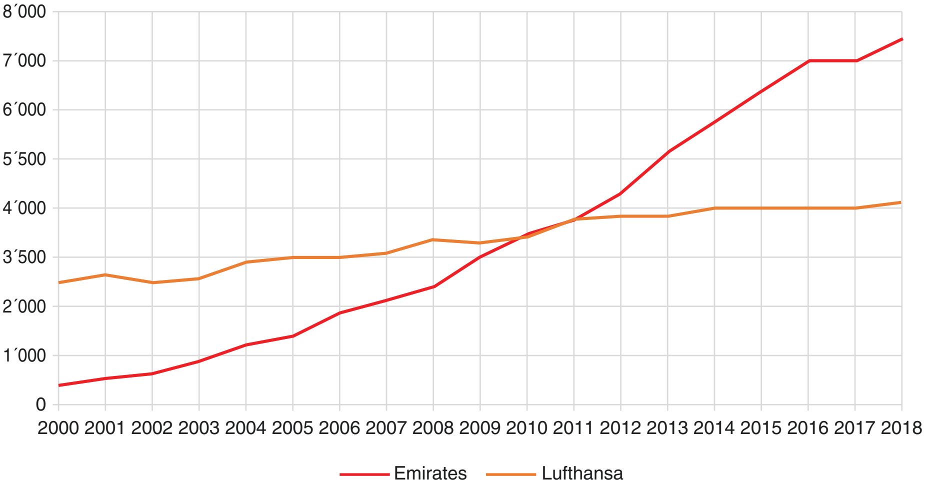


Fig. 6.6 Total production of Emirates and Lufthansa (ASK in September week). (Author's own figure and analysis based on OAG, 2019)

market space for Emirates. The differences are illustrated in Fig. 6.6, which compares Emirates production development (measured in ASK) with Lufthansa‘s.

6.2.2 Fleet Planning

Based on the market opportunities, the infrastructural capabilities and the airline‘s competencies, network strategy defines a growth plan, which is the basis for the airline's fleet plan.

As outlined earlier, the size of the fleet determines almost half of the airline's costs long-term. Once the fleet has been defined, the respective personnel resources (cockpit crew, cabin crew, technicians etc.) to operate the fleet are formed. Basically, the fleet determines the size of the company. Therefore, it is crucial that fleet planning is regarded as a strategic and long-term decision. It is of the same magnitude as decisions about building a plant in the industrial sector. Fleet planning decisions are long-term decisions. Purchased aircraft usually stay in the fleet for up to 25 years. Terms of 5–7 years are usual for aircraft lease contracts.

The key factors in fleet planning are set out below. We will discuss them in more detail later.

- **General Factors**
  - Overall fleet capacity.
  - Structure of the fleet (how many large, how many small aircraft).
  - Developments in aircraft technology.
  - Commonalities with current fleet.
  - Roll-over requirements of current fleet.
  - Flexibility.

- **Aircraft Specifics**
  - Economics.
  - Range and performance potential.
  - Purchase prices.

- **Timing**
  - Availability of aircraft (delivery slots).
  - Cabin product cycles (as equipping an aircraft with new cabin products usually requires long downtimes, which should be coordinated with large checks[3]).
  - Investment capabilities.

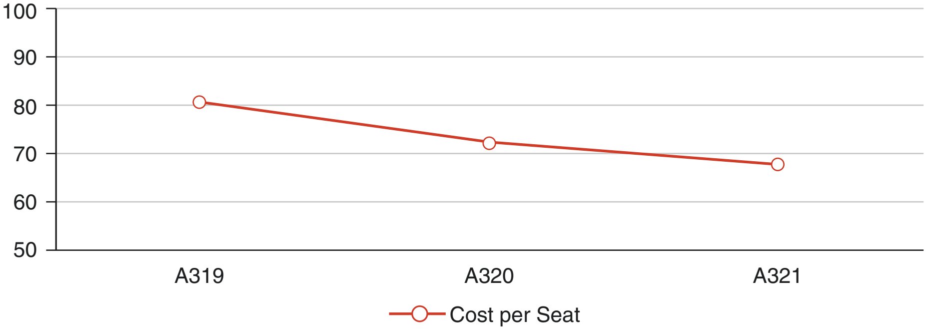
6.2.2.1 General Factors

- **Overall Fleet Capacity**

The overall fleet size is derived from the growth plan, which is based on expectations about the development of relevant economies, the airline growth strategy, considering expected infrastructure limitations.

- **Structure of the Fleet**

The fleet structure addresses the mix of different aircraft sizes. Usual aircraft for scheduled carriers cover sizes from 50 to 220 seaters in short- and medium-haul traffic and 200–500 seaters in long-haul traffic. The larger the aircraft, the higher the flight cost, but the lower the unit cost (unit cost = trip cost per seat). It is logical that if a larger aircraft with lower unit cost can be filled, lower prices can be offered – or in other terms: the offering is more competitive. ◘ Figure 6.7 shows average unit costs of selected short-haul aircraft.



◘ **Fig. 6.7** Average unit cost of selected short-haul aircraft. (Author's own figure)

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[3] D-checks usually take place every 6–7 years.

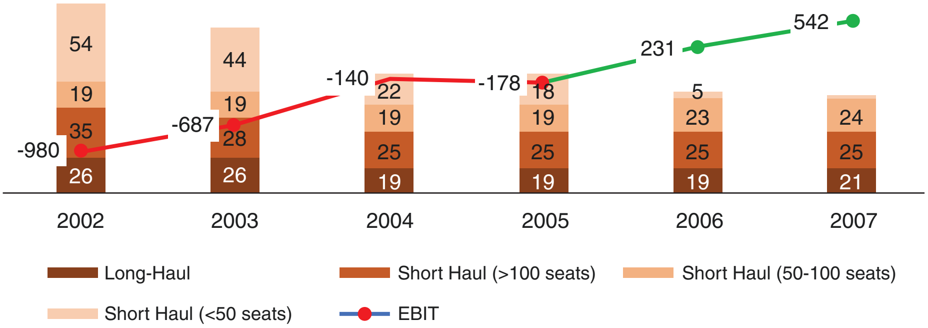


Fig. 6.8 SWISS fleet and EBIT development. (SWISS, 2002–2008)

▶ Example: SWISS Turn-around with a New Fleet Structure

Getting the fleet right was one of the main factors in the turnaround of SWISS. SWISS started in 2002 with a high amount of small aircraft. During the restructuring, the fleet was reduced by letting go of most of the 50- and 80-seater aircraft. Consequently, overall unit cost declined. As the aircraft could be filled with passengers, the airline was profitable – see Fig. 6.8 below. ◀

▪ Developments in Aircraft Technology

Operating an economic fleet gives a competitive advantage right from the start. Therefore, fleet planning has to take technological cycles of manufacturers into consideration. New aircraft types offer advantages in flight economics like lower fuel burn, lower maintenance cost and less operating personnel. For example, technology led to a reduction in flight deck personnel from up to five positions in the 1950s (captain, first officer, flight engineer, radio operator, navigator) to two positions in the 1990s (captain, first officer).

▪ Commonalities with Current Fleet

The major aircraft suppliers offer fleet families. Aircraft of different sizes in one fleet family have similar parts and can be operated in the same way. This offers advantages in maintenance due to reduced part stocks and mechanics being able to work on all aircraft using a single qualification. Likewise, pilots are able to fly all aircraft, reducing the amount of training.

At airlines operating both short/medium-haul and long-haul aircraft, pilot careers usually follow this pattern: first officer short-haul – first officer long-haul – captain short-haul – captain long-haul. When long- and short-haul aircraft of the same manufacturer are operated, training times are shorter.

▪ Roll-over Requirements of Current Fleet

Aircrafts undergo regular check patterns. As their parts are constantly exchanged, they usually can be operated for 25 years or even more. At the end of an aircraft life, costly life-extension programs and landing gear overhauls are required. The cost of these programs, the better economics of new aircraft (preferably new technology aircraft), purchase prices and the investment capabilities of the airline define the roll-over timings and requirements.

- **Flexibility**

Good fleet plans have flexibility embedded. Upward flexibility is secured by options on additional aircraft. Together with a fixed aircraft order, the manufacturer usually grants options. Options are bound to specific delivery months in the future. With a few years lead time the options can be changed into fixed deliveries or cancelled.

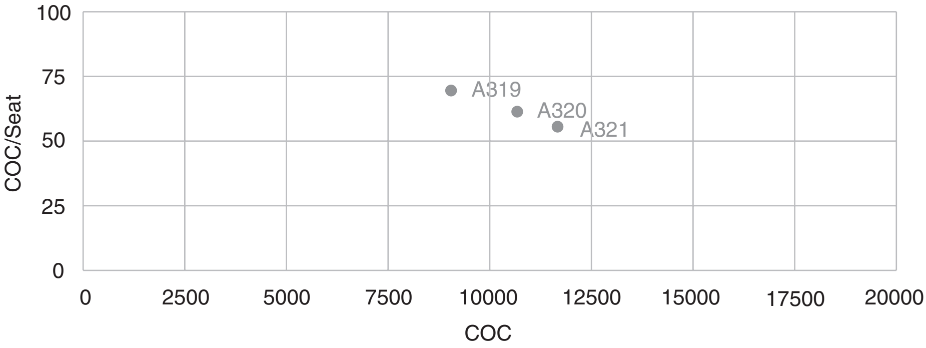
Downward flexibility is supported by a certain number of aircraft, which are due to be replaced (roll-over). Instead of replacing them, they leave the fleet without replacement.

Some publications argue that a good share of leased aircraft in a fleet increases the fleet flexibility. It is argued that downward flexibility can be easily executed by not replacing expiring lease contracts. We are of a different opinion. Renewing lease contract usually starts 1–2 years before the end of the contract in order to maintain negotiation power versus the lessor. While a crisis or an economic downturn cannot be forecasted with 1–2 years lead time, the flexibility potential of a lease is limited. In our view, high amounts of lease aircraft weaken the ability of an airline to manage a crisis as lease rates lead to a constant cash-out flow. During a crisis, cash-in suddenly drops and airlines with large, leased fleets are at higher risk to be short on liquidity.

6.2.2.2Aircraft Specifics

- **Economics**

Key economic indicators are cash operating cost (COC), direct operating cost (DOC) and the unit cost (COC per seat, DOC per seat), usually presented in two dimensional diagrams (see ◘ Fig. 6.9). Cash operating cost are composed by cost for fuel burn, maintenance cost, cockpit and cabin crew, fees (landing and ATC) and ground handling cost. Direct operating cost are cash operating cost plus the aircraft cost (depreciation and insurance). Unit cost depends on the seating capac-



◘ **Fig. 6.9** Cash-operating cost and cash-operating cost per seat diagram for selected aircraft. (Author's own figure) ity of the airplane, as the cash operating cost (or direct operating cost) is divided by the number of seats. When comparing aircraft in class configurations, similar class configurations should be taken into consideration to prevent a distortion in the calculation of unit cost.

Range and Performance

Depending on the route network, certain aircraft are more suitable. Hot and high airports such as Mexico City or long ranges like Dubai–Sydney require special aircraft performance. This limits the choice of applicable models.

Purchase Prices

Aircraft prices range from $30 m to $400 m or more. Fleet orders put a high burden on the financial capabilities of an airline, thus having a direct impact on the amount of aircraft acquisitions possible. Aircraft leases can be used to lower the initial cash flow requirement but require constant cash flows over the lease period.

6.2.2.3 Timing

A fleet plan has to consider the realities. Sometimes the desired aircraft are not available at the required time. Sometimes one has to invest in current technology as the new technology aircraft are just a few years too late. Therefore, the question of timing (or possibility to implement the plan) is an additional factor, which shapes a fleet plan.

Availability of Aircraft

Developing a new aircraft is an immense task, which stretches even large airplane manufacturers to its limits. There are several examples of manufacturers who did not survive the development of a new aircraft. In the 1990s Fairchild Dornier aimed at developing a new 70–100-seater aircraft, but in the end, it required so much investment funds that the company went bankrupt. Bombardier, who developed the CSeries, had to be supported by the Canadian state and in the end had to sell the program to Airbus, who rebranded it into the A220 series.

Only a few companies undergo the venture to produce commercial aircraft – in general we have a duopoly with Airbus and Boeing, who recently teamed up (or planned to team up) with the main suppliers of smaller aircraft Bombardier (Airbus) and Embraer (Boeing). Effectively, the aircraft supply side is limited to the manufacturing capabilities of Boeing and Airbus, so delivery slots for new aircraft have to be planned well in advance.

To bridge time until delivery, aircraft are leased. Again, the right aircraft must be available at the right time. Depending on the configuration of the aircraft (engine, cockpit, etc.), the aircraft of the same manufacturer might not fit the rest of the fleet. Especially long-haul aircraft initially require costly cabin reconfigurations, which often make bridging solutions not attractive.

Cabin Product Cycles

For short and medium-haul aircraft, cabin product cycles are not an important factor as the short/medium-haul cabin product is rather straightforward and a reconfiguration can be done within reasonable downtimes (a few days per aircraft).

For long-haul aircraft the story is different. Changing the cabin product configuration (e.g. installing new first class seats or new business class seats, changing the inflight entertainment system) usually requires downtimes of several weeks to months. To save downtime, these product changes are usually planned when the major maintenance checks are conducted. These large checks usually take up to several weeks. As the aircraft is anyway totally stripped down, new cabins can easily be installed. Depending on the aircraft, large checks occur every 6 years or more. Therefore, a good fleet plan is coordinated with the product development cycle in order to synchronise checks and product upgrades.

Another strategy employed by airlines is to introduce new cabin products with the advent of new aircraft. Likewise, the fleet plan has to consider product cycles.

From Fleet Plan to Aircraft Acquisition

Once a fleet plan is established and the fleet additions are clear, a simple investment calculation is done in order to check whether the purchase price is in line with the benefit assumptions. Based on the fleet plan, all relevant departments develop their own plans to support a smooth phase-in of the aircraft. Crew planning needs to plan the necessary training and sourcing of cockpit personnel well in advance. Due to the complex training and career patterns, this could require lead times of up to 3 years. Maintenance likewise needs to plan, source and train its maintenance personnel well in advance. Commercial departments need to initialise new routes about a year in advance, etc. Once the fleet has been defined, the next planning level – schedule planning – can be executed. This is described in the next section.

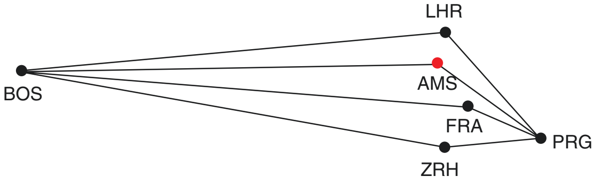
6.3 Route Planning – Initial Step of Schedule Planning

Route planning includes all activities to secure the most beneficial use of the given fleet. It includes all market-oriented tasks like opening up destinations, selecting the right flight times to meet customer demand, employing the right aircraft sizes on the given routes and constructing a hub with feed and de-feed structures, so that most valuable connection streams can be routed through it.

6.3.1 Selecting the Right Destination Portfolio

6.3.1.1 Market Data

In the airline industry, passenger data are widely collected and published. National statistical agencies (e.g. Department of Transportation (DOT) in the United States) publish passenger figures for routes. Airports collect passenger data. Anonymised booking data of computer reservation systems can be purchased. Through these



◘ **Fig. 6.10** Different itineraries for the O&D PRG-BOS. (Author's own figure)

and other sources, there are enough market data around to estimate passenger volumes between each airport in the world.

The data are usually collected in an origin to destination (O&D) view. When a passenger travels from Prag (PRG) via Amsterdam (AMS) to Boston (BOS), he counts as one PRG-BOS O&D passenger, as he wants to travel from PRG to BOS. His itinerary is PRG-AMS-BOS. The demand on the O&D PRG-BOS is interesting to know for all suitable hub carriers, who can try to route him through their hubs with different itineraries – see ◘ Fig. 6.10 below.

Assessing the customer segments (business or leisure, premium or non-premium demand) and price levels is more complicated, as price data are usually not available. Airlines rely on market studies, the expertise of its salespeople, crawling websites of competitors and other business intelligence.

6.3.1.2Schedule Offering

Taking market data, price estimates and competitor data into account, a schedule is compiled. While pure leisure routes can be served with lower frequencies, business travel demands frequent schedules. In short/medium-haul traffic the schedule should offer the possibility for day returns with at least two flights per day. The flights should be offered on all weekdays, with fewer frequencies on weekends. ◘ Table 6.5 shows a typical schedule on the Zurich-Brussels route from SWISS, suiting business demand out of Zurich. The schedule offers morning flights out of Zurich and several return flights in the afternoon. Midday flights offer additional travel possibilities, but they are mainly focused on connection traffic from long-haul and other European flights. On weekends, the schedule is reduced as demand is lower.

For long-haul traffic, a daily offering is usually required to capture valuable business demand. ◘ Table 6.6 shows the flights to North America offered in a typical week of the summer timetable. It illustrates the differences between a more business-focused carrier (SWISS) and a leisure carrier (Edelweiss) operation out of ZRH. While SWISS offers most long-haul flights daily or even twice daily, Edelweiss conducts only a few flights per week to its destinations.

Once the desired scheduling is clear, revenues and cost for the service are calculated. The necessary cost data are usually available in the route profitability systems. How to evaluate a route with these data will be described in detail in ▶ Sect. 6.4.

Table 6.5 Zurich-Brussels vv. – typical schedule pattern for a business routes

ZRH-BRU		BRU-ZRH	
LX 786	07:35–08:55	LX 771	07:00–08:15
LX 780	12:55–14:10	LX 787	09:55–11:15
LX 782	17:00–18:15	LX 781	14:55–16:10
LX 788	18:15–19:30	LX 783	18:55–20:05
LX 770	21:00–22:20	LX 789	20:10–21:15

Table compiled by author

Table 6.6 Long-haul offerings of SWISS and Edelweiss to the United States and Canada in a typical week in August 2019

		Mo	Tu	We	Th	Sa	Su
SWISS	Boston	2	2	2	1	2	2
	New York (EWR)	1	1	1	1	1	1
	New York (JFK)	3	3	3	3	3	3
	Chicago	2	2	1	2	1	2
	Miami	1	1	1	1	1	1
	Los Angeles	1	1	1	1	1	1
	San Francisco	1	1	1	1	1	1
	Montreal	1	1	1	1	1	1
Edelweiss	Orlando					1	
	Tampa			1			
	San Diego	1				1	
	Las Vegas	1					1
	Vancouver		1		1	1	1
	Calgary				1		

Table compiled by author

6.3.1.3 Selecting the Right Timings

The timings of the schedule need to balance market preferences with operational restrictions, hub structures and, of course, slot availabilities. Hub structures basically pre-define the range of possible timings, as arrival and departures of flights need to be coordinated at the hub, to offer good and competitive connections. Therefore, hub structures are discussed first. Other constraints (slots, operational, etc.) are discussed in ► Sect. 6.5, where operational scheduling is in focus.

6.3.1.4 Hub Structures

We focus on European hub structures and analyse the structures of SWISS in Zurich and KLM in Amsterdam in order to illustrate the key requirements of a hub. As seen in ► Sect. 6.2, Amsterdam offers the best infrastructure for a hub with high peak capacity and good minimum connecting times (MCT). Zurich offers good MCT, but low peak capacity for a hub. So, KLM is able to develop a large hub system with a significant reach, while SWISS in Zurich has to focus its hub.

6.3.1.5 Example: SWISS Hub Structure in Zurich

With the necessity to focus its operation, SWISS network in Zurich serves only key long-haul destinations. As they cannot be operated frequently without connection passengers, all long-haul flights must be coordinated with feeding and de-feeding flight in a hub structure.

In describing the hub structure, we will first discuss long-haul timings and then combine them with possible timings of the European operation to create a wave pattern.

■ Long-Haul Timings

Long-haul timings have to take time zone differences between origin and destination as well as night curfews at these airports into consideration. In addition, the timings should enable an efficient use of the expensive aircraft resources. The productivity of an aircraft is measured in *block hours per day*, which counts the hours an aircraft is operating, i.e. “off block”, meaning the time between leaving the departure gate and arriving at the arrival gate. Short turnaround times (time on the ground between block times) at outstations and matching arrival and departure timings at the home airport enable a productive operation. With more than 15 block hours per day for a long-haul aircraft, SWISS achieves a very high productivity with its long-haul fleet.

Timings depend on the geographical location of the destination. Flights to America are usually offered in a day flight/night flight rotation, meaning that the westbound flight is flown during day time and the eastbound flight at night. Flying westwards, time “is saved” as the time difference compensates for most of the travel time (e.g. a flight leaving at 12:55 local time in Zurich arrives at 15:45 local time in New York). Eastwards flights are likewise “extended” so they can cover the night.

Example: Timings of Zurich-Miami-Zurich Flights

Flights from Europe to North America need to leave until early afternoon in Europe, in order to not arrive too late at their destination. The rotation pattern of the winter flights between Zurich and Miami shown in ▪ Table 6.7 illustrate schedule possibilities. In winter two flights depart from Zurich to Miami. LX066 leaves at 09:50 in Zurich. This is the earliest departure time possible, as the flight requires incoming feeder flights from Europe arriving until 09:00. LX064 leaves at 13:15 in Zurich and arrives at 19:00 in Miami, meaning that passengers will reach their hotel or home about 21:00 or 22:00. Most passengers would not choose a later arrival as they do not want to transfer during the night in Miami to their final location. So LX064 should not be timed later. Both flights can be "turned around" and leave Miami on the same day. While LX067 allows 2 h20 on the ground, LX065 is planned with tighter turnaround times in order to arrive at the right time for the midday wave in Zurich.

► Example: Timings of Zurich-Singapore-Zurich Flights

Flights to South East Asia have a different pattern compared to flight to North America. ▪ Table 6.8 shows the schedule for SWISS flights to and from Singapore. Here the westbound flight leaves late at night in Zurich to arrive at late afternoon Singapore, as customers have a high demand for the night flight. The timings enable passengers to work the whole day in Zurich and then take the flight in the late evening at 22:45 shortly before the night curfew in Zurich. The return flight offers the same advantage as it leaves Singapore at 23:10. An earlier departure in Singapore is not possible due to the night curfew in Zurich, which does not permit arrivals before 06:10 in Zurich. Due to the restrictions presented by the night curfew in Zurich, the airplane has a long turnaround of 5 h 15 min in Singapore. ◄

▪ Short-Haul Timings and Hub Wave Pattern

In a hub system flights are scheduled so that arrivals and departures are bundled in a short time window, allowing short connection times. These time windows are

▪ Table 6.7 Schedules of Zurich-Miami and Miami-Zurich flights during the winter timetable

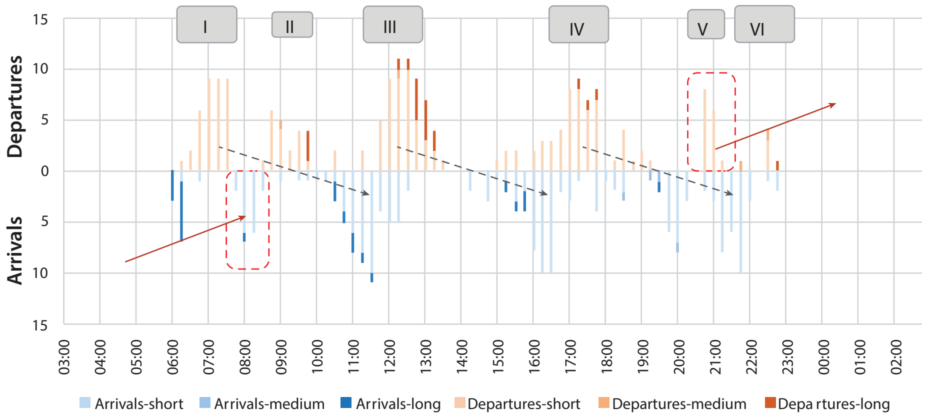
	Departure (Local Time)	Arrival (Local Time)
LX066 ZRH-*MIA*	09:50	*15:35*
LX067 *MIA*-ZRH	*17:55 (2:20 turnaround)*	08:05 (next day)
LX064 ZRH-*MIA*	13:15	*19:00*
LX065 *MIA*-ZRH	*20:45 (1:45 turnaround)*	11:00

Table compiled by author

Table 6.8 Schedules of Zurich-Singapore and Singapore-Zurich flights during the summer timetable

	Departure (Local Time)	Arrival (Local Time)
LX0176 ZRH-*SIN*	22:45	*16:55*
LX0177 *SIN*-ZRH	*23:10 (5:15 turnaround)*	06:10 (next day)

Table compiled by author



Short: less then 2000km
Medium: between 2000km and 4000km
Long: more than 4000km

Fig. 6.11 SWISS hub structure in ZRH (Author's own figure and analysis based on OAG, 2019)

called "waves" and the flow of incoming and outgoing flights at a hub is called "wave pattern.".

To ensure a high productivity of the short-haul fleet, the wave pattern should be constructed in a way that aircraft can hit most waves and still maintain short turnaround times. The hub structure is shown in Fig. 6.11, which is a typical way to present a hub structure. It shows how many arrivals or departures occur within 15-minute intervals. Arrivals are presented below the horizontal axis while departures are presented above the horizontal axis. The hub consists of six waves (I to VI), where arrivals are coordinated with departures.

The hub structure differentiates between short (<2000 km), medium (2000–4000 km) and long-haul (>4000 km) flights. The ranges are shown in Fig. 6.12.

The usual rotation of a short-haul plane is: departure in the morning around 07:30 (Wave I – morning wave) – return to Zurich around 11:00 and depart around 12:30 (Wave III – midday wave) – return to Zurich around 16:00 and depart around 17:30 (Wave IV – afternoon wave) – return in the evening around 21:30 (Wave VI – evening). The four waves I, III, IV, VI are the main waves in Zurich.

◘ **Fig. 6.12** Ranges short, medium and long around Zurich. (Great Circle Mapper, n.d.)

Long-haul flights in all directions can be fitted into the main wave pattern of the four waves. Flights to US/Far East leave around 12:30 to 13:30 (Wave III) and return around 10:00 to 11:00 (Wave III) from the East coast or 15:30 to 16:30 (Wave IV) from the west coast or far east. Flights to India and Middle East leave around 12:30 to 13:30 (Wave III) and return around 6:00 to 6:30 (Wave I). Flights to South East Asia and South Africa leave in the evening at 22:45 (Wave VI) and return in the morning 2 days later at 6:00 to 6:30 (Wave I).

Besides enabling long-haul flights to all directions, the basic European rotation pattern (Wave I – Wave III – Wave IV – Wave VI) offers good timings for the local demand as well. It suits valuable day trips as it offers flights out of Zurich in the morning with return options in the afternoon and the evening.

The wave structure is completed by two smaller waves (Wave II and Wave V). These waves support incoming demand from Europe to Zurich as the flights start in the morning at the outstations in Europe and enables returns in the evening. The production in these waves requires "overnighters" which are flights not staying overnight in the Zurich, but in the outstations, with the disadvantages of additional cost for crew hotel accommodation and less maintenance flexibility, as the planes are not available at their home base.

On the other side, Waves II and V make it possible to fit longer European rotations into the network. The basic structure (Wave I – Wave III – Wave IV – Wave VI) fits for all destinations which are reachable with a block time of 2 h 20 min or less. Destinations like Lisbon or Athens are longer and can be fitted into the wave pattern with reasonable productivity only by using Waves II and V. Thus, flights to Athens leave in Wave II and return in Wave IV, or leave in Wave III and return in Wave V. This is complemented by an overnight service leaving in Wave V and arriving in Wave II. Resultingly, ATH has all long-haul connections (with longer connection times in the morning and evening).

As the wave pattern in ◘ Fig. 6.11 shows, Wave II is additionally used to offer long-haul flights. These are usually second frequencies to long-haul destinations besides the frequencies out of the basic waves (e.g. JFK, SFO, ORD in summer, MIA in winter – refer to the schedule laid out in ◘ Table 6.7).

The example of the ZRH hub demonstrates how short-haul timings for a hub carrier are interdependent on its long-haul offer and vice versa. For example, it

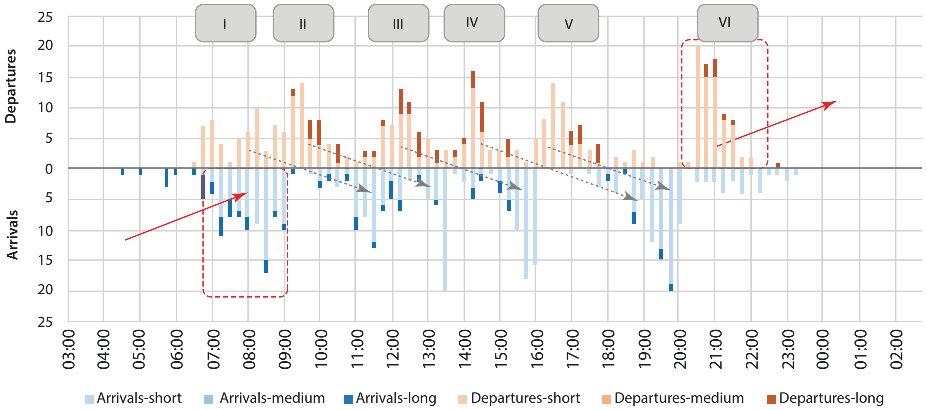


Fig. 6.13 KLM hub structure in Amsterdam (Author's own figure and analysis based on OAG, 2019)

does not make sense to offer short-haul departures before 06:50 as these flights cannot de-feed long-haul arrivals. Likewise, short-haul arrivals after 22:05 do not make sense, as they would not connect to the evening long-haul departures. Flights scheduled in these time windows are only possible to destinations with sufficient local demand (e.g. London).

► Example: KLM Hub Structure in Amsterdam

The hub structure of KLM in Amsterdam is shown in Fig. 6.13. As Amsterdam offers more capacity, KLM is able to schedule up to 20 arrivals or departures in 15 minutes. KLMs Hub has six waves. Short-haul planes rotate from Wave I or II into Wave III and IV – from Wave III and IV into Wave V and from Wave V into Wave VI. In contrast to SWISS, KLM has a high number of overnighters leaving in Wave VI and returning the next day into Wave II. This enables KLM to start its first major long-haul departures to North America at 10:00, while SWISS has its main intercontinental wave starting later at 12:30. ◄

Once the hub-structures are set, the timings of all flights carrying considerable amounts of connecting traffic are coordinated in order to match the wave systems. Only flights without connecting traffic can be timed outside the waves. With the timing options predetermined by the hub structure, network management can develop schedules to all the possible destinations. Whether they are realised, depends on the economic viability. The tools applied to assess the economic viability will be the focus in the next section.

6.4 Economic Evaluation

The economic evaluation of an airline network is focused on analysing which parts of the network make profit and which parts do not. To improve unprofitable parts, the usual network measures are employed, like changing aircraft, adapting the frequency or even cancelling the service. Economic evaluation is supported by route profitability systems, providing the necessary data in a structured form.

6.4.1 Route Profitability – The Point-to-Point View

The classical route profitability is structured according to the key decisions of an airline:

- Does the passenger cover its variable costs? (Is taking another passenger right?)
- Does the flight cover its variable costs? (Is it right to conduct the flight?)
- Does the route cover its fixed costs of the directly involved resources (such as aircraft, crew, maintenance) – (Is the flight covering the cost of all resources which are directly involved?)
- Does the route cover all costs, taking overheads into consideration?

The structure of a typical route profitability is as follows:

Ticket revenues
\+ Other Passenger Revenues
\+ Cargo Revenues
\+ Other route related revenues
= Total route revenues

./. Passenger variable costs (Meals, Reservation costs, …)

./. Flight variable costs (Fuel, Catering, Ground Handling, Landing fees, Air Traffic Control Fees)
= Flight contribution

./. Direct fixed cost (Cockpit Personnel, Cabin Personnel, Aircraft Depreciation, Maintenance)
= Contribution to Overhead (CB2OH)

./. Overhead Cost
= Net Profit

Good calculation systems usually are able to directly assign revenues, passenger variable costs and flight related costs to a flight. The remaining costs are distributed using production measures or sales figures as a basis (e.g. block hours, flight hours, seats, passengers, revenue, etc.).

In a point-to-point system the calculation of each single flight with the structure described above is sufficient to supply all relevant data for economic evaluation. Decisions are based on contribution to overhead or net profit figures of each flight.

6.4.2 Route Profitability – The Hub Carrier View

To assess the economics of a hub system, the structure of the route profitability stays the same. But there is one added complication: How do you allocate the revenue of transfer passengers to the flights they are travelling on? The allocation should be done in such a way that it does not lead to wrong decision making.

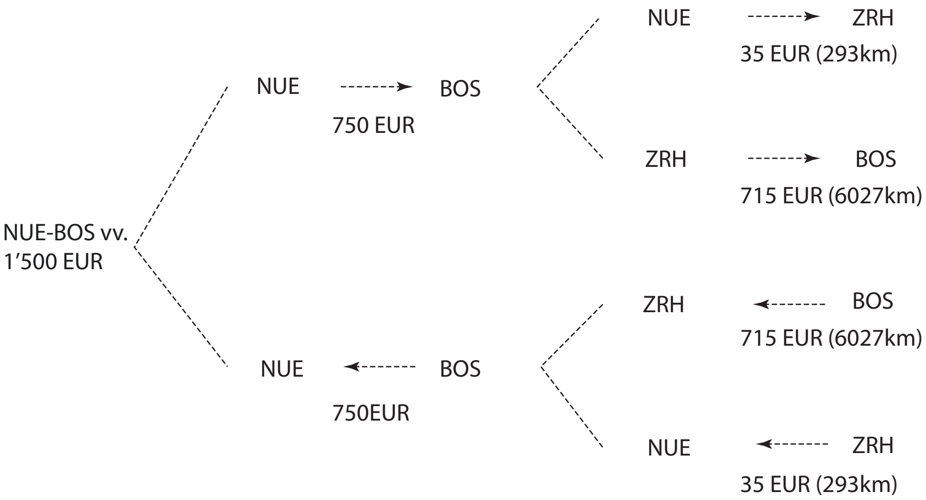
Take for example a passenger traveling from Nuremberg (NUE) via Zurich (ZRH) to Boston (BOS). Let us assume he or she pays EUR 1′500 for the round trip. For the roundtrip he or she uses four flights NUE-ZRH, ZRH-BOS, BOS-ZRH, ZRH-NUE. In order to do the route calculation, the revenue needs to be split and distributed among the four flights involved.

It is rather easy to split the revenue between the two itineraries NUE-ZRH-BOS and BOS-ZRH-NUE. Both get half of the total round trip revenue. But, how to split the revenue between NUE-ZRH and ZRH-BOS or BOS-ZRH and ZRH-NUE?

As there is no logical way to distribute the revenue among the routes involved, carriers usually use a straightforward allocation method. This is usually the stage length (great circle distance) of the route. In our example, the revenue would be split as shown in ◘ Fig. 6.14.

It is obvious, that this calculation method favours longer routes, as very little of the revenue is allocated to the short feeder flights. An economic assessment of a hub route system based only on route profitability with prorated revenues (the distribution is called prorate) is not enough and leads to wrong decision making. We will illustrate this in the following example.

Assume we have two routes LYS-ZRH and ZRH-CPH shown in ◘ Table 6.9. Both transport local passengers and connecting passengers from LYS to CPH. In our example the connecting revenues are prorated among the two routes according



◘ **Fig. 6.14** Split of the ticket price for NUE-BOS vv. on flights involved (Author's own figure)

▣ **Table 6.9** Route profitability of LYS-ZRH and ZRH-CPH

	LYS-ZRH	**ZRH-CPH**
Local passengers	80	75
Connecting passengers	125	125
Total passengers	**205**	**200**
Revenue local passengers	8,000	12,000
Revenue connecting passengers (prorated)	2,700	8,550
Total revenue	**10,700**	**20,550**
Total cost	–14,000	–16,000
Net profit (onboard)	**–3,300**	**4,550**
Margin	***–31%***	***22%***

Table compiled by author

to their stage length (great circle distance). The calculation shows that LYS-ZRH is unprofitable, as it does not deliver a positive contribution to overhead. If we close the route, we miss the connecting passengers on ZRH-CPH and the route will be unprofitable as well. The calculation based on prorating obviously leads to wrong decision making.

In order to aid decision making, the entire revenue of a feeder flight must be considered. In network route profitability calculations, the revenue of transfer passengers generated in the network is added to each flight indicating the value of each flight for the network.

In our example, the other part of the connection revenue is added to each route, so both routes receive the full connection revenue. This calculation in shown in ▣ Table 6.10.

Both routes, ZRH-LYS and ZRH-CPH, deliver a positive network contribution and are kept in the network. The overall network delivers a positive contribution.

When this technique was introduced, it was highly criticised that the double-counting leads to excessive growth, as all routes are profitable and therefore network management can justify more airplanes than necessary. It is obvious that the revenue of connecting passengers is allocated several times to all the flights within the travel itinerary. So, it is double counting!

But what the critics forgot is the purpose of the evaluation. The purpose is not to increase the dimension of the network, but to best allocate a given and fixed fleet to all potential routes. That could mean that a low performing feeder route gets downscaled by reducing frequencies, in order to make the capacity available for more frequencies on a high performing route, or even start a new route. So, the process is a constant screening for better opportunities to improve the low performing parts of the network. In this respect, the network contribution or the net-

Table 6.10 Network profitability of LYS-ZRH and ZRH-CPH

	LYS-ZRH	ZRH-CPH	Total
Local passengers	80	75	155
Connecting passengers	125	125	250
Total passengers	**205**	**200**	**405**
Revenue local passengers	8,000	12,000	20,000
Revenue connecting passengers (prorated)	2,700	8,550	11,250
Revenue connecting passengers in the network	*8,550*	*2,700*	
Total revenue	**19,250**	**23,250**	**31,250**
Total cost	−14,000	−16,000	−30,000
Network profit value	***5,250***	***7,250***	
Margin	***27%***	***31%***	
Net profit (whole network)			**1,250**
Average revenue per local passenger	*100*	*160*	
Average revenue per connecting passenger			*90*

Table compiled by author

work margin (=network contribution / network revenue) is the key figure and supports right decision making.

6.4.2.1 Using Route Profitability for Network Development

While the fleet is given in schedule planning, network development is about identifying the right long-term fleet size. In order to do this, one needs to see whether there are parts of the network, which do not deliver any value and hence should be closed, thus reducing the need for additional aircraft. Is the network route profitability – as outlined above – obsolete for this analysis and do we need a different method? Should a network developer disregard all network route profitability figures? Of course not, but the figures need to be used for structural analysis in the right manner.

To show how the profitability figures can be used for structural analysis, we need to develop a deeper understanding of the economic logic of a hub system. Therefore, we will first discuss the economic logic of a hub system and then develop the right approach for using the network route profitability for structural analysis.

6.4.2.2 Economic Logic of a Hub System

We will develop the hub logic based on major structural decisions. The steps of the decisions are shown in Fig. 6.15.

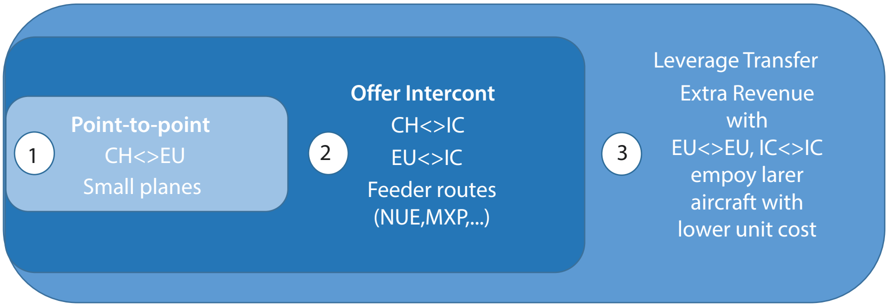


Fig. 6.15 "Building blocks" of a hub system. (Author's own figure)

(A) **Starting Point – European Point-to-Point Offer**

Let us assume that we are a small carrier operating point-to-point services from our home base ZRH to European destinations. The point-to-point offering is focused on local traffic. Thus, the carrier will offer routes with sufficient point-to-point traffic volume. Usually all major destinations (LON, PAR, HAM, etc.) will be in our schedule. To tap into the valuable business travel demand, we need to offer at least morning and evening services to these destinations. To use the aircraft throughout the entire day, we need to offer services during midday as well. In order to balance revenue and costs, the carrier is restricted in the size of its aircraft. Let us assume that the right aircraft size is about 100 seats.

(B) **Next Step – Establishing a Hub and Offering Long-Haul Services**

As the home base ZRH has considerable traffic volume to long-haul markets, we decide to start a long-haul network. It should likewise tap into business travel markets, so it requires daily services to the major long-haul destinations (NYC, HKG, BKK, SIN, etc.). As the local market demand is not sufficient to fill the planes on all days of the week and in all seasons, the offer needs to be complemented by a hub system, bringing more passengers to our home base with feeder flights. So, we add all the complexity of connecting traffic to our business. As long-haul markets need a broader feed base, we will start connecting a few "pure" feed markets to our network (like STR or MIL for the hub system ZRH).

(C) **Last Step – Leveraging the Short-Haul System**

Once we started offering connecting travel, we can leverage our system by accepting intra-European connecting traffic. As connecting traffic is an inferior product to direct traffic, we have to offer lower prices for a routing NCE-ZRH-CPH compared to NCE-CPH direct. However, the additional traffic helps us fill larger planes with better unit costs. In order to remain profitable, the revenue of the European connection traffic needs to cover the marginal cost of employing larger aircraft to maintain profitability.

6.4.2.3 Structural Figures

As discussed above, connecting traffic offers the opportunity to deploy larger aircraft and better utilise their capacity, as a connection system can tap into many more markets than a point-to-point system.

Take our example above in ▣ Table 6.10. In a point-to-point system, the route ZRH-LYS only has demand of 80 passengers filling a 100 seater. With connecting passengers, the route can be upgraded to a 220 seater. The system is economically sustainable if the connecting passengers cover the delta cost of employing a 220 seater vs. a 100 seater on both their routes. With the cost estimates of the example below, we see that the price of a connecting flight can be significantly lower than a point-to-point flight, even if the passenger travels on two flights.

In our example, the overall network delivers a contribution margin of EUR 1250. When we reduce the connection revenue per passenger, we can calculate the situation where the result goes down to zero. In our example the threshold is reached, when the average price per connection passenger is EUR 80. The network margin of ZRH-LYS is 22% at this point (see ▣ Table 6.11). We call this network margin the "network threshold." In a structural assessment, all flights should deliver a margin over the network threshold.

▣ **Table 6.11** Network with two routes and an overall profitability of 0

	LYS-ZRH	ZRH-CPH	Total
Local passengers	80	75	155
Connecting passengers	125	125	250
Total passengers	**205**	**200**	**405**
Revenue local passengers	8,000	12,000	20,000
Revenue connecting passengers (prorated)	2,400	7,600	10,000
Revenue connecting passengers in the network	*7,600*	*2,400*	
Total revenue	**18,000**	**22,000**	**30,000**
Total cost	−14,000	−16,000	−30,000
Network profit value	***4,000***	***6,000***	
Margin	***22%***	***27%***	
Net profit (whole network)			**0**
Average revenue per local passenger	*100*	*160*	
Average revenue per connecting passenger			*80*

Table compiled by author

A simple formula can be developed to calculate the network threshold. According to the hub logic explained earlier, the connection revenue should cover at least the marginal cost of the routes involved. If we assume that a connecting itinerary uses two flights, the revenue must cover twice the average marginal cost. In our example, we assume that the trip cost of the 100 seater on ZRH-LYS would be EUR10,000. Thus, the cost difference between the 220 seater and the 100 seater would be EUR 4,000. Under these assumptions the network threshold can be computed as following (see Attachment 1 for the development of the formula):

$$N = \frac{1}{2 + \frac{1}{a}}$$

with a = marginal trip costs/trip cost of smallest aircraft (point-point).

In the example $a = 4'000\ /10'000 = 0.4$

$$N = 22\%$$

The results of the structural analysis show, which parts of the network are low contributors to the overall network result. If the whole network result does not fulfil the required profit levels (to ensure financial stability), the low performing network parts are candidates for resizing. However, the decision to resize the fleet must be based on a calculation of the entire network, as the structural analysis can only deliver hints, but does not assess the overall profit level.

6.5 Operational Schedule Planning – Final Step of Schedule Planning

Operational schedule planning is the final step in schedule planning following the route planning. It includes all steps necessary to realise a flyable schedule.

We have seen in the first chapter that airlines have high fixed costs due to high asset costs and long lead times for training operational personnel. Therefore, the task of constructing an operational schedule is focused on achieving high productivity of the operational resources (aircraft, crew) while meeting economic and operational constraints.

Economic constraints are framed by the market situation (size and structure of demand, willingness to pay and competitive situation). These have been addressed in the former chapters. Therefore, this chapter concentrates on the operational constraints, which scheduling needs to take into consideration. Key constrains are slots at capacity-constrained airports, necessary ground times to turn around an aircraft, necessary ground times to fulfil maintenance requirements and timing requirements of hub systems.

6.5.1 Slots at Capacity-Constrained Airports

Most major European airports are slot controlled, as the demand by airlines to schedule flights at these airports exceeds the capacity of the airport. The capacity of an airport is dependent on its runway system, the route structure in its approach and departure airspace (the terminal manoeuvring zone – TMA), the technical equipment for controlling the airspace and regulations imposed by regulators (EASA, ICAO) or local authorities (noise regulations, etc.). Based on all these restrictions, the maximum arrival and departure movements as well as the maximum movements per given timeframe are established.

For example, Zurich Airport has three runways: runway 10/28, runway 14/32 and runway 16/34 (see ◘ Fig. 6.16). The standard operation handles approaches on runway 14 and departures on runway 28. As runway 28 is shorter than the other runways, aircraft requiring more runway length for take-off have to leave from runway 16. Departures on runway 16 must be coordinated with departures on runway 28 (crossing-runway) and arrivals on runway 14 (intersecting routes in the air), so that the runways cannot be operated independently from each other. Operations

◘ **Fig. 6.16** Runway layout in Zurich. (Google, n.d.)

on runway 14 (arrivals) and 28 (departure) are independent. Therefore, the system in Zurich is only partly independent, lowering the maximum capacity. The maximum arrival and departure capacity is around 36 movements per hour, but not more than 66 movements per hour all together.

The maximum capacity determines the number of slots the airlines can use to plan departures or arrivals. In the case of Zurich 66 departures or arrivals in total are possible within an hour, while departures or arrivals alone should not exceed 36 each. In Europe and most other airports, the slots are allocated in 5-minute intervals, so departures or arrivals are scheduled at 12:00, 12:05, 12:10, …

When the demand of airlines exceeds the number of slots available, a mechanism must be established to prioritise the demand and allocate the slots accordingly. This is done according to EU regulation (EU 95/93 from 1993) by an independent slot coordinator. The slot coordinator acts according to a fixed set of rules and ensures that slot allocation complies with the overall regulation. Slots will be assigned for each new flight schedule period (summer schedule usually from the end of March until the end of October and winter schedule from the end of October to the end of March).

One of the cornerstones of the regulation is the “grandfather rule” meaning that an airline, which has used 80% of its slot in a schedule period, is given the same slot in the same period of the succeeding year, if they apply for it. This gives the airlines planning security as they can gradually develop their schedules and safeguard their high aircraft investments. (If this rule would not exist, an airline could never be certain that it can offer the same schedule over a longer period and fully utilise its fleet.) Slots which are not used according to the “grandfather rule” will be assigned according to the rules laid out in the regulation, favouring new entrants.

After the initial slot allocation, usually in October for the following summer schedule or in May for the following winter schedule, the IATA slot coordination conferences take place.[4] In these conferences, airlines, airport representatives and slot coordinators come together. In the conference, airlines try to exchange slots between each other or discuss possibilities with slot coordinators to receive slots within the overall regulation. Sometimes, shifting the schedule by a few minutes opens more possibilities. At these conferences, timing improvements according to the schedule needs are achieved.

Regulation usually only allows slots to be exchanged and not sold. One exception is the airport London Heathrow. As demand was so high, the regulator facilitated a purchasing process, where an airline holding grandfather rights can sell the slots to another airline. For very high demand time windows, the prices can go into several millions.[5]

With the slots received by slot allocation or exchange with other airlines, the airline can construct a schedule. Slots that are not used are handed back to the slot coordinator, who will redistribute the slots to other airlines depending on demand.

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[4] See ► www.iata.org – e.g., for summer schedule 2020 the conference took place from November 12–15, 2019 (145. IATA slot conference in Brisbane, Australia).

[5] One of the highest prices paid was 75 m USD paid by Oman Air to Air France in 2016 for a slot pair (arrival and departure slot) including a morning arrival (O’Connell & Collingridge, 2016).

6.5.2 Operational Ground Times

Minimum operational ground times are defined by the operations department and need to be met by the schedule. Minimum ground times describe the required time to turn around an aircraft – that is the time between the arrival and departure of the aircraft.

During the ground time, passengers disembark, the luggage and cargo is unloaded, the aircraft is cleaned and fuelled, meals and beverages are loaded, new passengers board and luggage and cargo are loaded. Usually disembarking, cleaning and boarding take up most of the time. Depending on the destination, special security checks must be conducted which add extra time.

Usually, minimum ground times for Airbus A320 aircraft are around 40–45 minutes at hub carriers. Point-to-point carriers have shorter ground times as they do not have connecting passengers. They have strict reporting guidelines, which ensure that all passengers to board a plane are present at boarding time. In contrast, passengers at hub carriers come in random order during the boarding process, as connecting passengers might show up only shortly before boarding closes. Additionally, some connection passengers do not make their connection, but their luggage does. As security rules require that only the luggage of boarded passengers can be transported, luggage of passengers not on board must be unloaded.

Minimum ground times for long-haul planes are about 1:30–2:00 depending on required security checks and the loading of catering equipment.

6.5.3 Technical Ground Times

Aircraft are maintained according to a tight schedule of checks. Ground times for daily and weekly checks must be allocated in the schedule. Short-haul aircraft are usually maintained during the night, while long-haul aircraft are maintained during the day during allocated time slots.

Longer checks, requiring several days, are usually planned in seasons with lower demand (i.e., winter). Here the overall schedule is reduced in order to free up capacity for longer checks.

6.5.4 Aircraft Productivity

Aircraft productivity or aircraft utilisation is measured in block hours[6] per aircraft per day. Long-haul aircraft achieve an average utilisation of 14 to 15 block hours per day – meaning that out of 24 hours per day, 7–8 hours are spent on the ground (for turn-around, maintenance) and 14–15 hours are spent in operation.

Utilisation of short-haul aircraft is lower because they usually do not operate during the night and have more turnarounds throughout the day. For hub carriers,

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[6] A block hour is the duration from "block-off" (aircraft leaves a gate) to "block-on" (aircraft has reached the gate at its destination).

a productivity of 10–11 hours is already high. Point-to-point carriers achieve higher productivities. This is due to the different nature of their business models.

Compared to point-to-point carriers, hub carriers must bundle incoming and outgoing flights at their hubs. Flights with short block times need to arrive in the same time window as flights with longer block times, in order to synchronise the connection streams. Aircraft on flights with shorter block times usually wait at their outstations, reducing the aircraft productivity. Point-to-point carriers do not offer connections and, therefore, do not need to care about the synchronisation of flights.

In addition, hub carriers have a more limited time window of the day for their operation than point-to-point carriers. In the hub system of SWISS at Zurich, the short-haul flights need to wait for connections from long-haul services until they can depart. First intercontinental flights arrive in Zurich at 06:10 – meaning that the flights to Europe cannot leave before 6:50 if they need to transport connecting passengers from long-haul flights (minimum connecting time in Zurich is 40 min.). Likewise, the last short-haul flights need to arrive at 22:00 or earlier, in order to connect to the long hauls leaving at 22:40. Therefore, the hub carrier in ZRH can operate its short-haul rotations from 06:50 to 22:00, whereas point-to-point carriers can use the whole range of opening hours of Zurich airport from 06:00 to 22:40.

The effects of a hub system and its routes, as well as the opening time of its hub, on the productivity is shown in the table below. As the last landing has to be at 22:00 (in order to connect to the long-haul night flights) the 6 wave system barely covers destinations of 2 hours block time. If all the destinations are within 1.5 hours block time, the maximum productivity is around 9 hrs. If the average block hours is close to 2 hours, the productivity comes close to 12 h. However, as discussed above, this is not possible as the connections to long-haul in the evening could not be met. Given the opening times of Zurich airport, the productivity maximum for a hub carrier is around 10–11 hours (Table 6.12).

Table 6.12 Aircraft productivity in hub systems

		Last theoretical landing at night			Airplane productivity during the day		
	Number of flights per day	4	6	8	4	6	8
Block period per flight	01:00	13:05	16:35	20:05	04:00	06:00	08:0
	01:30	15:05	19:35	00:05	06:00	09:00	n.a.
	02:00	17:05	22:35	04:05	08:00	12:00	n.a.
	02:30	19:05	01:35	08:05	10:00	n.a.	n.a.
	03:00	21:05	04:35	12:05	12:00	n.a.	n.a.

Table compiled by author

6.6 Revenue Management

Once the schedule is set, it is a fixed input for the revenue management process. The task of revenue management is to maximise the revenue based on a given schedule.

Revenue management steers each single flight. Usually the flights are loaded into the reservation systems one year before they are conducted. The flights are then open for booking.

Usually early demand is not willing to pay high fares, but late demand shortly before the flight is willing to. Therefore, revenue has to combine the different demands in an optimal way. It should not sell too many seats upfront in order to have enough available when the high paying demand shortly before the flight emerges. On the other hand, it should not sell too few seats upfront and then end up with too many empty seats.

As discussed, a flight in a hub system can easily be booked by 100 markets as numerous connection flows can use the flight. Therefore, revenue management must find the optimum mix by combining the demand curves and willingness to pay for all the possible markets.

Revenue management is very IT-system dependent. The system generates forecasts for each flight and then gives availabilities to markets according to the price levels they are willing to pay. As the forecasts are historically based, flight analysts calibrate the forecasts and the availabilities to react on new trends, different seasons, events, competitor behaviours, etc.

Once an airline went through all the planning steps outlined in the preceding chapters, it should have a right-sized fleet, allocated its fleet in the most profitable way to its network and attracted the best mix of passengers. This airline will have a good chance to survive in the market.

? Review Questions

- Do you think that European low-cost carriers could ever move to a hub system?
- How do you think will the increasing awareness about climate change impact the hub system, especially short-haul feeder flights?
- Would you change anything about the slot system? Do you think it is fair?
- Do you see any possibility to implement artificial intelligence in network and operational planning?

Attachment I: Network Threshold Formula

The general basic formula for the network margin n is:

$$n = \frac{Rc + Rl - Cl - Cd}{Rc + Rl} \tag{6.1}$$

where:

Rl is the revenue of all local passengers of the route.

Rc is the full revenue of all connecting passengers (onboard and in the network) of the route.

Cl is the cost of the smallest aircraft of the fleet on the route (large enough to cover the local demand).

Cd is the cost difference of the smallest to the next larger aircraft in the fleet.

The system is economically sound when the connection revenue is at least large enough to cover its marginal costs minus the profit of its local route. It is assumed that the passenger takes two flights to fly to his connection itinerary, so that

$$Rc = 2Cd - (Rl - Cl) \tag{6.2}$$

If we insert (6.2) into (6.1), we receive:

$$n = \frac{2Cd - (Rl - Cl) + Rl - Cl - Cd}{2Cd - (Rl - Cl) + Rl} = \frac{Cd}{2Cd + Cl} = \frac{1}{2 + \frac{Cl}{Cd}}$$

If we define.

$Cd = a * Cl$ or $a = \frac{Cd}{Cl}$. then the final formula for the minimum network threshold is:

$$n = \frac{1}{2 + \frac{1}{a}}$$

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Managing Airports

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Contents

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Managing Airports

Summary

- Learn how airport infrastructures are designed and adjusted for different use cases
- Understand the key elements of airport profitability and its systemic limitations
- Review the importance of consumer preferences in airport service offerings
- Learn about collaboration between airport stakeholders
- Understand the commercial aspects of airport ecosystems

This chapter presents the basics of airport management. Airports are embedded within the aviation value chain by providing key infrastructure to handle flights. This infrastructure can be designed and adjusted in order to cater for different use cases, which are presented in the chapter. Furthermore, the profitability of an airport consists of different revenues that an airport earns to cover its different expenses. In order to stay competitive, it is imperative that airports adjust their service offerings to their consumers' preferences. However, airports need to act beyond their daily operations by collaborating with different stakeholders who are part of the airport ecosystem and thus influence it. The chapter signifies the importance of this collaboration by exemplifying the economic and political importance of airports as well as the commercial aspects in terms of attracting passenger and airlines.

7.1 Introduction

An airport consists of an airfield and its infrastructure where regular commercial air traffic normally takes place. In contrast, general aviation is usually only marginally represented. Military airfields are not declared as airports (unless for mixed use cases). Airports usually meet a higher safety standard than other airfields such as landing strips. Depending on their size, airports have different airport infrastructure such as hangars, aircraft maintenance facilities, ground handling facilities, air traffic control and passenger services (restaurants, lounges and security services).

7.1.1 Airport Ecosystems

Airports are part of the wider aviation value chain by providing the infrastructure needed to handle flights from their origin to their destination. However, their actual function goes beyond their original function of channelling passengers and/or cargo to their respective flights. Every airport finds itself embedded in a system where it aims to create value, interacts with stakeholders and needs to consider different aspects in its operations.

The value chain incorporates different activities that create value for the airport users within the airport ecosystem. The first part of the value chain consists of the airport operator who provides the basic infrastructure such as the runway, terminal, electricity, etc. needed for an airport. This is followed by air traffic control, who provide the necessary communications and services to ensure a safe and efficient operation at the airport. This is followed by ground services who offer the necessary services such as handling luggage, checking in passengers or loading cargo to make the logistics within an airport possible. Further value is added by the addition of retailers who provide a shopping experience within the terminal building for passengers and the general public who use the airport infrastructure. The final part of the value chain then consists of the end users who perceive the value created by an airport. These consist of passengers, airlines as well as the public.

Stakeholders involved with the airport can be divided into different actors. The public is directly affected the airport's operations and hence forms an important stakeholder in terms of the acceptance of an airport. The regulator ensures that the airports are run according to international and national regulations by providing the legislative framework and monitoring the compliance with it. Air traffic control, whilst being part of the value chain, is also a stakeholder as airports need to be embedded within the air traffic service system to ensure flawless operations. As airports are an important driver for economic development, governments are a major stakeholder for airports and are often involved in extending or even building new airports as a catalyst for economic growth. Passengers represent a major stakeholder as their presence provides the mainstay for almost every airport worldwide. Hence it is important for airports to interact with passengers and ensure that the facilities meet their requirements. The passengers primarily use the airport as part of a journey with an airline. Therefore, airlines represent another important stakeholder who need to be considered as they choose their airports based on operational and economic means.

Surrounding the airport system, we can find the well-known spheres. The political and social spheres regard the positive and negative impacts of airports on society such as the creation of employment or noise emissions. The environmental sphere presents other aspects such as pollution and emissions that are generated by the aircraft operations. The economic sphere assesses the airport's profitability and economic impact on the catchment area of an airport. Furthermore, the technological sphere provides the technological developments and innovations needed to provide optimised operations at an airport.

7.1.2 Business Models

The definition of an airport's business model is fundamental and strategically relevant for the airport operator. In addition to tasks and fields of activity, the revenue structure, corporate management and single-/dual-till setups depend on those models. Finding the right business models for an airport is a lengthy process in which many different individual factors must be taken into account. If necessary, adjustments or changes have to be made due to long-term trends in air traffic. A constant review of the market situation as well as the airport's own circumstances is essential. The following strategic concepts play an essential role in the positioning of airports:

- **Hub Airports**

The hub airport is defined as an airport from which one or more airlines offer an integrated service network to a large number of different destinations with a high frequency of connections. It thus represents a central traffic hub or transfer airport for one or more scheduled airlines. Hub airports specialise in scheduled airlines and are geared towards their needs. They offer a high-quality service adapted to frequent travellers and premium customers. This includes, for example, fast transport connections, lounges and business facilities. However, they also cater for holiday flight passengers and, in some cases, low-cost passengers. Hub airports have a high proportion of transfer traffic. In order to perform this function, operators provide special infrastructure and services.

- **Hybrid Models**

The hybrid models without clear specialisation or positioning are characterised as medium-sized hubs and point-to-point airports, focussing on heterogeneous airlines and having a strong orientation towards their catchment areas. However, meeting the diverging requirements of the different customer groups has proven difficult. In addition, clear positioning, for example through differentiation or cost leadership, is not possible. Airports, therefore, face the challenge of successfully competing with rival airports in overlapping catchment areas by implementing hybrid strategies.

- **Specialisation on Low-Cost Airlines**

The term “low-cost airport” is increasingly used for airports that specialise in low-cost airlines. Low-cost airlines often establish a base at lower-cost airports, such as regional or military airports, which are located within easy reach of economic centres or large cities. The concept also applies for various secondary airports and is representative for airport business models, which are difficult in being profitable due to their size and missing economies of scale, with competition as a result of the increasing number of regional airports in the last two decades.

- **Cargo Airports**

In addition to cargo-only airports, there are major airports (e.g. Frankfurt, Schiphol, Charles de Gaulle) that promote cargo operations as a second mainstay. In order to handle this cargo volume, the airports have a specific logistic infrastructure on the one hand and are less subject to legal restrictions such as the ban on night flights on the other. Having achieved good intermodality (rail and road connections), freight can be transported onwards by the shortest route. In addition, cargo airports should have sufficient space for cargo terminals (freight centres). A cargo terminal includes a cargo receiving/dispatch area, a sorting and storage area, a cargo loading/unloading area, storage areas for special cargo (including perishable goods) and administration (freight forwarders and cargo airlines/departments).

7.1.3 Airport Planning Requirements

There are many reasons for creating or expanding an airport. Although airports are clearly becoming business enterprises that are profit oriented, it is important to remember that they are ultimately service providers and do not sell a product in the true sense of the word. In almost every case, one *does not create a market* for an airport; rather, one satisfies a market need *with* an airport. Once that need is satisfied, achieving maximum profitability becomes the new goal – especially in today's competitive environment. Financial and operative rewards are likely to be further enhanced in any economic recovery period. It is important to note, however, that accurately forecasting demand is not an exact science and cannot assure profitability.

Constructing new airports and changes to existing ones are business-as-usual tasks throughout the system. Holistic planning decisions on the airport level can enhance the system and benefit the region in different ways. International policy decisions have recognised the benefits of good transport systems and the effect of airports on the economy. The effect of international policy decisions can also be seen on a more political level through the European Union's economic initiatives and policies that are designed to diminish regional disparities among its member states, by bringing them in line using improvements such as road and rail transportation systems. When such efforts target the air transport system, effective "plans of action" (supranational level) must be coordinated with the provisions of the respective airport master plans (national or regional levels). This plan is in essence a detailed study of an airport's development over time. Such plans are reviewed at regular intervals, modified accordingly and supported by detailed forecasting and other data.

7.1.4 Airport Components

In order to fully appreciate the complexity of planning airport infrastructure, it is important to be familiar with all the components that make up an airport and to then realise that an inefficient operation in any one of these components may lead to an overall inefficiency and impair profitability, not to mention an impairment of the safety of the airport as a whole.

By definition, tangible components, whether located airside or landside, are physical items we can touch – this includes, for example, the runway which is at the heart of the matter in that it "defines" the airport. Without the runway, there is no "airport" in the classical sense. Runways are expensive to build and maintain and will be a key item on any budget. An inoperative runway will have an immediate effect on the entire airport and likely, the air transport system within which the airport is located. In short, a well-maintained runway is at the heart of an airport – failure here will lead to consequences throughout the system. The next obvious tangible item for a commercial airport would be the passenger terminal. This "processing" centre for the airport is supported by a number of significant support items as illustrated below.

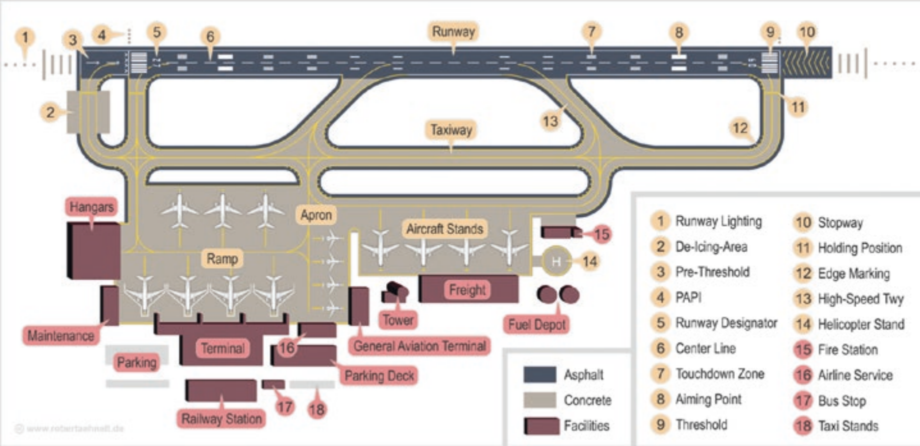


Fig. 7.1 Tangible components of an airport (Aehnelt, 2011)

Figure 7.1 depicts the diverse infrastructure found at a typical airport with business and leisure aviation. The infrastructure is not limited to that shown and the airside/landside categories are not bespoke buildings as some facilities may "straddle" them (e.g. passenger and cargo terminals or hangars). The facilities will also vary from airport to airport depending on size, airport location and operation.

7.1.5 Airport Costs and Revenues

It is important to remember that an airport is part of a system and that its cost, as well as potential to generate income, will be dependent on its importance and function within that system. In spite of this interdependency between airport and system, it is necessary and advantageous to have an independent accounting system for each airport in the system – even if several airports are operated under one ownership. Just as an individual airport may provide services to several other airports in the system and hence generate revenue from them, it may need to purchase services from that system which, in turn, would result in costs (e.g. technical, administrative, legal or other services).

The expenses that an airport incurs can be calculated in a number of ways (hourly, flat rate, project based, etc.) and differ little from the norm of any business. Official authorities, for example, routinely provide services for airports that must be compensated and become "costs" to the airport. In other words, an airport is a business and its balance sheet looks very much like that of any other business by including normal operating, administrative, maintenance costs and so on. The difference between the airport's and any other balance sheet is that the results or costs here have a direct impact on "airport charges" – the critical revenue generators for an airport. In short, airport "costs" establish a basis for airport charges. However, as the ICAO Airport Economics Manual points out, it is important not to rely on the balance sheet alone in determining "charges" because in the accounts, for example, assets may be depreciated in accordance with (established) national accounting standards which do not reflect the true operating life of an asset and hence paint a false picture of actual depreciation. Depreciation should, therefore, be included (by selecting the appropriate method) and shown at the end of the accounting year to provide an accurate basis for charges on air traffic. This will include cost for non-aviation/off airport services (e.g. meteorological services).

As a matter of reference, it is worth noting that capital charges (interest expense, depreciation and amortisation) relating to investments in airport infrastructure represent a large portion of the airport's total costs – as much as 25–50% for airports with on-going capital improvement programmes and up to 90% for new green field airports (IATA, 2010).

