



Master in Management

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Chair of Quantitative Methods for Management

**MANAGERIAL ACTIONS TOWARD IATA’S “NET ZERO
CARBON EMISSION CHALLENGE”**

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Abstract

This thesis investigates and tries to define managerial practices aimed to facilitate the IATA Net Zero Carbon Emission challenge in the airline industry. The study combines theoretical frameworks with insights from industry practitioners to provide a comprehensive understanding of the challenges and strategies associated with sustainability in aviation.

Through interviews with managers from Austrian Airlines, Eurowings Discover and the Lufthansa Group, valuable insights were obtained in relation to industry practitioners view on the challenge as well as actual insights on how to address the sustainability challenge.

The research explores various dimensions of sustainability decision-making, including strategic and operational considerations, regulatory frameworks, customer demands, and the role of technology. It examines the complex interplay between economic feasibility, environmental impact, and customer expectations, highlighting the need for airlines to strike a balance between sustainability goals and financial viability.

Alongside the interviews conducted with industry managers, a unique contribution of this study is the development of a "Sustainability Decision-Making Matrix for Aviation." Drawing inspiration from the Boston Consulting Group (BCG) Growth Share Matrix, this framework offers a practical and generalizable approach for airlines in making sustainable decisions. By combining theoretical insights from the interviews with a structured matrix-based method, this research provides a valuable tool that can guide and inform sustainable decision-making processes in the airline industry.

This study also identifies limitations and future directions for new research on the topic.

While the thesis and its findings have global applicability, it is important to note that the focus primarily lies on the western world, as the interviewees are professionals working for European airlines.

The findings underscore the importance of collaboration and stakeholder engagement in

driving sustainable change in the airline industry.

Overall, this thesis contributes to the existing knowledge on sustainability in the airline industry by integrating theoretical perspectives with practical insights as well as offering a decision-making matrix specifically designed to guide tailored sustainability-related choices in the airline industry.

Chapter 1: Introduction and Context

The aviation industry plays a crucial role in meeting the mobility needs of society and contributes significantly to global economic development. According to the International Civil Aviation Organization (ICAO) (Gittens et al., 2019), the industry provides employment to approximately 65.5 million individuals and contributes \$2.7 trillion to the global economy, representing 3.6 percent of the world's GDP. For isolated countries or territories, the significance of aviation is even more pronounced, as illustrated by the example of New Zealand. In New Zealand, the aviation industry supports 329,000 jobs and contributes NZD 20.7 billion to the national GDP, which corresponds to 11.2 percent of the country's total GDP (IATA, 2019).

Moreover, various studies have highlighted the economic benefits of aviation in terms of access to markets, specialization, economies of scale, and Foreign Direct Investment (FDI). The industry also provides substantial social benefits, such as employment opportunities, leisure travel, cultural exchange, consumer choice, and visiting friends and family (Boons et al., 2013; DfT, 2003a; OEF, 2006). These factors have contributed to the consistent increase in the number of air passengers each year, as evidenced in Figure 1. The growth trend in air travel is expected to continue, with analysts predicting that the number of individual air passenger journeys will exceed 10 billion by 2050 (IATA, 2022b).

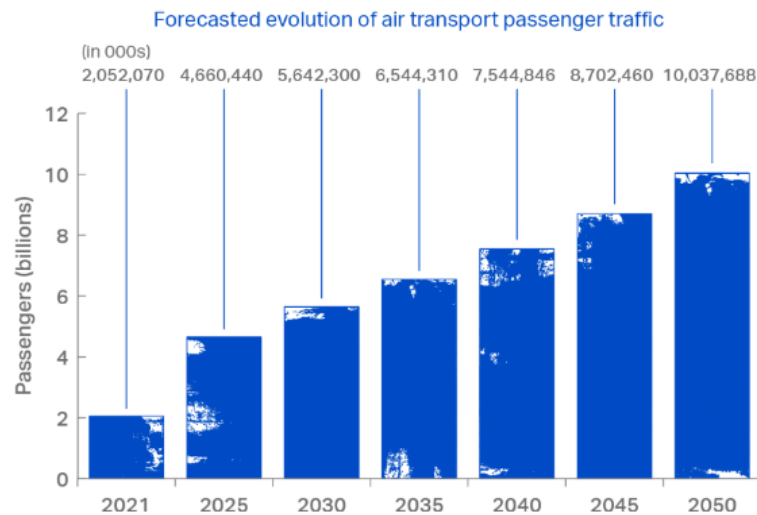


Figure 1: Forecasted evolution of air transport passenger traffic

Source: (IATA, 2022b)

