Aalto University
School of Science

Master's Programme in Industrial Engineering and Management

The impact of EU sustainability regulations: demand implications and growth prospects of LCCs

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Master's Thesis
2025

Aalto University
School of Science

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Title The impact of EU sustainability regulations: demand implications and growth prospects of LCCs

Degree programme Industrial Engineering and Management

Major Strategy

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Collaborative partner A Swedish case company

Date April 14, 2025 **Number of pages** 91 **Language** English

Abstract

This thesis aims to explore how European low cost carriers (LCCs) steer their way through sustainability-related cost pressures, regulatory pressures and changing competition in a fast changing operating environment. Using a qualitative research approach, the study includes semi-structured interviews with industry informants, accompanied by a quantitative analysis of the costs of an airline, with a specific focus on the costs of fuel and the financial implications of using SAF. The qualitative analysis, using the Gioia method, identifies the future of European aviation demand and strategic planning for sustainability related cost increases, and the focus is on three major areas: regulatory adaptation and demand dynamics, cost management, and competitive strategy, together with growth strategies for LCCs. The study incorporates case company from the Nordic region, providing deeper insights into how airlines operating in Europe are adapting to sustainability pressures within the broader European regulatory framework. The results show that the price demand sensitivity is high and a focus on cost minimization strategies creates a problem for LCCs given the existing regulatory constraints such as SAF blending requirements and capacity limitations. However, the LCCs that are in a good financial health and have a strong market position should still be well placed to manage the increasing costs and should keep on growing, despite the market being more and more congested. The quantitative component uses the financial reports of certain airlines to present fuel cost statistics and how sustainability policies affect the profitability of LCC operations. The results indicate that while LCCs face growing regulatory pressures, they can address cost issues by improving the performance, engaging partners and defining their service offerings. However, it seems that to grow in this regulatory environment, the focus on costs may have to be balanced with the need to be competitive in the market. This study offers a comprehensive evaluation of how sustainability policies affect competitive forces and future growth of LCCs in the European aviation market based on both qualitative data and quantitative cost analysis.

Keywords Aviation, Sustainability Costs, LCCs, SAF, EU Aviation Regulations, Strategic Responses to Sustainability Cost Pressures

Aalto-yliopisto
Perustieteiden
korkeakoulu

Tekijä	Antton Alamettälä
Työn nimi	EU:n kestävyysregulaation vaikutukset: kysynnän muutokset ja halpalentoyhtiöiden kasvunäkymät
Koulutusohjelma	Tuotantotalous
Pääaine	Strategia
Työn valvoja	Prof. Natalia Vuori
Työn ohjaajat	Prof. Antti Tolvanen,
Yhteistyötaho	Ruotsalainen kohdeyritys
Päivämäärä Huhtikuu 14, 2025	**Sivumäärä** 91 **Kieli** englanti

Tiivistelmä

Tämän tutkimuksen tavoitteena on selvittää, miten Euroopan halpalentoyhtiöt (low-cost carriers, LCC:t) sopeutuvat kestävyyteen liittyviin kustannuspaineisiin, sääntelyyn ja muuttuvaan kilpailutilanteeseen nopeasti kehittyvässä toimintaympäristössä. Tutkimus toteutettiin laadullisena tutkimuksena, jossa pääaineistona käytettiin puolistrukturoituja haastatteluja pääosin eri puolilta Eurooppaa olevien ilmailualan asiantuntijoiden kanssa. Laadullista aineistoa täydennettiin määrällisellä analyysillä, joka kohdistui lentoyhtiöiden kustannusrakenteisiin, erityisesti polttoainekustannuksiin ja kestävän lentopolttoaineen (SAF) käytön aiheuttamiin taloudellisiin vaikutuksiin. Tutkimuksen laadullisen aineiston analysoinnissa hyödynnettiin Gioia-menetelmää, jonka avulla tunnistettiin kolme keskeistä teemaa: sääntelyyn sopeutuminen ja kysyntämuutokset Euroopassa, kustannusten hallinta sekä kilpailu- ja kasvustrategiat halpalentoyhtiöille. Tutkimuksessa hyödynnettiin pohjoismaalaista case-yhtiötä, mikä mahdollisti haastattelu verkoston luomisen ja syvemmän näkemyksen siitä, kuinka eurooppalaiset lentoyhtiöt käytännössä sopeutuvat kestävyyssääntelyyn. Tulokset osoittavat, että lcc yhtiöiden asiakkaat ovat enemmän hintatietoisia kuin keskiverto asiakas, mutta lentomatkustuksen kysynnän odotetaan silti pysyvän vahvana kustannusten noususta huolimatta seuraavien kymmenen vuoden aikana. Tulokset osoittavat, että halpalentoyhtiöt pystyvät luultavasti sopeutumaan kestävyysvaatimusten aiheuttamiin sääntelymuutoksiin ja nouseviin kustannuksiin niiden tehokkaiden ja joustavien rakenteiden ansioista, vaikka lisääntyneet kustannuspaineet asettavatkin haasteita niiden nykyisille kustannusten minimointiin perustuville liiketoimintamalleille. Siitä huolimatta vahvan strategisen ja taloudellisen aseman omaavat halpalentoyhtiöt pystyvät sopeutumaan nouseviin kustannuksiin ja ylläpitämään kasvuaan. Kvantitatiivinen analyysi osoitti, että vaikka sääntely aiheuttaa lentoyhtiöille jatkuvia kustannuspaineita, etenkin lcc yhtiölle joilla on suurempi paine kustannusrakenteessa polttoaineen hinnan nousuun, kuitenkin polttoaineen hinnan nousu kestävyys syistä ei voida pelkästään kustannusrakenteen takia sanoa että lcc yhtiöt ovat vaikeammassa tilanteessa kuin perinteiset lentoyhtiöt. Kvantitatiivinen analyysi lisäksi paljastaa että, yhtiöt voivat vastata kustannus nousuihin parantamalla operatiivista tehokkuutta entisestään sekä aktiivisella sidosryhmäyhteistyöllä sijoittaen kestävään polttoaineeseen.

Tutkimus tarjoaa laajan näkemyksen siitä, miten kestävyyspolitiikat vaikuttavat kilpailuasetelmaan ja halpalentoyhtiöiden tulevaisuuden kasvumahdollisuuksiin Euroopan lentoliikennemarkkinoilla tulevan vuosikymmenen aikana.

Avainsanat Kestävyyskustannukset, Halpalentoyhtiöt (LCC), Kestävä lentopolttoaine (SAF), EU:n kestävä lentoliikennesääntely, Strategiset vastaukset kestävyyden kustannuspaineisiin

Preface and acknowledgements

I would like to express my sincere gratitude to all those who have supported me throughout the process of writing this thesis. Conducting the research in collaboration with the case company offered a valuable opportunity to explore a timely and relevant topic, and I am thankful to the individuals at the company who made this work possible through their support and insight.

I would also like to thank my academic supervisor Natalia Vuori and thesis advisor Antti Tolvanen for their helpful guidance and encouragement. Their support made it possible to navigate the process and stay focused throughout.

To my friends, family –and foremost to my partner–I am grateful for your interest, encouragement, and presence. Our conversations and shared moments helped me keep perspective and balance during a process that often demanded long hours of independent work.

Finally, I wish to thank myself for maintaining determination and balance throughout this journey. I am especially grateful that, even during times when my well-being and health were not at their best, I was able to listen to myself, acknowledge those challenges, and still remain committed to the work. This experience required persistence and self-awareness, and completing it despite moments of difficulty has been both demanding and deeply meaningful. It has contributed not only to my academic development but also to my personal growth and understanding of my own limits and strengths.

Helsinki, April 14, 2025

Antton Alamettälä

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1 Introduction

This part presents the thesis subject by explaining its background and motivation. The research topics and aims of the study are also addressed as well as the research questions. Finally, this part explains the research strategy, thesis scope, and study format.

1.1 Background and motivation

The European aviation industry is undergoing a massive change which is being driven by environmental constraints, regulation and the increasing desire to reduce carbon emissions. This is following the larger trend of climate change, aviation is a climate-critical transport business sector. The European Union has set strict environmental policies that include reducing emissions by 55 percent by the year 2030 and to achieve climate neutrality by the year 2050. These goals pose a great financial and operational challenge to airlines especially with the implementation of sustainable aviation fuel mandates. These mandates demand steadily increasing the share of SAF and blending it with conventional jet fuel. SAF is currently three to four times more expensive than conventional jet fuel with limited price forecast ability, which means that its implementation will increase the costs for airlines.

LCCs, which are based on low cost business models, are especially sensitive to these changes as they pursue largely price sensitive customer segments. Their plans are based on high aircraft productivity, ancillary services such as charging extra for additional bags, food and drink and seat selection – and small airports to reduce the costs of the operation. LCC business model is more novel than that of the competing one based on network value. LCCs recently gained major market share globally as well as in Europe from legacy carriers. However, as sustainability regulations increase costs, LCCs might be pushed to shift their strategies to remain profitable and competitive. The sustainability regulations present a financial challenge to aviation industry as a whole also affecting full service carriers (FSCs), which serve long haul routes and high paying customers as well. It is therefore important to see how these different airline business models respond to sustainability pressures, the findings derived from this research can serve as a base to make educated and literature based a guesses of the future of the European aviation industry dynamics in response to sustainability regulation. Although the existing aviation sustainability literature has reviewed studies on emission reduction measures, fuel substitution, and policy issues; there is limited investigation of how LCCs address sustainability related cost increases in this novel and partly unbalanced market – unbalanced due to arguments implying that these regulations do affect the industry and competition within evenly. The purpose of this paper is to help reduce this research gap by analyzing the effects of sustainability costs on the competitive dynamics of the European airline industry with a particular emphasis on the strategic actions of LCCs.

1.2 Research questions and objectives

The obejctive of this study is to investigate how sustainability related cost increases affect LCCs in Europe and how these airlines try to respond to these challenges in order to keep their competitiveness while environment pressures increase. This objective encompasses two dimensions: in the first dimension the implications of sustainability driven costs on European air travel demand and passenger behaviour are analysed; in the second dimension, strategic growth adaptations of LCCs in response to these pressures are examined.

The first dimension is addressed by looking at how increasing sustainability-related expenses – e.g., those driven by mandates on SAF – affect air travel demand. The price of sustainable aviation fuel is considerably higher than that of conventional jet fuel, which means additional costs for airlines and may affect passenger choice, particularly in the price-sensitive markets served mainly by LCCs. In addition, capacity constraints, e.g., restricted aircraft supply and regulatory imposed flight limitations, may also affect the demand patterns. Hence, it is crucial to examine these factors collectively to understand their combined impact on the overall scenario along with other economic factors such as GDP growth, income, and changing consumer preferences towards sustainability. This type of analysis can be used to assess the magnitude to which these factors will alter behavioural responses, including changes in leisure and business travel. Therefore, the first primary research question, along with its sub-question, is stated as follows:

RQ1: How do sustainability-driven cost increases and other capacity constraints (e.g., aircraft availability, flight caps) jointly influence European air travel demand over the next decade?

RQ1.1: To what extent do sustainability-driven cost increases, such as rising SAF costs, impact air travel demand across different passenger segments (e.g., leisure versus business travelers)?

The second dimension of this research is more specific to low cost carriers and their capacity to sustain their growth ambitions in the face of increasing sustainability related financial pressures. Past and current strategies employed by LCCs include point-to-point travel, high aircraft utilization, the use of secondary airports, minimal turnaround times and extensive ancillary revenue streams in a bid to maintain their low cost position and keep profitable. However, sustainability costs rising mainly from mandatory SAF quotas and other environmental regulations are a significant threat to their low cost operating models. This study will seek to establish whether LCCs can sustain or even align their growth strategies to remain competitive or whether there is a need to rationalize and realign to high yield routes only. In addition, this study will examine how airlines may have to change their cost management, pricing, route planning and revenue management, including increasing the availability of ancillary services to address these rising sustainability pressures. The second primary research question, along with its sub-questions, is as follows:

RQ2: Are low-cost carriers able to sustain growth under increasing sustainability-related costs in the EU, and if so, what strategic adaptations enable them to achieve this growth?

RQ2.1: What specific cost and operational challenges do sustainability mandates, such as SAF quotas, pose for LCC business models?

RQ2.2: What strategic and operational adjustments (e.g., route optimization, aircraft utilization, ancillary revenue generation) enable LCCs to maintain profitability and competitive fares under sustainability-related cost increases?

RQ2.3: How do sustainability-driven market dynamics reshape competitive relationships between LCCs, full-service carriers within the European context?

In order to achieve these goals and contribute both theoretical insights that can enhance current academic understanding of strategic responses within airline management literature, and also practical recommendations that can assist airline managers, policymakers, and other stakeholders in navigating the evolving regulatory and competitive environment of European aviation, the study aims to answer the research questions and sub-questions stated above.

1.3 Research approach and scope

The methodology used in this research includes both theoretical and empirical approaches in order to offer a systematic examination of the way sustainability related cost increases affect LCCs and their strategic responses. This dual approach allows for an examination of the general factors including regulations and market forces that impact the airline industry while still being able to grasp the actual impact and strategic changes of industry participants. The theoretical finding of this study is based on a review of the literature on aviation sustainability, cost structures and airline business strategies. In this regard, the study, after reviewing previous research on sustainability mandates, especially those by the European Union, determines the main costs affecting LCCs, which include SAF regulations, carbon pricing, and operational efficiency constraints. Furthermore, the theoretical review looks at the competitive structure of European aviation and how sustainability costs affect different airline business models. This literature informed analysis forms a useful conceptual basis for organising the empirical findings in the study.

The empirical component is based on a qualitative approach, which uses interviews of key stakeholders from the airline industry to explore how sustainability related costs impact operational and strategic decision making. The interviews include opinions and insights from industry professionals, airline executives and others who are familiar with the regulatory and competitive challenges of EU aviation. The empirical analysis documents current strategies that LCCs use to address sustainability costs, evaluates the feasibility of SAF adoption within their cost structures, and examines their growth opportunities in the context of increasing environmental requirements. In addition, the study examines how passenger price sensitivity and changing travel behaviours affect LCCs' margin to offer competitive prices while meeting sustainability targets. This study focuses on the European airline industry, one of the most regulated by sustainability standards. Even though the primary focus is on LCCs, the study also examines the interactions with full service carriers (FSCs) to understand competitive interactions in a changing regulatory environment. Due to the cost focused nature of LCCs operations, these airlines present a interesting case to analyse the wider implications of sustainability regulations on the aviation sector. The findings are specific to a given industry context, however the mechanisms explored in this study are relevant to a wider set of aviation stakeholders, those operating in markets where sustainability requirements are increasing rapidly in upcoming years.

1.4 Structure of the thesis

This thesis is structured into five main sections. The first section provides an introduction to the study, outlining its background, research questions, objectives, and scope. The second section consists of a literature review, synthesizing relevant academic research on aviation sustainability, cost structures, and airline business strategies. This section explores existing theoretical frameworks to contextualize sustainability-driven cost increases in the aviation industry, particularly focusing on how they impact low-cost carriers (LCCs) compared to full-service carriers (FSCs). Additionally, it reviews literature on European regulatory environment.

The third section details the research methodology, describing the empirical approach, study design, data collection methods, and the analytical framework applied to examine the gathered data. This includes an overview of the qualitative approach, the interview process, and a brief qualitative cost structure analysis, which assesses key financial pressures arising from sustainability regulations.

The fourth section presents the empirical findings derived from the qualitative research, incorporating stakeholder perspectives obtained through interviews. This section examines how sustainability-driven costs affect aviation demand in Europe with the existing and upcoming environemtal sustainability regualtions in EU. This section also focuses on LCC growth opportunities and percieved growth directions based on the interview data gathered. The results further include LCC operations, demand patterns, and strategic adaptation. Findings are illustrated with direct quotations from the interview data from industry professionals to highlight key themes and challenges.

The findings are based on interview data collected from industry professionals, and stakeholder perspectives on the impact of sustainability-driven costs on aviation demand in Europe are explored. This section systematically examines how both current and future environmental sustainability regulations within the European Union affect the strategic thinking of airlines especially LCCs. The empirical results are grouped into three main dimensions based on the Gioia method to help organize the analysis of the qualitative data. In this framework, key themes emerge regarding the challenges and opportunities that sustainability mandates pose to LCCs. These are regulatory cost burdens, shifts in passenger demand patterns, and strategic adaptations in response to increasing operational costs. Moreover, this section discusses the perceived growth trajectories of LCCs with increasing sustainability pressures, as informed by interview participants. Discourse on LCC operations, demand elasticity, and the strategic adjustments needed to sustain competitive positioning in the face of an evolving regulatory landscape is detailed. The empirical analysis also considers how LCCs manage fuel cost volatility, including in relation to SAF adoption and existing barriers. For more detail and back up, the outcomes are supported by direct quotes from industry executives, highlighting the main difficulties, stakeholder requirements, and management decision making mechanisms. The inclusion of stakeholder's views guarantees that the analysis is based on the actual industry issues and strategic needs, providing a more accurate view of how sustainability-related cost structures affect airline competition and market behavior.

The final section provides the study's conclusions, linking the empirical findings with the theoretical discussion from the literature review. This section also explores practical implications for airline strategy, contributions to the existing literature on aviation business models and sustainability, and the study's limitations. Additionally, it identifies areas for future research, particularly regarding the long-term effects of sustainability regulations on LCCs and their competitive positioning in the European aviation market.

2 Literature review

This literature review aims to trace the historical evolution and the present nature of the aviation industry, with the emphasis on the main economic, regulatory and sustainability aspects. It reviews the history of air travel from the earliest developments through post-war growth and the current market patterns and trends and reviews the link between economic development and the demand for air travel. The review highlights the role of regulatory frameworks, such as sustainability policies and the adoption of SAF, in determining airline operations. A comparison between low cost carriers and full service carriers is made to distinguish the differences in their business models, costs and their responses to regulatory and environmental issues. In so doing, this section builds on the existing literature to identify the links between economic trends, regulatory developments and sustainability in the aviation sector.

2.1 Historical Growth of Air Travel

2.1.1 Early Developments in Aviation

The foundation of modern aviation was established in the early twentieth century, and air travel graduated from a novelty to an essential component of global transportation. The first scheduled passenger airline service began in 1914, and thus began commercial aviation. Development of airports and air traffic control systems, to support safe and efficient flight operations, were also occurring. Improvement in aircraft engine technology also increased the range and capacity of early aircraft thus making commercial air travel feasible [Commission, 2022]. Economic reasons fuel the mid twentieth century increase in air travel. Air travel became affordable to a wider demographic with the help of increasing global wealth and the growth of the middle class. However, government policies, and regulatory changes, have been key players in the making of the industry as well. Another example includes the deregulation of the airline industry in the United States as well as globally in 1978 which, in turn, amplified competition, reduced fares, and, to some extent, gave rise to low-cost carriers [Gillen, 2006].

For example, the establishment of the EU and the liberalization of the European aviation market in the 1990s was the key to the development of the industry. The establishment of a single aviation market enabled airlines to operate across member states and hence create competition as well as facilitate the growth of LCCs such as Ryanair and EasyJet. These carriers also followed new and innovative business models, which concentrated on reducing the costs and increasing the use of aircraft rather than introducing new products and services, thus being able to offer lower fares and get more customers [Kotze, 2017]. However, the aviation industry has its share of challenges including safety, regulations and financial risks. But it has its fair share of strengths and has over the years exhibited strong capacity to bounce back and grow. The developments that took place in the initial years of aviation created a solid foundation for the modern interconnected air transportation system

[Kotze, 2017, Gillen, 2006]. In the contemporary world, sustainability has become one of the main concerns. This paper will also highlight that, with respect to environmental concerns and climate change, public awareness has risen and, consequently, the application of sustainable practices and technologies has intensified. Some of the efforts made to improve the environmental impact of air travel include the production of SAFs and the implementation of environmental standards globally and regionally [Gössling and Dolnicar, 2023, Király, 2023]. These measures show that the industry is shifting its focus and learning to manage the conflict between economic viability and ecological accountability [Wong et al., 2024].

2.1.2 Post-War Expansion

The development of aviation sector took a new dimension after the second world war. This was due to the fact that the world was introduced to jet engines and this led to the production of the first jet propelled commercial aircraft such as the Boeing 707. These changes enhanced the duration of flight and the number of passengers that could be carried leading to the growth of international air travel. At the same time, airlines created a vast system of international connections, which further entrenched aviation in the world economy. The period immediately after the Second World War was a period of growth and change in the aviation sector. The economy also started up again and this caused a huge increase in the demand for air travel. The increase in aircraft size also led to the increase in the number of domestic and international routes. Thus, the invention of jet engines changed the face of the industry because it made flying faster and more reliable [Kotze, 2017, Commission, 2022]. This is because during this period, aviation became an essential part of the global transportation system. The increased accessibility and lower costs of air travel led to the growth of tourism and trade and hence economic and cultural development. Airports and airlines were also greatly developed by governments and other private companies to meet the increasing demand and need of passengers and cargo [Király, 2023, Kotze, 2017].

This era also helped to build the modern airline industry as major airlines took shape and rules were put in place. They were established to oversee the safety standards, air traffic control and the allocation of airspace, so that the sector which was growing rapidly could be made to operate safely and effectively [Király, 2023, Orhan, 2021]. However, this expansion was not without its problems. This resulted in congestion at major airports and in the skies, which in turn called for improved air traffic management and control systems due to the increasing density of air traffic. The environment related to aviation, for instance noise and emissions issues, were identified as an issue, and, consequently, very early conversations on sustainability began [Kotze, 2017, Lee et al., 2021]. The post-war expansion made it possible to build on the developments taking place in the aviation industry and, therefore, further innovations and adjustments were necessary. However, growing the industry meant that there was more awareness of the environmental impacts that led to the development of more environmentally friendly ways of running the industry. The concern on emissions reduction has been one of the most important issues in current aviation discourse especially in Europe [Gössling et al., 2009, Amankwah-Amoah, 2020].

2.1.3 Trends in Air Travel Growth and Market Dynamics

The expansion of air travel has been due to globalization and liberalization of air transport markets and has led to a significant growth in passengers and freight. Global air travel has expanded at an average annual rate of 4% [IATA, 2024a].