Aeronautical Revenues As indicated previously, airport charges represent a major source of airport revenue. They are based on a defined "cost basis," the type of airport, the items charged and the airport infrastructure. This kind of revenue is directly associated with air traffic. In contrast, non-aeronautical activities are not directly associated to air traffic. Therefore, they are not subject to ICAO-cost recovery policies but established through the cost basis associated with fuel, catering, ground handling, real estate services and services to third parties. In sum, revenues and expenditures consist of the items listed in ▣ Table 7.1.

▣ **Table 7.1** Revenues and expenses of an airport (Graham, 2008)

Revenues	Expenses
Charges on air traffic: Landing charges Passenger charges Cargo charges Hangar charges Safety and security charges Noise charges Other charges **Revenues from ground activities** Ground services Ground handling **Revenues from non-aeronautical activities** Fuel and oil concessions Restaurants, bars, cafeterias, shops Catering service Parking fees Rentals Other concessions Other commercial activities **Revenues from financial activities** e.g. income from interest **Grants and subsidies** **Other revenues**	**Personnel expenses** **Depreciation** **Other expenses** Suppliers Expenses for contracted services (provisions for facilities and services) Other administrative costs Non-financial costs **Financial costs** Interest fees Other financial fees

7.2 Airport Competition

The degree of competition between airports depends on the availability of choices for passengers and the level of interaction with neighbouring aerodromes' operations (Forsyth et al., 2010). Airport operators may choose to cooperate with other airports or decide to serve certain markets only and, therefore, affect the customer base. The size and structure of an airport's catchment area can also include an indicator of both the accessibility and intermodality with other means of transport such as railways, buses or cars. Quantitative research in the aviation sector, predominantly containing data envelopment analysis (DEA) techniques and the concepts of decision-making units (DMU), does not elaborate on a possible explanation of the competitive forces between airports, leaving a gap for additional investigation of their qualitative and subjective aspects for the air transport industry. In the following paragraphs on airport competition, we review the geographical spread and intermodality, the concept of airport systems and partnerships as well as airports' operating concepts and service offerings.

7.2.1 Spatial Development and Intermodality

The most common approach to describing competition in a geographical context is the catchment area concept (Pavlyuk, 2012). The concept includes the definition of different competitive levels for point-to-point and transfer airports, components of departing and arriving travellers and estimations of passenger flows. With the incorporation of the catchment area concept into spatial elements in the aviation industry, researchers found that the development of multiple airports within the same metropolitan area can lead to strategic cost advantages for affected operators and their contractors.

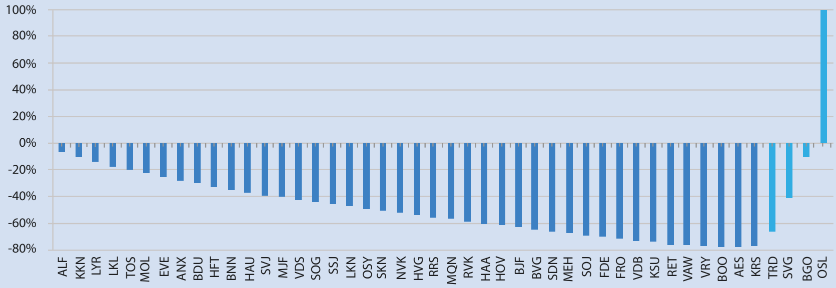
The scaling effects resulted from proportionally higher costs for one single airport when growing in size and traffic, so airport operators can share their cost structure and generate a competitive advantage through a spatial setup (Appold & Kasarda, 2011). Airport operators in close proximity can differentiate the service offerings between each other, resulting in an imperfect stage of competition and less comparability of spatially proximate airports. The service operators and contractors in a spatial setup of metropolitan airport systems compete for commercial activities of the individual concessions, but this does not result in a perfect stage of a one-to-one competition between two distinct airports yet.

Mini Case Avinor

Avinor is 100% owned by the Government of Norway but incorporated as a limited liability company subject to regular laws. Avinor owns and operates 45 airports in Norway and controls all the key aviation infrastructure.

Avinor is the sole provider of air navigation services within Norwegian airspace and has a virtual monopoly of air travel originating and ending in Norway, capturing approximately 99% of domestic passengers and approximately 90% of international passengers.

The Government of Norway has established that the company should operate to support the population in providing a vital form of transportation, rather than seeking to maximise profits. Consequently, Avinor's reported EBIT margins for its airports are lower when compared to other European airport companies. The company faces limited competition within Norway, as international airports in other Scandinavian countries are not readily accessible to the Norwegian population. Additionally, while other forms of transport are used in the south of Norway, the topography of the country and the large distances between population centres means that air travel is the most efficient mode of travel. Fast rail connections are limited to the Oslo region and cover relatively short distances. The location of Norway on the periphery of Europe also means that air travel is largely required when travelling internationally. The concept still allows the airport system as a whole to be financially profitable, with 4 airports subsidising the other 41 (◘ Fig. 7.2).



◘ **Fig. 7.2** Cumulative distribution of EBIT share by Avinor airport (Müller et al., 2012)

The growth of leisure travel with low-cost carriers (LCC) also accelerated the development of so-called secondary airports in Europe that share most of the passenger base with at least one larger international airport. Those secondary and mainly regional airports face additional competition with Europe's increasing rail network because of improved connections and shortening travel times between cities and metropolitan areas (Chiambaretto, 2012). In the case of landside operations that include commuters, visitors and local residents as potential customers, however, the intermodality, access time and the catchment area represent a relevant competitive factor because today's airport accessibility concepts include not only rail infrastructure for regional and long-distance services, but also multiple highway intersections for improved access options by car and bus.

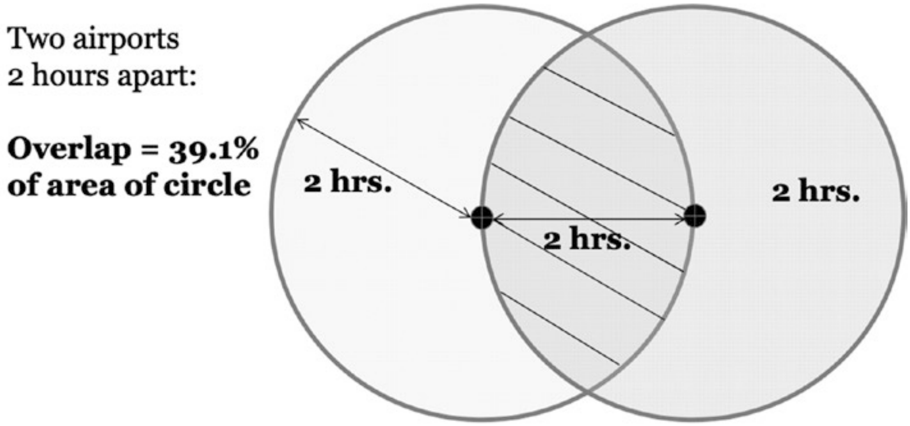
Catchment areas can vary in size based on the destinations flown from a particular airport, as well as the offered service levels. Increased levels of commercial services and higher service quality result in expanded catchment areas and more diversified customer groups (Lieshout, 2012). The effect of intermodality on travelled distances to access the airport applies to ground transportation as well as airlines' multi-hub approaches using a portfolio of transfer airports, expanding the competition beyond the scope of neighbouring aerodromes, and including transfer passengers as retail customers.

Overlapping Catchment Area – A European Analysis

According to an analysis by Thelle et al. (2012) on behalf of Copenhagen Economics, 63% of all European citizens live within the 2-hours catchment area of two or more airports (>1 mio. passengers). The catchment overlap for the area (assuming circular catchment areas) is more than 39% (Fig. 7.3).

7.2.2 Airport Systems and Partnerships

Airport operations, forming a system within, e.g. the European aviation market, require holistic concepts such as total airport management (TAM) and airport collaborative decision making (A-CDM). Those networks positively affect service levels and revenue including commercial activities and collaboration between airport operators and business partners. The benefits of airport-stakeholder cooperation in a TAM environment can result in benchmarks for airport profitability. Despite the influence on total income through joint efforts, the concept of airport ownership by other airport operators often results in increased financial attractiveness rather than service improvements (Forsyth et al., 2011). In addition to the return-



Note: The area of the overlap (the shaded area) relative to the catchment area of a 2 hour drive can be calculated mathematically as 39.1%. Two airports three hours apart will have an overlapping area of 14.4%.

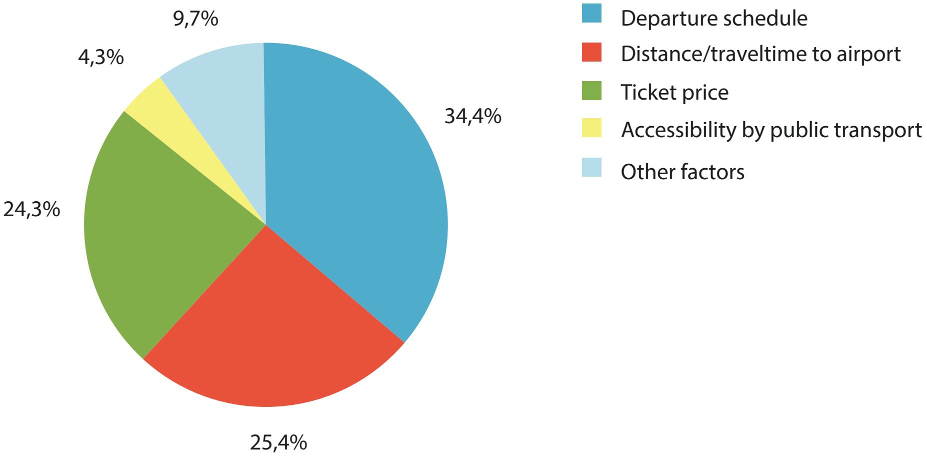
Source: Copenhagen Economics

Fig. 7.3 Overlapping catchment area of two airports (Thelle et al., 2012) on-investment (ROI) from such airport stakes, operators consider vertical contractual relationships with airlines similar to those with retail partners, requiring initial investments to attract partners but eventually resulting in a share of fixed costs to maintain the airport infrastructure.

Decisive Factors in Airport Choice

KiM Netherlands assessed the airport selection preferences of Dutch travellers in 2011 and found that an airport's schedule and catchment area (travel time) are leading the choice model, followed by ticket prices in third place (▣ Fig. 7.4).

Airport operators' collaboration with retailers and airlines imply that all three serve each other and address clients' needs for transportation and consumer services. Collaborating within a partially monopolistic market structure such as airports as well as embedded service offerings, however, may result in so-called differential pricing through an imperfect stage of demand and supply (Gillen, 2011). The airport-airline partnership does not always represent a sustainable collaboration. Low-cost carriers seem to show less-binding commitments in case of decreasing margins with routes (especially for European short-haul connections), affecting the departure airport's customer base and profitability, as well. Passengers perceive these levels of partnership differently. When assessing the influence of European aerodromes' catchment areas on the airport's market power, passengers evaluate an airport's competitiveness based on the availability of routes, while airlines mainly refer to the size of airports in their assessment; however, both passengers and airlines rarely consider pricing or service aspects as the main objective for the airports' level of competitiveness.



▣ **Fig. 7.4** Airport choice model (Gordijn & Kolkman, 2011)

7.2.3 Operating Concepts and Service Offerings

The airports' investments in service offerings for passengers of full-service carriers (FSC) differ from those offerings for passengers flying with low-cost carriers (LCC), mainly leisure travellers (Njoya & Niemeier, 2011). Small but more specific investments in dedicated low-cost terminals bear an economic risk and may result in losses, if LCCs decide to discontinue operations from such airports, eventually affecting the nonaeronautical income of the operator. Secondary airports, serving LCCs, show elements of increased competition with other regional airports than with primary airports, as main airports serve a broader range of airlines, passengers and routes (Carlisle, 2013).

Safeguarding those passenger and traffic flows remains essential to airport operators, business partners and airlines, resulting in above-mentioned vertical relationships and mutual investments in both the infrastructure and retail offerings. Carlisle (2013) concluded that geographical aspects matter with respect to market growth. This results in an increased importance of retaining passengers at individual airports in Europe, representing a mature aviation market with less potential to grow traffic and commercial revenue, as opposed to airports in emerging Asia or South America. Nonaeronautical revenue, as opposed to a fixed aeronautical income per aircraft and passenger, represents a flexible component at European airports and can vary by criteria such as traveller or customer type, departure and arrival time or the individual performance and efficiency of each service.

Low-cost concepts and financial relationships resulted in an increased commercialisation of the airport business in Europe in the 1990s and 2000s, which included the provision of incentives as part of lower landing fees or handling charges, mainly providing competitive advantages to airlines rather than on ground business partners. Airports, showing capabilities to set discretionary price levels, do not maximise those fees and charges when operators and associated concessionaires manage to generate a certain level of nonaeronautical income instead (Kratzsch & Sieg, 2011). Such a threshold behaviour does not apply to most regional airports as those operations represent a comparatively small market power, requiring investors to achieve profit maximisation through all available revenue channels or cost reduction measures. Regional airport operators face more fluctuations in passenger traffic and commercial income than international operators but require a different organisational setup and the definition of multi-task roles for their workforce.

7.3 Performance Management

Most airports in Europe do not perform at an optimal scale, requiring specific management skills and the implementation of adaptive concepts to improve profitability from aeronautical and commercial activities (Adler et al., 2013). Economic inefficiencies such as financial losses or the need for communal subsidies create capacity issues and gaps in the optimal use of an aerodrome's infrastructure and retail space. The analysis of the efficiency and development of airport operations and the fluctuations of an airport's financial performance can be done by traditional strategic frameworks such as airport master planning (AMP). However, improved and adaptive concepts are required, addressing the importance of managerial instruments and the implementation of sustainable strategies, especially for privatised airports. In the following paragraphs, related to performance management, the review includes measurements of efficiency and profitability, capacity constraints and options for the development of airports and concessions, as well as the financial implications of regulatory and ownership structures.

7.3.1 Efficiency and Profitability

The influencing elements for the efficiency of airports and their stakeholders seem to differ in a geographical context. Airports with increased commercial focus on LCC operations show higher efficiency scores than those primarily serving traditional carriers (Bezić et al., 2010). Specific examples of such scenarios can be found in the United Kingdom and Germany, showing that the efficiency gain can be achieved through increased competition among regional airports in Europe. Airport operators face difficulties in achieving profitable results because of the ongoing transitions from traditional to low-cost operations (in Europe), without understanding the requirements of an optimised concept for a particular location or consumer group (Graham, 2013).

U.S. airports indicate that LCC operations negatively affect the efficiency of large and primary airports that started offering low-cost and traditional services to LCC and FSC. Despite this fact, the U.S. airline industry, however, are increasing their LCC efforts, appreciating the airports' initiatives and resulting in more LCC service offerings from primary airports. Airport operators experience passenger and aircraft traffic as the primary driver of their cost and revenue structure, affecting every part of the commercial business (Carlisle, 2013). When assessing business cases related to low-cost operations at airports, geographical differences for commercial offerings and airline operations exist between the aviation markets of Europe, Asia and North America.

Usually, airport executives explain cost efficiency through profitability, expressed by expenses and revenue; however, regional airports' executives mainly focus on labour and capital as input and passenger traffic as output parameters (Merkert et al., 2012). The minimum number for passenger traffic to achieve an airport's economic break-even has increased over time and negatively affects small and regional airports because of the proportionally high capital investments in the infrastructure and retail space. The exposure towards more LCC operations and leisure travellers, showing seasonal traffic variations at regional airports in Europe, in particular, negatively marks the operational and financial input-output performance for business owners. The profitability of standalone and mainly regional operators, as opposed to airport groups, depends on the capabilities of providing commercial opportunities and other in-house services to improve all available

▣ **Table 7.2** Airport industry KPIs (ACI Airport Economics and Statistics, 2014–2020)

Global airport industry KPI	2013	2015	2017	2019
Industry revenue (billion US$)	142.5	151.8	161.3	172.2
% Aeronautical	55.5	56.0	56.0	55.8
% Non-aeronautical (commercial)	40.4	39.8	39.4	39.9
% Retail concessions	28.0	26.0	28.8	30.2
% Car parking	22.0	22.6	20.5	20.1
% Property and real estate	15.0	15.7	15.0	15.0
% Other (incl. advertising, fuel)	35.0	35.7	35.7	34.7
% Non-operating	4.1	4.2	4.6	4.3
Cost per passenger (US$)	16.82	15.58	13.55	13.69
Profit margin (%)	16.0	17.2	22.2	20.8
Return on investment (%)	6.3	6.4	7.3	7.4

income options through revenue from direct sales or concessions (Adler et al., 2013) (▣ Table 7.2).

7.3.2 Capacity and Development

The gap between demand and supply of capacity for aircraft movements at congested airports determines the so-called capacity crunch and affects efficiency improvements to a significant extent (Marian, 2012). Large airports are facing capacity constraints with hub airlines' peaking system to optimise the feeder flights and it is recommended that airports and airlines should increase de-peaking efforts to distribute capacity and resources evenly, thereby improving the financial efficiency of airport operators at lower costs. De-hubbing, a process similar to de-peaking, includes the diversification of airports to attract more airlines, avoiding congestion by one single carrier's hub-and-spoke network and attracting a broader portfolio of passenger types (Redondi et al., 2012).

Efforts to decrease congestion also prevent delays and positively influence passengers' well-being, the travel experience as well as the spending behaviour. Concepts for future airport developments extend to passenger services, as travellers want to be in control of individual trips end-to-end. Today, economic input-output frameworks within a decision-making model can enable airport executives to manage the travel experience by passengers. Airport operators and business partners possess enough control over their business-related input and output parameters to administer the infrastructure, capacity and service offerings.

Airport collaborative decision-making (A-CDM) models are considered being very effective, especially for the deployment of A-CDM across regions or countries. In addition to these influential elements by airport operators, the size of airports serves as a positive determinant of commercial revenue. In Europe, an airport's size plays a critical role in sustaining economic as well as passenger and airline traffic fluctuations, also affecting profitability from retail offerings (Painvin, 2011).

7.3.3 Regulation and Ownership

A quantitative frontier model can assess the relationship between airport ownership, regulation and performance, often confirming an undesirable effect as part of a positive and significant correlation between regulated environments and costs, while private ownership disclosed a beneficiary effect. Very similar to that and using a data envelopment analysis (DEA) approach, the largest efficiency gains at airports can be seen through moves from governmentally regulated enterprises to privately owned companies. Despite the relevance of ownership structures, the communication and cooperation between stakeholders at airports seem to complement the effectiveness of both the management organisation and the leadership style (Noronen-Juhola, 2012).

Regulatory elements in combination with non-aeronautical revenue are able to show that retail activities at airports can make price regulations obsolete. Price control can lead to improved service quality at airports if operators have to compensate the capped aeronautical revenue through enriched commercial and service-oriented offerings. When analysing the value determinants of European airports in order to characterise the financial attractiveness to investors, you can find that state control harms economic evaluation criteria and results in a negative perception by stakeholders, including airport operators.

Various airport studies with respect to efficiency drivers of operators and partners have concluded with the importance of size and private ownership as positive influencers. However, Ison et al. (2011) confirmed the positive influence of airport privatisation on operational efficiency, but also found the trends of increased commercialisation being more relevant than the ownership structure. The privatisation of airports in Europe does not always result in performance improvements but serves as an approach to raise financial capital and share economic risks between a broader group of investors and business owners.

7.4 Service Quality

Airport operators manage a multi-product concept and offer a variety of services that travellers perceive differently. The level of satisfaction may differ based on the type of travel, the services expected and offered or a combination of other perceptive elements throughout the journey. The conceptual model of an airport's service quality includes a foundation to detect gaps towards customer satisfaction.

However, it requires additional elements to identify passengers' preferences and determining the service and product implementation strategy by business owners (Tsai & Kuo, 2011). In the following paragraphs related to service quality, we review service expectations and fulfilment requirements, travellers' perceptions and service quality assessments as well as the travel experience and its interdependencies.

7.4.1 Expectations and Requirements

The service expectations of different types of travellers differ significantly. Leisure travellers expect more functionality, interactivity and diversification from an airport's product portfolio than business travellers. With respect to time spent in accessing an airport and within the terminal, however, business travellers are less likely to accept the so-called traffic leakage than leisure travellers (Lian & Rønnevik, 2011). The competitive disadvantage of secondary airports due to the aerodromes' remote locations can only be partially compensated by the benefits of short distances within the premises, e.g. between check-in areas and departure gates. A business traveller expects and appreciates the reduced waiting time, however, after a certain threshold time, also spends less money within retail facilities than a leisure traveller, resulting in the need for differentiated service offerings by passenger type (or personas).

There is a positive relationship between service ranking and economic performance and airport operators are able to make advanced assumptions on the fulfilment level of quality expectations based on an airport's own financial indicators (Pérezgonzález & Gilbey, 2011). Airport investors can respond to these different expectations through broad and customised commercial/service offerings that also provide optimised use of an airport's excess infrastructure or space. The number and types of services offered at aerodromes affect a passenger's perception of the airport's economic and operational performance.

In general, airports can leverage offerings through convenience, loyalty, individual features or pricing, enabling smaller airport operators to differentiate themselves from competitors through innovation such as providing additional services to regional carriers and passengers. Innovation in the aviation industry, focusing on adding value to passengers, can lead to substantial business growth for both aeronautical and commercial services (Gumus et al., 2013). When applying quality requirements to international travellers using different service models, airports can elaborate on the fact that interaction, convenience and culture are equally necessary to fulfil passengers' needs for service satisfaction and value creation.

ACI Passenger Personas

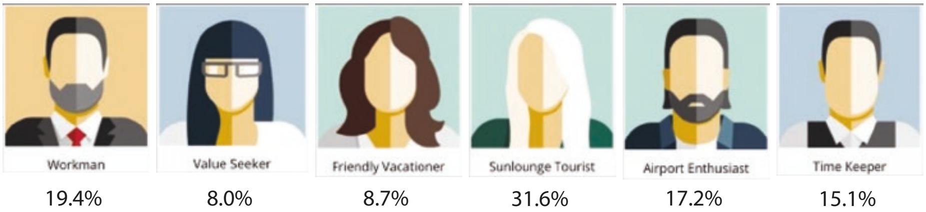
In 2016, using Airport Service Quality (ASQ) data, ACI introduced the concept of *passenger personas* to help better describe airport customers. Personas are fictional characters or typologies created to represent the different user types that might use a product or service, such as an internet website, brand or product in varying ways. In a customer experience context, personas tell you what prospective and current customers are thinking and doing as they weigh their options to address a need to which an airport will respond. Beyond the idea of a one-dimensional profile of people that airports need to influence, actionable personas reveal insights about customers' decisions as well as their specific attitudes, needs, expectations and concerns. This in turn can help airports steer customer experience initiatives in the right direction (■ Fig. 7.5).

7.4.2 Perception and Evaluation

The perceptive capabilities of customers do not always follow reason, but it can help understand the reward/recognition elements by frequent travellers towards airport staff courtesy. Differences in the service perception by persona show the importance of the cultural influence, with a specific focus on transfer passengers. Those passengers in transit use airside offerings while showing different consumption patterns and service needs than landside customers or departing passengers (Freathy & O'Connell, 2012).

The perception of safety measures seems to affect customer satisfaction. When including travel purpose and loyalty factors to assess the airline's level of service, research has found that leisure travellers value safety criteria significantly higher than business travellers do. Tourists value commercial prices and the availability of products as critical satisfaction factors of their shopping experience in a duty-free retail store. The evaluation of flight quality by LCC passengers shows that leisure travellers care less about service quality aspects than business travellers do (Lin & Chen, 2013).

Airport customers value staff courtesy, availability of information displays and the sanitation of facilities as convenience factors of personal satisfaction. A predictable indicator of client satisfaction is terminal cleanliness. The conclusions from those service quality assessments apply to passengers, employees and business partners of airport operators. Staff courtesy and hygiene factors represent an indicator of client satisfaction in commercial areas for all passengers, with lounge facilities mainly affecting the service experience of business travellers.



■ **Fig. 7.5** Persona (and their global shares among airport customers) (ACI, 2017)

7.4.3 Experiences and Dependencies

A service experience results from the combination of expectation and perception. Decision makers of service quality improvements at airports have to consider preferences and satisfaction levels by different types of passengers as part of the persona concept. Operators and business partners should address gaps in service quality via passengers' evaluation criteria and individually expressed expectations. A positive journey experience results from a passenger-centric approach. The travel experience covers time spent in the airport or on board the aircraft but also includes the distance spread inside the terminal (Hanaoka & Saraswati, 2011).

Research studies deployed the five-element tangibles, reliability, responsiveness, access and empathy of the renowned service quality (SERVQUAL) model into a quality assessment tool for aviation stakeholders to manage service quality and the value proposition to passengers. Pabedinskaitė and Akstinaitė (2014) extended SERVQUAL to include both airlines and airports and combined the service classification with expert opinions. They concluded that tangibles, such as staff and equipment, and reliability, such as operations and safety, seem to have a significant positive influence on the perception of service quality by travellers.

Airports have to incorporate a customer-centric approach into the business strategy and service delivery plan. Service quality, customer value and company image affect passengers' shopping intentions and purchasing decisions. Travelers make decisions for cost and price reasons but also include service quality criteria into the considerations for a final selection. Product and marketing managers of a duty-free retail operator can affect the shopping experience through the definition of quality attributes for the product, customer service or the store's layout, with leisure travellers showing a higher responsiveness towards a holistic retail concept than business travellers (Lin & Chen, 2013).

7.5 Strategic Planning (Commercial Services)

Airport operators manage a complex service and product portfolio in an economically uncertain environment and under changing conditions with respect to passenger and aircraft movements. Strategies to improve revenue include an adaptive and sustainable use of the airport's infrastructure, enabling commercial partners to deploy mechanisms of maximising yields within existing perimeters and developing new services in collaboration with other airport partners (Forsyth et al., 2011). To accommodate for a passenger's need for information about the airport experience and offerings in the terminal, operators have to define strategies aiming at the individual requirements by different traveller types and airlines. In the following paragraphs related to strategic planning, we review the concepts of market segments and consumer groups, the implications of product and service development as well as the process of strategy deployment and adaptations.

7.5.1 Market Segmentation and Consumer Groups

The market orientation and deregulation of the airport ecosystems in the European Union (and other markets) require an integrated approach for business owners and policy makers to define and control commercial activities of both landside and airside airport areas. Airport operators have to consider commercial opportunities by airlines and service providers as well as passengers' preferences for accessing the airport, environmental consciousness and social needs, including market segments beyond the scope of consumption by travellers. Investors in the aviation industry added service maturity, time sensitivity and corporate involvement to the strategic focus on traditional market segments such as full-service and low-cost carriers or business and leisure travellers, enabling products and services also for non-airlines/non-travel market segments (Harrison et al., 2015).

Airport operators' focus on traveller types also includes age, gender, culture and other criteria to differentiate offerings and reflect the broad consumer portfolio in the service business of aerodromes (Freathy & O'Connell, 2012). Travelers and non-travellers represent important stakeholders and customers for landside areas. Those facilities are publicly accessible and relevant for airport visitors, neighbouring residents and employees, thus becoming critical contributors to the financial profitability of airport operations. Non-travellers seem to appreciate the convenience of access and extended opening hours or using the airport infrastructure for recreational purposes. Travellers and consumers of airside services show a higher time sensitivity because of the constraints by scheduled departures and boarding slots, requiring operators to improve the focus on specific persona types (Harrison et al., 2015).

7.5.2 Product and Service Development

Product managers include the customers' motivation (airline customers and passengers) when defining offerings and translate them into travellers' and non-travellers' intentions to experience services at airports. The motives of passengers and the time constraints at airports result in service requirements that reflect this portfolio of stimulating elements for leisure and business travellers (Lin & Chen, 2013). It becomes difficult to define compelling offerings that can attract different types of travellers within short timeframes, with limited options for reselling after a passenger's departure.

With respect to the element of time, researchers analysed the correlation between time spent at the airport and conversion rates airside. They concluded that leisure travellers complete most of the consumption cycle in the first 2 hours of waiting time, while business travellers usually start increasing such expenditures only after unexpected delays and a waiting time of 2 hours or more. Airports have to present services to business travellers in a very short timeframe if delays at airports are less likely to occur. The service and product satisfaction by travellers depends on which portfolio they refer to. Customers in *high-street* retail stores evaluate their commercial experience more differentiated than consumers buying convenience products or services for daily use (Perng et al., 2010).

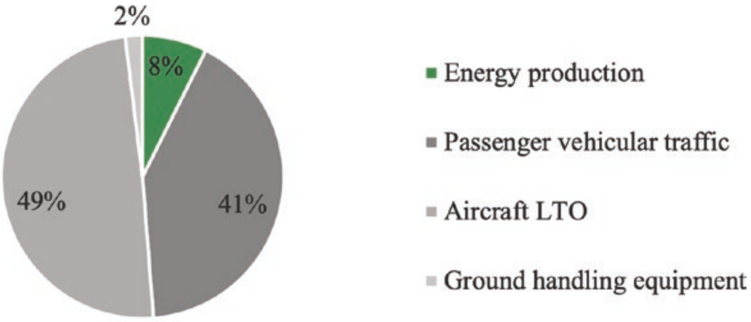
7.5.3 Strategy Deployment and Adaptations

Business owners at airports can implement retail strategies based on the statistical estimations for commercial revenue by different traveller types (Torres et al., 2005). In addition, concessionaires may use the generalisation from experiences made at shopping malls, where they tested the introduction of kiosks, pushcarts or stalls to assess revenue implications from the emotional responsiveness of consumers. Runyan et al. (2012) found that the existence of a pleasant environment and the grouping of in-mall kiosks by products result in a positive reception by customers, who generally tend to rate those non-traditional retail spaces more negatively and perceiving salespeople to be more aggressive than the in-store personnel. Despite the applicability of general models, both the business concept and strategy also have to include aviation-centric characteristics, especially the relationship between service quality and customer satisfaction (Baker, 2013). Baker stated that good results from service excellence positively affect customer loyalty as well as the financial performance and strategy of the assessed businesses in the aviation industry.

Operators predominantly base long-term strategies on master plans that contain assumptions on aircraft traffic volume, passenger development and commercial predictions for the aviation sector or the economy (Kwakkel et al., 2012). According to this research, business owners need to break down the existing master plans into adaptive concepts, enabling executives to include uncertainties such as capacity constraints or third-party risks and, therefore, improving the response time and the continuous financial viability of retail operations. The strategic framework of a commercial organisation at airports may include a customer-centric approach, focusing on very individualised needs by traveller type and employees, ensuring a holistic and flexible concept for the total operations of a service provider or retailer (Vel et al., 2012). Freathy and O'Connell (2012) confirmed the importance of broad and holistic strategies for concessionaires and the necessity to understand consumer needs, the requirements for large landside and airside retail spaces and how business owners should adapt service and product offerings to travel patterns.

7.5.4 Environmental Sustainability of Airports

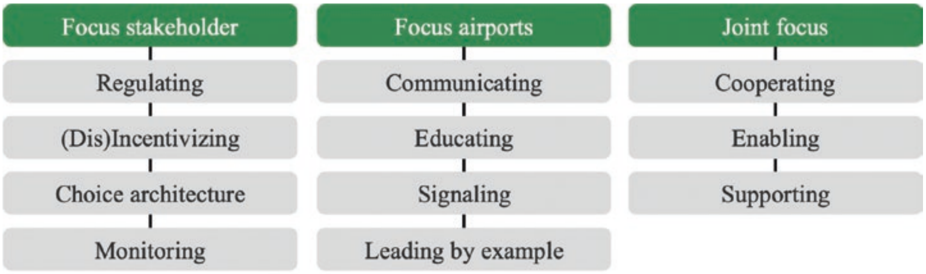
Economic and social benefits of airports come at an environmental cost, which has resulted in increasing public scrutiny in recent times. As a result, airports have introduced diverse measures and initiatives, such as the Airport Carbon Accreditation program, in order to curtail their own negative environmental footprint leading to notable progress. However, these measures primarily focus on the impact that is directly under the airport's control hence omitting the footprint pro-



Source: Adapted from Postorino and Mantecchini, 2014, p. 85

Note: Sources under the control of the airport are shown in green

Fig. 7.6 Sources of CO_2 emission at airport ecosystems. (Author's own figure, adapted from Postorino & Mantecchini, 2014)



Source: Own illustration

Fig. 7.7 Dimensions of ASSIF. (Author's own figure)

duced by other actors at the airport premises such as airlines, commercial partners or passengers (Fig. 7.6).

Since the impact of these airport stakeholders exceeds the airport's direct footprint, it is essential to understand the methods airports can utilise to affect the environmental behaviour of their stakeholders. Qualitative research has revealed 11 levers used by airports to reduce the environmental impact of their stakeholders. Levers such as choice architecture, signalling, enabling and eight others form the building blocks of the airport sustainability stakeholder influence framework (ASSIF) providing airports with a comprehensive overview of options for affecting their stakeholders' footprint (Fig. 7.7).

Review Questions

- What are the key elements of an airport's business model?
- Should airports be operated as a public or private infrastructure?
- What are the competing elements of airport platforms?

- How can airport operators focus on the customer diversity (airlines, service providers, passengers, non-travellers)?
- How can airport strategies cater to the mid- and long-term changes in air traffic? And what are the challenges?
- Why are airport operators a key player in environmental sustainability, but not the only contributor?

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8

Demand and Marketing in Aviation

Andreas Wittmer and Thomas Bieger

Contents

A. Wittmer et al. (eds.), *Aviation Systems*, Classroom Companion: Business, https://doi.org/10.1007/978-3-030-79549-8_8

Summary

- The buying behaviour and thereby the influence of different marketing instruments vary among market segments.
- In general, the most important marketing instruments are product service (especially for business customers), customer relation management, brand, pricing and distribution.
- Seat quality and seamless service chain from booking to the plane and onwards to the final destination location are the most important elements of service quality where the most innovations take place and whole ecosystems appear.
- With the evolution of airline alliances and mergers, single brands are more and more replaced by brand portfolios.
- Price and distribution are the instruments which are closely linked to capacity control and network management.
- Specific market segments and situational readiness to pay have to be the bases of dynamic prices. Accordingly, price discrimination has to be made based on market segments, time of booking etc. Price discrimination needs fencing to avoid cannibalisation.

Marketing instruments are used to influence the buying behaviour of passengers and, therefore, vary between the different segments. In terms of aviation, aspects such as product service, customer relation management, brand, pricing and distribution are important marketing instruments. The service quality consists of the seat quality and the seamless service encountered by the passenger throughout the entire journey from booking until after the arrival. In a consecutive step, the concept of customer value is explained and applied to the aviation industry. Branding is also an important marketing instrument that is seeing a change from single brands to a portfolio of different brands, especially within airline groups. Furthermore, the concepts of distribution and pricing from previous chapters are embedded as additional marketing instruments for airlines. The bases of pricing are determined by specific market segments and situational readiness to pay, which airlines use to determine their dynamic prices and implement price discrimination.

8.1 Introduction

This chapter provides an overview on the marketing of airlines – the most "end-customer" linked sub-industry of the aviation value chain. It is presented from the perspective of the customer and starts with market segments and their respective needs. The most important marketing instruments like product/service, brand, price/distribution and customer relationship management are discussed. Special emphasis is placed on pricing which is considered an integrated instrument of capacity management. Modern price management with aspects of fencing and framing are illustrated.

Introductory Case: Booking an Airline Ticket

By Andreas Wittmer and Christopher Siegrist

Today, customers are facing a huge variety of different prices as well as rules and conditions that apply. Just imagine flying on a certain date, e.g. on 13 May 2020 from Zurich to London and returning to Zurich after a four-day stay. An average airline would offer four to six different price categories in the economy class. Some tariffs, usually the most expensive ones, allow for flexible rebooking and rescheduling; other tariffs only apply to certain dates and planes. When considering online offers within a certain timeframe, the following questions arise:

- Which price category would you choose?
- Based on which criteria?
- What do you think would be an average customer's preference?

Market research (◘ Table 8.1) shows that for the customer's choice the most important attributes, apart from price, are image (brand), punctuality and direct connections. The main purpose of airline marketing is to direct buyers to more expensive products and to adjust prices as closely as possible to their maximum willingness to pay. As the latter may differ between individuals and travel situation, pricing in aviation tends to become more and more individual and situational.

◘ Table 8.1 Attributes for customer choice (1 = most important, 10 = least important)

	Directly answered importance's		**Covered answered (variance decomposition)**	
	Economy class	**Business class**	**Economy class**	**Business class**
Total travel expenses	5	8	1	1
Direct connections	2	1	2	2
Sympathy/brand	7	7	3	3
Number of daily connections	10	10	4	4
Total travel time	6	3	n/a	n/a
Arrival and departure time	8	6	n/a	n/a
Punctuality	3	4	n/a	n/a
Travel convenience	4	5	n/a	n/a
Security	1	2	n/a	n/a
Frequent flyer program, status	9	9	n/a	n/a

Table compiled by author based on own research

- What would make you to pay more for an airline ticket?
- In which situations would you be prepared to pay more for an airline ticket?

As shown in the introductory case, in the aviation industry, marketing related to image and price is highly important – despite the commodity character of air transportation as a service. In the short run, the main goal of aviation marketing should be maximising the return per available seat kilometre (by maximising and optimising the mix of seat load factor and yield). This can be achieved by using instruments such as building of reputation through image and service, pricing and availability/distribution.

In the long run, marketing must contribute to a maximisation of customer value and equity in the sense of increased customer benefits and quality of customer experiences. Loyal customers are a main asset in each service industry. The acquisition of new customers is cost-intensive and risky due to high information and transaction costs and because customer-perceived quality risks have to be overcome or compensated. Perceived customer value is defined as the difference between perceived comparable costs (compared with costs of alternatives) and comparable benefits (compared with benefits of alternatives). It is the basis of loyal long-term customer relations. Loyal customers contribute to the company's success by word of mouth, frequent bookings, a reduced price sensitivity and by purchasing more and different goods from the company (Woodruff, 1997; Belz & Bieger, 2006; Boetsch et al., 2011).

8.2 Demand and Market Segmentation

The demand for air transportation in terms of passenger tickets or cargo services is the final component within the aviation value chain and thus the main driver for the development of the entire aviation system. It is important to understand both the dynamics of this demand and the requirements of the customers. However, like in any dynamic market, demand depends on exogenous variables, e.g. general economic climate, business mood or cultural developments. Certain segments of aviation, like business travel or cargo, react particularly strong to economic downturns, which for example have been experienced during the crisis in 2001 and 2008/2009.

Furthermore, in cyclical and dynamic markets, unlike in many other markets, demand is also driven by the supply side. New quality and types of air transport create new demand. For example, the introduction of low-cost transport resulted in an increased demand in aviation as new types of travelling (e.g., students travelling to parties) and new market segments (e.g., retired people on business trips) started to grow (Signorini et al., 2002).

Conventional market research investigates the importance of certain criteria or quality dimensions. However, often only a selection of quality dimensions, which are mentioned by surveyed customers, are considered. Thus, results do not reflect the real decision behaviour where trade-offs and resource restrictions play a role. Modern market research therefore applies methods which allow for an identification of the so-called "revealed motives" or "preferences," which customers sometimes are not willing to or are not able to disclose (Verhoef & Franses, 2003; Whitehead et al., 2008). Often the so-called choice modelling approach is applied to identify revealed preferences. Customers may choose from different options. They have to identify the option which they prefer most and, thus, they have to make a decision. By using choice models, the importance of different quality dimensions can be identified. Based on this method, a study on the importance of different service elements on long-haul travel has been conducted (Laesser & Wittmer, 2007; Boetsch et al., 2011). The results show a significant difference between stated and revealed preferences even for business travellers.

Customers' preferences differ between market segments. Market segments are defined as groups of customers with similar preferences and/or buying behaviour (Kotler, 1991). Market segments can be distinguished by situational, socio-economic, demographic or psychographic criteria. Situational criteria become more and more important. Depending on age and sex, a business traveller might have characteristic needs. For instance, a person, who is comfort-oriented, still likes to travel in full-service business class, whereas a person who is very pragmatic might prefer the no-frill economy class. Market segments in the travel industry can be clustered according to motivations, socioeconomics and psychographic criteria. An example of a model, which categorises customers in six segments, is presented in ▣ Fig. 8.1:

Situational segmentation groups the passengers according to their booking preferences and travel requirements. These segments primarily differentiate and compare customers according to their situation, which can change over the course of time. Therefore, segments such as

Bargain Hunter
Functionals / Cheap Chic
Age Profile: 20 – 45
Business Travel: marginal flyer
Leisure Travel: occasional flyer
Segment Size: Major

Modern Mainstream
High Streets Shopper / Travel Experiencers
Age Profile: 25 – 45
Business Travel: occasional flyer
Leisure Travel: occasional flyer
Segment Size: Major

Traditionals
Conservatives / Habituals
Age Profile: 55+
Business Travel: marginal flyer
Leisure Travel: occasional flyer
Segment Size: Major

Trendsetters
Cosmopolitans / Discoverers / Globetrotter
Age Profile: 18 – 40
Business Travel: frequent flyer
Leisure Travel: frequent flyer
Segment Size: Medium

Established Seniority
Corporate Seniors
Age Profile: 45 - 70
Business Travel: frequent flyer
Leisure Travel: frequent flyer
Segment Size: Medium

High Society
Company Leaders / VIPs / Celebrities
Age Profile: 20 – 99
Business Travel: high frequent flyer
Leisure Travel: frequent flyer
Segment Size: Niche

▣ **Fig. 8.1** Customer categorisation (Eelmann & Becker, 2007)

- Sales channels
- Time and date of flight/booking
- Ticket flexibility
- Seat availability
- Frequent flyer benefits
- Airport services
- In-flight services
- Location and access of origin and destination airport are used.

Socio-economic and demographic segmentation focus on the grouping according to variables that are given by social and demographic factors. These include

- Gender
- Age
- Nationality
- Income
- Marital status
- First language (mother tongue)
- Occupation
- Education background
- Religion, etc.

thus giving a clearer image of the customer's standard of living and their cultural background. This can explain certain spending patterns, e.g. religion can explain the hike in travel around religious holidays. As such, airlines can adjust their product offerings to create the best customer value for customers according to where they come from and how they live.

Proceeding into the mental aspects of the customer, *psychographic segmentation* provides a grouping according to criteria such as

- Travel behaviour
- Motives
- Values
- Cultural background
- Journey purpose: the reason for travelling, such as leisure or business travel
- Length of journey: short- versus long-haul travel
- Travel class: economy, premium economy, business, first
- Travel experience: frequency of air travel
- Loyalty program membership: account balance and status level
- Destination choice
- Airline preference (e.g. based on brand, business model, safety perception, service standards, quality levels)
- Carbon offsetting options

Putting this into context, customers can be segmented by their preference for travel classes or the purpose of their journey, for example.

In conclusion, market segmentation offers a wide range of aspects to divide customers into and understand their needs better. Being able to create customer groups using the different types of segmentation criteria is vital for an airline to understand its customers and provide the best customer value possible. The criteria allow for customer segments to be created which can be focused on and appropriately catered for.

Mini Case: Customer Segmentation in Asia

By Andreas Wittmer and Christopher Siegrist

To define different customer segments for the Singapore Tourism Board, a survey was conducted by a group of researchers among Asian business travellers and travel managers. Furthermore, data regarding booking patterns and spending patterns were analysed and added to the study as well. The results allowed for a better overview regarding preferences and behaviours among the seemingly heterogenous mass of Asian business travellers. The results could be divided into four different customer segments:

A large proportion (32%) of the travellers could be identified as a *stereotypical suit* meaning that they represent the stereotypical businessman. They typically prefer factors that facilitate their travels such as non-stop flights, convenient flight times, and flexibility and tend to be price agnostic. Nearly two thirds of them admitted to breaking company travel policies to book more expensive convenient flights, while they would only book with low-cost carriers if there were considerable advantages regarding convenience. Demographically speaking, most of the stereotypical suits are non-millennials working in medium-sized or large companies.

The second segment was attributed to travellers called *service seekers.* Making up to 34% of all business travellers, they prefer service such as attentive staff and additional facilities. They tend to regard travel as a perk of their jobs and have a sense of adventure. While they have the highest willingness to pay for extra service, their sense of adventure also makes them open to more basic options such as sharing budget accommodation. More than half of the service seekers hail from China and Indonesia.

The *belt tighteners* are the most price-conscious of all types. They are unwilling to pay for extra service and prefer the lowest price twice as likely than others. When it comes to flights, they are willing to substitute time for a lower price. However, they tend to stick to domestic travel and are mostly from junior management within SMEs, thus implying that they have tighter travel budgets. The cost focus also causes them to have a lower than average view of travel being a perk of the job.

The final segment are the *point maximisers*. These travellers are typically frequent flyers that do not see travel as a perk but see the collection of loyalty points as a motivation to travel. They frequently evade the company's travel policy to maximise their spending and value extra comfort. What distinguishes them from service seekers is the fact that they are not willing to pay for the extra comfort and services at their own expense but rather at the company's. Therefore, it is not surprising that most of them are made up of Singaporeans and Japanese, two countries that tend to have a higher spending on business travel (▣ Fig. 8.2).

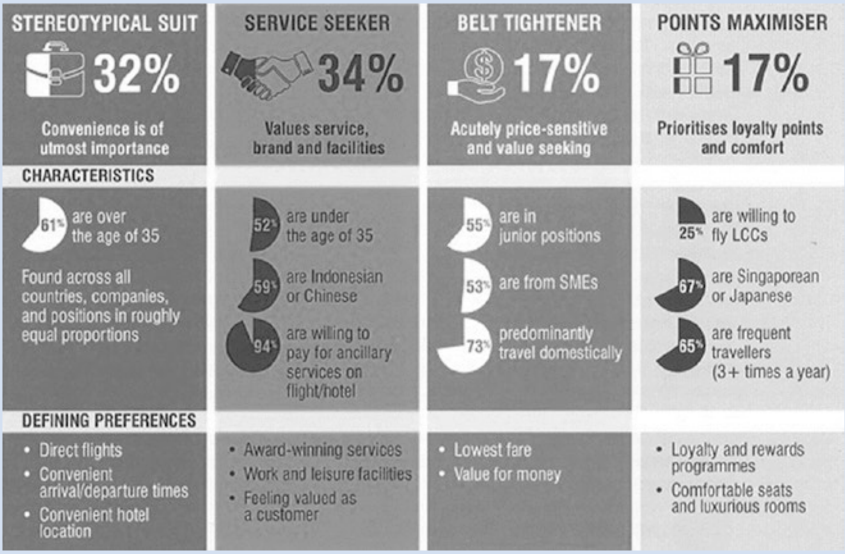


Fig. 8.2 Asian business traveller archetypes (Singapore Tourism Board, 2015)

8.3 Product and Service

Network development and management teams define the core product of an airline by determining the routes to be served, frequencies offered, type of aircraft used and departure time. The marketing departments of companies are usually responsible for defining the service quality of the transport product. Habitually, this includes decisions about in-flight services like

- Seat quality
- Meal service
- Entertainment (from newspapers to interactive electronic entertainment systems)
- Service quality offered on-board, reflected by service culture, communication and interaction of the cabin crew

Due to technical innovations, quality of seating in an aircraft has again become a major differentiating factor. This is especially true for business and first class but increasingly also for economy class. Important service elements are the seat pitch (distance between seats), the possibility to adjust seat- and backrest and possibly to transform the seat into a flatbed as well as the cushioning quality (hard, totally flat, flexible, etc.). Also, the configuration of the personal in-flight entertainment system is an issue. In the eyes of the customer, especially in categories with more expensive fares like business class, the sleep comfort is one of the main value drivers (◘ Fig. 8.3).

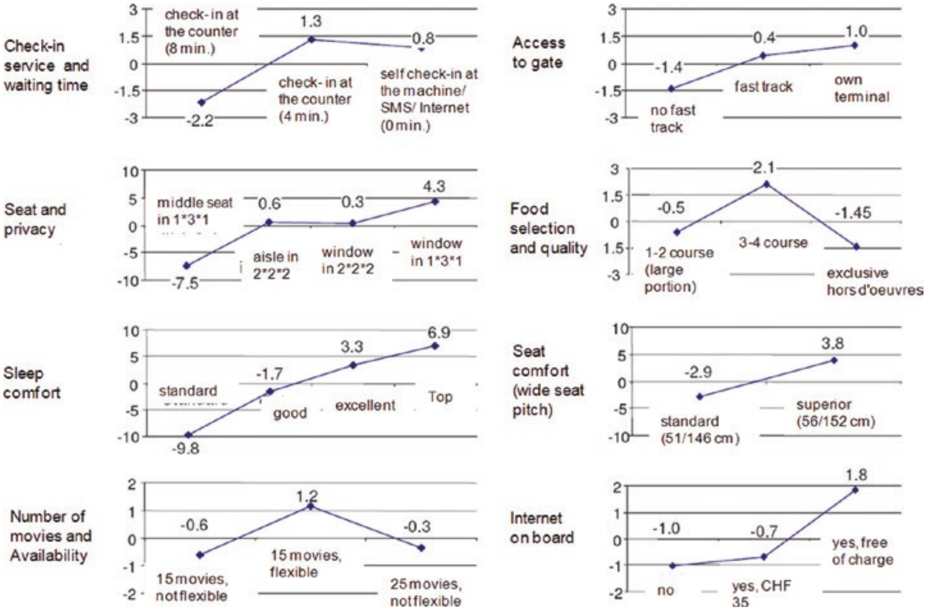


Fig. 8.3 Partial benefit (utility) values of C-class product development parameters (Boetsch et al., 2011)

As for meal service, the conventional standard airline meal has been differentiated into a wide variety of service categories. In the economy class, a number of different service categories exist, ranging from no-frills to full meals. In business and first class, there is a tendency towards individualisation in the form of buffet breakfast or individually created meals which change several times throughout the year. It is important not to underestimate class-specific expectations of customers. Some service elements like meals and drinks normally have to be categorised as revealed preferences. These are not identified in traditional surveys. Especially for business passengers, meals from a social expectation are not considered to be of high importance. Accordingly, surveys which just investigate stated preferences tend to underestimate the weight of these service elements.

Concerning in-flight entertainment systems, there is a trend towards increased individualisation which results in the industry standard being "audio and video on demand" systems or systems that stream on a personal device. However, traditional newspaper service is still very much appreciated. Due to logistical issues and the weight of newspapers, which adds to fuel consumption, this service is quite costly. With the introduction of wireless internet connection onboard, the introduction of e-papers is becoming widespread in the industry, thus reducing costs related to fuel consumption.

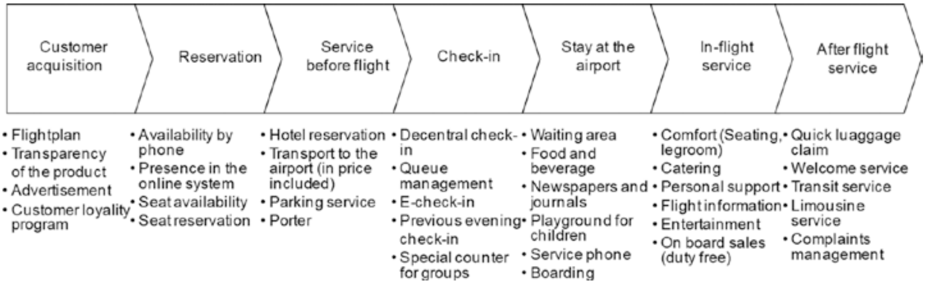
The concept of "service culture" can be defined as the values a company has regarding the delivery of professional service. Service culture defines the role of frontline service staff (Bieger, 2007; Wittmer, 2005). As significant differences in individual service expectations exist, flight attendants need to be guided by the company service culture. They need to be aware of limits to individual requirements and to be trained on how and when to say "no." Today, in-flight products can still be differentiated by individual service cultures. Thus, the selection and training of flight attendants still constitutes an important element of the design of the service product. Role models and values communicated by brands play an important in the implementation of a service culture. The internal effects of brand values represent a major topic in recent research (Esch et al., 2006; Henkel, 2008).

Due to technical reasons, the variety of service designs is limited, and due to a commoditisation of the in-flight product, airlines try to find ways of differentiating their services before and after the flight. Therefore, most service innovations tend to take place before and after the flight. Innovative service elements emerge with respect to each element of the aviation service chain (▣ Fig. 8.4). Frequent flyers as well as business and first-class travellers can spend the waiting time before boarding in increasingly sophisticated lounges. First-class travellers may check-in at check-in counters which have an infrastructure like a reception. Furthermore, airports increasingly offer premium travellers fast tracks through security, limousine services to the aircraft as well as priority luggage delivery.

In addition to the differentiation of products along the service chain for different service classes (which can be regarded as a kind of horizontal service differentiation), airlines also differentiate service classes among customers (which can be regarded as a kind of vertical service differentiation). A differentiation of categories of customers based on their status as frequent travellers takes place. ▣ Table 8.2 provides an example of the differentiation of service elements between the four status categories in the Lufthansa Group system:

For frequent travellers, senators and so-called "HON Circle" passengers, three categories of lounges are available. An "ordinary" traveller, however, has to wait in the terminal building for an economy class flight. The frequent traveller benefits also include waiting list priority and access to personal services like priority check-ins. On board of the aircraft, further differences exist in the so-called soft service elements (e.g. flight attendants usually call premium status passengers by their name).

However, the product and services also include alliances at several stages along the aviation value chain. Before the flight, alliances can coordinate timetables, advertising, etc. to create a more attractive proposition when booking flights.



▣ **Fig. 8.4** Services along the value chain. (Author's own figure)

Table 8.2 Status categories of the Lufthansa Group

	Miles & More member	**Frequent traveller**	**Senator**	**HON Circle member**
Qualification	Joining Miles & More (M&M)	160 points p.a. incl. 80 from M&M partner airlines	480 points p.a. incl. 240 from M&M partner airlines	1500 points p.a. from M&M partner airlines
Key benefits	Collect and redeem points	Priority check-in	Access to Senator and Star Alliance Gold Lounges	Highest waitlist priority
		Access to business lounge	Two upgrade vouchers	Access to the First Class Lounge and First Class Terminal
		Higher luggage allowance + benefits of the lower status	Priority baggage delivery + benefits of the lower status	Senator Partner Card
				Exclusive limousine and transfer service
				Six upgrade vouchers + benefits of the lower status

Table compiled by author based on Swiss (n.d.), Miles and More (n.d.)

Furthermore, frequent flyers benefit from alliance partnerships, allowing them to collect and redeem miles with alliance partners, thus increasing the product offering in terms of available flights. Alliance partners mutually recognise their frequent flyers, thus granting the same service and privileges on partner carriers as well. This creates a loyalty towards the alliance and its partner airlines. Using the previous example of Lufthansa, a senator looking to fly from Germany to New Zealand would likely choose an itinerary consisting of Star Alliance carriers only in order to enjoy the extra services such as increased baggage allowance and lounge access. This demonstrates that the alliances also form a considerable part of the product and service proposition of an airline.

Recently environmental impacts of aviation became more publicly discussed and relevant. In connection with experiences in digital interaction, which was pushed by the COVID-19 pandemic, frequent flyer benefits were questioned, especially with respect to a less flying society for the benefit of the environment in connection with the digital meeting experiences gained during the pandemic.

8.4 Customer Relationship Management

As mentioned before, the acquisition of new service customers in general is expensive due to the intransparent nature of the product and the risks involved for new customers (Laesser & Jäger, 2001). On the one hand, it could be assumed, that in the airline industry this is no longer the case due to the commoditisation of air transport products. On the other hand, the industry itself continuously creates barriers for customers to change their providers. On an individual level, these barriers are frequent flyer and status programs as well as familiarisation with the specifications of the in-flight services. On a company or institutional level, barriers are special discount agreements for certain revenue categories. Because such barriers create lock-in effects (binding the customer to the airline) and are increasingly an industry trend, a single airline cannot refrain from offering and creating this type of instrument of relationship management. In the aviation industry, the pure low-cost carrier model represents the only business model, which does not put a major emphasis on these instruments (e.g. loyalty programs). This can partly be because by utilisation of this type of business model, decisions about routes and operations are made on a short-term basis. Thus, due to the absence of a whole transport network, these airlines have fewer possibilities to build loyal, long-term customer relationships. Typically, customers choose low cost products as a result of a very opportunistic decision making.

Customer loyalty not only leads to recurring and thus more frequent purchases. There are also important side effects like (Sund et al., 2009)

- Word of mouth
- Reduced price sensitivity
- Greater share of wallet
- Benefits from personal interactions such as pro-active feedback to the customer (for the effects of customer loyalty, please refer to literature about service standard management)

Important drivers of customer loyalty, on customer side, to enter into a relation with a provider (perceived relationship value) are (Conze, 2007):

- Access to better service
- Tangible, monetary and non-monetary rewards
- Elements of social recognition

From the customer’s perspective, the relationship with a service provider can also be perceived as a lock-in situation, which creates a perceived negative relationship value such as reduced flexibility and choice.

Thus, for airline customer loyalty management programs, a database is crucial. Besides travel patterns, individual preferences, for example, a special need for mineral water during night flights or a personal preference regarding a particular type of seat are recorded in the customer data base. Feedback from frontline staff (e.g. check-in staff) or flight attendants on board may provide this particular information.

The perception of relationship value differs between individuals and groups and also between situational contexts. This means that to a business traveller, who travels on his own, the value of personal recognition might be of major importance, whereas when travelling with his family, the same value might only be of minor importance. Consequently, a market segment and situational customer relationship management are needed.

The reward system represents an important element of loyalty management systems. Today, most airlines operate a point- or mileage-collection system. The underlying mechanism is to transform monetary value, the so-called kick-back, into a new "currency." The latter is perceived higher than a pure financial reward due to a lower transparency but higher prestige. Market research found that customers tend to be more in favour of points, which entitle them to certain services rather than being rewarded by the respective monetary value (Herrmann et al., 2001). Apart from transparency and prestige mentioned above, an important element of this effect is the possibility to build up a new category of savings. Thus, the design of the compensation programs is an important task. The more exclusive the benefits and the more attractive the saving possibilities are, the higher the added customer value of the compensation system. The design of the compensation schemes also has to be differentiated by market segments. For example, a flight, which is offered free of charge, will not have the same value to a frequently flying business traveller than it will have to a travelling tourist.

Status systems allow for a differentiation of customers and for providing them with personally identifiable services like limousine services or personal attention. Experience shows that status is even more important than the pure reward. Therefore, nowadays, airlines heavily invest in the development and in the operation of this type of rewards.

Positive effects of customer loyalty management should lead to a higher perceived customer value and by this to customer equity (customer lifetime value) and company value (Woodruff, 1997). Modern database systems enable airlines to forecast and calculate customer life-time-value. This value can be defined as the discounted future profit from a customer. For many airlines, about 5% of the passengers with a frequent traveller status generate up to 80% of total revenues.

8.5 Customer Value

Mini Case: British Airways – Cost-Cutting and Customer Value Decline

By Andreas Wittmer and Christopher Siegrist

In the 1990s, British Airways was found to be the airline carrying the most international passengers. The British legacy carrier was quick to use this position for their new marketing campaign "the world's favourite airline" to highlight their elevated customer value as opposed to other airlines. The good reputation was largely due to their premium services offered in terms of on-board service, food, products, etc. the pinnacle being their supersonic flights onboard Concorde.

As the airline industry faced adverse forces due to events like 9/11 or the 2008 credit crunch, airlines were forced to reduce their costs to stay competitive, including British Airways. As losses mounted, Willie Walsh was appointed CEO of British Airways in 2005. After the merger with Iberia and the financial performance improved, British Airways aimed to become even more competitive by further cutting costs. The first measure took place in 2013 with the introduction of budget fares without luggage allowance in order to compete with low-cost carriers offering no-frills tickets. In 2016 this was extended by adding charges for seat selection on cheap tickets. Furthermore, British Airways introduced several measures in 2016 including a new pricing structure with different flexibility and the abolishment of free food and drinks on board short-haul economy flights. A year later, British Airways began refitting their short-haul Airbus aircraft to include two more rows, less legroom and fewer toilets. This led to a poorer in-flight product and therefore lower customer value.

The decrease in customer value was noticed by customers and actively communicated. British Airways identified the decreasing customer satisfaction and took countermeasures to increase customer value and satisfaction. As such, the product is being revamped on board as well as on the ground with improved lounges, in-flight Wi-Fi, improved catering, etc. It is important for British Airways to retain customer value, as it is impossible for them to compete on a cost-basis with low-cost carriers, due to their legacy structures carrying higher historic-driven costs.

8.5.1 Customer Value Theory

Customer value is defined as the result of perceived benefits and extra benefits for the customer while in the process of collaborating with the supplier. The value in this sense consists of the difference between the customer value relative to the perceived benefits and the relative perceived costs. The former consists of the satisfaction and perceived benefits of a product/service compared to the satisfaction and perceived benefits from alternatives. The perceived satisfaction and benefits result from the quality of service, which in turn is a result of a comparison between the expectations and the performance of a product/service. The latter is the result of perceived immaterial (e.g. travel time) and material (financial) costs, resulting in perceived costs, and the perceived costs of alternatives. Furthermore, risk plays an important role especially in the airline business. Customers accept to deviate from their optimal customer value due to certain risks in relation with operational safety and security, e.g. customers accept and value proper security processes, which are generally a hassle, increase travel time and make the stay at the airport less comfortable (◘ Fig. 8.5).

For airlines to produce customer value, they need to maintain a supplier and customer perspective. The former sees the value of a customer in the sense of customer equity, whereas the latter places importance on the value for the customer as in value and benefits the customer perceives. Therefore, customer value is defined as consisting of perceived benefits and extra-benefits of the customer in the

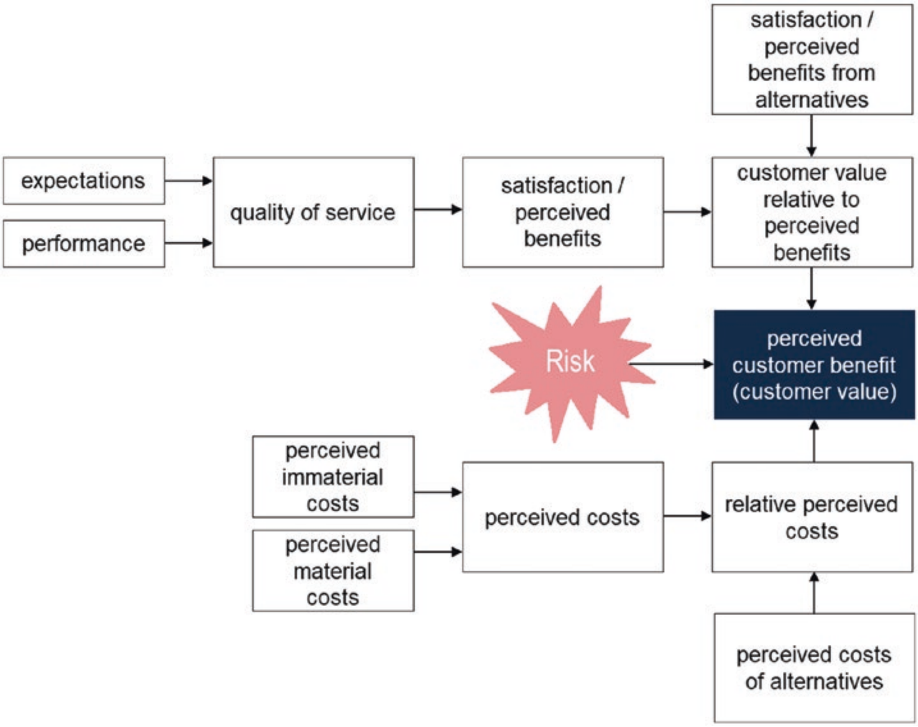


Fig. 8.5 Customer value structural model (Wittmer & Bieger, 2000)

process of collaboration and for the effort/service of the supplier. As such, it is vital for airlines to ensure that they utilise the potential of their customer equity by offering customer value to their customer which they, in turn, recognise as a benefit. This forms the basic task for the airlines to fulfil in order to attract customers.

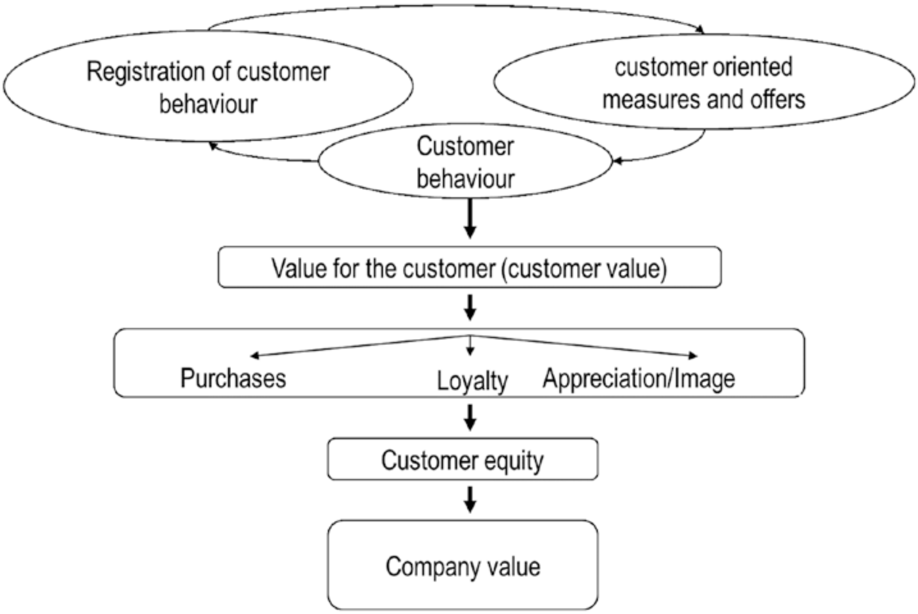
For an airline this translates into various opportunities along the airline value chain where customer value can be created. This starts with the customer acquisition and continues through reservations, check-in, etc. right through the after-flight service. For each stage there are a variety of measures that can create customer value. Examples include frequent flyer programmes for customer acquisition, complimentary airport transfers as part of the pre-flight service or catering during the in-flight service. Concludingly, many aspects of an airline's customer proposition are influential when it comes to forming and offering customer value. However, it is not always about the quality and quantity of measures, e.g. customer value can also be created through simplicity. For example, low-cost carriers offer customer value in the sense of allowing a "bare bones product," thus increasing individualisation of their offerings according to the customers' needs.

To maintain a good customer value, it is important for airlines to continuously evaluate their customer value proposition. This also includes identifying risks and taking appropriate actions to mitigate the impacts of those risks. Examples for risks that could decrease customer value are long security queues at airports, delays caused by weather, etc. This is where airlines need to have measures in place to maintain a stable customer value, even during disruption. Therefore, actions such as contingency planning or cooperation with other stakeholders also form a part of customer value.

8.5.2 Management of Customer Value

Looking at the aviation value chain, numerous opportunities are presented to an airline to create a customer value that makes the airline distinguishable for the customer. In face of the commoditisation of air travel and the basic product being a seat on an aircraft, it is essential for airlines to provide customer value. As previously mentioned, this can happen at many stages throughout the customer's journey with an airline.