Aviation, despite its economic benefits, also has a significant adverse environmental impact. The scientific community has conducted extensive research on aviation's contribution to CO₂ emissions, and in 2019, the industry accounted for 1.03 GtCO₂, which represents 3.1% of global CO₂ emissions from fossil fuel combustion (Bergero et al., 2023). With passenger projections showing exponential growth, the adverse effects of aviation on climate change due to its CO₂ emissions are expected to worsen. Thus, policymakers, researchers, and stakeholders must implement policies, regulations, and new technologies aimed at reducing the industry's environmental impact (Grewe et al., 2021).

Furthermore, the harmful effects of aircraft CO₂ emissions on human health and the environment have been demonstrated in numerous studies (Brasseur et al., 2016; Grewe et al., 2021; Lee et al., 2010; Terrenoire et al., 2019). According to the Air Transport Action Group (ATAG¹), a significant proportion of aviation emissions, about 80%, are generated by flights

¹ The Air Transport Action Group (ATAG) is a highly respected not-for-profit association representing all sectors of the commercial aviation industry. ATAG has a wide-reaching and international membership comprising some 40 organisations worldwide.

over 1,500km, which are generally considered to have no practical alternatives (ATAG, 2020). As passenger numbers continue to rise, CO₂ emissions are expected to increase, with aviation CO₂ emissions projected to reach 21.2 Gt between 2021 and 2050 (as shown in Figure 2), thus, to avoid undesirable climate impacts, it is crucial to limit future Global Greenhouse Gas emissions (GHG) (Winchester, 2019).

Figure 2 (IATA, 2022b) provides insights into the expected growth path of CO₂ emissions during the forecasted period (2020 to 2050). The figure highlights two key strategies to address carbon emissions: maintaining emissions at 2019 levels through the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA²) scheme mainly leveraging carbon offsetting and SAF while incorporating newer technologies into the mix from 2035 onwards would start the decline to reach net Zero CO₂ emissions by 2050.

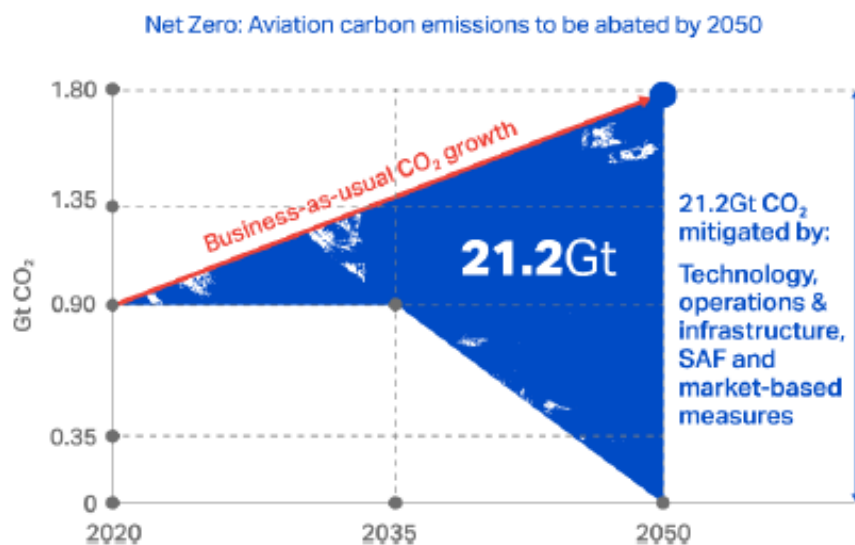


Figure 2: Net Zero: Aviation carbon emissions to be abated by 2050

Source: (IATA, 2022b)

ATAG aims to ensure that the aviation industry can continue to grow according to market demands and deliver the enormous social and economic benefits that it provides to the world, while addressing its environmental impact.

ATAG's current mission is to help drive the industry towards net-zero carbon for air transport by 2050.

Source: <https://www.atag.org/about-atag/>

² Sponsored by ICAO

Chaabouni et al. (Chaabouni et al., 2016) assert that a reciprocal cause-and-effect relationship exists between CO₂ emissions and economic growth, as well as between economic growth and healthcare costs. Consequently, the aviation industry must balance the imperative of economic growth with the need to curtail CO₂ emissions to reach net zero by 2050.