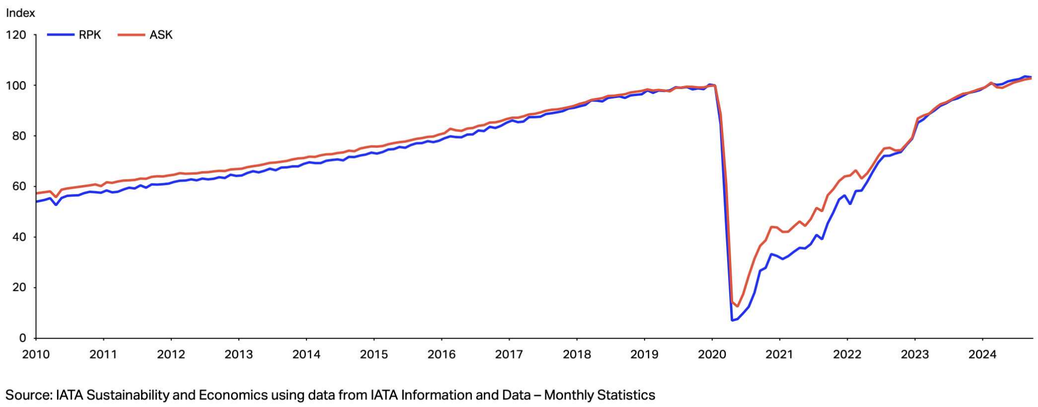


Figure 1: RPK and available seat kilometers (ASK) correspondence over longer period of time to further illustrate the historical trends of aviation supply and demand. As seen from the grap, covid is the only relevant drop within [IATA, 2024a].

Passenger traffic has been affected by various economic and external shocks that have caused fluctuations. Some periods of economic downturn, like the global financial crisis, led to temporary decrease in air travel demand. But, in recent past, the COVID-19 pandemic led to a unprecedented decline in the industry with airlines struggling with financial challenges. These challenges also present opportunities; for example, the Trump presidency in the US can increase the share of Europes incoming travel from China, this could mean that Europe stands to gain from increased Asian long haul market while the US stands to lose in the short term. During the first Trump election, Europes share of Chinese outbound long-haul travel rose from 61.1% to 78.9%, the same trend could be occurring during the second election. This could mean more travel demand from China to Europe and within Europe [CAPA, 2025]. However, the aviation sector has proved to be quite robust and is now on the way to recovery as more people are allowed to travel and more people get vaccinated. Recovery trends have been different across regions and markets, home-based travel has recovered faster than intercontinental traffic [Király, 2023, Royal and Economics, 2025]. IATA estimated that the pandemic caused the industry to experience a loss of growth of about four years. As of September 2023, air travel demand has fully recovered to pre-pandemic levels and is expected to grow at an annual rate of 3.8% until 2043 [IATA, 2024a].

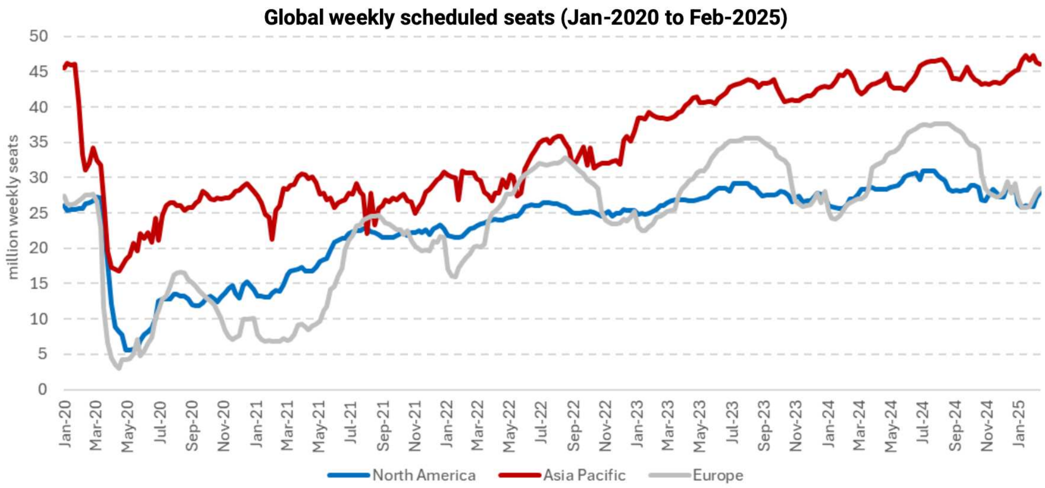
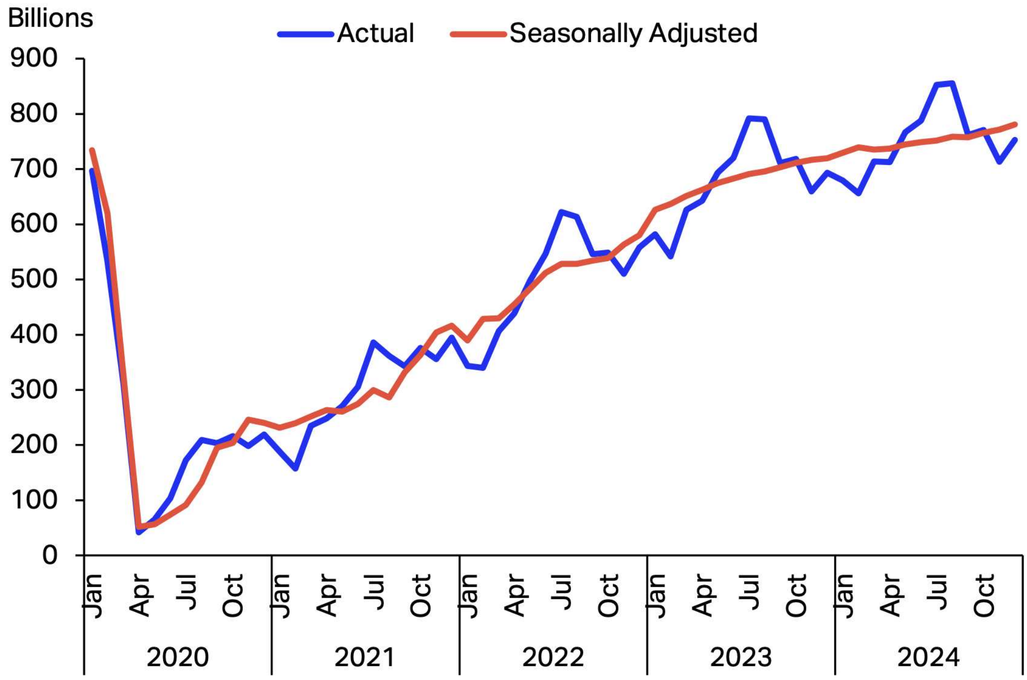


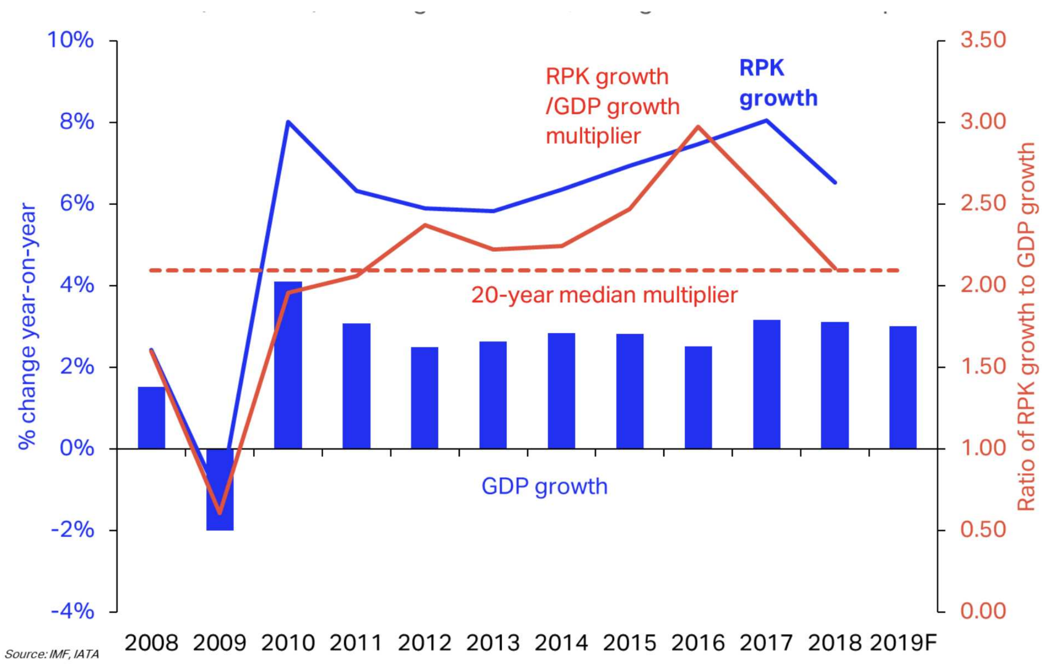
Figure 2: Global seats, this represents the global supply. It is the key capacity metric used in the airline industry to analyze supply trends, market recovery, and changes in airline operations [IATA, 2024a].

GDP growth has been linked to rising demand for air travel within Europe, with the effects of the growth rates differing with respect to the region and the context of the analysis. Cook et al. [Cook et al., 2017] argue that there is a statistical relationship between the GDP per capita and the passenger traffic and that location and education are additional factors that influence demand. Mukkala and Tervo [Mukkala and Tervo, 2013] show that there is a mutual causality between the variables: economic growth is the main driver of air passenger transportation in the core regions, whereas growth of passenger transportation leads to growth of GDP in the peripheral regions. Moreover, Clewlow [Clewlow, 2011] finds that regions with high speed rail services reduce the short haul air travel although overall airport traffic is on the rise and Iacus et al. [Iacus et al., 2020] show that closure of airways (for instance, during the COVID 19 outbreak) results in adverse effects on GDP. A prominent trend in the passenger aviation sector is the growth of LCCs which have expanded market reach by providing lower fares and thus encouraging demand especially for short sector distances. This competitive environment has made the traditional full service carriers (FSCs) to change their strategies and offer different services, network, and frequent flyer programs. FSCs have also spent money on fleet renewal and environmental concerns to keep their market share. In Europe, the biggest LCC, Ryanair carried 184 million passengers in 2024 with 584 aircraft [Ryanair, 2024b]. These competitive strategies demonstrate the various ways that airlines strive to capture and retain customers while also taking into consideration environmental concerns [Kotze, 2017].



Sources: IATA Sustainability and Economics using data from IATA Information and Data - Monthly Statistics

Figure 3: Revenue Passenger Kilometers (RPK) is a key metric used in the airline industry to measure actual passenger demand. RPK reflects the total distance traveled by paying passengers [IATA, 2024].



RPK growth in respect to GDP. This grap shows the relation ship of aviation demand in response to GDP growth. This showcasses that when GDP growth is stronger so is aviation demand. [Iata, 2019]

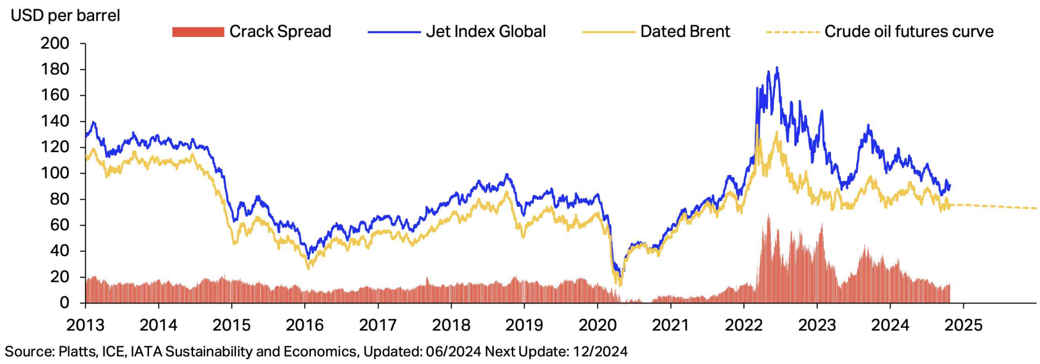


Figure 4: Global oil prices have recently declined significantly, with jet fuel prices dropping even faster than crude oil. As a result, the price difference between jet fuel and crude oil has narrowed to unusually low levels, reaching figures well below recent and long-term averages. A major factor behind the decline in jet fuel prices is the reduced demand for diesel. Since refineries produce both fuels, lower diesel demand allows for more optimized jet fuel production. This shift is largely driven by the increasing use of LNG-powered trucks, particularly in China [Iata, 2024b].

2.1.4 Developments in Air Cargo and Sustainability Initiatives

The role of air cargo is an additional topical aspect in the advancing sustainable era of aviotion in EU. Revenues obtained from the sales of cargo and the associated bargaining power bring in a new perspective on how airlines can fund their sustainability projects. Airline purchases the fuel for its own use to improve the sustainability of its operations. But cargo operations offer one more way of negotiating the purchase of sustainable fuel. It is possible to negotiate the use of SAF in freight operations with cargo partners. This in turn enables cargo operators to cut their carbon emissions and be part of the sustainability efforts throughout the value chain. These agreements can therefore be used by airlines to influence freight companies to adopt sustainable practices and thereby extend the sustainability efforts made in passenger transportation. The current situation regarding the impact of cargo on the overall sustainability of airlines is not well understood, but it is becoming more important as cargo activities keep on expanding. Many FSCs include cargo services in their strategies and operate dedicated freighter fleets or carry out cargo in the belly of passenger aircrafts to move large loads [Boeing, 2024].

The growth of cargo traffic has been influenced by global trade patterns and technological advancements, particularly the expansion of e-commerce. The demand for expedited shipping has driven increased air cargo volumes, especially in the express and parcel sectors. In response, airlines have expanded cargo operations, optimized supply chains, and invested in dedicated freighter aircraft [Orhan, 2021, Bullerdiek et al., 2021]. Air cargo has had a double digit demand increase for the past 14 months, the demand rate is expected to decrease in 2025 with a predicted increase of 6% by IATA (other forecasts include Xeneta projects with a forecast of 4-6% growth). This demand increase in cargo is expected to outweight the forcasted increase in cargo supply growth, forecasts for supply growth range between 3% to 5% [CAPA, 2025]. This could be relevant for FSC in EU, if they are able to negotiate SAF offtake agreements from cargo side, and thus increase the reveneu allocated for puchase of SAF.

2.2 Sustainability Regulations Impacting Airlines and SAF

2.2.1 Environmental Concerns

Environmental concerns are a key driver of sustainability initiatives in the aviation industry. The sector is a major contributor to climate change through the emission of greenhouse gases (GHGs) including carbon dioxide (CO_2) at high altitudes. Emissions of these gases intensify global climate change, which requires change from the current fossil fuel system [Miyoshi and Merkert, 2015]. One promising solution is SAFs which can potentially contribute significantly to emission reduction. However, the economic and regulatory barriers to the adoption of SAFs are still present. Some mechanisms are needed to support the integration of SAFs into the market, such as quota obligation schemes [Bullerdiek et al., 2021]. The effectiveness of SAFs is crucial for the aviation industry to achieve sustainability goals and reduce its ecological impact.

The European Union (EU) has put in place several regulatory frameworks in order to address the environmental impacts of aviation. Policies such as the EU Emissions Trading System (ETS) and the Renewable Energy Directive are meant to reduce CO_2 emissions and promote the use of renewable energy sources in aviation. These measures are part of a wider effort to ensure that aviation can sustainably operate in a carbon constrained global economy and meet wider climate objectives. Compliance with these regulations is a costly proposition for airlines, which consequently alter their strategic and operational decisions [Toru, 2009]. Besides the regulatory requirements, sustainability is also being incorporated into the business strategies of airlines. Companies such as SAS integrate sustainability into all levels of operation and treat it as a core rather than an ancillary element. This strategic focus enables the organization to address environmental risks, develop stakeholder trust, and enhance corporate reputation. The financial aspects of sustainability actions, including those regarding SAFs and novel green technologies, demand the need for research and infrastructure investment. However, these long-term investments can result in cost reductions and enhanced operational performance. For instance, Ryanair has partnered with Trinity College Dublin to enhance the research on SAF, which highlights the increasing industry focus on innovation [Kotze, 2017, Ryanair, 2024b].

Beyond the environmental concerns, sustainability efforts in the aviation sector are also involved in broader social responsibility initiatives. Airlines such as SAS are actively involved in the development of sustainable fuels in partnership with other airlines and suppliers and have incorporated environmental responsibility in various aspects of their operations and practices to support corporate social responsibility [Kotze, 2017]. The transition to SAFs is both a social opportunity and challenge. SAF production creates employment in research, production, and distribution; however, the high costs may lead to increased ticket prices, which could limit the availability of air travel and thus increase social inequality [Kotze, 2017], [Barke et al., 2022]. The social impacts of aviation are multidimensional, having positive impacts on mobility and economic development on the one hand, and negative impacts on the environment and social equity on the other hand. This is because these concerns can only be addressed through an integrated approach that includes the incorporation of sustainability into every aspect of airline management, engagement with local populations, and encouragement of new green technologies. Therefore, in this case, the aviation industry can improve its corporate social responsibility and play a part of shaping a sustainable and equitable future [Illanes et al., 2024, Amankwah-Amoah, 2020, Commission, 2022].

2.2.2 EU Emissions Trading System (ETS)

The European Union's central policy mechanism for its climate strategy is the EU Emissions Trading System (ETS). The ETS works on a cap and trade basis, with the ETS imposing a progressively declining limit on total emissions from covered installa-

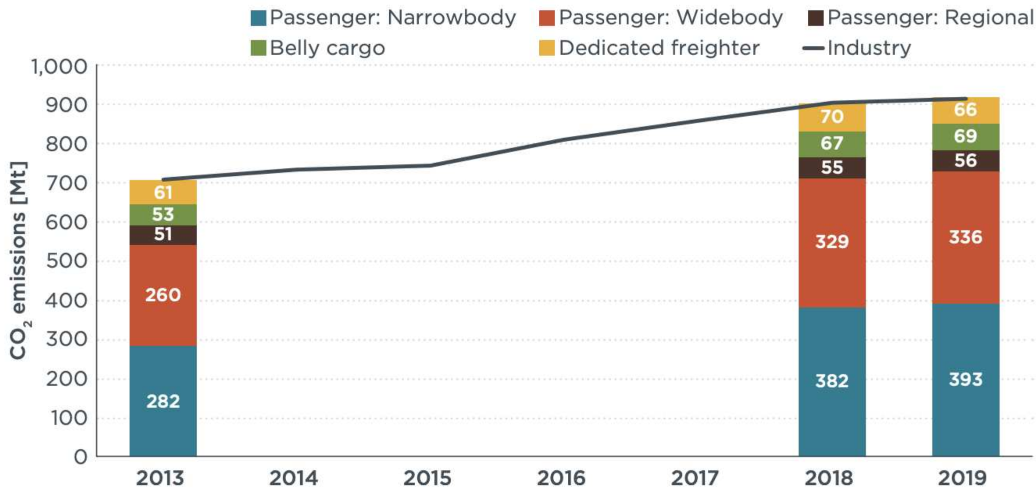


Figure 5: CO2 emissions by operations and aircraft class in the three analyzed years. [ICCT, 2020]

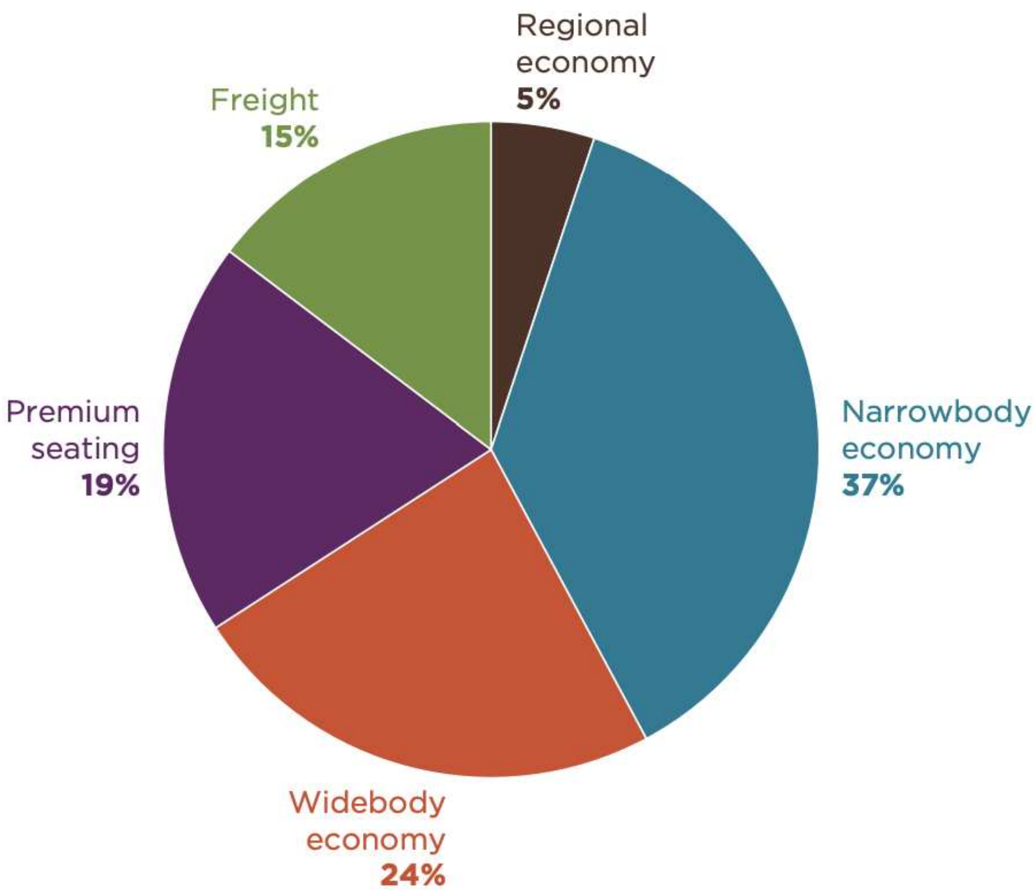


Figure 6: CO2 emissions by operations and aircraft seating class, 2019 [ICCT, 2020]

tions. In this framework, companies get or buy emission allowances that they can trade as needed, so that emission reduction is market driven [Scheelhaase et al., 2012]. The aviation sector was incorporated into the EU ETS in 2012, encompassing all flights within the European Economic Area (EEA). This inclusion is imposing regulatory requirements on airlines that need them to effectively manage their carbon emissions and their allowances. The system gives financial incentives for emission reduction by encouraging airlines to improve fuel efficiency, to invest in new aircraft, and to use SAF [Dray et al., 2010].