By observing customer behaviour, airlines can register the behaviour, sort it according to different criteria, e.g. customer segmentation, and create the profiles they want to cater for. This translates into different customer-oriented measures and offers along the value chain. The result is additional value for the customer, i.e. customer value. The aim of the customer value is to leave a good impression on the customer with the aim of increasing future purchases, increasing loyalty and leaving the customer with a positive image of the brand. Looking at this from a company perspective, this is the previously discussed value of the customer, i.e. customer equity. By increasing the base of customers that are loyal, high-spenders and positively affiliated to the company, the company value increases (■ Fig. 8.6).



■ **Fig. 8.6** Management of customer value. (Author's own figure)

Therefore, it is essential for an airline to maintain a product that implies a high customer value to maintain a high-valued company by having a high customer equity. This is where it is essential to have a clearly differentiated product so that the customer considers the benefit of alternative products to be lesser, thus increasing the customer value of the perceived benefits and in turn widening the difference between perceived benefits and perceived costs (i.e., more customer value). For an airline this means that they must go the extra mile to offer a unique experience for the customer throughout the journey, may it be beforehand, during the flight or at the airport. Innovation is also important to stay ahead of the competition. Airlines are actively looking for innovative ways to create higher customer value. As an example, Air New Zealand has been continuously experimenting with ways to make the long flights to New Zealand in economy class more bearable. This has led to products such as the Skycouch where passengers can book multiple economy seats that let passengers enjoy a bed. In future, the carrier is also looking at offering pod-type bunk beds in economy to even further increase the customer value for its economy passengers.

Mini Case: Customer Value at Emirates

By Andreas Wittmer and Christopher Siegrist

When booking with Emirates, passengers can book their journey easily through the airline's website, offering a multitude of destinations across the globe. To offer maximum connectivity and customer value, Emirates operates a global hub in Dubai thus offering the customer a wide range of connections to book. During the booking process customers can also amend the product by adding meal preferences, seat selection as well as enjoying benefits for frequent flyers.

Before the flight, premium passengers are picked up by a chauffeur-driven limousine that takes them to the airport. Upon arrival at the airport, customers can proceed to their respective check-in desks, which are separated by travel class and frequent flyer status, thus offering additional customer value tailored to the customer. From there, premium passengers can proceed to the lounges, where they can wait for their flight while enjoying the food and beverage offerings, away from the general terminal area.

Emirates is the largest operator of the biggest commercial passenger plane, the Airbus A380. Unsurprisingly, the A380 forms the flagship of the Emirates fleet being the most common and recognisable aircraft type in the fleet. In economy class, this translates into regular economy class seats which are augmented by premium service. As such the premium service includes food and drinks, a comprehensive selection of inflight entertainment and free Wi-Fi. In business class, flat beds and improved catering provide customers with a more pleasant stay on board. In addition to the seat itself, customer value is further enhanced by offering a bar and lounge area on board for business class passengers to mix and socialise. First class portrays the most premium experience by offering enclosed seats, offering more privacy, gourmet food and a bathroom with shower exclusively for their first-class customers.

After their arrival, certain destinations offer arrivals lounges for eligible customers to provide a place to refresh after a flight. Furthermore, business and first-class passengers will enjoy a welcome service and limousine transfer to their final destination, therefore concluding the journey with Emirates.

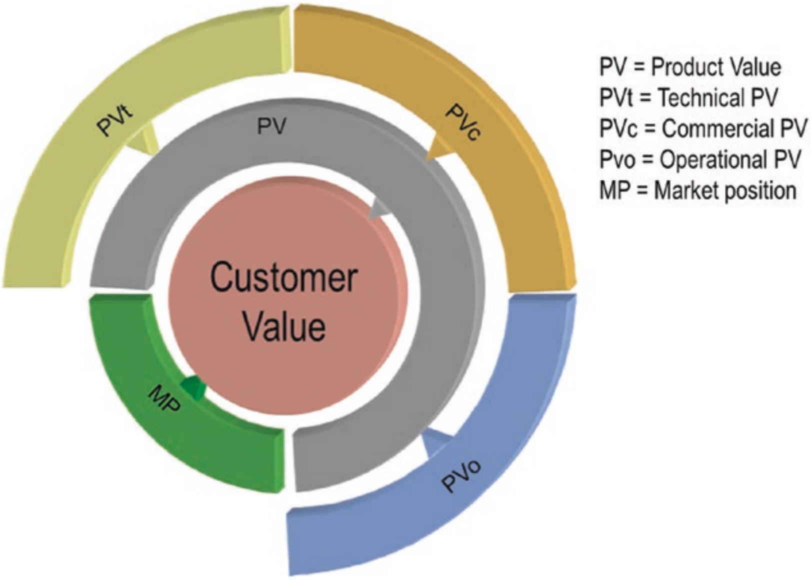
Concludingly, Emirates tries to create customer value by enhancing the basic product (i.e. the seat) with amenities and services. However, the customer value does not only start with the flight itself, it also spans from booking the flight right through to leaving the airport. The customer value is created according to the perceived value of the customer to Emirates, i.e. premium passengers enjoy an increased customer value. At the same time, the basic economy product is also enhanced to create an attractive differentiation from other competitors.

8.5.3 Customer Value Analysis

To remain competitive, it is important for the airlines to continuously assess and monitor their performance regarding customer value. To achieve this, it is necessary to monitor the company success which is quantifiable in terms of the strategically saved company value. This can be decomposed into the combination of market success consisting of value maximisation and commercial success in terms of profit maximisation.

The process begins with the initial step of determining the initial situation of the company, i.e. how competitive it is. What follows is the formulation of goals to set where the company wants to head competition-wise. In a third step, recommendations on how to achieve those goals are issued, before culminating in the fourth step where the necessary actions are taken. To analyse the customer value in this context, the company choses an average customer in the market or a specific segment who is to be used. This customer is among the customers shared with competitors in the same market or segment. Using this customer, the company can form their initial criteria to assess the customer value (Schauenburg Consulting, 2015).

Customer value consists of different components, the two main ones being market position and product value. The former consists mainly of the firm's market share amongst the competitors, as described previously. Furthermore, it also includes reputation and market access as well as their derived aspects. The latter consists of three subsets, specifically technical product value, commercial product value and operational product value. Using the example of an aircraft, the technical product value encompasses aspects such as product quality, state-of-the-art or technical sales support. Commercial product value includes financing terms and investment volume, whereas the operational product value consists of aspects such as direct operating costs of the aircraft (DOC), after-sales services and delivery in terms of reliability. By dividing customer value into many smaller subsets of aspects, firms, i.e. airlines can analyse the different drivers that influence the customer value and act accordingly.



▣ **Fig. 8.7** Customer value (Schauenburg Consulting, n.d.)

Schauenburg Consulting (n.d.) uses an own model to evaluate the concept of customer value. The two immediate factors influencing customer value are market position and product value. The former primarily consists of aspects such as market access and reputation which determine the perception of the respective product in the market. This can be influenced by having a significant market share, extensive sales support, etc. However, a larger share of customer value is determined by the product value, i.e. the product's attributes. The product value is divided into three sub-categories to differentiate between technical, commercial and operational product values. These bring a wide range of aspects that determine a product's customer value. The following case will use the example of a commuter aircraft to demonstrate the application of the model (▣ Fig. 8.7).

Mini Case: Customer Value in Commuter Aircraft

By Andreas Wittmer and Christopher Siegrist

There are several different aspects that an operator considers when choosing a commuter aircraft for their fleet. As per the Schauenburg model, there are different aspects of product value and also the market position that influence the perceived customer value of the aircraft operator. Hence, it is vital for aircraft manufacturers to understand the thought processes behind the buying process of an aircraft buyer. The example of a 19-seat commuter aircraft would look as follows.

On an abstract level, aspects such as reputation and market access influence the market position of the product and therefore the customer value. Resultingly, it is important for manufacturers to invest resources into developing a strong market position. This includes working on their brand and image, besides working on sales promotions and customer relations, e.g. demonstrations at air shows or setting up regional sales offices around the world. All these measures enhance the market position and make the aircraft well-known in the industry, which will make it more likely to be considered in aircraft evaluations by prospective buyers. While it may seem abstract and minor, the market position can also have a greater influence on customer value, e.g. the initial problems with the Boeing 737 Max greatly reduced the reputation of the airframe, which also has an influence on the passenger's perception of the product. Therefore, the public perception of an aircraft can greatly affect the market position and in turn customer value and is also considered by airlines.

However, in a technical industry such as aviation, product value itself is the biggest driver as the commuter aircraft needs to meet the operator's required profile, as to fit into its flight operations. The manufacturer needs to offer a commuter aircraft that maximises the technical product value. Therefore, the quality of the aircraft needs to be high whilst it also needs to be state of the art with adequate avionics, functional yet comfortable cabins, etc. Furthermore, technical support is vital to facilitate the aircraft's entry into service with the prospective operator. Concludingly, the aircraft itself needs to meet the mission profile of the respective operator; therefore, it is important for the manufacturer to have a varied aircraft portfolio either encompassing different aircraft layouts or even different variants of an aircraft type.

In addition to the technical aspect of product value, commercial product value is important. This concerns mostly financial aspects such as financing terms and investment volume. The acquisition of a commuter aircraft is capital intensive; hence, it is important for the manufacturer to present attractive solutions for the purchase. This includes offering attractive leasing rates, start-up aids, etc. to make it easier for a prospective buyer to finance the commuter aircraft. Also, the actual cost of the aircraft influences the customer value as well as the associated costs of bringing it into the aviation system, i.e. the launch costs.

Ultimately, operational aspects leading up to customer value are important too. The direct operating costs need to be competitive and allow for the operators to make a profit on their routes with the typical load factors. But also, the delivery needs to suit the customer's need in terms of delivery reliability and delivery slots available. Popular aircraft types such as the Airbus A320 or Boeing 737 have extensive waiting lists, which can deter prospective buyers as they cannot acquire an aircraft when they need it. Furthermore, after-sales services need to be of a high-standard by supplying the necessary documentation to operate the aircraft easily or also having an extensive supply of spare parts to minimise aircraft downtime.

It becomes apparent that to create the highest customer value possible, an aircraft manufacturer needs to continuously adapt their offering to the needs of prospective buyers. However, a micro-segmentation of the aircraft portfolio is unrealistic due to operational and financial constraints. Therefore, designing and selling an aircraft (here a commuter aircraft) is a constant balancing act for manufacturers to maximise the customer value whilst creating a versatile aircraft to cater to a wide market segment (◘ Fig. 8.8).

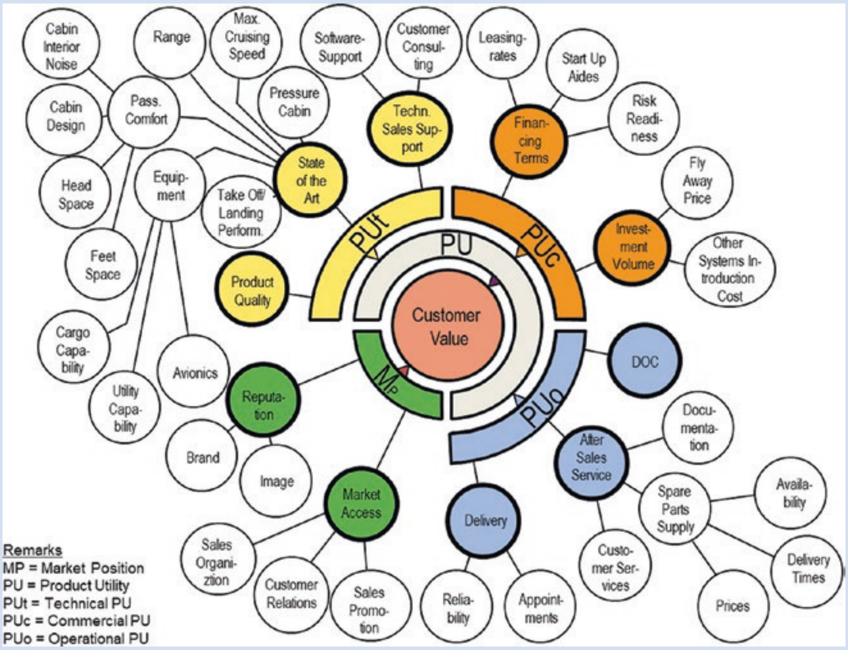


Fig. 8.8 Example for a 19-seat commuter aircraft (Schauenburg Consulting, n.d.)

Mini Case: Passenger Preferences at Zurich Airport

By Andreas Wittmer and Christopher Siegrist

A study by the author of this chapter was conducted at Zurich Airport to analyse the different preferences of passengers departing. The goal was to share customer value as an integral part of growth in passenger demand. Using a logarithmic linear regression, the different preferences were to be analysed to determine their sensitivity and the elasticity in relation to customer value.

For the regression, a set of long-haul destinations in Asia, North and South America and Africa were chosen. Accordingly, passengers travelling to those destinations were asked to rate the importance of different aspects regarding their journeys. These included comfort, frequent flyer programmes, punctuality, daily connections, travel time, safety, etc. Using regression, the influences could be analysed. The results showed that almost all factors enjoyed at least some degree of importance, the most important being safety and direct connections. Both were rated as the most important aspect by 40% of the passengers. Far less important were the number of daily connections and the frequent flyer programmes, both being placed varying degrees of unimportance by a considerable proportion of passengers. Approximately 40% view both aspects at least as rather unimportant.

Interestingly, all important aspects were directly affecting the flight such as punctuality, travel time or comfort. Whereas the two unimportant factors previously mentioned are not directly affecting the flight that customers have booked as those aspects influence the customer's booking behaviour. It is thinkable that for the destinations analysed, the majority of passengers are leisure travellers without any airline loyalty, who prefer to get to the destination as easily, quick and safe as possible.

8.6 Corporate Identity: Branding

A brand can be defined as "a name, term, sign, symbol, or design, or combination of them which is intended to identify the goods and services of one seller or group of sellers and to differentiate them from those of competitors" (Kotler, 1991; Keller, 1993). In service industries, brands play an important role for

- The identification and positioning of otherwise rather homogenous service products on the market
- The reduction of risk by serving as an element of trust and orientation for the customers

Therefore, brands have always played an important role in the airline industry, and the positioning of the airline by creating a strong brand has been a major marketing tool. Brands transport images not only to the markets; they also have an internal effect (Henkel, 2008). They serve as an element of identification for employees, and thus for the whole organisation. Brands are an important instrument for conveying the significance of a service culture and for defining role models and expectations and transferring them to employees. Brand management, consequently, always needs to consider internal and external effects. The brand management of airlines includes:

- The definition of the brand content in the form of image
- The brand claim
- The brand logo

Importantly, today, brand management of airlines also includes the management of the brand within the brand portfolio. Many airlines nowadays own a subset of other companies and subsidiaries. This includes, for instance, the presence in other markets and the operation of other business models. A lot of airlines also are members of strategic alliances – like Star Alliance, Sky Team or oneworld – which also have their own brands. To manage a brand portfolio, it is essential that the two following mechanisms are used to the portfolio's advantage:

- Brand transfer: transferring positive elements of a stronger brand to another, weaker brand within the portfolio
- Positioning power: building the strength of a brand by clarifying its focus and considering homogeneity within the brand portfolio

Brands with diverse images and customer benefits, like a network carrier which operates a low-cost carrier, must be distinctively positioned within the brand portfolio and clearly communicated to customers. Closeness between brands can, in turn be helpful, if the positive elements of a brand of a strategic alliance ought to be transferred to a company brand.

The two main concepts used for structuring brand portfolios in the airline sector are:

- The endorser brand is like a certificate or a sub-label. It serves to communicate an interrelation with certain quality and values. Strategic alliance brands are frequently used for this purpose, e.g. when the logo of the strategic alliance is shown as a kind of sub-brand together with the main brand of the airline.
- The brand family concept with daughter and parent brand: a large and strong brand, such as Lufthansa, operates daughter companies for a specific market or functions like Lufthansa CityLine.

8.7 Pricing and Distribution (Revenue Management)

Mini Case: Ebookers

By Andreas Wittmer and Christopher Siegrist

When booking flights through one of the many sales channels, the prospective passenger faces an array of flight options at varying prices. Taking the following example of a passenger booking a non-stop return flight to London in economy through Ebookers, a Swiss online travel agent, receives the following results:

Time of booking: 21 November 2019
Outbound: 10 February 2020
Return: 15 February 2020
Price range: CHF 258 (easyJet) – CHF 300 (British Airways)

Now the customer elects to filter the search results to better suit his/her needs. Thus, the customer elects to limit the search to flights to an early morning outbound flight and an evening flight back to maximise his/her time in London. This causes the search results to change as follows:

Time of booking: 21 November 2019
Outbound: 10 February 2020, **early morning**
Return: 15 February 2020, **evening**
Price range: CHF 263 (SWISS) – CHF 434 (SWISS + easyJet)

Evidently, minor changes to the criteria, such as defining certain timespans, have a considerable influence on the resulting prices. Obviously, the easiest explanation would be that the customer is aiming to travel during peak hours where a lot of business travellers will try to commute to the financial centre in London. However, as this chapter will demonstrate, pricing of flights is a complex process and the factors influencing pricing can be difficult to determine.

For many service products the capacities are fixed after the processes have been defined, whereas the level of demand tends to be variable. In the airline industry, capacities are defined when the network management has decided on routes, frequencies, schedule times and types of aircraft used. Price, as a marketing instrument, has, therefore, also an important role in steering demand besides its traditional functions, such as generating revenue and positioning the product.

An empty seat on a certain route and flight is lost if it is not sold. This means that an additional passenger on a seat that would have been otherwise empty improves the overall profitability of a flight, once the variable costs for this additional passenger have been covered. Since all companies in the industry follow the same philosophy, there is a tendency to offer prices at marginal costs. This development eventually reduces the profitability of the whole industry. For this reason, airline companies should not just sell seats at prices which generate enough demand to fill their planes. An airline's pricing strategy should aim at skimming the maximum willingness to pay from each single passenger.

Dynamic pricing has become very important in the airline sector. Airlines try to adjust their pricing decisions to competitors' prices. This is possible because – thanks to open access to booking systems – there is hardly any service sector which is as transparent as the airline industry. Some airlines even use scout programs to check the prices of competitors for certain routes and flights. Different price strategies may be applied within dynamic pricing. For example:

- Matching strategy: to match or even undercut the prices of competitors. This is a strategy used for gaining or preserving market shares.
- Skimming strategy: to keep prices higher than those of competitors and "skim" the market of well-paying customers.

While prices were set and maintained for a whole season during the IATA regime, today prices are adjusted close to every second. The most advanced yield management systems consider the latest booking requests of customers and evaluate the current booking situation and the probability to sell a seat at a higher price later on. Practitioners call yield management consequently the art of saying "no" at the right moment (consider the principles of yield management as virtual optioning). On its way from seasonal prices to virtual optioning, the evolution of yield management has taken important steps, for instance, introducing flexible prices on a weekly basis (▣ Fig. 8.9).

It is obvious that flexible pricing mechanisms must be combined with decisions about sales channels and distribution. Flexible pricing systems, like virtual optioning, can only be applied, if there is an instant transfer of information and, therefore, a close contact to customers, which is provided by online booking systems. Certain tariff categories, however, are still frequently booked through travel agencies. To avoid an economic cannibalisation of the main market, special discounts usually need to be distributed through special channels, for instance, through cooperation with retailers. Therefore, in most airline companies, yield management and distribution are in the hands of the same department. This way, the two most important instruments for capacity and inventory control (which also need to be closely linked to network management) are closely coordinated. For traditional

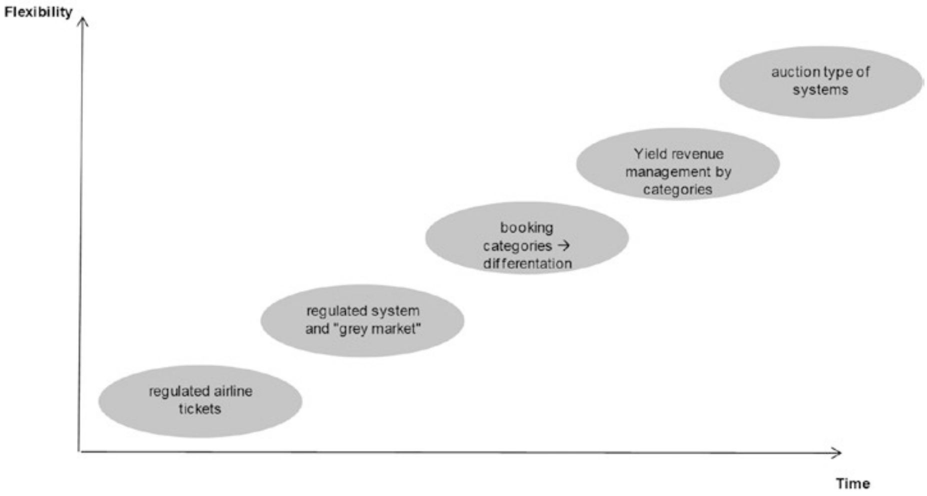


Fig. 8.9 Evolution of yield management systems. (Author's own figure)

sales forces, having to apply yield management and flexible distribution management may constitute a "cultural shock" because it affects formerly important values like personal relation, trust, and long-term stability.

As seen in the introductory case, the slightest changes can have a noticeable impact on the flight prices. In this case, it was a change in the factor time; however, there is a wide variety of determinants that influence the prices. Beginning with the internal perspective, an important determinant of flight price fixing is the cost of production. An airline's cost base is very influential as it determines the lowest price possible at which a ticket can be sold without incurring a loss. In a competitive environment this encourages airlines to increase efficiency and reduce costs to stay competitive. Another aspect of the internal perspective are the company-set targets on the routes, where airline will set revenue and other fiscal targets that must be met. Therefore, prices will also be influenced by the targeted performance. Moving to an exterior perspective, demand and market conditions also need to be considered. Thus, the composition of the demand, i.e. the proportion of different customer segments or profiles influences the price depending on their spending behaviour. On the same note, the market potential has to be considered to estimate the demand and set prices accordingly. Another aspect to consider is the interests of other airline companies. Should another airline try to enter the route, airlines would have to consider this in setting their prices e.g. using predatory pricing to keep competition off lucrative routes. Lastly, political stakeholders can influence the prices. For example, governments can enforce certain air traffic targets by restricting airport slots to certain routes and/or subsidising certain flights by declaring them as public service obligations (PSOs). Both political measures can exert an influence on the price fixing. In conclusion, there are several aspects and measures that can influence the price setting of airline tickets, thus underlining the complexity of the topic.

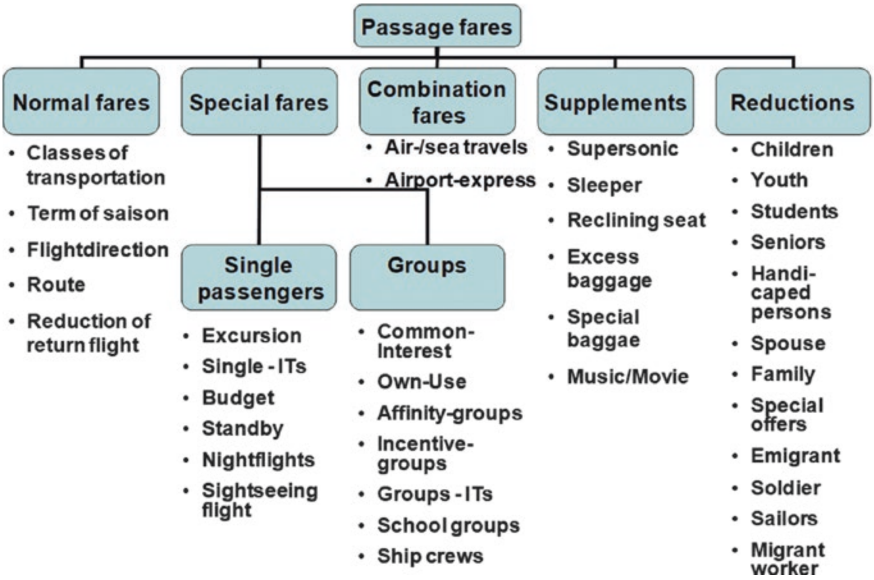


Fig. 8.10 Structure of passenger tariffs (Pompl, 2007)

For each passenger there is a maximum price he or she is willing to pay in a certain situation based on his/her individual and situational utility function. A person who has to travel urgently to another continent to close an important deal is likely to accept almost any price, whereas somebody who is planning his/her weekend deciding between staying at home and partying with friends in another town, will most probably not be prepared to pay too high prices. If a passenger pays less than he would be ready to pay, he takes advantage of what is called a “consumer’s rent” and basically makes a virtual profit. The final goal of each pricing system is consequently to charge each passenger, reflected as a single dot on the demand curve, according to his or her maximum readiness to pay. The challenge is to avoid that a customer who is prepared to pay a high price can switch to a lower price category. This can be achieved by creating price systems that include discounts or surcharges for certain additional services or benefits. For this reason, customers have to be “fenced” (for the concept of fencing: Ng, 2008) (Fig. 8.10).

Mini Case: Big Data in Aviation

By Andreas Wittmer and Christopher Siegrist

As in many industries, big data provide a great potential in aviation, especially airlines. Potential uses of big data including on-board service, customer service and maintenance. As an example, airlines can use big data to store customer preferences and provide a more personalised service onboard or provide more customer service in terms of service recovery such as rebooking missed connections before arrival. Another very promising area which could profit from big data is pricing, i.e. revenue management.

An ideal case for airlines would be the micro-segmentation where the airline could set an individual price for each customer to minimise the consumer surplus. Whilst this has been an unachievable task for a long time, newest advances in big data and blockchain technology are starting to make this possible. On a transatlantic flight, there is a potential of 1000 gigabytes of data to be recorded. With the shift from traditional sales channels to online bookings, airlines can closely monitor the customer's behaviour such as when and how long a customer looks at upgrade offers, or which other flight offers have been checked beforehand. Also, the application in customer service can influence pricing as it offers a more personalised service to customer, thus increasing their loyalty towards an airline and/or alliance. This increases their willingness to pay, i.e. reduces the elasticity of demand, which in turn allows airlines to charge higher prices to increase profit margins. Unsurprisingly, approximately 60% of airlines believe that big data analytics is their top priority in the foreseeable future. Ryanair, for example, is taking the use of big data even further to become a one-stop-shop for all travel offering flights, hotels, rental cars, etc.

However, there are risks associated with the use of big data. For example, it will be necessary to move away from arbitrary personal data such as preferences, as it will be more important to accurately predict the customer's need, i.e. a customer will not necessarily want a gin and tonic just because they usually had one on recent flights. Moreover, handling such a large amount of data comes with a lot of responsibility, as it contains sensitive information regarding customers. Unsurprisingly, security is mentioned as a top 3 challenge by a third or all airlines when it comes to adopting big data. In 2019, British Airways faced a large data breach, revealing customer's credit card data and other personal information, incurring a fine of over £183 m. This demonstrates the importance of data security in the future, should big data gradually gain importance.

Nevertheless, big data provide a promising method for airlines to maximise their profit margins by understanding their customers better and being able to increase each customer's spending according to their willingness to pay. As such, big airline groups such as IAG or Lufthansa are eager to focus on this promising trend.

(Source: Hodgson & Waldmeir, 2018)

Airlines usually use two main concepts of price management:

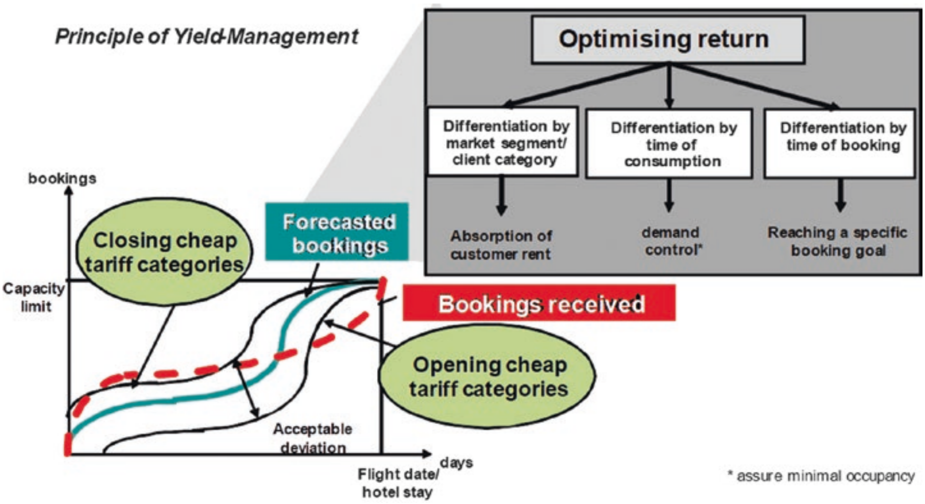
- Pricing according to service and booking category:
  Until the 1970s airline pricing was regulated by the rules and norms of the International Air Transport Association (IATA). Prices were set on an industry level. If airlines did not comply with the industry prices, they were to be fined or completely excluded from the association. At that time there were two service categories: a standard fare and a first-class fare. Once wide-body planes had been introduced and capacities increased, airlines needed to sell more seats and use prices as a marketing instrument for controlling demand. As a consequence, airlines increasingly applied flexible pricing. At first, tickets were sold to other countries, on the so-called "grey markets," and repurchased by travel agencies. Later, more and more exemptions and special categories were endorsed

by IATA. At a certain point, the price span between the cheapest and the most expensive economy class ticket has been stretched to an extent where it was no longer acceptable for customers. Airlines consequently introduced a new service class which still plays an important role today: the business class.

Most airlines nowadays operate at least a two-class – in most cases a three-class – system. Low-cost carriers, however, mainly operate just a single class system. Usually, the price of the next higher service class is two to three times the price of the average ticket in the lower class. Within the different service classes there are additional booking classes.

While airlines distinguish service classes by service product elements (such as lounge access, ground service, seat quality, and meals), booking classes are differentiated by booking conditions (such as minimum pre-booking time, restrictions on rebooking, or minimum requirements concerning the length of stay at the destination). A very important booking condition is the so-called Sunday rule. For many flights the lowest economy class fares only apply if the passenger chooses to stay at the destination over the weekend. In this way, business travellers are deterred from taking advantage of low tariff categories.

- Pricing according to the reservation curve within the timespan before the flight: Based on previous years and statistical forecast models an expected reservation curve for a particular flight on a specific day and time is estimated. Besides statistical data, external information, for instance information about special events at the destination or – shortly before departure time – weather conditions, is considered on a day-to-day basis. Integrating such external information is the task of the price managers who are part of the yield management department of an airline (◘ Fig. 8.11).



◘ **Fig. 8.11** Principle of revenue/yield management. (Author's own figure)

If the actual bookings are below the estimated booking curve, lower and cheaper price categories will be made available for purchase; for example, cheaper fares in the business class will be offered or additional seats will be available for passengers who redeem their frequent flyer miles. Yet, these lower-price categories are opened for a limited number of seats only. The opposite applies if the demand is stronger than expected. In that case, the availability of cheaper booking categories is reduced. Ten to twelve months prior to the flight, when the booking period starts, the most important question is how many seats to allocate to each booking category in advance. The decision will also be based on the experience of previous years and on demand trends.

Another concept of price management involves different pricing according to the distribution channels (Friesen, 2008). Airlines have various channels to distribute their tickets through, all of them varying in commission, costs, channel form, etc. Usually airlines prefer to use the cheapest distribution channels to offer tickets, as it allows them to offer them at no extra cost and hence give the customer the lowest price. Nowadays, the cheapest distribution channel is the internet as it comes without commission or service fee; the only costs being the costs to set up and run the booking interface. The internet therefore allows to offer the customer the cheapest fare possible in a competitive market, as it does not require the customer to pay a service fee nor does it incur commission. Other airline-owned channels are also attractive due to the lack of commission; however, they require a service charge to be levied on the customer's booking in order to cover the additional costs. Traditional booking channels such as the global distribution system (GDS) and travel agents are still present; however, they are financed by paying commissions per booking which make them less attractive for airlines. Furthermore, they also pass on their respective service fees to customers, making the tickets more expensive and less competitive. Finally, there are also special channels such as the group fares and the employee distribution channel. Both serve niche segments by offering mass discounts in the case of the former and heavily discounted staff tickets in the latter case. They come at no extra cost; however, due to their specialised nature, they are not compatible for widespread usage across the airline.

Ticket prices can also vary according to the price profile of the respective airlines. Network carriers tend to have very flexible price models that vary over time. This flexible reaction is a result of revenue management. Furthermore, there is the profile of a best price guarantee, where the earlier a customer books, the cheaper the ticket is. Therefore, the price rises incrementally as the departure date draws closer. Additionally, as the seat load factor (SLF) increases, so does the price. So, the price increases increase as a result of the increasing load factor as the departure draws closer. This profile is embraced by the likes of easyJet and Ryanair. Another profile is the flat rate which was offered by the Swiss airline Helvetic up until 2004. More recently, this flat rate profile has seen a renaissance with the advent of private jet memberships such as Surf Air. These operators offer memberships which grant access to fixed ticket prices onboard private jets. It follows that the price changes and therefore the ticket prices depend on the price profile that the airline pursues.

Ancillary and supplementary revenues pose another influence on pricing. Ancillary revenues form revenue that goes beyond the sale of the ticket but is related to the ticket itself. Hence, it includes the sale of meals, check-in luggage, seat selection, etc., a strategy frequently employed by low-cost carriers that sell no-frills tickets. Similar yet distinct, supplementary revenue describes the sale of extra services beyond the air transport, i.e. upselling. This ranges from selling travel insurance, offering hotel and rental car bookings to offering bookable transfers to the airline customers. While both mean extra expenditure for the customer, they can influence the pricing as airlines can choose to offer very low fares in order to entice the customer to spend more money on ancillary and/or supplementary services.

Concerning the future development of pricing, the role of flat rates is heavily discussed. Flat rates have the advantage that less investment in yield management is necessary, both in terms of software and manpower. For the customer, flat rates provide greater market transparency and reduced transaction costs and might therefore help to increase customer trust into services. However, until today, wherever flat rate systems have been competing with flexible pricing systems, the latter have succeeded because most customers are not willing to accept slightly higher prices for the sake of long-term stability and transparency.

Another important debate is concerned with the long-term impact of yield management on the industry. It seems clear that due to the tendency to employ marginal pricing within a competitive market, yield management systems may lead to lower average ticket prices. Airlines can only avoid this development by implementing strict capacity control and if they have the ability to apply skimming strategies thanks to a superior product. Another effect of pricing is closely linked to the demand side: flexible pricing may erode the image of an airline within a market segment. It may also lead to negatively perceived price fairness, and thus potentially result in negative behavioural intentions and actions (refer to Fasciati, 2009 for a model of negative perceived price fairness and). Price fairness can be defined as the "general opinion of consumers on a given price in comparison with the quality of the product." It can be divided into procedural and transactional fairness (Fasciati, 2009). All in all, there seem to be powerful forces at work that lead towards more individual and flexible pricing through combined supply and demand side effects.

Research shows that through increased transparency and proper information, as well as learning effects on the customer side, the acceptance of flexible prices is growing. This applies if customers know why they are paying more and if they can be convinced by a clear rationale that flexible pricing is not only about increasing the airlines' profits at their expense. According to the dual entitlement theory, customers perceive price increases as being negative, if they believe they are for the sole benefit of the service provider (Kahneman et al., 1986).

Review Questions

- Which are the most important differences between leisure and business customers in regard to their needs and preferences?
- What potential innovations aimed at optimising the service chain for airline passengers do you consider feasible?
- What types of brand structure exist for airlines? Compare pros and cons for each structure.
- What are different developments of airline price systems? What could be future developments of potential pricing systems? Why has the use of flat rates hardly been successful? What were the different steps in the development of the price systems of airlines? What could be future developments?

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Passenger Behaviouristics

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Summary

- Passenger behaviour is the study of how passengers think, feel, reason, select, and use products and services related to air travel.
- Aviation decision making explains and predicts a passenger's choices of air travel and future travel intention.
- Passenger decisions can be explained by using different behavioural theories, which explain how decisions are not always utility maximising and rationally explainable.
- Understanding passenger behaviour is the key for airlines and airports to improve their products and services as well as their marketing strategies.
- Meeting passengers' requirements leads to long-term profitability of the aviation industry.

In this chapter, the concept of passenger behaviour is explained using different decision theories while showing how the knowledge is applied in the industry. Passenger behaviour is synonymous for the study of how passengers think, feel, select and use products and services within air travel, i.e. their behaviour. Aviation decision making explains the passenger's choice of air travel and predicts their future travel intentions. However, some of the theories presented also go on to explain why some passenger decisions are not utility maximising and rationally explainable. Therefore, it is essential for airlines and airports to understand these passenger behaviours and improve their products, services and marketing accordingly. After all, understanding and meeting passenger requirements ensure that companies in the aviation industry stay profitable in the long run.

9.1 Decision Theories

Passenger behaviour is the study of the dynamic interaction of affect and cognition, behaviour and the environment by which human beings select, purchase and use products and services.

A variety of decision-making theories and constructs have been developed to describe the interaction of psychological processes that lead to the decision whether to purchase a product or a service. Most models have an economic background but are open for cognitive processes of consumers during a decision process. Most theories rely on the stimulus-organism-response (S-O-R) paradigm (Jacoby, 2002). Stimuli (S) are antecedents of the consumer's buying behaviour and comprise all external (marketing and environmental) factors that affect the individuals towards a product whereas cognitive processes trigger information gathering. Individuals in turn respond (R) with two contrasting forms of behaviour – either approach or avoidance.

Dimensions of a supportive or avoiding response are further motivation, ability and opportunity. Motivation describes the involvement and the perceived importance of the purchase (affective processes). High levels of motivation increase the number of support or counter arguments. Ability refers to cognitive information processing. The opportunity reflects the limited ability to process information as well as to copy strategies, especially when the individual has to deal with high levels of distraction (Wright, 1980). Furthermore, consumers have well-defined preferences, aim at maximising utility (reasonably) and thus select that option, which maximises his or her received economic and other value.

Theories which help to understand and explain consumer decisions are shortly summarised below:

- Judgement and decision theory deals with the judgement of offerings by consumers and how they make buying decisions (Arkes & Hammond, 1988).
- Prospect theory states that risks and safety issues influence decisions (Kahneman & Tversky, 1979).
- The theory of planned behaviour links beliefs to behaviour. It argues that behavioural intention is the closest predictor of actual social behaviour. Purchase intention in a buying process may thus be formed through attitudes, social norms and perceived behavioural control before evaluating alternative choices (Ajzen, 1985).
- The theory of bounded rationality argues that human beings are only capable to deal with a limited number of factors when making decisions. Hence the rationality of decisions is limited by the tractability of the decision problem, the cognitive limitations of the mind and the time available to make the decision (Bettman, 1979; Bettman et al., 1998).
- Customer value theory uses the value of convenience to argue for reasonable decision behaviour (Beiger & Belz, 2006).
- Attitude-behaviour gap theory assumes that there is a gap between the attitude of human being and their behaviours (Triandis, 1977, 1980).

Most of these theories rely on the assumption that consumers decide rationally by looking at the decision process and the decision itself. Cognitive processes are often relaxed, but it is exactly those heuristics in cognitive processes, which actually explain consumer decisions. Restrictions to the economic rational decision behaviour appear if choice heuristics, risk and uncertainty, bounded rationality, planned behaviour and convenience are taken into account.

In air transport, all these theories play a role, when passengers decide to buy an airline ticket. Especially the attitude-behaviour gap has become more prominent with respect to pro-environmental behaviour: passengers wanting to travel less and behave more environmentally friendly (attitude), but still travelling according to their needs (behaviour). This phenomenon can especially be seen with the younger generation of air travellers, lobbying strongly for the environment and for flying less, but being among the more frequently flying group of people.

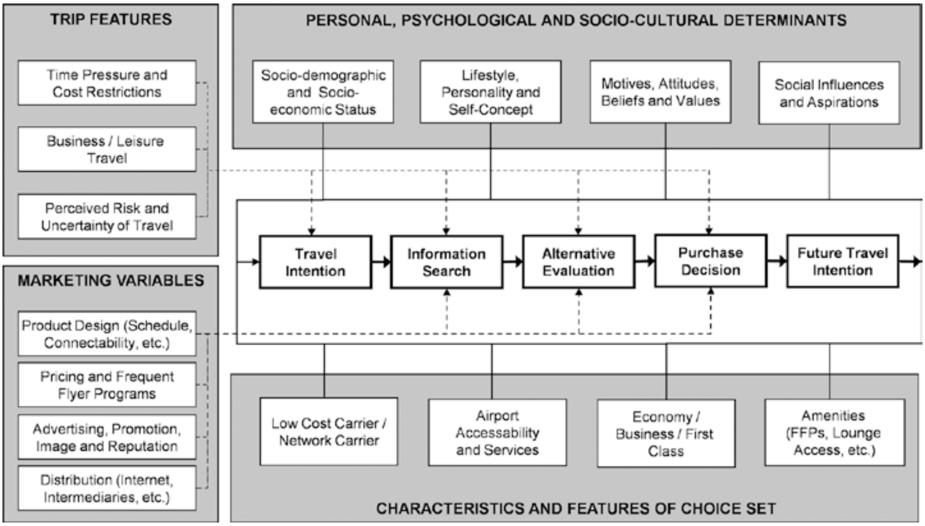
Also, the “risk (safety)” factor plays an important role in an airline ticket purchasing process. It is not only financial and service risks about obtaining the best value for money when buying an airline ticket, but also the risk of not receiving a safe travel.

In general, the decision-making process is the predominant aspect of consumer behaviour in travel and tourism and particularly in aviation. There are two approaches to explain and predict a passenger's choices of air travel and future travel intention.

While the first approach centres around the affective nature of decision making and choice behaviour, such as attitude, belief, intention, value, risk perception, involvement, trait and personality, etc., the second approach is rooted in economics and psychology and stresses that a passenger follows a utility maximisation strategy when making a decision (Jeng & Fesenmaier, 2002). Although these two perspectives have provided many insights into the decision-making process, the underlying models are rather reductionist, as they seem unable to capture the temporal and dynamic nature of passenger behaviour, the various decision heuristics/rules decision makers may employ and the many situational and environmental factors a consumer is confounded by. However, the descriptive model presented in ■ Fig. 9.1 provides one of the central frameworks highlighting the specifics of passenger behaviour.

This model consists of the five fundamental steps involved in the aviation decision making process:

- Every decision-making process starts with a problem recognition. In the context of aviation, this is more often than not the intention to travel from one destination to another rather than the flying experience itself.
- The next step in the process of decision making can be described as an evolving and dynamic information processing that includes internal as well as external sources of information.
- The assessment of information and its integration processes results in the cognitive evaluation of the alternatives in the evoked set.



■ **Fig. 9.1** Aviation decision making. (Author's own figure adapted from Howard & Sheth, 1969)

- The consumer then applies a number of decision rules and heuristics which finally lead to one purchase decision. It is important to recognise that, in fact, passengers do not simply make a choice of air travel but make a three-way choice of airport, airline and access mode (excluding the upper-level choices of destination and main mode), where the nature of the substitution patterns amongst these three choice dimensions is not clear a priori (Alotaibi, 1992).
- Finally, the passenger assesses the performance of this decision during the service delivery, resulting either in satisfaction or in dissatisfaction and therefore influencing the passenger's behavioural intentions in the future.

Decisions are not the result of internal cognitive processes alone, but they are also influenced by external situational variations. The most important (but not conclusive) influence factors in aviation decision-making are discussed subsequently.

Mini Case: Do Customers "Walk the Talk"? – Attitude-Behaviour Gap in Air Transport

By Adrian Müller

Consumer behaviour in aviation is complex and the predictability of behaviours is limited. This is particularly well illustrated by the example of the climate debate. Customer surveys and representative studies show an increase in environmental awareness among airline passengers (European Investment Bank, 2020; World Economic Forum, 2019, 2020). How then can it be explained that aviation is still growing strongly and low-cost flight offers are still booming?

One possible explanation is that attitudes are not always reflected in actual behaviour. This is known as the **attitude-behaviour gap**. Contrary to the postulate of the theory of planned behaviour, a positive attitude towards climate protection is not a reliable predictor of climate-friendly travel behaviour. The phenomenon has been investigated in countless studies (e.g. Boulstridge & Carrigan, 2000; Hibbert et al., 2013; Juvan & Dolnicar, 2014a and b; Higham et al., 2016) The deviating behaviour is justified with a variety of arguments.

Among others, arguments range from lack of information to choose vacation options that have low environmental costs; reliance on technological solutions (Gössling et al., 2009; Lorenzoni et al., 2007); buying offsets or using the excuse of smaller footprints from everyday life or environmentally friendly behaviours at home (Becken, 2007; Buckley, 2011); justifying the disregard of environmental considerations with the need for relaxation and escape (Wearing et al., 2002); to claiming that other issues are of greater importance or simply asserting that there are no alternatives to current behaviours (Becken, 2007; Buckley, 2011; Lorenzoni et al., 2007).

Instead of behaviour change, the discrepancy between attitude then results in **cognitive dissonance** or **feelings of guilt**. The fact that environmentally friendly consumer behaviour cannot be easily predicted is one of the major challenges facing airlines and policymakers. It is important to understand that customers do not always "walk the talk."

9.2 Personal, Psychological and Socio-cultural Determinants

There are a lot of internal dynamics involved in passengers' decision-making processes. The literature classifies and divides these determinants into three basic categories: personal, psychological and socio-cultural factors (Solomon, 2020):

- Personal factors refer to determinants that are unique for each passenger, such as age, sex, place of domicile, occupational and economic conditions, lifestyle, personality and self-concept. People change the products and services that they buy not only over their lifetimes, but also depending on their personal economic situation and lifestyle, i.e. a person's pattern of living. Personality and self-concept refer to the unique characteristics of a person which lead to relatively consistent and lasting responses to one's own environment. To understand these personal factors passengers' major AIO dimensions need to be measured, i.e. activities (work, hobbies, shopping, support, etc.), interest (food, fashion, family recreation, etc.) and opinions (about themselves, products, etc.).
- Psychological factors include motivation, perception, learning, beliefs and attitudes. A motive (drive) is a need that is sufficiently pressing to direct the person to seek satisfaction of the need. Perception is the process by which people select, organise and interpret information to form a meaningful picture of the world. Learning drives change in individual behaviour arising from experience. While belief is a descriptive thought that a person holds about something, attitude is a person's consistently favourable or unfavourable evaluation, feeling and tendency towards an object or idea.
- Socio-cultural factors are a set of basic values, perceptions, wants and behaviours learned by a member of society from family and other important institutions. A group of people with shared value systems based on common life experiences and situations may build a sub-culture that includes nationalities, religions, racial groups and geographic regions. As a person normally belongs to many groups, his/her position can be defined in terms of both role and status. Almost every society has some form of social structure and cultural influences that are influencing consumer behaviour.

These personal, psychological and socio-cultural determinants create the inner or personal characteristics of a passenger, and therefore influence the way he/she is, behaves and buys (Solomon, 2020). It is, however, difficult to find a reliable connection between the individual personality and the passenger behaviour. Like computers, passengers undergo stages of information processing in which sensory stimuli are perceived, processed and stored. Perception means the process of selecting, processing and interpreting input from the environment to make it purposeful. Moreover, passengers' skills and knowledge are connected to learning and predetermined changes of behaviour. The learning process can come through a simple association between the sensation and the reaction to it, or through a complicated set of rational activities. Memory also plays a role in the learning process since a lot of behavioural patterns are trained and experiences are stored somewhere in the brain ready to be unlocked if prompted by cues. In addition, passengers who expect that they will need to deal with similar situations in the future start to form attitudes in anticipation of this event. Katz's (1960) functional theory of attitudes identifies four attitude functions that facilitate behaviour: utilitarian function, value-expressive function, ego-defensive function and knowledge function.

The force that drives passengers to behave as they do is the motivation process. It occurs when a biological or learned need is aroused that orients passengers' activities towards meeting the needs or achievement of the definite aim. In every decision-making process several motives play a role, not only one. However, not everyone is motivated to the same extent. The level of motivation depends on the passengers' involvement, which is the perceived relevance in a specific situation based on the inherent needs, values and interest. Socio-economic development, structural modernisation and industrialisation emphasise the importance of values (Khalifa, 2004). The idea that a value is a belief that some condition is preferable to its opposite has been refined by Woo (1992) by discerning four levels of meaning: "First, we can take values to mean what is of true worth to people in the broad context of the well-being and survival of individuals, and by extension, of the species as a whole. …Second, we can take value to mean what a society collectively sees as important and worthy of individual pursuits […] regardless of whether or not such highly valued objects of consumption really contribute to his or her well-being. …Third, we take value at the level of the individual to refer to what the individual holds to be worthwhile to possess, to strive or exchange for. …Fourth, we take value in the most concrete sense to refer to the amount of utility that consumers see as residing in a particular object and that they aim to maximize out of a particular act of buying or consuming." Despite the importance of values, the pattern of consumption reflecting a person's allocation of time and money is driven by his/her lifestyle. Contemporary research of lifestyle segmentation groups consumers according to a combination of three variables – activities, interests and opinions – known as AIOs. The most well-known psychographic study is the Values and Lifestyles (VALS™) System developed by SRI International.

9.3 Trip Features

Data that are systematically published by the aviation industry do not immediately reveal the information relevant to the influence of trip features on the decision-making process of passengers. Of foremost importance is the fact that passengers tend to be treated not as individuals but as "movements." For example, data may be presented not in terms of individual passengers but passenger/kilometres. Another characteristic is the treatment of individual passengers who make a change of airline or plane during a journey (e.g., from London to Honolulu via Chicago). In many cases, the data will report this as two or more passenger journeys. In particular domestic flights, which depart and arrive at airports within the same "statistical jurisdiction," passengers may be counted twice as "interlining" passengers, who change from one aircraft to another at the airport. Transfer passengers, those arriving at and departing from an airport on the same aircraft, tend to be counted once, but sometimes not at all. ▣ Figure 9.2 shows the variability of

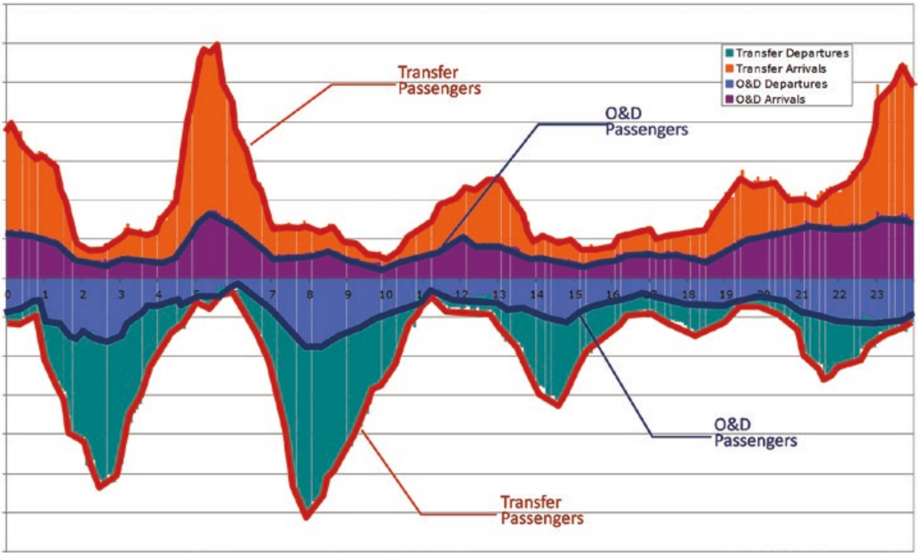


Fig. 9.2 Passenger profile (Heusinkveld, 2009)

the demand profile of transfer and origin and destination passengers within a day. Despite these issues, trip features – most importantly the purpose of trip – are one of the most influential factors of passenger behaviour (Fodness & Murray, 2007).

In recent years there has been a constant growth of the leisure travel market, among other things due to the increased popularity of short breaks and the market penetration of low-cost carriers (LCCs). Leisure tourism spending has more than doubled since the year 2000 (WTTC, 2020; Statista, 2021). The drastic changes in the aviation industry since the LCC revolution (Campbell & Kingsley Jones, 2002) have not only multiplied the market potential of airline passengers, but also made air travel a commodity. Interestingly, epidemiological studies have reported that around 50% of the population, however, suffer anything from a slight discomfort or apprehension to a very intense fear of flying, and about 10% suffer from such a high degree of fear or anxiety that they avoid flying altogether (Capafons et al., 1999). For airlines it is crucial to understand that passengers are stressed when flying because taking a plane is framed by nothing less than a fear of crashing, whether it is during take-off and landing or caused by turbulence, engine failure or terrorism. Regardless of the depth of this fear and its diverse manifestations, sitting on a plane, passengers are confined and subjected to reduced atmospheric pressure, reduced oxygen pressure, reduced air humidity, aircraft motion, movement restriction (confined space) and dehydration (Bor, 2003).

Since risk has become a core concept in consumer behaviour in general, its impact on aviation decision-making is predominant. The individual risk profile captures three fundamental domains (Conchar et al., 2004): factors that are relatively static in nature (i.e., demographics, personality), dynamic factors (i.e., needs, involvement) and cultural factors, which shape the consumer's response to every aspect of perceived risk. However, more important are the risk-reduction strategies that can be found in the literature. Many consumers are found to rely on well-known brands as indicators of quality, since an established service provider normally has a good reputation and is therefore less likely to do anything which will risk that reputation. Well-known brands may also give consumers confidence in their products or services, because, if many other consumers buy them, then the implication is that they must be satisfied. This increases the chance that the service chosen will be satisfactory. Price information can also be used to reduce risk and uncertainty. Buying a high-priced service may be favoured by consumers who associate high prices with high quality. At least in situations where there is a high perceived risk in choosing among brands and where the buyer lacks information and experience, price has been found to be used by consumers as a cue to quality (Boksberger et al., 2007).

9.4 Marketing Variables

Since the end of the 1990s, the rise of the Internet as a booking channel gave airlines the opportunity to bypass intermediaries and sell their tickets directly to a much broader audience. In 2019, an estimated 65% of all travel bookings were generated online (Travel & Tourism – Worldwide, n.d.). Booking airline tickets on the internet is now common and frequent for passengers in all segments. Whereas initially it was mainly the LCCs that drove this trend, today all carriers distribute tickets via their own websites and through online travel agencies (OTA) such as Booking or Expedia. OTAs emerged as a major global player in the travel market, offering a one-stop solution for holiday bookings.

Furthermore, today an increasing number of passengers book their flights on a mobile device. IATA had already acknowledged in 2016 that “Passengers will also be entering a “post-mobile” world, a world in which mobile is not viewed as “a” channel but “the” channel” (Harteveldt, 2016). While for airlines certainly direct distribution becomes more important, third-party retailers will not entirely disappear. For special segments such as group travel or more complex bookings, physical stores remain relevant. Therefore, most airlines rely on a multi-channel approach.

The importance of the Internet reflects preferences of consumers as well as airlines. Consumers have embraced the Internet for convenience and the depth of information available through electronic channels, although for some sectors of the public – senior citizens, persons with some disabilities and the economically disadvantaged – access to the Internet is still problematic. At the same time, airlines have realised that the Internet allows them to reach a widely dispersed base of potential consumers very quickly, while, simultaneously, it reduces distribution costs by 75% or more. Sales on an airline’s own website are by far the least expensive avenue for airlines, since the electronic search and booking capabilities allow airlines to avoid commissions, CRS booking fees, and labour costs for reservation agents (O’Toole & Ionides, 2005). However, selling only through your own website comes with the downside of limited reach (Koo et al., 2011).

The growth in popularity of the Internet has made information search and comparison of airline prices much easier. This is one of the contributory factors to the decline in airline average prices. The trend among leisure passengers indicates that they expect and will continue to expect low fares. Low fares have been the main stimulus for growth in leisure travel, with leisure passengers being prepared to switch destinations for good deals. In other words, price sensitivity is directly related to the possibilities of substitution for airlines. To date, most airlines have adopted a discriminatory pricing policy to alter passengers' buying behaviour. Thus, the heart of airline marketing became its pricing tactics and frequent flyer programmes (FFPs).

Given their all-prevailing presence in the aviation industry, airlines are faced with the challenge of keeping their prices and FFPs, that is, they must continuously make their programmes sufficiently appealing to attract and retain members (Aksoy et al., 2003; Shaw, 2002). Recognising that low prices and mileage awards are unlikely to produce genuine loyalty amongst passengers, there is consensus that delivering high quality service is the core competitive advantage for an airline's profitability and sustained development (Morash & Ozment, 1994; Ostrowski et al., 1993). Moreover, in this environment, a favourable image may separate and distinguish one airline company from its competitors. The more favourable an airline's image, the more likely passengers will assume that the services offered by that airline are better, of higher quality and worth more in actual price (Park et al., 2004). The purpose of an airline's image is to reflect a distinctive competence in comparison to their competitors and to allow the airline's name, symbol/logo or identity to mean something distinctive, with a corresponding appeal. In general, passengers retain airline images in their memory. When passengers contemplate air travel, a favourable image of a specific airline can lead to a preferred choice among their choice set. Therefore, airline image is considered a significant determinant in the decision-making process of passengers.

9.5 Characteristics and Features of the Choice Set

The choice of airport and airline is ambivalent and influenced by a number of determinants (Francis et al., 2004). There is a great variability in airports (Fodness & Murray, 2007): some cater almost exclusively to business travellers (London City Airport), others service primarily leisure travellers (Ft. Lauderdale International Airport), some are nearly always crowded (JFK), while others have excess capacity and unused spaces (Kuala Lumpur International Airport). A comprehensive model of airport service quality expectations and perceptions will need to include airport characteristics in its conceptual framework.

An airport creates the traveller's first and last impression of a city or country, and it is a known fact that a pleasant airport experience encourages spending and influences future travel plans. However, service quality levels vary considerably from airport to airport and even from one service provider to another at a single airport. Thus, the Airports Council International (ACI) conducts an airport service quality benchmark programme (ASQ Awards) with over 400 airports in more than 95 countries, surveying over 670,000 passengers annually. Service quality becomes an even more determining factor when considering connecting passengers, who account for more than 50% of traffic at some large hub airports. These passengers have a choice of various transit hubs when planning their travel. Discerning customers will pick the airport that can offer the most seamless and efficient journey.

Managerial attention should be focused on the fact that passengers demand higher standards of service, and, where they have a choice, they will tend to choose the airports which give the best quality of service. This stresses the importance of ensuring quality of ground handling services as well. These services, which include passenger check-in, security, shopping and lounge experience, transfer to and from the aircraft, baggage claim and customs are all part of the service chain. Any disturbance in these services has a major impact on passenger satisfaction as well as on the smooth operation of an airport.

Mini Case: From Service Quality to Customer Experience – Changi Airport

By Adrian Müller

For a total of 11 times and for the last 7 years in a row (2007–2020), Singapore's Changi Airport has been named the **world's best airport** by the rating organisation Skytrax. The south-east Asian mega hub is certified as a "5-star-airport for facilities, comfort and cleanliness, shopping, food & beverages, staff service and security/immigration" (Skytrax, 2020). The airport, whose annual passenger numbers are close to 70 million, is renowned for delivering a superior and consistent quality level.

What makes the airport special, however, is not the core product, i.e. simple passenger handling, but the fact that the airport creates a **unique customer experience**. In 2019, the opening of Changi Jewel, a 14,000-square-meter leisure attraction including the Rain Vortex, the world's largest and tallest indoor waterfall at 40 meters, was the culmination so far of Changi's transformation from service quality to customer experience (Changi Airport, n.d.-b).

How did Changi manage this transformation? The reasons lie in the company's **service culture**. Changi's vision is "to be the world's leading airport company, growing a safe, secure and vibrant air hub in Singapore and enhancing the communities we serve worldwide."

This is reflected in the so-called Changi service DNA of which the airport is proud. This consists of the following elements: **personalised, stress-free** and **positively surprising** are the three key elements through which the airport wants to ensure customer centricity in all their activities (Changi Airport, n.d.-a) (◘ Fig. 9.3).

The Changi DNA aims to enable every single employee to deliver exceptional service quality. In combination with special infrastructure, this creates this unique "Changi experience." For the airport, superior service quality is not a matter of chance but of design.

The competencies of the employees are to be enhanced through **constant learning** and further **development**. This is the basic prerequisite for service excellence and forms the basis for **service-driven initiatives**. In this way, customer feedback should

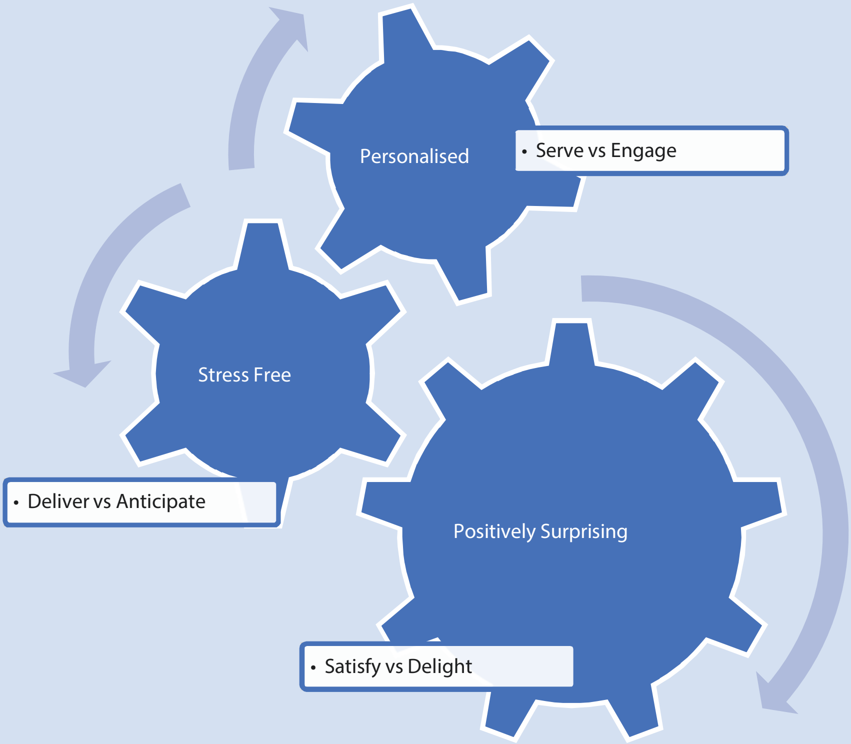


Fig. 9.3 Changi's service DNA components. (Author's own figure)

not only be recognised, but also implemented. Employees are encouraged to engage with their customers, to communicate and collaborate with them and to involve them in the service delivery process (Changi Airport, n.d.-a).

By putting service quality at the core of the company's operations, rather than just managing it, Changi accomplishes the transformation from service quality to customer experience. Not only the total of over 600 awards won, but also the commercial success show that this strategy is effective.

It is expected that passenger traffic at Changi Airport will grow by 3–4%[1] each year for the next 20 years. Based on this rate, the current airport capacity will be reached in the late 2020s.

The Changi East expansion project, with a new, third runway, one of the largest mega-terminals in the world, and a range of new facilities, aims to ensure that Changi Airport is equipped to **handle** and **impress more and more passengers** and their constantly increasing expectations. The "Changi service DNA" will again play a central role in this (▣ Fig. 9.4).

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[1] Based on pre-Covid data.

Fig. 9.4 Interior at Changi Airport (Changi Airport, n.d.-c)

Regarding the choice of airline, various approaches exist to group airlines' business models and their associated value propositions to airline customers. Traditionally, the aviation industry was divided into two main overarching business models: full-service network carriers (FSNC) and low-cost carriers (LCC). The FSNC model is based on the idea of generating the greatest possible network effects and offering a large number of connections. Yield management, demand-oriented pricing, brand image and service quality play an important role in attracting customers. In contrast, the LCC model focuses on point-to-point connections. Accordingly, network effects play a less important role. In this model, competitive advantages can be achieved by reducing complexity, saving costs and opening new revenue sources, for instance, by unbundling certain services from the ticket price (Wittmer et al., 2012). However, over the last decades, the aviation industry has been subject to major changes. This has changed the requirements for successful business models (Rossy et al., 2019). Scholarly aviation research has identified a "convergence of models": the business model of low-cost carriers goes towards full-service, and the business model of full-service carriers goes towards low-cost. Consequently, four generic business models with different value propositions can be distinguished: the no-frills carriers, the unbundlers, the boutique carriers and the connectors.

All business models in aviation strive for a low-cost structure as costs are a crucial success factor in the airline industry (O'Connell, 2007). Besides these four different types of airline business models, hybrid business models also exist. These combine different aspects of generic business models. One example of a hybrid business model is the combination of aspects of no-frills and connector, where the airline offers unbundled tickets at the lowest possible price on its short-haul flights, while offering superior service and all-inclusive tickets on long-haul flights. Allocating different airlines to generic business models, especially when considering hybrid business models, is not that simple and straightforward. Nonetheless, the airline's business model is of essence for the successful positioning within the highly competitive market as well as for the value proposition of the airline (Rajaguru, 2016). In summary, the traditional division into LCC and FSNC business models no longer does justice to the current landscape of the airline industry. Today, all airlines are actually LCCs as they optimised their cost structure over the past years. However, there are still many differentiating factors and characteristics of airlines that the customers can choose from.

A further feature of passengers' choice set is the distinction between business and leisure travel including the associated amenities. For Davidson and Cope (2003), business travel includes all trips "whose purpose is linked with the traveller's employment or business interests." While business travel only accounts for around 13% of passengers for airlines, it is responsible for up to 75% of airlines profits (UNWTO, 2019). Although global statistics are scarce, it is estimated that Americans alone take more than 400 million long-haul business trips annually (Trondent, 2020). Corporate travel policies used to focus on saving money. However, because air travel can be tedious, managers are often worried about employee comfort, convenience and productivity as it is considered counterproductive if an employee arrives tired or stressed and their performance suffers. Companies are also more willing to pay more to book last-minute flights or non-stop options, although not necessarily for business class seats. Many companies allow their employees to use business travel to earn and retain frequent flyer miles and points, which are becoming increasingly valuable to airlines as a source of revenue and data. While business travel is certainly an important segment, it is, however, the leisure travel market that shapes the airline industry.

According to IATA, business class contributes a major part to airlines' revenue. More importantly, the operating profit margin of the business class is higher compared to the one of the economy class. Business class has been growing in the last decade but so has the demand for low-cost seats. In the short-haul market, operated to a great extent by LCCs, more and more business destinations are offered and an increasing share of business-related travel is handled by low-cost airlines on short-haul routes. But new premium economy classes offer an option for business and leisure passengers travelling in economy on long-haul routes.

