Commercial Aviation in Tension between Sustainability and Process Optimization at Airports

Masterarbeit

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1 Introduction

1.1 Motivation

Commercial aviation is one of the most dynamic industries in the world: The volatility of the oil price, economic fluctuations, geopolitical uncertainties, supply consolidation and bankruptcies of individual airlines determine the industry and thus the actions of several players in aviation. According to forecasts by airlines and aircraft manufacturers, the growth in global air traffic will continue to increase. Airbus (2018) sees an additional global demand for around 37,000 aircraft over the upcoming 20 years. Aviation is often declared both in media and in public with words such as *climate killer* or *environmentally harmful*. They appeal individuals to reduce air travel in order to minimize their ecological footprint.

On the one hand there is the public endeavor to minimize individual travel activities. On the other hand, an increased growth in air traffic is forecast, especially in the Asian-Pacific region. In China and India alone, an additional annual passenger volume of more than 1.14 billion is expected by 2035 (IATA (2020). While the Asia-Pacific market is forecast to be the driver of commercial aviation in the future, global air traffic in terms of passengers transported will increase by 3.7 % (annual compound average growth rate). At first glance, these developments are diametrically opposed. This is primarily due to the fact that global air traffic emits pollutants through the combustion of fossil fuels in aircraft and the level of pollution has a positive correlation with growth.

Since the positive growth of aviation is inevitable, the call for a climate-friendly and sustainable orientation of the industry in society is getting louder. According to Lee et al. (2020), aviation has so far contributed 3.5 % to anthropogenic global warming, which corresponds to 32.6 billion tons of carbon dioxide emissions. Although the focus in the public debate is primarily on carbon dioxide emissions, Lee et al. (2020) state that the majority of emissions sources are non-carbon dioxide. To make aviation more environmentally friendly and sustainable, a one-sided focus on carbon dioxide emissions from aircraft is insufficient.

In addition to alternative types of propulsion (Geffert (2018)), which address the problem of pollutant emissions, approaches can also be found that indirectly support sustainable aviation. For example, weight reductions and aerodynamic changes in the aircraft can lead to reduced consumption of kerosene, which in turn leads to a lower level of pollution. However, relevant aspects concerning safety must not be ignored. Furthermore, in the field of layout design of airports, e.g. the usage of permeable surfaces or in the respective approach behavior of aircraft, starting points can be found to integrate sustainability and

environmentally conscious actions into aviation. Though not only emissions as carbon dioxide should be considered, but also indicators such as noise pollution, sustainability and the provision of natural habitats.

Hence the following research question arises:

How might commercial aviation and environmentally consciousness be combined?

The following issues can be derived from this:

- *How could processes and procedures in commercial aviation be economically optimized and made sustainable at the same time?*
- *How could measures for the design of environmentally conscious aviation be developed and cataloged?*
- *What are the challenges for aviation in terms of process optimization and sustainability?*

In answering these research questions, it is of pivotal importance to consider and examine aviation with all its actors and reciprocal relationships.

1.2 Aim of this Paper

This thesis aims to address the lack of a scientific view of aviation from a process-optimizing and sustainable perspective. In particular, the object of this thesis is to present several possibilities and challenges to make aviation greener and more sustainable. A sustainability action matrix is provided through which measures are developed and categorized in order to give decision-makers a support function.

In a computational study, the popular hub-and-spoke system in aviation is examined with regard to pollutant emissions. Direct connections serve as a comparison, whereby various parameters such as types of engines or the utilization of aircraft that influence the pollution are examined and thus varied.

This work is limited to commercial aviation and negates air traffic in the cargo or business aviation sector.

1.3 Thesis Structure

This thesis is structured as follows: Chapter 2 introduces the research design that is used for this thesis. Basic definitions and terminology related to sustainability are presented in Chapter 3. Measures, agreements and an introduction to pollutant emissions are discussed

in Chapter 4, with a literature review also taking place. The turnaround of commercial aircraft is described and characterized in its sub-processes and options for optimization are presented in Chapter 5. In Chapter 6, measures, processes and approaches are highlighted that are able to combine economic optimization and sustainability. This is framed with a sustainability action matrix, a tool to derive environmentally friendly measures in aviation. In chapter 7 a computational study is presented, which is split into two case studies and examines the pollution between hub-and-spoke systems on the one hand and direct connections on the other.

10 Conclusion

The aim of this thesis is to answer the research question to what extent process optimization and environmentally conscious, sustainable thinking in commercial aviation can be reconciled.

To answer this question, a terminology of sustainability was first presented, which is processed in this thesis. The term sustainability can be viewed in different ways and defined from several perspectives such as the environment, the economy and society.

In addition, an introduction to commercial aviation was given, in which, in addition to the relevance of these, current developments and projects are presented, which should make aviation more sustainable and emission-free. This is flanked by a literature overview in which literature and recognized papers are presented that deal with the topics of aviation and the environment.

The turnaround of commercial aircraft was described in its individual processes and its complexity emphasized by showing the strictly timed sequence. Based on this, process optimizations of individual sub-processes were presented and explained, whereby these are also sustainable according to the presented terminology.

In this thesis, a new cataloging and monitoring tool was developed, which, taking into account several dimensions in aviation, can develop economic and process-optimizing measures that are sustainable at the same time. With the help of this tool, the sustainability action matrix, such measures were developed and presented in various areas of aviation. The matrix also serves as a monitoring tool, since indicators are assigned to each measure, which can measure the degree of effectiveness in the short, medium and long term. In addition, an expansion of the matrix was presented, which can also map digitization approaches.

The results of the thesis show that process optimization and sustainability can be reconciled. In this way, several areas in commercial aviation can be found which need optimization and in which a sustainable orientation can be integrated. This can range from the types of propulsion and the flight behavior of the aircraft to the layout of the airport and the apron vehicles. It must be emphasized, however, that many measures and approaches are investment cost-intensive and that amortization can only be expected in the long term. However, environmentally friendly measures are extremely difficult to assess in monetary terms, as the benefits only appear in the long term in most cases. In addition, it is difficult to determine opportunity costs.

Various approaches can already be found by airlines which, based on their corporate social responsibility, are motivated to include low-emission aircraft in their fleets or compensate for pollutant emissions. However, such an environmentally conscious corporate philosophy

can only be found to a very limited extent, especially with low cost carriers.

At this point, legal framework conditions must be adopted on a global level, which move the players in aviation in the direction of sustainable optimization. To do this, realistic short, medium and long-term milestones must be defined. This has already been initiated in agreements such as CORSIA or Clean Sky. However, this must always be further developed and adjusted with a view to the economic, social and environmental conditions.

In addition, a computational study was presented in this thesis, which compares the pollutant emissions between the hub-and-spoke system and a network of direct connections between selected airports. The pollutants CO_2, NO_X and HC were illuminated. The results of the study show that more pollutants are emitted in the hub-and-spoke system than in direct connections. This is primarily due to the increased number of flights, which increases when changing at a hub. From a business point of view, the hub-and-spoke system is more efficient and more economically optimized by bundling transport flows. At this point, at first glance, process optimization can only be combined with sustainability to a limited extent. However, an environmentally conscious component can be integrated via low-emission engines and optimized flight behavior, especially during approach.

This thesis shows that process optimization and sustainable approaches in aviation are not mutually exclusive. There are various approaches to integrating an environmentally conscious component into aviation. The task of research will be to continue to accompany this development and to show that sustainability can be integrated into aviation.