The incorporation of aviation into the EU ETS has led to increased operational costs for airlines because of the need to buy emission allowances. The main mitigation strategy that has been adopted is the use of SAF that has lower lifecycle carbon emissions than conventional jet fuel. Nevertheless, the uptake of SAF is limited by its high cost and limited feedstock, which calls for financial support in the form of subsidies and policy incentives [Király, 2023]. Airlines must nurture the SAF investment against the preservation of price competitiveness in a very price-sensitive market. Besides fuel alternatives, compliance with the EU ETS has faster fleet modernization. Increasingly, airlines are buying fuel-efficient aircraft to reduce emissions and, in effect, cut on emission allowances [Fageda and Teixidó, 2022]. These improvements, in addition to being useful for regulatory purposes, are cost-effective because they lead to long-term fuel savings [Kotze, 2017]. These findings further support the argument that the EU ETS and its associated carbon markets present a cost-effective and efficient tool for reducing aviation emissions, with significant co-benefits in terms of fuel savings and sustainability outcomes. The dynamics between regulatory actions, technological advancement, and market dynamics continue to define the changing dynamics of sustainability in the aviation sector. The EU ETS has emerged as a key catalyst for change within the aviation industry, driving innovation, collaboration, and environmental stewardship. As the aviation sector continues to face pressing environmental challenges, the EU ETS will play a crucial role in shaping the future of sustainable air travel along with other emission mitigation structures, regulations or techonological.

2.2.3 Traditional Jet Fuels vs Sustainable Aviation Fuels (SAFs)

Conventional jet fuels are primarily of petroleum origin and have been the standard in aviation for many years. These fuels, Jet A and Jet A-1, are kerosene based. However, traditional jet fuels have adverse environmental impacts that lead to greenhouse gas emissions and other pollutants that affect air quality and climate change [Kotze, 2017, Commission, 2022]. On the other hand, SAFs are developed to address the environmental effects of aviation and meet the sustainability goals of the aviation industry. SAF can be produced from a number of feedstocks including used oils, crop residues and other forms of waste including municipal solid waste. The production processes of SAF are to produce fuels that are essentially identical to conventional jet fuels, but with a lower carbon emission [Braun et al., 2024]. The European Union has been quite active in encouraging the consumption of SAF through various means such as regulations and incentives such as the EU ETS, ReFuelEU and the CORSIA [Iata, 2024, Bullerdiek et al., 2021]. The implementation of SAF brings about challenges and advantages to the aviation sector. The first major demerit is the high price of SAF as opposed to conventional jet fuels. At the moment, SAF is more expensive than conventional jet fuel because the technology is still under development and there are small-scale production facilities, which makes airlines pay more for operating costs when choosing SAF [EASA, 2023, Shehab et al., 2023, Bullerdiek et al., 2021].

Furthermore, the latest work by the European Union Aviation Safety Agency (EASA) presents both the present and future of the market for SAF in the European Union. The 2023 State of the EU SAF Market report by EASA reveals that SAF prices are on the average much higher than conventional jet fuel, with prices of aviation biofuels standing at 2,768 EUR per tonne while fossil based alternatives were priced at 816 EUR per tonne. This price difference is an indicator of the financial dilemma that airlines face in fulfilling the ReFuelEU Aviation Regulation targets which include a 6% SAF blending obligation by 2030, with a 1.2% sub-target for synthetic aviation fuels [EASA, 2023]. EASA's review shows that the European Union is on target to produce enough SAF to fulfill the 2030 minimum blending target of 2.8 million tonnes, but synthetic aviation fuels are still under development, and none of the announced facilities is under final investment decision as of early 2024. This highlights the role of policy frameworks, industrial partnerships, and technological innovation in scaling up SAF production, overcoming the high market cost, and supporting the overall decarbonization objectives of the ReFuelEU Aviation Regulation [De Jong, 2018]. Through increasing the collaboration within the aviation value chain and investing in improved production pathways like Fischer-Tropsch or synthetic fuels from biogenic or atmospheric CO2, the EU seeks to cut emissions, promote technological advancement, and build a stronger aviation industry in EU and globally [EASA, 2023].

2.2.4 Sustainable Aviation Fuel Mandates

SAF mandates are also part of the European Union's strategy to curb greenhouse gas emissions that are associated with aviation. These regulations are based on the principle that airlines must enhance the usage of SAF because it is derived from renewable sources and has a lower carbon footprint than conventional jet fuel. The implementation of SAF mandates has financial implications; however, because SAF is more costly than traditional jet fuel, it raises airlines' operating costs [Berghöfer and Lucey, 2014]. IATAs general director Willie Walsh points out that the financial aspect of SAF implementation is great; according to him, to achieve net zero by the year of 2050 is estimated to cost 4,7 trillion US dollars. He also argues further that the aviation industry cannot be made to carry this sustainability burden alone and that we need collective action from across the value chain. Walsh also stresses the importance of cooperation between governments, fuel suppliers, and manufacturers to increase the production of SAF and decrease its cost [IATA, 2024a]. This cost disparity presents challenges, especially for airlines with low margins, which may result in higher fares and lower passenger traffic [Bullerdiek et al., 2021]. Although SAF is compatible with current aircraft engines, higher blend ratios (more than 50%) may need some technical modifications, although the current mandate is 2% by 2025. Also, the problems of blending and delivering SAF at airports need to be solved [Barke et al., 2022]. The implementation of SAF mandates is in line with other EU sustainability strategies, such as the Single European Sky, which aims at enhancing the performance of air navigation systems with the view of reducing emissions [EBAA, 2024]. The integration of SAF rules into this system shows that the EU has set its sights on sustainability over the long term [Jordão, 2016]. Moreover, the development of SAF technology and infrastructure creates economic value and fosters innovation in the aviation sector [EASA, 2025].

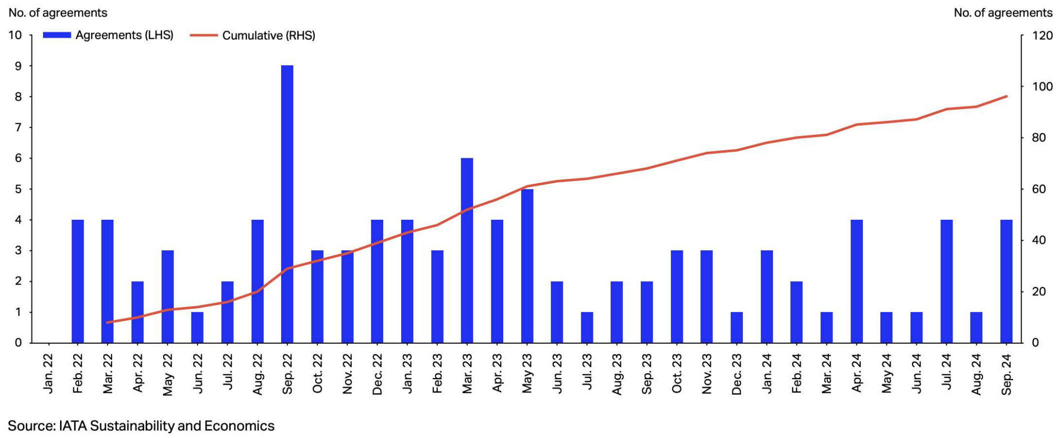


Figure 7: Number of SAF offtake agreements, as of June 2024. In 2024 SAF production was around 1Mt, it is forecasted to double in 2025. Aviation market has consumed all the SAF that has been produced with a price of USD 2,350 per tonne (or 3.1x jet fuel) in 2024. This price is expected to drop in the coming years. [IATA, 2024a]

2.2.5 Other Key EU Directives and Policies

The ReFuelEU Aviation initiative is another important policy that aims at increasing the consumption of SAF in the aviation sector. ReFuelEU Aviation is consistent with the overall objectives of the European Green Deal to decarbonize the continent by 2050. ReFuelEU Aviation solves the problem of the need for universal application of sustainable fuels in the aviation sector by focusing on the use of SAF for both intra-EU and extra-EU flights [Royal and Economics, 2025, Comission, 2024]. This policy framework requires airports in the European Union (over 800,000 passengers per year) to guarantee that airlines receive a minimum of 2% SAF kerosine blend by 2025, increasing to 6% in 2030, 20% in 2035, and eventually 70% by 2050 [Comission, 2024]. In addition, the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), which is a global scheme, is also of importance to EU airlines. CORSIA is a market-based mechanism that was established to stabilize CO_2 emissions from international aviation and requires carriers to offset their emissions growth after the level of 2020. The cooperation of the EU with CORSIA shows that the EU is part of the global efforts in emission reduction of aviation pollution while at the same time illustrating the relationship between regional emission trading systems like the EU ETS and international market based measures [Mayeres et al., 2023, Comission, 2024].

The European Union has also brought in more rules to decrease the energy intensity of aviation and demand across the sector. These policies aim at enhancing the efficiency of aircraft, optimizing the flight operations and integrating innovative and more efficient technologies to reduce environmental impacts [Illanes et al., 2024]. In parallel, the EU has created several research and development programs to accelerate the transition to sustainable aviation. This includes focused grant making for SAF production innovations, research infrastructure for cleaner engine designs and the dissemination of good practices within the industry [Wong et al., 2024]. Through the implementation of CORSIA and other global mechanisms, the EU intends to increase the rate of decarbonization of air travel in order to meet its long-term goal of climate neutrality.

2.2.6 Regional Differences in Sustainability Regulations and Reporting

The International Civil Aviation Organization (ICAO) is a major international organization that sets global standards for aviation sustainability. Its Standards and Recommended Practices (SARPs) ensure that international aviation operations are conducted safely, effectively and in an environmentally friendly manner. These guidelines are particularly important for the European airline industry, which must meet not only the regional but also the international regulatory requirements. The Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) is one of the main initiatives of ICAO, which seeks to freeze the growth of CO_2 emissions at the 2020 level. Thus, airlines are supposed to compensate for the emissions that are greater than this baseline, in line with the broader European climate goals. The implementation of CORSIA has implications for operations and has involved the introduction of more efficient technologies and emissions reduction practices. Also, ICAO has established standards for sustainable aviation fuels (SAF) to encourage the use of alternatives that are less harmful to the environment than conventional jet fuels. The European Union has strengthened these efforts by specifying the amounts of SAF that must be blended into fuel, which will help to spur innovation and investment in the sector [Király, 2023, Scheelhaase et al., 2024].

Sustainability regulations affect airlines differently depending on the region they operate in. The European Union has been most aggressive in implementing its sustainability policy, including SAF mandates. This regulation is equally applicable throughout Europe; however, it may be combined with other country-specific aviation-related taxes. For instance, the Danish government has announced a new aviation tax, which is expected to come into effect from Jan-2025, and the cost of the tax will rise from €6 to €6.85 per departing passenger. Such country-specific measures enable more effective control of the sustainability of aviation at the national level [Ryanair, 2024b]. On the other hand, regulatory frameworks in areas like Southeast Asia (SEAO) are rather complicated. Decarbonizing the aviation sector is a challenge that SEAO has addressed through the examination of prior expert interviews and the literature. Nevertheless, low demand for SAF in the region has led to the region not being self-dependent in the production of SAF, thus revealing market and regulatory risks [Wong et al., 2024]. Also, in the US, a major airline, Southwest, has recently downgraded its sustainability efforts. This is because Southwest airlines has laid off some few employees from its sustainability team and has plans to sell its stake at a renewable energy startup [Article, 2025]. Despite the increasing support of regulators and investors in alternative fuels, the high costs and limited supply chain capacity are major challenges that cannot be addressed by market mechanisms only, this is why regulation such as the one EU matters a great deal, is without one, companies might be pursued to only pursue the recommendations made by shareholders to pursue profit instead of environmental sustainability. Sustainability reporting also shows different tendencies between countries. Sustainability reporting is mandatory in Europe, which increases the accountability of companies and builds the investors' confidence especially from the financial sector [Iata, 2024a]. This focus on disclosure means that European airlines have more reason to embrace sustainability strategies in their operations. On the contrary, in areas where sustainability reporting is not highly regarded, airlines may not have much pressure to enhance their environmental stewardship [Király, 2023]. These differences suggest that policy makers need strategies that are specific to the region's economic and regulatory situations but ones that also align with further global sustainability goals.

2.3 Business Model and Cost Structure overview

2.4 Overview of Low-Cost Carriers (LCCs)

2.4.1 Typical Business Model Characteristics of LCCs

LCCs are different from full service carriers (FSCs) by using a low cost model that is characterized by simplified operations and low prices. LCCs use many approaches to reduce costs, which include using a single type of aircraft, which reduces on maintenance and training costs, using secondary airports that charge less fees and using the point to point model to increase aircraft productivity [Lodewijks, 2008, Orhan, 2021, Sengur and Sengur, 2017].

Large LCCs in Europe usually have a pure low cost model, which means they focus on efficiency and on time performance, or a hybrid model where ancillary services are offered to cater for a wider customer base [Francis et al., 2003]. This is done by offering a basic service and selling other necessities like meals and selection of seats separately to help boost revenue from other sources. This strategy fits well with the price discipline of the clients they target and at the same time guarantees profitability [Király, 2023]. This is because yield management is used to set prices of tickets according to demand to reach near full capacity [Lodewijks, 2008, Király, 2023]. Moreover, using secondary airports also improves the operation because it helps in avoiding congestion and decreasing the turn around time [Lodewijks, 2008, Orhan, 2021]. The liberalization of the airline sector has also helped the LCCs' growth; this has enabled the carriers to enter more markets and offer lower prices [Bitzan and Peoples, 2016]. The development of the hybrid LCC models shows that the industry is evolving to meet customers' needs. Some low cost airlines are now providing additional services such as premium seats, loyalty programs and partnership with other airlines while retaining low costs [Sengur and Sengur, 2017]. Sustainability is a new issue for LCCs, especially with regard to the integration of SAF. Since SAFs emissions are lower and price higher than that of conventional jet fuel, its cost is a major issue for LCCs [Iata, 2024a, Colantuono, 2021]. More stringent regulations may lead to more investments in SAF which will force LCCs to address the conflict between cost and sustainability.

Furthermore, the empirical evidence from Europe's LCCs suggests that these carriers grow or change supply very fast to underutilized secondary airports and often create completely new passenger traffic rather than shifting passengers from traditional airlines. About half of the traffic on short-haul routes carried by LCCs has been shown to be newly created, rather than simply a shift from other airlines including FSCs. This phenomenon not only offers consumers a greater choice of destinations and frequencies, but also has strategic implications for the incumbent network carriers, who tend to respond by altering aircraft size or route structure, rather than by abandoning routes altogether. Hence, the LCC surge may not affect full service hub and spoke networks as badly as was first feared; instead it demonstrates the flexibility of both market segments in liberalised European market environment pressuring the market to shift towards consumers [O'Connell and Williams, 2005]. This analysis by ICAO [ICAO, 2003] of European LCCs reveals that there are two distinct low cost business models in the European market. The first, like Ryanair, targets secondary airports, low frequencies, and low cost. This includes bilaterally pushing for lower fees with airports and suppliers and identifying new leisure markets with minimal direct competition. The second, based on easyJet, is based on the operation from primary, higher cost airports at higher frequencies, covering business and leisure markets, which may well involve more direct competition with incumbent carriers. Both models seek economies of scale through simplified operations and fleet homogeneity but differ in market selection, competitive strategy, and the extent to which they interface with established FSC networks.

2.4.2 Cost Structure in LCCs

The cost structure of LCCs is based on the idea to keep the operational costs at the minimum level by using fleet standardization, unbundling services (no frills-carrier), high aircraft utilization and secondary airports. Fleet uniformity is cost effective in terms of maintenance and training costs; and the high aircraft turnover is efficient use of the aircraft. The use of secondary airports also entails lower charges for landing and avoids congestion [Lodewijks, 2008, Orhan, 2021]. Baggage fees, seat selection, and in-flight sales are sources of ancillary revenue that help boost revenue and cover the low fares [Karaağaoğlu and Gündüz, 2023]. Labor costs are another area of optimization which LCCs typically achieve through the use of more flexible workforce and lower wage bill than that of FSCs. Fuel efficiency is also a concern, which is why the use of modern aircraft and operational optimization minimizes fuel use. Nevertheless, the introduction of SAF is a financial issue because of the higher price of the fuel that can affect the price of the ticket and the profitability of the airline [EASA, 2025, Illanes et al., 2024]. The current challenge is to develop the necessary infrastructure and shift to producing SAF so that LCCs can meet the long-term sustainability targets without lowering the margings significantly.

Many LCCs lack well-defined sustainability policies, and implementation often lags behind public commitments [Wong et al., 2024]. Transparency in sustainability reporting is essential, yet many airlines do not disclose comprehensive environmental data, hindering industry-wide progress [Kim and Son, 2021]. Leading LCCs, such as Ryanair, have made strides in sustainability efforts, though further advancements are required [Kotze, 2017]. Another stude found that Ryanair emerged as a financially strong airline post-pandemic, benefiting from low debt levels, strong liquidity, and a cost-efficient operational model. Its strategic focus on fuel-efficient aircraft and strict cost control contributed to its financial resilience. In contrast, Wizz Air's aggressive expansion strategy led to increased financial risk due to high debt levels, while Norwegian and Finnair improved their financial positions but remained dependent on debt [De Lorenzo, 2024]. LCCs benefit from cost-efficient business models, their financial performance varies significantly based on strategic choices and risk exposure. Learning from best practices, such as SAS's approach to sustainability communication, may offer valuable insights for LCCs aiming to enhance their environmental strategies while maintaining cost efficiency.

Some European LCCs have not developed clear sustainability strategies and the implementation is often poor and behind the companies' words without a trustworthy communication [Wong et al., 2024]. It is very important to have sustainability reporting transparent and many airlines do not provide environmental information in detail which hampers the overall development of the industry [Kim and Son, 2021]. Some of the leading LCCs, including Ryanair, have also made some positive sustainability improvements; however, more improvement is needed [Kotze, 2017]. Other study reported that Ryanair was a very healthy airline financially after the pandemic because it had low debts, a good level of liquidity and a very efficient cost structure. Its focus on fuel efficient aircraft and strict cost control helped it to become financially strong. Wizz Air's aggressive growth strategy led to higher financial risk due not only to high levels of debt, but also to the fact that the company had higher amount of financial risk. Norwegian and Finnair also enhanced their financial strength but still depended on debt [De Lorenzo, 2024]. Costs are the main advantage of low cost carriers; nonetheless, their financial results differ greatly depending on the strategies and risks taken. As an example, it is possible to distinguish the best practices, such as the way of sustainability communication of SAS, which can be useful for LCCs in order to improve their environmental performance without overburdening their finances.

2.5 Overview of Full-Service Carriers (FSCs)

2.5.1 Typical Business Model Characteristics of FSCs

Full-Service Carriers (FSCs) distinguish themselves through extensive service offerings, including multiple cabin classes, frequent scheduling, and comprehensive in-flight and ground services. These carriers typically operate from major hubs and maintain extensive networks, enhancing connectivity through a hub-and-spoke model. Their business model prioritizes service differentiation, offering economy, business, and first-class options with varying levels of comfort and amenities. Complimentary meals, in-flight entertainment, and premium ground services, such as dedicated check-in counters and lounges, contribute to their high service standards. Network connectivity is central to FSC operations, allowing for efficient passenger transfers and optimizing aircraft utilization. Frequent flight scheduling appeals to business travelers who prioritize flexibility and time efficiency [Gillen, 2006]. However, these advantages come with higher operational costs. FSCs face substantial expenses related to aircraft acquisition, maintenance, and crew salaries, along with higher fees for operating at major airports [Lodewijks, 2008]. Their complex service structure, requiring a diverse fleet and specialized staff, further adds to cost pressures. Sustainability has become an increasing priority for FSCs, prompting investment in fuel-efficient aircraft, optimized flight routes, and SAFs. Transitioning to greener practices requires significant financial investment but is essential to maintaining competitiveness in an era of heightened environmental awareness [Wong et al., 2024]. Unlike LCCs, which inherently operate with lower emissions due to streamlined operations, FSCs must balance sustainability initiatives with service quality [Kotze, 2017]. Strategies such as fleet modernization and optimized route planning are essential for reducing emissions while maintaining service differentiation [Bitzan and Peoples, 2016].

FSCs can be characterized by the range of services they provide including; multiple cabin classes: economy, economy-plus and first class, frequent scheduling and complete in flight and ground services. These carriers usually operate from large hubs and have dense networks which they create by using the hub and spoke model. Their business model is based on the principle of service differentiation, whereby they provide economy, business and first class seats with different levels of space and features for different customer segments. Meals and other in-flight entertainments, as well as better ground services such as separate check-in counters and lounges, are some of the features that depict their high level of service delivery, that also add costs. Network connectivity is an essential aspect in the operations of FSCs since it facilitates the movement of passengers and helps in the proper utilization of aircraft. Frequent flights are important to business travelers who are always on the watch for flexibility in their scheduling [Gillen, 2006]. However, these advantages come at a cost financially and can also have an negative affect on the agility of the network carrier business model. FSCs incur high operating costs, which include the expense of acquiring, maintaining, and operating aircraft, paying crew salaries, and incurring higher charges for operating at large airports [Lodewijks, 2008]. The high level of service variety, which is characterized by the need for a large variety of aircraft and personnel, only increases the pressure on costs. The agility lost with these operating structures can also play a disadvantege with the fast evolving aviation market in EU. FSCs typically rely on a scheduling strategy called the bank structure. A bank structure refers to the scheduling strategy in which multiple inbound flights arrive at a hub within a short time frame. This incoming traffic is followed by a wave of outbound departures. This system allows for efficient passenger transfers and maximizes aircraft utilization for FSC. While this bank strucutre is vital for FSC with the current aviation market it is vulnerable to congestions and delays and rigidity. This means that an FSC might not be able to reschedule some flights with agility because of the bank structure. Sustainability has recently gained much attention for FSCs, and they have made investments in fuel-efficient aircraft, environmentally friendly flight paths, and SAFs. The transition to green practices is not cheap but it is necessary to sustainability in a world where people and governments are more concerned with the environment [Wong et al., 2024]. FSCs have to consider sustainability without compromising on service delivery [Kotze, 2017]. Fleet replacement and route design are critical for reducing emissions without compromising on service differentiation [Bitzan and Peoples, 2016].

2.5.2 Cost Structure in FSCs

FSCs operate under a more complex cost structure than LCCs, largely due to their broader range of services and network scale. Fuel expenditure remains a significant cost component, further influenced by the industry's shift toward SAF adoption [Mayeres et al., 2023]. Beyond fuel, expenses include catering, ground handling, and aircraft maintenance. Cost optimization strategies, such as establishing maintenance bases in lower-cost regions like Budapest, help mitigate expenses [Lodewijks, 2008]. Additionally, the growing demand for SAFs among cargo airlines and shippers further impacts pricing and availability [IATA, 2024a]. FSCs have the potential to lead in sustainability reporting by implementing comprehensive environmental disclosure structures. Transparent reporting not only enhances corporate reputation but also drives industry-wide improvements in sustainability practices [Iata, 2024a]. As regulatory and consumer pressures for greener aviation increase, FSCs must align cost management with sustainability commitments to maintain long-term competitiveness.