9.6 Service Quality, Customer Satisfaction, Perceived Value and Behavioural Intentions

For decades, the main emphasis of services marketing has been on exchange behaviour and discrete transactions. Despite a dramatic shift in focus from transactions to relationships (Berry, 2002), the literature has identified a number of favourable behavioural intentions which are assumed to be consequences of consumers' service evaluation, as well as predictors of profitability and sustainable competitive advantage (Cronin Jr. et al., 2000). These intentions have been categorised as consumer loyalty, willingness to recommend, word-of-mouth, retention and willingness to pay price premiums for the service provided. The variables "intention to repurchase the same airline service" and "willingness to recommend it" have previously been used as indicators in aviation (Chen, 2008). Theory suggests that customer retention is a major key to increased market share and ultimately the ability of an airline to generate profit. In other words, the evaluation of service performance as the comparison process of passengers' experience of the service performance with certain individual comparison standards for this performance (Sultan & Simpson, 2000) will be the significant driver of passengers' behavioural intentions in the future (Ostrowski et al., 1993). Therefore, it is an important issue to better understand the determinants affecting passenger loyalty or the choice of airline and the relationships between determinants. It is commonly believed that high service quality, customer satisfaction and perceived value lead to positive behavioural intentions (Park et al., 2004). Subsequently, the definitions of these variables and the relationships between them are discussed.

Asubonteng et al. (1996) define perceived service quality as "the difference between consumers' expectations for service performance prior to the service encounter and their perceptions of the service received." Service quality is considered the leading measure of performance in the service sector, but literature also reveals that service quality is neither easy to define nor easy to measure. It is generally accepted that the most prominent and scientific role in attempting to pinpoint service quality has been played by Parasuraman, Zeithaml and Berry, who published the first article in their long series in 1985. In their studies, they aimed to identify the generic underlying components of service quality as well as a scale to measure these components. Analysing several different services, they identified tangibility, reliability, responsiveness, assurance and empathy as the five principal components that consumers use to evaluate service quality. When evaluating airline service quality, Tsaur et al. (2002) reported that, among the fifteen service criteria tested, two of the most important attributes concerned relationships (i.e. "courtesy of attendants" and "responsiveness of attendants"). Although SERVQUAL has been tested empirically by numerous researchers, there are major concerns about how to best conceptualise and operationalise the service quality construct. As the notion of service quality in airline operations has consequently become of increasing importance, satisfaction among airline passengers has thus received much attention (Callan & Kyndt, 2001; Ostrowski et al., 1993).

A number of studies have examined the relationship between service quality and customer satisfaction, and there has been much debate about the distinction and association between service quality and customer satisfaction. Previous studies generally agree that customer satisfaction and service quality are conceptually distinct. However, there is disagreement about the causal order between service quality and customer satisfaction. Some researchers argue that service quality leads to customer satisfaction, while others argue that customer satisfaction is an antecedent of service quality. Adopting this distinction, Rust and Oliver (1994) state that service quality perception requires neither experience with the service nor with the service provider and in contrast customer satisfaction is purely experimental. In this dominant line of research, service quality is viewed as a more enduring concept, whereas customer satisfaction is a more extensive concept (Parasuraman et al., 1988). Consequently, the concept of customer satisfaction can be described as being superior to service quality because the quality components affect customers' satisfaction at the encounter-specific level. A widely accepted definition of customer satisfaction is given by Oliver (1997): "Satisfaction is the consumer's fulfilment response. It is a judgement that a product or service feature, or the product of service itself, provided (or is providing) a pleasurable level of consumption-related fulfilment, including levels of under- or over-fulfilment…" In a competitive environment, satisfying passengers in transportation services has a beneficial effect on a carrier's long-term survival (Rhea & Shrock, 1987). Airlines should know how their services are meeting their passengers' needs and wants because the extent to which passenger needs and wants are met has come to be called passenger satisfaction/dissatisfaction.

Perceived value is considered one of the most significant factors in an organisation's success (Sánchez-Fernández & Iniesta-Bonillo, 2007). The notion of "value creation" reflects the increased recognition of perceived value as one of the most important measures in gaining a competitive edge (Woodruff, 1997). The utilitarian perspective of value is based on the concept of trade-off derived from the field of economics. It states that price is the value of a service, and therefore consumers spend their income as to maximise the "value" they get from services. Reflecting on these peculiarities Zeithaml (1988) states that "value is the customer's overall assessment of the utility of a product based on perceptions of what is received and what is given." The behavioural perspective treats the value construct more comprehensively and attempts to explain it not only with price variation, but also with other factors. Woodruff (1997) later elaborated on Zeithaml's (1988) conceptualisation and provided similar explanations of the value construct with a customer value hierarchy approach: "Customer value is a customer's perceived preference for and evaluation of those product attributes, attribute performances, and consequences arising from use that facilitate (or block) achieving the customer's goals and purposes in use situations."

Value-added services are instruments with which companies can gain a competitive advantage in the airline industry. Value-added strategies, such as FFPs, increase the long-term value of the relationship of a passenger with the airline, offering greater benefits to repeat passengers than to occasional passengers. Dennett et al. (2000), for example, claim that including pre-bookable services in the charter airline industry adds to the overall perceived value from the consumers' perspective. Airline passengers have raised their expectations regarding the level of service quality, while seeking better value for their money. Offering a good service to passengers may not be sufficient to attract and retain passengers because they seek value as a combination of fares and quality. However, customer value management poses special problems in the context of the aviation industry. In service industries, companies are not entirely in control of output, since consumer-related factors (e.g., socio-demographic characteristics, involvement, etc.) and situation-related factors (e.g., time pressure, peer pressure, etc.) instantly influence the service produced. In aviation, there is not only the problem of external influencing factors. The production process itself is a complex one, in which activities of many different departments have to come together in the right way and at the right time, if superior perceived value is to be sustained (Kozak et al., 2003; Shaw, 2002). And even though airlines deliver what they promise in terms of safety, punctuality, aircraft cleanliness and in-flight service, the perceived value of services does not depend on these factors alone. This is to say that offering higher levels of quality is only worthwhile to the extent that consumers believe that value is being enhanced. In view of that, it can be argued that, as air travel becomes more akin to a commodity, the top priority for marketers is to establish which extrinsic and intrinsic cues consumers use to signal superior value. To gain a competitive advantage, airlines should establish and sustain relationships with their customers. This is also known as "relationship value" (Le Bel, 2005).

? Review Questions

- Explain the different behaviour theories: theory of planned behaviour, theory of bounded rationality, judgement and decision theory, attitude behaviour gap theory, customer value theory and prospect theory.
- What are the five steps of aviation decision making?
- What is meant by personal, psychological and socio-cultural determinants?
- Explain the influence of the Internet as a marketing variable in passenger behaviour.
- What are the characteristics and features of the choice set in aviation decision making?
- How do passengers evaluate service quality, customer satisfaction and perceived value? What are the similarities and differences between these concepts?

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Authorities and Regulations in Aviation

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Contents

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Summary

- Aviation is dominated by supranational and international regulation and authorities; national authorities only have few competencies for aviation regulations.
- The Chicago Convention and the freedoms of the air are the bases for the whole aviation industry.
- The International Civil Aviation Organization (ICAO) as a part of the UNO is the most important regulator in aviation worldwide.
- The European Aviation Safety Agency (EASA) is the most important regulator of European aviation.
- The airspace is clearly structured in classes and types; strict rules for air traffic help to ensure safety.
- Passengers in Europe or of European Airlines benefit from special passenger rights.

Supranational as well as international regulations and authorities shape the regulatory field in aviation. As such, national authorities have few competencies in terms of implementing aviation regulations. In this chapter, different regulations and their respective bodies are presented and explained. Beginning with the basic regulations of the Chicago Convention and the freedoms of air, the industry-wide basis is presented. Furthermore, supranational authorities regulate aviation worldwide, which is exemplified by the UNO body called ICAO. On a European level, EASA is concerned with regulating important aspects. Regulations also shape the airspace by dividing it into different classes and types, accompanied by specific rules to ensure safety. Also from a consumer perspective, supranational and European laws protect passengers by awarding them with special rights in the case of damage or delays.

10.1 Introduction

Aviation is governed by international organisations and regulations. The most important organisation is the International Civil Aviation Organization (ICAO). Because ICAO is based on a multilateral agreement (the Chicago Convention) signed by more than 190 countries and having the power to legislate in the field of aviation, this organisation is called supranational. The national civil aviation authorities (CAA) have to comply with the ICAO regulations. In Europe, the Joint Aviation Authorities (JAA) have first established guidelines in aviation. Now the European Aviation Safety Agency (EASA) has replaced the JAA with the power to legislate in the field of aviation.

Contrary to popular opinion, the freedom in the air is limited. Especially commercial aviation has to observe a substantial number of regulations. The airspace is organised in a complicated structure of classes and types. Violations of the rules of circulation in the air are punished severely. On the other hand, the strict regulations in aviation have brought special rights for passenger transported by airlines.

10.2 International and Supranational Organisations

10.2.1 UNO and ICAO

The International Civil Aviation Organization (ICAO) is a special agency of the United Nations (UN) and was founded as part of the Chicago Convention (CHI) in 1944. Currently it consists of 190 member states; an actual list is published under ► www.icao.int/cgi/statesDB4.pl?en (Müller & Schmid, 2009; the following chapter is based on this publication). ICAO has a typical trinomial organisational structure and according to its competencies and functions it has legal capacity in regard to public international law. The plenary assembly and the council are the most important institutions; the secretariat and different committees are subordinate to the council (Schwenk & Giemulla, 2005).

The decision-making body of ICAO is the assembly, which is also termed legislature (Erler, 1967). It is composed of delegates of each signatory state and meets at least in a three-year cycle. Usually, decisions are made based on the majority of votes, whereby each delegation is entitled to one vote. In practice, the assembly confines itself to define the guidelines of operations. It is responsible for decisions on budget and for the composition of the members of its committees (Art. 48 and 49 CHI).

The council constitutes the executive body of the ICAO and comprises 36 members. It is elected by the assembly. The latter has conferred a large part of its competencies on the council. Based on the original and delegated authorisation, the council appoints committees and commissions, decides upon their work programme and enacts or alters regulations regarding international civil aviation. In addition to legislative and administrative functions, the council is responsible for arbitrational settlements. It can be described as the "standing main executive body" (Erler, 1967).

Besides the aviation committee and the air transportation commission mentioned in the CHI, ICAO commands a committee on legal matters, assistance and financial affairs as well as a secretariat which is headed by a secretary general nominated by the council (Schwenk & Giemulla, 2005). Amongst these committees, the ICAO aviation committee has an exceptional position. It consists of a group of technical experts appointed by the council for a period of 3 years based on their personal competence and knowledge. The focus of the aviation committee is on technical not on political aspects. It addresses, for example, issues regarding aircraft certification, aviation workforce and ground control. It is responsible for the development of international civil aviation regulations (Art. 56 and 57 CHI).

10.2.2 ECAC and JAA

The European Civil Aviation Conference (ECAC) is an independent regional organisation. Founded in 1955 as an intergovernmental organisation, the ECAC seeks to harmonise civil aviation policies and practices amongst its member states and, at the same time, promote understanding on policy matters between its member states and other parts of the world. The ECAC's mission is the promotion of the continued development of a safe, efficient and sustainable European air transport system (ECAC, n.d.). Currently, it is formed by 44 member states. ECAC is not a subject of international law. Its foundation was initiated by the Council of Europe and ICAO (Schwenk & Giemulla, 2005).

The plenary conference constitutes the main body of ECAC. It incorporates the ministerial delegation of all ECAC member states and meets every 3 years. It determines the work programme, the financial framework and additional important decisions concerning control (Weber, 2003). Besides the plenary conference, regular and extraordinary meetings between the heads of national aviation authorities take place (Riedel, 2006). In these meetings the heads of the national authorities draft internationally effective resolutions just like the plenary conference. Today, the meetings held by the heads of the national aviation authorities have emancipated themselves from the plenary conference in such a way that they may be termed the ECAC's "permanent executive body" (Weber, 2003). Like ICAO, ECAC has a permanent structure including a secretariat as well as a variety of committees. For specific air traffic tasks, additional institutions may be established besides the working committees under the organisational and legal umbrellas of the conference. A corresponding work agreement between the participating member states is the basis for the establishment of such institutions (Riedel, 2006).

The Joint Aviation Authorities (JAA), which counted 42 member states, was an institution of ECAC (Jäger, 1995). The Agreement of Cyprus from 11 September, 1990 is one of the central agreements on which the JAA was based on. Its status under international law is unsolved (Riedel, 2006). In any case it has no legal capacity of its own (Froehlich, 2008). The board and the committee were the most important bodies; subordinate to these bodies were the specialist department and the secretariat. The board decided upon political guidelines of the JAA, long-term goals and the general work programme. The committee was responsible for the control and implementation of these regulations within individual measures. The committee was composed of one representative of each of the aviation authorities which joined the JAA (Art. 4 Agreement of Cyprus). Below this level, which is also termed "governing body", the JAA had a technical base which is called "executive" (Riedel, 2006). The latter was made up mainly of a secretariat, a liaison office including the department's airworthiness, air traffic and licenses as well as a training organisation. The heads of departments were subordinate to the chief executive. The majority of staff of the subdivisions was recruited from the national aviation administrations (Jäger, 1995).

The tasks of the JAA were successively taken over by the European Aviation Safety Agency (EASA). Since 30 June 2009, the JAA no longer exists. Only in the area of professional training does a successor organisation called Joint Aviation Authorities Training Organisation (JAA TO) remains. This is a non-profit organisation and an associated body of the ECAC. JAA TO has a history of more than 46 years training the Aviation Industry and Authorities for Outstanding Safety. JAA TO is the ICAO Regional Training Center of Excellence (RTCE) in Europe and a leading member of the EASA Virtual Academy (EVA). JAA TO schedules more than 500 training courses annually at its headquarters in Schiphol-Rijk, The Netherlands, as well as at partner and customer locations worldwide. Within the aviation community, JAA TO also serves as a platform to learn and exchange views on the latest regulatory developments. In addition, JAA TO provides advisory services/knowledge solutions as well as assistance with building capacity for training departments (JAA TO, n.d.).

10.2.3EC and EASA

Within article I-1 of the proposed European Constitution of the year 2004 the European Community (EC) is described as a partly integrated and partly intergovernmental union of states (Breitenmoser & Husheer, 2002). The EC is a complex and multi-layered system of fusion of powers, which is based on a "thicket" of primary community law, which has been growing for more than 50 years (Oppermann, 2005). In 2007 the European Member States agreed to abandon the constitution and to amend the existing treaties, which would remain in force. The new treaty became the Lisbon Treaty on its signing in Lisbon on 13 December 2007.

The European Parliament (EP), the Council, the Commission, the European Court of Justice (ECJ) and the European Court of Auditors (ECA) are the main bodies of the European Coal and Steel Community (ECSC), the European Economic Community (EEC; today the European Community) and the European Atomic Energy Community (EAEC), which have been united already. Today, in 2021, the EC counts 27 member states (European Commission, 2021).

The European Aviation Safety Agency (EASA) represents a special organisation of the European Community (EC) with a legal personality of its own (Art. 19 (EC) No. 1592/2002 EASA). Its legal capacity in regard to public international law is partial and particulate (Riedel, 2006). Currently, EASA has 31 member states (EASA, n.d.). Regulation (EC) No. 1592/2002 of the European Parliament and the Council represented its legal basis. In 2008, the Regulation was substituted by Regulation (EC) No. 216/2008 (called basis regulation). The headquarters of EASA are in Cologne with an office in Brussels. EASA employs more than 800 aviation experts and administrators.

According to the regulation (EC) No. 216/2008, EASA has a board of directors and a head of agency called executive director. The board of directors ensures the contact between the agency, the member states and the commission. It is responsible for the agency's major control decisions and decides upon the work programme and the budget. The board of directors meets on a regular basis, or as required. Furthermore, it appoints the executive director at the proposal of the commission and exerts considerable influence on the selection of personnel for the rest of the agency's bodies as well as on the organisation of the subordinated administrative machinery. The board of directors includes representatives of each contracting state and a commission representative. In elections, each member has one vote. The board of directors is obligated to establish an advisory body of interested parties, which consists of representatives of the aviation industry, the

European-wide operating airlines and the transportation associations as well as the consumers' organisations. Due to the extensive competencies of the board of directors, the powers of the executive director – the second main body of EASA – are very limited. The foundation of EASA is divided into a rule-making directorate, a certification directorate, a quality and standardisation directorate and an administrative directorate.

10.3 International Regulations in Aviation

10.3.1 The Chicago Convention and the Freedoms of the Air

In the field of international air traffic law, the Chicago Convention (CHI) from 7 December, 1944, represents the central agreement of international civil aviation. Due to its universal character, it has been called "magna carta for the post-war development of international civil aviation" (Weber, 2003).

Art. 1 CHI states: "The signatory states acknowledge that every state has complete and exclusive sovereignty over airspace above its territory". However, the claim of exclusive sovereignty over airspace above the territory of contracting states contradicts the character of aviation, which is international in its nature. Subsequently, for international aviation to become possible, the states have to agree upon multilateral conventions and bilateral aviation treaties which regulate cross-border air traffic. Consequentially, the preamble of the CHI states that "The undersigned governments have agreed upon certain principles and agreements so that international civil aviation may be developed in a secure and structured manner and may be established on the basis of equal opportunities and can be operated in a sound and economical way".

As soon as the end of World War II was foreseeable, preparations for the Chicago Convention started. In 1944, the United States invited to a diplomatic congress to discuss the future of the aviation industry. Prior to the negotiations a multilateral system of traffic rights was strived for. However, during the conference two very different positions emerged (Wenglorz, 1992). After World War II the United States had a military aircraft fleet which was extremely strong (about 300,000 aircraft) including various transport aircraft. These transport aircraft could easily be transformed into a fleet of civil aircraft. Against this backdrop the US delegation argued for an "Open Sky" at the Conference. The British in contrast called for an orderly market development (Larsen et al., 2006).

The principle of an orderly market development meant a contractual regulation of all aviation services. It was aimed to negotiate all competition parameters within bilateral aviation treaties: number of seats, model of aircraft, frequencies, flight paths, landing rights, etc. In contrast to this was the global opening of the aviation market, the so-called open skies (Larsen et al., 2006). These diverging positions caused prolonged and difficult negotiations which resulted at last in the formulation of the "eight freedoms of the air""(Wenglorz, 1992). The liberalisation of the air transport system brought the possibility to exchange flight codes.

Therefore, today, we have the following nine freedoms of the air (Brinkhoff & Windhorn, 2008; Müller, 2007):

First Freedom: The Right to Fly Across Foreign Territories Without Landing

The right to fly across a contracting state's territory (partner country) without landing is also known as the technical freedom (■ Fig. 10.1).

Second Freedom: The Right to Make Technical Stopovers

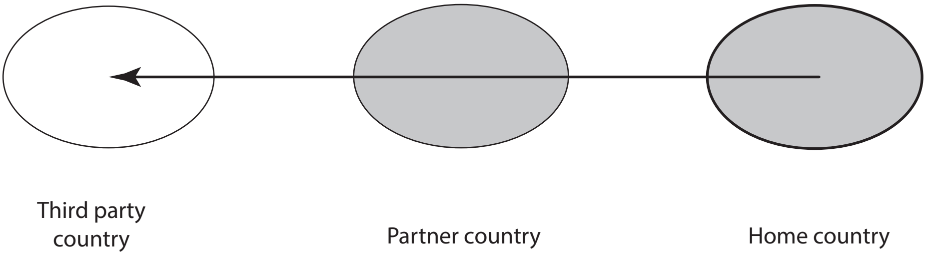
The second freedom is the right to make technical stopovers on a contracting state's territory, for example, to refuel, to change crew or to carry out technical repairs. The most famous example of the second freedom is Shannon Airport, which was used as a stopping point for most North Atlantic flights until the 1960s (■ Fig. 10.2).

Third Freedom: Right to Transport from the Home State into a Contracting State

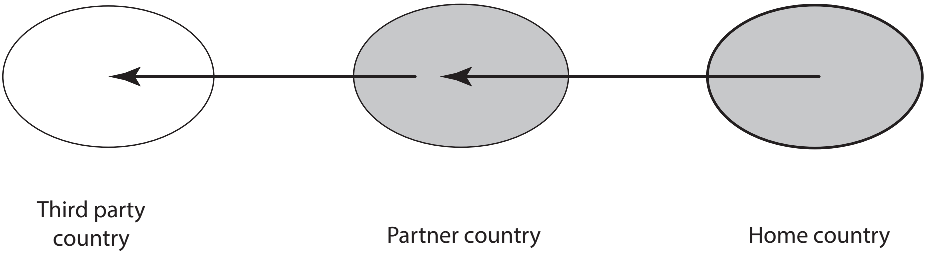
The third freedom is the right to take on board passengers, freight and mail in the home state and to unload in a contracting state's territory. The third freedom is the first commercial freedom (■ Fig. 10.3).

Fourth Freedom: Right to Transport from a Contracting State into the Home State

The fourth freedom is the right to take on board passengers, freight and mail in another contracting state and to transport them to the home state of the carrier. The third and fourth freedom rights are almost always granted simultaneously in bilateral agreements between countries (■ Fig. 10.4).



■ **Fig. 10.1** First freedom. (Author's own figure)



■ **Fig. 10.2** Second freedom. (Author's own figure)

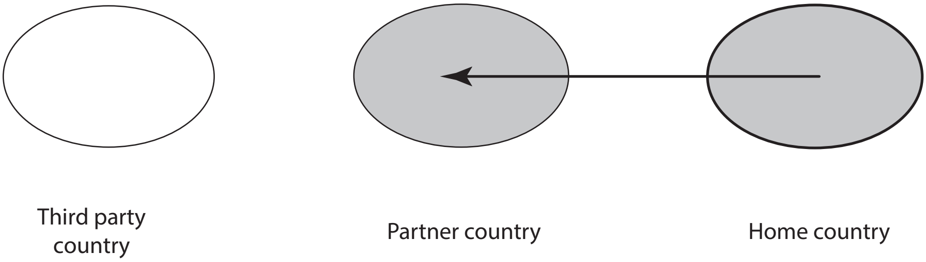


Fig. 10.3 Third freedom. (Author's own figure)

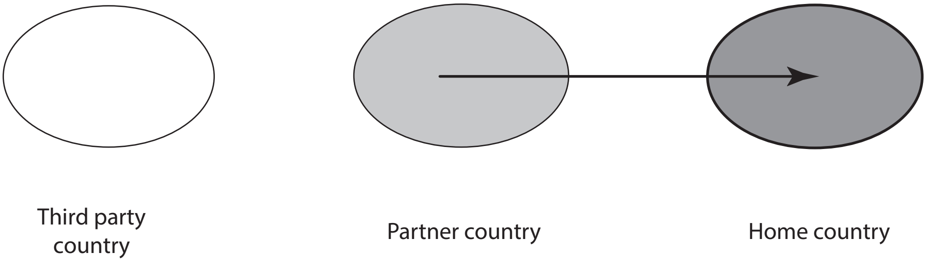


Fig. 10.4 Fourth freedom. (Author's own figure)

Fifth Freedom: Right to Transport Between a Contracting and a Third-Party State

The fifth freedom is the right to transport passengers, freight and mail between the contracting states and third-party states on a particular route. The fifth freedom can be distinguished whether the third-party state is at the beginning, the intermediate or the end of the flight (Fig. 10.5).

Sixth Freedom: Right to Transport from a Contracting State into the Home State and Further to Third-Party States or from Third-Party States into the Home State and Further into the Contracting State

The sixth freedom is the right to take on board passengers, freight and mail in another contracting state and to transfer to a third-party state via the home state; the sixth freedom constitutes a combination of freedoms 3 and 4 (Fig. 10.6).

Seventh Freedom: Right to Transport Between Contracting States and a Third-Party State Without Connection to the Home State

The seventh freedom is the right to permanently transport passengers, freight and mail between two contracting states or between a contracting state and a third-party state. Thus, the seventh freedom is a special case of the fifth freedom (Fig. 10.7).

Eighth Freedom: Right to Transport Within the Contracting State

The eight freedom is the right to permanently transport passengers, freight and mail within another contracting state between the airports available, whereby the flight begins and ends in the other contracting state. The eighth freedom is also referred to as "right of cabotage" or "successive cabotage" (Fig. 10.8).

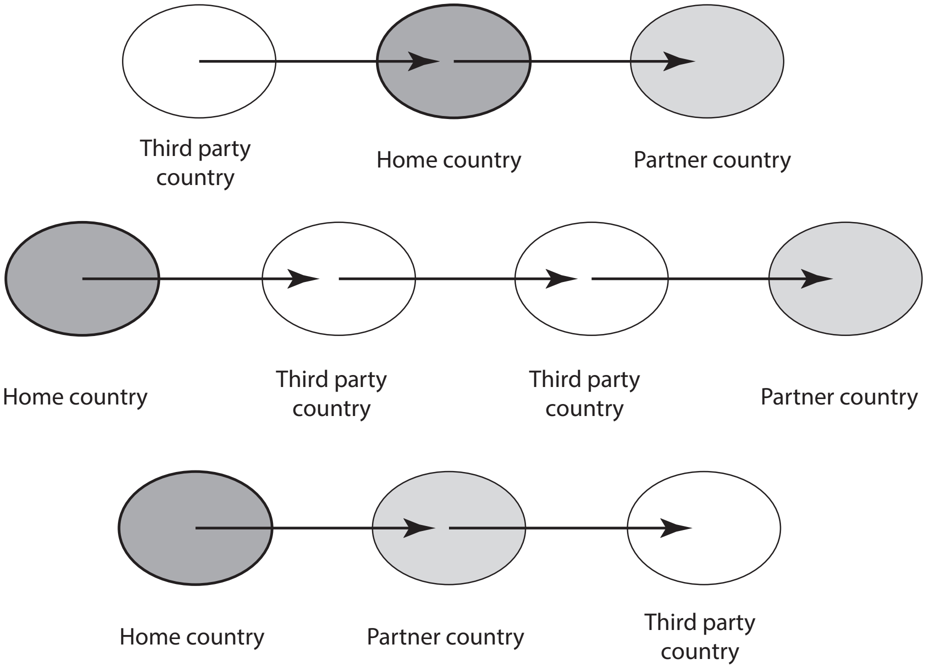


Fig. 10.5 Fifth freedom. (Author's own figure)

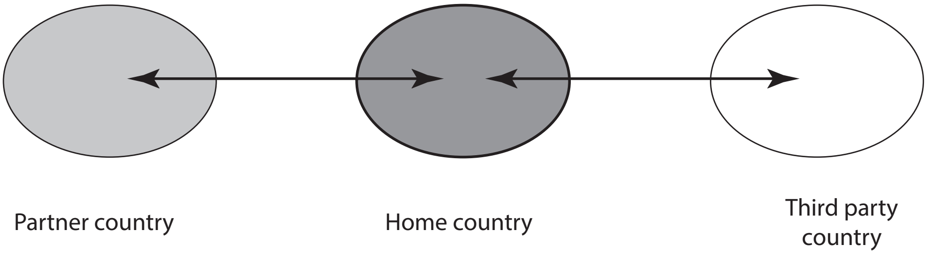


Fig. 10.6 Sixth freedom. (Author's own figure)

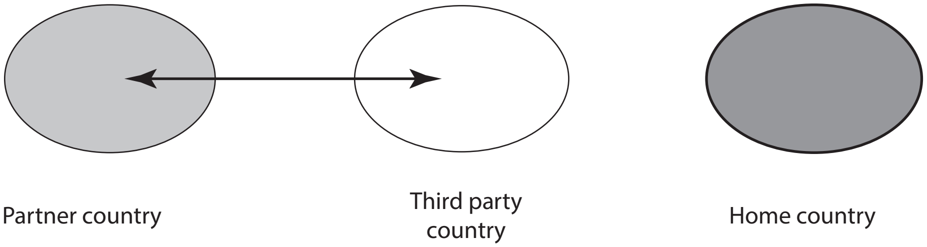


Fig. 10.7 Seventh freedom. (Author's own figure)

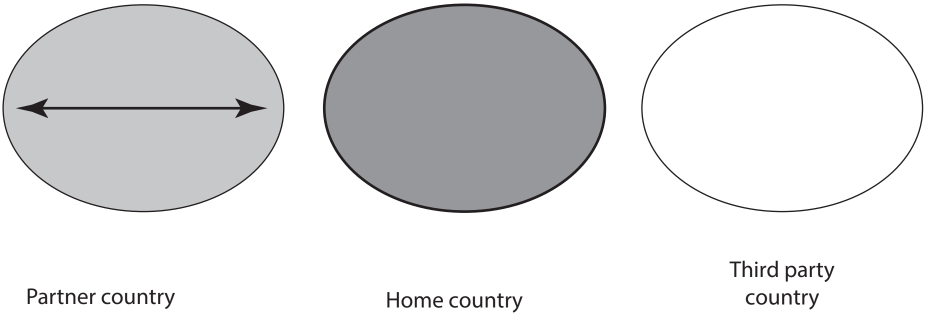


Fig. 10.8 Eighth freedom. (Author's own figure)

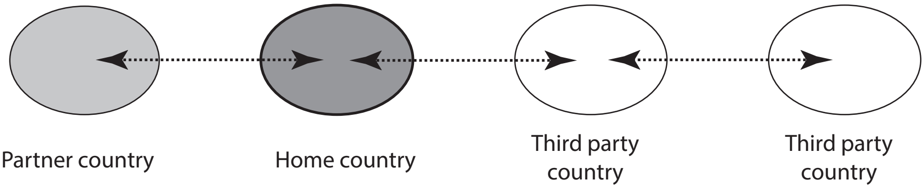


Fig. 10.9 Ninth freedom. (Author's own figure)

Ninth Freedom: Right to Transport Under the Flight Code of a Partner Airline

The ninth freedom is the right to carry passengers or cargo within a foreign country without continuing service to or from one's own country. It is sometimes also known as "stand alone cabotage". It differs from the aviation definition of "true cabotage," in that it does not directly relate to one's own country (Fig. 10.9).

Concrete details of the nine freedoms of the air, the flight paths, frequencies and especially the prices could not be determined due to the differing economic powers of the states participating in the Chicago Convention.

During the conference, merely aviation regulations dealing with registration, safety standards, etc., could be defined. Thus, in order to standardise the international air traffic, particularly with regard to flight paths and pricing, another organisation was founded, the International Air Transport Association (IATA). This association consists of airline representatives, whereby it is irrelevant whether the airlines operate under state control or private ownership and whether they operate scheduled or non-scheduled air services. The main task of IATA is the international pricing of those flights which are agreed upon during IATA transport conferences and are referred to in various bilateral aviation agreements (Haanappel, 2008). ICAO, the CHI and IATA created the basis on which the states were able to negotiate bilateral aviation agreements, the nine freedoms, different flight paths, their frequencies and prices. Over the years an international network of bilateral aviation agreements had been established (Wenglorz, 1992).

10.3.2 The European Regulation of Air Law

When the European Economic Community (EEC; today the European Community) was founded in 1957, European air traffic was of minor importance and compared to other modes of transport it had a special position; the EEC competition rules did not apply for airline companies and there was no real competition between airlines. The first liberalisation proposal was made by the council in the 1970s. After the European Court of Justice (ECJ) decided by the judgment of 30 April 1986 that the competition rules stated in the EEC Treaty also had to be applied to air traffic, the proposal was adopted by the council.

During the 1990s, within the framework of the liberalisation of scheduled air services, the EC has removed a complex system of international law which had been established by states in order to secure their air sovereignty (their share in the market). Compared to the United States, the deregulation process within the EC was significantly slower because the European airlines and other stakeholders tried to influence the opening-up process in their favour (Grundmann, 1999). Often liberalisation was interpreted as opening-up foreign markets and at the same time protecting own markets as long as possible (Haldimann, 1996).

Since 1993, the freedom for air transport services is granted within the European market. This implicates that generally all EC airline companies are allowed to operate from all airports within the community (cabotage). According to common rules, time slots were assigned and access to ground services at airports was liberalised (Oppermann, 2005). Along with the liberalisation, the market pattern and the price structure also changed (hub-and-spoke system, discount tariffs and dumping prices). It also led to the merger of airlines and the formation of alliances (Dettling-Ott, 1991).

In conjunction with the liberalisation of the domestic airline market, various harmonisation measures were implemented. In the light of increasing flight delays and cancellations, the passenger rights were strengthened. In terms of environmental protection, the EC primarily aimed to reduce aircraft noise. In addition, air traffic control services, air traffic management and the use of the European airspace were “Europeanised”. In the field of aircraft construction, the European Aviation Safety Agency (EASA) took up its operational function (Oppermann, 2005).

In Europe, the air traffic law developed on an intergovernmental level within ECAC. At the end of the 1960s, ECAC prepared the International Agreement on the Procedure for the Establishment of Tariffs for Scheduled Air Services. At the beginning of the 1970s, ECAC was preoccupied with establishing the accreditation regulations for the first Airbus and for this purpose ran a task force named “Joint Airworthiness Authorities”. In the mid-1980s, the liberalisation of air traffic within Europe became a new focus of ECAC. Today, ECAC contributes significantly to harmonising legislation within Europe, unless decisions are made within the EC Institution. ECAC also has a bridge-building function between the Central and Eastern European States and the states of the EC and generates ideas in areas such as environmental protection, security, defence against external threats, air traffic control, etc.

10.3.3Types of Regulations

The provisions of the ICAO can be divided into primary and secondary legal regulations. The provisions of the Chicago Convention itself are part of primary international air traffic law. This legislation enters into force directly through ratification of the respective treaty. As with many other multilateral agreements the main operational regulations are secondary legislation (Tietje, 2001). On this level, which is subordinate to the primary legislation, ICAO provides the members states with the possibility to govern a certain issue independently according to the specific national circumstances ("opting out").

The secondary ICAO legislation is essentially made up of:

- Standards.
- Recommended practice.
- Procedures for air navigation services – PANS.
- Regional supplementary procedures – SUPPS.

According to Art. 54 lit. 1 CHI, the standards and recommended practices are to be handled separately from the procedures. The CHI itself does not define standards, recommended practice or procedures. In addition to the terms "standards and recommended practices" (SARPS), the CHI uses terms such as rules (Art. 12 and 28 CHI), regulations (Art. 12 CHI) and coordinated measures (Art. 25 CHI) for SARPS. At its first convocation, the legislature of the ICAO confirmed the binding character of the standards and defined them as follows:

> *Standard means any specification for physical characteristics, configuration, material, performance, personnel or procedure, the uniform application of which is recognized as necessary for the safety or regularity of international air navigation and to which Contacting Stats will conform in accordance with the Convention; in the event of impossibility of compliance, notification to the Council is compulsory under Art. 38 of the Convention.*

Standards can generally be identified through the following introduction: "The contracting states shall...". For a member state the standards and procedures enter into effect if it does not avail itself of the possibility of "opting out" provided for in Art. 38 CHI. Recommended practices usually begin with the following phrase: """The contracting states may...". During the first convocation a recommended practice was defined in the following terms:

> *Recommended Practice means any specification for physical characteristics, material, performance, personnel or procedure, the uniform application of which is recognized as desirable in the interest of safety, regularity or efficiency of international air navigation, and to which Contracting States will endeavour to conform in accordance with the Convention.*

However, within the scope of international cooperation documents (doc.) and working papers (WP) play an important role although they have – like the recommended practices – no legally binding character.

The SARPS are maximum and minimum requirements which member states should not exceed or undershoot and which aim at harmonising the national regulations, standards, procedures and organisations of signatory states in regard to aircraft, personnel, airways and support services as much as possible (Art. 37 I CHI).

Not only the articles of the Chicago Convention itself but also the following 19 annexes to this convention are very important for the aviation industry:

1. Aviation personnel.
2. Air traffic regulations.
3. Meteorological services.
4. Aeronautical charts.
5. Telecommunication.
6. Operation of aircraft.
7. Registration and labelling of aircraft.
8. Airworthiness.
9. Facilitation of approach and flight handling.
10. Communication system.
11. Air traffic control cervices.
12. Search and rescue services.
13. Aircraft accident investigation.
14. Airport classification.
15. Flight information services.
16. Environmental protection.
17. Air safety.
18. Transportation of dangerous goods.
19. Safety management.

In contrast to supranational organisations like the EC, ICAO does not possess sovereign powers. Insofar as the standards of the CHI are "self-executing" they do not need to be transformed into national law, but they have direct effects. Art. 5, 8, 15, 16, 20, 24, 29, 32, 33 and 36 of the CHI have already been declared directly applicable by US courts. Courts have not yet made a decision on whether the amendments to the CHI are also directly applicable.

EC legislation can also be divided into primary and secondary community laws. The primary community law includes the treaties establishing the European community which were based on international law. In contrast, the regulations and policies issued by the bodies of the EC according to the corresponding provisions of the treaty are part of the secondary community law (Jaag, 2003). Within the scope of international cooperation, soft law, which consists of resolutions, declarations, recommendations and similar statements, also plays a significant role. Compared with hard law, these provisions have no binding effects, but they can have considerable political leverage. In the context of European civil aviation, the soft law is made by ECAC which has a purely advisory capacity. ECAC has an external effect through recommendations, resolutions, guidelines and other conclusions.

In contrast to the regulations and procedures of the ICAO, the provisions of the EC are directly applicable to the citizens of the member states without any transposition into national legislation. It is neither permitted nor necessary to transpose them into national law. Hence, they directly intervene in the legislation of the member states, more than any other supranational regulation, and are therefore the most effective means to harmonise legislation (Jaag, 2003).

Like the regulations of ICAO, those of the EC primarily address the member states. Such regulations are aimed at harmonising the provisions of member states. A direct unification is not paramount. Legislation has to be established by the national legislator according to the guidelines of the community. For reasons of legal security, the regulation has to be transformed into national law. In cases where these regulations are not at all or not properly applied by member states, where they are not sufficiently published or where conflicting national regulations are not suspended, national legislation still has to be interpreted in accordance with the regulations. Policy-compliant interpretation of national legislation may, by way of exception, show direct effects on citizens (Jaag, 2003).

The supranational air traffic law can be divided into three different levels: on the top level are the EASA regulations, on the level below the implementation guidelines and on the lowest level the certification specifications (CS). Since EASA cannot issue the CS without the council and the parliament, the legal character of these provisions, which are mainly operational, is still unexplained. There is no "opting out" in the EASA regulation.

10.4 Implementation of International Regulations

In the United States, the route network and airfares were subject to state regulation until the end of the 1970s. This regulatory system was criticised by many economists. Liberal forces noted that the prices were excessive and that it was not possible to adapt prices to consumer demand. They also argued that competition was determined by non-price factors such as on-board catering, and that only air taxi companies had the possibility to operate exclusively on profitable routes, as they were not legally bound to the government regulations. The US Congress responded to calls for more competition within air traffic by deregulating freight traffic through the introduction of the Air Cargo Act in 1977. Applied also to passenger traffic, it established the Airline Deregulation Act in 1978. Ever since, the United States expedites the opening up of the aviation markets at a national and international level using the term Open Sky Policy (Weber, 2003).

In the course of the deregulation policy, the United States notified IATA that it would deprive its airlines of the permission to further participate in the IATA price-fixing conferences. In the previous practice it had been up to the airlines whether they participate in the IATA conferences or not. This meant that IATA's importance in pricing decreased. Worldwide, the focus shifted towards a greater competition between airlines (Hobe, 1998). In addition, in 1987, the European Conference of Air Carriers adopted a price system which only prescribes the margins for pricing, but otherwise gives the airlines a free hand to determine their prices. In developing countries, there is also an increasing tendency towards pricing by regional organisations. However, today, the main purpose of the IATA is still to determine prices for scheduled air traffic. Most bilateral aviation agreements include a clause requiring the signatory states to base their prices on the tariffs determined by IATA.

The deregulation process initiated by the United States reached Switzerland some 20 years later. In 1998, the Swiss Federal Assembly decided to repeal Art. 103 of the aviation law, which required that domestic, continental and international scheduled flights that are of public interest be operated exclusively by a Swiss mixed-economy airline, in which the state had a financial stake (former Swissair). On 1 June, 2002 the agreement between the Swiss Confederation and the European Community of 21 June, 1999 entered into force. This meant that despite the Swiss refusal to enter the European Economic Area on 14 March, 1995 the Swiss aviation market was integrated into the competitive European aviation market. Together with six additional agreements, the agreement on air transport that applies between Switzerland and the EC forms an overall package.

The bilateral agreements specified the conditions at which the opening-up of the Swiss market would take place. The aviation agreement was generally formulated so as to put Switzerland in the area of air traffic on a par with countries that have entered the EC (the so-called "as-if" status) (Bentzien, 1998). This approach of the aviation agreement is already expressed in the correspondence as per amendment 8 of the transit agreement between the negotiating delegations of the EC and Switzerland. This correspondence states that the EC and Switzerland take the opportunity to successfully conclude the negotiations about land transport, to stress the importance of fertile cooperation as well as liberalisation of air traffic. They believe that based on the *acquis communautaire* a satisfying solution has to be reached.

The core of the aviation agreement between Switzerland and the European Community consists of the regulations about traffic rights included in ▶ Chap. 3. Based on reciprocity, the Swiss airlines gained access to the liberalised aviation market of the EC in a series of steps through the agreement. The third and fourth freedom applies to the signatory states since the agreement came into force (1 July 1, 2002). Two years after the inception of the agreement (1 July, 2004), the Swiss airline companies received the fifth, sixth and seventh freedoms. Finally, 5 years after the inception (1 July, 2007) the contracting parties entered negotiations about the eighth freedom (Art. 15 paragraph 3 Civil Aviation Agreement). In accordance with Art. 21 of the aviation agreement, a committee of representatives of the signatory parties is appointed. This committee is responsible for the correct application of the agreement. The signatory parties carry out consultations within the framework of the joint committee and exchange the information that is necessary for the correct implementation of the agreement. The main objective of these consultations with regard to the relationship to third countries is to examine and consider appropriate procedures in the context of the open sky policy pursued by the United States since 1978. In addition, the joint committee also deals with issues related to the formation of strategic alliances (Bentzien, 1998).

On 1 September 2004 the new Art. 103 of the air transport regulation in Switzerland came into force. This happened against the background of the intervention of the federal government regarding the concept of entrenchment of the Swiss national civil aviation in 2001 and the response of the EC committee to this comportment. The new Art. 103 is based mainly on the aviation agreement (Art. 13 and Art. 14) which stipulates that, if at all, state support is only granted under certain conditions.

It is difficult to reconcile liberalisation with national interests. In a liberal system, laws play only a minor role. Consistent liberalisation may conflict with national interests such as environmental protection, capacity utilisation of airports or the offer of a venture in regard to regularity, capacity and prices at which certain routes are operated (Dettling-Ott, 1991).

10.5 Special Aspects of Air Law

10.5.1 Definition and Qualification of Air Law

The term "air law" is used synonymously with the term "air traffic law" and "aviation law" (Brinkhoff & Windhorn, 2008). Jurists with special aviation knowledge use the general term "air law". Other people prefer the term "aviation law" to avoid misunderstandings with environmental protection.

The most common definition of air law can be quoted as follows: "Air law is the entirety of legal special standards which refer to the utilization of the space above the earth's surface which is filled with air by means of devices which remain in the airspace by virtue of the properties of air, and whose subordinate position in the special standards of air law seems necessary according to a reasonable point of view of traffic" (Meyer, 1961).

The qualification of air law is controversial. A distinction has to be made between air law and space law. The border line could be drawn at about 100 km above mean sea level (called Kaman Line), where the aerodynamic forces lose their effects (Brinkhoff & Windhorn, 2008). Air law is classified as private air law and public air traffic law. Therefore, air law is a mixed law subject. The private air law regulates above all matters of civil liability and insurance, rights in aircraft, the utilisation of airports as well as questions concerning the neighbourly law in terms of emission. The public air traffic law primarily regulates the registration and the operation of aircraft and airports as well as the associated questions of security and local regularity policies.

Air law is shaped by international rules. Multilateral and bilateral conventions overrule national air law (derogation). Therefore, the national aviation authorities have few possibilities to influence the air law itself. The strict hierarchy of rules in the air law can be represented as follows (◘ Fig. 10.10):

The most important multilateral and bilateral conventions can be listed in chronological order as follows:

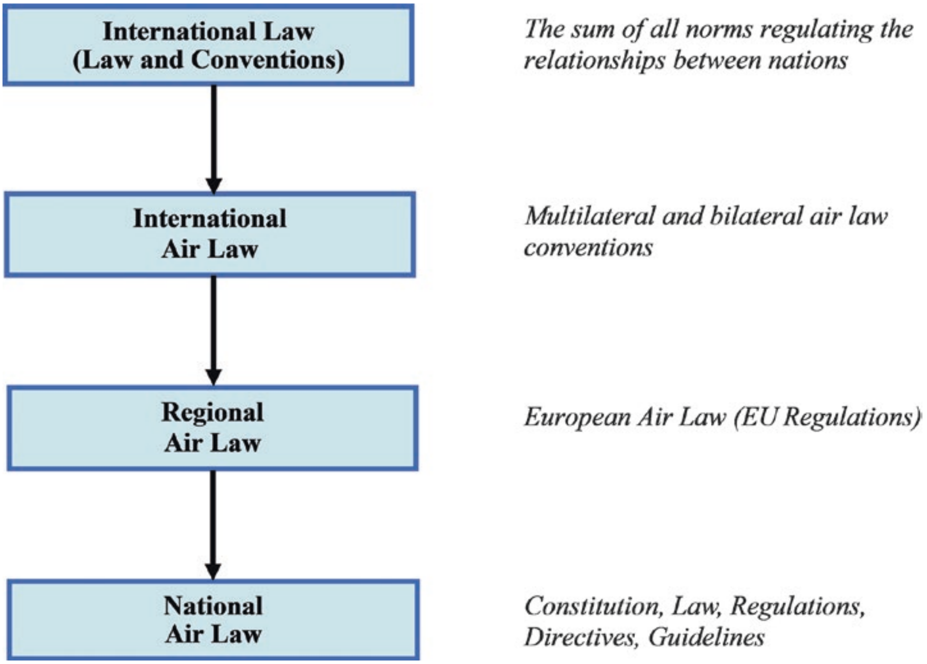


Fig. 10.10 Hierarchy of rules in the air law. (Müller, 2020)

- International conventions under public law.
  - 1919 CINA – with prohibition of cabotage
  - 1944 Convention of Chicago (ICAO foundation)
  - 1945 IATA Convention (190 airlines)
  - 1960 Euro Control Convention (above 7600 m).
- Conventions in the international private air traffic.
  - 1929 Warsaw Convention (limitation on liability)
  - 1975 Protocols of Montreal (special drawing rights)
  - 1997 EG-VO 2027/97 (commercially unrestricted liability)
  - 1999 Montreal Convention for the Unification of Certain Rules for International Carriage by Air (compulsory insurance for passenger seats).

10.5.2 Structure of the Airspace

Even in the skies, freedom is not boundless. Especially in the vicinity of airports or on densely occupied airways, air traffic is so dense that traffic regulations are of utmost importance. With the introduction of the Chicago Convention, and Annex 2 in particular, binding traffic regulations were set for civil aviation for the first time. Switzerland has adopted and partly even refined these regulations in the Rules of the Air.

Unlike in road traffic, in aviation the third dimension, that is, the vertical expansion, also needs to be taken into account with regard to all regulations. Therefore, for pilots it is very important to be informed about the airspace structure and the traffic regulations. Violations of relevant regulations may be sanctioned just like driving a car on the wrong side of the road.

The airspace above a certain state territory is precisely defined in terms of its lateral boundaries by the territory's national frontiers. In terms of altitude, it only ranges as far as the state can claim a legitimate interest. The upper airspace is the area above 7500 m AMSL or FL 200 in which only fixed-wing aircraft can fly. Special regulations and control apply in this area. The lower airspace, however, is also structured. In general, two different types of classification apply:

- Classification of the airspace according to classes with the same terms of use.
- Classification of the airspace according to types with the same function.

ICAO has combined both possibilities of distinction and Switzerland has adopted this classification system. The next paragraphs will first consider the different airspace classes followed by a discussion of the different types of airspace.

In total, ICAO has defined seven airspace classes which are referred to using a letter designation from “A” to “G”. Classes “A” to “E” are controlled airspace. Classes “F” and “G” are uncontrolled airspace. Class A represents the most restricted class – no visual flights are permitted. Class G, in contrast, allows for the maximum degree of freedom; flights may be conducted without radio or transponders. In principle, the airspace classes may be characterised as follows:

Class A: – All operations must be conducted under instrument flight rules (IFR) and are subject to ATC clearances and instructions. ATC separation is provided to all aircraft.

Class B: – Operations may be conducted under IFR, special visual flight rules (SVFR), or visual flight rules (VFR). However, all aircraft are subject to ATC clearances and instructions. ATC separation is provided to all aircraft. Note: Not all airports that are subject to class B airspace allow (SVFR) special visual flight rules.

Class C: – Operations may be conducted under IFR, SVFR or VFR; however, all aircraft are subject to ATC clearances and instructions. ATC separation is provided to all aircraft operating under IFR or SVFR and, as necessary, to any aircraft operating under VFR when any aircraft operating under IFR is involved. All VFR operations will be provided with safety alerts and, upon request, conflict resolution instructions.

Class D: – Operations may be conducted under IFR, SVFR or VFR; however, all aircraft are subject to ATC clearances and instructions. ATC separation is provided to aircraft operating under IFR or SVFR only. All traffic will receive safety alerts and, on pilot request, conflict resolution instructions.

Class E: – Operations may be conducted under IFR, SVFR or VFR. ATC separation is provided only to aircraft operating under IFR and SVFR within a surface area. As far as practical, ATC may provide safety alerts to aircraft operating under VFR.

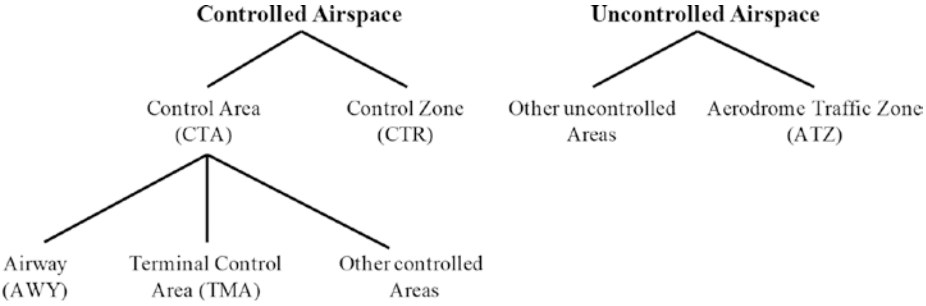


Fig. 10.11 Types of airspaces. (Müller, 2020)

Class F: – Operations may be conducted under IFR or VFR. ATC separation will be provided, so far as practical, to aircraft operating under IFR.

Class G: – Operations may be conducted under IFR or VFR. ATC separation is not provided.

While Switzerland has adopted all seven airspace classes into its aviation law, only four are currently being applied, namely G, E, D and C. Other countries have limited the use of the airspace classes even further. Italy, for example, only uses classes A and G. These airspace classes are generally not altitude dependent, meaning that airspace of the classes C, D or E can also extend to the ground for example in case of control zones (CTR).

Besides being classified according to classes with the same terms of use, airspace can also be divided according to its function into so-called airspace types. Generally, a distinction is made between uncontrolled and controlled airspaces (Fig. 10.11):

Control zones always extend from the ground and reach to a specified altitude. In Switzerland, they are principally classified as airspace classes D or C and, therefore, require ATC clearance. All Swiss airports that offer air traffic management are protected by a control zone. The only exception is Samedan which has no control zone but a flight information zone (FIZ), a classification of airspace unknown by ICAO. In order to protect aircraft landing and taking-off the aerodrome traffic zone (ATZ) is normally not a controlled airspace. An ATZ is only a controlled airspace if it is located within a CTR. The control area (CTA) is the generic term for the whole airspace comprising TMA, AWY and the rest of the controlled airspace, but not including the CTR. Thus, the airspace types may, for example, have the following configuration (Fig. 10.12):

10.5.3 Rules of Circulation in the Air

The third chapter of the Rules of the Air (RAC) includes numerous general provisions in articles 6 to 37 which will be discussed in the following. The fundamental principle is included in article 6. It states that a third party's life or property must

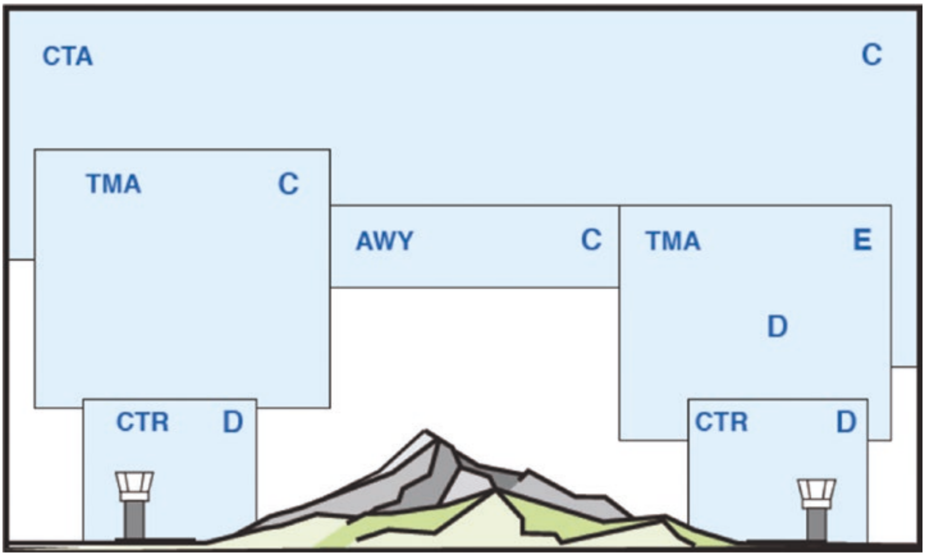


Fig. 10.12 Airspace types. (Müller, 2020)

never be put at risk. This principle does, for instance, also apply for hang gliders and model aircraft. Should a collision occur between such aircraft, at least one of the two pilots has undoubtedly breached this provision.

The RAC provisions of the ICAO were adopted by the European Union largely unchanged in Commission Regulation (EU) No 923/2012. This regulation is abbreviated SERA (standard European rules of the air). Switzerland has also transposed this regulation unchanged into its national law (Müller, 2020).

Anyone who feels ill, tired or is under the influence of narcotics, alcohol, medication, drugs, etc., and therefore is functionally impaired may neither work as a crew member on an aircraft nor perform parachute jumps.

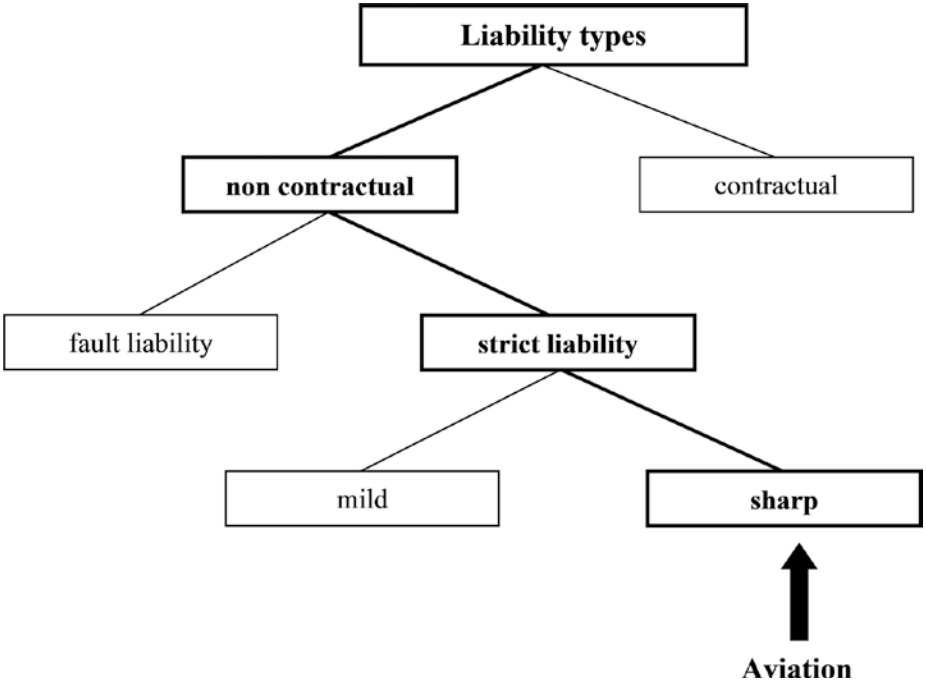
In case the pilot has no way of checking the latest weather information – for whatever reason (e.g. lack of time, lack of access to phone) – he must not undertake a flight leaving the area of the airfield. Moreover, provision has to be made for an alternative airport which must be open. In contrast to commercial aviation that requires fuel supplies which are sufficient for 45 minutes for piston aircraft and 30 minutes for jet aircraft, article 8 of the Rules of the Air just states that pilots need to provide for enough fuel supplies. If a private pilot needs to make an emergency landing due to lack of fuel, he has clearly breached this regulation, since he has to consider headwinds, traffic diversion, etc., as well.

Flights below flight level 100 may not exceed an airspeed of 460 km/h (250 kt) IAS without prior permission by the Federal Office or the appropriate air traffic services unit. Aircraft that need to fly at a higher speed due to their performance data have to maintain the lowest possible speed in accordance with the respective flight condition; the relevant air traffic services unit has to be informed by the pilot in command about this.

For flights conducted under visual flight rules, aviation law does not specify concrete measurable minimum distances in regard to approaching other aircraft. Both on the ground and in the sky aircraft always change their direction to the right to avoid collision. For flights conducted under instrument flight rules air traffic control ensures that there is sufficient distance between aircraft by staggering the air traffic. A threat of collision must not exist at any time. The aircraft size or the type of its use (e.g. military or commercial aircraft) does not influence the right of way. However, it is reasonable that smaller aircraft dodge larger and faster aircraft. At visual flight an aircraft may conduct rolling motions (about its longitudinal axis) to indicate that it has noticed another aircraft. In Switzerland, the rules on distance and right of way are stated in the Rules of the Air and the Aeronautical Information Publication (AIP) as regulations for the prevention of collisions.

10.5.4 Liability and Insurance in Air Law

In principle, air travel is a safe means of transport and in relation to the kilometres travelled, it causes relatively few damages. In case of an accident involving an aircraft, however, normally questions related to liability and insurance become relevant at once. To answer these questions, first the different types of liability and the consequences for aviation need to be understood (▪ Fig. 10.13).



▪ **Fig. 10.13** Liability types. (Müller, 2020)

The operation of aircraft is subject to strict liability. Even the commissioning of an aircraft alone is considered as an induction of a dangerous situation, like it is also the case with motor vehicles. Independently of any fault, the holder of the aircraft is therefore liable for personal injury or material damage which has been caused to a third party by the aircraft. In this context, the holder of the aircraft is deemed to be the operator. The operator does not have to be identical to the owner (e.g. a bank or an industrialist) or the pilot (pilot in command).

Similarly, the holder of an animal is also subject to strict liability, but he is subject to a so-called mild liability for the consequences. This means that the holder of the animal is not liable, if he can prove that he has taken all reasonable measures to avoid any damage (e.g. providing information about a dangerous dog on a sign at the garden gate). As has been stated, regarding the operation of aircraft, however, strict liability applies. This implies that even if the holder of the aircraft has taken all possible precautions and is therefore not at fault, he is still liable for damages to third parties on the ground.

Third parties on the ground who have suffered damage usually do not have a contract of any kind with the holder of the aircraft and thus the non-contractual liability, that is, the strict liability generally applies. If student pilots, passengers or freight are being transported, a contractual relationship exists. In this case, the liability has to be assessed quite differently. The pilot is liable when flying for private purposes, the airline company is liable for commercial flights and the flight school for training flights. At the same time, it is now of major importance, with regard to liability, who bears the responsibility for the damage. Therefore, the contractual relationship will be discussed in more detail in the following paragraphs. In cases of contractual liability, the damage and fault (slight negligence is sufficient) have to be established. Furthermore, the correlation between damage and fault has to be proven. It is possible to exclude, through contractual agreement, liability for damages caused by slight negligence, but not for damages caused by gross negligence or deliberate act.

Depending on the type of flight, the aggrieved party may take action against different persons or companies. In contrast to road traffic, though, it is not possible that the aggrieved party sues the relevant insurance company directly. In the following, only those cases that are relevant for future private pilots will be discussed. Commercial flight, where the liability of the airline is most important, is therefore not considered. As for training flights, based on the service contract student pilots may take action against the flight school, but not against the insurance directly. It is up to the flight school to claim the insurance benefits. If the flight instructor has caused the accident by violating his obligation of due diligence that he has under labour law, the flight school may also take recourse action against the flight instructor. In connection with this, it has to be recognised that the activity of a flight instructor is a job prone to causing damage. This means that only in the case of recurrence, slight negligence will lead to liability. The student pilot may only take action against the instructor or the manufacturer of the aircraft on the basis of non-contractual liability; however, in this case he would have to verify, among other things, the fault of the instructor or the manufacturer, respectively.

As for private flights, the issue of liability is comparable to that of training flights, but generally an additional distinction has to be made between the holder and the owner. The owner is usually covered by comprehensive insurance, so that he can, on his part, make an insurance claim.

As stated in article 125 of the Aviation Ordinance, the holder of the aircraft has to provide a guarantee that he is able to meet possible liability claims by an aggrieved party on the ground. Almost always this guarantee is provided through liability insurance. Thus, de facto a statutory insurance obligation exists for the holder of the aircraft for such damages. Article 132a of the Aviation Ordinance provides for a further guarantee by the aircraft holder: he has to ensure 250,000 Special Drawing Rights per passenger for potential liability claims from travellers. For non-commercially used aircraft the Special Drawing Rights may be reduced to a number of 100,000, if the take-off weight does not exceed 2700 kg. For damages to the aircraft itself, no statutory insurance obligation exists, but a comprehensive insurance, covering this sort of damages, may be arranged by the holder of the aircraft on a voluntary basis. Charterers of an aircraft should obtain information about what sort of comprehensive insurance is in place before using a hired aircraft. If a charterer returns a damaged aircraft, he has to cover the damage himself or, if a comprehensive insurance is in place, pay the deductible, the loss of bonus and the operating losses that result from the standstill of the aircraft, unless another agreement has been made.

10.5.5 Passenger Rights

The EC-Regulation No 261/2004 of the European Parliament and of the Council, dated 11 February 2004 has established common rules on compensation and assistance to passengers in the event of denied boarding and of cancellation or long delay of flights. These rights can be divided into four categories:

- Denied boarding.
- Cancellation.
- Delay.
- Other demands (not treated in the EC-Regulation 261/2004).

In the first three cases, the operating air carrier shall immediately compensate the passengers as follows:

(a) EUR 250 for all flights of 1500 kilometres or less.
(b) EUR 400 for all intra-community flights of more than 1500 kilometres, and for all other flights between 1500 and 3500 kilometres.
(c) EUR 600 for all flights not falling under (a) or (b).

The compensation shall be paid in cash, by electronic bank transfer, bank orders or bank cheques or, with the signed agreement of the passenger, in travel vouchers and/or other services. The distances shall be measured by the great circle route method.

According to the exact wording of EC-Regulation 261/2004, an air transport company would actually only have to pay compensation in the event of denied boarding. However, on 19 November 2009, the European Court of Justice ruled in cases C-402/07 and C-432/07 of the Sturgeon family as plaintiffs against Condor Flugdienst GmbH that, in an analogous interpretation of the regulations, compensation is owed not only in the event of cancellation, but also in the event of a delay of more than 3 hours. However, this Sturgeon case law has not yet been recognised by Switzerland; in any case, the Bülach District Court rejected a corresponding claim on 2 February 2016 (Hempel, 2016).

According to Art. 5 Para. 3 of the EC-Regulation 261/2004 an operating air carrier shall not be obliged to pay compensation, if it can prove that the cancellation is caused by extraordinary circumstances which could not have been avoided, even if all reasonable measures had been taken. In the meantime, there is extensive court practice on this provision, as the following case shows as an example.

Mini Case: Judgement of the European Court of Justice (Third Chamber) 4 May 2017

(Case C-315/15, Marcela Pešková and Jiří Peška vs. Travel Service a.s., published by ► http://curia.europa.eu/)

The applicants in the main proceedings booked a flight from Burgas (Bulgaria) to Ostrava (Czech Republic) with Travel Service. That flight was carried out on 10 August 2013 with an arrival delay of 5 hours and 20 minutes. That flight formed part of the following scheduled routing: Prague — Burgas — Brno (Czech Republic) — Burgas — Ostrava. During the flight from Prague to Burgas, a technical failure in a valve was found. Its repair took 1 hour and 45 minutes. During the landing of the flight from Burgas to Brno, according to Travel Service, the aircraft collided with a bird and so the aircraft was subject to checks, although no damage was found. Nonetheless, a Travel Service technician was taken by private aircraft from Slaný (Czech Republic) to Brno to put the aircraft back in operation. He was told by the aircraft's crew that the checks had already been performed by another firm but its authorisation to carry out the checks was not accepted by Sunwing, the owner of the aircraft. Travel Service once again checked the point of impact, which had earlier been cleaned, and found no traces on the engines or other parts of the aircraft. The aircraft then flew from Brno to Burgas, then from Burgas to Ostrava, the flight taken by the applicants.

By application lodged on 26 November 2013 at the Obvodní soud pro Prahu 6 (Prague 6 District Court), the applicants in the main proceedings each claimed payment of a sum of around CZK 6825 (6825 Czech Crowns, approximately EUR 250) under Article 7(1)(a) of Regulation No 261/2004. By decision of 22 May 2014, that court upheld their claim on the ground that the facts of the case could not be considered 'extraordinary circumstances' within the meaning of Article 5(3) of that regulation since the choice of procedure to return an aircraft to service following a technical problem, such as a collision with a bird, lay with Travel Service. In that regard, the Obvodní soud pro Prahu 6 (Prague 6 District Court) added that Travel Service had not established that it had done all it could to prevent a delay to the flight, since it merely stated that ‘it was necessary’ after the aircraft suffered the collision with a bird to wait for the arrival of the authorised technician.

On 18 August 2014, Travel Service appealed to the Ústavní soud (Constitutional Court, Czech Republic) against the decision of the Obvodní soud pro Prahu 6 (Prague 6 District Court) of 22 May 2014. By decision of 20 November 2014, the Ústavní soud (Constitutional Court) upheld the appeal and set aside the decision of the Obvodní soud pro Prahu 6 (Prague 6 District Court) on the ground that it had infringed Travel Service’s fundamental right to a fair hearing and the fundamental right to a hearing before the proper statutory court. As a court of last instance, it was required to refer a question for a preliminary ruling to the Court under Article 267 TFEU, given that the answer to the question of whether the collision of an aircraft with a bird, combined with other technical difficulties, should be classified as ‘extraordinary circumstances’ within the meaning of Article 5(3) of Regulation No 261/2004 was not clear from either that regulation or the Court’s case-law.

In those circumstances, the Obvodní soud pro Prahu 6 (Prague 6 District Court) decided to stay the proceedings and to refer the following questions (below in a shortened version) to the Court of Justice for a preliminary ruling:

1. Is a collision between an aircraft and a bird an event within normal operation or does it constitute extraordinary circumstances?
2. If the collision between an aircraft and a bird constitutes extraordinary circumstances, may preventative control systems established around airports (such as sonic bird deterrents, cooperation with ornithologists, the elimination of spaces where birds typically gather or fly, using light as a deterrent and so on) be considered to be reasonable measures to be taken by the air carrier to avoid such a collision?
3. If a collision between an aircraft and a bird is an event within normal operation, may it also be considered to be an event with the obligation to inform passengers of their rights?
4. If the body of technical and administrative measures taken following a collision between an aircraft and a bird, which nevertheless did not result in damage to the aircraft, constitutes exceptional circumstances with the obligation to inform passengers of their rights, is it permissible to require, as reasonable measures, the air carrier to take into consideration, when it schedules flights, the risk that it will be necessary to take such technical and administrative measures following a collision between an aircraft and a bird and to make provision for that fact in the flight schedule?
5. How must the obligation on the air carrier to pay compensation be assessed where the delay is caused not only by administrative and technical measures adopted following a collision between the aircraft and a bird, which did not result in damage to the aircraft, but also to a significant extent by repairing a technical problem unconnected with that collision?