FSCs are operating under a more complex cost structure than LCCs because of their broader range of services and network scale. The industry's shift toward SAF adoption [Mayeres et al., 2023] is affecting fuel expenditure in the further. Other costs include catering, ground handling and aircraft maintenance. From the literature, cost optimization strategies such as establishing maintenance bases in lower cost regions, for example, Budapest, help to mitigate the costs [Lodewijks, 2008]. The growing demand for SAFs among cargo airlines and shippers also impacts pricing and availability of the product [IATA, 2024a]. FSCs can lead in sustainability reporting by implementing environmental disclosure structures that are comprehensive and reliable. Improvements in sustainability practices are also driven by transparent reporting, which also enhances corporate reputation [Iata, 2024a]. As the regulatory and consumer pressures for greener aviation increase, FSCs must align cost management with sustainability commitments to sustain long term competitiveness.

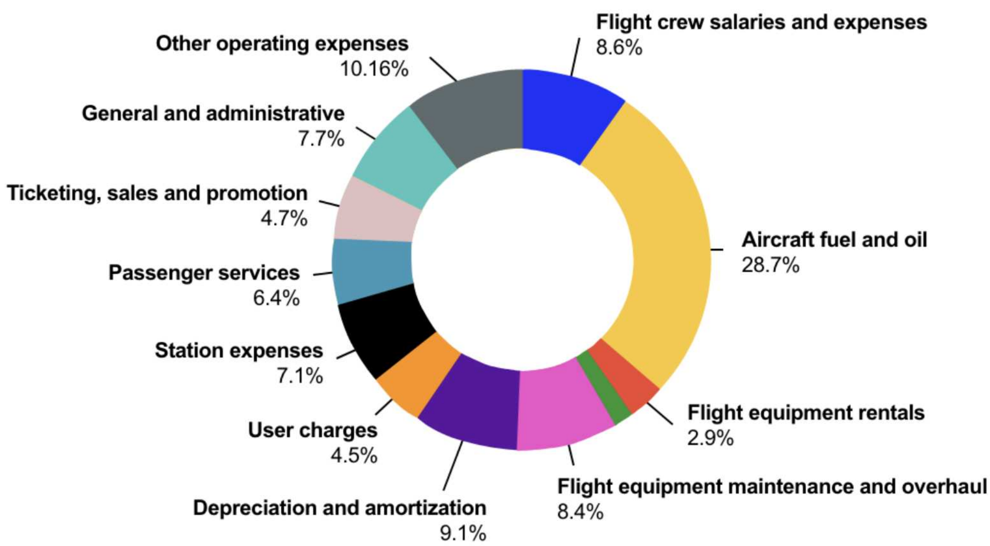


Figure 8: A network carrier average cost structure. In the context of this thesis, the key point of interest from this figure is the aircraft fuel and oil category, which constitutes a significant 28.7% of the total. Similarly this will be the part affected by the increase of fuel price due to SAF. For LCC this expenditure portion is even greater, 40 - 50 %. [Iata, 2024] data from World Air Transport Statistics (WATS, 2022).

3 Methodology

This section describes the research strategy and methodology used to address the study's research questions. The chapter begins by describing the research methodology and study design. They serve as the foundation for the chosen methodological framework. A description of the data-collecting methodologies follows. This details the process of obtaining qualitative insights from industry specialists. Finally, the data analysis method is described, detailing how the obtained data was methodically evaluated using Gioia method to find major themes and patterns related to the study's aims [Gioia et al., 2013].

3.1 Research approach

This paper has a qualitative research design to examine how low cost carriers in Europe tackle the problems of sustainability related cost constraints, regulatory requirements and competitive pressures. Qualitative research is appropriate for use in complex and dynamic business environments where industry practitioners have to develop new strategies to address regulatory and market forces [Silverman, 2021]. Since sustainability requirements bring about new operational issues and financial risks for LCCs, a indirect, generative study is suitable for identifying patterns and industry solutions [Stebbins, 2001]. The study employs a theory building approach whereby data collected from industry stakeholders is analyzed in order to understand how sustainability issues affect airline business models, costs and competition. This approach is consistent with the grounded theory methodology which is useful in studies aiming at identifying new topics where current theories are not sufficient [Glaser and Strauss, 2017]. The key strength of the grounded theory is that it is generative, that is, the findings are generated from the data and are not based on hypotheses [Strauss and Corbin, 1998]. To guarantee theoretical and empirical data analysis, the study uses a recursive data collection process [Miles and Huberman, 1994] such that the initial interviews are used to guide the subsequent interviews and the study is able to remain current with regard to the strategic issues. This improves theoretical sensitivity to allow for a more detailed study of how LCCs manage sustainability related cost pressures over time.

For data analysis, the study uses the Gioia method [Gioia et al., 2013] as a framework for systematically identifying patterns and themes in qualitative data. It is extensively used in strategic and organizational research to categorize qualitative observations into first-order concepts, second-order themes, and aggregate dimensions. The Gioia approach guarantees methodological rigor through the ability to reason inductively and abductively – that is, empirical findings inform theory-building, but existing theoretical perspectives also help refine interpretations [Langley and Abdallah, 2015]. This guarantees that conclusions are not only based on industry experience, but they also help to deepen the understanding of how sustainability-related costs affect the strategic and operational decisions of LCCs in Europe. Using qualitative empirical research in combination with theory-building techniques, this study provides an empirically grounded, yet theoretically rich analysis of how LCCs steer through sustainability pressures in a increasingly regulated aviation market.

This study is strengthened further by its use of an European airline company as a case company which provides a real world context for sustainability related cost pressures, regulatory constraints and competitive dynamics. Qualitative research is particularly well served by case studies as they allow the exploration of specific industry challenges and strategic responses in depth [Yin, 2017]. This study focuses on a single Swedish airline to derive rich empirical data that increases the understanding of how sustainability regulations affect decision making processes at the operational and strategic level in airlines in EU. While data collection was not limited to this single airline, the company also helped to ensure access to additional interviewees by leveraging its industry connections. Through its network, interviews were also secured with aviation experts across Europe and globally, thus expanding the study's empirical base. Case studies are well positioned for theory building research as they allow for the recognition of patterns that may hold across the broader European low cost carrier sector [Eisenhardt, 1989]. The choice made in terms of methodological approach guarantees that the results are relevant to the real life situation of the airline industry and also contribute to the academic debate on sustainability and competitive strategy.

In addition to the qualitative analysis, this study also performs a quantitative assessment of airlines' costs in Europe. It specifically looks at the share of fuel costs in total operating expenses over the past few years. This numerical analysis gives a real-life view of how fuel spending changes with the airline business model and offers a better understanding of the financial impact of sustainability-induced cost pressures. Fuel expenditure as a percentage of overall operating expense was collected from the financial reports of sample European low-cost and full-service airlines that are easily retrievable to the public. Some relevant US operating LCC are also included in the analysis as this is the area from where the LCC business model originated. The analysis covers the last few years to identify the changes in fuel use and their effects on the costs of airlines. This data serves as a reference to determine the financial impact of the SAF standard, especially since the cost of SAF is expected to be higher than that of conventional jet fuel, and SAF will be used as a blend with conventional jet fuel. This analysis helps contextualize strategic responses by LCCs and FSCs to rising fuel prices and sustainability requirements. The findings also inform discussions on cost management strategies, pricing adjustments, and competitive positioning under increasing sustainability mandates.

Given the nature of the research setting, the study employs a study design mostly concentrating on the opinions of industry executives and other key stakeholders. While case study research is often criticized for its lack of generalizability, in this case it is an effective tool for producing frameworks that provide practical insights for a specific business or sector, with this case emerging environmental sustainability costs on aviation. Regulatory frameworks and market structures differ greatly among geological locations and airline business models, given the varying levels of competition and regulation. By conducting an assessment of industry-specific dynamics in the EU, the study hopes to give conclusions that are both theoretically important and practically applicable to airlines navigating the obstacles provided by sustainability regulations in the European market.

3.2 Data collection

3.2.1 Qualitative data collection

This study's data was gathered through semi-structured interviews with European aviation industry experts. Experts include representatives from European aviation sector, from varying fields including: fuel, network management, revenue, sustainability, government/legislation, airports, LCC, and strategy. Other stakeholders that are also involved work as consultants for the aviation sector and thus are considered experts within the field. First, relevant academic materials, industry reports, and policy papers are reviewed to contextualize the regulatory environment and economic restrictions that influence airline decision-making. Second, semi-structured interviews with industry experts are part of the empirical component. This makes it possible to study major issues in a flexible but systematic way, and to let participants present their viewpoints and provide insight into real world applications. The research has an interpretative approach, trying to create knowledge inductively from the lived experiences and strategic evaluations of individuals directly involved in the field. The semi-structured interview approach was chosen as the major data-gathering method because it provides both a systematic study of important topics and the opportunity for respondents to comment on areas of specific significance to their expertise. Further supporting the qualitative approach is the fact that this kind of regulation has not done previously and the regulatory factors influencing can be subject to change. Wide amounts of data concerning this topics sustainability approach are not available publicly.

This method is particularly effective when investigating complex issues such as the intersection of sustainability costs and airline operations, as it enables respondents to articulate their perspectives in depth while allowing the researcher to focus on emerging themes. Semi-structured interviews are well suited for studies examining industry professionals' insights, as they provide a balance between maintaining consistency across interviews and allowing for deeper exploration where relevant.

The recruitment of interview participants followed a snowball sampling approach, a widely used technique in qualitative research that facilitates access to information-rich respondents and acknowledges the limitations of non-random sampling. The initial set of interviewees was identified based on professional networks within the airline industry, after which participants were asked to suggest additional contacts who could contribute further insights into the study's core themes. The first stage of interviews was conducted with five industry professionals without a structured question set, allowing for an open-ended discussion to identify key areas of concern and interest. Based on the emerging themes, the second stage included ten additional interviews using a semi-structured format, designed to explore the identified topics while maintaining the flexibility for participants to highlight issues they deemed particularly relevant. A final set of five interviews was conducted with new participants selected based on the responses obtained in earlier discussions, ensuring that critical perspectives were thoroughly examined and allowing for further refinement of the emerging theoretical insights.

The final sample size was derived from the principle of data saturation where further interviews did not form new themes or insights that are relevant to the study. The data collection process was structured but the study was adaptive, that is, it allowed for some tweaking of the methods as the study progressed. All interviewees were briefed on certain findings from the previous interviews where relevant, to ensure that crucial aspects of sustainability-driven cost pressures on low-cost carriers were explored to full extent without overly influencing the responses. All the interviews were conducted either face to face or by virtual meetings (Microsoft Teams), based on the availability and desire of the participants. All interviews were audio recorded with the consent of the participants and then transcribed to be analyzed. Since the aim of the study is to explore the perceptions regarding sustainability issues as a threat, the sample comprised participants who occupied different positions and had worked in different parts of the industry. This provided a rich data set of perspectives to develop an overall picture of how low-cost carriers address sustainability costs in the European airline industry.

The interview sample depicts industry stakeholders in managerial and senior positions, which align with the objectives of this study. Since the research focuses on environmental sustainability–driven cost pressures and their effects on airline operations, it is important to collect data from people who are familiar with the strategic decision making process in the aviation sector. Leaders are in a position to offer practical views on regulatory compliance, costs, and strategic planning over the long term. This is because the inevitable concentration on senior management limits the representation of some employee groups, but it ensures that the study captures the perspectives most important to the research questions. To make sure that the sample was broad and informative, the initial list of interviewees was composed of people who were familiar with airline operations, regulations and sustainability strategies. The sampling strategy focused on including individuals who had knowledge in areas such as fuel management, network planning, finance, and environmental regulation since these are important in understanding how airlines steer through sustainability requirements. This ensured that the participants represented both internal airline decision makers and external influencers of industry practices to enhance the validity of the findings.

The interviews were conducted by themes, starting from the general discussion of the overall effects of sustainability regulations on the airline industry and then moving toward more specific questions about cost management and competitive strategy. At the beginning of the interview, participants were able to express their overall views on the matter before moving on to more specific aspects of sustainability-related cost pressures. The semi-structured flexibility of the interviews enabled interviewees to concentrate on those aspects which they were most knowledgeable about while at the same time covering important research themes. There were set interview questions for consistency across the discussions, but the sequence and emphasis of the questions were tailored to the knowledge and experience of each participant.

The interviews were made in the context of virtual meetings in and in person interviews, specifically Microsoft Teams, for instance. About half of the interviews were conducted via Microsoft Teams, the rest of the interviews were conducted in office settings. All interviews were video recorded with the consent of the participant and transcribed using an automated transcription tool, with further edits being made to improve the overall accuracy. Since the study was conducted using two languages (English and Finnish), it was crucial to maintain the meaning of the data collected as much as possible, to avoid misinterpretation due to language barriers. When translating the interviews, filler words and redundant phrases were removed to make the text more concise without compromising the ability to capture the subject's message. This way, the data collected is a true and complete depiction of how low-cost carriers in Europe are addressing sustainability-driven cost pressures.

3.2.2 Quantitative data collection

Beyond the qualitative data collected through interviews, this analysis performs a quantitative analysis of airlines' costs using open source financial data from companies' annual reports. Financial disclosures of major European low cost carriers (with the exception of Spirit, US) and full service carriers were reviewed to get historical information on fuel costs as a percentage of total operating expenses. This approach offers an empirical assessment of cost trends, and thus allows an evaluation of the financial implications of rising fuel prices and sustainability mandates, especially those regarding the adoption of Sustainable Aviation Fuel.

The financial reports of relevant airlines were taken from their websites and regulatory filings. Airlines were chosen for inclusion based on data availability and the continuity of the data over multiple years. The final dataset comprises of Ryanair, Wizz Air, Norwegian, EasyJet, Pegasus and Spirit (US) as low cost carriers. And Lufthansa, IAG, Finnair and SAS as full service carriers. These companies were chosen because they are significant carriers, have different business models and are important for European aviation sustainability policies. Spirit Airlines (US) was included as a benchmark for LCC efficiency, providing a comparative perspective on fuel cost structures beyond Europe. Despite operating in the U.S., Spirit shares key cost-saving strategies with European LCCs, making it relevant for analyzing fuel price sensitivity and sustainability cost impacts across different regulatory environments, also historically Ryanair and Spirit shared similar cost strategy approaches. Moreover, the fuel cost benchmarks of the industry from the International Air Transport Association (IATA) were also incorporated to put the situation in a broader perspective, the data within IATA report is primarily from FSC. The time period of analysis

Number	Expertise	Interview length (minutes)	Code
	First set, unstructure		
1	Aviation, Sustainability	*45*	A1
2	Aviation, Strategy Network	*45*	A2
3	Aviation, Government	*57*	A3
4	Aviation, Strategy	*43*	A4
5	Aviation, Strategy	*63*	A5
6	Aviation, Fuel	*54*	A6
	Second set, semi-structured		
7	Aviation, Network	*53*	A7
8	Aviation, Sustainability	*73*	A8
9	Aviation, Strategy	*57*	A9
10	Aviation, Revenue	*58*	A10
11	Aviation, Strategy	*59*	A11
12	Aviation, Government	*58*	A12
13	Aviation, Fuel	*57*	A13
14	Aviation, Sustainability	*58*	A14
15	Aviation, Business	*44*	A15
	Third set, semi-structured		
16	Aviation, Business	*55*	A16
17	Aviation, Airport	*65*	A17
18	Aviation, LCC	*41*	A18
19	Aviatoin, LCC	*58*	A19
20	Aviation, Airport	*32*	A20
21	Aviatoin, LCC	*57*	A21

Figure 9: List of interview participants

is from 2020 to 2023, which includes the pre-COVID, COVID, and post-COVID periods, as well as the first years of the SAF blending requirements that were enacted in European aviation policy. The primary variable of interest in this study is the fuel cost as a percentage of total operating expenses that helps in identifying the difference between low cost and full service carriers. This metric was computed from the airline's income statement where fuel spend is broken out separately. Other financial variables considered in the analysis are: Total operating expenses (€ million): This is the annual expenditure of each airline in its operations. Fuel cost (€ million): This is the actual fuel expenditure as appearing in the financial statements of the airlines. Fuel cost percentage (%), calculated as:

$$\text{fuel cost percentage}(\%) = \left(\frac{\text{fuel cost (€)}}{\text{total operating expenses (€)}}\right) \times 100$$

Other major cost components were: flight crew salaries and expenses, depreciation and amortization, aircraft maintenance and leasing costs. This quantitive approach allows to compare the cost structures and to reveal the relative share of fuel costs to the total costs of low cost carriers and full service carriers. Given that low cost carriers have a leaner cost structure they should be more sensitive to fuel price volatility and SAF cost increases than full service carriers.

Once extracted, the financial data were standardized and cleaned to ensure comparability across different reporting formats. While most airlines report fuel costs as a discrete operating expense, some variations exist in cost categorization, requiring alignment adjustments. All figures were analyzed in euros to maintain currency consistency across firms. To assess the impact of fuel price fluctuations, a time-series analysis was conducted on fuel costs from 2020 to 2023, focusing on: year-over-year changes in fuel cost percentages, the effect of external price shocks (e.g., post-pandemic recovery, geopolitical oil price volatility) and the influence of SAF mandates on cost structures. By comparing low-cost carriers and full-service carriers over multiple years, this study highlights the greater proportional impact of SAF mandates on low-cost carriers, given their higher fuel expenditure relative to total operating costs. This cost sensitivity has strategic implications, as low-cost carriers must either absorb additional costs, pass them to consumers, or seek operational efficiencies, such as fleet renewal, SAF investments, or fuel hedging strategies.

After being extracted, the financial data were standardized and cleaned to make them comparable across different reporting formats. While almost all airlines report fuel costs as a separate operating expense, there are some differences in costs classification and therefore some adjustments were needed. To determine the effect of fuel price changes, time series analysis was conducted on fuel costs from 2020 to 2023, focusing on: analysis of annual changes in fuel cost in percentages, impact of price shocks (post pandemic recovery, geopolitical oil price volatility) and impact of SAF mandates on cost structure.

3.3 Data analysis

The data collected was analyzed systematically using the Gioia method [Gioia et al., 2013] to ensure that the data was organized and interpreted in a systematic way and in an inductive manner. This approach is suitable for this study as it helps in identifying patterns and emerging themes from the perceptions of industry professionals. The process involved dividing the qualitative data into structured coding stages, starting from the initial descriptive level of insight to more theoretical level that is relevant to the research objectives of the study.

The first stage of analysis was to consolidate the statements made by the interviewees into short and precise responses that properly reflected the ideas of the participants. These summaries were first-order codes, which identified the particular opinions and stories related to the participants. Because of the generative nature of the research, this stage focused on leaving the interviewees' words as close to their original form as possible in order not to bring in earlier theoretical concepts into the data analysis. Right after the first-order coding, the codes were grouped into sets according to the phenomena they represent, which produced the second-order themes. This stage involved an iterative process of coding comparison and refinement to guarantee that the themes derived from the interviews are valid and credible. The themes were developed from the data in this qualitative, ground theory study. Hence, this study was able to generate a understanding of how sustainability – driven cost pressures affect low cost carriers.

The last stage of analysis was to integrate the second-order themes into aggregate dimensions that represented the overall strategic and operational issues raised in the interviews. These dimensions were higher level constructs that helped to provide a coherent interpretation of the data and to link the empirical findings to theoretical insights into aviation sustainability issues. The coding process was mainly done in Microsoft Excel in order to guarantee the systematic organization and structure of the qualitative data; Atlas.ti was applied as an additional tool. The tools helped in data management and to make comparisons across several interviews. This allowed for a more free and precise coding technique while keeping flexibility and precision in the identification of emerging themes. Maintaining objectivity was an important factor in the coding process. Where more than one participant used the same concept, the coding process captured these differences while still respecting the particular response of each participant. As the analysis continued, previously assigned codes were revisited and refined where needed to guarantee the coherence and analytical strength of the coding framework. Insignificant codes were removed from the final categorization in order to ensure that the themes identified contributed meaningfully to the study's findings.