The European Court of Justice made the following consideration of the questions referred, recognised the existence of extraordinary circumstances and therefore denied Travel Service's obligation to pay compensation to the passengers of the delayed flight (below in a shortened version):

The First Question

It is clear from the Court's case-law that the premature failure of certain parts of an aircraft does not constitute extraordinary circumstances, since such a breakdown remains intrinsically linked to the operating system of the aircraft. That unexpected event is not outside the actual control of the air carrier, since it is required to ensure the maintenance and proper functioning of the aircraft it operates for the purposes of its business. In the present case, a collision between an aircraft and a bird, as well as any damage caused by that collision, since they are not intrinsically linked to the operating system of the aircraft, are not by their nature or origin inherent in the normal exercise of the activity of the air carrier concerned and are outside its actual control. Accordingly, that collision must be classified as 'extraordinary circumstances'.

The Second Question

An air carrier is to be released from its obligation to pay passengers compensation if the carrier can prove that the cancellation or delay of 3 hours or more is caused by extraordinary circumstances, which could not have been avoided even if all reasonable measures had been taken. Since not all extraordinary circumstances confer exemption, the onus is on the air carrier seeking to rely on them to establish that they could not, on any view, have been avoided by measures appropriate to the situation, that is to say, by measures which, at the time those extraordinary circumstances arise, meet, inter alia, conditions which are technically and economically viable for the air carrier concerned. Thus, the Court therefore established an individualised and flexible concept of 'reasonable measures', leaving to the national court the task of assessing whether, in the circumstances of the particular case, the air carrier could be regarded as having taken measures appropriate to the situation. The answer to the second question is that Article 5 of Regulation No 261/2004, must be interpreted as meaning that the 'reasonable measures', which an air carrier must take in order to reduce or even prevent the risks of collision with a bird and thus be released from its obligation to compensate passengers, include control measures preventing the presence of such birds. This is only the case provided that, in particular at the technical and administrative levels, such measures can actually be taken by that air carrier, that those measures do not require it to make intolerable sacrifices in the light of the capacities of its undertaking and that that carrier has shown that those measures were actually in effect when the flight was affected by the collision with a bird. It is for the referring court to satisfy itself that those conditions have been met.

The Third Question

It is clear from the order for reference that, following a collision with a bird, the aircraft concerned, operated by Travel Service, underwent a safety check after landing. It was carried out by an authorised firm without any damage being found on the aircraft. In that regard, it must be noted that it is for the air carrier, faced with extraordinary circumstances such as the collision of its aircraft with a bird, to adopt measures appropriate to the situation, thereby deploying all its resources in terms of staff or equipment and the financial means at its disposal in order to avoid, as far as possible, the cancellation or delay of its flights. Furthermore, and insofar as it is apparent from the order for reference that the owner of the aircraft had refused to recognise the authorisation of the local firm which carried out the check of the aircraft concerned, it must be recalled that the obligations fulfilled by air carriers under Regulation No 261/2004 are so fulfilled without prejudice to that carrier's right to seek compensation from any person who caused the delay, including third parties, as provided for in Article 13 of that regulation. Such compensation may accordingly reduce or even remove the financial burden borne by carriers in consequence of those obligations (judgment of 17 September 2015, van der Lans, C-257/14, EU:C:2015:618, paragraph 46 and the case-law cited). Having regard to the foregoing considerations, the answer to the third question is that Article 5(3) of Regulation No 261/2004, read in the light of recital 14 thereof, must be interpreted as meaning that cancellation or delay of a flight is not due to extraordinary circumstances when that cancellation or delay is the result of the use by the air carrier of an expert of its choice to carry out fresh safety checks necessitated by a collision with a bird, after those checks have already been carried out by an expert authorised under the applicable rules. By its second question, the referring court asks, in essence, whether Article 5(3) of Regulation No 261/2004, read in the light of recital 14 thereof, must be interpreted as meaning that the 'reasonable measures' which an air carrier must take in order to reduce or even prevent the risks of collision with a bird and thus be released from its obligation to compensate passengers under Article 7 of that regulation, include control measures preventing the presence of such birds. The referring court cites, as examples, sonic or light bird deterrents, cooperation with ornithologists or the elimination of spaces where birds typically gather or fly. Other technical devices typically fitted on board aircraft were, furthermore, referred to during the hearing before the Court. It is also apparent from the order for reference and the arguments in front of the Court that anti-bird control measures could be the responsibility of various air transport operators, who are, inter alia, the air carriers, airport managers or even the Member States' air traffic controllers. It is in that context that the second question must be answered. As is apparent from Article 5(3) of Regulation No 261/2004, read in conjunction with recital 7 thereof, the reasonable measures which must be taken in order to avoid the delay or cancellation of flights are the responsibility of the air carrier itself. It follows therefrom that, in order to assess whether an air carrier has actually taken the necessary preventative measures in order to reduce and even prevent the risks of any collisions with birds enabling it to be released from its obligation of compensating passengers under Article 7 of that regulation, only those measures which can actually be its responsibility must be taken into account, excluding those which are the responsibility of other parties, such as, inter alia, airport managers or the competent air traffic controllers. Thus, in the context of the individual examination, which it must carry out in accordance with the case-law referred to in paragraph 30 of this judgment, the national court must, first of all, assess whether, in particular at the technical and administrative levels, the air carrier concerned was, in circumstances such as those in the main proceedings, actually in a position to take, directly or indirectly, preventative measures likely to reduce and even prevent the risks of possible collisions with birds. If it is not, the air carrier is not required to compensate the passengers under Article 7 of Regulation No 261/2004. If such measures could actually be taken by the air carrier concerned, it is for the national court, next, in accordance with the case-law recalled in paragraph 29 of this judgment, to ensure that the measures concerned did not require it to make intolerable sacrifices in the light of the capacities of its undertaking. Finally, if such measures could be taken by the air carrier concerned without making intolerable sacrifices in the light of the capacities of its undertaking, it is for that carrier to show that those measures were actually taken as regards the flight affected by the collision with a bird.

The Fourth Question

In the present case, it must be noted that it does not at all emerge from the description of the facts of the main proceedings made by the referring court that the delay, equal to or in excess of 3 hours in arrival of the flight at issue, could have been caused by any failure on the part of the air carrier concerned to provide for sufficient reserve time for the required safety checks to be made. In a situation, such as that at issue in the main proceedings, where a delay equal to or in excess of 3 hours in arrival is caused not only by extraordinary circumstances but also by another event falling outside that category, it is for the national court to determine whether, with regard to that part of the delay which the air carrier claims is caused by extraordinary circumstances, that carrier has proved that that part of the delay was due to extraordinary circumstances and could not have been avoided, even if all reasonable measures had been taken. And in respect of which, all reasonable measures had been taken by that carrier to avoid the consequences thereof. If so, that court must deduct the delay caused by those extraordinary circumstances from the total length of the delay in arrival of that flight. Therefore, there is no need to answer the fourth question.

The Fifth Question

In order to assess in such a situation whether compensation in respect of the delay in arrival of that flight must be paid, the national court must take into consideration only the delay due to the event which was not part of the extraordinary circumstances, in respect of which compensation can be paid only if it is equal to or in excess of 3 hours in arrival of the flight concerned. Giving regard to all the foregoing considerations, the answer to the fifth question is that in the event of a delay to a flight equal to or in excess of 3 hours in arrival caused not only by extraordinary circumstances, which could not have been avoided by measures appropriate to the situation and which was subject to all reasonable measures by the air carrier to avoid the consequences thereof, but also in other circumstances not in that category, the delay caused by the first event must be deducted from the total length of the delay in arrival of the flight concerned in order to assess whether compensation for the delay in arrival of that flight must be paid as provided for in Article 7 of that regulation.

Review Questions

- What are the most important international and supranational aviation organisations?
- How can the nine freedoms of the air be described?
- What does the Chicago Convention and its annexes regulate?
- Which are the two different possibilities to classify the airspace?
- How many classes of airspace has the ICAO defined?
- What are controlled and uncontrolled airspaces?
- What are the most important rules of circulation in the air?
- How can the aviation liability be defined in the system of liability types?
- What are the passenger rights in aviation in accordance with the EC-Regulation?
- When does an air carrier not have to pay compensation to passengers in the event of a delay?

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11

The Holy Grail of Aviation: Risk, Safety and Security

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Contents

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Summary

- Risk, safety and security are inescapable structural conditions of air transportation.
- Risk is multidimensional and perceived differently by air passengers.
- Measures of aviation safety and security are set up at global, regional and local levels.
- New approaches in aviation integrate all management systems dealing with risk, safety and security.
- According to ICAO Annex 19, all relevant players in the aviation industry have to implement a safety management system (SMS).
- In order to optimise safety and security, not only an SMS is needed, but also a corresponding safety culture.

Risk, safety and security are vital structural conditions to conduct safe and smooth air transportation. The concept of risk is multidimensional and its perception differs among passengers. To ensure the safety and security in aviation, measures are set up on global, regional and local scales. This chapter presents new approaches in the aviation system that manage risk, safety and security. On a regulatory level, safety management systems (SMS) are mandated by ICAO for all players within the aviation industry. However, an SMS needs to be accompanied by a safety culture that embraces the values needed for the SMS to succeed in identifying and rectifying problems. Therefore, important aspects surrounding an encouraging safety culture need to be considered.

11.1 Introduction

> Every technology produces, provokes, programs a specific accident […]. The invention of the boat was the invention of shipwrecks. The invention of the steam engine and the locomotive was the invention of derailments. The invention of the highway was the invention of three hundred cars colliding in five minutes. The invention of the airplane was the invention of the plane crash. (Virilio & Lotringer, 1983, p. 32)

Since the brothers Orville and Wilbur Wright pioneered the age of powered flight on 17 December 1903, the airline industry has expanded rapidly and is now approaching more than 2 billion passengers per year. For the future, the IATA passenger forecast for 2019–2039 estimates a worldwide average annual growth of 3.7% (IATA, 2020a). At the same time IATA (2020b) noticed a downward trend in hull losses per million sectors with the number dropping from 0.18 in 2018 to 0.15 in 2019. Similarly, the National Transportation Safety Board (2020) reports a drop in the fatal accident rate of 0.030 per 100,000 flight hours for all commercial airline operations in the period between 1983 and 2000 to 0.016 in the period between 2001 and 2017. In other words, risk, safety and security have become an inescapable structural condition of air travel that is often expressed in a statistical calculation. In doing so, probability expresses a tendency for a system failure to occur which applies equally to the whole population. However, as it is the application of a ratio that is essentially a binary condition, it must always be wrong for any particular case. For example, 100 aircraft are about to depart, and it has been computed that each aircraft has a 99% chance of arriving safely. But, in practice, each plane will either arrive safely or it will not, i.e. in any individual case such a ratio has no rational meaning. If 99 aircraft arrive safely and one crashes, then for the 99 safe arrivals the prediction is too pessimistic but for the one that crashed it is too optimistic. For a passenger considering a flight in one of those aircraft, the significant consideration is not the probability, but if it will arrive safely (Jackson & Carter, 1992). Therefore, this chapter initially discusses the risk perceived by passengers and then highlights safety and security measures of the aviation industry.

11.2 Risk

Psychological research suggests that people tend to overestimate risks that can be characterised as unknown compared to those risks which are obvious, involuntary and uncontrollable and are certain to cause fear (Slovic et al., 2000). Ironically, due to the psychological impact of aircraft disasters, flying represents a life-or-death decision for many people, yet a recent study showed that the vast majority of aircraft accidents are survivable (NTSB, 2001). Therefore, not surprisingly, people estimate commercial air travel to be up to five times riskier than the statistical fatalities suggest (Greco, 1989). The overestimation of negative outcomes is an occurrence commonly found in people who are fearful of a certain object or situation (Hengen & Alpers, 2019) (◘ Table 11.1).

Accordingly, Bauer introduced the term risk to the scientific discussion and contended that "consumer behavior involves risk in the sense that any action of a consumer will produce consequences which he cannot anticipate with anything approaching certainty, and some of which at least are likely to be unpleasant" (Bauer, 1960, p. 390). The consideration of subjectivity leads to a definition of perceived risk: "...the amount that would be lost (i.e., that which is at stake) if the consequences of an act were not favorable, and the individual's subjective feeling of certainty that the consequences will be unfavorable" (Cunningham, 1967, p. 37). Thus, perceived risk is conceptualised on losses, significance and uncertainty (Yates & Stone, 1992) where the amount of loss is proportional to the degree of mismatch between the required outcome and the attained reference outcome on a particular attribute. This amount can be converted into risk perception by taking into account the probability of the attribute failing to meet the required outcome and the significance of the attribute. Finally, a multiplicative combination of the significance and uncertainty of each loss determines perceived value. This conceptualisation of perceived risk in empirical research has become standardised as a multidimensional construct that includes financial, functional, physical, psychological, social and temporal losses. These loss components have been adapted to the context of air travel and tested empirically (Boksberger et al., 2007):

Table 11.1 Comparative risk of air travel in 2018 within the EU28 territory

Mode of transport and situation	Fatalities $^{+}$(annual average 2010–2018)	Fatality rate *(persons killed per billion passenger-kilometres) **(persons killed per 100,000 in employment)	Comparative risk of air travel in Europe (EU28 Territory)
Air	18 $^{+}$	0.03 *	n.a.
Bus and coach	93	0.20 *	6.7 times riskier
Passenger cars	11,230	2.65 *	88.3 times riskier
Moped and motorcycle	4498	41.61 *	1387 times riskier
Rail	16	0.39 *	13 times riskier
Sea	4	0.17 *	5.6 times riskier
Working on the job	3581	1.63 **	54.3 times riskier

Table compiled by author based on European Commission, 2020; Eurostat, 2011–2019, 2012–2019

- Financial risk represents the perceived likelihood of not getting the best value for money resulting from an overpriced ticket and/or due to a service replacement. In general, it is the risk that the service purchased may not be worth the money paid for it.
- Functional risk is the perceived likelihood of a service failure (minor fatality) and/or an inferior service performance (quality) responsible that a passenger will not attain the best possible benefit or utility.
- Physical risk is the probability that due to a service failure (major fatality) or through the physical and environmental circumstances of flying (reduced oxygen pressure and air humidity), the passenger is injured or harmed.
- Psychological risk is the likelihood of embarrassment or the loss of self-esteem resulting from a flying experience. Furthermore, it is the risk of a negative effect on the passenger’s peace of mind or self-perception resulting from difficulties between airline passengers.
- Social risk is the probability that an image or a reputation of the chosen airline adversely affects the way others think about the passenger.
- Temporal risk represents the time loss associated with a service failure and/or the extra effort getting the failure adjusted, repaired or replaced. In other words, the likelihood of time loss during check-in, time loss due to inconvenient schedule, delays, etc.

Based on a structured self-administered questionnaire 1177 data sets were collected online. To ensure that respondents were familiar with the context, they were asked to rate each item considering their last flight and the airline that provided this flight. 889 valid responses were received. 43.8% of respondents were female and 56.2% male. The mean age of respondents was 31 years, with a standard deviation of 8.6 years. The passenger profile of respondents shows that about two thirds of respondents had undertaken 1–5 airline trips in the last 12 months with the main reasons for travelling being business (22.5%) and leisure (77.5%) (Boksberger et al., 2007).

▣ Table 11.2 presents the average importance and probability ratings for the six perceived losses. All importance scores of the perceived components were above the indifference threshold of four. This indicates that respondents considered these perceived risk dimensions (i.e. perceived losses) important to some degree. Perceived financial risk was considered most important by respondents, whereas perceived social risk was considered least important. When comparing the average probability rating of each perceived risk component, it becomes evident that all mean scores are in a small range between 2.16 and 3.24 (▣ Table 11.2). Even though this result indicates that respondents consider air travel being a relatively safe and secure mode of transport, it may also support the findings of cognitive dissonance theory. The latter explains that due to passengers' high awareness of and concerns about risk in commercial air travel, they strive for cognitive equilibrium by marginalising the likelihood of a possible fatality after leaving the aircraft.

Bringing the two subcomponents (degree of importance and probability of perceived losses) into equation, the mean scores of the six perceived risk dimensions ranged from 8.94 to 18.06. These mean scores were ranked and tested for signifi-

▣ **Table 11.2** Importance, probability and mean score

	Average importance [a]	**Average probability** [b]	**Mean score** [c]
Financial risk	5.605	3.242	18.062 (1)
Functional risk	4.577	3.014	13.794 (3)
Physical risk	5.205	2.360	12.399 (5)
Psychological risk	4.585	2.753	12.605 (4)
Social risk	4.101	2.157	8.939 (6)
Temporal risk	4.975	3.122	15.730 (2)

Boksberger et al. (2007)

Note: [a] Total number of 880 respondents using listwise deletion

[b] Total number of 864 respondents using listwise deletion

[c] Total number of 855 respondents using listwise deletion

The rankings are in parentheses

cant difference from the indifference threshold of 16. Overall, perceived financial risk (t-value = 6.135, $\rho = 0.000$) ranked highest of all perceived risk components. Moreover, perceived financial risk was the only perceived risk component with an average score above the indifference threshold. Perceived temporal risk ranked second highest with a reported t-value of −0.834 which was non-significant at the 0.05 level. The bottom four perceived risk components, namely perceived functional risk (t-value = −8.380), perceived psychological risk (t-value = −13.206), perceived physical risk (t-value = 13.481) and perceived social risk (t-value = −31.568) were all significant at the 0.05 level. The relatively low score of perceived social risk supports the findings of Kaplan et al. (1974), who concluded that perceived psychological risk and perceived social risk are interrelated.

Linked to the definition of perceived risk the study reveals that passengers' risk assessment varies depending on socio-demographic characteristics. Women are more sensitive to the magnitude of perceived risk than men, for example; perception of risk increases with the age of the passengers; perceived risk is influenced by passengers' cultural background and perceived risk is negatively influenced by passengers' income. In addition to these socio-demographic characteristics, the findings propose that perceived risk is akin to people's experiences, buying goals and general risk-taking behaviour. The recovery of commercial air travel after the marked downturn at the time of the Gulf War in 1991 and 1986, followed by the terrorist attack of 11 September 2001 and the SARS epidemic, further implies that people are reaching alternative conclusions on perceived risk associated with flying, depending on the route and the airline (Floyd et al., 2003; Sönmez & Graefe, 1998). In the wake of perceived risk in air travel there are growing concerns about safety and security issues which will be addressed in the next sections.

The considerations above show that aviation is confronted with both operational risks and external risks, especially attacks by terrorists or cyber criminals. For this reason, not only international but also national authorities are placing a special focus on optimising safety and security.

11.3 Safety

11.3.1 Regulatory Arrangements and Requirements

In order to meet the requirements of aviation safety, a number of organisations and institutions have been set up at global, regional and local levels to develop common rules, regulations, standards and procedures regarding safety issues and to oversee their implementation in the airline industry. Over decades, the regulatory framework and safety requirements have been built up. They are continually being amended and enhanced to achieve an ever-increasing safety performance and to meet future challenges posed by the implementation of new air navigation concepts and the need to ensure sustainable development of civil aviation. Three basic layers of safety regulation can be distinguished, namely:

- International regulatory arrangements and requirements.
- National regulatory arrangements and requirements.
- Regional regulatory arrangements and requirements.

The International Civil Aviation Organization (ICAO) represents the major international organisation. Based on the Convention on International Civil Aviation (also known as the Chicago Convention), which was signed on 7 December 1944, and not only concerned the sovereignty of states and the right to fly, but also the obligation of states to provide infrastructure, safety and security, it sets forth the purpose of the ICAO (see ► Chap. 10.2.1): "[w]hereas … the future development of international civil aviation can greatly help to create and preserve friendship and understanding among the nations and peoples of the world, yet its abuse can become a threat to the general security; and whereas it is desirable to avoid friction and to promote that co-operation between nations and peoples upon which the peace of the world depends; therefore, the undersigned governments having agreed on certain principles and arrangements in order that international civil aviation may be developed in a safe and orderly manner and that international air transport services may be established on the basis of equality of opportunity and operated soundly and economically". The ICAO SARPS (Standards and Recommended Practices) state the standards expected and provide encouraged recommendations within 19 annexes. Even though the ICAO oversees the development of safety regulatory frameworks on regional and national levels, a considerable variation exists in the implementation of the international safety regulations.

For example, the Federal Aviation Agency (FAA) has adopted safety as its mission and holds, "[o]ur mission is to provide the safest, most efficient aerospace system in the world and our mantra is to improve the safety and efficiency of aviation, while being responsive to our customers and accountable to the public" (FAA, 2009). The compliance mandates released by the FAA impacts all business functions of the aviation industry – operationally and strategically. The European Aviation Safety Agency (2008) elaborated and prioritised the following issues concerning aviation safety:

1. Ground safety.
2. Runway safety.
3. Safety management system (SMS) and safety culture.
4. Flight crew performance.
5. Loss of control (general).
6. Approach and landing.
7. Aviation system complexity.
8. Fire, smoke and fumes.
9. Air-ground communications.
10. Mid-air collision.
11. Controlled flight into terrain (CFIT).
12. Icing.
13. Bird strike.
14. Loss of control (weight and balance).
15. Air navigation.

16. Airworthiness (maintenance and design).
17. Maintenance.
18. Automation.

While by definition aviation safety refers to all efforts that are taken to ensure air travel is free from factors that may lead to injury or loss, it is rapidly becoming increasingly complex and difficult to allocate safety accountabilities and responsibilities. In order to ensure aviation safety, the safety responsibilities are cascaded down, defined clearly, documented comprehensively and are communicated between the regulator, the airline company and the operational unit.

Beside the enforcement of the international, regional and national regulatory arrangements and requirements, every regulator is required to carry out investigations into those air accidents that take place within their own territory. The sole purpose of these investigations is the prevention of aircraft accidents and therefore the improvement of aviation safety. In order to avoid conflicts with the fact that a supervisory authority might be involved in the actual root cause of an air accident, by issuing inappropriate regulations or by failing in its obligations, aircraft accident investigation bureaus are independent of aviation agencies (Ale et al., 2006; Moses & Savage, 1989).

Aviation safety requires airlines to have a method of measuring effectiveness and performance of maintenance and inspection. Moreover, it requires them to have internal evaluation programmes for continual monitoring of internal processes, programmes and procedures. Subsequently, the eight building blocks of safety management are presented (FAA, 2006):

1. Senior management's commitment to the management of safety.
2. Effective safety reporting.
3. Continuous monitoring through systems to collect, analyse and share safety-related data arising from normal operations.
4. Investigation of safety occurrences with the objective of identifying systemic safety deficiencies rather than assigning blame.
5. Sharing safety lessons learned and best practices through the active exchange of safety information.
6. Integration of safety training (including human factors) for operational personnel.
7. Effective implementation of standard operating procedures (SOPs), including the use of checklists and briefings.
8. Continuous improvement of the overall level of safety.

Judgment errors among operational units are well-documented and have contributed to numerous accidents, injuries and fatalities (NTSB, 2001). In general, the human factor is seen as the weakest link in aviation safety. Thus, crew resource management and line-orientated flight training have become standard procedures in the airline industry. The training involves a full mission simulation of situations which are representative of line operations, with special emphasis on situations that involve communications, management and leadership. A special focus is put

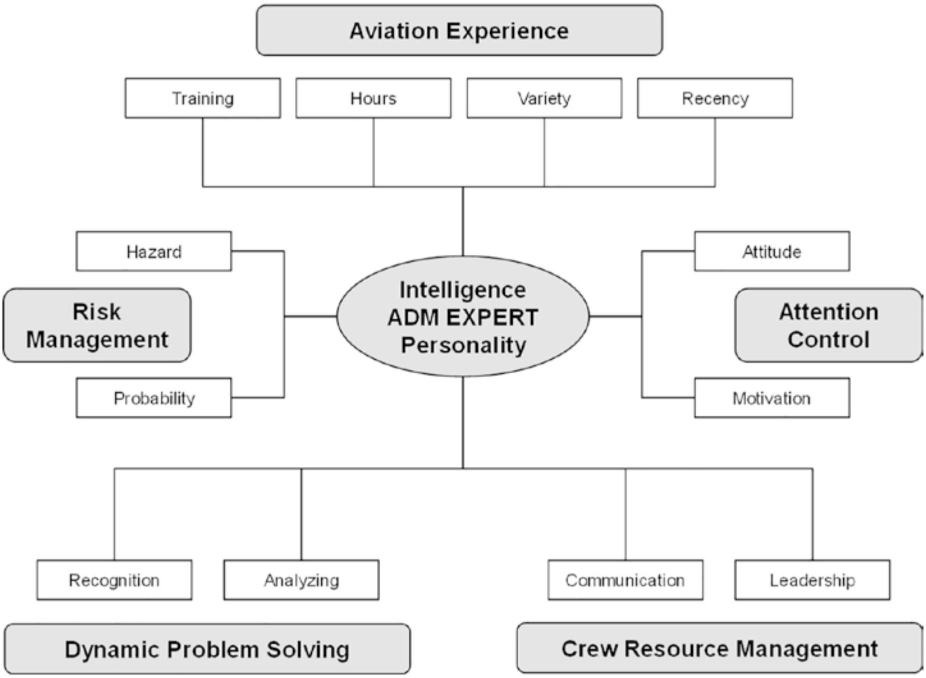

Fig. 11.1 Air traveller's decision making. (Author's own figure adapted from Jensen, 1997)

on aeronautical decision making (ADM), which can be characterised by decisions made under stress and involve ill-structured problems in which a flight crew must react quickly in a dynamic and uncertain environment (Jensen, 1997) (Fig. 11.1).

In summary, aviation safety by a large proportion depends on the geographical area, the age of the aircraft and the airline.

11.3.2 Safety Management System

A safety management system can be described as follows: (ICAO Annex 19 page 1–2)

- A systematic approach to managing safety, including the necessary organisational structures, accountabilities, policies and procedures.
- The objective of a safety management system is to provide a structured management approach to control safety risks in operations.
- Effective safety management must take into account the organisation's specific structures and processes related to safety of operations.

According to ICAO Annex 19 page 3–1 each state shall establish a state safety programme (SSP) for the management of safety in the state in order to achieve an acceptable level of safety performance in civil aviation. The SSP shall include the following components:

(a) State safety policy and objectives.
(b) State safety risk management.
(c) State safety assurance.
(d) State safety promotion.

All relevant players in the aviation industry have to implement an SMS according to ICAO Annex 19 page 4–1:

- An **aviation service provider** shall establish an SMS in accordance with the framework elements and be in accordance with the size of the company and the complexity of its aviation products or services.
- The SMS of an **approved training organisation** that is exposed to safety risks related to aircraft operations during the provision of its services shall be made acceptable to the state(s) responsible for the organisation's approval.
- The SMS of a **certified operator** of aeroplanes or helicopters authorised to conduct international commercial air transport shall be made acceptable to the state of the operator.
- The SMS of an **approved maintenance organisation** providing services to operators of aeroplanes or helicopters engaged in international commercial air transport shall be made acceptable to the state(s) responsible for the organisation's approval.
- The SMS of an organisation responsible for the type **design of aircraft** shall be made acceptable to the State of Design.
- The SMS of an organisation responsible for the **manufacture of aircraft** shall be made acceptable to the state of manufacture.
- The SMS of **an ATS provider** shall be made acceptable to the state responsible for the provider's designation.

The SMS should as a minimum include a process to identify actual and potential safety hazards and assess the associated risks, a process to develop and implement remedial action necessary to maintain an acceptable level of safety and provision for continuous monitoring and regular assessment of the appropriateness and effectiveness of safety management activities (ICAO Annex 19 page 4–1). The basis for the introduction of an SMS is the safety policy, which according to ICAO Annex 19 page 4–1 App. 2–2 should:

(a) Reflect organisational commitment regarding safety.
(b) Include a clear statement about the provision of the necessary resources for the implementation of the safety policy.
(c) Include safety reporting procedures.
(d) Clearly indicate which types of behaviours are unacceptable related to the service provider's aviation activities and include the circumstances under which disciplinary action would not apply.
(e) Be signed by the accountable executive of the organisation.
(f) Be communicated, with visible endorsement, throughout the organisation.
(g) Be periodically reviewed to ensure it remains relevant and appropriate to the service provider.

ICAO recommends a sequential 10-step approach to implement an SMS to ensure that all necessary elements to build an efficient system are present (SKYbrary, 2010).

- **Step 1: Planning**

Following a logical progression, the SMS process starts with careful planning. The creation of a planning group composed of the appropriate experience base within the company is an important part of planning. The formation of the group should include the designation of a safety manager, development of a realistic safety strategy and preparation of an implementation plan for the SMS.

- **Step 2: Senior Management's Commitment to Safety**

The ultimate responsibility for safety rests on the shoulders of senior management. The stage for a positive safety culture is set by the extent to which company leaders accept the importance of proactive risk management. Safety objectives must be practical, achievable, regularly reviewed and reassessed, and communicated to the staff with a clear endorsement by senior management. Safety plans and program documents should be signed and supported by the CEO. They should include a reasonable reporting chain for safety issues that goes through the safety manager and ends at the CEO, if necessary. Appropriate resources should be visibly allocated to support the safety manager and the operation of the safety program.

- **Step 3: Organisation**

The resilience of a company is influenced by its way of conducting business and managing safety. In order to efficiently support the implementation of an SMS, the company safety manager should be appointed by and have direct access to the CEO. There should be a safety committee that is structured to support safety management, has a clear statement of responsibilities and accountabilities and oversees training and competency.

- **Step 4: Hazard Identification**

In a good safety culture, hazard identification is proactive rather than reactive and is non-punitive. When humans operate in fear of punishment for normal mistakes, errors and unsafe actions will remain hidden, and opportunities for improvement and prevention will be lost. Proactive hazard identification processes such as the line operations safety audit (LOSA) provide a continuous commitment to safety. Management must provide these processes with adequate resources to systematically record, store and competently analyse data on identified hazards.

- **Step 5: Risk Management**

Following hazard identification, risk management serves to focus safety efforts on those hazards posing the greatest risks. This requires that all risks be critically assessed and ranked according to their accident potential. Both the likelihood of occurrence and the severity of consequences must be taken into account. If risks are deemed acceptable, the company's operations may continue unchanged, at least for the present. However, even "acceptable" risks can be the focus of SMS efforts to reduce overall accident exposure. If risks are considered unacceptable, operations must be stopped or altered until steps can be taken to remove or avoid the identified hazards.

Risk management is a closed-loop process in which residual risks are assessed and cost-benefits analysed after each risk-reduction step. This process is assisted by staff feedback on actions taken and the success of procedures put into place.

■ Step 6: Safety Investigation

Lessons learned about safety are more beneficial when they include a focus on root causes ("why") rather than only on a description of the accident or incident ("what"). Identifying root causes requires trained investigators who look beyond the obvious causes at other possible contributing factors, including, but not limited to, organisational issues. Key operational staff must be properly trained to conduct safety investigations and have appropriate management support. Their output in terms of safety lessons learned should be disseminated throughout the organisation. The regulatory authority must also be aware of causal findings so they can be transferred to other operators as appropriate.

■ Step 7: Safety Analysis

In order to be accepted by all stakeholders, an SMS must encompass objective trend analyses, occurrence investigation, hazard identification, risk assessment, risk mitigation and monitoring of safety performance. Solid analytical capabilities provide compelling evidence to steer cultural change. Analytical tools and specialists support the risk-management process through the use of an up-to-date safety database. Safety recommendations should be proposed to senior management, and corrective measures must be taken and tracked to verify their effectiveness.

■ Step 8: Safety Promotion and Training

Safety awareness within an organisation is continuously improved by keeping staff informed of current safety issues. This can be accomplished using appropriate training, safety documents and participation in safety-related seminars. Training must be viewed as an investment in the future of the organisation, rather than as an expense. All employees, regardless of their role and experience, can benefit from safety analysis feedback and lessons learned.

■ Step 9: Safety Information Management

A large amount of data is generated when operating an SMS. When the information is not properly recorded, stored and used, it can be a waste of time and money. A safety management manual is the vehicle to document how the SMS relates to other functions within the organisation and how SMS data should flow and be used within the company. Appropriate approaches for the dissemination of safety information, including necessary technical support and equipment, must be implemented while simultaneously assuring the protection of sensitive safety and personal-identification information.

- **Step 10: Safety Oversight and Performance Monitoring**

The last step “closes the loop”. Feedback to continuously improve the system is based on the following: safety oversight through inspections and audits to document for staff and management that the safety actions are properly performed and safety performance monitoring to assess if the efforts of the SMS remain effective and are meeting the organisation’s safety objectives. This requires the identification of accepted performance indicators, dissemination of findings and implementation of corrective actions to improve the system.

11.3.3Safety Culture

> » The safety culture of an organisation is the product of individual and group values, attitudes, perceptions, competencies, and patterns of behaviour that determine the commitment to, and the style and proficiency of, an organisation’s health and safety management. Organisations with a positive safety culture are characterised by communications founded on mutual trust, by shared perceptions of the importance of safety and by confidence in the efficacy of preventive measures. (ACSNI, 1993).

Safety culture is the way safety is perceived, valued and prioritised in an organisation. It reflects the real commitment to safety at all levels in the organisation. Safety culture is not something you get or buy; it is something an organisation acquires as a product of the combined effects of organisational culture, professional culture and national culture. Safety culture can therefore be positive, negative or neutral. Its essence is in what people believe about the importance of safety, including what they think that their peers, superiors and leaders really believe about safety as a priority.

Safety culture can have a direct impact on safe performance: injury rates, accident rates, patient safety. If someone believes that safety is not really important, then workarounds, cutting corners or making unsafe decisions or judgements will be the result, especially when there is a small perceived risk rather than an obvious danger. A safety management system represents an organisation’s competence in the area of safety, and it is important to have an SMS and competent safety staff to execute it. But such rules and processes may not always be followed. To ensure the required commitment to safety, organisational leaders must show that safety is their priority.

Organisations need both: an SMS and a healthy safety culture in order to achieve acceptable safety performance. But with aviation, there is the problem that it is generally very safe, with serious accident outcomes occurring only rarely. This means that almost all organisations will assume they are already safe. There may be few incident reports, and these may be of low severity; safety cases may be well in hand for current operations and future changes. Real aircraft accidents are usually complex and multiple causes can be identified, so it is not always easy to see them coming. Even harder to see are contributing situations which affect an organisation’s “forward vision” in safety.

The safety culture of an aviation company consists of the following elements:

- **Informed Culture.**

Safety culture manager has current knowledge about the human, technical, organisational and environmental factors

- **Reporting Culture.**

An organisational climate in which people are prepared to report their errors and near misses

- **Flexible Culture.**

A culture in which an organisation is able to reconfigure itself in the face of high-tempo operation

- **Learning Culture.**

An organisation must possess the willingness and the competence to draw the right conclusions from its safety information system along with the will to implement these

- **Just Culture.**

An atmosphere of trust in which people are encouraged to provide essential information, but in which they are also clear about where the line must be drawn between acceptable and unacceptable behaviours

The International Civil Aviation Organisation (ICAO) published the third edition of its Document 9859 Safety Management Manual (SMM) in 2013. This document contains important basic information on safety culture (ICAO, 2013).

Safety Culture Has the Potential to Affect the Following: (Art. 2.6.6 ICAO DOC 9859)

(a) Interactions between senior and junior members of a group.
(b) Interactions between industry and regulatory authority personnel.
(c) The degree to which information is shared internally and with the regulatory authorities.
(d) The prevalence of teamwork in the regulatory authority or industry organisation.
(e) Reactions of personnel under demanding operational conditions.
(f) The acceptance and utilisation of particular technologies.
(g) The tendency to take punitive measures in reaction to operational errors within a product or service provider or by the regulatory authorities.

Indicative of a Positive Organisational Culture: (Art. 2.6.8 ICAO DOC 9859)

The way in which management deals with day-to-day safety issues is also fundamental to improving organisational culture. Collaborative interaction between frontline personnel and their safety and quality counterparts, as well as the representatives of the regulatory authority, is indicative of a positive organisational culture. This relationship should be characterised by professional courtesy, while maintaining respective roles as necessary to ensure objectivity or accountability.

- **Reporting Culture: (Art. 2.6.14 ICAO DOC 9859)**

Reporting culture emerges from the personnel's beliefs about and attitudes towards the benefits and potential detriments associated with reporting systems, and the ultimate effect on their acceptance or utilisation of such systems. It is greatly influenced by organisational, professional and national cultures and is one criterion for judging the effectiveness of a safety system. A healthy reporting culture aims to differentiate between intentional and unintentional deviations and determine the best course of action for both the organisation as a whole and the individuals directly involved.

11.3.4 Human Factors

In connection with safety in aviation, human factors must also be considered. There are many different definitions of human factors. A comprehensive and understandable definition is given by the Civil Aviation Safety Authority (CASA) of Australia:

> *The term human factors refers to the wide range of issues that affect how people perform tasks in their work and non-work environments. The study of human factors involves applying scientific knowledge about the human body and mind, to better understand human capabilities and limitations so that there is the best possible fit between people and the systems in which they operate. Human factors are the social and personal skills (for example communication and decision making) which complement technical skills, and are important for safe and efficient aviation. … The primary focus of any human factors initiative is to improve safety and efficiency by reducing and managing human error made by individuals and organisations. Human factors is about understanding humans – our behaviour and performance. Then, from an operational perspective, we apply that human factors knowledge to optimise the fit between people and the systems in which they work, to improve safety and performance.* (CASA, 2014).

The ICAO DOC 9684 Human Factors Training Manual already states in the introduction that human performance is a causal factor in the majority of aircraft accidents (ICAO, 1998). If the accident rate is to be decreased, human factors issues in aviation must be better understood and human factors knowledge more broadly and proactively applied. By proactively it is meant that human factors knowledge should be applied and integrated during the systems design and certification stages, as well as during the operational personnel certification process, before the systems and the people become operational (ICAO, 1998). The accuracy of this statement is unfortunately tragically illustrated by the crash of an Air France Airbus A330 on 1 June 2009.

Mini Case: Accident Air France Flight AF 447 on 1 June 2009

(Bureau d'Enquêtes et d'Analyses pour la sécurité BEA. Final Report on the accident on 1 June 2009 to the Airbus A330–203 registered F-GZCP operated by Air France flight AF 447 Rio de Janeiro–Paris. Published 27 July 2012).

On 31 May 2009, the Airbus A330 flight AF 447 took off from Rio de Janeiro for Paris Charles de Gaulle. The aeroplane was in contact with the Brazilian Atlantico control centre at FL 350. At around 02:02 UTC, the captain left the cockpit. The crew made a course change of 12 degrees to the left at approximately 02:08 UTC, probably to avoid returns detected by the weather radar. At 02:10:05 UTC, likely following the obstruction of the Pitot probes by ice crystals, the speed indications were incorrect and some automatic systems disconnected. The aeroplane's flight path was not controlled by the two co-pilots. They were rejoined 1 minute and 30 seconds later by the Captain, while the aeroplane was in a stall situation that lasted until the impact with the sea at 02:14:28 UTC.

According to the investigation by the BEA 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.[1]
- Inappropriate control inputs that destabilised the flight path.
- The crew not making the connection between the loss of indicated airspeeds and the appropriate procedure.
- The pilot non flying's late identification of the deviation in the flight path and insufficient correction by the pilot flying.
- 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.

In fact, the flight data recorder shows that ice crystals blocked the three pitot tubes and provided unreliable indications of speed. Finally, the autopilot and the auto throttle were switched off by the board system. In this situation, the pilot flying on the right seat reacts with a strong pull on the control stick. The aircraft begins to rise sharply and already 5 seconds later the stall warning sounds. The pilot non flying on the left seat demands "to push". But after a short down input on the control stick the pilot flying again pulls upward until the nose up limit stop. The almost-new Airbus A330 is now climbing at 7,000 ft. per minute from FL 350 to FL 375. At the same time, the speed decreases massively. To compensate for the loss of speed, the flying pilot increases power and sets the thrust levers to TOGA. But this only increases the aircraft's angle of attack even more and the flow on the wings finally breaks off. The Airbus ultimately descends in a full stall at 600,000 ft./h or 200 km/h. Neither the

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[1] Alternate law is a mode in which certain protective mechanisms of the Airbus' fly-by-wire system are deactivated when certain failures occur.

two pilots nor the captain, who has returned to the cockpit in the meantime, understand the situation and therefore do not initiate a stall recovery.

At first glance, it is not understandable why the pilot flying did not simply maintain course and altitude after the autopilot failed. But two reasons make his reaction more understandable.

- On the Air France checklist for unreliable speed indication valid at the time, the first item after switching off the autopilot and the auto throttle is “15° pitch up and TOGA”. Only six points later and not in bold letters the procedure specifies “level off when at or above MSL or circuit altitude”.
- The flying pilot had no additional aerobatic training and had no practice in dealing with stall situations. A real stall on the Airbus A330 had never been simulated in the simulator.

This accident makes it clear how important the mastery of manual flying still is for pilots today. The FAA therefore published a safety alert for operators (SAFO) on 1 April 2014 with the recommended action: “Operators are encouraged to take an integrated approach by incorporating emphasis of manual flight operations into both line operations and training.”

EASA also reacted and even went one step further. Commission Regulation (EU) No 1178.2011, FCL.745.A now stipulates that all pilots for a CPL, an ATPL or a jet rating must complete an advanced UPRT course (upset prevention recovery training). This course must be completed in an approved training organisation (ATO) and must include at least:

- 5 hours of theoretical knowledge instruction
- Pre-flight briefings and post-flight debriefings.
- 3 hours of dual flight instruction (including recovery from stall event and from incipient spin) with a flight instructor for aeroplanes FI (A) qualified in accordance with point FCL.915 (e) and consisting of advanced UPRT in an aeroplane qualified for the training task.

This additional training is intended to address the human factors associated with the difficulties of manual flying.

11.4 Security

The current aviation security structure, its policies, requirements and practices have evolved since the enforcement of the Convention on International Civil Aviation and were heavily influenced by a series of high-profile aviation security incidents. Historically, the national governments have maintained that providing security was the responsibility of air carriers and airports as part of their cost of doing business. However, with the rise in air piracy and terrorist activities that threatened commercial aviation but also national security, discussions began to emerge about who should have the responsibility for providing security at airports. In other words, aviation security is not so much related to the airplane itself, but rather to intelligence gathering, pre-boarding procedures and airport security personnel. The various components to aviation security were as follows (Seidenstat, 2004):

- Intelligence gathering: National and international intelligence and law enforcement agencies around the globe work together to identify and disrupt terrorist activities. Customs and border protection activities further identify potential terrorists and bar their entry into a country and airports respectively.
- Controlling access to secure air operations areas: Existing access controls include requirements intended to prevent unauthorised individuals from using forged, stolen or outdated identification or their familiarity with airport procedures to gain access to secured areas. The focus of this function is the clearing and badging of personnel with access to airport areas and aircraft.
- Screening of passengers and carry-on luggage: Screening checkpoints and the screeners who operate them are a key line of defence against the introduction of dangerous objects such as weapons or explosives into the aviation system. Over two million passengers and their baggage must be checked each day for articles that could pose threats to the safety of an aircraft and those aboard it. The air carriers are responsible for screening passengers and their baggage before they are permitted into the secure areas of an airport or onto an aircraft. Air carriers can use their own employees to conduct screening activities, but mostly air carriers hire security companies to do the screening.
- Screening of checked baggage and cargo: The methods used include explosive detection systems (EDS), explosive tract detection systems (ETD), canines and baggage matching with passengers.
- Aircraft protection: Hardened cockpit doors prevent unauthorised access to the flight deck and pilots undergo special training to become authorised and ready to protect the cockpit with firearms. In addition, undercover armed air marshals are stationed on flights.

The key to effective security is vigilance for the aviation industry, which depends on careful audit and regular testing of the security system. A core principle in security is that the measures to protect and prevent an attack should be commensurate with the risk. This should be kept under continual review, with measures increased and decreased, commensurate with changes in the risk. Traditionally, authorities have employed a “layered approach” to aviation security. As new threats emerge, an additional layer of measures is applied. In the wake of the 9/11 disasters, security measures were aggravated worldwide while announced and unannounced inspections of airport security increased. The theory goes that, in doing so, you counter the specific threat and provide a level of redundancy should another measure fail. There is growing realisation that this approach is not sustainable and indeed several holes in aviation security still exist (see ◘ Fig. 11.2). Moreover, the efficiency of airport and airline processes has been degraded by these layers of security measures, with questionable effectiveness in terms of security.

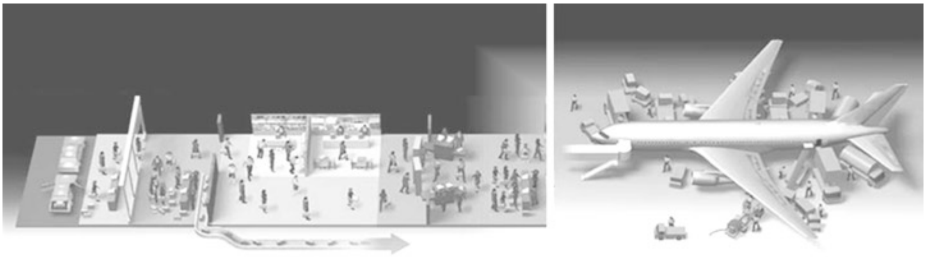

Fig. 11.2 Holes in aviation Security. (TIME graphic by Joe Lertola; Todd Curtis, ► AirSafe.com)

Review Questions

- Why must failure probabilities always be wrong for any particular case?
- Why do people tend to overestimate risks caused by aviation?
- What is meant by "perceived risk" and how does one conceptualise this type of risk?
- What is the principal international organisation for regulatory arrangements and requirements in aviation?
- What is meant by aviation safety and who has the responsibility of providing aviation security? Provide examples for the components of aviation security.
- What is a safety management system (SMS)?
- What does the SMS focus on?
- What are the key processes of an SMS?
- What are the roles and responsibilities within the SMS?
- What is the difference between SMS and a flight safety program?
- What is the difference between SMS and quality management system (QMS)?
- Why are human factors an important part of flight safety?

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Human Factors in Aviation

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Contents

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Summary

- The field of human factors helps to understand how errors and accidents happen in workplaces using different models such as SHELL and Swiss Cheese Model.
- These models help to understand the roots of accidents, the interactions between humans and other humans or machines as well as environments that can reduce and/or prevent human error.
- Culture is an important aspect of human factors and has got a considerable influence on human factors.
- The culture is shaped on many levels such as business, industry and national level. The latter is of considerable importance in multi-national organisations such as airlines.
- Airlines incorporate different measures to prevent human errors such as Crew Resource Management (CRM) or standardised communication as part of the standard operating procedures (SOPs). Furthermore, they create a "Just Culture" where integrity and collective learning from mistakes are the centrepiece.

In the field of human factors, errors and accidents in workplaces are analysed and explained using different models. The aim of human factors is to understand the roots of accidents. This includes analysing interactions between humans and other humans or humans and machines, as well as environments that can prevent or at least minimise human error. The culture hereby presents an important aspect with a considerable influence on human factors. Many aspects such as business, industry or nationality can influence culture, whereby the latter is especially important for multi-national organisations such as airlines. Airlines implement a wide array of measures to prevent human errors such as Crew Resource Management or standardised communication as part of standard operating procedures (SOPs). These measures are complemented by a "Just Culture" promoting integrity and collective learning to further minimise human errors.

12.1 The Origin, Development and Importance of Human Factors

It is estimated that between 70 and 90% of all aircraft incidents result from decisions and actions taken by people in maintenance and operation areas (Adam, 2006). Such people could be pilots, maintenance staff, air traffic controllers or executive managers of aviation-related companies. According to Adams, human factors is a "body of knowledge" that has evolved rather than it has been invented or discovered. As a result, it is not possible to determine at which point in history human factors have first been introduced. It is said that ancient civilisations applied the knowledge of human factors already as far back as 5000 BC. What can be determined, however, is when the term of human factors first appeared in the English language. It has its origin in the aviation industry and was informally used in accident investigation reports of the British Royal Air Force. The main goal was to improve the efficiency of operations and reduce human errors leading to aircraft accidents.

Interestingly, engineers who designed and built the first aircrafts initially did not have a proper understanding of the limitations of the people operating these aircrafts. By applying human factors in a professional context in the aviation sector, it became possible to understand the reasons behind certain aviation incidents. Moreover, they could learn from past accidents and continuously improve procedures to avoid such incidents in the future.

The overall purpose of the concept of human factors is to improve the relationship between the human employee, technology and the environment. Furthermore, the aim is to combine the best characteristics of people with the best features of systems to eliminate or at least reduce errors in the operation of aviation-related processes.

After World War I, human factors continuously developed over the next few years. This development can be seen in the example of the “Link Trainer” which is known to be the world’s first commercially built flight simulator in the 1930s. Edwin Albert Link simulator was based on revolutionary techniques and equipment (McFadden, 2018). Today, flight simulators are used by airlines all around the world to train flight deck and cabin crew.

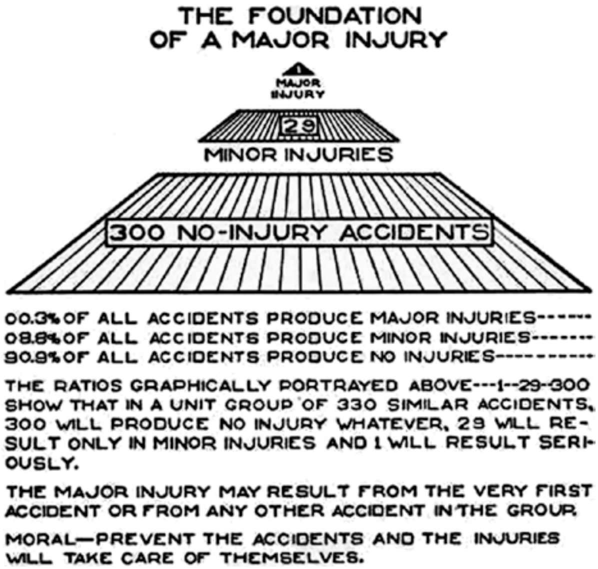
Between the 1940s and the 1970s, the application of human factors expanded rapidly, and more stringent medical and psychological standards were incorporated into the aviation industry. Further research was carried out in the fields of spatial disorientation, fatigue and pilot information processing abilities. Although these steps showed a positive development, they only focused on individual pilots Thus, all accidents that did not involve mechanical failures of the aircraft were seen as a result of a pilot error (Adams, 2006).

Several aircraft incidents in the early 1970s caused by human errors led to the development of a training programme called “Cockpit Resource Management” which later evolved into “Crew Resource Management”, in short CRM. The concept, developed by NASA psychologist John Lauber, focusses on interpersonal communication, leadership and decision-making. Nowadays, it is an integral part of staff training of most, if not all airlines (Adams, 2006).

12.2 Human Factors Models

In this short chapter, we present a number of human factors models from the past and present. Human factor models help to understand different factors influencing humans under certain conditions. They help to learn and improve as well as increase safety.

Fig. 12.1 Heinrich Pyramid (Heinrich, 1941)



00.3% OF ALL ACCIDENTS PRODUCE MAJOR INJURIES------
08.8% OF ALL ACCIDENTS PRODUCE MINOR INJURIES-------
90.9% OF ALL ACCIDENTS PRODUCE NO INJURIES----------

THE RATIOS GRAPHICALLY PORTRAYED ABOVE---1--29-300 SHOW THAT IN A UNIT GROUP OF 330 SIMILAR ACCIDENTS, 300 WILL PRODUCE NO INJURY WHATEVER, 29 WILL RESULT ONLY IN MINOR INJURIES AND 1 WILL RESULT SERIOUSLY.

THE MAJOR INJURY MAY RESULT FROM THE VERY FIRST ACCIDENT OR FROM ANY OTHER ACCIDENT IN THE GROUP.

MORAL—PREVENT THE ACCIDENTS AND THE INJURIES WILL TAKE CARE OF THEMSELVES.

12.2.1 Beginning of Human Factors Models – The Heinrich Pyramid

In his pioneering book *Industrial Accident Prevention: A Scientific Approach*, Heinrich (1931) claimed that 88% of causal factors of industrial accidents or incidents are "unsafe acts of persons". His background as an occupational health and safety researcher was based on the analysis of data from workplace injuries with accident data that was collected from a large insurance company. He concluded that for every serious accident, 29 minor injuries (accidents) and 300 near misses have been in place. This conceptual model is referred to as the Heinrich Pyramid (Fig. 12.1) also known as Accident Triangle, Safety Pyramid or Heinrich's Law[1]. Recent critics of this model cite that its focus is too much on the blame of an individual (Johnson, 2011) and not enough attention on management systems. It is also deemed too simplistic and inconsistent (Anderson & Denkl, 2010) in its descriptive and predictive validity (Marsden, 2020).

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[1] Further research of Frank E Bird derived this model into a 1–10–30-600 ratio (fatal accident-serious accidents-accidents-incidents).

12.2.2ICAO SHELL Model

In 1972 it was the research of Edwards (1972) that first introduced the SHELL model[2], known nowadays by its building-block structure, which was modified by Hawkins in 1984 (Hawkins & Orlady, 1993)[3]. The acronym SHELL, derived from its components (software, hardware, environment and liveware), assists in understanding the relationship of these components' interactions. As such, the model suggests that human error is not the only cause of an accident, but often the variety of latent and active failures in a system that causes it. With the human component in the model's centre (liveware), the related factors in regard to resources and environment clarify the scope of this aviation human factors model. A disparity between the liveware and any of the other four components contributes to human error (Skybrary, 2019a).

Liveware – Software (the interface between people and software)

Examples: checklists, standard operating procedures (SOPs), computer software, manuals and regulations.

Liveware – Hardware (the interface between people and hardware)

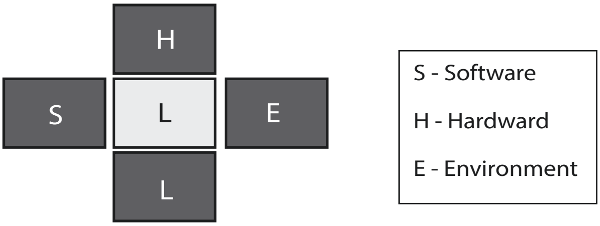
Examples: equipment, machines and facilities.

Liveware – Environment (the interface between people and the environment)

Examples: relationship between human and both the internal and external environments, illness, fatigue, weather factors, aviation infrastructure and terrain.

Liveware – Liveware (the interface between people and other people)

Examples: communication among peers in the working environment and its peripheral staff, organisational culture, interpersonal skills, group dynamics and Crew Resource Management (CRM) (▣ Fig. 12.2).



▣ **Fig. 12.2** SHELL Model. (Author's own figure based on Edwards, 1972 and Hawkins & Orlady, 1993)

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[2] ICAO Doc 9859, *Safety Management Manual*.

[3] Variants also exist as SCHELL that added culture (Keightley, 2004) and SHELL-T that added team performance (Cacciabue, 2004).

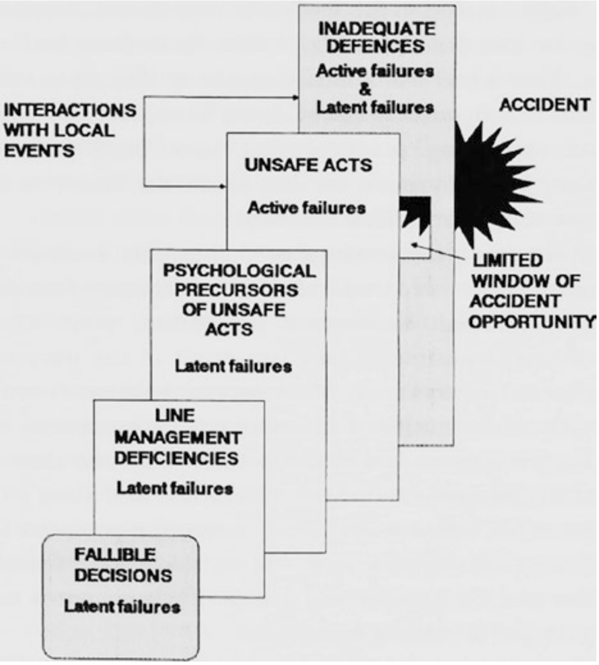
12.2.3 The Swiss Cheese Model

Reason's (1990a and b) Swiss Cheese Model of accident causation has been widely adopted and applied in risk management, healthcare (Hinton-Walker et al., 2006; Kamoun & Nicho, 2014), engineering (Lubnau II et al., 2004 and aviation safety. Its original purpose was *"…to provide an essentially cognitive psychological account of the nature, varieties, and the mental sources of human error"* (Eurocontrol, 2006).

Reason argues that most accidents are caused by one or more of the following failure domains:

- Organisational influences
- Supervision
- Preconditions
- Specific acts (◘ Fig. 12.3)

Active and latent failures are also part of this model. Active failures can be directly linked to an accident, for example, the non-functioning of a cockpit instrument. Latent failures, the first three of above-mentioned domains, may lie dormant for a certain amount of time, before they contribute to an accident[4].



◘ Fig. 12.3 Relationship between the various human contributions to accidents and the basic elements of production (Reason, 1990a, 1990b)

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[4] See also ICAO Circular 240-AN/144, pp.6–13 for a comprehensive example.

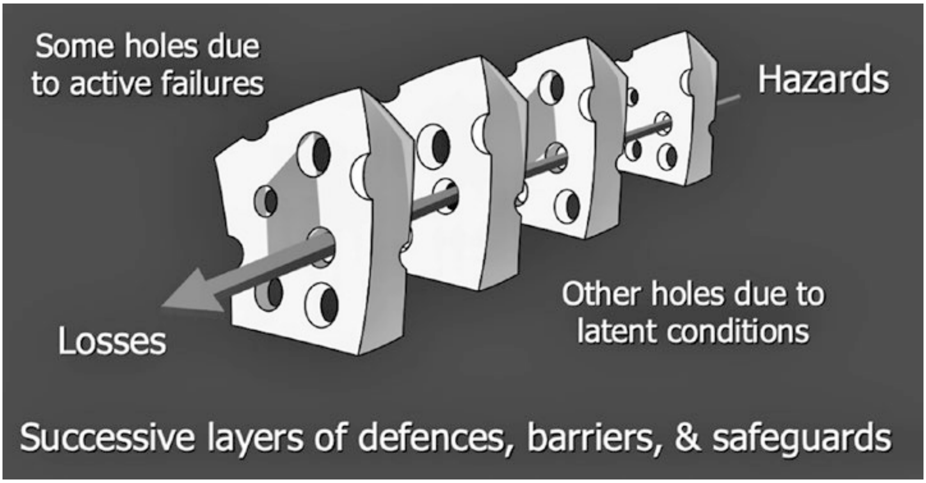

Fig. 12.4 Swiss Cheese Model (Eurocontrol, 2006)

Multiple slices of Swiss cheese represent an organisation's layers/barriers of defence, a principle derived from computer security. The Emmental cheese of Switzerland, with its varying positions of holes, characterizes this model metaphorically. Holes symbolize weaknesses in a system. When each slice aligns its holes momentarily, the hazard passes through all slices of defence, leading to an accident/loss. This concept highlights the importance for individuals and organisations to not only identify specific risks but, where specific domains (slices) may be aligned, also apply commensurate mitigation strategies. An often-applied tool is, for example, to "buy time". Destabilised approaches[5] of aircraft have been a large contributor to accidents (Flight Safety Foundation, 2019). In many cases, flying a go-around would have provided crews with valuable extra time, thus avoiding such accidents (Fig. 12.4).

12.2.4 The Dirty Dozen

In a recent address to airlines and its staff, ICAO (2020) applied the Dirty Dozen Model of Gordon Dupont. Whilst ICAO Circular 240-AN/144 lists over 300 human error originators, this concept was developed in 1993 during Dupont's time with Transport Canada and had its roots in human performance in aircraft maintenance[6]. It has since become a cornerstone in other aviation-related areas (i.e. air traffic control) and additional industries. The model refers to the 12 most common

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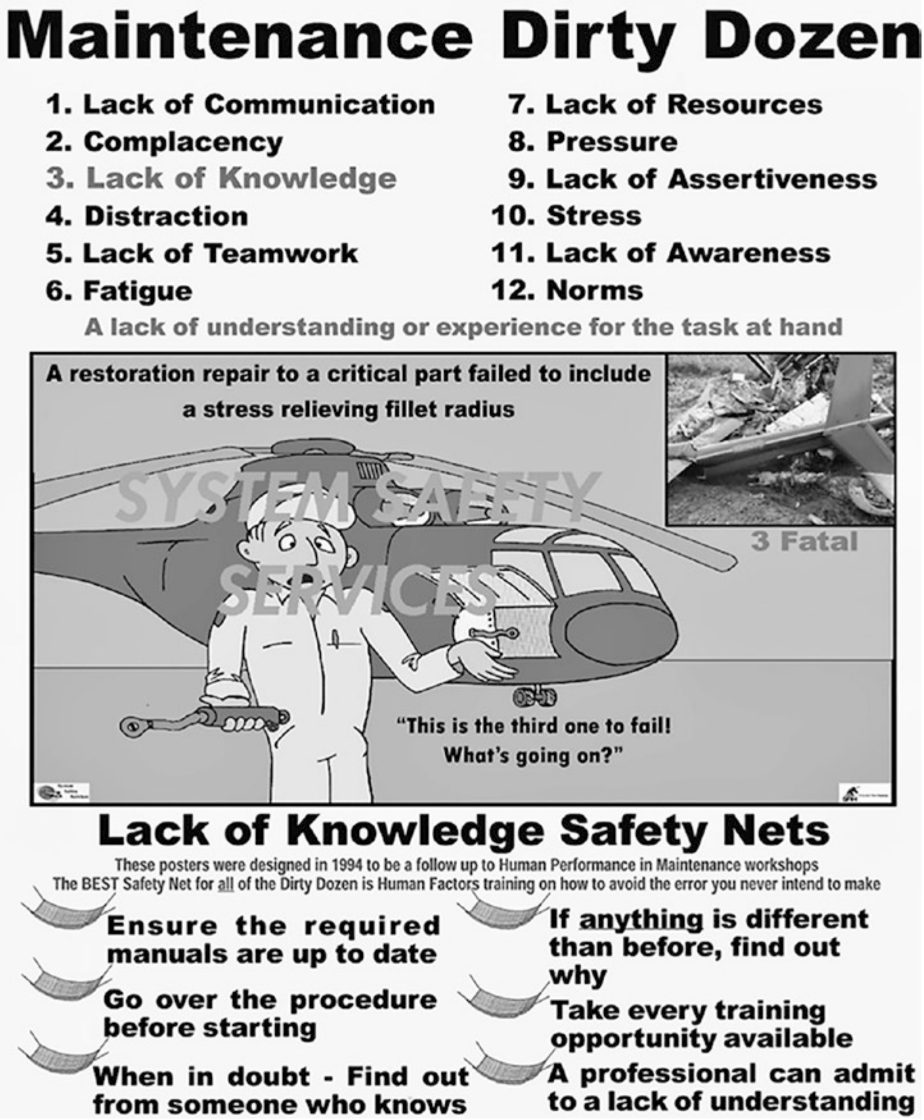
[5] Referred to as lateral, horizontal, navigational or configurational compromise.

[6] For example, UK CAA CAP715.



Maintenance Dirty Dozen

1. Lack of Communication
2. Complacency
3. Lack of Knowledge
4. Distraction
5. Lack of Teamwork
6. Fatigue
7. Lack of Resources
8. Pressure
9. Lack of Assertiveness
10. Stress
11. Lack of Awareness
12. Norms

A lack of understanding or experience for the task at hand

A restoration repair to a critical part failed to include a stress relieving fillet radius

Lack of Knowledge Safety Nets

These posters were designed in 1994 to be a follow up to Human Performance in Maintenance workshops
The BEST Safety Net for all of the Dirty Dozen is Human Factors training on how to avoid the error you never intend to make

Ensure the required manuals are up to date

Go over the procedure before starting

When in doubt - Find out from someone who knows

If anything is different than before, find out why

Take every training opportunity available

A professional can admit to a lack of understanding

Fig. 12.5 The Dirty Dozen safety poster (System Safety, 2010)

human error conditions that lead to accidents and aims to mitigate human error. These countermeasures are listed with each identified condition[7] (Fig. 12.5):

1. Lack of communication
2. Distraction
3. Lack of resources
4. Stress
5. Complacency
6. Lack of teamwork

7. Pressure
8. Lack of awareness
9. Lack of knowledge
10. Fatigue
11. Lack of assertiveness
12. Norms

There is not much research literature that documents the original model of The Dirty Dozen, nor has this term been mentioned in its document (Transport Canada, 2003). The work of Dupont was largely of physical nature in the form of maintenance safety posters[8] and intended as an introduction for elementary work and servicing duties. Additionally, this concept was proposed during Dupont's time working for the Canadian authorities[9], with focus on human factors issues in aircraft maintenance. A domain that in the 1990s had not yet had a significant research publication exposure.

12.2.5 The Human Factors Analysis and Classification System (HFACS)

"The Human Factors Analysis and Classification System (HFACS) framework bridges the gap between theory and practice by providing investigators with a comprehensive, user-friendly tool for identifying and classifying the human causes of aviation accidents" (Shappell & Wiegmann, 2000). The model elaborates on Reason's Swiss Cheese Model. However, the definition and context in an everyday operation require these cheese holes to be defined from a system failure perspective. In order to understand the causal factors that lead to an accident, the aim for the HFACS is therefore to describe these holes, which was prepared based on the analysed data of over 300 Naval aviation accidents (Shappell & Wiegmann, 1997, 2003). Originally used by the US Air Force, many other domains applied this model in recent years, for example, maritime[10] (Wang et al., 2020), railway (Li, Liu, & Liu, 2019a), chemical (Li, Tang, et al., 2019b), mining (Zhang et al., 2019) and healthcare[11] (Cohen et al., 2018; Judy et al., 2020).

Based on Reason's concept of latent and active failures, the HFACS defines four levels of failure: (1) Unsafe Acts, (2) Preconditions for Unsafe Acts, (3) Unsafe Supervision and (4) Organisational Influences (▣ Fig. 12.6).

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[7] Transport Canada - Human Performance Factors for Elementary Work and Servicing TC14175.

[8] Transport Canada Human Performance in Maintenance (HPIM) Part 1.

[9] From March 1993 to August 1999.

[10] Also known as HFACS-MA.

[11] Also known as HFACS-HC.

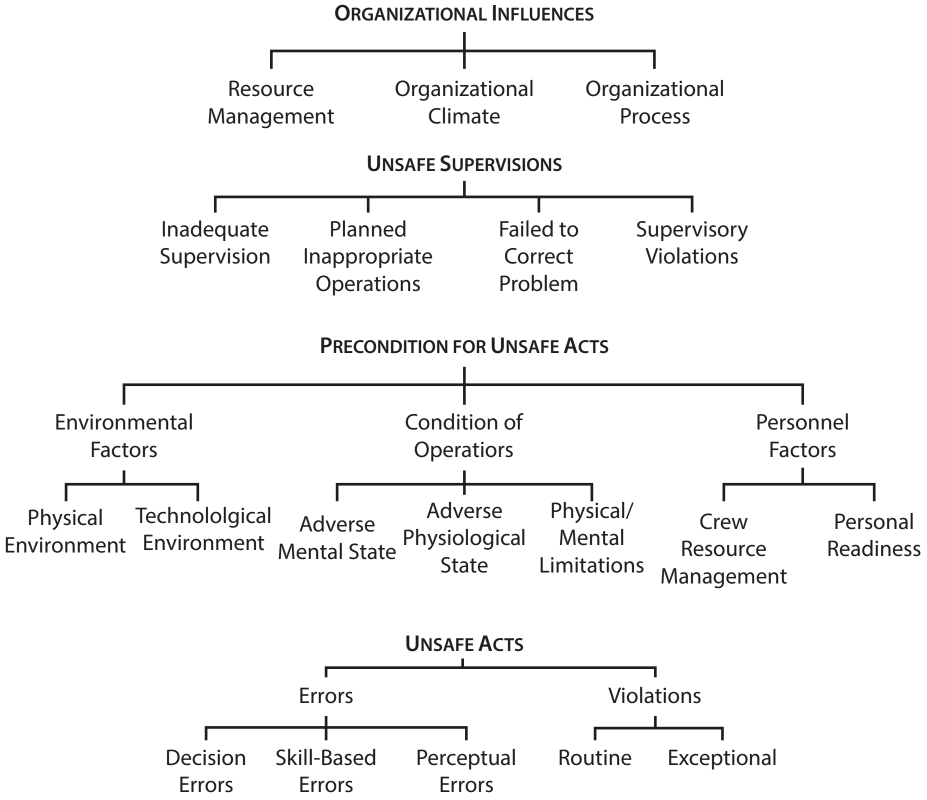

Fig. 12.6 HFACS framework (Skybrary, 2019b)

12.2.6 Safety-I and Safety-II

Whilst not explicitly a human factors model, the prominent work of Hollnagel (2014) with Safety-I and Safety-II is regarded as very influential in High Reliability Organisations (HROs) such as aviation, nuclear (Hollnagel, 2013) or medical industry (Staender, 2015; Ball & Frerk, 2015). Whilst Safety-I is not a concept of Hollnagel, Safety-II is, and challenges the absence of a positive learning culture. It is a fundamental change in its approach to a resilient safety management system and instrumental to human factors research, which is part of this method. This is, for example, mirrored by seeing humans as a resource, a concept that is also established in Crew Resource Management (CRM). "*Safety-I relates to a condition where the aim is to be sure that the number of unwanted outputs will be as low as possible, whereas Safety-II concerns the condition of being certain that the success of outputs will be as high as possible*" (Vanderhaegen, 2015) (Table 12.1).

This mind shift sets a new approach as to learning from mistakes (Dekker, 2014) and of a different learning culture in general. In the aviation industry, simulators are widely used as a tool for training and checking of pilots, as regulations dictate license renewals in defined intervals. These simulator events are normally

Table 12.1 Comparison of Safety-I versus Safety-II (Storesund & Roberts, 2020)

	Safety-I	**Safety-II**
Definition of safety	As few things as possible go wrong	As many things as possible go right
Safety management principle	Reactive, respond when something happens, or is categorised as an unacceptable risk	Proactive, continuously trying to anticipate developments and events
Explanations of accidents	Accidents are caused by failures and malfunctions. The purpose of an investigation is to identify causes and contributory factors	Things basically happen in the same way, regardless of the outcome. The purpose of an investigation is to understand how things usually go right as a basis for explaining how things occasionally go wrong
Attitude to the human factor	Humans are predominantly seen as a liability or a hazard	Humans are seen as a resource necessary for system flexibility and resilience
Role of performance variability	Harmful, should be prevented as far as possible	Inevitable but also useful. Should be monitored and managed

preceded by a briefing and followed by time for reflection. In the past, the focus in many organisations has often been on "what went wrong". Such understandings are typically existent in organisations with blaming culture practices[12] (Casey et al., 2017). This practice is disputed by Safety-II and recent learning research suggests (Dieckmann et al., 2017) that this is a sensible shift in the way employees improve their competencies and contribute best towards their organisations (Edmondson, 1999 & 2018).

12.3 Culture as a Key Human Factor

Confucius, the Chinese philosopher, stated long ago: *"All people are the same. Only their habits are different"*. Hilb (2000) states that the more we know about different behaviours and habits, the more effectively we can manage and work in different cultures.

Culture can be viewed as consisting of everything that is human made (Herskovitz, 1955); everything that people have, think and do as members of their society (Ferraro, 1990); communication (Hall, 1981, 1959; Hall & Hall, 1989,

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[12] see also ► Chap. 4.

1990); a semi-permeable membrane between a social group and its environment (Hall, 1977); a system of shared meanings (Geertz, 1973); the way of life of a group of people (Barnouw, 1979); collective programming of the mind (Hofstede, 1980); inherited ethical habit (Fukuyama, 1995); a "tool kit" of habits, skills and styles from which people construct "strategies of action" (Swidler, 1986); one being composed of both "objective culture", such as chairs, tools and jet planes, and "subjective culture", such as categories, norms, roles and values (Triandis, 1994); a set of understandings shared among persons who have been similarly socialised (Terpstra & David, 1991); or a costing system consisting of sub-systems, such as kinship, educational, economic, political, religious, association, health and recreational systems (Harris & Moran, 1996).

Based on a thorough review of 270 different definitions of culture, some core elements of culture are as follows (Wittmer, 2005):

- Culture is shared by collectives such as social groups (von Keller, 1982).
- Culture steers behaviour (von Keller, 1982).
- Culture is learned (von Keller, 1982).
- Culture is transferred through and inherent in symbols (von Keller, 1982).
- Culture is the instrument a society uses to adapt to its environment (von Keller, 1982).
- Culture is inherent in values (Hofstede, 2001).
- Culture is highly inter-related. Hall stated: *"you touch a culture in one place and everything else is affected"* (Hall, 1977).
- Culture can be viewed as a set of dimensions (Hofstede, 2001).

Based on these elements, Wittmer (2005) defines culture by combining several definitions by other authors:

Culture

Culture comprises all collectively shared, implicit or explicit, norms of behaviour, patterns of behaviour, expressions of behaviour, rituals of behaviour, values and dimensions which are learned by members of a social group including their embodiments in artefacts, and transferred from generation to generation by symbols. The essential core of culture consists of traditional (i.e. historically derived and selected) ideas and especially their attached values. Culture systems may, on the one hand, be considered as products of action, and on the other hand as conditioning elements of future action. Culture is highly inter-related with the systems surrounding it, triggering feedback in the event of disturbances. And culture is distinct and can be found on different levels in life relating to nationality, business/industry, corporate or services.

Looking at the cultures of different nations, different background issues play an important role (for example: religions, location (countryside or city), education, etc.). To structure the wide perception of culture, a division between national culture, business culture and corporate/industry culture is appropriate (Chong, 2001). These three levels of culture interact with each other but are different in the way they are defined and perceived (◘ Fig. 12.7).

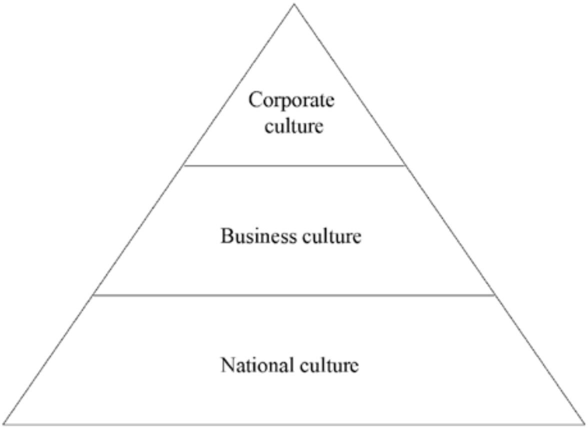

Fig. 12.7 Three levels of culture. (Author's own figure based on Chong, 2001)

12.3.1 Corporate Culture

Corporate or organisational culture includes different theoretical views. It interacts very closely with leadership. Leaders create and manage culture, and culture defines what is seen as important in an organisation. Some common meanings are the following (cited from different sources in Schein, 1985; Schein, 1992):

- Observed behavioural regularities when people interact, such as the language used and the rituals around deference and demeanour (Goffman, 1967; Goffman, 1959; Ritti & Funkhouser, 1982; Schein, 1978; Schein, 1968; Van Maanen, 1979).
- The norms that evolve in working groups, such as the particular norm of "a fair day's work for a fair day's pay" that evolved in the Bank Wiring Room in the Hawthorne studies (Homans, 1950).
- The dominant values espoused by an organisation, such as "product quality" or "price leadership" (Deal & Kennedy, 1982).
- The philosophy that guides an organisation's policy towards employees and/or customers (Ouchi, 1981; Pascale & Athos, 1981).
- The rules of the game for getting along in the organisation, "the ropes" that a newcomer must learn in order to become an accepted member (Ritti & Funkhouser, 1982; Schein, 1978, 1968; Van Maanen, 1979).
- The feeling or climate that is conveyed in an organisation by the physical layout and the way in which members of the organisation interact with customers or other outsiders (Taguiri & Litwin, 1968).

According to Cartwright and Cooper (2000), there are different types of organisational cultures shown in Table 12.2 and an overview is given in Fig. 12.8.

Some of these culture types fit better together than others. For example, a person who has worked in an environment where high autonomy was requested, will have problems being in a culture where suddenly somebody controls and directs all the time, as would be the case in a power culture. On the other hand, a person who is used to being controlled and told what to do is likely to be lost in an autonomous

▪ **Table 12.2** Types of organisational cultures (Cartwright & Cooper, 1992)

Type	Main characteristics
Power	Centralisation of power – swift to react Emphasis on individual rather than group decision-making Essentially autocratic and suppressive of challenge Tend to function on implicit rather than explicit rules Quality of customer service often tiered to reflect the status and prestige of the customer Individual members motivated to act by a sense of personal loyalty to the "boss" (patriarchal power) or fear of punishment (autocratic power)
Role	Bureaucratic and hierarchical Emphasis on formal procedures, written rules and regulations concerning the way in which work is to be conducted Role requirements and boundaries of authority clearly defined Impersonal and highly predictable Values fast, efficient and standardised customer service Individuals frequently feel that as individuals they are easily dispensable in that the role a person serves in the organisation is more important than the individual/personality who occupies that role
Task/achievement	Emphasis on team commitment and a zealous belief in the organisation's mission The way in which work is organised is determined by the task requirements Tend to offer their customers tailored products Flexibility and high levels of worker autonomy Potentially extremely satisfying and creative environments to work in but also often exhausting
Person/support	Emphasis on egalitarianism Exists and functions solely to nurture the personal growth and development of its individual members More often found in communities or co-operative than commercial profit-making organisations

culture. This theory takes different corporate cultures into account, so one may ask how difficult it might be to integrate two companies or to lead a company with different sub-cultures.

Corporate culture is a challenge, especially for airlines, which organise some part of the business very strictly and other parts more relaxed. There are two worlds around an airline, a company-related world and a flight-related world. The flight-related world functions based on:

- Rules
- Standards
- Task fulfilment
- Compliance

and a dependency on others, often in a top-down way. In other words, the flight-related world in an organisational context functions along elements of a role culture. Pilots are experts in operator thinking, following rules and ensuring

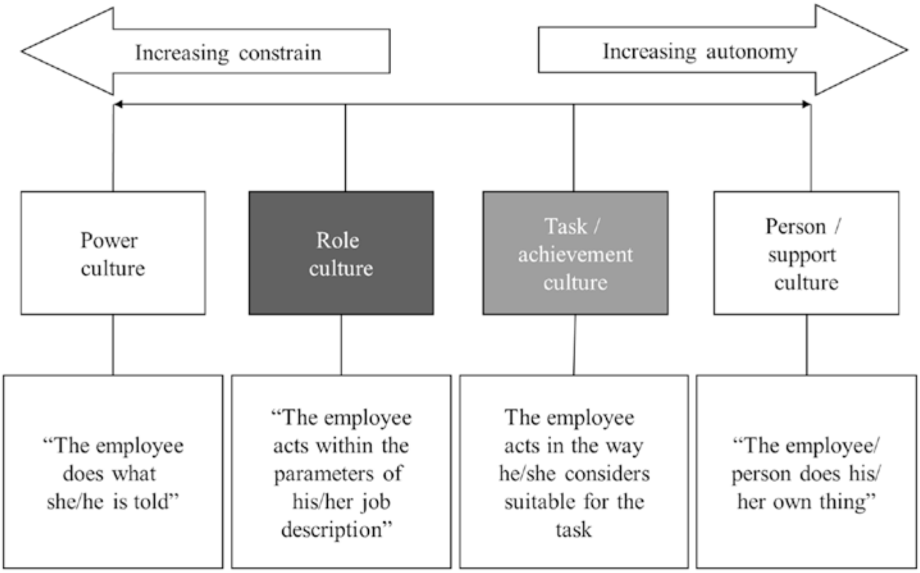

Fig. 12.8 Relation between culture types regarding constraints on individuals' freedom. (Author's own figure based on Cartwright & Cooper, 1992)

compliance. The pilots flight-related world is narrowly defined (e.g. processes, working hours, checklists, uniforms, careers, etc.). In a flight-related world, standardisation means success and safety.

The company- or management-related world functions based on:

- Being part of a management team
- Being a host
- Being a mission creator
- Being an individual in a team
- Freedom of scope
- Self-determination
- Inspiration
- Interpretation

Hence, the company or management world is rather functioning along a task achievement culture. The gap between the different corporate culture types is regularly a challenge for airlines, as pilots may not understand management decisions and management may not understand why pilots are so specific and detailed on issues, that from a management perspective may not be of the highest relevance. The company world is not narrowly defined, but it must rather fit into the external market and economic environment. Factors such as agility, innovation, inspiration, dynamics, creativity, structure, etc. are important. For the company (and its managers), personal success is individualisation, while company success is a team effort.

12.3.2 Business/Industry Culture

The business culture is a sub-culture of the national culture. It comprises the effective rules of the game, the boundaries between competition and unethical behaviour as well as the codes for conduct in business dealings (Terpstra & David, 1991). Characteristics of business cultures are (Terpstra & David, 1991):

- Shared values (e.g. ethical values on how to do business, business ideologies and ideas of quality, co-operation, tolerance, hierarchy, control, etc.)
- Shared norms (guidelines, leadership principles, etc.)
- Shared attitudes (attitudes of the employees towards task, product, colleagues, leadership, company, development, customers, etc.)
- Shared artefacts (languages and language rules; behaviour, architecture, conferences; and meetings, parties, rituals and ceremonies, myths and anecdotes; etc.)

Business culture defines the way people do business in different countries, industries or business levels. They have an influence on the organisational design, the design of jobs, motivation, decision-making, group behaviour, leadership and management and organisational development (Pheysey, 1993). All these issues create a business culture emanating from the inside of an organisation. In contrast, the national culture and behaviour is influencing all these organisational issues. Hence, the business culture evolves from the national culture and from the organisational culture and behaviour. It differs in different industries, business areas and hierarchical levels.

Industry culture is especially interesting in the aviation industry including airlines and the whole supply chain they initiate. Reasons for the dedicated industry culture lie in the high safety and compliance levels which are demanded in this industry. Aviation is heavily regulated and safety, not only related to safe operations but also a highly controlled technology innovation, production environment and supply chain, plays a key role for a distinct industry culture in the aviation industry.

12.3.3 National Culture

National culture is the basis of the way people in a country think or behave. It is a way of life in which a person grows up and lives. Sometimes there are different ethnic groups in a single country, who have different values and who therefore behave differently. Hence, it is important to make a distinction between nation and country.

In recent years, managers and researchers have recognised the importance of organisational culture as a socialising influence on climate. Unfortunately, the understanding of organisational culture has tended to limit rather than enhance the understanding of national cultures. Many managers believe that organisational culture moderates or erases the influence of national culture. They assume that employees working for the same organisation, even if they have different nationalities, are more similar than different. They believe that national differences are only important in working with foreign clients, and not working with colleagues from the same organisation. But organisational culture does not erase national culture. Employees and managers bring their ethnicity into the workplace (Boyacigiller & Adler, 1991). Hofstede (2001) found cultural differences within multi-national organisations. In his study, national culture explained 50% of the differences in employees' attitudes and behaviours. National culture explained more of the difference than professional role, age, gender or race did. It was also found that when employees work in a multicultural environment within a multicultural organisation, their nationalities are emphasised: Swiss become even more Swiss and Australians even more Australian, Singaporeans more Singaporean, Americans more American and so on. Maybe the pressure to conform to the organisational culture of a foreign company brings out employees' resistance, causing them to cling more firmly to their own national identities (Adler, 1997).

Different concepts of cultural dimensions offer a possibility of describing, classifying and ranking single cultures or countries. Often specific information about countries is obtained through the creation of an index or dichotomy according to which countries are allocated different positions.

There are different concepts of cultural dimensions. Those were developed by Kluckhohn (1953) and Hall (1977), who each made fundamentally new and early contributions to the field. The six cultural dimensions developed by Hofstede (2001); Hofstede (1980) as well as Trompenaars and Hampden-Turner (1997) present the largest bodies of quantitative information on cultural influences today. Furthermore, the Globe study by House et al. (2004) developed and revealed nine cultural dimensions based on Hofstede's dimensions.

There are two additional researchers who work in the field of cultural dimensions concepts. These are Triandis (1972, 1982) and Adler (1997). Both work on cultural dimensions but they have not added any new cultural dimensions to the already existing ones. They have contributed to the field by analysing and systematising existing cultural dimensions. Empirical underpinnings to their work, however, remain anecdotal.

With respect to the discussion of human factors in the aviation industry and especially with airlines, particularly Hofstede's cultural dimensions are regularly used. Hofstede provides an ongoing adoption of his model and dimensions, so that his approach has become the broadest and most used one in practice. For this reason, Hofstede's cultural dimensions are focused on in the following paragraphs.

Hofstede statistically computed six different cultural dimensions: power distance, uncertainty avoidance, individualism, masculinity, long-term orientation and indulgence. He developed an index for each of these dimensions on which countries are placed according to statistically generated values. The following section presents the six dimensions and their possible impacts on management issues.

12.3.3.1 Power Distance (PDI)

The term power distance refers to the emotional distance between management and its subordinates. Power distance focuses on differences between the hierarchical levels and how different societies handle its occurrence (Hofstede, 2001).

According to Hofstede (2001), power distance describes *"the extent to which the less powerful members of institutions and organisations within a country expect and accept that power is distributed unequally"* (p. 98). In other words, the concept of power distance highlights the tolerance of human inequality and its implications for societies in general, at the workplace, at school, in the family and at other areas.

12.3.3.2 Uncertainty Avoidance (UAI)

Hofstede's uncertainty avoidance dimension explains the issue of how a country deals with uncertainty in different areas. Three fields, in which societies have developed ways to deal with and overcome the anxiety that arises from uncertainty towards the future, have been identified. These are: technology, law and religion.

> *Technology helps to avoid uncertainties caused by nature. Laws and rules try to prevent uncertainties in the behaviour of other people. Religion is a way of relating to the transcendental forces that are assumed to control man's personal future. …Modern societies do not differ essentially from traditional ones in this respect* (Hofstede, 1991).

12.3.3.3 Individualism (IDV)

Individualism includes the span from extreme individualism and extreme collectivism in a society. Hofstede (1991) defines this dimension in the following way:

> *Individualism pertains to societies in which the ties between individuals are loose: everyone is expected to look after himself or herself and his or her immediate family. Collectivism as its opposite pertains to societies in which people from birth onwards are integrated into strong, cohesive in-groups, which throughout people's lifetime continue to protect them in exchange for unquestioning loyalty (p. 51).*

12.3.3.4 Masculinity (MAS)

The masculinity dimension Hofstede refers to socially and culturally determined roles of men and women in society using the adjectives masculine and feminine. The biological roles of men and women are referred to as male and female and have a different meaning in this context. The most important differentiation between the two is the fact that socially constructed gender roles are relative, whereas biological roles are usually absolute. This means that a man can behave in a feminine way and a woman can show masculine behaviour, which can indicate deviation from a country's conventions. The attribution of masculine or feminine traits to specific behaviour differs from country to country, but apart from this difference, ideas about gender roles are very similar in both traditional and modern societies:

> *Masculinity stands for a society in which social gender roles are clearly distinct: men are supposed to be assertive, tough, and focused on material success; women are supposed to be more modest, tender, and concerned with the quality of life. Femininity stands for a society in which social gender roles overlap: Both men and women are supposed to be modest, tender, and concerned with the quality of life (Hofstede, 2001).*

For the masculinity dimension, Hofstede (1980) establishes a connection with attitudes towards environmental issues. He suggests: *"…that the main non-rational value issue that opposes economists and environmentalists in this discussion is based on the masculinity-femininity dimension" (p.208)*.

12.3.3.5 Long-Term Orientation (LTO)

The long-term orientation dimension focuses on future orientation versus present and past orientation. Hofstede describes long-term orientation in the following way:

> *Long-term orientation stands for the fostering of virtues oriented towards future rewards perseverance and thrift. Its opposite pole, short term orientation, stands for the fostering virtues related to the past and present, in particular, respect for tradition, and preservation of 'face' and fulfilling social obligations (Hofstede, 2001, p. 359)*

12.3.3.6 Indulgence (IVR)

Indulgence describes the level access to cover basic needs with respect to enjoying life versus restraints by strong social norms. Hofstede defines indulgence the following way:

> *Indulgence stands for a society that allows relatively free gratification of basic and natural human drives related to enjoying life and having fun. Restraint stands for a society that suppresses gratification of needs and regulates it by means of strict social norms* (Hofstede Insights, n.d.).

12.4 National Culture as a Key Human Factor in Aviation

Especially airlines employ more and more international staff on a global scale. One example is Emirates Airlines, where up to 80% of the employees are foreigners (non-Emirati) (Emirates Airlines, 2015). This indicates that there are national cultural challenges and human factor issues. Hence, a frequently raised question is how human factors may be influenced by national culture. The public stereotype opinion might suggest that national culture per se has a tendency towards the cause for mishaps, for example, the recent accident of Pakistan Air flight 8303 on 22 May 2020 (BBC, 2020; Aviation Herald, 2020). This however would fall short of a systematic analysis and requires a deeper look beyond the view of such opinions (Al-Wardi, 2017), for example the general missing oversight with the licensing authorities in this particular accident (CAPA, 2020). Contributing factors such as weather (Luers & Haines, 1983), infrastructure, air traffic control and communication are just a few more to mention. Additionally, training programmes and the organisational culture of airlines may have an equally important influence. It may therefore be difficult to argue that national culture has a direct relationship with human factors and associated accident rates, as data may be too variable and hard to quantify for a meaningful correlation analysis.

Helmreich and Merritt (1998) concluded:

> *Some authors have correlated national culture with accident rates and concluded that pilots in certain countries are safer than others. We take umbrage with the simplicity of this statement. The resources allocated to the aviation infrastructure vary widely around the globe. While pilots in Europe enjoy some of the most sophisticated Air Traffic Control support, pilots in parts of Africa and Asia are faced with little or no support; indeed, the runways may not even be lit for lack of electricity or stolen equipment. Accident rates are a function of the entire aviation environment, including government regulation and oversight, and the allocation of resources for infrastructure and support, not just pilot proficiency (pp. 104–5)*

A different view however was presented in later studies (Klein et al., 2001), which confirmed the correlation between culture and its implications on flight safety (Enomoto & Geisler, 2017). The work of Mearns and Yule (2009) highlighted that *"…more proximal influences such as perceived management commitment to safety and the efficacy of safety measures exert more impact on workforce behaviour and subsequent accident rates than fundamental national values"*. The question may therefore be, how this is being applied and managed in aviation organisations that work primarily with multi-national staff, and as such have a greater exposure. The challenge to collaboratively work in high-risk industries such as aviation, requires carefully defined frameworks. Large multi-national airlines prove that high safety rankings can be achieved by applying appropriate management practices. Approximately 50% of the present top ten airlines operate on a large scale with multi-national crews (Airline Ratings, 2020).

Three main points should be considered:

- Human Factors/Crew Resource Management (CRM) training programmes
- Communication, its competency and authority's oversight
- Standard operating procedures (SOPs)

12.4.1 Human Factors/Crew Resource Management (CRM) Training Programmes

Research around cultural structures are prominent in literature, for example, the GLOBE project (House et al., 2004), Trompenaars (Trompenaars & Hampden-Turner, 1997) or Triandis (Singelis et al., 1995). For this short discussion, the expansive work of anthropologist Hofstede (1980) with his model of 6 dimensions and its resulting country indexes is considered in order to exemplify the influence of national culture on human factors. Of particular interest in our discussion are the first four dimensions, namely, (1) Masculinity, (2) Power Distance, (3) Uncertainty Avoidance and (4) Individualism. These were the four original dimensions distinguished by the research of Hofstede. Data from 70 countries and 116′000 individuals were initially collected with country indexes calculated for each of the six dimensions (Hofstede, 1980) (◘ Fig. 12.9).

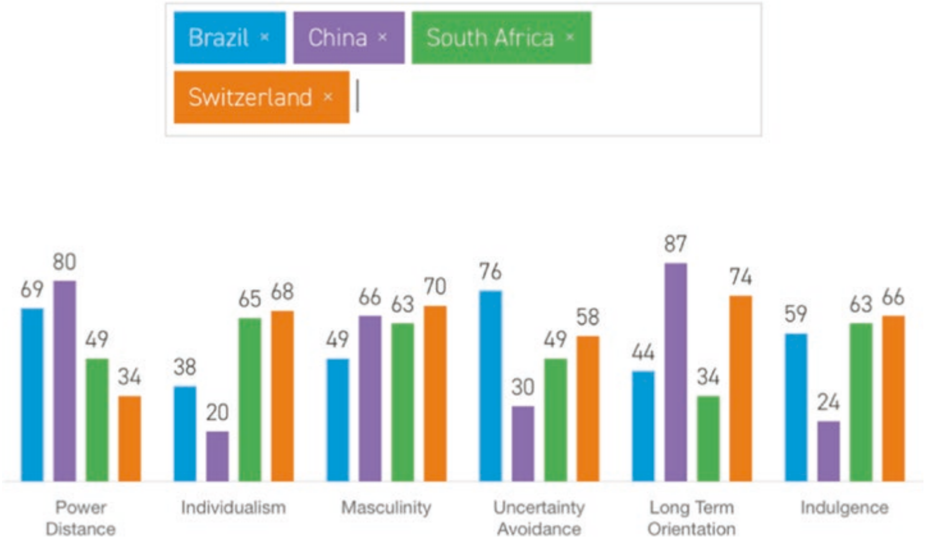

Fig. 12.9 Example of comparison between four different countries (Hofstede, 2020)

Helmreich & Merritt (1998, p.249) have further elaborated on Hofstede's research in the above-described study, whereby these national indexes were compared to pilots from different countries, which resulted in an index of their own. Subsequent research with 9400 pilots from 19 countries validated Hofstede's findings (Merritt, 2000). The table below illustrates an extract of nine selected countries. As one can see, these indexes differ somehow remarkably although the formulae of Hofstede have been adopted[13], particularly in regards to individualism (IDV) whose numbers are much higher and to a lower degree with power distance (PD).

A study by Boeing in 1993 (Enomoto & Geisler, 2017) found that high PD countries had a high rate of accidents, while countries with high IDV scores had lower accident rates.

The legal framework mandates airlines with systematic human factors training programmes, also known as Crew Resource Management (CRM), in which PD and IDV are addressed[14].

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[13] This explains why these numbers may be higher than 100 or lower than 0.

[14] ICAO Annex 6 Part I ► Chap. 9 Para 9.3.1, ICAO DOC 9683-AN/950, Human Factors Training Manual, ICAO Circular 302, Human Factor Digest No. 16 and EASA EU-OPS 1.940.

Mini Case: Bad Apples of Power Distance

By Mark Roth

Power distance (PD) was an important factor in past accidents. On 14 November 1990, Alitalia flight 404 on approach into Zurich impacted with the ground, killing all 40 passengers and 6 crew members[15]. Whilst a technical fault with one of the navigation instruments was the primary cause of the accident, it was the First Officer that called for a go-around, which was overturned by the Captain. Other examples are Tenerife Disaster in 1977, making it the deadliest accident in aviation history[16], or Korean Air flight 801 in 1997 in Guam[17]. An example in younger history is the Asiana accident in San Francisco in 2013[18]. It can thus be argued that hierarchical gradients, and as such power distance, were a vital contributing factor to these accidents and has since been addressed among most airlines within their human factors training programmes.

Mini Case: Earning Good Fruit from Human Factors Training

By Mark Roth

Brazilian First Officer Lucas is doing his final line-check with a large multinational airline on a night flight from Bangkok to Dubai. After six months of vigorous training, moving across continents, relocating his family, leaving friends behind, tonight will be the final assessment that certifies him as an Airbus A380 First Officer. He is nervous; however, he feels that he finds himself in an environment where he is able to contribute and be his best. The cockpit routine tonight requires the Captain to insert the data from the calculated take-off performance into the flight management computer; speeds that are essential and will help the pilots to decide when to abort a take-off or when to continue. In a second step, First Officer Lucas will have to check these insertions. As he shortly after finds out, it appears that the Captain has inserted a wrong number. Instead of assuming that the examiner knows what he is doing, breaking the natural boundaries of power distance (according to ▣ Table 12.3 with a high index of 125 for Brazil), First Officer Lucas speaks up and challenges the Captain, asking if he could confirm that the inserted numbers are correct. The mistake is quickly resolved and corrected. Such speaking up would not have happened, would it not be for the sake of human factors training that addresses and mandates this. Hence it is an important tool that takes national culture and its influence towards human factors into account, thus contributing to the safety of airlines.

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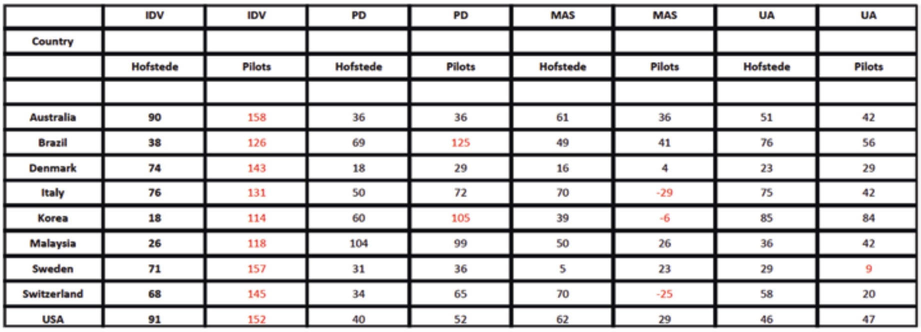
[15] See Final Report of the Federal Aircraft Accident Inquiry Board, Nr. 1190/57–1457.

[16] ► https://www.faasafety.gov/files/gslac/courses/content/232/1081/finaldutchreport.pdf

[17] ► https://www.ntsb.gov/investigations/AccidentReports/Reports/AAR0001.pdf

[18] ► https://www.ntsb.gov/investigations/AccidentReports/Reports/AAR1401.pdf

Table 12.3 Pilots' scores compared to their average national scores (Roth, 2016; data derived from Helmreich & Merritt, 1998, p. 249)



	IDV	IDV	PD	PD	MAS	MAS	UA	UA
Country								
	Hofstede	Pilots	Hofstede	Pilots	Hofstede	Pilots	Hofstede	Pilots
Australia	90	158	36	36	61	36	51	42
Brazil	38	126	69	125	49	41	76	56
Denmark	74	143	18	29	16	4	23	29
Italy	76	131	50	72	70	-29	75	42
Korea	18	114	60	105	39	-6	85	84
Malaysia	26	118	104	99	50	26	36	42
Sweden	71	157	31	36	5	23	29	9
Switzerland	68	145	34	65	70	-25	58	20
USA	91	152	40	52	62	29	46	47

IDV **Individualism,** *PD* **Power Distance,** *MAS* **Masculinity,** *UA* **Uncertainty Avoidance**

12.4.2 Communication

It can be argued that working among a homogenous group in terms of nationality reduces many communication issues. In a globalised world with an increase in multi-national aviation organisations and its challenges in communication (Cookson, 2019; Rice & Stohl, 2006), ICAO mandated its member states in 2003 to introduce harmonised English language proficiency (ELP) licensing[19]. Empirical observation however suggests (Roth, 2016) that unified standards among different member states do still not exist[20]. Good communication skills support the breaking of cultural barriers (Gladwell, 2008, p.197). The work of Meyer (2014) highlights that effective communication among different nationalities correlates strongly on its composition. Low-context versus high-context cultures, for example, act and react differently. Team members should ideally be able to maintain effective, clear and concise communication skills, also under pressure, in a calm manner. The continuous sharing of information by keeping team members in the loop should be paired with active listening. Misunderstandings are quickly resolved and no room for ambiguities maintained.

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[19] ICAO DOC 9835 and CIR 323 and EASA REG No 1178/2011.

[20] ICAO Circular 323.

Mini Case: Understanding English Accents by Emirates Pilots

By Andreas Wittmer and Mark Roth

Emirates Airlines is a truly international company with employees from all over the world running one of the most successful global airlines in the world. The internationality brings intercultural challenges (human factors), for example, with respect to speaking English with different accents (Fig. 12.10).

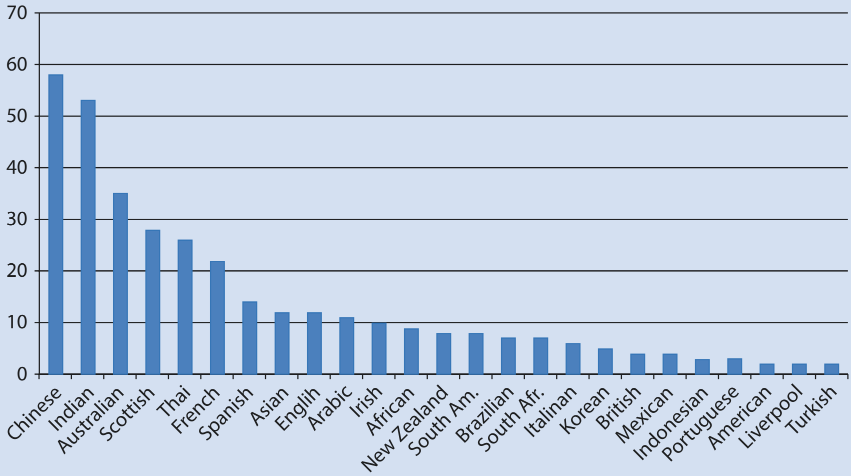

Fig. 12.10 Accents with which flight crew have difficulty understanding while speaking English (Emirates, 2011)

12.4.3 Standard Operating Procedures (SOPs)

Having recognised the importance of communication skills as a key competency of personnel working at the operational level, it is the standard operating procedures (SOPs) that can be referred to as another common language that needs to be established, cultivated and maintained. All airframe manufacturers establish SOPs to safely operate their aircraft with respect to guidelines and limitations. Airlines may add own SOPs in their operator's manuals. Empirical observation suggests that airlines with large multi-national exposure apply SOPs in a relatively strict framework (Roth, 2016). Given the above discussed challenges, this appears to build a solid pillar on the foundation of safety.

12.4.4 Just Culture in an Aviation Context

Today's man-machine-environments in highly efficient, cost-effective and safe systems require careful analysis in regard to its inter-relationships (Song & Xie, 2014; Long & Dhillon, 2016). Whilst common agreement exists that making errors is human, that is, with the old Latin phrase, *errare human est*, dealing with such at the organisational and legislation level appears to create rather diversified conflicts of interest.

The majority of aviation accidents can be associated with human error (Johnson, 1995). Boeing (2007, p.16), for example, estimates that human error accounts for 80% of accidents. In the early days of aviation, machine error was responsible for the majority of accidents; however, technical advancement and progress diverted that number increasingly towards human causes.

An important element of a mature safety culture is based on Just Culture (Reason, 1995). The basic concept, designed by James Reason in the 1990s, has been adopted by various industries and its legislation recognised at national, European and international levels[21]. As opposed to a "blame culture", where the focus lays on individuals and their shortcomings, a "no-blame culture" could be defined as one that steers away from the "who" to the "what". The view of Just Culture is based on an *atmosphere of trust* between the employees and their organisation (Dekker, 2016). Frontline personnel are encouraged (or even rewarded) for reporting safety-relevant information; however, they also understand where the line between acceptable (unpunishable) and unacceptable (punishable) behaviour is to be drawn. This line however, or rather who is drawing it, has sparked much debate between jurisdiction and lawmakers on the one hand, and aviation organisations and its employees on the other hand (Schiller, 2019). It has often made it difficult to implement Just Culture policies in practice. Whilst viewed in a legal framework (courts and prosecutors), voluntary reporting of people, its investigation and findings, may potentially result in criminalisation of individuals[22] (Michaelides & Mateou, 2010). This in turn may have the adverse effect that frontline personnel may no longer feel encouraged to voluntarily report (Wertheimer, 2019; IFATCA, 2019). High-risk organisations should therefore systematically mandate and cultivate such safe environments (Edmondson, 2019).

ICAO (2016) has in the past repeatedly raised concerns in regard to the worldwide implementation of Just Culture policies. At this stage it appears that mainly operators in the Western world have adopted such, which highlights the crucial influence towards embracing such concepts, that national culture may have[23].

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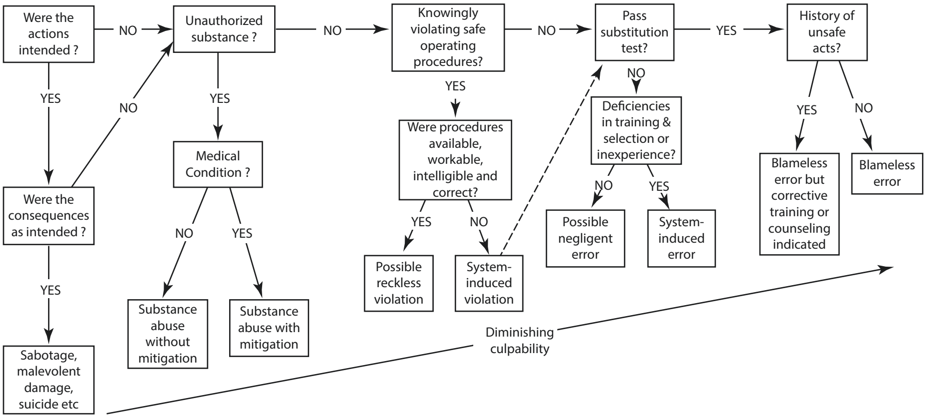
[21] For a detailed outline see Pellegrino F (2019) The Just Culture Principles in Aviation Law, Legal Studies in International, European and Comparative Criminal Law 3, 2019, Springer Nature Switzerland AG.

[22] The Federal Court, Switzerland's highest court, confirmed a verdict of the Federal Criminal Court against an air traffic controller of Skyguide, Switzerland's air traffic control provider, for disruption of public traffic pursuant to Article 237 of the Swiss Criminal Code (decision of 27 June 2019, 6B_1220/2018).

[23] An exception identified was Buddha Air (2020a) from Nepal that was founded by a retired Supreme Court Justice, former Chief Election Commissioner and a minister in the former government of Nepal (Buddha Air, 2020b). In light of above discussed challenges between operators and prosecutors, this appears to be an interesting combination of interests.



◘ **Fig. 12.11** A decision tree for determining the culpability of unsafe acts (Reason, 1995, p. 209)

Furthermore, empirical observation of aviation organisations in the Middle East suggest that such policies may be theoretically be in place (i.e. to be found in some HR manuals), however mainly for compliance purposes rather than being a lived-by culture. In Europe, Eurocontrol (2016) and in Switzerland Skyguide (2017a and b), Wertheimer (2019) and Swiss International all have mandated their organisations to Just Culture (◘ Fig. 12.11).

It could be argued that the identified challenge of "drawing the line" has found an early application by Reason's *decision tree for determining the culpability of unsafe acts* tool. It exemplifies the need for prosecutors and judges to collaboratively work with aviation experts in order to define the decision tree's conclusions. Decisive determination of where this line between acceptable (unpunishable) and unacceptable (punishable) behaviour needs to be set can therefore only be based upon both expertise (Pellegrino, 2019, p.126).

Mini Case: Just Culture Applied Well

By Mark Roth

A fictive example of a Just Culture applied well can be found online at:

► https://www.skyguide.ch/en/company/safety/

Example: Just Culture gone wrong

Captain R and First Officer C have observed during a landing, that the aircraft touched down just shortly after the touchdown zone of the landing runway. As the wind was coming with a nice breeze against the aircraft and the landing weight was very light, they decided to continue the landing on this long runway, which was completed uneventfully. The organisation's operation handbook states, that a landing *should* be in the touch-down zone and a go-around *should* be considered, if this cannot be accomplished. Pilots R and C, in an effort to be honest about their potential error, raised an Air Safety Report and provided all details as required. Two days later, both were taken off from line flying duties and called for a meeting on their day off. Upon entering the room, they quickly understood that not only the Flight Safety Officer was sitting across the long table, but also the deputy chief pilot and a lady from HR. They were swiftly reminded on the regulatory requirements and questioned why a go-around was not flown. After a short gathering of information, the deputy chief pilot without further delay informed the two pilots about the decision to issue them a written warning letter. The HR lady then continued to explain that, should there be any further reason for an additional warning letter during the following 12 months, their contracts may potentially be terminated. Six months after this incident the company decided to change the wording in their operating handbook with due consideration of prevailing conditions (i.e. runway length, wind and aircraft weight) and the possibility to continue a landing. The warning letter however, remained in the two pilots' files.

? Review Questions

- Apart from the above discussed areas, can you think of other parts of the aviation system where human factors and its models can be relevant?
- How do Hofstede's cultural dimensions play a role in the human factors discussion?
- What influence does culture have when employees are faced with having to deal with stressful situations?
- How does the concept of Safety Culture work in your organisation? How do you maintain high standards?
- Which human factors model would you regard as the most comprehensive one?
- What development and shift in human factors programmes would you expect in an increasing globalised world?
- What are benefits and challenges of Just Culture policy in organisations?

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Risk Management in Aviation

Roland Müller and Andreas Wittmer

Contents

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Summary

- Risk Management is an ongoing process based on a systematic collection and analysis of all relevant risks for a company.
- Aviation companies are particularly exposed to risks and must lay special emphasis on a comprehensive Risk Management.
- The quality of Risk Management is extremely dependent on the enterprise culture; an efficient Risk Management starts at a board level.
- In the operational area the Corporate Risk Management may be complemented and optimised by an integrated Safety Management System.
- Risk Management is always opportunity management too.
- For aviation companies it is recommended to consider a D&O-Insurance.

Risk Management is a process based on the systematic collection and analysis of all relevant risks facing a company. Risks are particularly present in the aviation industry, and therefore necessitates a special emphasis on a comprehensive Risk Management. The quality of Risk Management is shaped by the enterprise culture and starts at a board level. By integrating a Safety Management System, the operational area of Corporate Risk Management can be further improved. It is important to realise that Risk Management is opportunity management too, where potential improvements need to be actively identified. For aviation companies it makes sense to evaluate a Director's and Officer's Insurance (D&O) to insure the management against any financial liabilities resulting from damage claims. However, these are expensive and require a time-consuming evaluation.

13.1 Introduction

Risk Management is not a new subject, neither for individuals nor for companies. Risk Management for individuals means the execution of certain actions, providing them with increased control over future events and a confidence to move forward with their interests intact, despite the uncertainty of events ahead (Kalia & Müller, 2019). What is new is the number of legal regulations for Risk Management in enterprises.

In an enterprise, several individuals work together. This already leads to a bundled wish for increased control over the future and risks. In addition, the performance of an enterprise has direct or indirect effects not only on the employees but also on the owners, customers, suppliers and other stakeholders. They all want the enterprise to know their risks and take corresponding mitigation actions. Especially in the aviation industry, operators, pilots and passengers have a greater need for safety and security based on an efficient Risk Management.

All enterprises are confronted with risks. Unfortunately, risks are often recognised too late, so that neither enough time nor adequate measures are available to prevent the resultant damage from the realisation of the risk potential. To prevent this, every far-sighted enterprise management should aim to recognise possible risks and minimise the most dangerous amongst these as far as possible through adequate strategic or surgical measures. Therefore, consciously or unconsciously, every enterprise management pursues Risk Management as a rule (Kalia & Müller, 2019).

Unfortunately, even the best Risk Management System cannot guarantee that all risks are recognised, correctly assessed and appropriately mitigated. In particular, the so-called Black Swan risks, which no one thinks about at all, can suddenly appear and lead to incidents or even accidents. Nevertheless, it is worthwhile to devote sufficient attention and resources to risk management in order to increase the scope for action. At the same time, risks should also be understood as opportunities or chances, as the following case from practice shows.

Mini Case: Risk of Helicopter Crashes at Swiss Rescue Service (REGA) as an Opportunity or Chance for New Revenue Sources

(Rega 2013 with Annual Report 2012. Real flight training – but not in the air. *Swiss Rescue Service Zurich 2013*, 9.)

Rega (Swiss Rescue Service) currently operates 18 helicopters. These are used not only during the day, but also at night and in IMC. The 11 AgustaWestland Da Vinci helicopters are also used in the mountains in difficult weather conditions. It is therefore not surprising that Rega's Master Risk List originally rated the risk potential of helicopter crashes as very high.

The following reasons were identified as the causes for this risk:

- Technical deficiencies
- Operational deficiencies
- Operations with increased risk (weather, night, mountains)
- Human errors
- Inadequate training
- Cause in Crew Resource Management (CRM)
- Lack of risk analysis
- Hasty actions

The Executive Management examined already in 2011 all possible measures to mitigate this risk as part of the individual risk processing. Finally, the following list emerged:

1. Training, living and complying with safety culture guidelines
2. Challenging selection of new pilots
3. Training and CRM
4. Regular training and checks
5. Regular audits
6. Introduction of Safety Management (SMS)
7. Train pilots according to Instrument Flight Rules (IFR)
8. TCAS and Flocie retrofitting
9. Simulator training

In 2011, however, there was no simulator for the Agusta Westland Da Vinci mountain helicopter. The construction and certification of such a new simulator was offered by Agusta Westland at the price of almost two new helicopters. Rega's Foundation Board therefore discussed intensively whether it would really be worthwhile to purchase such an expensive simulator just to mitigate the risk of helicopter crashes. Finally, however, the purchase of a simulator was approved. The annual report 2012 states: "Highly trained crews are crucial for the safety and success of rescue flights. That is why Rega is investing in a simulator for the AgustaWestland Da Vinci helicopter. In addition to 'regular' flight training, it will also be possible to practise accident scenarios realistically and efficiently in the simulator without danger, noise or polluting the environment. ... All Da Vinci helicopter pilots, as well as the paramedics making up the cockpit crew, will complete up to eight training exercises in the simulator every year".

In fact, the pilots and crew members were trained in the simulator for around 600 hours each of the following years. But a simulator can easily be used for up to 2500 hours per year. Rega's Executive Management therefore rented out the simulator to helicopter operators on oil platforms, in particular, during the operating hours that were not required. The rental income ultimately covered the costs of purchasing the simulator very quickly. Since then, the simulator has become an additional source of income for Rega. The risk of a helicopter crash has thus become a real opportunity or chance for Swiss Rescue Service.

13.2 Importance of Risk and Safety Management in Aviation

Aviation systems are characterised by a huge number of complex interactions and interdependencies among stakeholders as well as disastrous consequences in case of an accident. Hence, safety and risk management has accompanied aviation since the early days. What has changed over the last decade is the way how safety in aviation is managed. Safety in aviation can be measured by the number of injured passengers in relation to the flown kilometres. Flying has become the safest industry worldwide with a current ratio of 0.14 casualties per one billion flown kilometres; in other words: a passenger has to fly for 10,297 years each week from Zurich to New York to experience an accident in theory (Maggi, 2009). Given the estimated worldwide air traffic of about 39,000,000 flights, the accident rate is one fatal accident per almost two million flights (Aviation Safety Network airliner accident statistics, 2019). Despite this convincing numbers, all stakeholders in Aviation still concentrate on further improvement of aviation safety.

Technical progress and globalisation triggered and immense growth of the aviation industry, especially between 1944 and 2001. International and national aviation authorities developed minimum safety standards, which led to numerous safety guidelines and regulations. The recent amendments of the International Civil Aviation (ICAO) Annexes 6, 14 and especially 19 (safety management in

◘ **Fig. 13.1** Nexus of risk management and safety management systems. (Author's own figure)

2013, 2nd ed. 2016) have established the obligation for Aviation Service Providers to introduce a Safety Management System (SMS). Therefore, several consultancies offer special services in Risk and Safety Management Systems to aviation industries (e.g. AeroEx in Buchs SG, www.aeroex.eu).

The subject Corporate Governance is important for all companies (small, medium or big, family held or stock quoted, private or public). One recommendation in the leading codes of best practice for Corporate Governance is the implementation of a Risk Management System (RMS). The actual UK Corporate Governance Code (Financial Reporting Council, 2010) demands in chapter A.1: the board of directors has to control that the systems of risk management are robust and defensible. In addition, UK Financial Services Authority (FSA) Rule 7.2.5 requires companies to describe the main features of the internal control and Risk Management Systems in relation to the financial reporting process.

The overall risk management in the context of Corporate Governance has to be distinguished from the focused operational risk management in aviation. 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 effected by an organisation's structure, work and authority flows and people and management information systems. It is designed to help the organisation accomplish specific goals or objectives.

The challenge for the aviation industry is to combine the 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 follows (◘ Fig. 13.1):

Research by the Board Foundation (International Board Foundation, n.d.) showed that one of the main mistakes made by the Management Board was an insufficient or missing risk management. That is why risk management assumes a key significance in the area of corporate governance (Müller et al., 2014). The 10 most common and important mistakes and deficiencies at a board level are listed as follows (► Box 13.1):

Box 13.1 Mistakes and Deficiencies at Board Level (Kalia & Müller, 2019)

1. Wrong structure and insufficient qualification of the Board of Directors (BoD), particularly concerning the function of the Chairman combined with the absence of the non-executive Board members.
2. Board members are not sufficiently prepared and do not have the necessary overview.
3. Board decisions are influenced by conflicts of interests supported by insufficient internal regulations.
4. Missing or insufficient strategy identifications and strategy control.
5. Missing or insufficient risk management, particularly concerning liquidity planning and succession regulations.
6. Low frequency of board meetings, so that the Board of Directors can only react to changes and events instead of being proactive.
7. Unsatisfactory provision of information and information evaluation, by insufficient or delayed reporting to the Board of Directors in particular.
8. Delayed or incorrect decision making, according to incomplete decision documents in particular.
9. Insufficient cooperation between Board of Directors and Executive Management, in particular unclear allocation of duties and competence.
10. Absence of periodic evaluation of the Board members and Executive Management; inefficient Board and Executive Board members are replaced too late.

13.3 Definitions in Risk Management

▪ Hazard

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

▪ Hazard Identification

Hazard identification (HAZID) is the process of identifying hazards, which forms the essential first step of a risk assessment (ICAO, 2016). There are two possible purposes in identifying hazards: to obtain a list of hazards for subsequent evaluation using other risk assessment techniques (failure case selection) and to perform a qualitative evaluation of the significance of hazards and the measures for reducing the resulting risks (hazard assessment).

Risk

Risks are unforeseen deviations from the expected values caused by accidental interferences deriving from the unpredictability of the future (Gleissner & Romeike, 2005). The ratio between the probability of occurrence and the expected measure of damages is referred to as individual risk (Müller et al., 2014). Besides the negative implication of risk, risk management is always a balancing act between risk opportunities and threats.

Risk Management

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 analysing and prioritising recognised risks, as well as defining and implementing adequate strategic or surgical measures to minimise non-tolerable risks (Kalia & Müller, 2019). The overall strategy, the crisis management and the regulation of damages are not part of the Risk Management.

Safety

The state in which the possibility of harm to persons or of property damage is reduced to, and maintained at or below, an acceptable level through a continuing process of hazard identification and safety risk management (ICAO, 2016). In the context of SMS, the ICAO manual defines the feasible and acceptable level of safety as ALARP (as low as reasonably possible). The SMS's primary aim is to reduce its risk to an acceptable level of safety (ALOS) defined by the Civil Aviation Authority (CAA). Risk cannot be reduced to zero; therefore, the risk is measured against an acceptable level of safety.

Safety Culture

Safety culture is the set of enduring values and attitudes regarding safety issues, shared by every member at every level of an organisation. Safety culture refers to the extent to which every individual and every group of the organisation is aware of the risks and unknown hazards induced by its activities, is continuously behaving to preserve and enhance safety, is willing and able to adapt itself when facing safety issues and is willing to communicate safety issues as well as consistently evaluates safety related behaviour (ECAST, 2010).

Safety Management System

Safety Management System (SMS) can be characterised by a "dynamic Risk Management System based on quality management principles in a structure scaled appropriately to the operational risk, applied in a safety culture environment" (Stolzer et al., 2008). One important part of SMS consists of the (proactive) identification of potential hazards, linking them to realistic consequences and evaluating them with a probability and severity of impact. Secondly, SMS includes the whole process of safety assurance by a performance based monitoring of the implemented mitigation actions and a periodical reassessment of the safety situation. Safety Management's aim is to establish an organisational safety culture. It also includes appropriate Safety Training. The SMS is not a substitute for compliance with regulation and has the necessary infrastructure, facilities, working procedures and competent personnel.

- **Security**

Security must be distinguished from safety. According to the regulation 300/2008 of the European Parliament "aviation security" means a combination of measures and human and material resources intended to safeguard civil aviation against acts of unlawful interference that jeopardise the security of civil aviation. Further, "security control" means the application of means by which the introduction of prohibited articles may be prevented.

13.4 Implementing a Risk Management System

13.4.1 Integration in Corporate Governance

Until about 1970, risk management had been focused on financial risks, especially the risk of debtor losses. In the next 10 years, the risk range was extended with operational risks. In the last decade of the century, 2000 market and liquidity risks had been added to the risk frame. Only at the beginning of this century, corporate governance completed the risk radar (Fig. 13.2):

The Risk Management process does not have its own dynamics; it should therefore be integrated in the internal and external audit and strategy process. Objectives flow from strategy into the Risk Management process; the results of the risk considerations are not only important for the priorities of the Audit plan, but also for the SWOT analysis in the strategy process (Boutellier & Kalia, 2006).

Fig. 13.2 Risk radar for corporate risk management (Kägi & Pauli, 2003)

One of the important ways to complete the link between strategy and Risk Management is to have a feedback loop from the Risk Management function to the strategy function. This is normally not done (and if done at all, this occurs implicitly through reporting mechanisms); doing so, however, provides a clear picture of how the risks and Risk Management have performed in terms of achieving strategic objectives. This will facilitate integrating information also from the subsidiaries and divisions into the next strategy and Risk Management cycle. To do this, a brief proposal should be provided by the Risk Management function to the strategy implementation function for the beginning of the next strategy implementation cycle. The risk feedback from the subsidiaries could have clear and important implications for the strategy process (Kalia & Müller, 2019).

13.4.2 Ten Steps for the Implementation of a Corporate Risk Management

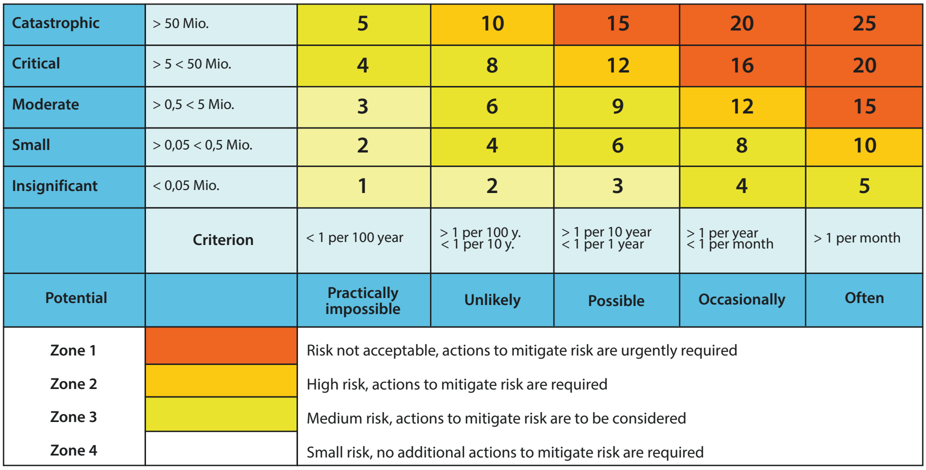
The introduction and implementation of a risk management in an aviation enterprise can be carried out according to the following steps (Müller et al., 2014):

1. Determine the risk organisation and nominate a project manager
2. Collect all possible risks by SWOT analysis and questionnaire
3. Determine the relevant risks and evaluate by risk assessment
4. Creating a Master Risk List with priorities
5. Decision on a risk policy by the Board of Directors
6. Check possible measures to reduce the important risks including insurance evaluation
7. Definition of specific mitigation measures with the corresponding budget
8. Introduction of a risk reporting system
9. Analysis of accidents and incidents under the view of new risks
10. Periodic review of the organisation, the process and the Master Risk List

The risk organisation can be determined in three different ways. The Board of Directors can carry out the duty alone. For small companies this is an appropriate solution. In bigger companies the task should be delegated to the audit committee or to a special risk management committee. But even with such a delegation, the Board of Directors remains responsible for the process and for the information given on the subject in the annual report.

The SWOT analysis includes actual risks for the business, but this collection is never complete. Therefore, it is necessary to question all employees with a special questionnaire. Directors and officers have to answer the question in the same way. This bottom-up and top-down approaches furnish the best results. The Swiss Air-Rescue Rega collected a total of 520 risks in the year 2007 from its employees. After the first evaluation, 350 relevant risks remained and were further judged in a risk assessment according to the following matrix (Müller et al., 2014) (■ Table 13.1):

Table 13.1 Risk potential evaluated by a risk assessment (Müller et al., 2014)



Catastrophic	> 50 Mio.	**5**	**10**	**15**	**20**	**25**
Critical	> 5 < 50 Mio.	**4**	**8**	**12**	**16**	**20**
Moderate	> 0,5 < 5 Mio.	**3**	**6**	**9**	**12**	**15**
Small	> 0,05 < 0,5 Mio.	**2**	**4**	**6**	**8**	**10**
Insignificant	< 0,05 Mio.	**1**	**2**	**3**	**4**	**5**
	Criterion	< 1 per 100 year	> 1 per 100 y. < 1 per 10 y.	> 1 per 10 year < 1 per 1 year	> 1 per year < 1 per month	> 1 per month
Potential		**Practically impossible**	**Unlikely**	**Possible**	**Occasionally**	**Often**
Zone 1	🟥	Risk not acceptable, actions to mitigate risk are urgently required				
Zone 2	🟧	High risk, actions to mitigate risk are required				
Zone 3	🟨	Medium risk, actions to mitigate risk are to be considered				
Zone 4	⬜	Small risk, no additional actions to mitigate risk are required				

The risk assessment classifies the identified risks based on probability and impact. It suffices to judge the risks appropriate to the organisation. The focus of the risk assessment lies in the risk perception, and not in the exact estimates of the probability. It is suggested to use a five-by-five matrix to display the risks in an overview. For risks with an advance warning time, the use of a surprise factor may be appropriate (reduction of the probability by the multiple 1). As an example for the outcome of a risk assessment, the first part of the Master Risk List of a regional airport is shown below. The top risk is an income subject and the second rank is a security issue, both huge problems of airports (Schulz et al., 2010) (Table 13.2).

As part of the risk management strategy, the Board of Directors sets the risk management strategy based on the risk policy and decides for each risk whether it is acceptable or not. Furthermore, the Board defines the appropriate mitigation strategy. The mitigation process has to be supervised and controlled. Therefore, it helps to define key performance indicators (KPIs) or other measurable indicators to supervise the implementation process.

Risk Management is not a one-time achievement but a steady and ongoing process. Therefore, the Board of Directors and the Executive Board should at least review the whole risk management process and the top 10 risks on the updated Master Risk List on a yearly basis. This may also include risk-reporting possibilities (Kalia & Müller, 2019). In conclusion, a mature Risk Management System, in contrast to an ad-hoc Risk Management System which only aims to comply with legal standards, is an important factor for the success of an aviation enterprise. Risk management has to become a part of the company's culture in order to unfold its full potential.

Table 13.2 Master risk list of a regional airport

Risk title	**Risk description**	**Prob-ability**	**Impact**	**Poten-tial**	**Rank**
Reduction of passenger numbers	Airlines cancel rotations because of financial problems or because of a pandemic	3	4	12	**1**
Attack	Sabotage or terror attacks	2	5	10	**2**
Withdrawal of licence	Withdrawal of operating permit for political of regulatory reasons	2	5	10	**3**
Aircraft accidents	Accident of airliner or chartered aircraft	2	5	10	**4**
Lighting	Accidents are caused by missing or weak lighting on runways or airfields	3	3	9	**5**
Obstacle clearance	Construction within the obstacle area cannot be prevented for the lack of eminent domain	3	3	9	**6**
Towing risk	Accident at the tow of big aircrafts or many parked aircrafts	3	3	9	**7**
Aircraft stairway	Accident of a passenger leaving the aircraft on an unsuitable stairway	3	3	9	**8**
Static tests	Accidents resulting from static tests	3	3	9	**9**
Static test areas	Prohibition of static tests without measures against acoustic noise	3	3	9	**10**
Market risks	Higher costs/lower revenues	3	3	9	**11**
Collision of vehicle with aircraft	Collision of vehicles with aircrafts on tarmac or taxiway	3	3	9	**12**
Damages to persons	Damages to persons on tarmac (passengers, employees, suppliers)	3	3	9	**13**
Confusion of the type of fuel	Filling with the wrong type of fuel	2	4	8	**14**
Fuel tank	Detonation of fuel tank	2	4	8	**15**
Animals	Accidents due to animals on the runway	2	4	8	**16**

(continued)

Table 13.2 (continued)

Risk title	Risk description	Probability	Impact	Potential	Rank
Helicopter landing pad	Helicopter collides with fuel station and causes detonation	2	4	8	**17**
Case of fire	Case of fire in the administrative building, terminal or hangar	2	4	8	**18**
Constraints of the Federal Office of Civil Aviation (FOCA)	Non-compliance with the constraints of the FOCA either leads to limitations imposed by national or local legislation or to accidents	2	4	8	**19**
Fire brigade	In the event of an accident not enough staff or material is available according to regulations	2	4	8	**20**
Runway conditions	Accident due to inadequately maintained runways	2	4	8	**21**
Personnel gaps	Personnel gaps without representation or without licence leads to business interruptions	3	2	6	**22**
Jet blast	Accidents resulting from jet blast at the end of the runway	3	2	6	**24**
Vandalism	Devastation caused by airport opponents or dismissed employees	3	2	6	**26**
Working atmosphere	Operational failure due to strike or accident caused by violation of regulations	2	3	6	**27**
Taxiway conditions	Accident due to inadequately maintained taxiways	2	3	6	**28**
Fuel leakage	Leakage of fuel from aircrafts or fuel tanks	3	2	6	**29**
Collision with tank lorry	Collision of a tank lorry with aircraft	2	3	6	**30**

Table compiled by author

13.4.3 Safety Management System Based on Corporate Risk Management

Safety concept in aviation may have different purposes, for example (ICAO, 2016):

- Zero accidents or serious incidents
- Freedom from hazards
- Attitudes of employees of aviation organisations towards unsafe acts and conditions
- Error avoidance
- Regulatory compliance

Whatever the purposes are, they all have one underlying commonality: the possibility of absolute control. Zero accidents, freedom from hazards, and so forth, convey the idea that it would be possible to bring all variables that can precipitate bad or damaging outcomes under control. However, while the elimination of accidents and/or serious incidents and the achievement of absolute control are certainly desirable, they are unachievable goals in open and dynamic operational contexts. Hazards are integral components of operational contexts in aviation. Failures and operational errors will occur in aviation, in spite of the best and most accomplished efforts to prevent them. No human activity or human-made system can be guaranteed to be absolutely free from hazards and operational errors (ICAO, 2016).

Safety is therefore a concept that must encompass relatives rather than absolutes, whereby safety risks arising from the consequences of hazards in operational contexts must be acceptable in an inherently safe system. The key issue still resides in control, but relative rather than absolute control. As long as safety risks and operational errors are kept under a reasonable degree of control, a system as open and dynamic as commercial civil aviation is considered to be safe. In other words, safety risks and operational errors that are controlled to a reasonable degree are acceptable in an inherently safe system (ICAO, 2016). Safety Management exists since the early days of aviation. What has changed over the years is the way we handle them. Where risk management was once done by a “fly-crash-fix-fly” approach, Safety Management nowadays tries to deal more intensely with the complexity of an aviation system. The ICAO manual illustrates this with a good example: when one leans on a windowsill, there is the danger of pushing the flowerpot out of the window. In this case, the traditional approach in Safety Management would lead to reminders about being careful when leaning on windowsills. Current Safety Management would result in an installation of a containment net under the window (ICAO, 2016).

Relevant for the implementation of SMS are the standards and recommended practices (SARPs). They can be found in the ICAO annexes 6, 11, 14, 19 and in the ICAO Safety Management Manual. 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. Until now, only 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 maximum take-off weight. Furthermore, every organisation needs to have a person accountable for managing the program (EU-OPS, Council Regulation No. 3922/91). Despite the fact that EASA concluded that EU-OPS is consistent with the major principles of the ICAO SMS, the EASA already placed a notice of proposed amendment (NPA). The NPA-2008-22c mainly contains the ICAO standards with more detailed requirements for small operations.

13.5 Director's and Officer's Insurance

Rising awareness for issues related to Corporate Governance among authorities, the media and shareholders, as well as a growing number of liability occasionally supported by litigation finance companies, lead to an increasing demand for adequate insurance cover for members of the strategic and operational management levels. This shall insure them if they should become subject to civil action for damages. In the English-speaking world, the Director's and Officer's Insurance was established for this purpose. Initially, it was argued that this kind of insurance would make institutions rely on the insurance coverage, and therefore neglect their own duties. Within a short period of time, it became evident, though, that even D&O-Insurances provide only a limited degree of protection, and that it is still imperative for institutions to carry out their duties diligently. However, these insurances have contributed to the fact that liability claims are brought in front of court more frequently than in the past.

In view of the many risks in aviation enterprises, the Board of Directors should evaluate the possibility, the costs and the advantages of a D&O-Insurance in connection with risk management. Concluding a D&O-Insurance contract is far from easy and a time-consuming affair. The insurers request detailed information via extensive questionnaires, plus miscellaneous business documents. If existing risks are not disclosed, the insurance will not cover related claims. The terms of policy as well as the determination of insurance coverage differ between various insurance companies. It is recommended to consult a specialist insurance broker in D&O-Insurance and compare different offers.