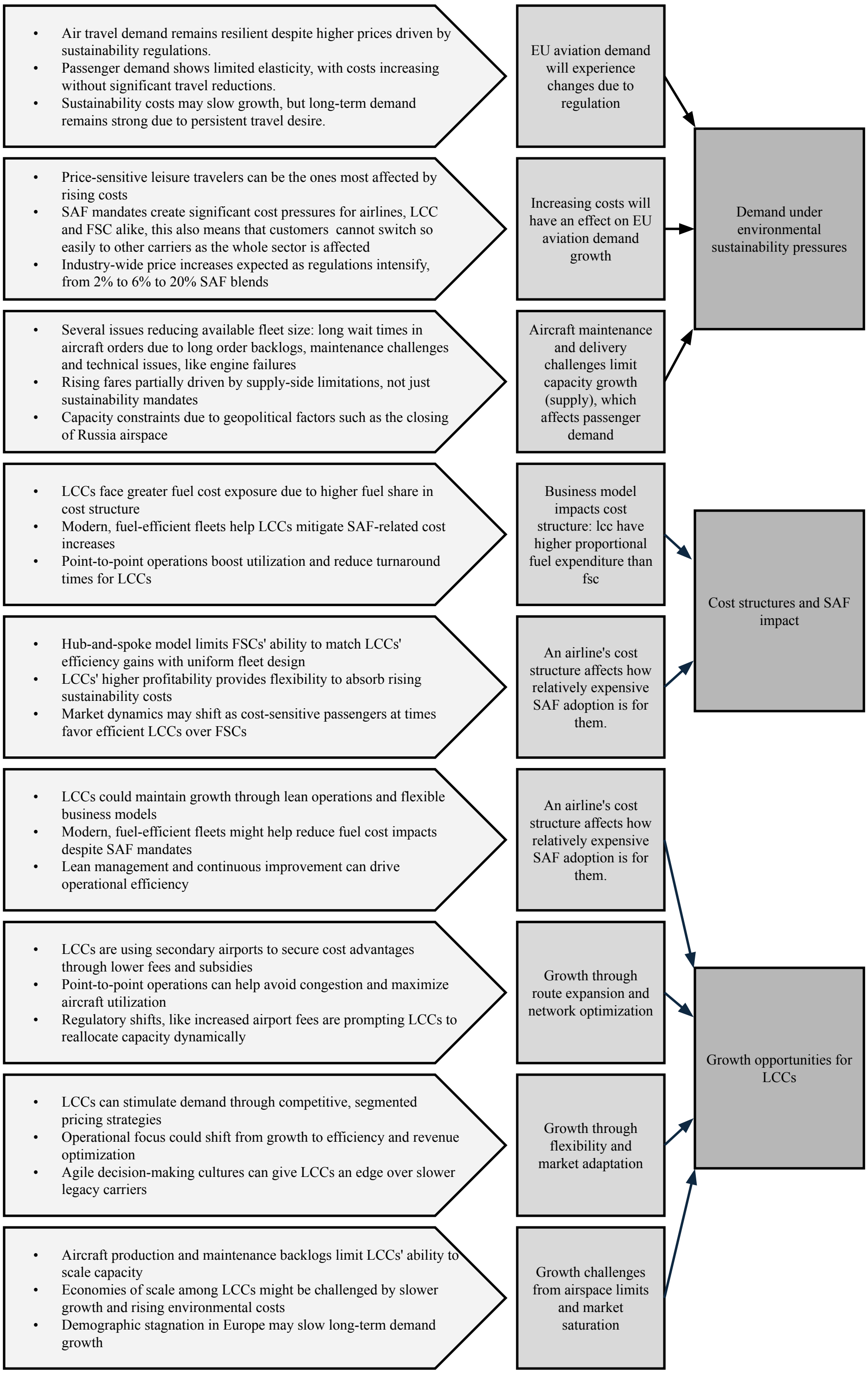


Figure 10: Data structure of the qualitative analysis

2nd order themes	Quotes from interviews
EU aviation demand will experience changes due to regulation	*"Demand continues to grow despite the higher prices (due to regualtion and SAF). There is still a strong willingness to travel, and demand has remained resilient. This is beneficial for airlines, as they can sustain higher fares without experiencing a major drop in passenger numbers."* *"Demand for air travel will continue to grow, but at a slower rate due to sustainability regulations driving up costs. However, because air travel demand is inherently strong, growth will still occur—just at a more moderate pace."*
Increasing costs will have an effect on EU aviation demand growth	*"According to airlines, a 2\% SAF share is still manageable, but as it increases to 6\% or 20\%, the situation becomes more difficult. Cost increases are already visible, but they are still under control for now."* *"The situation changes when the SAF mandate increases to 6\%. At that point, costs will rise so significantly that they will likely be reflected in ticket prices more clearly. A 6\% mandate is expected to create such a large cost burden that it will be difficult to absorb within the cost structure without price increases. This phase will be critical for airlines' cost strategies."*
Aircraft maintenance and delivery challenges limit capacity growth (supply), which affects passenger demand	*"The real bottleneck in the industry may not be demand but rather the availability of aircraft."* *"This is largely due to reduced capacity. Some airlines have either stopped flying to destinations like Japan, Korea, and China entirely, or have significantly cut back on the number of flights. This limited supply contributes to keeping prices elevated."* *"Airlines can fully utilize their existing fleets as long as aircraft are not undergoing maintenance. However, acquiring new planes is a different story. Airlines often face long wait times due to substantial order backlogs. The situation is further complicated by ongoing technical issues, such as engine problems affecting multiple aircraft types."*
Business model impacts cost structure: LCCs have higher proportional fuel expenditure than FSC	*"The challenge has already become evident: since a larger share of low-cost carriers' cost structure comes from fuel, they find it relatively much more difficult to manage cost increases than full-service carriers."* *"Low-cost carriers distinguish themselves with competitive, young, and fuel-efficient fleets. This is critical to their strategy, as fuel costs represent a larger share of their cost structure than for full-service airlines. Maintaining a modern, fuel-efficient fleet is vital for LCCs and provides them with a significant competitive advantage."*
An airline's cost structure affects how relatively expensive SAF adoption is for them.	*"The ability to invest in sustainable aviation fuel (SAF) production likely depends on an airline's financial strength. A strong balance sheet makes such investments more feasible. For example, major low-cost carriers like Ryanair and Wizz Air likely have the financial stability to pursue this strategy."* *"Although all airlines must comply with EU directives such as the SAF distribution mandate, LCCs' cost-efficiency-based business model makes them particularly dependent on fleet efficiency and optimal fuel use."*
Growth through cost efficiency and new revenue streams	*"Low-cost carriers have agility that enables them to build flexible business models in collaboration with other stakeholders. This flexibility, combined with their already efficient business model, can, at worst, significantly widen the gap between them and traditional airlines."* *"Many European low-cost carriers have optimized their cost structures so precisely that they can maintain profitability even if fuel costs rise slightly."* *"For low-cost carriers, it is clear that their interest lies in expanding their offering to include services related to time spent at the destination, as profit margins on flights themselves are often small. Larger ancillary services, such as week-long hotel packages or experiences organized at the destination, serve as a significant source of revenue."*
Growth through route expansion and airport optimization	*"LCCs choose secondary airports because they have lower fees, which already reduces operating costs. But beyond that, LCCs negotiate subsidies from airports that otherwise wouldn't have much traffic. These smaller airports pay LCCs to fly there because, without them, there wouldn't be enough passenger volume to sustain operations."* *"A crucial part of their strategy will be sticking to secondary airports, as we've discussed. There's a lot of money to be made there, and major hub airports will never offer the same financial incentives that smaller airports do."* *"There is still room for growth in Europe, but it's becoming more limited, especially in Western Europe. Airlines like Wizz Air are finding opportunities in Eastern and Southern Europe, where markets are less saturated and competition isn't as intense as in the West."*
Growth through flexibility and market adaptation	*"Low-cost airlines are able to make decisions and adapt more quickly. Legacy carriers may have a wealth of knowledge, but they are not always able to respond rapidly. For example, they might spend five years considering which aircraft would be the best choice for them."* *"During expansion, a shift in customer segments may also occur—if low-cost airlines begin targeting specific groups, such as business travelers, they may start competing more directly with traditional network carriers."*
Growth challenges from aircraft constraints and market saturation	*"The real constraint is not whether demand exists but whether airlines can get enough planes into service to meet demand. Right now, Boeing and Airbus have significant production backlogs, making it difficult for airlines to scale up operations as quickly as they might want."* *"A shortage of aircraft will limit growth in the coming years, as new planes are not readily available. For this reason, significant market expansion is unlikely in the near future."* *"Trends like the flight caps in Amsterdam could spread to other European airports, further restricting airline growth. If more governments impose limits on flight numbers for environmental reasons, it will drive up costs for acquiring airport slots, making expansion even more expensive."*

Figure 11: Second-order themes with excerpts from interview data

4 Results

This section presents the findings derived from the empirical research conducted for this study. From the analysis of qualitative interview data, several aggregate dimensions were revealed using the Gioia method to help organize the key themes emerging from the interviews. The results are in line with the data structure and the aggregate dimensions are presented in a logical sequence to address the research questions. In the previous section, the aggregate dimensions were introduced and in this section, they will be linked to the structure of the document and the themes will be the headings of the results section. Furthermore, before each theme the correlation within each aggregate dimensions will be portrayed with a simple model. The following section includes direct quotations from interview participants where they have expressed their perspectives and experiences in their own words, translated from Finnish to English. Not all findings from this study were uniform so as many quotations as possible were taken into account and also contradicting findings were brought about.

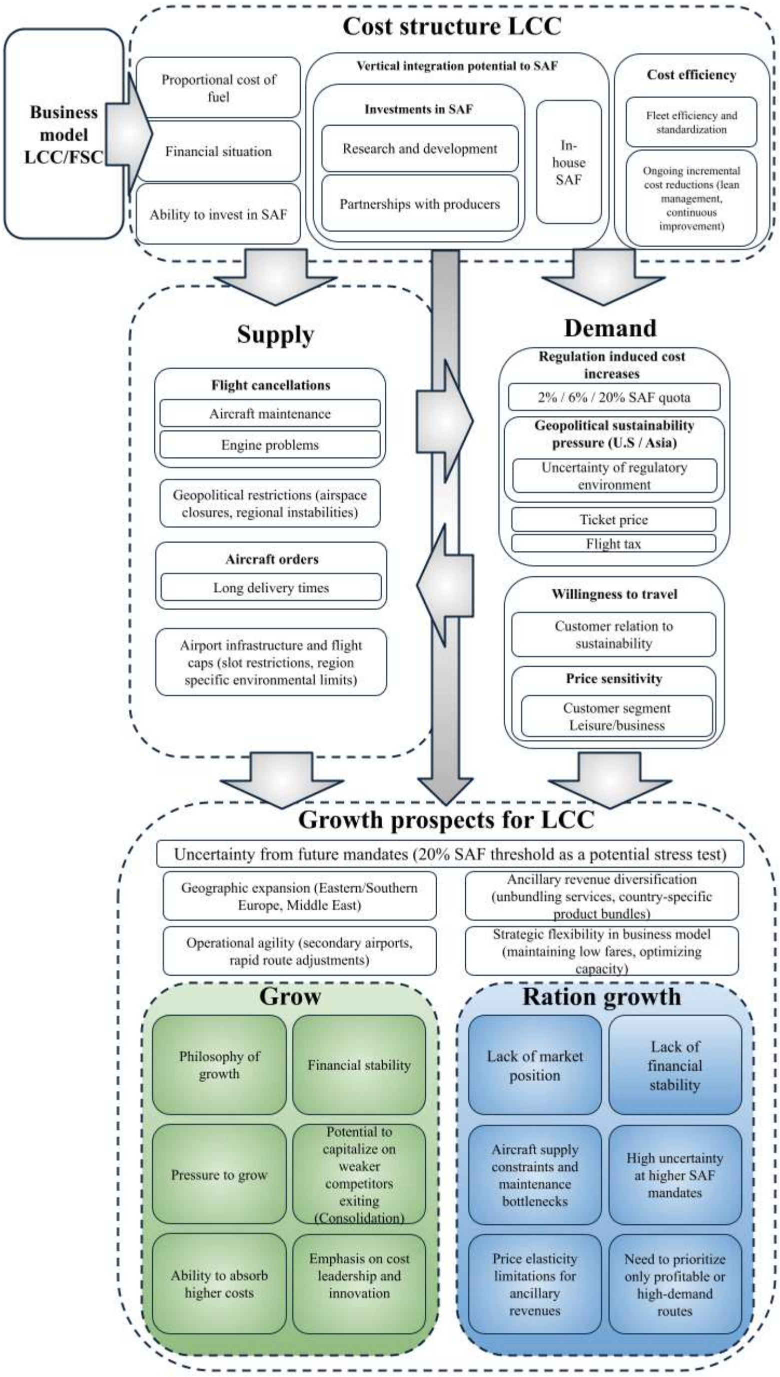


Figure 12: Strategic Adaptation Model for LCCs under Sustainability Pressures

4.1 Demand under sustainability pressures

4.1.1 EU aviation demand will experience changes due to regulation

The expectation based on the interviews is that air travel demand in Europe will remain strong despite the sustainability driven cost increases. The findings from the interviews show that sustainability regulations may influence the pricing structures, meaning that some sustainability regulation costs will be directed to ticket prices. However they are unlikely to result in a sharp decrease in air travel demand. Instead, air travel demand remains high, because consumers appear willing to travel even at higher prices. The data from interviews suggests that overall demand for air travel will continue to increase. For instance, one of the interviewees argued that:

> *"In general, we believe that demand for air travel will continue to grow (even thought the regulatory environment is changing in Europe). It's not going to decline, and we don't expect fewer people to travel. This is our primary assumption moving forward."* -A10

This view is consistent with historical data which show that air travel has grown at relatively steady rates over time despite economic downturns, fuel price fluctuations, and changes in regulations. The fundamental demand side dynamics indicate that while costs may rise due to sustainability mandates, they are not likely to do so to a degree that will fundamentally alter consumer behavior in the short to medium term. Further, empirical evidence from the interview data supports this reasoning as ticket prices are already higher than they were before the pandemic but demand remains strong and increasing. A participant in the interview noted that

> *"Ticket prices today are generally higher than pre-COVID levels, yet demand remains strong, even surpassing 2019 levels in many cases."* -A11

It seems that despite the increase in ticket fares due to factors like inflation or higher fuel expenses and sustainability charges have not reduced travel rates as expected.A significant pent-up demand combined with the perceived need for air travel, for both business and leisure keeps passenger numbers high. Additionally it appears that demand remains strong even as airlines adapt their pricing tactics to account for increased costs. An interviewee highlighted this pattern during an interview.

> *"Demand continues to grow despite the higher prices. There is still a strong willingness to travel, and demand has remained resilient. This is beneficial for airlines, as they can sustain higher fares without experiencing a major drop in passenger numbers."* -A10

This seems to imply that airlines might have more pricing power than thought, being able to impose sustainability related costs on passengers without necessarily seeing demand drop. The findings suggest that sustainability pressures are likely to bring cost driven constraints, but they are unlikely to disrupt the growth trajectory of air travel in Europe. It appears from the interview data that consumers are willing to pay additional moderate price increases to continue travel. Based on the market data available there is limited evidence on whether the consumer cares about whether their costs increase is directly because they support sustainability, this can be partly seen with voluntary sustainability costs alongside tickets, but these have not been that successful yet, the voluntary sustainability pick up rate is marginal, meaning only a small amount of customers want to voluntarily pay extra for the ticket. Hence, it can be inferred that the sustainability costs will be incorporated into the market without leading to a reduction in total passenger volumes. While the overall trend in air travel demand is positive, interview findings indicate that sustainability related cost pressures may slow, rather than reverse, growth. An interview participant stressed that

> *"We've established that despite rising ticket prices, demand continues to grow."* -A10

This is further supported by the findings which show that while ticket prices are expected to increase due to increasing regulatory requirements, demand elasticity is limited. Higher fares may not lead to major demand contraction but rather to a slower transition of consumers' travel behavior or spending allocations. The existence of a sustained demand is a key factor that can be attributed to the underlying human desire to travel. An interviewee stated

> *"Travel desire remains, that is certain. People want to travel, and they will continue to do so in the future."* -A12

This intrinsic motivation implies that, although consumers may alter their travelling behaviour in case of increasing prices (for instance, by selecting different destinations, reducing spending on other services, or focusing on certain types of journeys), the demand for air transportation itself should not disappear even if ticket prices would increase, this price increase has happened before and it has not affected demand. However, interview data suggest that although demand growth will continue, it may do so at a slower pace because of sustainability standards. One of the participants described this outlook, saying that

> *"Demand for air travel will continue to grow, but at a slower rate due to sustainability regulations driving up costs. However, because air travel demand is inherently strong, growth will still occur—just at a more moderate pace."* -A18

This is an example of a sustainability-driven cost pressure: rather than sending companies into a tailspin, these measures may just be forcing them to readjust their growth expectations. The results of the research can be concluded as follows: while sustainability costs will affect the industry, they are not likely to derail the overall growth trajectory of air travel demand. Instead, growth is probably going to carry on, potentially just at a mildly reduced phase as airlines and passengers navigate the new regulatory environment. Resilience of consumer demand and the strategic importance of air travel for most economies in the contemporary world show that sustainability pressures will define, but not undo, long-term trends in European aviation.

4.1.2 Increasing costs will have an effect on EU aviation demand growth

Sustainability related cost increase is expected to have an effect for air travel demand. This effect could be most noticable in the more price conscious passenger segments.

Interview findings show that the overall demand for air travel remains strong; however, sustainability regulations related costs such as the mandated use of SAF will increase costs, which airlines are likely to partly recover from consumers through higher ticket prices. This in turn may change travel behaviour in some price-sensitive sectors and some passengers may be more affected than others. A clear finding from the interviews is that the most significant effect will likely occur in the most price-sensitive travellers, especially in the leisure market, however as discussed in the previous chapter, this does not mean that the price-sensitive segment will forgo flying altogether. One participant said that:

> *"The biggest impact will be felt by price-sensitive leisure travelers."* -A18

Whereas business travelers or high income passengers are likely to concern themselves with convenience or class of service, budget conscience leisure travellers will often lead their decision making process with cost of flying. Moderate increases in prices that are due to sustainability induced cost pressures and they might be met by alterations in travel frequency or route choice or a shift to other means of transport where applicable, though as discussed in the first section travel demand is strong and still forecasted to remain strong even with moderate price increases. However, the effect of rising costs is not expected to be uniform across all passenger segments. Instead, variation in income and expenditure behaviour indicates that some segments will be more price insensitive than the others. An interviewee further elaborated on this disparity and said that

> *"Ultimately, the effect of rising sustainability costs will not be evenly distributed across passenger segments. Higher-end travelers with more disposable income will be able to absorb the increases, while budget-conscious travelers may be forced to cut back, reconsider their travel frequency, or seek alternative destinations."* -A18

This indicates that demand may remain fairly constant among high income travellers, but that airlines targeting price sensitive customers (e.g. LCCs) may have more difficulty maintaining demand as costs increase.

The greatest cost escalation is predicted to occur in steps with increasing SAF mandates that are scheduled to gradually increase in the coming years. Today's SAF quotas of 2% are relatively low and could be managed within the current cost structure, but interview findings indicate that as these mandates rise, airlines will not be able to bear the extra costs without increasing ticket prices. One participant outlined this transition, saying that:

> *"The situation changes when the SAF mandate increases to 6%. At that point, costs will rise so significantly that they will likely be reflected in ticket prices more clearly. A 6% mandate is expected to create such a large cost burden that it will be difficult to absorb within the cost structure without price increases. This phase will be critical for airlines' cost strategies."* -A14

These findings show that while the initial sustainability cost can be kept within the limits, the higher levels of the mandated SAF quotas are expected to lead to more pronounced price effects. This will be particularly relevant as the SAF blends will increase. As the SAF blend requirement period of 2% ends and once it goes beyond 6%, where cost absorption strategies will become increasingly difficult to sustain without affecting fare prices. Sustainability targets are rising, and airlines will be facing growing challenges in controlling costs and keeping prices competitive. They pointed out that although a 2% SAF mandate is still within the manageable range given the current cost structure, higher blending requirements will pose substantial cost challenges, such as the 20% that is being introduced 2035. One interviewee explained that

> *"According to airlines, a 2% SAF share is still manageable, but as it increases to 6% or 20%, the situation becomes more difficult. Cost increases are already visible, but they are still under control for now."*
> -A17

This could indicate that the industry's capacity to cover the costs related to sustainability will decrease with time and that more price changes will be needed as prices will increase drastically in the future. Besides airline-specific problems, the rising SAF costs will affect the general competition trends. Since all airlines operating in the EU have to meet the same regulatory standards, the sustainability-related price increase may be felt by everyone in the market. As one of the participants noted,

> *"When market prices change, it affects the entire industry. This means that if SAF increases ticket prices, it shifts the entire market's price levels, and no individual airline can avoid the impact." -A17*

This finding shows that sustainability costs are systemic. This means that passengers cannot switch to airlines that are not affected by these increases. Instead, price changes will become industry standard and could further impact demand growth. These increases in airline fares are likely to challenge ecpecially the price-sensitive customers. It is also important to understand the sustainability-related price increase in the context of the general pricing trends in the airline industry. An interviewee noted that

> *"It's also important to note that airfares have already risen significantly in recent years, even before sustainability-related costs have had a major impact. Prices today are 30–40% higher than they were in 2019, especially following COVID-19 and the surge (increase) in demand in 2023. (due to covid restrictions)"* -A10

This implies that passengers have already learned to cope with higher prices in the post pandemic world with a demand to travel. This coping with higher prices may dampen some of the shocks that may be associated with future price increases that are sustainability related. However, it is still not known how much more passengers are willing to pay for the price hikes, especially if the sustainability regulations lead to the continued rise of costs in the long run as they as likely to.

In conclusion, while the costs induced by sustainability mandates may not necessarily result in a decline in the overall demand, they are likely to decelerate the growth, particularly in the price-sensitive markets. The industry cost control will depend on how airlines will respond to the increasing SAF blending requirements into their pricing policies. Furthermore, since airfares have increased a lot in the past years it means that passengers have a certain price sensitivity but it is not known whether this will be the same as sustainability regulations become more stringent.

4.1.3 The impact of aircraft maintenance and delivery constraints on airline capacity

While discussions on air travel demand often focus on passenger willingness to pay and regulatory pressures, industry experts highlight that supply side constraints are just as important in determining market behavior. More specifically, limitations in aircraft availability—caused by long investment cycles, production delays, and maintenance challenges—are advancing as significant factors that are limiting airlines' potential to meet rising demand. Since fleet expansion and renewal processes are spread over decades, airlines must make long-term strategic decisions about aircraft acquisitions partly in blind without knowing all the variables, such as geopolitical situation or the advancements of the regulatory environment in EU. An interviewee noted this as a fact, saying that

> *"Airlines must plan aircraft investments decades in advance."* -A17

This is a common long term planning horizon in the industry, where capacity constraints cannot be solved easily from short term demand or regulatory changes. However, as fares have already risen significantly in the last few years and further increases to offset sustainability costs may not be easy to sustain. However, interview findings suggest that price increases are not only the function of sustainability-related costs, but are also heavily influenced by aircraft availability constraints. An interview partner noted that

> *"Given this existing price increase, further raising fares to accommodate sustainability costs will be challenging. The real bottleneck in the industry may not be demand but rather the availability of aircraft."* -A10

This observation indicates that although consumer demand is still strong, airlines may not be able to increase capacity to meet that demand because of problems with the supply of aircraft. Thus, the industry's supply and demand balance is a function of market forces like pricing as well as a function of other factors like aircraft delivery and order schedules and maintenance. Furthermore, geopolitical factors and operational constraints have only worsened capacity constraints on certain long-haul routes. For instance, one of the interviewees said that:

"That said, prices for these routes are still higher than they would be if Russian airspace were accessible. This is largely due to reduced capacity. Some airlines have either stopped flying to destinations like Japan, Korea, and China entirely, or have significantly cut back on the number of flights. This limited supply contributes to keeping prices elevated." -A10

The closure of Russian airspace has forced many airlines to reroute their flights, which increases their operating costs and reduces the number of available seats on key intercontinental routes. As a result, fares remain high not only because of demand-side factors, but also because of restricted capacity, which indicates the importance of supply-side constraints in determining ticket prices and passenger accessibility. These findings, when taken together, indicate that while sustainability-related costs are a factor in pricing pressures, the industry's primary constraint may be simply the inability to supply sufficient capacity. Supply chain disruptions, long-term fleet investment cycles, and geopolitical challenges are the main factors that lead to the continuing imbalance between demand and available seating, affecting both prices and availability of routes. In addition to long-term investment decisions and geopolitical constraints, ongoing maintenance challenges and aircraft delivery delays also restrict capacity growth, and thus exert supply-side pressures on the industry. One interviewee underscored this distinction, explaining that:

"Airlines can fully utilize their existing fleets as long as aircraft are not undergoing maintenance. However, acquiring new planes is a different story. Airlines often face long wait times due to substantial order backlogs. The situation is further complicated by ongoing technical issues, such as engine problems affecting multiple aircraft types." -A10

These delays mean that while demand remains high, airlines may not be able to grow their fleets fast enough to match it, extending supply restraints and high prices. These constraints' severity has already been shown by recent disruptions to airline operations caused by technical issues, one of which a case in point is illustrated by an interviewee who explained how an airline had to cancel a large number of flights because of aircraft availability due to engine issues and shortage of maintanence.