All D&O-Insurances are based on the "Claims-Made-principle". Only those damages that are claimed during the policy period are covered. A pre-risk coverage covers damages which were caused before the start of the policy, but which are claimed within the term of the insurance. This type of insurance generally exists, if the damage or the consequent claim was unknown at the time the insurance was taken out. In principle, those claims that are asserted after the insurance has expired – and the insurance had not been renewed – are not covered. This is true even if the damage was caused during the policy period. In this case, an extended reporting period of 1–3 years can be purchased. However, this special cover has to be agreed on before the end of the insurance contract. Instances that may lead to a claim can be reported in writing until the insurance expires. If these instances lead to damage claims after the insurance has expired, they will be treated as if they had been asserted at the time of reporting. Importantly, this special cover also needs to be arranged explicitly.

Basically all members of the strategic and operational management levels are insured:

- Members of the Board of Directors and members of the Supervisory Board
- Members of the management board
- Members of the internal company board of control
- Members acting as de facto legal bodies
- According to contractual arrangements the following can also be insured:
- Spouses, heirs and legal representatives of the defendants
- Co-defendant employees
- Board of Directors of third-party companies

All management members of the policy holder are insured. If the policy holder is a holding company, the management members of the company's subsidiaries are also included. A subsidiary in this case is a company of which the holding company directly or indirectly owns more than 50% of the voting rights or owns 20–50% of the voting rights and additionally exercises a dominant influence on the management of the company. Future risks for newly founded subsidiaries or companies that have been taken over are partially covered as well. It is important to note that coverage is not automatically provided to all new subsidiaries. Any agreements on exclusions such as geographical areas included, financial institutions, the size of the balance sheet total, etc., should urgently be looked at.

At first sight, the services offered are comprehensive:

- Damages and costs which are imposed on the Board of Directors and managers
- Defence of unjustified claims
- Assumption of defence costs (experts' and legal costs, which are related to the complaint)
- Consequential loss caused by mass redundancy and severance schemes

In fact, important coverage exclusions and additional individual coverage exclusions, such as financial transactions within the group, are regularly set within the general conditions of the D&O-Insurances:

- Punishable acts or omissions
- Personal injuries and property as well as environmental damage
- Internal liability (company against organs)
- Social contributions
- Demands of a major shareholder (from about 15–20% voting right upwards)
- Liability against the group resulting from vocational guidance
- Crimes of honour and money laundering

? Review Questions

- How can Risk Management and HAZID be defined?
- What is the difference between safety and security in aviation?
- How can a risk also be an opportunity or a chance?
- What are the 10 most common and important mistakes and deficiencies of BoD?
- How can a Risk Management System be implemented in an aviation enterprise?
- How can the concrete potential of a risk be evaluated?

- What are the top-rated risks of an airport?
- What different purposes does a safety concept in aviation have?
- Which regulations are important for the Safety Management System?
- Who is protected by a Director's and Officer's Insurance?
- What is not covered by a Director's and Officer's Insurance?

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14

Aviation Governance

Roland Müller

Contents

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Summary

- Corporate Governance in aviation is important for the long-term success of all enterprises in the aviation industry.
- Corporate Governance produces a measurable added value for the company itself, for their shareholders and stakeholders.
- Corporate Governance has two main functions in aviation companies: clarification of organisational rules (who has which tasks, competences and responsibilities) and clarification of organisational relationships (content and conditions of internal and external contracts).
- Building a talented board of directors in an aviation enterprise is a challenge but one of the key elements for an efficient steering and controlling.
- Aviation Governance should be established on four levels: situational, strategic, integrated and controlled.

In aviation, Corporate Governance is important as it produces a measurable added value for the company itself, its shareholders and stakeholders. Corporate Governance has got two main functions: clarification of organisational rules and organisational relationships. For this, governance, risk and compliance systems are created that consist of control, compliance and risk management as well as an internal audit mechanism. To ensure an efficient steering and controlling under Corporate Governance, it is key to build a talented board of directors in an aviation enterprise. Furthermore, Aviation Governance should be established on four levels: situational, strategic, integrated and controlled.

14.1 Introduction

Corporate Governance was an issue for the first time in 1930 after shareholders had experienced the dramatic stock market crash of 1929. It became obvious that shareholders only have a theoretical power. The real power in a company rests with the board of directors (BoD). After the publication of the first UK Code for Corporate Governance 1992, the subject had been discussed in a larger circle. Specific recommendations for improving the interaction of shareholders, stakeholders, BoD and Executive Management (EM) were available now.

Today, over 120 Codes for Corporate Governance exist worldwide, and an almost incalculable amount of literature is published on this subject. Even the jurisdiction relating to liability claims against directors and officers were influenced by the debate on this issue. Nowadays, it is clear that even an effective Corporate Governance cannot guarantee the success of an enterprise, but it can support it to a considerable degree. In particular, the composition of the BoD and the internal regulation of tasks and competencies of the strategic and executive management are critical factors for long-term success. Corporate Governance is therefore of particular importance in the complex aviation system.

14.2 Significance and Function of Corporate Governance

The term “Aviation Governance” is the shortened form for “Corporate Governance in aviation”. Corporate Governance can be defined by a word-for-word translation for “leading a corporation”. But the meaning of this term is much broader. One of the leading experts for Corporate Governance, Sir Adrian Cadbury, summarised the meaning as follows: “Corporate Governance is concerned with holding the balance between economic and social goals and between individual and communal goals. The aim is to align the interests of individuals, corporations and the society as closely as possible”. (Cadbury, 1999). Corporate Governance is also a set of relationships between a company’s management and its board, shareholders and other stakeholders (OECD, 2015); it is the system by which companies are strategically directed, integratively managed as well as holistically controlled in an entrepreneurial and ethical way, in a manner appropriate to each particular context (Hilb, 2008).

In the Swiss Code of Best Practice for Corporate Governance, edited by Economiesuisse (2014), Corporate Governance is defined as a guiding principle: “Corporate governance encompasses all of the principles aimed at safeguarding sustainable company interests. While maintaining decision-making capability and efficiency at the highest level of a company, these principles are intended to guarantee transparency and a healthy balance of management and control”. In fact, Corporate Governance comprises principles for all types of companies, even for non-profit organisations and for all other fields of business. Therefore, Corporate Governance is also an important subject for the aviation industry.

Codes for best practices of Corporate Governance have been established all around the world, but differ from country to country (the European Corporate Governance Institute provides a list of all codes: ▶ https://ecgi.global/content/codes). The most important and most relevant countries to consider hereby are the United Kingdom (Cadbury Report, Combined Code), South Africa (King’s Report) and the United States. (Sarbanes-Oxley Act). The London Stock Exchange published a practical guide to help the board of directors implement the recommendations found in the UK Combined Code in 2004 (London Stock Exchange, 2004). This guide is highly recommended and worth downloading from ▶ www.londonstockexchange.com.

In all codes one point has a high priority: the problem of power and control in complex organisations. Therefore, checks and balances in the outer and inner circle of a company are very important. This situation can be illustrated with two triangles, where one is surrounded by the other, as shown (Böckli, 1996) (◘ Fig. 14.1):

Corporate Governance has two different functions (Müller, 2004):

- *In the sense of organisational control*: uppermost constitution of business management, that is, appropriate specification of the tasks and functional structuring and formation of the topmost management bodies.
- *In the sense of organisational correlation*: relationship of the uppermost management bodies to the shareholders and to business relevant shareholder groups (Shareholder Value and Stakeholder Value).

Fig. 14.1 Corporate Governance as a system of checks and balance. (Author's own figure based on Böckli, 1996)

The codes for Corporate Governance, for the most part, contain no absolute obligatory provisions. Rather, deviations from the recommendations are possible, but then there must be justification for this deviation, fully in the sense of "comply or explain". If a company fulfils all recommendations for Corporate Governance, it is enough to declare this in the annual report. If there is a deviation, three measures have to be taken. Firstly, it must be explained why a certain recommendation is not being followed. Secondly, it is to point out which solution is chosen in its place (or, in the event of "large-scale rejection", why a solution is not considered necessary). Finally, the management has to declare that the chosen solution will be strictly followed as described (Financial Reporting Council, 2018a).

Good Corporate Governance is based on clear structures and strategies. Therefore, bylaws, regulations, minutes and other documents are necessary. This is linked with formalism and expenditure of time. But the outcome of good Corporate Governance is a clear value proved by the following 10 points (based on Müller, 2004):

1. Appropriate Relationship Between Owners and Management.

The owners can clarify their goals and values in a written owner's strategy. Based on that, the board of directors has to establish an appropriate business strategy. The owner's strategy provides clarity and a clean separation of roles between owners and management.

2. Efficiency in Management and Control.

Clear tasks, precise skills and responsibilities are associated with an increase in the clarity of leadership. This leads to a more accurate implementation of controlling and reporting, which ultimately leads to an improvement in strategic leadership. The focus on the clear central task stimulates awareness and encourages the development of core competencies.

3. Reduction of the Leadership Effort.

Clear roles and responsibilities reduce tensions in the management and avoid unnecessary duplication. The leadership effort can be reduced.

4. Improvement of the Ratings for Banks.

New banking regulations require detailed audits of clients and transactions. Not only hard facts, such as balance sheets and income statements, but also soft facts, like the composition of the board of directors and the name of the audit company, are important nowadays for bank rating. As a result, compliance with the recommendations of Good Corporate Governance will improve the creditworthiness.

5. Reduction of Insurance Premiums.

Risk management is an integral part of Corporate Governance. Risks are systematically collected, assessed and mitigated as far as possible. The insurance company will receive an objective and complete overview of the risk situation. As a result, the company benefits from reduced insurance premiums.

6. Strengthening Customer Relationships.

Customers who rely on stable relationships are guaranteed to have a supplier who places a big importance on continuity and long-term business development. On this basis, stable customer relationships are built and established.

7. Improvement of Supplier Relations.

Companies with a consistent implementation of Corporate Governance, in particular with respect to the quality focus, are reliable partner suppliers.

8. Simplification of Cooperation.

Joint ventures between companies and cooperation in group structures become easier with transparent and well-documented organisations. Corporate Governance can help simplify such cooperation.

9. Liability Prevention.

In most countries, the "Business Judgement Rule" is applied in court. According to this rule, the judges have to consider whether the directors or officers have acted as a reasonable businessman in a concrete situation. Today, judges expect the management to comply with the recommendation for good Corporate Governance.

10. Improvement of Ethic Conduct.

Aviation companies with a careful implementation of Corporate Governance guidelines improve the ethic conduct of all employees. Corruption and bribes cannot be ruled out by clear guidelines, but at least reduced.

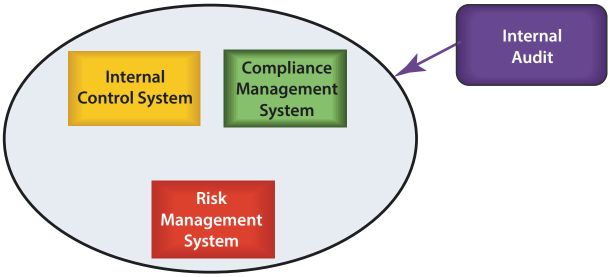

Fig. 14.2 Modern GRC system (governance, risk and compliance system). (Author’s own figure)

14.3 Modern GRC System for the Aviation Industry

Corporate Governance has a special significance for the whole aviation industry. Every company that manufactures, maintains or operates aircraft, but also every airport and air traffic control centre must have a special focus on safety and security. As a consequence, risk management is the first subject of Corporate Governance with a special importance for the aviation industry. The second point is the monitoring and documentation of the processes through an Internal Control System (ICS). And finally, the third point is to ensure compliance with all external and internal regulations. An enormous number of national and international regulations must be followed and monitored especially from the International Civil Aviation Organization (ICAO) or from the European Aviation Safety Agency (EASA). These three systems should be implemented and monitored by the board of directors. An internal audit can also be used for this purpose. This creates a modern GRC system (Governance, Risk and Compliance System), which can be graphically represented as follows (Fig. 14.2):

Of course, these three systems are not enough on their own. Another subject of Corporate Governance with special importance to the aviation industry is the financial planning and controlling. Aviation enterprises require high financial resources. The frequency and the amplitude between profits and losses are much higher than in any other industry.

14.4 Building a Talented Board of Directors

The composition of the board of directors (BoD) and of the executive management (EM) is another important subject of Corporate Governance. However, the rights and duties of a board of directors vary greatly depending on the national company law.

In countries with a *monistic system (single-tier)*, members of the executive board can also be elected to the board of directors. Such BoD usually have important and non-delegable duties. Countries influenced by the “common law” legal tradition have a monistic system. These include Great Britain, Ireland, Malta and Cyprus. However, some other European countries have also adopted this system, such as Belgium, Greece, Iceland, Luxembourg, Spain, Sweden and Switzerland.

In countries with a dualistic system (two-tier), there is a strict separation of personnel between the board of directors and the executive board. The dualistic system is particularly pronounced in Germany, the Netherlands, Denmark and Austria. In these countries, the BoD mainly have the task of appointing and supervising the members of the executive board. All other tasks, in particular the definition of strategy and the financial monitoring and control of the company, are assigned to the executive board.

The board of directors is a group of individuals who are elected by stockholders to establish corporate management policies and make decisions on major company issues, such as company strategy. The board of directors' role is to provide entrepreneurial leadership of the company within a framework of prudent and effective controls, set strategic aims and set the company's values and standards as well as ensure that its obligations to its shareholders and others are understood and met (Financial Reporting Council, 2008 and 2018a). Therefore, it is clear that the board of directors is a key element for the success of a company.

Building a talented and efficient board of directors is demanding. Especially, the balance between requests and remuneration is difficult to find. A practical exercise can make the facts clearer.

Define Key Elements (Number of Members, Personal and Social Skills, Constitution and Committees) for a Talented Board in the Following Company

- Airline with home base in Europe.
- Operating 3 A-320 and 3 Dash 8–300.
- Destinations in Europe only.
- 150 employees
- EASA Part-145 licence for repair and overhaul.
- Low price strategy with small administration.
- Actual family owners with target initial public offering (IPO).

The number of members should be three for small companies, five for medium companies and seven for big and public listed companies. An odd number is favourable to prevent stalemates. The criteria for the distinction in small, medium or big companies are assets, turnover and employees. In the European countries, the following figures are significant (◘ Table 14.1):

◘ **Table 14.1** Qualification criteria for enterprise categories

Enterprise category	Headcount	Turnover	or	Balance sheet total
Medium-sized	<250	≤€ 50 million		≤ € 43 million
Small	<50	≤€ 10 million		≤ € 10 million
Micro	<10	≤€ 2 million		≤ € 2 million

European Commission Recommendation 2003/361/EC

In Switzerland, the criteria are the same, but according to Art. 727 of the Swiss Code of Obligations (CO) the figures are different to qualify a big enterprise: more than CHF 20 Mio. assets, more than CHF 40 Mio. turnover and more than 250 FTE (full time employees).

In medium and big companies, the chairman of the board and the CEO should not act in personal union due to the resulting advantages and disadvantages:

- Advantages of a personal union:
  - Detailed knowledge in technical and business concerns.
  - Current and direct information by means of the management function.
  - Versatile opportunities for self-motivation via profit sharing.
  - Safeguarding pursuant to employment law and according to social insurance law.
- Disadvantages of a personal union:
  - Independence and with that limited objectivity.
  - Risk of pursuing own interests.
  - Insufficient information of the remaining executive boards.
  - Difficult control can cause tension in the executive board.

The nomination of a chairman is compulsory, that of a vice-chairman is optional. But a vice-chairman is recommended because the chairman could get ill or have an accident, and in consequence would no more be able to fulfil his duty. Furthermore, the chairman could have a conflict of interest. In all these cases, it is useful when the vice-chairman can lead the meeting of the board of directors.

The most important point is the optimal selection of the board members. The majority should be non-executive and independent. This qualification is only fulfilled by a person who has not been an employee of an aviation enterprise in the last 5 years, who is not an important shareholder, customer or supplier and who has no close relationship with the auditor. Each member should have useful knowledge and helpful social skills to complement the aspect of a general view on the whole board of directors. To be sure that all the requested skills are represented, the following matrix is helpful (◘ Table 14.2):

It is necessary to carefully select the secretary of the board because he has access to all documents, hears everything in the meetings and even knows the details of the enterprise strategy. He/she must be absolutely loyal to the company and keep secrets strictly confidential. An ideal but expensive solution is the appointment of a lawyer as the board secretary. In this connection, it should be added that minutes of meetings are very important not only for the company but especially for the board members. In cases of responsibility and liability, minutes are the sources for accusation and defence. Short minutes without details of discussions or documents as basis are almost worthless. Minutes should always be signed by the chairman and the secretary. Further information and help for taking minutes can be found in Müller (2015).

Art. 716a CO assigns the ultimate direction of the company to the board of directors, which has non-transferable and inalienable duties. The board is responsible for the following:

Table 14.2 Optimal composition of the board of directors

Social role Know how	Coach/ team-player	Analyst	Critic	Entrepreneur	Sponsor/ communicator
Auditing/controlling					
Aviation knowledge					
Marketing/customer					
Risk management / compliance					
Human resources/ international relations					

Hilb (2008)

(a) The ultimate management of the company and giving of relevant directives.
(b) The establishment of the organisation.
(c) The structuring of the accounting system and the financial controls, as well as the financial planning.
(d) The appointment and removal of the persons entrusted with the management and representation of the company.
(e) The ultimate supervision of the persons entrusted with the management of the company in particular in view of compliance with the law, the articles of incorporation, regulations and directives.
(f) The preparation of the business report, as well as the preparation of the general meeting of shareholders and the implementation of its resolutions.
(g) The notification of the judge in the case of over indebtedness.

Furthermore, Art. 717 CO states that the board of directors shall perform their duties with due care and will safeguard the interests of the company. If a member of the board of directors has a conflict of interest, this problem must be disclosed in accordance with Art. 717a CO. The board of directors must then immediately take all measures to ensure that the conflict of interest does not influence the decisions of the board of directors.

The board of directors issues organisational regulations, which are based on Art. 716b CO. They define the organisation, responsibilities and authority of the executive bodies or spheres within a company, that is, the board of directors and its members, committees and chairman; the chief executive officer as well as the executive management of the company, and its subsidiaries and divisions. Such organisational regulations are generally concerned with the operation of the organisation, setting out the form, manner or procedure in which a company should run. Although organisational regulations tend to contain some aspects of Corporate Governance, the section remains rather limited in scope and has a different purpose. Internal Corporate Governance guidelines provide the framework for governance in a company; they promote the effective functioning of the board and its committees and establish a set of expectations as to how the board should perform its functions. They promote the interests of shareholders and further the company's commitment to best practices in Corporate Governance.

The case of Swissair, which is summarised below, demonstrates how important the composition of the board of directors is. Even though these events leading to grounding of the entire Swissair fleet took place over 20 years ago, this case is still am impressive example of how bad Corporate Governance can lead to the demise of a company. Rightfully, Prof. Martin Hilb concludes from his analysis of several real cases that:

> The board of directors should possess in breadth the same market/product and functional know-how as top management, to be able to direct and control effectively and efficiently. Complementary team roles such as the roles of a critical thinker, a controller or a creative thinker have to be present on the board. Furthermore, each member should play the role of one stakeholder such as customer, shareholder, employee and society/environment. (Hilb, 2021).

A special question that should also be clarified in the organisational regulations is the benefit or the unnecessary expense of committees. According to the Swiss Code of Best Practice for Corporate Governance, it is recommended to form three committees: an audit committee, a nomination committee and a remuneration committee. But in boards with only three members, it should be seriously evaluated if such committees are really helpful. A committee is always a way to focus on a special task. Therefore, it is usually an advantage to have at least an audit committee to concentrate on financial aspects. The nomination and remuneration committee can be merged into one for practical reasons. For example, it is not possible to find a CEO without discussing the remuneration.

Audit committee members need to be able to evaluate and supervise any issue of internal auditing and external financial reporting. Many audit committees are also responsible for overseeing risk management. Therefore, it is essential that audit committee members have the financial skills and capabilities to carry out these activities adequately. Corporate Governance codes recommend that board committees are composed of non-executive and preferably independent members. Non-executive directors are board members who do not simultaneously serve as members of the management board. Independent directors are individuals who are not affiliated with the company, whether in a shareholding, supplier, customer, consulting, family or current or recent employment capacity. The UK Corporate Governance Code of the Financial Reporting Council (2018b) states in paragraph 10 that a BoD member is no longer independent if that member:

- Is or has been an employee of the company or group within the last 5 years.
- Has, or has had within the last 3 years, a material business relationship with the company, either directly or as a partner, shareholder, director or senior employee of a body that has such a relationship with the company.

- Has received or receives additional remuneration from the company apart from a director's fee, participates in the company's share option or a performance-related pay scheme, or is a member of the company's pension scheme.
- Has close family ties with any of the company's advisers, directors or senior employees;
- Holds cross-directorships or has significant links with other directors through involvement in other companies or bodies.
- Represents a significant shareholder.
- Has served on the board for more than 9 years from the date of their first appointment.

The purpose of an audit committee is to ensure that all financial reporting and control systems employed by the company and its particular divisions meet the requirements of the adopted accounting standards and regulations. Furthermore, it should ensure that both the internal and external audits and control procedures are adequate to confirm the compliance with standards and regulations. Moreover, such a committee should serve as an independent and objective body to monitor the integrity of the financial reporting. The committee should maintain an orderly financial and administrative status and ensure the introduction and maintenance of systems that are applied to support the achievement of such goals in the areas of finance, accounting and legal. Even if the audit committee fulfils specific responsibilities, such as review internal interim accounts, liquidity reports and annual accounts, the board of directors remains fully responsible for the structuring of the accounting system and the financial controls, as well as the financial planning.

Aviation enterprises are confronted with risks to a greater extent. Therefore, a special risk management committee could be an appropriate remedy. The purpose of such a committee should be:

- To determine and assess business and safety risks within the company.
- To oversee the process of business and safety risk management.
- To confirm mitigating actions, including proper insurance cover, are in place to reduce risks to acceptable levels.
- To report quarterly to the board of directors and make propositions for further improvement of the risk management.
- To ensure that the company maintains a register of business and safety risks together with the mitigating actions to reduce the risks.
- To review the proper management of the identified business and safety risks; this includes the necessary risk management process.
- To guarantee protection of data privacy.
- To supervise the conformity of all processes with the legal requirements.
- To report quarterly to the board of directors and recommend measures for risk awareness and management.

Mini Case: Composition of the Swissair BoD in the Years 1996 to 2001

(Winfried Ruigrok (2004). A tale of strategic and governance errors. *EBF issue 17,* 56–60.)

In the 1990s, Swissair was known in the airline industry for its high quality and its high prices. It successfully targeted the international business travellers and ranked as one of the top ten airlines worldwide in number of international passengers carried. Swissair was also known for its excellent industrial relations. It paid significantly higher salaries than other European airlines, both to pilots and other staff, and was a preferred employer for Swiss business school graduates. Despite its high costs, Swissair had a strong balance sheet.

Nevertheless, Swissair had no liquid funds left on 1 October 2001, and all Swissair planes were grounded for fear of confiscation by foreign creditors. Shortly afterwards, Swissair went into receivership. How could the demise of this renowned and financially strong airline come about?

In his analysis, Prof. Winfried Ruigrok comes to the conclusion that the demise of Swissair was caused by errors in Corporate Governance and strategy. But these errors were aggravated by the convergence of several independent forces – airline industry liberalisation, competitors' global alliances, uncertain attempts at restructuring, and finally the timing of the temporary collapse of air travel due to fears of terrorism. By the time the World Trade Towers and the pentagon were hit, Swissair was in no shape to withstand this final blow to its existence.

But one factor also contributed significantly to Swissair's demise: the composition of the board of directors. In accordance with the recommendations of numerous codes for Corporate Governance, Swissair's BoD should have consisted of only seven to a maximum of nine members. For this to be the case, some of these members would have had to have compelling experience in aviation. At Swissair, however, exactly the opposite was the case. In 1996, Swissair's board of directors had a total of 26 members, but none of them had even the slightest knowledge of aviation. The backgrounds of the board members were:

- Banking industry
- Energy company
- Canton Zurich and Geneva
- Federal government
- Parliament
- Trade fair organiser
- PTT
- Zurich and Basel city councils

Moreover, there was only one committee, which made the situation even worse. This case clearly shows that the composition of the BoD is of great importance. Politicians should only be appointed with restraint and only if they can actually make a contribution to the management of the company.

14.5 Recommendations for Aviation Governance

Since the first code of best practice for Corporate Governance was published in 1992, more than 120 different codes have been published. Most of them are directed to listed, or at least large companies. A few of them contain recommendations for public or non-profit organisations, but none of them are especially addressed to the Aviation Governance. This is one of the reasons that result in the following main weaknesses of current corporate practices (Hilb, 2010):

- Most national Corporate Governance guidelines propose a "one size fits all" approach, which is dangerous.
- There is a lack of strategic direction in most board practices.
- Board selection, appraisal, remuneration and development often lack integration and professionalism.
- Often there is a lack of in-depth know how in risk management at a board level.

To avoid these problems, it is necessary to extract those recommendations from the most relevant codes which are not only adoptable, but also useful for the aviation Industry. A good starting point is the well-established UK Corporate Governance Code in the 2018 version (◘ Table 14.3):

The I.FPM Center for Corporate Governance at the University of St.Gallen followed this path already for small and medium enterprises (Binder et al., 2009). Based on this publication, it is possible to give specific recommendations for Aviation Governance subdivided into a situational level, strategic level, integrated level and controlling level.

14.5.1 Situational Level

Under this aspect only those recommendations are listed which give due consideration of the particular circumstances within the aviation industry:

- *The Advantages and Disadvantages of the Aviation Industry.*

The possible advantages (e.g. international, English language as standard) should be exploited and the possible disadvantages (e.g. huge number of regulations, high risk business, necessity of financial resources and fast change) should be actively counteracted for the sake of effective direction and control of the aviation industry.

- *Ownership Interests Within the Aviation Industry.*

The owner (shareholder, public corporation or investors) should lay down a comprehensive ownership strategy which reflects the ownership interests and is to be periodically reviewed and revised as required. The ownership strategy should particularly comprise the aspects of corporate vision, independence or alliance, management structure, growth, financing, risk policy, dividend policy and succession planning.

Table 14.3 Main principles of the UK Corporate Governance Code

The role of the board	Every company should be headed by an effective board which is collectively responsible for the long-term success of the company
Division of responsibilities	There should be a clear division of responsibilities at the head of the company between the running of the board and the executive responsibility for the running of the company's business
The chairman	The chairman is responsible for leadership of the board and ensuring its effectiveness on all aspects of its role
The non-executive directors	As part of their role as members of a unitary board, non-executive directors should constructively challenge and help develop proposals on strategy
The composition of the board	The board and its committees should have the appropriate balance of skills, experience, independence and knowledge of the company to enable them to discharge their respective duties and responsibilities effectively
Appointments to the board	There should be a formal, rigorous and transparent procedure for the appointment of new directors to the board
Commitment	All directors should be able to allocate sufficient time to the company to discharge their responsibilities effectively
Development	All directors should receive induction on joining the board and should regularly update and refresh their skills and knowledge
Information and support	The board should be supplied in a timely manner with information in a form and of a quality appropriate to enable it to discharge its duties
Evaluation	The board should undertake a formal and rigorous annual evaluation of its own performance and that of its committees and individual directors
Re-evaluation	All directors should be submitted for re-election at regular intervals, subject to continued satisfactory performance
Financial and business reporting	The board should present a balanced and understandable assessment of the company's position and prospects
Risk management and internal control	The board is responsible for determining the nature and extent of the risks it is willing to take in achieving its strategic goals; the board should maintain sound risk management and internal control
Audit committee and auditors	The board should establish formal and transparent arrangements for corporate reporting and risk management; set internal control principles and maintain an appropriate relationship with the company's auditor
Responsibilities of the shareholders and disclosure	Stewardship code (upcoming) Disclosure and transparency rules

Financial Reporting Council (2018b)

- *Size of the Board of Directors.*

The size of the board of directors should be dependent on the individual situations. For small enterprises (up to 50 employees) the IFPM Center for Corporate Governance at the University of St.Gallen recommends 3 directors, for medium-sized enterprises (up to 500 employees) 5 directors and for public or large enterprises (over 500 employees) seven directors.

- *Structure of the Board of Directors.*

Boards of directors should include an independent chairperson as well as an additional independent member. A vice-chairperson is to be elected. The secretary of the board of directors should not be a member of the board and, as far as possible, be independent. A person is deemed independent when no situational circumstances exist which could encroach upon his or her free opinion-forming towards the shareholders, the board of directors or the executive management (e.g. main customer, main supplier and employee of the enterprise).

14.5.2 Strategic Level

The recommendations under the strategic level target the direction of the enterprises, especially the strategy and the organisation:

- *Main Duties of the Board of Directors.*

According to Art. 716a of the Swiss Company Law, the inalienable and non-transferable duties can be summarised in "4 S": strategy, systems, staff and supervisions. To comply with the "Strategy Duty" the board of directors determines the strategic objectives, the resources for their achievement and provides for an ongoing balance between objectives and resources. To fulfil the "Systems Duty" the board of directors sets up the organisation and is responsible for the structuring of the accounting system, the financial planning and financial controls as well as for risk and crisis management. Concerning the "Staff Duty" the board of directors is responsible for the appointment and removal of the persons entrusted with the management. And finally, the "Supervision Duty" determines the board of directors responsible for the ultimate supervision of the persons entrusted with the management; the board of directors has to ensure compliance with the law, regulations, directives and ethical guidelines.

- *Corporate Strategy.*

The board of directors and the executive management have to formulate a corporate strategy on the basis of the strategy laid down by the owners of the company. This corporate strategy should be periodically reviewed and revised as required. The development and implementation of such a strategy is to be clearly embedded within appropriate procedures and comprises the following stages: SWOT-analyses, strategy vision, approval of strategy by the board of directors, business plan, financial plan, setting up the implementation and periodic control.

- *Clarification of Roles Between Board of Directors and Executive Management.*
The board of directors provides the strategic prerequisites, approves the corporate strategy and monitors its implementation. The executive management develops and implements the corporate strategy. The board of directors should delegate operative tasks to the executive management. In critical situations, the board of directors needs to deal with the affairs of the enterprise, particularly intensively, to devote additional time to the enterprise as well as to intervene operatively as the situation requires.

- *Requirements of the Members of Board of Directors and Executive Management.*
The successful direction and management of an aviation enterprise requires the members of the board of directors and executive management to be personalities showing integrity and commitment, while possessing professional as well as leadership and social competences. Due to the internationality of the regulations in the aviation industry, all board members should have adequate knowledge of the English language. At least one member must have practical experience or qualified theoretical knowledge in aviation.

- *Organisational Regulation.*
An organisational regulation is mandatory for a delegation of management activities to the executive management. It should regulate the functions and collaboration of the board of directors and the executive management, in particular apportionment of duties, competences and responsibilities, signatory power, frequency of meetings with main agenda points and internal and external communication. The organisational regulation is to be issued by the board of directors and should be regularly reviewed.

- *Decision-Making Within the Board of Directors.*
With regard to important decisions, the board of directors should give due consideration to the relevant interests of the various stakeholders. For this purpose, each member of the board should conduct SWOT analysis from a different stakeholder's point of view according to the "Four Hats Principle" (including customers, owners, personnel and society).

14.5.3 Integrated Level

An efficient board of directors and executive management is the target of the recommendations on this level:

- *Constitution of the Board of Directors.*
The board of directors should function as a team based on a culture of trust. In addition, the members of the board should be equipped with various role skills such as the roles of a critical thinker, controller or innovative thinker. In an aviation enterprise, the board of directors should comprise at least one female member; this is to assure more success-relevant diversity in the decision-taking process. With

special committees (audit, nomination and remuneration and risk management) the efficiency of the board can be increased.

- *Chairperson of the Board of Directors.*

The chairperson of the board of directors should lead by example and make every effort to achieve a constructive and open corporate culture of trust between the shareholders, the board of directors, the executive management and the workforce. The chairperson is responsible for upholding the interests of the aviation enterprise, the introduction of new ideas, the elaboration of current challenges as well as the effective preparation and chairing of the meetings of the board. He must ensure the provision of punctual and relevant information to the entire board of directors.

- *Avoidance of Conflicts of Interest.*

All members of the BoD and the EM are to avoid conflicts of interest. In any case of conflict of interest arising, such has to be reported to the chairperson of the BoD. The chairperson of the BoD should then be responsible for proposing an adequate solution on the matter (generally in the absence of the member affected) to the BoD.

- *Objectives and Assessment of Board of Directors and Executive Management.*

The board of directors has to periodically assess its capabilities as a corporate organ for the aviation enterprise. In coordination with the other members of the board, the chairman must annually assess the capabilities of himself and of the other members. The same assessment should be done for all members of the executive board. All assessments are to be conducted based on previously agreed qualitative criteria and quantitative objectives.

- *Remuneration of Board of Directors and Executive Management.*

The board of directors has to ensure that the aviation enterprise remunerates the members of the board and the members of the executive management based on internal fairness, external equity and competitive company performance.

- *Instruction and Training of Board of Directors and Executive Management.*

Especially in the fast-changing aviation industry, the instruction and training of all employees are very important. Therefore, the board of directors has to ensure a suitable induction of newly elected members and an adequate advanced training of members of the board of directors and the executive management.

- *Succession Planning.*

Based on international regulations, the national civil aviation authorities (CAAs) demand assessments for higher qualified postholders (e.g. postholder flight operations, postholder ground operations, postholder crew training or postholder maintenance). The board of directors has to undertake early and careful planning of the succession of such postholders as well as of members of the board of directors or of the executive management.

14.5.4 Controlling Level

Finally, under the aspect of controlling, it is possible to list concrete recommendations for effective supervision within the aviation enterprise:

- *Information and Reporting.*
Decisions in an aviation industry must be based on actual and precise information. The board of directors must therefore establish a management information system (MIS) which is adjusted to the requirements of the aviation enterprise. The monthly reporting should include all relevant details for direction and control activities such as CEO report, CFO report, cockpit charts, projects status, rolling liquidity plan for 12 months and a quarterly forecast.

- *Communication and Whistle-Blowing System.*
The chairperson of the board of directors and the president of the executive management are obliged to ensure a mutual corporate culture of trust. This represents the basis for sustainable business success. It can be helpful to implement a whistle-blowing system, by which an employee can report ethical or criminal misconduct to a fellow employee or superior within the aviation enterprise without fearing negative consequences.

- *Risk Management and Safety Management System.*
The board of directors has to implement and control an efficient risk management system for permanent and systematic recording of all kinds of risks with regard to the existence and the development of the aviation enterprise. It must involve analysing and prioritising recognised risks as well as defining and implementing adequate strategic or surgical measures to minimise non-tolerable risks. A special safety management system (SMS) should be the tool to manage the safety in aviation.

- *Compliance with Regulations.*
The board of directors has to safeguard the compliance of the aviation business with appropriate legal and ethical standards. A permanent monitoring of the international and national laws and regulations is necessary.

- *Keeping Minutes.*
The board of directors has to ensure suitable and sufficient keeping of minutes of its meetings which record its deliberations and resolutions passed. With regard to the executive management, records within the minutes should only be that of resolutions passed. The execution of all resolutions must be monitored with proper record of pending items.

- *Financial Auditors.*
The board of directors has to propose the election of competent and independent financial auditors to the general meeting of shareholders. The board is to obtain an assessment of their effectiveness. For this purpose, the board or a delegated member thereof is to meet with the financial auditors at least once a year.

- *Annual Report to the Owner.*

The board of directors has the duty to report to the shareholders on the activities of the board of directors and the executive management. The annual report for the past financial year is to be presented to the shareholders at the annual general meeting. A written form of the annual report should also include details of the effective direction and control of the aviation enterprise.

? Review Questions

- How can the term "Corporate Governance" be defined?
- What are the two main functions of Corporate Governance?
- In which areas will a concrete added value be created through Corporate Governance?
- What are the qualification criteria for aviation enterprise categories?
- How many directors should be nominated for a small, medium or big enterprise?
- What are the advantages and disadvantages of a personal union between the BoD chairman and CEO?
- How should the board of directors in an aviation company be composed?
- Which committees are useful for an aviation company?
- How can Corporate Governance in aviation be improved on the situational level?
- How can Corporate Governance in aviation be improved on the strategic level?
- How can Corporate Governance in aviation be improved on the integrated level?
- How can Corporate Governance in aviation be improved on the controlling level?

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15

Long-Term Planning of Organizations in Industries with High Uncertainty Environments

Erik Linden

Contents

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Summary

1. During an environmental shock:
    - Do not exaggerate the current, short-term developments, because of unproductive uncertainty.
    - Introduce a three-step process to embrace uncertainty in the organization by sensing changes, seizing opportunities and transforming the organization accordingly.
2. To prepare for future environmental shocks:
    - Develop a common strategy language, introduce uncertainty as a standard factor for long-term planning, manage uncertainty proactively and make long-term plans accordingly.
    - Foster a continuous dialogue with formal and informal strategy meetings on various levels of the organization and with various stakeholders.
    - Be aware of the strategy tools being used; they might be vital for the success of long-term planning and other organizational outcomes.
    - Make the board a co-creating team. If the board does not have the necessary capabilities and experience, compose it differently and heterogeneously.

Organizations can experience environmental shocks that cause significant changes to the environment that a company operates in. An example of this is the COVID-19 pandemic which is possibly changing the aviation system for decades to come. Therefore, it is important for firms within the industry to react effectively to such environmental shocks. During such a shock, it is important to not exaggerate current, short-term developments due to the underlying uncertainty that the shock is surfacing. To embrace this uncertainty, it is important to sense changes, seize opportunities and transform the organization accordingly. Also, to prepare for future shocks, a common strategy language should be developed while part of it shall be uncertainty as one of the main factors. This allows uncertainty to be managed proactively and long-term plans to be made accordingly. Finally, it is necessary to foster a continuous dialogue with formal and informal strategy meetings, use the right strategy tools as well as ensure a heterogenous capability and creativity level in the board.

15.1 Introduction

In 2021, the outlook for the aviation system is different than it was months and years before. The pandemic COVID-19 has been spreading across the globe, causing significant change to the environment and the functioning of the aviation system. The aviation system is undergoing an unprecedented, historical change, which might influence its players and central network actors for years and maybe decades. How is it possible that so many decision-makers seemed to be surprised by such a development? What should have been their reaction? can someone strategically prepare for such environmental shocks and high levels of environmental uncertainty?

This book chapter gives guidance to strategy actors of aviation organizations being struck by environmental shocks. The frameworks and concepts of this chapter help aviation managers to think strategically during times of shocks and prepare themselves for future ones by developing more resilient aviation organizations. Practical recommendations are to not exaggerate the short-term developments and get paralyzed by uncertainty, introducing a three-step process by developing dynamic capabilities of sensing changes, seizing opportunities and transforming the organization accordingly, defining roles and involvement of actors as well as to, in the long-term, develop a common strategy language, foster a continuous dialogue on environmental change and make the board a co-creating team to use its capabilities and experience.

15.2 What Is the Real Issue of Long-term Planning in Aviation?

The aviation system has a history with shocks that impacted the system heavily in the last five decades: Oil crises, Wars, SARS, 9/11, financial crises and Eyjafjallajökull or Indonesian volcano ash clouds. Nevertheless, environmental shocks disrupt the airline system (meaning airlines at front and whole supply chains immediately after) and impact it for the years to come. During the first wave of the COVID19 panedmic, airlines were going bankrupt internationally, and governments supported airlines and many other aviation organizations with credits, loans or other measures to ensure liquidity shortages. Others tried to secure their future without any governmental support, blaming others of misconduct by approaching governments or investors to offer financial shields. One could observe that nearly every aviation organization worldwide was challenged to secure the long-term survival of their organization. How can aviation actors make plans for environmental shocks, such as COVID-19, to reduce the exposure to the risks that such shocks pose as well as to strategically innovate, adapt and emerge successfully from shocks?

Each of the above-mentioned shocks had specific characteristics, yet all have something in common: an increase in the level of uncertainty posed by the external environment of organizations. A continuous transformation within the aviation system through changes in the political, economic, ecological, social, technological or legislator spheres, or transformations on the market and customer side, combined with these external shocks, created a vacuum for strategic planning for many organizations in recent years, thus lifting them into a stadium of unproductive uncertainty and paralysis for long-term thinking and acting. Therefore, it is important to learn how to prepare for and strategically innovate, adapt and emerge successfully from shocks, while COVID-19 offers pressure and urgency to do so (Gudmundsson & Merkert, 2020).

This part of the book chapter aims at comprehensively summarizing main strategic management theories and frameworks on how to shape organizations strategically in times of environmental change, rising levels of uncertainty and external shocks. These frameworks and theories ought to be used to embrace uncertainty as standard factor for aviation organizations (since it will be anyways) and introducing robust strategic structures and processes to handle shocks proactively, by creating a culture of resilience and openness to transformation. This summary helps aviation decision-makers to create organizations' preparedness for shocks as well as offers opportunities for recovery strategies following major shocks. It further bases its assumptions on the systemic view of the aviation industry introduced in the first chapters of this book. It highlights possible avenues on how aviation managers could make plans for shocks by reducing the exposure to the risks that such shocks pose as well as strategically innovate, adapt and emerge successfully from environmental shocks and high levels of uncertainty.

15.3 Theoretical Background to Long-Term Planning in Times of Uncertainty

15.3.1 Environmental Shocks Are no Black Swans, but Increases in the Level of Uncertainty

Every year, the World Economic Forum (WEF) asks managers before the annual meeting in Davos, what they consider to be the most significant risks for the business world (WEF, 2020). For the year 2020, environmental issues such as climate change, cyber-attacks and data breaches were named as the most probable global risks (p. 3). More than a year later, the world looks different: the disease COVID-19 has been spreading across the globe, causing significant change to society and also to aviation organizations internationally. Obviously, managers across the globe, and specifically aviation managers were surprised by COVID-19 and its massive impact. The pandemic is impacting not only central network actors of the system, such as airlines, airports or service providers, but literally everyone involved in the aviation system. How could something like this happen and how could managers not be prepared for a global pandemic?

Lipsitch et al. (2009) found that the problem of infectious diseases are a "combination of urgency, uncertainty and the costs of interventions [which] makes the effort to control infectious diseases especially difficult". No doubt, globally spread infectious diseases are relatively rare events. The high damage potential is usually assigned a very low probability, which also means that pandemics are assigned a subordinate role compared to other risks. This is why some organizations might not have dedicated action and strategic plans for globally spread infectious diseases. Also, organizations were simply not able to quantify the impact of such an event. Managers of aviation organizations asked themselves: how should I predict, calculate or even make plans for such events? Not being able to answer these questions, pandemics and other environmental shocks with massive impact are often referred to as "black swans"[1] (Deloitte, 2020; Winston, 2020).

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[1] The term originates from the author Nassim Nicholas Taleb (2007). He uses the term to describe extreme impact of rare and unpredictable outlier events and the human tendency to find simplistic explanations for these events, retrospectively – such as financial crises.

Definition

To be called a black swan, the event must first of all be a surprise to the observer. Second, it has to have a significant effect. Third, after the first recorded instance of the event, it must be rationalized in hindsight, as if it could have been expected.

However, COVID-19 did not arise in a vacuum. Pandemic plans have already been made by many countries, politicians and organizations. Even the WEF managers rated "infectious diseases" as their number 10 risk for the next 10 years (WEF, 2020, p. 3). So, COVID-19, and the same goes for other major environmental shocks in the recent decades, should not have been a surprise at all to aviation managers. Especially, because one might even say that aviation managers should be used to such environmental shocks, since they have a history with them. Similarly, Nassim Nicholas Taleb and Mark Spitznagel highlight in their article in the NZZ in March 2020 that COVID-19 is definitely no black swan, but should rather be described as an event which is inevitable, because of the structure of the modern, globalized world. Still, calling environmental shocks a black swan or not does not help any manager per se to make better plans for such events or cope with them. It seems evident that shocks, such as the financial crisis of 2008, ecological shocks or pandemics are events in the external environment of an organization that creates high levels of uncertainty[2]. The answer to the problems may be found in the management of uncertainty and the external environment and a shock is therefore basically two-fold from an actionable perspective: operative reaction to the short-term development and long-term reaction with strategic planning to use the crisis resulting from such shocks as an opportunity.

15.3.2 Strategy-as-Practice as Answer to How to Deal with High Levels of Uncertainty

Several theories and frameworks of strategic management have guided the discussions on how organizations may be strategically organized and structured in a more resilient way, to embrace high levels of uncertainty and prepare organizations for environmental shocks. The theories have only recently been led by researching the actual doings of strategy actors to tackle the real actions and problems of strategic managers.

Definition

"Strategy-as-practice focuses on the micro-level social activities, processes and practices that characterize organizational strategy and strategizing" Golsorkhi et al. (2010).

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[2] In 1921, Knight (1921) distinguished uncertainty as being a lack of knowledge which is immeasurable and impossible to calculate from risk which is calculable and fundamental uncertainty as literal ambiguity. This definition of uncertainty is since then referred to as Knightian uncertainty.

This theoretical push in strategy research is ought to make the theories practically more useful. Among others, an aim of this recent theoretical development is to find how strategic managers can embrace higher levels of uncertainty of their environment and make strategic plans accordingly by aligning their internal structures, processes and resources to the environmental change – vital characteristics in times of external shocks. The following paragraphs shall give an overview of this recent theoretical development to give guidance to aviation managers in times of shocks and environmental changes. It may not be possible to predict environmental shocks in the form of occurrence, nor can the impact be quantified. However, what these theories of strategic management highlight is that the **proactive management of uncertainty and a strong long-term perspective during and after such shocks might help react to changes in the external environment faster and more efficiently and create more resilient organizations, possibly helping to manage even black swans in the future**.

15.4 Applications of Long-Term Planning in Times of Environmental Uncertainty

15.4.1 Long-Term Planning During Environmental Shocks

Scholars of strategic management have found that during shocks, such as COVID-19, managers should not get paralyzed by unproductive uncertainty, and as soon as possible introduce a three-step process to embrace uncertainty in the organization by sensing changes, seizing opportunities and transforming the organization accordingly to make the organization more resilient of environmental changes in the long-run, as well as clearly define roles and involvement of actors during crisis management in this three-step process. This will enable aviation managers to think strategically, even when facing short-term challenges.

Tip

Do not get paralyzed by uncertainty but manage it proactively and develop uncertainty capabilities.

It is important that aviation managers do not get paralyzed by uncertainty, resulting in unproductive uncertainty[3]. Decision-makers of the aviation industry must embrace uncertainty as a critical aspect not only for their short-term actions but also for their long-term planning process – thus developing uncertainty capabilities or dynamic capabilities with a special focus on managing uncertain environments. These capabilities enable managers to open their eyes to options and alternatives of the present

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[3] The term was introduced by Nathan Furr in his HBR article “Don’t Let Uncertainty Paralyze You” in April 2020.

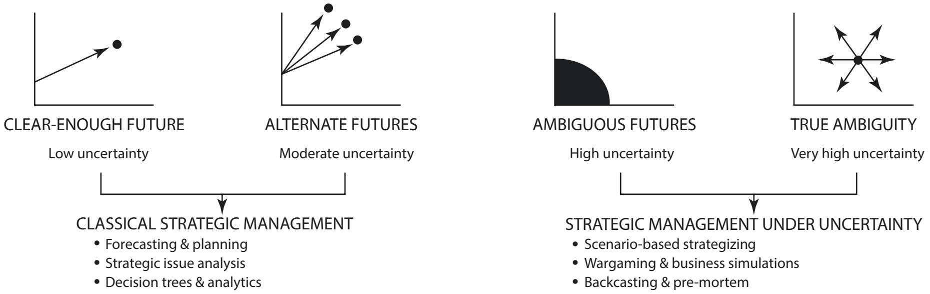

Fig. 15.1 Classical strategic management and strategic management under uncertainty (author's own figure, adapted from prior studies of Star, 2007, Amram & Kulatilaka, 1999, Thorén & Vendel, 2019)

and the future. Human nature leads managers to make strategic decisions based on their lived experience as well as on the history of one's own prior decisions, and routines rather than with an eye on the bigger picture and environmental change. In times of black swans, shocks or incremental, environmental change, it is tempting to firefight, but it is crucial to consider the future and thus long-term assumptions as well. Nathan Furr (2020) found that during times of unproductive uncertainty, managers often get trapped in imagining extreme performances. On the contrary, managers who are skilled in managing uncertainty think in terms of probabilities and alternatives instead. These managers also perceive the crisis as a huge opportunity for the long-term development and sustainable success of their respective organization.

Through embracing uncertainty as a vital factor for long-term planning, aviation managers will understand that strategy under uncertainty is different than classical strategic management (see Fig. 15.1; adapted from prior studies of Thorén & Vendel, 2019). Where classical strategic management is important in times of *clear-enough* or *alternate futures*, strategic management under uncertainty means that managers need to deal with higher *ambiguous futures* and even *true ambiguity*. For true ambiguity, what this specifically means, is that there is no predictable range of outcomes. Managers should deal with this by using scenario-based approaches, wargaming and business simulations as well as backcasting or pre-mortem. The latter strategy tools might especially be useful for aviation actors, since the aviation system has a history with external shocks, thus offering many exemplary cases that might be useful for future assumptions and planning under high levels of uncertainty.

Thus, acknowledging and embracing these high levels of uncertainty during times of shocks for the short- and also the long-run will prevent managers of unproductive uncertainty and support managers in making better decisions about the future of their organizations.

Tip

Introduce a three-step process to develop dynamic capabilities and thus embrace uncertainty within your organization.

Besides the possible paralysis through high levels of uncertainty, external shocks also influence the strategic processes of organizations in a major way. Strategic management scholars have found that under high levels of uncertainty and in times of shocks, long-term plans need to be adapted accordingly and more regularly. Thus, in times of environmental shocks, climate change or digitalization, agile and more flexible long-term plans are vital for the success of an organization (Eisenhardt et al., 2010). Such dynamic plans create temporary but also sustainable competitive advantage.

To embrace uncertainty, it is essential to demonstrate a determination to sense what is happening in the environment, seize the opportunities arising from the environmental change and transform the organization accordingly (Hodgkinson & Healey, 2011). The terms *sense*, *seize* and *transform* are vital terms for long-term planning of organizations and refer to the "theory of dynamic capabilities", first introduced by Teece et al. (1997). **The goal of dynamic capabilities is to integrate, build and transform internal and external competences to address rapidly changing environments as an organization**. Therefore, aviation managers enable their organization to become a "learning organization", partly breaking with established routines and structures, to adapt to the new environment and develop into a more resilient organization.

Definition

A so-called learning organization is a company that facilitates the learning of its members and continuously transforms itself (Pedler et al., 1996).

Following this three-step process of sensing, seizing and transforming, aviation managers will be able to manage the associated uncertainties of the environment more proactively, often and much more regular and agile. The following paragraphs will highlight what this three-step process specifically means for aviation managers in times of environmental shocks and what they need to be aware of:

1. ***Sensing***: First of all, in a situation of uncertainty, it is vital to grasp and describe the problem. It is essential to learn quickly and build or rebuild strategic resources, which requires routines of interaction in coordinated search and learning procedures (Pavlou & El Sawy, 2011; Schilke, 2014). What was certain before might be uncertain in the new situation. Therefore, one should 1: define the most critical key performance indicators[4] for the uncertain situation – both for the short- and long-run. What are the most critical factors – of the event and for the organization? In the case of COVID-19, what are the performance indicators impacted by the disease? 2: It is crucial to distinguish between the short- and long-term impact, for example, on the business model, the supply chain or the workforce respectively the resource base of the organization. 3: It is beneficial to work with scenarios, wargames or general business simulations

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[4] A performance indicator or key performance indicator (KPI) is a type of performance measurement to evaluate the success of an organization or of a particular activity (such as projects, programmes, products, events and other initiatives) in which it engages.

to embrace uncertainty. 4: It is necessary to work with extreme alternatives and options to develop a large range of possible futures, e.g. for the impact on liquidity, other financial measures and operational metrics. 5: Managers should try to design dashboards to filter the most relevant and urgent information and be up-to-date in real-time. **The better the type and level of uncertainty is understood, the more likely it is that efficient and effective trade-offs can be made between different outcomes for the organization and decisions to be taken more objectively**. Therefore, managers should think in terms of options, and not binary outcomes (Helfat & Peteraf, 2015). For example, governments might change their rules for production facilities fast, regulators might introduce new rules of compliance, airlines might change their fleet strategy and aircraft manufacturers might change their supply chain management according to the new environment. Thus, aviation managers should **be aware that nothing is completely within their control and assumptions are not conclusive**. Changes might happen fast and the true capability of sensing is to continuously challenge the previously established assumptions – literally as a learning organization.

2. ***Seizing***: Once the essential parameters have been identified in a broader context, the next step is to analyse causal relationships for the own organization (Teece et al., 1997). What does environmental change mean for my own business and how can I leverage it? For example, aviation managers must be able to link, e.g. behavioural changes of customers, suppliers or partners, as well as new regulations with their existing business model and structures of the organization. They need to be able to engineer design choices and opportunities for their own business. While engineering design choices, aviation managers should also identify possible markets and the timing for these seizing alternatives (Day & Schoemaker, 2016). To enable this, **managers might break down the significant environmental change into smaller, more manageable steps for which a solution may already exist or which are easier to calculate**. These smaller shares then need to be adjusted to the internal context and the structure of the organization. These discrete and manageable sets of options should be made clear and definite to build trust and commitment – internally and externally with the main stakeholders. Seizing means, for example, for network carriers to rethink their loyalty programmes because of behavioural change patterns of customers. For LCCs, seizing opportunities of, e.g. COVID-19 could mean to alter revenue sources and out-of-the-box forward integration because of new work possibilities and more home-office. **Understanding causal relations of the environmental change and internal structures and resources is vital in this second phase of seizing**.
3. ***Transforming***: Thirdly, environmental change requires the ability of an organization to actually transform its asset structure and accomplish the necessary internal and external transformation (Teece et al., 1997). **Aviation managers should develop an action plan for adjusting their internal and external strategic assets**. The long-term competitive advantage might be fostered through the integration of external activities and technologies by selecting the boundaries of the organization and therefore looking for possible alliances, networks or partnerships. In the case of COVID-19, this means that new strategic assumptions might nurture a change in the structure, processes, designs and incentives of the organization –

maybe even long overdue anyways. It is helpful to think of decentralization, local autonomy and strategic alliances or networks to transform the organization (Birkinshaw et al., 2016). Therefore, managers should also think of possible exit strategies of non-productive, inefficient programmes or technologies. In this transformation phase, aviation managers need to be aware of their communication of such a transformation (Helfat & Peteraf, 2015). **Roles and responsibilities should be clearly defined, and transformation needs to be clearly communicated and made transparent to accomplish an effective and efficient alignment**. If not done properly this transformation in times of COVID-19 might backlash, offering opportunities for unions, governments or other societal and political stakeholders that might see the transformation critical, to restrict the transformation of happening at all, causing long-term damage to the success of the organization. Thus, short-term actions based on such long-term assumptions might be vital, but also risky when not done properly.

Mini Case Airline Management in the COVID-19 Crisis

Andreas Wittmer and Erik Linden

During the COVID-19 crisis, airlines were confronted with fast reduction of passenger demand of up to 99%. Suddenly, airline managers realized that it is not possible anymore to follow hierarchies and institutionalized processes of the organization and that mid- to long-term scenarios did not have any validity anymore to manage the crisis. The crisis was worse than every worst-case scenario they had projected. Hence, task forces were built, where experts of different business units and departments came together on a daily basis to react on daily changes in the environment, deciding on a flight plan, operations, services (e.g. changing from passenger transport to fright transport), etc. These task forces had to work agile, dynamic and fast to react to new insights and regulations on a daily basis. At the same time, they still had to make sure that standard safety processes were handled in compliant ways. So, the management of airlines went from being an alternative future organization with rather hierarchical processes and practices to a true dynamic organization in terms of sensing, seizing and transforming the asset structure and capabilities of the organization (refer to ▣ Fig. 15.2).

With this example, we highlight that task forces managed the crisis very dynamic, agile and efficient and made airlines stronger and more resilient in a VUCA environment. For this reason, the question may be raised if a more dynamic and agile organization is better suited in an environment influenced by VUCA effects in the long term, and not solely during times of shocks or crisis. Hence, one should consider introducing more dynamic capabilities and processes in order to react more flexibly and agilely to changes. This can provide sustainable competitive advantages in the short term, but also in the long term, and make the company more resilient to crises and environmental changes – and these crisis and changes happen regularly in the aviation system.

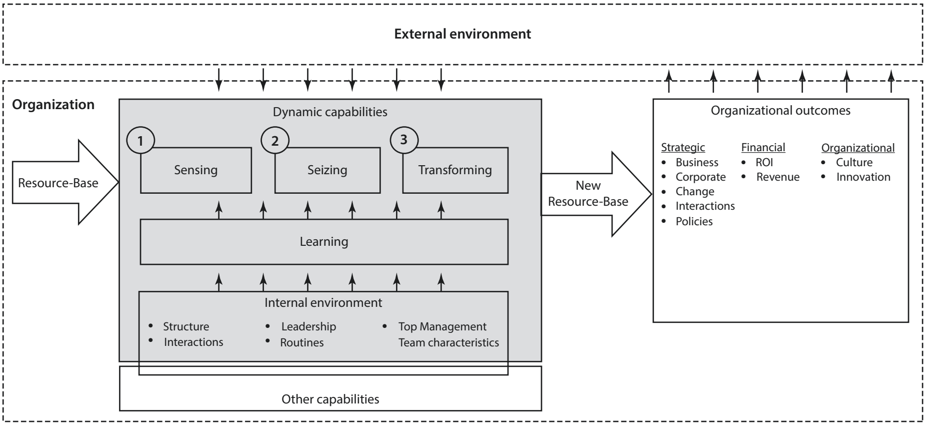

Fig. 15.2 Dynamic capabilities in and their relationships to the external and internal environment as well as organization outcomes (author's own figure)

Figure 15.2 offers a summary of the above-mentioned three-step process, illustrating how these dynamic capabilities of sensing, seizing and transforming are strongly interlinked with the external and internal environment of the organization. Further, what is illustrated in Fig. 15.2 is that these dynamic capabilities impact the strategic, organizational and financial outcome of the organization, highlighting that these capabilities are vital for the long-term success of organizations challenged by environmental change.

Mini Case: The Transformation of Skyguide as ANSP of Switzerland

Due to political, regulatory, technological and social pressure, the Air Traffic market is disrupted. Therefore, ANSPs need to transform their business and focus on operational and technological innovations to meet these new challenges of a cooperative and efficient airspace structure. For example, Europe is moving towards a new kind of Air Traffic Management (ATM) network enabled by new technologies, cooperative traffic management principles, innovative processes, a new approach to human resources management and by the emergence of new ANS business models. These changes, e.g. include totally digitized stripless working methods and systems evolving into Virtual Centres, a "common controller cockpit", enhanced satellite-based flight procedures or transforming the classic Air Traffic Management (ATM) business by introducing and integrating Unmanned Air Traffic Management (UTM), also called U-Space.

Therefore, an Air Navigation Service Provider (ANSP) must adapt to what is happening in the environment. Skyguide did this and, right now, is transforming its business to meet changing customer needs in a disrupted market of Air Navigation Services (ANS), which is on the cusp of a paradigm shift. They introduced a long-overdue technology-based strategy to transform the organization and adapt it to the new environment. How did they do it?

First, they invested a lot of time and effort into sensing the new challenges that arise in the future. This required them to build routines of interaction in coordinated search and learning procedures through internal and external workshops and several talks and sub-projects. They introduced new KPIs, worked with several scenarios of a possible future and discussed these with various stake- and shareholders and on different levels of the organization. On the basis of that, they created a shared vision for why they should exist in 2035.

Second, they analyzed causal relationships of this change for skyguide and were able to link behavioural changes of customers, suppliers and partners, as well as new regulations with their existing business model and structures of the organization. They were able to engineer design choices and opportunities for their own business. While engineering design choices, they identified possible markets and the timing for these seizing alternatives, thus introducing the vision of skyguide for 2035. They further pushed their strategy in terms of U-Space with a national and international partner network, thus using COVID-19 as enabler for a transformation that is long overdue. These discrete and manageable sets of options were made clear and definite to build trust and commitment – internally and externally with the main share- and stakeholders, such as the Federal Office of Civil Aviation (FOCA), one of their main stakeholders of the organization.

Environmental change required skyguide to be able to actually transform their asset structure and accomplish the necessary internal and external transformation through. Thus, in a third step of their transformation process, they looked for possible partners, networks and alliances, e.g. technology providers or research institutions in the area of u-space, to create, e.g. joint ventures or spinoffs for digital airspace solutions: “we would like to continue driving change in partnership with like-minded partners. Thus, we are open to explore partnerships and create value together; and we want to learn from, challenge and share experiences with our partners. Together is better” (skyguide, 2020). Thereby, they transformed their “business model, driven by (…their…) future operational concept and enabled by a transformed approach to human resources”, the CEO of skyguide, Alex Bristol, said in 2020 (skyguide, 2020).

However, even at skyguide, a more focused and strategic approach to stakeholder and crisis management could have transformed the organization more radically while this may have been nurtured in dedicating more resources to addressing the challenges they are facing from the external environment (possibly with the three step process of sensing, seizing and transforming as described before). This would have led to the organization being even more shock-resilient in the future.

15.4.2 Long-Term Planning to Prepare for Future External Shocks and High Levels of Uncertainty

Besides introducing a three-step process of strategic transformation, continuous long-term planning is vital to adapt, innovate and emerge on a sustainable foundation. To do this properly, scholars of strategic management found several aspects being decisive: fostering a common strategic language among strategic actors, introducing uncertainty as a standard factor for long-term planning (since it will be anyways), enabling an internal and external dialogue on environmental change and making the board a co-creator to use its capabilities and experience best.

Tip

Foster a common strategic language.

To foster strategy under high levels of uncertainty, aviation managers first need to speak the same language. The author of this book chapter does not mean the literal language that an organization speaks, which might be vital to address as well, but rather taking the actual *social practice* of strategizing seriously (Vaara & Whittington, 2012). **Strategic language is difficult and can lead to misunderstanding, even impacting the strategic and financial performance of organizations** (Seidl, 2006). Seidl (2006, p. 1) found that “every single strategy discourse can merely construct its own discourse-specific concepts”. This might lead to *productive misunderstandings* in strategy-making (Mantere, 2010; Seidl, 2006). On the contrary, good strategy discourse might lead to better sense-making in top management teams (Balogun et al., 2014) and strategic sense-making and sense-giving by middle-managers. Managers should not underestimate the importance of negotiations and written text documents of strategy. Narratives of strategizing ought to be seen “as a way of giving meaning to the practice that emerges from sensemaking activities, of constituting an overall sense of direction or purpose, of refocusing organizational identity and of enabling and constraining the ongoing activities of actors” (Fenton & Langley, 2011). Thus, texts and strategy documents play a vital role in strategizing. Pälli et al. (2009) show in a case study of Lahti city planners that “specific communicative purposes and lexico-grammatical features characterize the genre of strategy and how the actual negotiations over strategy text involve particular kinds of intersubjectivity and intertextuality” (p. 2). **For aviation managers, this means that they need to introduce key terms and definitions for their strategizing and approve these terms with their strategic actors within and outside of the organization on a regular basis**. This might especially be important for, e.g. aircraft manufacturers and their supply chain managers as well as their tiers in the supply chain. Speaking the same strategic language in such complex and uncertain environments means more efficiency and more effective supply chain management – vital in times of shocks and important to secure supply chain operations in times of historic circumstances that the aviation system is recently facing.

Tip

Introduce uncertainty as a standard factor for long-term planning.

Although embracing the uncertainty of the external environment being a vital factor for long-term planning, uncertainty does not arise only via external environments. Strategizing itself is concerned with the future of an organization, and this future is per se uncertain. Every decision itself creates new uncertainties. Thus, uncertainty also develops internally through decision-makers making decisions on future directions and plans of organizations. The challenge in this situation is not to crave for more information to reduce ambiguity, but rather feeling comfortable with uncertainty. As Johnson (2015) put it in an HBR article, "get comfortable with the unknown". Baran and Scott (2010) have studied how people in high-risk professions, such as firefighting, deal with uncertainty. What they found is the so-called theory of *organizing ambiguity*. Firefighters conceptualize their circumstances by "mak[ing] effective sense of the hazards within dangerous contexts such that they avoid catastrophic mistakes" (p. 43). Firefighters take action knowing that the environment might change and alterations from original plans may be needed. **Strategic aviation managers need to cope with uncertainty such as firefighters do. They need to make it their daily routine and habit to work with uncertainty – not solely for the sake of reacting to the environment, but also for their decision-making praxis and practices**. Aviation managers should therefore introduce uncertainty as a standard factor, since it will always be part of long-term planning anyways.

Tip

Enable an internal and external dialogue on environmental change.

What might help to embrace uncertainty as a standard factor is to enable an internal and external dialogue on environmental changes to challenge assumptions on a regular basis. A critical and open discussion on internal and external environmental changes should be fostered between the main stakeholders of the organization. This dialogue also fosters cognitive and reflexive functions, which are vital for strategy-making. **This means introducing more formal as well as informal strategy interactions for exchanging ideas and thoughts on recent changes in the environment and developing strategic initiatives or programmes**. One might assign dedicated teams to scan the environment, using "outside the box thinking" in so-called *analysis teams,* or engage with a large range of stakeholders in brainstorming or platform sessions. In the best case, aviation managers should foster such a dialogue on different levels as well as with the main stakeholders of the organization[5] (see ◘ Fig. 15.3 below).

Integrating these platforms for dialogue into a centralized, in the best case already established, "Governance, Risk and Compliance Management" tool (see prior book chapter for this issue) might be helpful to institutionalize the findings and build organizational routines, while complying with regulation, addressing the risks properly and assigning tasks and responsibilities efficiently.

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[5] According to the stakeholder management approach for strategic management, among others by Freeman and McVea (2005) and Buysse and Verbeke (2003). This is especially important in industries, which are highly dependent on main actors and dynamic in nature, such as the aviation system.

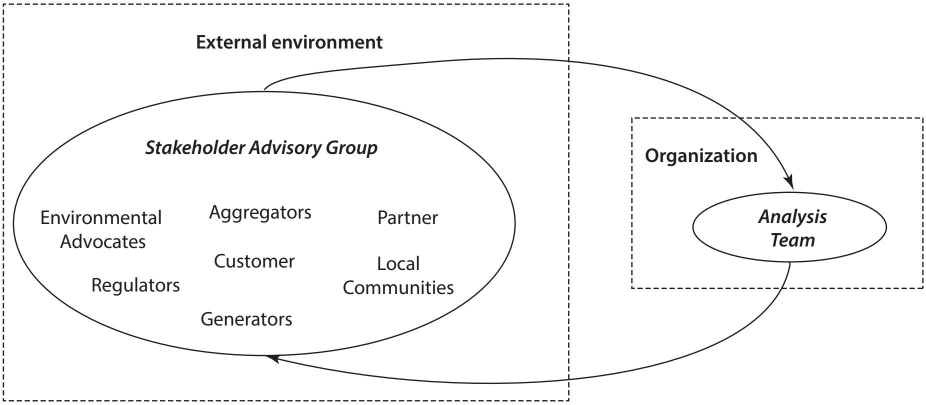

Fig. 15.3 Platform for internal and external dialogue on environmental change (author's own figure)

Mini Case

A good example for such an internal and external dialogue is the already mentioned ANSP of Switzerland, skyguide. They introduced a platform together with main stakeholders called SUSI (Swiss U-Space Implementation), which is hosted by the Federal Office for Civil Aviation (FOCA) in Switzerland. This dialogue-platform offers skyguide strategic reflexivity and dialogue on unmanned air traffic as well as an outside view into recent and future developments of this field, which might be vital for their long-term success in the ANSP market.