"A recent example is AirBaltic, which was forced to cancel thousands of flights for summer 2025 due to engine issues with their new aircraft. With planes grounded, they had no choice but to cancel a significant portion of their schedule, affecting many passengers." -A10

This case shows how unforeseen technical problems can cause an abrupt shortage of capacity that forces airlines to reduce their schedules and in turn lead to shortages of available passengers. Such incidents highlight the larger issue of supply side factors as a problem for aviation growth, while airlines try to grow their operations to meet demand potential, but also manage fleet reliability. Finally, industry experts agree that the most restrictive factor that could limit future capacity growth may not be related to consumer demand or regulatory costs, but to the most basic of all—aircraft availability. This is supported by one interviewee who summed up this view, saying that

> *"The real bottleneck in the industry may not be demand but rather the availability of aircraft. The key question is how many planes airlines will be able to deploy to meet growing demand."* -A10

This statement reinforces the notion that airlines' ability to increase services is now dependent increasingly on supply chain conditions of the manufacturers than on market trends in demand. Thus, with long lead times on aircraft deliveries and persisting maintenance issues, airlines may be unable to fully take advantage of strong demand trends or available markets, and capacity shortages and pricing pressures may persist in the near future of 5-10 years. Besides the current supply chain constraints and maintenance-related groundings, industry experts agree that aircraft delivery challenges will continue for several more years, which will further delay capacity expansion. An interviewee also pointed out that the challenges they face are likely to last for years, saying

> *"Aircraft delivery delays will not be fully resolved until 2028, meaning it will take approximately five more years before full capacity is available. This will slow growth in the short term."* -A17

This means that when airlines are trying to increase their fleet to meet growing demand, then structural delays in aircraft production will continue to complicate industry growth in the near future. In conclusion, although there is still a high demand for air travel, the availability of aircrafts is a major challenge that airlines face in order to meet this demand. Long investment cycles, maintenance-related groundings and order backlogs limit airlines' ability to increase capacity to meet market requirements. These constraints along with other factors like geopolitics and demographic structure of the market affect the top line and bottom line and in turn the demand. As supply side constraints prevent the industry from being able to grow fast enough to fully fill the market for new passengers or fully grow demand to find new customer segments. Hence, as delivery problems are expected to persist until at least 2028, supply side factors are likely to be a key determinant of the industry's growth rate in the coming years.

4.2 Cost structures and SAF impact

4.2.1 Business model impacts cost structure: LCCs have higher proportional fuel expenditure than FSC

The operating models of LCCs and FSCs are quite different and this is mainly due to the difference in their business and operational models. These distinctions are very important in determining the way in which each carrier type absorbs and responds to sustainability- induced cost increases, particularly fuel cost increases that are linked to SAF mandates. The research findings indicate that while LCCs are more vulnerable to fuel cost fluctuations compared to their network-based competitors, their cost-efficient business models and rigorous cost management strategies may provide them with a competitive advantage in adapting to the evolving regulatory landscape. Specifically, in the context of the European Union's increasingly stringent environmental regulations, LCCs' lean operational structures and flexibility could enable them to mitigate the financial burden of sustainability-related costs more effectively than traditional network carriers. Another major distinction in the cost structures is the fuel costs as a percentage of total operating costs. Low cost carriers being more efficient in their operations incur a higher fuel cost percentage than FSCs. This was reinforced by one of the interviewees,

> *"The challenge has already become evident: since a larger share of low-cost carriers' cost structure comes from fuel, they find it relatively much more difficult to manage cost increases than full-service carriers (solely due to fuel expenditure increases)."* -A8

These findings indicate that while LCCs benefit from lower overall cost structures, they remain highly sensitive to fuel price fluctuations, including those driven by SAF mandates. However, their competitive advantage stems from their ability to maintain highly fuel-efficient operations, primarily through the use of young and uniform aircraft fleets. As one interviewee noted:

> *"Low-cost carriers distinguish themselves with competitive, young, and fuel-efficient fleets. This is critical to their strategy, as fuel costs represent a larger share of their cost structure than for full-service airlines. Maintaining a modern, fuel-efficient fleet is vital for LCCs and provides them with a significant competitive advantage."* -A13

This cost efficiency focus is an important note, meaning that even though LCCs are more affected by rising fuel costs than other airlines, they are more prepared to overcome these challenges by replacing their fleet with more fuel efficient aircraft and implementing other fuel conservation measures. Moreover, the fundamental differences in operational models between LCCs and FSCs lead to the differences in cost efficiency. While legacy carriers use hub and spoke model to help with connection, LCCs operate largely on a point to point basis. One of the participants explained the effectiveness of this approach as:

"In contrast, LCCs operate a point-to-point model, meaning they are not dependent on coordinating connections. They schedule flights based purely on aircraft availability and demand, allowing them to achieve much higher aircraft utilization rates. While legacy carriers might optimize their structures as well, they are still constrained by their hub-and-spoke networks, which inherently limit aircraft efficiency." -A10

This operational flexibility reduces turnaround times and increases aircraft utilization rates that are good for the financial bottom line and allow LCCs to deal with fuel-related cost increases more easily. These findings show that while LCCs are more exposed to rising fuel costs than other airlines as a share of their costs, their business models — including efficient fleet management and high aircraft utilization — provide significant cost advantages. This operational resilience is not only assisting LCCs in dealing with sustainability-related cost pressures but may also allow LCCs to capture market share from less efficient FSCs in the event of increasing cost pressures.

LCCs' ability to maintain cost efficiency is also increased by their ability to achieve high aircraft utilization rates. Unlike FSCs, which are constrained by hub-and-spoke operations and bank structures that require longer turnaround times and connection buffers. LCCs can prioritize keeping their aircraft in continuous operation, this is the best option financially as aircraft is expensive if it is not flying and generating revenue. As one interviewee explained,

"An aircraft is most profitable when it's flying. If an LCC can keep a narrowbody aircraft in the air for 18–20 hours per day (just as an example), that's significantly more efficient than a legacy carrier operating the same aircraft for only 12–14 hours per day. The key issue is that when an aircraft is on the ground, it still incurs fixed costs—such as depreciation, lease payments, maintenance, and crew costs—while generating no revenue." -A10

This efficiency oriented strategy enables LCCs to keep the unit costs low and therefore are more resistant to the increase in fuel prices up to the level of SAF mandates. In addition to their operational efficiency, the cost oriented business models of LCCs provide them with strategic adaption in managing the sustainability related cost increases. Although LCCs have a greater share of fuel cost in their cost structure, yet they are generally more profitable than their full service competitors and thus could have some room to absorb cost shocks. One of the participants said,

"Given that Europe's leading low-cost carriers (LCCs) generally have higher profit margins than full-service carriers (FSCs), they may be in a better position to absorb rising environmental costs. One possible strategy for LCCs could be to accept lower margins while maintaining their growth plans, putting financial pressure on FSCs that cannot afford the same flexibility." -A15

This observation highlights a crucial strategic advantage: LCCs can leverage their profitability to remain competitive without immediately passing rising costs to consumers, thereby maintaining market share even under sustainability cost pressures. Also, the resilience of LCCs in the face of rising costs may lead to significant shifts in market dynamics. If fuel and sustainability-related costs continue to increase, LCCs' cost advantages could pressure weaker FSCs, potentially leading to market exits or consolidation. One interviewee predicted this competitive outcome, stating that

> *"The efficiency-driven philosophy of low-cost carriers, focused on cost minimization, gives them a strong position to face a tightening operating environment. This may also present an opportunity for them, as the weakest full-service carriers could exit the market if they cannot maintain profitability. This is especially likely if consumers remain cost-sensitive and choose cheaper flights."* -A7

In conclusion, because of their cost structure, LCCs have a greater relative exposure to fuel cost increases. However, their efficiency-focused operating strategies and relatively young fleets make them better equipped to deal with these pressures. Furthermore, their higher profitability puts them in a position to absorb rising sustainability costs without threatening their growth plans. These competitive advantages arguably enable LCCs to navigate cost increases more effectively than FSCs and potentially even gain market share as cost pressures increase based on the interview data. Therefore, differences in business models between LCCs and FSCs are key to understanding how sustainability-related cost increases will impact the competition in the aviation industry.

4.2.2 An airline's cost structure affects how relatively expensive SAF adoption is for them

The effects of implementing SAF on an airline's cost structure depends on its financial health, business model, and operational performance. Despite the fact that all airlines operating within the EU must comply with SAF mandates, how they deal with the costs and strive to achieve long-term cost savings depends on their financial health and cost structures. The interview results indicate that although low-cost carriers (LCCs) may be more sensitive to cost pressures owing to their fuel-focused strategies, their financial robustness and operational effectiveness may enable them to handle the SAF impact better than some full-service carriers (FSCs). A key finding from this research is that the financial robustness of airlines is a critical driver of how they deal with SAF-related cost pressures. Those airlines that are financially healthy are in a better position to make long-term investments in SAF production, which would allow them to reduce their fuel expenses over the long term and maybe even come up with new income sources. This was supported by one participant who said that

> *"The ability to invest in sustainable aviation fuel (SAF) production likely depends on an airline's financial strength. A strong balance sheet makes such investments more feasible. For example, major low-cost carriers*

like Ryanair and Wizz Air likely have the financial stability to pursue this strategy." -A15

This seems to indicate that LCCs – which traditionally have tighter margins than their legacy counterparts – are in a better position to directly invest in the production of SAF, which could help offset cost growth in the long term. Besides financial standing, airlines with aggressive investment policies may also have a competitive advantage by reducing their dependence on third-party fuel suppliers. Interviewees stressed that

> *"Finally, airlines might consider investing in sustainable aviation fuel production. Instead of relying entirely on energy companies like BP or Shell, airlines could take a more active role in SAF development, allowing them to profit from the transition to greener fuels rather than simply bearing the cost. These strategic moves could help airlines navigate the financial challenges of sustainability regulations while maintaining long-term competitiveness."* -A15

Through the production of SAF, airlines can control their fuel costs in the long run and at the same time show the sustainability of the fuel supply chain. From these findings it can be seen that while implementing SAF policy results in new cost pressures, such challenges can be turned into opportunities for airlines with strong financial health and potential to invest. Specifically for the well-capitalized LCCs, investment in SAF production may become a way to control the long-term costs and possibly outcompete financially weaker FSCs. However, achieving these advantages entails significant upfront investment, which may not be available for airlines that are financially weaker or have limited access to capital. The costs of implementing SAF are also a function of the differences in business models and operational productivity between LCCs and FSCs. Despite the fact that all airlines are affected by the same EU mandates, the cost-focused models of LCCs make them more sensitive to fuel price changes. However, their operational efficiencies and fleet management practices may enable them to have an edge when it comes to the relative costs of SAF. An interviewee said:

> *"Although all airlines must comply with EU directives such as the SAF distribution mandate, LCCs' cost-efficiency-based business model makes them particularly dependent on fleet efficiency and optimal fuel use. This gives them an advantage in certain markets but also places greater pressure on continuous fleet renewal and supply chain management."* -A13

This shows how LCCs' efficiency focused strategies can help overcome some of the cost implications of SAF requirements but at the same time highlights the continued capital requirements to support modern, fuel efficient fleets. Besides the business model efficiencies, it is the strategic investment in the SAF production that could redefine the cost structures and the long-term competitiveness. A number of participants saw co-investment in SAF production as a potential cost control measure. One participant commented that:

"If SAF becomes significantly more expensive than conventional jet fuel, owning or co-owning production facilities could offer both cost control and a new revenue stream. It's a strategy that airlines should seriously consider as sustainability costs rise." -A15

This would enable airlines to have more control over the fuel prices, make the airlines less dependent on third party suppliers and may also lead to creation of new revenue streams by selling the excess SAF to other airlines. This approach could be particularly interesting for LCCs with stronger financial position as it is consistent with their cost discipline and creates an opportunity to make sustainability compliance a source of competitive advantage. In conclusion, the relative cost burden of SAF adoption on airlines depends on their financial health, model, management as well as their market position. LCCs, despite having higher sensitivity to fuel costs because of their cost structure, can still capitalize on their operational efficiency and financial stability to manage these pressures. Some strategic investments, such as vertical integration into the production of SAF, could also assist airlines in the long run to reduce their costs and distinguish themselves in a sustainability focused market. Nevertheless, these options are capital intensive and therefore represent the role of financial strength and strategic planning in determining the way in which different types of airlines will find SAF adoption.

One additional aspect is the purchase of SAF. Broadly, you can purchase either mandatory SAF or voluntary SAF, both contributing to the same environmental regulatory goals and measurements. Mandatory SAF, as the name suggests, is required, and airlines must purchase it from EU airports. Airlines are obligated to purchase this SAF when landing at a major airport. An EU airport is defined as an airport that handles more than 800,000 passengers annually. Voluntary SAF, on the other hand, is purchased independently and at the airline's discretion. Airlines can use voluntary SAF to exceed the mandated SAF quotas or to meet regulatory requirements if they fall short of the required amount. An interviewee highlighted this about the price difference on the two different kinds of SAF:

"Fuel agreements are always made one year in advance, and this currently also applies to mandated SAF, as it is the seller's mandate (fuel supplier, e.g. Nest or Shell). This means that the fuel supplier incorporates a 12-month price risk, logistics costs, and margin into the mandated SAF price. Voluntary SAF is always purchased from the most cost-effective source on a one-off basis, whereas mandated SAF is country- or location-specific. The price difference will decrease in the future as the SAF index pricing model becomes more widespread, with mandated SAF being tied to a floating index." -A13

SAF does not yet have an indexed pricing mechanism, making the price of SAF less predictable for forecasting, and this uncertainty further increases the cost. Additionally, mandated SAF deals are made for the upcoming year, which includes additional price increases. Voluntary SAF, on the other hand, can be purchased when and where it is most cost-efficient. This could create an advantage for LCCs, which can occasionally operate from smaller airports without the mandated SAF requirement. Alternatively, financially stronger airlines could invest more heavily in voluntary SAF when it is at its lowest price.

4.2.3 Quantitative analysis: fuel cost structures and their impact on SAF adoption

A comparison of the costs of fuel as a percentage of the total operating expense continues to confirm the distinctions between LCCs FSCs made in literature review sections 2.1 and 2.2. The data reveals that fuel price increases, increase proportionally more with LCCs. This doesn't mean that FSC would automatically have it easier, it only means that the LCC cost structure is more strict and shows that FSCs have a more demanding cost structure. The qualitative data shows that LCCs have been spending a higher percentage of their total operating costs on fuel than FSCs, and when fuel costs increase, such as in the case with regulated SAF blending the procentual increase will be more rapid with LCC compared to FSC. For instance, in 2023, fuel costs for Ryanair, Wizz Air and Norwegian were 45%, 40% and 39% respectively, whereas Lufthansa and SAS, as FSCs, incurred lower fuel costs of 22% and 24% respectively. It is important to mention that some annual fluctuations especially in 2022 are due to the impact of the pandemic on fuel costs and the aviation market not depending highly on operating model.

The difference in cost structures supports the argument made in section 2.1 that LCCs have a more vulnerable business model to fuel price increases. This sensitivity to fuel costs also explains why LCCs focus on having fuel efficient fleets and procurement techniques. In addition, the cost implications of SAF adoption are clear: since LCCs have higher proportional fuel costs, any increase in fuel prices due to SAF mandates could be more detrimental to their total cost base. The IATA industry average reveals that fuel is the highest cost for airlines measured, center at 28.7%, other major costs were flight crew salaries and expenses at 8,6% and depreciation and amortization at 9,1%. As stated before fuel is much higher than the average for LCCs like Ryanair at 45% and Wizz Air at 40%, this is far above the average, which puts them under a lot of cost pressure from SAF mandates. However, section 2.2 shows that LCCs because of their low cost structures and high profitability could be in a better position to absorb these increases in costs or look for other solutions such as direct investment in SAF production. The interviews revealed that some of the most financially stable LCCs, such as Ryanair and Wizz Air, may be well placed to invest in SAF production using their own balance sheets, which could lead to lower fuel costs over the long term and act as a driver of vertical integration strategies. In conclusion, this qualitative analysis reveals the clear distinctions in the cost structures of LCCs and FSCs and why LCCs are most vulnerable to the increasing costs of SAF, purely based on the costs structures of different business models. This could also further pressure LCCs towards even more reasons to seeks cost control adaptation even further. This analysis also further establishes how business models are the driving force behind airlines'

	2023	2022	2021
SAS	*24%*	*24%*	*12%*
Pegasus	*39%*	*44%*	*29%*
Finnair	*31%*	*31%*	*16%*
Lufthansa	*22%*	*24%*	*12%*
IAG	*29%*	*28%*	*16%*
Spirit	*31%*	*34%*	*28%*
	2024	*2023*	*2022*
EasyJet	*29%*	*24%*	*21%*
Norwegian	*39%*	*45%*	*21%*
Wizzair	*40%*	*45%*	*30%*
Ryanair	*45%*	*43%*	*33%*

Figure 13: Fuel cost share in operating expenses (2023)

responses to sustainability issues, with cost structures being a key determinant of competitive advantage in a sustainability focused market.

4.3 Growth opportunities for LCCs

4.3.1 Growth through cost efficiency and new revenue streams

Cost efficiency has been a traditional component of low cost carriers business models, which have enabled them to be profitable while offering low fares. The research results show that efficiency will be an essential part of the growth plans of LCCs in the future as sustainability requirements increase the cost discipline. To become cost efficient organizations have to change not only their operating procedures but also their business approaches. There is one more factor that helps LCCs to keep the costs so low – the possibility of creating a flexible and lean operational model. For instance, one of the interviewees stated that

> *"Low-cost carriers have agility that enables them to build flexible business models in collaboration with other stakeholders. This flexibility, combined with their already efficient business model, can, at worst, significantly widen the gap between them and traditional airlines."* -A16

This flexibility is used to reflect rapid changes in operational processes, cost structures and partnerships and can give a competitive advantage to LCCs in dynamic market conditions. Another enabler that has been identified as crucial to the profitability of the airline is the maintenance of very lean cost structures. One participant stressed that:

> *"Many European low-cost carriers have optimized their cost structures so precisely that they can maintain profitability even if fuel costs rise slightly."* -A19

This efficiency is built in through measures like centralized fleet management, uniformly small aircraft that are easier to maintain and train for, and better fuel consumption. In addition, the interviewees believed that the following organizational structures are critical for long-term efficiency: Continuous improvement and operational simplicity. One interviewee also shared the following about these principles:

> *"I see efficient business management structures that utilize lean principles. The purpose of these structures is to build operations on continuous improvement and streamline processes. Decision-making processes enable swift responses, which is crucial in an increasingly complex future environment."* -A16

Through the implementation of lean practices, not only waste is reduced, but also the capacity of the airline to adapt to fluctuating demand and evolving regulatory requirements is enhanced. These findings indicate that LCCs' commitment to cost efficiency, when combined with operational flexibility, and a culture of continuous improvement, should continue to be a critical component of their growth strategies. Through keeping cost structures streamlined and applying lean management principles, LCCs are in a better position to manage rising operational costs and maintain their competitive market positioning. Another important avenue for growth is through increasing the sources of ancillary revenues, which have grown more significant for LCCs. As one interviewee stated,

> *"For low-cost carriers, it is clear that their interest lies in expanding their offering to include services related to time spent at the destination, as profit margins on flights themselves are often small. Larger ancillary services, such as week-long hotel packages or experiences organized at the destination, serve as a significant source of revenue."* -A21

— This shows how one can diversify beyond ticket sales to other services which can generate a huge amount of revenue. This is because, in the recent past, base fares have risen a lot, and therefore, airlines have had to look for other ways of increasing their profits. A participant in this study explained this shift:

> *"I believe, however, that in the future, low-cost carriers will increasingly shift their focus towards ancillary revenue rather than traditional cost savings. As base fares have already risen, the profitability of these airlines will depend more on additional services such as baggage fees, seat selection, food and beverage sales, and other ancillary offerings."* -A19

This increasing dependence on ancillary services reveals the way in which LCCs can continue to make revenue without having to raise the base fares. Revenue streams like baggage fees, onboard sales, and destination related services have the potential to increase profitability while maintaining low fares that are the core value proposition of LCCs. The role of sustainability related costs bring in one more level of complexity to the growth plans of LCCs. As the SAF mandates are increasing, the airlines are trying to find how to avoid the financial effects of it. An interviewee explained how LCCs can use the following mechanisms to address this issue:

> *"Low-cost carriers have a mechanism that allows them to lower their overall cost base and respond to price increases more efficiently than traditional airlines. The key question is whether they can fully offset the increase in fuel costs caused by SAF. Even if they cannot completely cover the additional costs, they can still manage them more effectively than traditional network carriers. For example, if fuel costs rise by 10%, low-cost carriers may be able to offset around 3% through traditional cost-saving measures, such as improving operational efficiency and negotiating lower contracts. This gives them a competitive advantage once again, as network carriers cannot reduce their costs as easily."* -A17

The findings indicate that operational efficiency, ancillary revenue diversification, and cost management will be critical to the growth of LCCs in the next few years. Although the sustainability costs are a major problem, the present flexibility, strong control, and creative ways of revenue generation of low cost carriers will be a good platform for growth in the next best of all worlds.

4.3.2 Growth through route expansion and airport optimization

The growth strategies of low-cost carriers (LCCs) in the European aviation market are dependent on the use of cost effective operational methods and, in particular, the use of secondary airports. These airports are much cheaper than the hub airports and, in some cases, charge lower fees and offer financial incentives to bring in airline traffic. This is because one of the participants in the interview highlighted the strategic importance of this approach and said:

> *"LCCs choose secondary airports because they have lower fees, which already reduces operating costs. But beyond that, LCCs negotiate subsidies from airports that otherwise wouldn't have much traffic. These smaller airports pay LCCs to fly there because, without them, there wouldn't be enough passenger volume to sustain operations."* -A10

This is a major competitive advantage for LCCs: the ability to secure operational cost savings through these partnerships with smaller, less-congested airports. This practice not only lowers the cost base but also enables airlines to offer more competitive fares to price sensitive customers. The financial structure of these agreements is also a clear example of the mutually beneficial relationship between LCCs and regional airports, where airlines bring passenger volume and, in turn, demand, leads to cost reductions and subsidies. Moreover, the prioritization of secondary airports as a core element of LCC growth strategies is also identified as a long-term operational focus. An interviewee noted:

> *"A crucial part of their strategy will be sticking to secondary airports, as we've discussed. There's a lot of money to be made there, and major hub airports will never offer the same financial incentives that smaller airports do."* -A10

The consistent utilization of these airports seems to be a deliberate, economically driven decision to keep cost efficiency in network expansion. Unlike full service carriers (FSCs), who rely on established hub and spoke networks and large, centrally located airports, LCCs operate predominantly on point to point networks, which enables them to avoid congestion and high fees of major hubs while simultaneously serving underserved markets. The implications of this strategy are not only operational cost savings, but also the geographical branding of destinations. An interview participant noted how LCCs often market routes actually operating through airports a considerable distance from the city centre as broader, more recognizable city names:

> *"This isn't just a Ryanair tactic—it's common across all LCCs. They will keep flying to smaller, lesser-known airports, even if those locations are far from the cities they claim to serve. They market destinations as 'Paris' or 'Brussels', but in reality, these airports can be one to two hours away from the city center (e.g., Paris Beauvais, Brussels Charleroi)."* -A10

LCCs use strategies to optimize their networks and keep costs down while facing challenges, like meeting customer expectations and the risk of passengers being disappointed when airport locations don't match up as expected.The effectiveness of using airports for LCC growth depends on balancing operational efficiency with a positive passenger experience for the long run, through route expansion and optimizing networks. The increasing presence of budget airlines (known as low cost carriers or LCCs) spreading throughout Europe indicates a mix of growth prospects and the growing hurdles linked to market saturation, in the regions airline industry landscape evolution as seen from interview findings show a shift in the scene from Western European markets offering vast network expansion opportunities according to one interviewees perspective, on the changing dynamics. The interviewee stated:

> *"There is still room for growth in Europe, but it's becoming more limited, especially in Western Europe. Airlines like Wizz Air are finding opportunities in Eastern and Southern Europe, where markets are less saturated and competition isn't as intense as in the West."* -A18

This insight reflects the trends in the industry, and shows how growth in established markets is being limited by factors like airport slot availability and regulations, as well as competitive forces that are increasingly adding pressure on airlines cost structures. The response to this challenge by airlines such as Wizz Air is to try out less crowded markets in Eastern and Southern Europe, where there can be fewer regulatory challenges and untapped passenger demand. This shift offers LCCs a chance to establish themselves in these regions and obtain airport agreements, while growing their routes without having to face intense competition. The growth of LCC airlines is not confined to Europe; they are also expanding internationally in order to expand their flight destinations and meet the demands of increasing customers in developing countries, as mentioned by a participant;

> *"Another growing trend is European LCCs expanding into Middle Eastern destinations, tapping into demand from both tourism and migrant worker travel."* -A18

Entering the Middle Eastern market strategically indicates changes, in the aviation industry worldwide as the need for both leisure and business travel rises steadily.The adaptable nature of the point to point approach adopted by low cost carriers enables expansion by reallocating aircraft to routes with minimal modifications.Furthermore cities like Dubai, Abu Dhabi and Doha in the Middle East have experienced increases in air travel volume due, to tourism programs and workforce mobility patterns. Expanding into markets generates income streams and reduces the vulnerabilities linked to depending heavily on European travel demand alone, for revenue generation purposes. LCCs not venture into geographic territories but also display impressive adaptability in managing costs and responding to market shifts effectively. During an interview one individual cited an instance illustrating how airlines such as Ryanair promptly adjust their operations in accordance, with modifications:

> *"Low-cost carriers, on the other hand, can make rapid adjustments. Ryanair has openly reduced its flights to Germany due to increased airport charges and aviation taxes in the country. Their strategy is straightforward: if costs rise excessively, they reallocate capacity elsewhere."* -A17

The LCC models operational agility is highlighted by its ability to quickly adjust capacity to markets through monitoring changes, in regulations and cost structures, like airport fees and environmental charges. This adaptability not only helps in cost efficiency but also allows LCC's to sustain growth even during times of regulatory and economic uncertainty. Expanding geographically and entering markets while managing capacity flexibly, showcases the tactics utilized by LCCs to uphold growth via expanding routes and optimizing networks effectively. In the future striking a balance, between expansion cost constraints and adhering to regulations will continue to serve as a factor in securing success.

The long term success of budget airlines (such, as LCCS) in the European aviation industry hinges on their skill in controlling expenses and maximizing the efficiency of their flight routes. In light of the escalating sustainability regulation expenses, within the sector, budget airlines need to embrace data driven methods when expanding their routes. A crucial aspect of their strategy lies in the nature of their direct flight network enabling these carriers to tweak their capacity based on evolving market dynamics. One individual encapsulated this flexibility by expressing; :

> *"LCCs, on the other hand, operate on a point-to-point model, which gives them the flexibility to abandon underperforming routes quickly. If an LCC realizes that a route isn't working, they simply move the aircraft elsewhere."* -A10

This flexibility, in operations gives an edge over the hub and spoke models by allowing LCCs to quickly adjust to changes in demand or profitability, on specific routes and shift capacity to more promising markets efficiently. This approach helps reduce losses from routes that are not performing well and improves the overall efficiency of the airline's route network. However, the growth of the route networks is now increasingly affected by the financial challenges posed by sustainability requirements particularly those related to meeting SAF quotas and emission taxes. The increasing expenses, in place for airlines in today's market demand them to review their expansion plans and focus on routes that generate passenger loads and improved financial outcomes as a top priority according to a recent interviewee discussing this new strategic direction;

> *"Rather than expanding rapidly across all possible markets, LCCs may need to focus on fewer, high-demand routes where they can ensure profitability. With sustainability costs raising the threshold for breaking even, they will likely have to be much more selective about where they deploy aircraft. This means prioritizing routes with strong demand and high load factors while potentially reducing or eliminating marginally profitable routes."* -A11

The change is a proposal of an change in the strategy from focusing on growing the market share by expanding capacity across the various markets to a strategy that focuses more on profitable growth. LCCs are predicted to focus more on the strengthening of their position in the existing and potentially profitable markets than on the battle for market shares through the increase of capacity in many markets. This strategic shift will require a greater reliance on data to identify the routes that are most profitable given the cost revenue balance. The final element of this growth plan is the implementation of a culture of decision making procedures. Low cost carriers are well known for their flexibility and innovation in order to meet the challenges of changing market trends. This cultural aspect has been found to be important in the advancement of the progress through the use of approaches to managing routes and networks, as one interviewee stated:

> *"Low-cost carriers are often agile and quick to implement changes, such as opening new destinations or adjusting their operations based on market conditions. They also tend to have a higher risk appetite and a stronger 'let's try and do it' mentality compared to traditional network carriers, which may operate in a more bureaucratic manner."* -A21

The flexibility of LCCs, along with their ability to seize opportunities in markets effectively positions them for network enhancements and growth potential. By staying flexible and concentrating on profitable routes while utilizing cost-effective airport agreements, LCCs are set up for continued expansion. This strategy is viable even in a market influenced by rising regulatory expenses and a high level of competition. Hence growth for LCCs via route expansions and network improvements is not solely about introducing destinations. The growth strategies involve a plan that combines using secondary airports effectively and leveraging their cost-effective landings that are unavailable for FSCs and with expanding with agility into diverse geographic markets and selecting routes strategically according to demand. These factors are backed by real-world insights gathered from interviews and offer a perspective, on the growth prospects for LCCs in the future.

4.3.3 Growth through flexibility and market adaptation

The rise of budget airlines, in the aviation sector seems to be driven by their ability for adjusting to market trends. This is according to interviews conducted with industry experts, who believe that budget carriers excel in adapting their services to evolving market dynamics. Budget airlines employ strategies such as pricing and adaptable market positioning as tools for navigating the industry landscape successfully. Additionally budget airlines increase customer demand through targeted pricing tactics. With these pricing strategies LCC are able to appeal to customer segments as highlighted by a respondent, in the interviews;

> *"Low-cost airlines' ability to generate demand through pricing is a significant competitive advantage. Their passengers can be divided into three groups: unique travelers, who fly almost exclusively with low-cost airlines; new demand, created by the attractive pricing of low-cost carriers; and shifted passengers, who choose a low-cost airline based on factors such as price, schedule, or destination."* -A17

This quote underscores the importance of pricing in helping LCCs expand their operations and create new demand. As they offer pricing strategies that attract customers looking for budget options. These airlines not retain the loyalty of passengers who prefer cost sensitive travel but also generate new interest from those who may not have considered air travel previously, or are just willing to try flying low-cost. Additionally, LCCs divert passengers from FSCs by offering options on their usual flight routes. The changing demand stimulation plays a role, as a key competitive advantage for LCC allowing them to thrive even in well established markets by influencing customer choices through competitive pricing strategies. Nevertheless it is crucial for LCCs and their continued success to adjust to a landscape where profitability no longer hinges on constant capacity expansion. With guidelines and rising operational expenses in play, LCCs must review their business strategies to align with the regulated market. One individual described this in this way;

> *"For European carriers, the key challenge will be adapting to a future where profitability isn't based on continuous growth but rather on efficiency, sustainability, and maximizing revenue from existing demand."*
> -A18

The industry is going through a change where being flexible is crucial.This applies to both: in operations and optimizing costs structures are a necessity for growth nowadays. LCCs are focusing strategically on generating revenue from passenger numbers instead of network value. They have to solve this while using resources efficiently without depending too much on expanding capacity limitlessly, this limitless growth has been a trend for LCCs. To stay competitive without relying on increasing capacity limits LCCs are looking into advanced pricing models additional revenue sources and scheduling methods that respond to demand. Alongside focusing to increase profits from customers demands, budget airlines are also reviewing the services they offer to appeal to wider range of different customer groups. While budget carriers have typically catered more towards leisure travel many flights are now aiming to attract business travelers by making changes, to their flight schedules, onboard services, and marketing strategies. As mentioned by one person in an interview;

> *"During expansion, a shift in customer segments may also occur—if low-cost airlines begin targeting specific groups, such as business travelers, they may start competing more directly with traditional network carriers."*
> -A17

The shift, towards catering to business travelers is been seen in airlines like easyJet that have been focusing on serving both leisure and corporate customers through features such as flight timing and with ticket options. This strategic move highlights, how LCCs are evolving to capture market share from network carriers, while still maintaining their efficient operational model. These findings reveal how pricing tactics and operational improvements based on efficiency and targeted customer grouping are elements, for the growth of LCC through adaptability to market changes. As competition changes over time, the capability of these airlines to mix cost leadership with service options will be a strategy in determining their future growth paths. The ability of LCCs to sustain growth, in changing market environments also heavily depends on their structures and cost saving methods. LCC stands out for its ability to meet customer demand by using pricing based on data and streamlining operations for cost efficiency through fleet management and maintenance practices as highlighted by an interviewee discussing the competitive edge these decisions offer:

> *"Ryanair has developed a highly efficient maintenance strategy for its 737 fleet that allows it to maintain safety while keeping costs lower than most competitors. This efficiency is largely due to its decision to operate a single aircraft type at scale, creating significant economies of scale in maintenance, training, and operations."* -A18

This way standardizing fleets makes operations more simple with respect to e.g. maintenance tasks and pilot training for LCCs. As a result, LCC can more easily modify its capacity during market fluctuations due to the uniformity of the fleet in terms of costs and the ability to buy aircraft in bulk from manufacturers. All of these strategic decisions are aimed at the flexibility that is so important for the growth and development of the agile LCCs. Besides the choices concerning their fleet management and expansion strategies, the unique culture of LCCs helps them to respond effectively to the market changes. While there are some airlines which are often limited by challenges and a long decision-making process, LCCs typically prefer agile strategies and are more willing to take risks while making critical business decisions. One participant was interviewed to compare the decision making of LCC airlines and full service carriers.

> *"Low-cost airlines are able to make decisions and adapt more quickly. Legacy carriers may have a wealth of knowledge, but they are not always able to respond rapidly. For example, they might spend five years considering which aircraft would be the best choice for them."* -A16

LCCs have a more agile culture and have fewer constraints, which allows them to easily test service options and pricing strategies as compared to other network airlines. Real world realization of this adaptability is visible in how these carriers are introducing new routes, cancelling unprofitable services without causing major disruptions and experimenting with innovative ways of creating additional revenue. Thus, the changes they made, enabled them to work effectively with minimum delay. This can make LCCs more flexible in the market, especially when there are changes in the market that may affect their competitiveness in the market. The regulation of the the EU market is one example of this, which increases the costs. As interviewees have stated it is possible that the cultural factors may be the advantage of LCCs over FSCs. In the future LCC could be considering collaboration within the aviation sector in order to expand their expansion opportunities. A review of LCC's past shows that they operated without collaboration in order to avoid the complications associated with partnerships and code sharing arrangements which are typical in the airline industry. These collaborations are often costly to LCCs, and they have managed fine without them so far. However, from the interviews conducted there could be an increasing interest in partnerships to enhance network coverage and enhance passenger convenience. One of the interviewees expressed his views on this shift;

> *"Another area where LCCs might evolve is in collaboration—both within the LCC sector and potentially beyond. They may explore new ways to work together, either through shared ticketing platforms, interlining on select routes, or even developing agreements with other LCCs to optimize connectivity without adopting the traditional hub-and-spoke model."* -A10

These collaborations could lead to a change in the LCC strategy and reveal new opportunities. LCC is positioned in the market as operating in more isolation from other airlines compared to FSC. FSC often take value from their network structure and can increase the value of the network with alliances such as the one world alliance, LCCs on the hand don't rely on that intensively on collaborations, at least not yet. It is possible that these collaborations would help them improve flight scheduling and network coverage coordination and possibly attract new customers. As a way of responding to market changes and regulations, it would serve as an expansion of their ability to adapt. The combination of the fleet, cultural adaptability and strategic partnerships is evidence of how LCC uses flexibility in operations to achieve growth. LCC's flexibility strategies will also remain relevant as regulations and market conditions shift in the aviation industry over time. Hence, in relation to sustainability requirements and changing customer demands, the ability to shift quickly to changes and incorporate them into the plans may give budget airlines an edge in competition. A participant in an interview stressed the importance of being proactive:

> *"Additionally, achieving a pioneering position in the adoption of technologies such as SAF could help enhance the airline's reputation and strengthen its brand. This would allow the airline to differentiate itself from slower-responding competitors and attract environmentally conscious customers."* - A21

The introduction of SAF presents both opportunities and challenges for LCCs. The cost of SAF is currently significantly higher than that of conventional jet fuel, but early adoption could have a reputational benefit and bring in environmentally conscious passengers. If LCCs position themselves as sustainability leaders, they could stand to gain new customer segments while also reducing the competitive disadvantage that comes with regulatory cost burdens. While there are external sustainability pressures, the fundamental constraint on growth in the near term is based on the data probably not environmental policies, but rather supply chain constraints. Aircraft availability has become a key bottleneck that is limiting fleet expansion plans across the industry. One interviewee put it like this:

> *"Regarding growth speed under sustainability pressures and rising costs, I don't believe these factors will significantly slow down expansion. Instead, the real constraint on growth is aircraft availability, not sustainability costs."* -A10

This observation highlights the importance of strategic fleet planning and procurement. LCCs often order large amounts of single aircraft type from a given manufacturer and so have an advantage with their order size. With this scale they might have a better growth position compared to their competitors, as discussed before thought the unpredictability of the delivery schedules wiehgts on the whole aviation industry currently, so airlines might not be in the optimal position to leverage this fully. Furthermore, this situation highlights the importance of aircraft utilization and network optimization as key drivers of growth through market adaptation as efficient. Ultimately, the capability of LCCs to sustain their competitive position will depend on their capability to continually measure, revise and improve their service delivery in light of changing market conditions. The LCC are constantly thriving towards cost optimization in the model inherently, they might not be weight down that much by heavy operation structures as some of their competitors, this could allow them to pursue and implement new strategies and hone the ones in use more efficinetly. An interviewee also pointed out that this operational ethos is completely different from the rigid frameworks which are typical for traditional airlines. This flexibility enables LCCs to explore novel customer value propositions like dynamic pricing, flexible fares, and expanded ancillary services. Operational flexibility will include continuing to be able to make relatively rapid operational adjustments, e.g., reconfiguring aircraft to newly identified high-demand sectors, or changing the schedule to meet competitive threats. Thus, the growth by flexibility and adaptive strategy for market-oriented low-cost carriers is based on the interaction of the following factors: sustainability strategy, operational flexibility, and market-oriented decision making. Thus the interviewees point out, LCCs might be able to keep on growing in the face of the increasing regulation in the environment sector. SAF increases costs in the long run, but overcoming the problems of the supply chain and using their flexibility. It is, therefore, likely that the further development of the LCC business model will be characterized by a search for greater effectiveness, creativity, and compatibility with the requirements of policymakers and customers.

4.3.4 Growth challenges from airspace limits and market saturation

The growth trajectory of low-cost carriers (LCCs) in the European aviation market is facing significant challenges. Major one derived from interview data are arising from operational constraints, particularly regarding aircraft availability and availability of aircraft maintenance, airlines are not able to keep their planes flying due to engine failures and ones aiming to order more planes to keep growing demand are unable to due to full order backlogs in the side of the manufacturers. The ability of airlines to expand their networks and increase capacity is fundamentally linked to the delivery schedules and production capabilities of aircraft manufacturers. One interviewee highlighted the immediate impact of this issue, noting:

> *"The real constraint is not whether demand exists but whether airlines can get enough planes into service to meet demand. Right now, Boeing and Airbus have significant production backlogs, making it difficult for airlines to scale up operations as quickly as they might want."* -A10

This production backlog is part of bigger supply chain issues that happened after the pandemic in various industries. In aviation there are only a few aircraft manufacturers, the relevant ones discussed here are Boeing (USA) and Airbus (EU). For LCCs, whose growth strategies have typically relied on achieving economies of scale through rapid fleet expansion, this constraint of not being able to order new planes is a problem to their operational plans to maintain and grow operations. The limited supply of new aircraft may slow down capacity growth, particularly for airlines that seek to standardize their fleets to simplify maintenance and training. Furthermore, the lack of availability of new aircraft deliveries is a problem in the market. Economies of scale might have an impact since carriers with prior bulk orders and good relationships with manufacturers will be able to get their deliveries more easily than the other smaller carriers. This situation increases the pressure on LCCs to come up with other strategies to grow, including increasing the use of aircraft, extending lease terms or even buying used planes from the market or by acquiring other airlines to address the shortage of planes in their fleet. These operational decisions are therefore significant from a strategic standpoint as they may increase the cost of maintenance or reduce the operational efficiency that is normally associated with standardized fleets. The inability of manufacturers to meet the rising global demand for narrow-body aircraft adds another layer of challenge to the problems related to fleet growth. This has made the airlines to review their growth plans and readjust their capacity for the next few years. An interview participant explained the short-term fleet growth outlook with caution:

> *"A shortage of aircraft will limit growth in the coming years, as new planes are not readily available. For this reason, significant market expansion is unlikely in the near future."* -A19

This statement highlights the expectation of slower growth in network expansion over the short term than what has been seen historically and what LCC are aiming to based on their historical growth directions. Despite the continuing strong demand, the physical limitations of fleet supply demand a more cautious growth strategy. This shift may force LCCs to concentrate on their most profitable routes and markets and therefore to rationalize their capacity to grow. These fleet-related constraints imply more than just the fleet strategies of individual airlines and affect the competitive dynamics of the sector as a whole. In particular, carriers that rely significantly on growth-related strategies might be vulnerable, as their operating models are designed for continual growth in capacity and route development, thougth as highlighted beofre their cost efficient structures might balance the scale. Therefore, in the coming years, the LCC industry may experience a strategic change towards more effective operation and moderate growth compared to the highly expansionary patterns of the previous decades. In addition to the direct constraints on the number of available aircraft, low-cost carriers (LCCs) are facing more fundamental structural issues, including market saturation, regulatory pressures, and changing demographics such as the demografic structure of Europe. A recent finding is the rising adoption of flight caps at major European airports. These caps are usually put in place over environmental concerns and capacity limits, which are a direct threat to the growth prospects of LCCs through the restriction of the number of available slots for new flights. An interviewee gave a clear example of this emerging trend:

> *"Trends like the flight caps in Amsterdam could spread to other European airports, further restricting airline growth. If more governments impose*

> *limits on flight numbers for environmental reasons, it will drive up costs for acquiring airport slots, making expansion even more expensive."* -A18

This phenomenon shows the increasing role of sustainability concerns in the operational strategy of the aviation sector. As environmental issues rise as an issue in policy-making, regulators across Europe are starting to consider slot limitations and emission-based charges to help cut emissions from aviation. This is an increased challenge for EU aviation as a whole. Given that these airport slots hit major airports rather than the whole country this could be somewhat avoided by the agility of LCC. Major airport landings are a great cost for network carriers, LCC can avoid most of it flying to secondary airports. However, geographical expansion may not be sufficient if cost pressures increase in all markets. The LCC business model is based on the argument of maintaining cost leadership, especially with respect to airport fees. As one participant noted, the use of low fee markets as the main growth engine is constrained

> *"Low-cost carriers have a certain degree of flexibility, but if all major markets were to start increasing fees and taxes, the situation would become significantly more challenging for them. They cannot build their entire business model solely on low-cost routes, such as those between Romania and Albania. They also require traffic from the major EU markets."* -A17

This statement illustrates the balance between minimizing costs and optimizing networks, for LCC this means that they as well need the customers partly provided by aviation sector as a whole. There are still gaps in the market, but the financial feasibility of these routes is contingent on airport incentives and passenger demand. As more countries implement measures such as aviation taxes and environmental levies, LCCs must re-evaluate their route networks and may have to increase fares, which can undermine the strategic value proposition for price-demanding customers, but this challenge is posed to hit EU aviation sector as a whole, not just the LCCs of Europe. The one point for the LCC growth is structurally linked to the need to expand further in order to keep the cost advantage and maintain effectiveness. The economics of the LCC model depend on the achievement of economies of scale, which in turn requires the continued growth in capacity and the allocation of fixed costs to a growing passenger base. In response to increasing regulatory costs and operational constraints, LCCs may be forced to alter their strategic priorities from volume growth to profitability growth. This was summed up effectively by one of the interviewees:

> *"LCCs depend on continuous expansion to maintain economies of scale and keep unit costs low. However, sustainability costs may force them to moderate their expansion, focusing more on profitability rather than just network growth."* -A11

This potential shift is a significant alteration from the historical growth patterns of LCCs, which have emphasized capacity growth to sustain low unit costs. In the future, carriers may have more nuanced strategies, such as improving their ancillary revenue models, controlling capacity to follow the demand of the season, and creating collaboration to increase network without necessarily increasing capacity. Finally, demographic trends create a long-term variable that may also limit LCC growth within Europe. Not all other regions have growing populations to support rising travel demand, many European countries have population decline or stagnation. Immigration has eased these effects to some degree, but the demographic trend remains mixed. One interviewee pointed out:

> *"In the long run, demographics also play a role. Europe's population is growing slowly, if at all, and without immigration, many countries would be experiencing population decline—similar to the situation in the U.S."*
> -A18

Stagnant demographics coupled with environmental rules and fleet restrictions present a confusing scenario with regard to LCC growth. Although air travel demand remains strong, the factors discussed above suggest that the period of very rapid, almost uncontrolled growth may be giving way to a period of more gradual, more thought-out growth. It will be vital for the industry to display innovation, regulatory understanding and operational efficiency in order to navigate these challenges. Hence, the growth challenges that LCCs face from airspace constraints and market density can be attributed to supply chain issues, regulatory pressures, cost structure issues, and demographic trends. These challenges can only be met by a strategic change from capacity-driven growth to efficiency and profitability oriented strategies. Based on the data gathered: partnerships, alliances and expansions into the non-EU markets could be the right ways to tackle these growth restrictions while maintaining competitive strength in the market that is gradually becoming more and limited.