Carton (2017) found in studies on NASA-teams in a paper published in 2017 that this sense of purpose might boost employees' coordination and collective enthusiasm, thus not only offering alignment to environmental change, but also fostering internal processes and employee satisfaction through involvement and sense-making.

Tip

Be aware of the strategy tools being used.

Such platforms may establish fast and interactive iterations of thinking and acting in the best case resulting in commitment, motivation and strategic change in- and outside of the organization more rapidly. This encouragement might help people to imagine the future, which counters the passivity and feeling of helplessness in times of shocks. However, and besides the great opportunities such platforms pose, **aviation managers should be aware of the tools being used during strategizing**. Tools are boundary objects for strategy-making and will, most probably, affect the success of the long-term planning process as well as firm performance (Spee & Jarzabkowski, 2009). Tools, such as scenarios or wargaming, might help to reduce uncertainty and align the organization to environmental change, but only if addressed correctly and for the right purpose. Jarzabkowski and Kaplan (2015) highlight that "strategy is not something an organization *has* but rather something that people in organizations *do* (Whittington, 2007). Tools are most usefully seen as parts of the process rather than purely as sources of the answer".

Tip

Make the board a co-creator in times of uncertainty.

Many organizations have problems and struggle with who is responsible for strategy-making in times of uncertain environments. Scholars found that the conversation between management and the board is especially relevant here, since these are the most crucial teams for strategizing. One should reduce the natural information asymmetry between these two most vital strategic teams. Scholars found that strategy meetings and workshops are vital for this relationship, among other effects, constructing shared views around strategic issues, creating consensus and introducing strategic change. Scholars found that the board might be the key strategizing actor, especially in times of environmental uncertainty, with Leblanc and Gillies (2005, p. 6) even argue that "nothing is more important to the wellbeing of [an organization] than its board". For example, in Switzerland, the board is the key strategizing actors even by law[6]. Among other duties, the board is responsible for the development of strategic objectives, the determination of the means necessary to achieve the goals, issuing the required instructions to the executing bodies and controlling the implementing bodies about the achievement of objectives (Müller et al., 2014). To do this, the board needs to be in a cooperative strategic dialogue with management and steer through strategic guidelines (Carpenter et al., 2004).

Attention

Despite strategy being a non-delegable duty, the strategic role of the board is not self-determined in organizations today.

Hence, and especially in times of environmental uncertainty, it is essential to define the role, function, responsibilities and involvement of the board in strategizing. Scholars highlight that the board needs to take a stronger strategic role (Cossin & Metayer, 2014; Hendry et al., 2010) and get involved more often especially in

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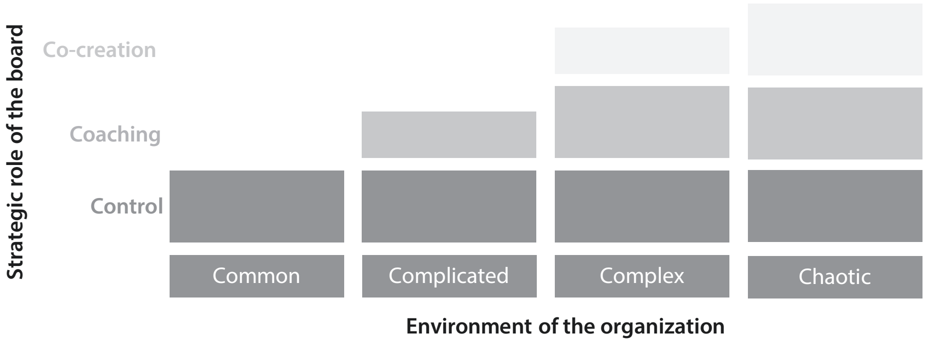
[6] Long-term planning is one of the major tasks the board in accordance with OR 716a of the Swiss Code of Obligations (OR). See more details to the role and duties of Swiss boards in Müller et al. (2014). This is comparable to other board-systems such as, e.g. the management board in the USA.



◘ **Fig. 15.4** The strategic role of the board is depending on the environment of the organization (author's own figure)

dynamic industries and in times of high levels of uncertainty (Garg & Eisenhardt, 2017; Judge & Talaulicar, 2017; Oehmichen et al., 2017). This might diverge from solely supervision, to coaching or even a co-creating role[7], depending on the context of the organization (see ◘ Fig. 15.4 below). **In times of highly uncertain environments, it might be advisable for boards to be co-creators, not only taking a controlling-, supervising- or coaching-role** (see ◘ Fig. 15.4).[8] Thus, in this so-to-say chaotic environments, the board needs to spend an equal amount of time on co-creating as on supervision. This would mean making most of the capabilities and, in the best case, the experience of its members. If the board does not lead strategically or does not have the necessary capabilities and experiences for such shocks, compose the team differently, since this is key for the success of the organizations.

When discussing strategic involvement and actions, a special focus needs to be placed on the interactions of the Chairperson and the CEO, who are the most influential and important actors for the long-term success of organizations (Ma et al., 2019; Nadler, 2004). Same as for dialogue with stakeholders, this includes introducing more formal as well as informal strategy interactions for exchanging ideas and thoughts on recent changes in the environment and developing strategic initiatives or programmes. One strategy workshop with the board per year might not be enough anymore to develop effective and sustainable strategies. **Aviation managers need to step-up their strategic game in their top management team and use platforms for strategizing in a regular fashion to make the enable the prior-described three-step process to be successful**. Only then, they will be able to develop literal *dynamic capabilities* and adapt, innovate and emerge from environmental shocks.

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[7] See Cossin and Metayer (2014) in their article on "How Strategic Is Your Board?" in the MIT Sloan Management Review. See also ◘ Fig. 15.4, which has been designed according to their article.

[8] Roles for communication are delegable. But it is important to define who communicates, how and to whom.

15.5 Discussion

The theories and frameworks highlighted in ► Chap. 3 offer guidance to aviation managers in times of high levels of uncertainty, during times of environmental shocks, as well as offer solutions on how to prepare for shocks in the future. Despite these approaches being vital for aligning the organization to the environment and sustainable organizational success, one should always reflect if strategic transformation is really needed and possible in the long-run. Besides not getting paralyzed, it is also important to be prudent and patient in times of environmental change or shocks, too. One should not overreact to environmental change too soon and align strategic assets, processes or even whole strategies based on short-term assumptions. These short-term actions might counteract established and successful long-term plans. Aviation managers should not be actionists in times of environmental change.

Also, new work developments seem to influence the actual strategy practices and praxis described in ► Chap. 3. This development of new work will open up opportunities. Full virtual workforces might be established on a level we have never seen before. In times of environmental shocks, it is partly not possible to meet in person. Thus, aviation managers need to be aware of the pitfalls and risks facing this new management characteristic by, e.g. leading virtual teams. Use virtual meetings properly and strategically and "break up your big virtual meetings" by embracing silence in brainstorming sessions and using breakout rooms to create a sense of accountability.

Raffoni (2020) highlights in her HBR article that leaders should ask themselves five main questions when leading virtually:

1. Am I being strategic enough?
2. Have I revamped communication plans for my direct team and the organization at large?
3. How might I reset roles and responsibilities to help people succeed?
4. Am I keeping my eye on (and communicating about) the big picture?
5. What more can I do to strengthen our company culture?

Managers should keep these five questions in mind, especially when leading virtually, but also for the long-run. The structure, strategy processes and interactions as well as new dynamic capabilities aviation managers are building right now will continue to serve them after environmental shocks and potentially for next shocks that are hitting the system in the future. Every shock, and every effective response to it, creates a new normal complete with new routines, new assumptions and possibly new technologies (Kanter, 2020). And thanks to the strategic theories and frameworks mentioned in ► Chap. 3 of this book chapter, aviation managers will be more ready for such shocks, with new dynamic capabilities to lead their organization more effectively than before – whether from home or the office.

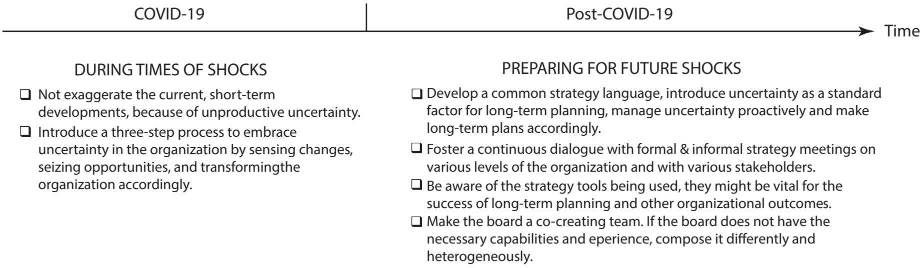
Further, in the aviation system, a shock such as COVID-19 exposes institutional gaps, divides partners or networks, and many problems and issues arise. This might be a huge opportunity through a strong quest for new powers, standards and characteristics in the aviation system. What one can see already is that customers might change their behaviour and needs, partners might want to rethink their agreements and manufacturers might change their requirements for suppliers. Also, in the wider system of the aviation system, legislators might want to add or tighten regulations, new technologies might emerge faster and sustainable solutions might be more important than ever before – not only to customers, but also to institutional actors. Government officials might want to fix long-standing systemic problems by nurturing change and incentivizing differenly. Strategizing of aviation managers needs to align to this so-called new normal of the aviation system. The frameworks and theories of this book chapter might help aviation managers to do so and think in the long-run, even if this might be counter to what managers are used to and lead to tough decisions in the short-run.

15.6 Summary: How to Make Long-Term Plans in Times of and Prepare for Environmental Shocks and High Levels of Uncertainty?

COVID-19 or other environmental shocks undeniably disrupted whole industries, increasing uncertainty for long-term planning. Thus, management of uncertainty is vital for the long-term success of organizations. These shocks are a strong call for long-term thinking. They mean high levels of uncertainty for aviation managers. This uncertainty might paralyze humans and lets them think in assumptions that might be too ambiguous for actual management. Anxiety and fear of the unknown kicks in, whereas most cannot imagine an upside during such shocks. Managers become paralyzed, caught in a state of unproductive uncertainty. Therefore, strategizing might be more important than ever before within the aviation system, to secure short-term operations, but to prepare the organization for future shocks already today. We therefore asked the following main question: *how to make plans for environmental shocks such as COVID-19 to reduce the exposure to the risks that such shocks pose as well as to strategically innovate, adapt and emerge successfully from shocks*?

This book chapter is a strong call for strategic action in times of environmental uncertainty and also in times of uncertainty in general. The author of this book chapter bases his findings on main theories and frameworks of strategic management literature and praxis. Strong recommendations for aviation managers are the following: aviation managers need to embrace uncertainty proactively and make long-term plans accordingly. They should introduce a three-step process to sense, seize and transform the organization according to the environmental change .

◘ Figure 15.5 summarizes these two crucial aspects of strategic management during times of shocks and strategic management to prepare for future shocks.



DURING TIMES OF SHOCKS

- ☐ Not exaggerate the current, short-term developments, because of unproductive uncertainty.
- ☐ Introduce a three-step process to embrace uncertainty in the organization by sensing changes, seizing opportunities, and transformingthe organization accordingly.

PREPARING FOR FUTURE SHOCKS

- ☐ Develop a common strategy language, introduce uncertainty as a standard factor for long-term planning, manage uncertainty proactively and make long-term plans accordingly.
- ☐ Foster a continuous dialogue with formal & informal strategy meetings on various levels of the organization and with various stakeholders.
- ☐ Be aware of the strategy tools being used, they might be vital for the success of long-term planning and other organizational outcomes.
- ☐ Make the board a co-creating team. If the board does not have the necessary capabilities and eperience, compose it differently and heterogeneously.

Fig. 15.5 A framework to make long-term plans in times of and prepare for environmental shocks and high levels of uncertainty (author's own figure)

Review Questions

Main Questions

Managers should address the following questions proactively: who (roles and involvement) is responsible for strategizing? When (process), how (interactions), how regular, for how long, with whom and with what tools does strategy happen in our organization?

Addressing these questions will help aviation managers to use uncertainty proactively and productively, make plans during times of environmental shocks and strategically innovate, adapt and emerge successfully from shocks. Also, these theories and frameworks will enable aviation managers to be well-prepared for future shocks through creating a common understanding for long-term planning as well as by developing a more resilient organization that is better prepared for such high levels of uncertainty.

Ten Key Questions to Answer to Embrace Uncertainty in Long-Term Planning

1. Was COVID-19 a black swan or not? Please discuss the implications of COVID-19 for long-term planning of an airline in detail.
2. What is a main theory in strategic management that helps to understand and embrace uncertainty as an important factor for long-term planning?
3. What are the three steps to develop dynamic capabilities?
4. What are main aspects of the first step to develop dynamic capabilities?
5. What are main aspects of the second step to develop dynamic capabilities?
6. What are main aspects of the third step to develop dynamic capabilities?
7. What is a good example of a company that developed dynamic capabilities in the aviation system? Please describe the example in detail and discuss the main benefits of each phase.
8. What are main aspects to be aware of when preparing for high levels of uncertainty in the long-run?

9. What kind of dialogue is important in times of high levels of uncertainty? Describe it in detail and discuss the main benefits of it.
10. What kind of role should Board of Directors play in times of high levels of uncertainty? Describe the role in detail and discuss the benefits this role has for long-term planning.

Appendix: Checklist for Aviation Managers to Make Long-Term Plans to Use during Times of Environmental Shocks and to Prepare for them

This is ought to be seen as an aviation checklist for long-term planners of aviation organizations in times of environmental change. Strategic managers may use this checklist for long-term planning during and after environmental shocks and in times of environmental uncertainty:

During an environmental shock:
- Do not exaggerate the current, short-term developments, because of unproductive uncertainty.
- Introduce a three-step process to embrace uncertainty in the organization by sensing changes, seizing opportunities and transforming the organization accordingly.

To prepare for future environmental shocks:
- Develop a common strategy language, introduce uncertainty as a standard factor for long-term planning, manage uncertainty proactively and make long-term plans accordingly.
- Foster a continuous dialogue with formal and informal strategy meetings on various levels of the organization and with various stakeholders.
- Be aware of the strategy tools being used; they might be vital for the success of long-term planning and other organizational outcomes.
- Make the board a co-creating team. If the board does not have the necessary capabilities and experience, compose it differently and heterogeneously.

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New Frontiers in Aviation: Supersonic, Space Travel and Drones

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16

New Frontiers in Aviation: Supersonic, Space Travel and Drones

Summary

- Future technologies addressed in this chapter appear in three areas:
  - Supersonic plane technologies
  - Space tourism plane technologies
  - Drone technologies
- Supersonic travel was possible from the 1960s until the new millennium but ultimately failed due to complexity of combining technological implementation and economic viability. These aspects pave the way for further research to re-launch the concept of supersonic travel in the future.
- Space tourism presents a new potential market for travellers. While the first companies are already trialling their products, the technological implementation and the price of space travel make it unclear as to when and how the market will develop.
- There are many different fields of application of drones. One of them being passenger transport. There are many obstacles and opportunities for done taxis. It will take some time until obstacles are overcome and trust in automated air vehicles will enter the market. The market entry will most likely be seen in markets where time versus cost efficiency gains are possible most likely in city transport, intercity transport and airport shuttle services.

This chapter addresses three areas of future technologies in aviation: supersonic aircraft, space tourism and drone technologies. Supersonic travel is not entirely novel to aviation as its roots begin in the 1960s and continued until to the turn of the millennium. However, new avenues are being explored to develop and re-introduce the concept of supersonic travel. Space tourism is a potential new market for travellers, with first companies already trialling products. However, the technological implementation and the price of space travel are uncertain. Meanwhile, the prospects of drones are promising with many fields offering potential applications of drones. One of the areas is passenger transport, where drones could help transform urban and intercity transport with drone taxis. Again, there are certain obstacles to be cleared, especially in terms of trust, before drones can be deployed for passenger transport.

16.1 Introduction

Innovations in technology are essential to redefining mobility and aviation in particular. Cutting-edge technology creates opportunities to transform the aviation system by enabling new business models and mobility services.

While in the previous chapters a focus was set on past developments and the current state of "regular" aviation, this chapter is somewhat different as we will examine what we call the "new frontiers of aviation". By this we mean developments and applications that somehow differ from ordinary aviation. First, this chapter breaks the sound barrier and examines supersonic air travel. Although this is an old and familiar topic that is making a comeback, some of the new concepts and business models are too revolutionary to be left out. Second, we leave this world and travel into space. While the race for outer space has long been decided, the idea of viewing our planet from weightlessness has lost none of its fascination. In fact, we have never been so close to space tourism as we are today. Several companies are making it possible for non-astronauts to travel into space – provided you have the necessary financial means. And thirdly, we deal with one of the most important developments in aviation of our time: the conquest of our airspace by small and large drones. Advances in robotics enable countless private and business applications of these unmanned aircraft. From filming and industrial surveying to the transportation of goods or even people, the new technologies are changing our aviation system permanently. These new horizons in aviation have great potential, for example, in terms of connectivity or value creation. However, they also hold challenges such as increasing the complexity of the aviation system or ecological or social issues. Although the technologies are new, the changes brought about by the innovations are comparable to the development cycles that global aviation has already gone through. The aim of this chapter is to provide an overview and to discuss the developments critically, while offering aviation managers a guideline for sensing current and relevant developments of the aviation including its wider system.

16.2 Supersonic Air Travel

In the first part of this chapter, we explore supersonic air travel. Since the concept is not new, we will investigate what has changed compared to the developments in the 1960s and what gives engineers reason to believe that supersonic concepts may not only be technically but also commercially viable in the future.

Terminology

- **Mach number:** A dimensionless quantity in fluid dynamics named after physicist Ernst Mach (1838–1916). The number measures the compressibility characteristics of the air. The parameter is also used by pilots to measure an aircraft's true airspeed.

$$\text{ratio}: \frac{\textbf{Object speed}}{\textbf{Speed of Sound}} = \textbf{Mach number}\left(M\right)$$

- **Subsonic flight:** Flights at speeds of less than Mach 1. Most commercial airplanes that carry people and cargo travel at this speed.
- **Transonic flight:** Airspeeds at or around Mach 1.
- **Supersonic flight:** Airspeeds above Mach 1. Aircraft at supersonic speeds fly faster than the speed of sound (768 mph or 1236 kph at sea level)
  - $1 < M < 3$: Compressibility effects and shock waves generated by the surface of the object.
  - $3 < M < 5$: Aerodynamic heating
- **Hypersonic flight:** Flights at airspeeds greater than Mach 5 (i.e. 5x the speed of sound).

16.2.1 History of Supersonic Air Travel

The first officially recorded manned supersonic flight was a test flight by US Air Force pilot Chuck Yaeger in a Bell X-1 on 14 October 1947 (Candel, 2004). This milestone has brought rapid technological progress, especially in military aviation. In civil aviation it was assumed from the 1950s onwards that supersonic transport (SST) should be possible from a technical point of view. The competition between the Eastern and Western powers was henceforth also evident in the development of SST (Dowling, 2020). The first success was achieved by the Soviet Union when they put the first civil supersonic aircraft, the Tu-144, into service in 1968. One year later, in 1969, the first flight of the famous Anglo-French Concorde took place. Despite efforts by manufacturers such as Boeing and Lockheed, the Americans failed in bringing their own model into regular service until the very end. The Tu-144 remained in flight until 1997, and the Concorde until 2003. Since then, no civil supersonic aircraft has been in commercial operation. It should be noted, however, that the Russian model only operated about 55 passenger flights, whereas the Concorde enjoyed much greater popularity (Dowling, 2020).

The value proposition that the Concorde offered consisted of two elements essentially: high speed travel saving time and the scarce product conveying a feeling of status and exclusivity, despite offering limited comfort with limited legroom in spartan cabins (Feuerherd, 2017). The demand existed right from the beginning, even though a seat on the Concorde was about four times the price of a regular business class ticket (Feuerherd, 2017). The target segment was always considered small. In total, only 16 Concordes were produced, all of which were delivered exclusively to British Airways and Air France – heavily subsidized by the respective governments (Orlebar, 2002). The biggest challenges at the beginning were therefore not related to customer acceptance but were rather of political nature. New York, for example, initially banned the aircraft due to noise concerns, which jeopardized the business case that was designed for the London-New York route (Orlebar, 2002). Alternatively, Dulles Airport was served, which triggered protests from customers in New York, leading to the decision soon being revised.

16.2.2 Challenges of Supersonic Air Travel

To answer the question of why this supersonic form of travel has not established itself, we will look at the various elements of the aviation system and their respective challenges.

■ *Technological System*

From a technological point of view, the three main challenges for supersonic air travel are: *aerodynamics, engine* and *aircraft structure*.

The aerodynamic issues mainly concern the drag of the aircraft (Hall, 2015). Drag is the mechanical force that moves in the opposite direction of the motion, which is generated by a solid object (aircraft) moving through a fluid (air). Drag is affected by the object (shape and size of the aircraft), the motion of the air (velocity and inclination to flow) and the properties of the air (mass, viscosity and compressibility) (Hall, 2015). The complex dependencies of the different variables are modelled with the so-called drag coefficient (Cd). Most importantly in the case of supersonic aircraft, drag rises significantly with velocity; therefore, it is imperative to minimize the coefficient of drag when designing supersonic aircraft. For this reason, previous designs have been highly streamlined. Another possibility to reduce the drag is by flying at higher altitudes with lower air density. When the wave drag increases at supersonic speeds, a supersonic aircraft requires substantially more power to overcome the drag than a conventional subsonic aircraft. Finally, also the lift to drag ratio (L/D) is an aerodynamic challenge. At supersonic speeds lift is generated differently and less efficiently. The design must consider this to provide enough lift in relation to the weight of the plane. To maintain altitude and airspeed, supplementary thrust is required.

Supersonic aircraft also pose certain challenges for the engine design, which differs significantly from regular passenger aircraft. The main reason being, that at supersonic speeds, the velocity of the air must be reduced first so that the turbofan intake can cope with it. Also, the specific fuel consumption of the engines is higher, due to the increased power that is required to overcome the aerodynamic issues.

Finally, the above-mentioned requirements strongly influence the structure of supersonic aircraft. The efforts to streamline the aircraft lead to a narrower fuselage and wing design, which, at the same time, also need to withstand greater stress and higher temperatures. This leads to aeroelasticity problems. Also, the higher cruising altitudes require greater cabin pressurization which results in stronger and, in the past, also heavier structures. This again created interaction effects with the L/D-ratio, as the weight of an empty Concorde, for example, was approximately 3 times the weight of an empty B747. It needs to be mentioned, however, that at the time no composite materials were available, which are stronger and more rigid for their weight compared to metals. New materials provide great potential for improvements in the design of supersonic aircraft.

■ *Economic System (Business Model)*

One of the main reasons why supersonic concepts have not yet become successful in aviation is their lack of economic viability. Several internal and external factors have made it difficult to establish a viable business model. Surprisingly, the least problems were on the revenue side. Despite ticket prices in the range of USD 10,000 for the previously described value proposition, demand existed especially in the high-net-worth segment (Feuerherd, 2017). However, the operators never managed to get the cost side under control. The aerodynamic restrictions resulted in higher fuel costs while passenger capacities were lower. This made it impossible to realize economies of scale. To put the problem in perspective, a Boeing 747 can carry three times as many passengers with the same fuel consumption as Concorde (De Syon, 2003). To make matters worse, Concorde was extremely high-maintenance. Estimates suggest that up to 18 hours of maintenance were required per flight hour (Feuerherd, 2017). These factors made the business model extremely vulnerable to external shocks. As oil prices rose, Concorde was forced to reduce the number of passengers on its flights to save on fuel costs. This unstable situation ultimately doomed the project when first a plane crashed in France in 2000 and then global demand collapsed the following year after 9/11.

Ultimately, the goal of an airline is to make money. However, Concorde's problems at various levels of the aviation system made this enormously difficult, which meant that the aircraft did not represent an interesting business case for airlines. The only reason British Airways and Air France were able to operate Concorde, at least partially, profitably over its lifetime is that they did not have to amortize capital costs for its costly development, as the prestige project had been heavily subsidized by governments (Domini & Chicot, 2018).

■ *Social and Environmental System*

A major issue of supersonic aircraft in the social and environmental systems is associated to the high noise levels during take-off and flying over inhabited areas in proximity of the airports. As mentioned above, supersonic jet engines need a comparably high specific thrust. This requires a high jet velocity, which unfortunately makes the engines very noisy, especially at low altitudes and speeds as well as during acceleration when taking off. Minimizing noise is central to society's acceptance of aviation. This applies to all types of aircraft, but especially to supersonic aircraft. Another noise issue concerns sonic boom, which occurs when an aircraft goes from subsonic to supersonic speeds. This loud bang, which can be clearly heard and felt on the ground, is unwanted by society. The problem of sonic boom can be circumvented by waiting until the aircraft is at high altitude over water before accelerating to supersonic speed. This method has been used by Concorde, but thereby categorically excludes use over land and thus a variety of routes. Through design changes, researchers are working to bring the volume of the sonic boom to a tolerable level over land.

Higher fuel consumption with lower passenger capacity consequently also results in a poorer environmental balance per passenger (Kharina et al., 2018). Studies estimate that even SST that are currently being developed on average burn five to seven times as much fuel per passenger as subsonic aircraft on representative routes. While the trend in regular aviation is towards steadily increasing efficiency and reducing emissions, this fact is a major criticism of supersonic technology that could further jeopardize its acceptance.

■ *Political and Regulatory System*

From a political or regulatory perspective, all the above aspects must be taken into account. In particular, the noise and environmental impact of SST are major hurdles in the approval of supersonic concepts (Domini & Chicot, 2018). Especially, after the crashes of Tu-144 and Concorde in the past, safety of SST is also a critical aspect which will be a focus of the certification process. From the perspective of global connectivity and potentially resulting economic benefits, politics are generally following the developments with great interest.

16.2.3 Outlook/Future of Supersonic Air Travel

After the failure of the Concorde project in 2003, there were initially no efforts to develop new supersonic concepts. Industry developments went primarily in two directions: on the one hand, the A380 was to renew the concept of the super jumbo in networks between mega-hubs, and on the other hand, more fuel-efficient aircraft were to make point-to-point traffic more economical. In the 2010s, however, several engineering teams began working again on the dream of supersonic passenger flight – learning from the mistakes of Concorde.

There are several reasons why plans for a supersonic aircraft have been brought back to life again. Primarily, solving the described problems of previous concepts is a great challenge for the developers, the solution of which would be associated with prestige. Aviation has always been driven by the will for technological achievement, and supersonic passenger flight is one of the remaining hurdles. New technologies in the 50 years since the development of Concorde and Tu-144, for example, in the areas of information technology and composite materials, may help to solve the existing problems.

On the operator side, the hoped-for benefit is clearly to push the speed limits in aviation. In other cases, such as high-speed rail, competition between modes of transportation led to the development of speed. On a continental level, the rail is trying to compete with the airplane in terms of speed, in which the latter is traditionally the faster mode. Since on the routes where supersonic transport is an option (especially transatlantic long-haul) the airplane has hardly any serious competition from other transport modes, the strong competition among the different airlines is the biggest challenge there. Currently, competition is mainly on cost and service quality, whereas speed is not a decisive competitive factor. Therefore, it could be a strategic option for a provider to redefine competition in the sense of a Blue Ocean strategy and to focus on the factor speed. However, this requires finding solutions to SST's existing problems first. Currently, there are several projects to revive supersonic passenger transport. Two different approaches can be identified.

Boom Technology is working on a design for a supersonic jet that can carry at least 55 passengers in an all-business class configuration. Ouverture aims to create a cost structure that will allow airlines to offer tickets at the price of a current business class ticket. As a result, the manufacturer advertises over 500 transatlantic routes. While fuel consumption has been reduced, the problem of sonic booms persists. By the end of 2017, reportedly more than 70 pre-orders had already been received from airlines (Boom Technology, n.d.).

Another concept that is close to completion is that of the Aerion Corporation. With the AS2, the company is working on a supersonic business jet that will carry 8–10 passengers at Mach 1.4. The company is working on technology that will reduce sonic booms. The first flight is scheduled for 2025. Spike Aerospace is also working on a smaller business jet for up to 18 people. The S-512 is also designed as a quiet jet that reaches up to Mach 1.6 and does not cause a loud sonic boom. Certification is being sought by 2023 (Aerion Supersonic, n.d.).

Other projects and concept studies exist, notably by NASA, which is working on eliminating sonic booms. However, all projects are still associated with great uncertainties and it is by no means certain that supersonic transport will become established in the near future.

16.2.4 Conclusion

The example of supersonic transport clearly shows the interdependencies within the aviation system. In particular, the interplay between technological feasibility and economic viability becomes apparent. While the technological possibilities have become much greater, economic challenges and societal trends have not necessarily developed in favour of supersonic aviation. The next few years will show whether the progress made by engineers can also be transformed into viable business models.

16.3 Space Tourism

Another frontier that aviation could soon overcome is that of our atmosphere. Visionary projects aim to make space travel possible for non-astronauts. For this reason, this sub-chapter is dedicated to space tourism.

16.3.1 From Air Travel to Space Tourism

Technological advancements in two domains have contributed to our ability to talk about space tourism today. In ► Sect. 16.2.3, we have already discussed in detail the developments in supersonic transportation. These advances contribute significantly to the feasibility of orbital space tourism experiences. The second crucial technology, without which this topic would not exist at all, is rocketry. A milestone in human history is the first manned orbit of the Earth by Yuri Gagarin on April 12, 1961. Although the Russian cosmonaut only spent 108 minutes in space, he proved once and for all that journeys into space are possible. As a result, a real competition for the conquest of space broke out between the major superpowers, which not only enabled the first manned moon landing by Neil Armstrong and Buzz Aldrin on July 16, 1969, but also formed the basis for countless technological developments that are indispensable today.

Even if for many years it was reserved for a small, select group of astronauts to fly into space, for many people the dream to look at our planet from afar was born. It would take until 2001 before the first space tourist could realize this dream. According to media reports, businessman Dennis Tito paid $20 million to fly to the International Space Station (ISS) on a Russian Soyuz rocket and stay there for seven days. After Tito, several other high-net-worth individuals became space tourists (Cole, 2015).

This also gave birth to the concept of space tourism (Johnson & Martin, 2016). At an early stage, it is probably more appropriate to speak of "personal space flight", as this form of travel is only accessible to a few individuals. Space tourism, on the other hand, already suggests the future of a kind of mass tourism that will make it possible for a broader clientele to travel into space. Such a development does not seem out of the question for the future, UBS market analysts already expect a market volume for space tourism of $3 billion in 2030 based on a market study (Klebnikov, 2020).

16.3.2 Future of Space Tourism

The question arises as to what forms space tourism might take. While in conventional tourism, with a few exceptions, the focus is not on the journey but on the destination as an attraction, this is not always the case in the currently discussed forms of space tourism. Especially, in sub-orbital space tourism, the offer includes only the experience of weightlessness without staying longer in space. In orbital space tourism, which was experienced by the Soyuz tourists, a stay is part of the offer. Other forms such as point-to-point space flights or trips to celestial bodies such as the moon could also be potential developments in the distant future (Webber, 2013).

The biggest change driving space tourism is the shift towards private providers of space flights. In conventional spaceflight, the influence or dependence on government space programmes has been decreasing for some time. Today, not only satellites but also astronauts are launched into space by public-private partnerships. This first happened in 2020 when the "Crew Demo-2" rocket of the private company SpaceX flew two NASA astronauts to the ISS. This can generally be seen as a sign of the ongoing commercialization of space travel, which is also giving a boost to space tourism. In the following, we will discuss some promising concepts.

Sub-orbital Space Tourism

Sub-orbital flights are flights into space that neither escape the gravitational field of the celestial body from which they started nor enter orbit around that body. Instead, unless the spacecraft continues to counteract gravity with a running propulsion system, it falls back towards the ground. By definition, these flights reach an altitude of about 100 km above sea level. Although orbital space tourism has already occurred, sub-orbital tourism in principle is easier to implement (Webber, 2013).

In this category, two companies are fighting for the domination of this new type of tourism market. These are Virgin Galactic, owned by billionaire aviation entrepreneur Richard Branson, and Blue Origin, owned by Amazon founder Jeff Bezos. While both concepts are rocket-powered systems capable of carrying up to six passengers, the technologies used differ greatly.

Virgin Galactic's SpaceShipTwo will be mounted beneath a carrier aircraft, bringing it to an altitude of 40,000 feet, where the spacecraft will be released before igniting the rocket engine and ascending to an altitude of about 90 km (Virgin

Galactic, n.d.). At the edge of space, passengers can experience a few minutes of microgravity before the vehicle re-enters and glides to a runway where it lands. The spacecraft can be reused.

Blue Origin relies on a more familiar concept from space travel. Attached to a carrier rocket, the capsule with the passengers is shot vertically up to an altitude of about 100 km, where the capsule detaches from the booster (Blue Origin, n.d.). The passengers then experience a few minutes of weightlessness before the capsule, attached to parachutes, drops back to earth. However, unlike space shuttle boosters, Blue Origin's launcher can also be reused because it also returns to Earth in a controlled manner.

Virgin Galactic has already flown several people into space for testing purposes. Already more than 600 people have bought tickets at a price of 200,000–250,000 US$ (UBS, 2020). Blue Origin prices are unknown, and more testing is needed before manned flights are possible at the time of writing this chapter. The target group of sub-orbital flights is high net worth individuals who are looking to be offered an exceptional luxury experience. Market analysts believe that the global target audience is as large as two million people who can afford this experience over the coming years. Once it will be possible to lower the prices, the market size is expected to grow by a factor of ten.

■ Orbital Space Tourism

In contrast to sub-orbital tourism, orbital tourists reach altitudes of up to 400 km above sea level where they spend days or even weeks circling the Earth. As already mentioned, this form of tourism has already taken place. Well-paying passengers could buy transportation in a Russian Soyuz rocket. This has reduced supply to a few flights and made scaling impossible. Billionaire Elon Musk's Space X company is now the first private company to work on orbital space tourism. The Falcon 9 rocket and Crew Dragon capsule are designed to carry up to seven passengers into space. Although exact figures are not yet available, it is estimated that a flight per person would cost around $50 million. In addition, NASA would add costs of about $35,000 per night for a stay on the ISS. Another concept under development is Boeing's Starliner capsule, which can also carry up to seven passengers. Boeing's plans foresee that contracts with NASA would allow it to sell the fifth cabin seat to tourists in addition to four astronauts.

It is too early to draw a conclusion on space tourism. It is considered certain that the corresponding offers will come onto the market, where they will meet with demand. However, it remains to be seen whether this form of tourism will become established and whether economically viable business models will be found (see Cohen, 2016). In order to make a possible forecast for the development, we can fall back on an established model from tourism research. Analogous to the development in other areas of tourism, it is likely that space tourism will develop progressively. Butler's (2006) Tourist area life cycle (TALC) postulates (▣ Fig. 16.1) three phases: pioneering, mature and mass.

Cole (2015) applies the TALC to space tourism. In a pioneer phase, the product is still to be regarded as an adventure journey. First, tourists undertake short sub-orbital flights. Prices are high and comparatively few tourists take advantage

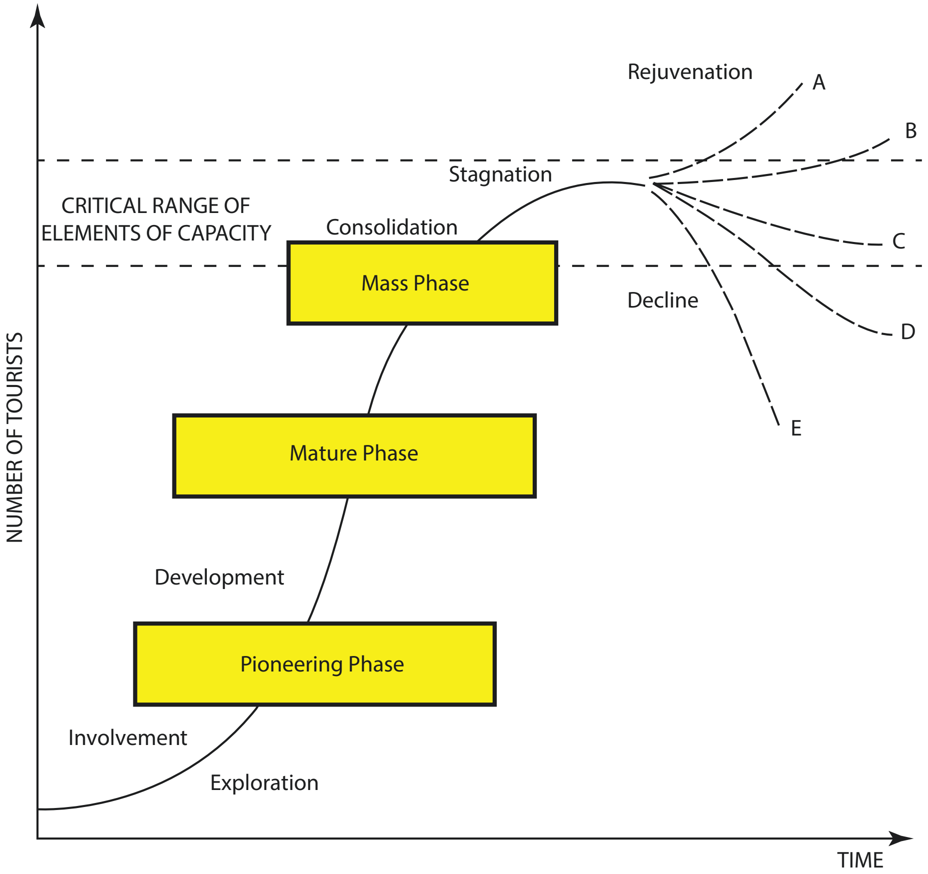

Fig. 16.1 Tourist area life cycle in space (Butler, 2006, as cited in Cole, 2015)

of the offer. This corresponds to the phase in which space tourism is at the time of writing. In a mature phase, demand will increase. Flights take place from different places and providers at lower prices. Up to hundreds of thousands of passengers travel to space. In the final, mass phase, the orbital infrastructure continues to develop so that it can accommodate hundreds of guests and offer a diverse range of services. Prices drop into the four-digit range and passenger numbers rise into the millions. Space developments, it is assumed, will then be subject to the same challenges as terrestrial tourism. Issues such as congestion and over-tourism, as well as sustainability issues, are also likely to arise in a mass phase at the latest.

To sum up, it is not possible to accurately predict whether space tourism will develop in exactly the same way as earth tourism and in what time horizon this would occur. It can, however, be said, that space tourism is yet another fascinating field of development related to the aviation industry.

16.4 Drones and Urban Air Mobility

(supported by Stephan Eberhardt and Erik Linden)

For quite some time now, companies and research have been dealing with the topic of AV (Autonomous vehicles) based on autonomous mobility. These companies are searching for alternatives to conventional public transport and are convinced that there are several advantages to the different AVs. They want alternatives to conventional public transport and see several advantages that these AVs bring with them. For example, they offer the possibility of reducing emissions (Lang et al., 2017); they can contribute to more safety on the roads (BMMVI, 2015; Lang et al., 2017); they can relieve the burden on the roads and reduce congestion in the cities (Lang et al., 2016, 2017); and they can ensure that you can do other things while driving and thus be more productive (Lang et al., 2017). With the development of AVs, companies have also started to focus on AVTOL (autonomous vertical take-off and landing) aircraft. The above-mentioned advantages also apply to AVTOLs. One can even argue that they express some advantages even more clearly. For example, they can relieve traffic jams even more since, unlike AVs, they do not travel on the roads but in the air. They can also make a better contribution to the time savings already achieved with the help of the AVs, as they can cross the direct line from A to Z via the air, reducing traveling time in congested cities massively.

Drones also play an important role in the development of AVTOL. A few years ago, drones were used for private purposes (aerial photography, fun), for military purposes (reconnaissance drones) or for the transport of goods. Today, they play an important role in the planning of passenger transport in the future. In the past, statements have been made about the future of the air transport industry according to which autonomous electric motorized air taxis should be the future, and some manufacturers even claim that this is already the case today (Kazim, 2019). In any case, it seems that the technology of drones has and will have a decisive influence on the development of air taxis (Eckl-Dorna, 2017).

16.4.1 Definitions of Drones

The term “drone” is the colloquial term for specific Unmanned Aerial Vehicles (UAVs). However, there currently are no uniform, and in particular, legally recognized definitions of the term. In scientific literature, a wide range of names for drones exist. The following five terms are the most common ones, emphasizing different aspects of drone technology:

- Remotely piloted aircraft (RPA)
- Remotely operated aircraft (ROA)
- Remotely piloted vehicle (RPV)
- Unmanned aircraft (UA)
- Unmanned aerial vehicle (UAV)
- Vertical take off and landing (VTOL) aircraft
- Autonomous vertical take off and landing (AVTOL) aircraft
- Short-run take off and landing (STOL) aircraft

Fig. 16.2 Type of wing arrangements. (Author's own figure)

To define "autonomous" vertical take-off and landing (AVTOL) aircraft, it is necessary to define what is currently understood under vertical take-off and landing (VTOL) aircraft.

The first vertical take-off and landing vehicles originated in the years 1950–1970. In the beginning, such VTOLs were mainly used for military purposes. However, practically all attempts to develop a VTOL were failures. When classifying a vehicle in the VTOL category, it is important to note that a characteristic of such objects is that the take-off and landing take place from the same point. The flying vehicles must not need a long runway. Initially, they were partly not pure VTOL because they needed a short run to take off. Therefore, these flying vehicles were also called short-run take off and landing (STOL) vehicles. Only with time, manufacturers developed machines that could actually take off from one and the same point (Intwala & Parikh, 2015, p. 186).

It was only later that flying objects were developed to such an extent that the first unmanned aerial vehicle (UAV) was invented. Such flying objects were equipped with more than one rotor, so-called multirotor systems. There were many different variants for the arrangement of the rotors (Fig. 16.2) (Intwala & Parikh, 2015, pp. 186–190).

The term UAV is most commonly used in the United States, highlighting the considerable autonomous flight capabilities of drones. In many cases, there are specific technical characteristics that distinguish drones and their definition:

- **Flight control functionality:** The system has sufficient technical functionality to ensure energy supply, manoeuvrability, navigation and robustness against environmental influences (e.g. wind), tailored to the drone's intended use.
- **Partial autonomy**: The system has partial autonomy capabilities for flight stabilization. Various advanced autonomy capabilities such as collision avoidance and autonomous execution of predefined flight routes are currently subject of research and development.
- **Data transmission:** They are integrated into a data transmission system which is used for remote control or for the transmission of further data according to the functionality of the drone.

- **Overall system:** The use of drones is integrated into a comprehensive system of control, evaluation of information collected by drones, maintenance, etc.
- **Payload:** Drones have the capacity to carry weight like sensors and cameras according to the overall functionality. They can carry out their mission independently without the intervention of a pilot.

Most commonly, drones are differentiated according to the type of arrangements of the wing.

16.4.2 Opportunities/Applications for the Drone Sector

There are different mega-trends influencing the drone business development. Some mega-trends, which affect the drone field, are population growth, mobility, climate change, digitalization and commodification. These mega-trends can be divided into the social, economic, environmental and technological realm. A central mega-trend is mobility. The trend towards a more sustainable and diverse understanding of mobility will deeply affect the future of transport and the use of different transport modes.

The sub-trends can all be assigned to one or more mega-trends and each sub-trend results in a commercial opportunity for the drone sector. As an example, the growing food demand, due to a significant growth in population, results in a high drone usage in agriculture. Or the increase in natural catastrophes results in a higher usage of drones for the investigation of insurance claims.

There are many diverse drone application opportunities, which span over 15 different industries:

- Agriculture
- Arts and entertainment
- Construction
- Educational services
- Energy
- Health care
- Information
- Insurance
- Logistics
- Mobility
- Mining, quarrying and oil
- Professional services
- Public administration
- Real estate
- Safety and security

There are big differences in terms of the market potential between these different industries. As of today, the largest industry in the drone market is energy (utilities), followed by construction and agriculture.

In the different industries, there are many different applications:

- **Delivery:** Transportation of packages, food, pharmaceuticals or other types of goods.
- **Dispensing and spraying**: Aerial distribution of solids or the process of spreading liquid substances.
- **Inspection and maintenance:** Examination of objects with the intent to find faults, errors, problems or malfunctions.
- **Localization and detection:** Seeking and supplying geographical coordinates of people or the process of detecting them.
- **Mapping:** Process of creating a diagrammatic representation of a given area, incl. 3D modelling.
- **Mobility:** Human transportation in the air in place of conventional mobility solutions (e.g. cars).
- **Monitoring:** Close and regular observation of objects to check progress or quality over a given period of time.
- **Photography and filming:** Aerial use of still cameras to capture images and the production of aerial videos.
- **Surveying:** Inspection of a section of the earth's surface to measure distances/structures and record them.

Of special interest is the mobility application with respect to human transport. Many companies in the aerospace or automotive industries as well as new start-ups are leading various projects to develop an autonomous, mostly electric vehicle that will transport people through the air. So-called air taxis may play a central role in the future of passenger transport management. The following table should therefore provide a brief overview of the major players in the air taxi market. The table also lists the key data of the project and the planned time horizon for implementation.

◘ Table 16.1 provides an overview of the air taxi vehicle suppliers. While some companies are very optimistic about the implementation timeline of their projects, others are more cautious and plan to implement them only towards the end of the 2020s. According to Hetzke, this is because the challenge for a timely implementation is the technology itself and everything around it (Münchenberg, 2019). By this he means above all security, who bears the responsibility, how to prevent cyber-attacks and whether the use is reserved only for the rich or whether everyone can afford an air taxi (Münchenberg, 2019). Many of these points are strongly related to policy and legislation in the regions concerned. On the one hand, the laws and infrastructure must be provided by the operational areas. On the other hand, the mindset of the population from the area of operation is also very important as to when one can expect an implementation of air taxis.

Air taxis offer increased mobility, reduced emissions, improved productivity, greater convenience, better safety and less congestion (Lang et al., 2017). These anticipated benefits are briefly discussed below.

Table 16.1 The different drone projects (Eberhardt, 2019)

Company	Project	Time-to-market
Airbus	**Name:** Vahana	2025
	Genre: AVTOL	
	Details: Single passenger transport; Payload of 200 kg; Speed of 91 km/h	
Airbus	**Name:** CityAirbus	2025
	Genre: Air taxi	
	Details: Multi passenger transport; Payload of 250 kg; Speed of 120 km/h	
Boeing	**Name:** PAV	2019 (test flights)
	Genre: AVTOL	
	Details: Multi passenger transport; Payload of 225 kg; Speed of 180 km/h	
Ehang	**Name:** eHang 216	2019
	Genre: Air taxi	
	Details: Multi passenger transport; Payload of 230 kg; Speed of 130 km/h	
Evolo	**Name:** Volocopter	2028
	Genre: Air taxi	
	Details: Multi passenger transport; Payload of 160 kg; Speed of 100 km/h	
Google	**Name:** Cora	2022
	Genre: Air taxi	
	Details: Multi passenger transport; Speed of 150 km/h	
Google	**Name:** Flyer	2022
	Genre: Air taxi	
	Details: Single passenger transport; Speed of 30 km/h	
Lilium	**Name:** Lilium Jet	Early 2020s
	Genre: Air taxi	
	Details: Multi passenger transport; Speed of 300 km/h	
Bell	**Name:** Nexus	2020
	Genre: Air taxi	
	Details: Multi passenger transport; Payload of 272 kg; Hybrid	

- **Increased mobility:** AV and AVTOL offer passengers the opportunity to switch to a means of transport that offers an alternative to conventional road transport. This additional means of transport is an alternative for those who do not like to drive on the roads or cannot drive themselves. The target group concerned may mainly include elderly or disabled persons for whom traditional means of transport are not an attractive option (Lang et al., 2017).
- **Reduced emissions:** If you look at the emissions of AV and AVTOL, you can see that they are rather low compared to traditional means of transport. This is strongly related to the propulsion of these means of transport. AV and AVTOL are often electrically driven and usually travel at the same speed. Even if electricity is produced with fossil fuel and the disposal of the battery sometimes causes high emissions, the total emissions can be kept low (Lang et al., 2017).
- **Improved productivity:** Looking at the time savings in using AV and AVTOL, you can see that they can increase productivity. The journeys become more predictable and shorter with the help of such autonomous means of transport. These time savings can be invested in other activities. In addition, autonomous driving allows passengers to work on the move (Lang et al., 2017).
- **Greater convenience:** AV and AVTOL can contribute to greater convenience. For example, you no longer have to look for a parking space. According to a study conducted by the Boston Consulting Group at the World Economic Forum, 43% of respondents believe that the search for a parking space is a criterion for the use of drones (Lang et al., 2016). The alternative use of the space that must be used for parking can also be used differently. The Boston Consulting Group sees the possibility of recreational facilities or parks (Lang et al., 2017).
- **Better safety:** In terms of security, AV and AVTOL can also offer added value. According to the Boston Consulting Group and Boston residents, traffic collisions can be reduced (Lang et al., 2017). AV and AVTOL can also provide increased safety for other road users, such as pedestrians and cyclists, as the roads are less busy (Lang et al., 2017). Furthermore, the German Federal Ministry of Transport and Digital Infrastructure mentioned in its report that AVs can drastically reduce the number of accidents caused by human error (BMMVI, 2015). Considering that this number currently accounts for 90% of all accidents, AVs and AVTOLs can provide better safety and some relief on the roads (BMMVI, 2015).
- **Less congestion:** The last anticipated benefit is less congestion. Especially, with the help of AVTOL, it is anticipated that there will be fewer vehicles on the roads. Thus, a smoother traffic flow and at the same time fewer accidents can be guaranteed (Lang et al., 2017). Studies also show that, with the help of AV, the result is up to 60% fewer cars on the streets in cities (Lang et al., 2016). Less congestion also means a reduction of unproductive time and thus time which can be invested differently. Here the two benefits improved productivity and less congestion flow together.

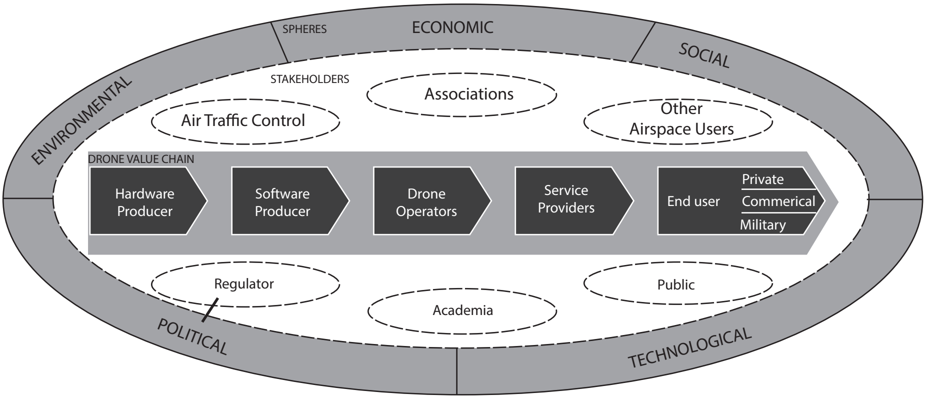

Fig. 16.3 The drone ecosystem. (Author's own figure)

16.4.3 The Drone Ecosystem

The Drone Value Chain can be split into five parts. The first part of the value chain are the drone hardware producers, followed by the software producers. The drone operators are companies who run the drones themselves and who then, for example, offer the collected data for sale. The service providers which follow the drone operators are companies who offer a broad range of services surrounding drones, for example, the maintenance of drones. Finally, there are three types of final end-users: private, commercial and military users. There are six relevant drone stakeholders surrounding the Drone Value Chain. Three of these stakeholders are directly involved in the airspace. The regulators of air traffic, as well as the air traffic controllers or enforcers. In addition, there are other airspace users which are affected by drones. The other three stakeholders are affected by or interested in the airspace. Academia, associations and the public are relevant stakeholders that have a lot of influence and should, therefore, be taken into account.

There are five spheres grouped around the stakeholders. While the political and social spheres concern the human aspects of the drone markets such as public opinions, the economic sphere examines the economic viability of drones. In addition, the environmental sphere looks at the environmental impact of the drone field and, finally, the technological sphere looks at the technological developments (Fig. 16.3).

16.4.4 Use Cases of Drone Passenger Transport

There are many different use cases for drones. This chapter limits and focuses on passenger transport use cases. These cases may not be feasible globally. But especially in countries with limited ground infrastructure, long and hassling commuter times as well as difficult topography, passenger drones may lead to new transport business cases in the future.

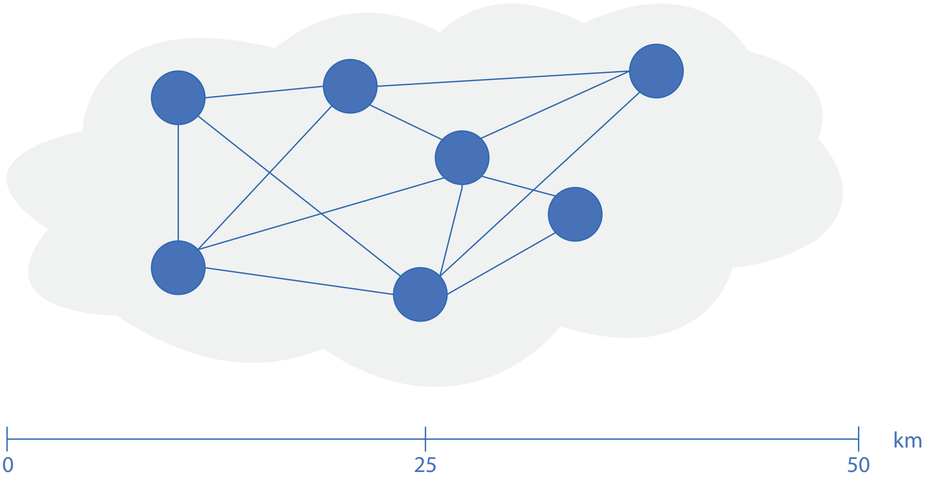

Fig. 16.4 Air taxi networks. (Author’s own figure based on Baur et al., 2018)

16.4.4.1 Air Taxi

This use case describes the use of drones as a means of transport for people between two possible landing pads in a defined area. One to two people and their hand luggage will be transported. This use case works in a similar way to the taxis that already operate on the roads today. The average distance to be covered by an air taxi is between 10 and 50 kilometres. The landing pads are located at various locations throughout the city and are intended to offer a large network of possible transport routes. The legal and operational conditions are all in place and there are no restrictions on the use of drones as air taxis (Baur et al., 2018, p. 9) (Fig. 16.4).

16.4.4.2 Airport Shuttles

Like the first use case with air taxis, this case covers similar and longer distances. In this case, drones are used to transport people from the airport to the city. The passenger is to be transported from the airport to various landing pads. These drones will transport up to four people and luggage with a total weight of 50–80 kg. Due to the longer distances, the battery charging stations are mainly located at the airport, where the drones wait for new passengers. Passengers can book their seats on planned flights (Baur et al., 2018, p. 10) (Fig. 16.5).

16.4.4.3 Intercity Flights

The third use case covers flights between two cities. These cities are just so far apart that drones can still access them. Yet they are also too close to each other, so that a connection by airplane does not make sense. The drones must provide space for two to four people and carry an additional weight of 20–40 kg of luggage. The distances to be covered are between 50 and 250 kilometres and a safety radius of an additional 50 kilometres. Due to the long distances involved, charging stations must be installed at both locations (landing pads). Here, the specified routes can be booked in advance via a system too (Baur et al., 2018, pp. 10–11) (Fig. 16.6).

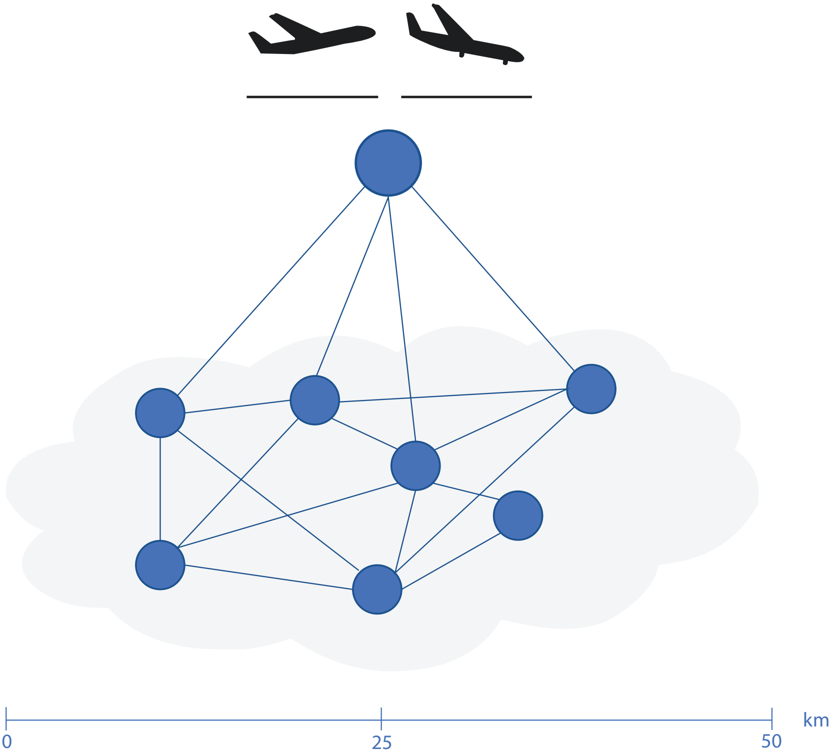

Fig. 16.5 Airport shuttle networks. (Author's own figure based on Baur et al., 2018)

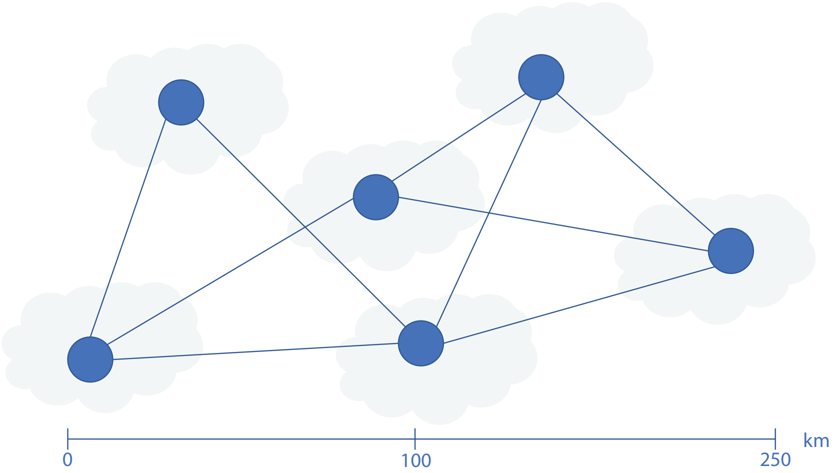

Fig. 16.6 Intercity flights network. (Author's own figure based on Baur et al., 2018)

16.5 Obstacles to the Implementation of Air Taxis

The implementation of unmanned air taxis will face many obstacles. The obstacles are divided into the three main categories of user, technology and law, in order to present them clearly.

16.5.1 User Obstacles

The acceptance by the end user plays a very central role in whether AVTOL is implemented successfully. Trust in automation is one of the many points that can influence its acceptance. Studies have shown that there are various factors that control trust in automation.

- **Perceived reliability of automation:** A study about autonomous cars has shown that meeting a performance expectation can increase the acceptance of a technology. However, in the reverse case, a major failure of the autonomous steering system can severely impair confidence in the technology even in the long term. Therefore, the mentioned study states perceived reliability as a key factor for the acceptance of a technology by the user (Nees, 2016).
- **Technology is safety**: Wittmer and Linden (2017, p. 18) highlight the security aspects as a very relevant factor in customer acceptance for the adoption of future mobility services. There are different types of safety. Passenger safety at night in urban regions is one of them (Piao et al., 2016). In this context, Merat et al. (2017) have found that vehicle interior space can play a decisive role. Today, however, cyber security concerns are also becoming increasingly important among users (Kyriakidis et al., 2015).
- **Confidence in a technology is the locus of control:** The authors Choi and Ji (2015) have confirmed this in their Technology Acceptance Model. Similarly, a study on autonomous driving in Germany found that 90% of all respondents would like to be able to intervene at any time or in the case of a dicey situation (Deloitte Analytics Institute, 2017). The user seems to always want to have a feeling of self-control. He wants to get into an autonomous vehicle with the conscience that, if he perceives it as necessary, he can take control of the drone in an emergency.
- **Social acceptance** is one of the major obstacles to the introduction of AVs. From a social view acceptance can be affected if jobs are lost due to automation (Deloitte Analytics Institute, 2017). Furthermore, accidents and problems of the technology or the system can have a massive impact on the acceptance. But even if accidents and problems occur, everything must be clearly regulated, and the users must know what the liability issue is (Deloitte Analytics Institute, 2017). Kyriakidis et al. (2015) also see further factors influencing social acceptance in cyber security, terrorism, other crime or the privacy and data of AV users.

- **Use:** Perceived usefulness, perceived ease of use and purpose of trip have a strong influence on acceptance (Deloitte Analytics Institute, 2017). According to Merat et al. (2017), the ease-of-use through easier access, low effort to use and, above all, low or no barriers for users with limited mobility are of major importance. The ease of use is achieved during the booking, as this is the main part where the user is required to actively provide input. However, the user-friendliness of Urban Air Mobility (UAM) can also be demonstrated in the user experience, where the user can have a pleasant journey.
- **Value of time** plays an important role in the choice of transport (Krueger et al., 2016). For the end user, time reliability is a decisive criterion for the use of a means of transport (Abir et al., 2017). In the case of AVTOL, this is reflected in the reliability and punctuality of the booking. Time can also play a central role in the journey itself. With the help of AVTOLs, traffic jams can be avoided and much more direct routes with higher speed can be used, and thus a lot of time can be saved during the journey (Lang et al., 2016). And finally, the user can do things other than driving and therefore make efficient use of his extra time.
- **Costs for the user** (Merat et al., 2017; Rychler & Giesler, 2016): The question is whether the use of autonomous vehicles is not reserved for the wealthy alone.
- **Different cultures, customs and ideas:** Rychler and Giesler (2016) mention that acceptance in industrialized countries will most likely face greater challenges than in emerging markets such as India or China.
- **Data security:** Data exchange (private and travel data) in the use of autonomous vehicles could lead to a confrontation with the acceptance of automation by some users in more developed countries (Kyriakidis et al., 2015).
- **Socio-demographic differences** play a central role in the acceptance of autonomous vehicles. Such socio-demographic impacts are age and gender (Kyriakidis et al., 2015; Payre et al., 2014; Rödel et al., 2014). As far as gender is concerned, it was found that women are more likely than men to use autonomous vehicles (Hohenberger et al., 2016). Age is just as important for acceptance. Young (Deloitte Analytics Institute, 2017), multimodal (Krueger et al., 2016) people are more willing to travel in autonomous vehicles than older people.

16.5.2 Technology Obstacles

One producer side obstacle could be the production costs, which are passed on to the user and makes it difficult to sell or use the product. Google (2019), for example, says that mass production for an autonomous car cannot be expected in the next few years. This is due to the very high costs of the individual parts (sensors, cameras, etc.).

But the technology itself can also be a challenge. What exactly should the unmanned drone look like to be accepted by users? What features does it need to function properly? At this stage, it appears that the most promising designs and technologies include multicopters, quadcopters, tilt-wingers and electrical vertical take-off and landing (eVTOL) aircraft (Hader, 2018).

In addition to the technology, the infrastructure and its costs are also a decisive factor whether and AVTOLs can be implemented. In addition to landing pads, charging and maintenance stations are also very important (Hader, 2018). It must be clarified where these are located and how they are structured. In addition, AVTOL also needs a strong cellular network to communicate with each other and to function properly (Hader, 2018). Here too, the infrastructure must be set up in such a way that smooth operations and security can be assured. If one imagines a door-to-door on-demand service for unmanned air taxis, this could be another obstacle to the infrastructure. This type of air taxi service would require a very dense network of landing pads (vertistops), which could pose major challenges for implementation (Hasan, 2018, p. 23). Equally important is vehicle localization. GPS is relevant to calculate your own position and route. This is especially important to ensure safe and accident-free traffic through the air. High-definition maps are needed to plan the routes on which the unmanned drone flies. Creating them is very cost-intensive and requires a lot of effort and infrastructure for development (Heineke et al., 2017). Drones need to be included in the airspace with other traffic around, which has to be monitored.

Finally, the drone must be ready and able to make the right decisions in every situation. However, programming this currently poses major obstacles for many developers (Goel, 2016). Even if there are already some methods for this, they are still in an early stage of development and therefore prone to errors (Tian et al., 2018, p. 1). Communication is also related to the ability to make decisions. The current state of technology calls for communication among autonomous vehicles when they are on the move. This requires, as already mentioned, a strong cellular network (Goel, 2016) on the one hand and a unified platform on the other hand, which has a generally valid and accepted standard to which the manufacturers and ultimately the autonomous vehicles themselves can adhere (Heineke et al., 2017).

16.5.3 Law Obstacles

The legal and regulatory bases are also a decisive factor for the acceptance and implementation of AVTOLs. Many changes and additions must be made to the regulation of air traffic and new legislation is needed (Zoldi et al., 2017). The operational risks include a safe operation of the autonomous vehicle, and how the automation will interact with the air traffic control system (Jenkins, 2017). In a study on Urban Air Mobility (UAM), regulations and certificates are regarded as one of the main barriers (Hasan, 2018). These are closely related to safety and security and thus ultimately linked to the acceptance by the user. If the regulatory framework conditions are clear and certificates are distributed for the unmanned air taxis, the confidence of the users, and thus their acceptance, increases (Hasan, 2018, pp. 52–53).

But these regulatory and legal foundations alone are not enough. There is also a need for tight management of air traffic (Lineberger et al., 2019). Ultimately, this management helps to ensure that air traffic can be handled safely and smoothly.

This, in turn, will help promote user acceptance of AVTOLs. As with the technological and communicative obstacles, sufficient laws and regulations can also provide a secure basis for customer acceptance.

Review Questions

- What are different definitions of drones?
- What are technical characteristics to distinguish drones?
- What are applications of drones?
- What are benefits of drones?
- Please explain the drone ecosystem.
- What are use cases of drone passenger transport?
- What are user obstacles of air taxis?
- What are technological obstacles of air taxis?
- What are regulatory obstacles of air taxis?

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