5 Discussion

In this chapter, key considerations drawn from the research findings are discussed; empirical results are integrated into existing market conditions and their implications are reflected upon. This chapter also includes a discussion of practical implications, as well as contributions to the literature and the limitations of the study, with suggestions for future research.

The purpose of this thesis was to determine how rising sustainability-related costs and regulatory pressures are impacting European aviation demand and LCCs growth in this changing environment. To this end, the study began by examining how sustainability related costs and capacity constraints affect future demand for air travel, with different levels of passenger price sensitivity and market responses. The first research question was: "How do sustainability-driven cost increases and other capacity constraints (e.g., aircraft availability, flight caps) jointly influence European air travel demand over the next decade?" Secondly, the thesis aimed to determine whether and how LCCs can keep growing with these increasing cost pressures, and if so, what strategic adaptations would enable them to do so. Thus, the second research question was stated as: "Are low-cost carriers able to sustain growth under increasing sustainability-related costs in the EU, and if so, what strategic adaptations enable them to achieve this growth?" The main findings from the study can be summarized into three major conclusions: 1) It is expected that air travel demand growth is to be resilient even with moderate sustainability cost increases and existing capacity constraints; however, effects of significantly larger future cost increments are not in the scope of this study; 2) The analysis of airline cost structures fails to offer a clear picture of whether the fuel costs, which are generally higher for LCCs, will be a threat or an advantage in the context of rising sustainability costs; and 3) LCC sector will continue to grow, financial health, strategic flexibility and adaptive business practices are crucial to determining whether any given LCC can sustain its growth, with the airline specific factors being the most important in addressing the challenges of future cost increases and operational constraints.

5.1 Key considerations

The empirical findings from this research have revealed several important issues regarding the effect of sustainability inspired policies and the rise in costs on European aviation demand and airline plans especially for LCCs. At first, it is evident that any regulatory standards like the SAF blending standards will raise the operating costs and, in turn, increase the fares that consumers pay for the service. However, from the interview data and market trends it can be seen that the demand for air travel in Europe is unlikely to decrease significantly, but rather continue to grow at a slightly lower rate. Air travel demand remains fairly strong and the evidence indicates that passengers are willing to pay additional fees for their trips for both leisure and business purposes. This remains the case even with the existing economic challenges like inflation and other factors that has caused airfares to rise shortly after the COVID-19 pandemic. Hence, it can be deduced that small increases in the ticket prices even if linked to sustainability are unlikely to affect the consumer's willingness to fly especially among the higher income or less price conscious passengers. However, the results also show that the sustainability related costs are expected to affect demand in a more sophisticated way than simply suppressing it, and the extent of this is still fairly unknown, and pre-pandemic market conditions with suppressed demand as well as the supply side constrictions may also have an effect on the demand growth rates in the coming years, such as slightly higher demand growth rates pre-pandemic as experts have stated that pandemic took some years of growth from aviation industry. For instance, demand from the price conscious leisure travellers may be most affected as prices rise further, leading to changes in behaviour such as reduced trips, changing modes of transport, or choosing different itineraries and destinations. Hence, the average demand trend for air travel in Europe remains positive, but this means that airlines, especially those that depend on price-sensitive customers, may stand to gain from adjusting their market expectations and strategies for growth and managing prices and capacity, respectively.

Furthermore, although the focus of sustainability pressures has mainly been on the demand side, the findings also reveal that there is another equally important limit coming from the supply side – aircraft availability. Problems with long aircraft procurement cycles, persistent manufacturing delays, and growing maintenance needs as a result of technical disruptions are limiting factors in aviation growth. These challenges include problems in aircraft availability that are further compounded by long production backlogs and maintenance issues that reduce fleet utilization, which pose a significant problem for airlines to be able to meet the consistently strong passenger demand that is forecasted to continue over the coming years. These supply side issues only serve to exacerbate the effects of the sustainability cost pressures, creating an operational environment in which airlines must manage the increasing costs of new regulations while facing limited capacity growth. The data collected from industry experts, however, shows that at the moment and in the near future, aircraft availability is a critical bottleneck. This limit means that airlines will have to pay close attention to fleet planning, improve maintenance efficiency and make strategic procurement decisions that go beyond the traditional demand management decisions. Hence, it can be seen that the short-term limits on growth and pricing strategies of the aviation industry are not only due to regulatory pressures or shifting consumer tastes but also to structural supply-chain issues and geopolitical factors. Under these circumstances, airlines must continue to watch their supply chains and keep some strategic degree of flexibility since aircraft shortages and delays, which are expected to continue until at least 2028, may severely limit their operational capacity and market timing in the near to medium term.

The findings show that as LCCs have a relatively higher fuel cost exposure ratio and most of their routes are purely intra-EU, they are more vulnerable. However, due to their strategic flexibility, cost management, and efficient operations, they are as a sector well-placed to manage the increasing cost pressures that come with European sustainability mandates. The empirical results show that the future growth of LCCs will depend to a large extent on their strategic actions, especially as they try to build on their operational efficiency, manage costs, and develop diverse revenue sources from traditional ticket fares. In particular, the results show that, despite the notion that LCCs have nearly maximized their cost positions and have limited further scope for cost reduction, there is still a strong narrative, supported by several industry stakeholders, that there are still opportunities for further incremental improvements through the refinement of operational activities. Although cost structures may appear to be fully optimized, the continuous improvement ethos typical of LCCs, which entails agile decision making, lean fleet management, and flexible network planning, may offer some extra, but marginal, efficiencies to help navigate rising cost environments. This continuous search for marginal improvements combined with cost control attitudes should enhance the strategic resilience of LCCs facing sustainability induced cost increases, although the quantity of these gains is likely to decline with increasing regulatory pressure.

Furthermore, the analysis also reveals the strategic importance of ancillary revenue streams as a way of complementing the efforts to address rising costs especially in the light of the challenges posed by SAF blending mandates. Although the traditional ancillary revenue streams such as baggage fees, seat selection, and onboard sales are practical in terms of pricing elasticity, there is still a potential to finding new strategic opportunities for the further unbundling of service offerings and innovative development of new revenue streams, such as selling the SAF certificate or venturing outside the flight. Participants identified potential for expanding these revenue streams via tailored, country specific service packages, deeper integration into destination related offerings, or other contextually relevant travel products. While discussing the limitations on the extent of price increases for established ancillary services, the findings-provide a convincing argument that the key strength of LCCs has less to do with how far prices can actually be raised, but instead, it is found in the basic strategic approach of the LCCs which is based on the principle of continuous innovation in the development of ancillary products and services as well as cost management. This philosophy, which is deeply rooted in the cultural practices of LCCs, enables airlines to continually look for and develop ways of diversifying their revenue base and targeting specific market segments even when ticket price increase is limited by consumer price sensitivity and regulatory constraints.

However, as the results show, the 20% SAF blending mandate that the EU plans to implement from 2035 is going to be a "stress test" for the entire European aviation sector in the future. This particular regulatory threshold has the potential to act as a clear inflection point according to the industry consensus revealed by the interviews and will particularly pose a significant threat to the cost management strategies of airlines and to their overall financial resilience in an industry where the margins of carriers are already tight on avarege. On the basis of the magnitude of cost increase that is expected at this mandate level, it can be confidently argued that not all LCCs will be financially strong and strategically flexible enough to manage this critical period effectively. Other airline specific factors such as financial strength, fleet planning, vertical integration and SAF production and investment as well as research and development of new ways to enhance ancillary revenues will therefore become the main drivers in determining which airlines will be able to take advantage of growth opportunities and which will shrink or may even exit the market or go through consolidation. All of this without the unknown factors at play such as specific engine failures or geopolitical tension or regulation. It is also important to note that this scenario is based on the assumption of regulatory parity; any changes or even enhancements of the current EU policies may change the competitive environment and thus the role of adaptivity as a key strategic capability.

In conclusion, low cost carriers will probably keep on growing in size and by market segment in EU by further implementing the principles of efficient operation and flexible business strategies. However, the context of the European aviation market development against the background of the increasing stringency of sustainability requirements is full of unknown factors and structural issues. The results of the study fully confirm the need for strategic flexibility, financial stability, cost management as a strategic approach, and the development of additional revenue streams from the sale of additional services as the key factors that will determine the success of future competition. The next wave of sustainability regulations, including the SAF quota increase, will undoubtedly be a “stress test” for European aviation, which will affect the cost management, strategic planning, and flexibility to supply-side constraints and regulatory pressures. Therefore, the ability to survive and evolve in this ever-increasingly stringent regulatory environment will be vastly different among airlines LCC and FSC alike, and in doing so, will have an changing and long lasting effect on the competitive structure of the European low cost carrier market.

5.2 Practical implications

The findings of this study have important practical implications for the European airline industry and its competition strategies within. Additional implications are for LCCs in particular as they strive to navigate and grow in the increasing financial pressures of sustainability regulations. As sustainability driven cost increases directly impact operational expenses, ticket pricing, and competitive positioning, airlines must adopt strategic adaptations to remain profitable while fulfilling regulatory mandates. This section discusses the most directly applicable practical implications of the study’s findings. The cost structure analysis in this study also reveals how sustainability mandates, like the introduction of SAF quotas impact LCCs differently from FSCs from the point of view of cost structure. LCCs with a cost conscious customer base must find ways to mitigate as much as possible from these cost increases. This includes optimizing fleet efficiency, renegotiating fuel procurement agreements and identifying operational efficiencies that reduce the reliance on high cost sustainability measures (e.g. finding more cost consious ways of obtaining SAF and çancel its cost increases) but still meet regulatory requirements. The insights from this study are a starting point for fursther forecasting the demand in Europe and how regulation could affect it, also how and if LCC are able to operate in this increasingly regulated market while managing their costs and evaluating their potential to keep their historical aggressive growth patterns.

The study also reveals the posibility for LCCs to revise their network route design (such as focusing on profitable routes, growing them solely or with the help of collaborations) and revenue management strategies (such as ancillary options and SAF investments) with the sustainability pressures. Since the elasticity of demand in air travel is high and especially so for price-sensitive passengers, airlines should assess whether route optimization such as concentrating on high-demand destinations or increasing ancillary revenue streams can balance sustainability-induced price increases. The demand forecast in this study shows that demand for air travel will keep on rising in Europe irrespective of the impending regulations within the next five to ten years. These trends help LCCs to design specific pricing plans to further attract different customer segments such as business travellers and find other sources of revenue, for instance, focusing on secondary airports and potentially finding subsidies from using them, and increasing the range of ancillary services. Moreover, the study reveals the significance of synchronizing sustainability plans with passengers' expectations and investors' demands, here communication matters and LCCs have a position to look for a trusted sustainable brand with clear strategy and communication backing it up. As regulations become more stringent, those airlines that can properly convey their sustainability initiatives and also prove the ability to control costs may have a competitive edge in attracting investors and passengers. The findings of this study can be used as a management brief to aviation executives, policymakers, and other industry decision makers in assessing the future of low cost aviation in Europe as well as the EU aviation in general when sustainability and SAF implementation is factored in. Although the results are initially applied to LCCs, they are also more general and can be applied to the entire European airline industry, especially in the context of competition with airlines from other countries that are not members of the EU and may not be subjected to the same regulatory pressures. With the help of the strategic suggestions used here, airlines can address sustainability-related cost pressures and maintain the effectiveness and competitiveness of their operations.

5.3 Contributions to the literature

This research adds value to the current literature on aviation business strategy and sustainability with focus on LCCs and their growth prospects in the context of emerging European environmental regulations within the next five to ten years. Previous literature has contributed to airline cost structures, strategy different business models within the aviation industry and their varied success, and on the effects on demand on the aviation market. There is a limited amount of previous research that has reviewed prior work on airline sustainability and regulatory compliance, and even fewer that have focused specifically on how LCCs navigate sustainability induced cost increases. This is likely mainly due to the fact this topic is pressing and the first SAF reguatlions have been introduced starting year of 2025, while this study was conducted. To this end, by studying the strategic responses of LCCs to these evolving challenges, this study seeks to offer novel insights to an area that has been rather under researched from an academic point of view due to the novelty of the regulations. The study also makes one of the key contributions of this study is the examination of LCC adaptation strategies from an operational and strategic perspective. Technological solutions like SAF adoption and carbon offset programs have been discussed in the existing research such as the amount of SAF a airplane is able to use. A limited amount of work has been done on how airlines alter their business models and pricing strategies to meet sustainability mandates. This can however be viewed through the less on costs increasing and particularly thought fuel costs increases from the point of view of the LCC, meaning what are LCC willing to do when costs increase and the airlines face financial struggle. Through examining these adaptations this paper helps to contribute to the understanding of the operational trade off's and revenue adjustments that LCCs make to stay competitive and compliant.

This research adds value to the existing literature by showcasing the effects of sustainability-related cost increases on different airline business models, LCC and FSC and how LCCs are able to cope within the market. Previous studies have argued that sustainability regulations are an industry-wide issue, this study shows that these costs can affect low-cost carriers (LCCs) and full-service carriers (FSCs) differently. Since FSCs mainly cater to high-yielding customers who may be willing to pay more for the extra comfort and might have network structure outside of Europe to mitigate EU internal costs, while LCCs depend on price-demanding customers and operate often mainly within EU, the study offers new insights into the competitive forces that are likely to build up as a result of sustainability policies. Moreover, this study looks at the stakeholder perspective, particularly with respect to how passenger demand is influenced by sustainability-induced price premium. Although many previous studies have investigated the impact of macroeconomic factors on air travel demand elasticity, this study goes beyond the prior work by discussing qualitative insights from industry stakeholders about how passenger preferences and price sensitivity may change with increasing sustainability pressures. Based on the predicted changes in consumer behaviour and passengers' categorization by their willingness to pay more for airlines tickets, regadless of the origin such as sustainable SAF fuel, this study helps to develop a more holistic view of how airlines can match their strategic actions to the changing market demands.

The study builds upon prior research on cost structure optimization, secondary airport strategies, and the expansion of ancillary revenue streams as potential approaches for LCCs to offset sustainability-related cost increases from the 2% (2025) and 6% (2030) SAF quotas. While aspects of these strategies mentioned in the paper have been discussed in earlier literature, this study broadens them by considering the specific challenges posed by sustainability mandates and if and how to LCC should grow and continue their operation. The insights provided here may serve as a foundation for further academic inquiry into the financial and strategic implications of environmental policies on different airline business models. By situating its findings at the intersection of sustainability regulations, airline cost structures, and competitive strategy, this study aims to contribute to both theoretical discussions on aviation sustainability and practical considerations for LCCs. The inclusion of multiple stakeholder perspectives within the interviews strengthens the study's relevance, providing a basis for further research into how airlines can navigate regulatory and economic pressures while maintaining operational viability.

5.4 Limitations and further research

5.4.1 Limitations

This study and the analyses within have been conducted within the context of academic standards and the study has both practical and theoretical implications; however, some limitations are presented. These constraints are attributed to the methodological choices made in the study, the nature of qualitative research, and the particular type of data collected. The results are based on mainly qualitative interview data which is a good way of gathering data from experts and finding out surprising patterns but it is subjective in the sense that it is based on the perceptions of the respondents. Like any other qualitative research, there is subjectivity in the data collected from the respondents as well as the analyst when coding the data. In an effort to reduce bias in data collection and analysis, however, it remains possible that bias exists, and it should be acknowledged in reviewing the findings. The third limitation has to do with the study's focus and the vantage point chosen for examining airline sustainability issues. The study focuses on the cost structures and strategic responses of LCCs and includes the voices and opinions of industry experts and stakeholders. However, passengers' willingness to pay extra for sustainability-related price premium is not directly surveyed through primary data such as wide range surways or similar, instead it is done through secondary data, from the stakeholders that have done such analyses and beyond. Analyzing the demand elasticity as a whole may involve a more accurate picture of consumer behavior by including a broader perspective.

The qualitative part of the study has some limitations regarding the data gathered from publicly available sources. Annual reports that this study used, are seen as reliable, audited financial data, but there are some limitations. First, airlines do not publicly identify the costs associated with SAF, at least not yet, and hence, industry estimates were used to predict the impact of SAF adoption. Second, fuel procurement strategies, such as hedging and direct SAF investments, are different among airlines and may impact the cost exposure that is not visible in the financial statements. Furthermore, market factors such as fuel price volatility resulting from geopolitical events lead to cost fluctuations that are not attributable to the airline business models. However, the use of standard financial metrics, industry benchmarks, and comparative cost analysis ensures that the results of the evaluation of the cost structures of airlines under sustainability pressure are valid.

Furthermore, this study is conducted on a single case context, the intra European aviation market, therefore its findings may not be generalizable to other regions with different regulatory environments, competitive features or customer behavior. Additionally, the time factor is not broad as regulation is a current topic and there is not yet wide amount of time differentiating knowledge on the matter, time variable as a large uncertainty as the environmental regulation of differing industries, aviation included. This regulatory environment is one that is subject to change and pressures widely such as the geopolitical situation including regulatory atmosphere from other regions such as the East and the West and also the geopolitical situation including wars within Europe, close by, or elsewhere, these factors introduce another level of uncertainty as well. The European Union has some of the most stringent sustainability targets within the global aviation sector, which means that the problems and the solutions discussed in this study can be different from those that can be identified in markets with less stringent environmental standards. The EU's regulatory environment is also ever-changing with sustainability goals and policy measures that can be liable to changes in the light of political, economic or technological factors. The changes in emission reduction targets, SAF blending mandates, or carbon price adjustments, for instance, can impact the costs and strategic decisions of airlines in ways that this study cannot capture. Also the price of sustainable actions, focusing on the price of SAF in the coming years is subject to high amounts of uncertainty, including technological advancements not yet seen, investments from regions other than Europe and developments in other industries closely tied with the manufacturing of SAF. Although the study gives a clear picture of the current LCC strategies in the existing regulatory environment, the findings of the study should be used with the understanding that sustainability policies are dynamic. More studies and simply more time is required to understand how these processes unfold in the future and how policy changes can affect competition among airlines in the future. Larger trends are at play as well as the developments of customer relation toward sustainability cost increases, this macroeconomic trend will influence air travel and its sustainability as well, and is rather hard one to predict with certainty. This study pays major attention to sustainability issues from the business and operational perspective; hence, other factors such as fuel price fluctuations, economic downturns, or changes in policies are not fully discussed. Though these external factors definitely impact the costs and nature of the airline industry and markets, they are not the primary focus of this study. LCCs' strategic recommendations for tackling sustainability costs are offered in the study, but their long-term effectiveness is unknown. Because regulatory systems, technological advancements, and the sustainability context in aviation will continue to change in the future, the effectiveness of these strategies is likely to change as well.

5.4.2 Further research

This paper presents a new approach to the changing demand in European aviation and the difficulties that LCCs encounter when trying to respond to sustainability-induced cost growth while also acknowledging several limitations and thereby suggests several directions for future research. Although the study presents practical implications and actionable recommendations, there are some aspects that have not been addressed fully and therefore require further investigation in order to develop a more comprehensive understanding of airline sustainability strategies in theory and practice. One possible direction for future research is the application and efficiency of the cost reduction measures in LCCs during the sustainability regulations. Even though this study reveals some potential strategic responses including, shifting of operations to secondary airports, increasing the diversity of the revenue base, and achieving greater size which reduces the unit costs—the actual application of these strategies as well as their sustainability needs further investigation. A follow-up study that would look at how these strategies are incorporated into the business models of low cost carriers and whether they actually produce bottom line results would add value to the current research and provide more specific recommendations for airline executives. A study worth while would be to further analyse the meaning of secondary airports and their future role with LCCs, the relationship of secondary airports to EU union airports and whether smaller airports are as well fully regulated to produce SAF fueling capabilities or not, this would have a significant cost implications based on the topical situation of mandatory and voluntary SAF price difference and other logistical challenges regarding fueling in secondary airports, the regulation related to this would also be of importance, as some airports might fall under the regulation but are simply unable to do so presently, what happens then and are there any sanctions becouse of it. Additionally partly related to airports, a case study of LCC airport negotiation leverage would be of importance, meaning, that how much leverage LCCs have over airport agrements and even wider policies. This includes the stretegy of LCC can alter a countries tax legistalations by pullling back of potential markets or destinations if a specific airport becomes unprofitable. Furthermore, although this study analyzes the sustainability induced cost pressures in terms of operations and finance, the consumer reaction to such changes presents an interesting topic.

Up to now, the question of whether passengers are ready to pay more for sustainable air travel has been discussed heatedly, and therefore, it is possible to suggest that future work should focus on the analysis of behavioral patterns in demand modeling and consumer research. Hence, it would be beneficial to examine the price flexibility of demand with respect to sustainability-related price changes and how these preferences differ across various customer categories. This would be of great interest to airlines when pricing their products and services as well as to policy makers when developing policies that govern the aviation industry, and to further underline the significance this is a highly pressing matter and done so far with this extend solely in Europe, other regions would as well benefit from knowledge derived from the policies made here. One pressing matter discussed to extent in this paper is the factor of aircraft deliveries and maintenance issues. This is another avenue of novel research, where does this problem originate and what are the implications from it towards the sustainable aviation globally. Additionally, key questions could be the few number of aircraft manufacturers and the barrier of entry to business and if that could be addressed, aviation is a crucial part of modern life and a safety critical one, yet only few manufacturers rule the market and so the delivery schedules are subject to uncertainty when minor supply chain or logistical problems arise that affect both the larger manufacturers.

Another potential area of investigation concerns the regulatory environment itself as it continues to evolve. The European Union's sustainability mandates are also evolving and revisions to emissions reduction targets, SAF blending requirements or carbon pricing mechanisms may change the financial burden on airlines. An analysis of how airlines alter their plans based on policy changes over time can offer a more complex view of the policy-cost competition interaction. Although this study focuses on LCCs in the European market, comparative research across different regulatory environments may offer insights into how sustainability pressures affect airline strategies globally. Another direction could be on the policy making level, this could be done as a qualitative based case sudy and interview the policy makers at the European Union, the results would have an impact on the direction to which regulation is headed and how much other regions developments matter on this global issue. The sustainability challenges and how airlines operating in different regions with different environmental policies. Comparing the findings of this study to those of other regions, such as North America, Asia, or the Middle East, could help to contextualize the results and identify best practices or alternative strategic responses. Besides, this study has some limitations, including the difficulty in quantifying the effects of sustainability regulations on airline financial performance and competitiveness. Further work could investigate the creation of more sophisticated financial performance measures that capture sustainability costs to allow better comparison across airlines and business models. Thus, the formation of such measurement frameworks would advance the understanding of how sustainability initiatives influence the competitiveness of airlines in the short and long term. Therefore, future studies could further develop these research directions and refine the theoretical frameworks and generate more in-depth empirical findings on how sustainability regulations affect airline business strategies.

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