To address such core challenge, the International Air Transport Association (IATA³) took action in October 2021 by initiating the “Net Zero Carbon Emission Challenge⁴”, which aims to reduce the aviation industry's carbon footprint to zero by 2050 (IATA, 2021).

IATA in its Net Zero Resolution includes a comprehensive strategy that involves implementing a combination of innovative measures, such as the use of Sustainable Aviation Fuel (SAF), advancements in technology (particularly pertaining to new aircraft and propulsion systems), improvements in operational and infrastructure practices, as well as offsetting and carbon capture (Mikosz, 2021).

Despite the primary focus of the IATA challenge being innovation processes, it is noteworthy that this initiative is not driven by conventional innovation concepts, but instead by sustainability and social awareness objectives. In this context, the innovation area is considered a means of serving a broader sustainable and social scope. As noted by Fontanet-Perez et al., and Kallbekken and Victor (Fontanet-Pérez et al., 2022; Kallbekken & Victor, 2022) the introduction of costly measures such as sustainable fuels, would have been unlikely used by airlines unless they were forced to do so.

³ The International Air Transport Association (IATA) is the trade association for the world's airlines. It supports many areas of aviation activity and helps formulate industry policy on critical aviation issues. IATA is the prime vehicle for inter-airline co-operation in promoting safe, reliable, secure and economical air services for the benefit of the world's consumers (OECD, 2016).

IATA aims to be the force for value creation and innovation driving a safe, secure and profitable air transport industry that sustainably connects and enriches the world. IATA's mission is to represent, lead, and serve the airline industry (OECD, 2016).

⁴ Commonly referred as “Net Zero Challenge”

The resolution adopted by IATA is consistent with prior actions taken by international bodies and governments, including United Nations' Sustainable Developmental Goals (SDGs), the Paris Agreement, and the CORSIA scheme, which reflect the commitment of the global community towards sustainable and environmentally responsible practices.

By committing to achieving net zero carbon emissions by 2050, the IATA is supporting SDG 11 and SDG 13 (United Nations Department of Economic and Social Affairs, 2020). The Paris Agreement aims to limit global warming to below 2 degrees Celsius above pre-industrial levels, and since the aviation industry is a contributor to global greenhouse gas emissions, the resolution and the industry have strong ties, despite the regulation not being directly related to the industry itself.

Compared to all the other regulation, CORSIA is industry-related scheme and specifically aims to reduce directly aviation's CO₂ emissions. Specifically, under CORSIA, airlines are required to purchase eligible emission units to offset increases in their CO₂ emissions until 2035 above a baseline, which is defined as the average of emissions in 2019 and 2020. Even though this measure goes into the right direction, it is considered a short to medium term (IATA, 2022a) and non-resolutive measure (Winchester, 2019).

It is therefore of outmost importance to thoroughly cover all the aspects, across all domains of expertise, of the IATA net zero challenge and propose feasible set of actions or recommendations to facilitate its implementation.

Numerous studies (Albers et al., 2009; Chin & Zhang, 2013; Larsson et al., 2019; Malina et al., 2012; J. Scheelhaase et al., 2018; J. D. Scheelhaase, 2019; Winchester et al., 2013) have been conducted to examine the economic and environmental impacts of climate policies

related to aviation, with some trying to put forward regulatory solutions to reduce carbon dioxide emissions from the aviation industry.

Moreover, additional studies have scrutinized the business model implications that would need to be instituted to attain net zero in response to the IATA challenge (Fontanet-Pérez et al., 2022; Gössling & Humpe, 2023; Rotondo et al., 2019).

Instead, the purpose of this paper is to investigate potential actions that could be put in place by airline managers to facilitate the transition to the IATA challenge.

Therefore, the research question that this paper intends to answer is: how can airlines facilitate the transition toward the IATA Net Zero Challenge through an effective set of managerial actions?

To achieve this goal, a qualitative methodology is adopted, specifically through the utilization of semi-structured interviews conducted with industry manager.

The dissertation will incorporate three fundamental concepts, namely responsible, social, and sustainable innovation.

These terms are often used interchangeably; however, they have distinct differences and are essential component of the Corporate Social Responsibility⁵ (CSR) concept. Responsible innovation refers to the ethical and socially acceptable design and deployment of technology, while considering its possible effects on society and the environment (Owen & Pansera, 2019). Meanwhile, sustainable innovation involves the development of innovative solutions that satisfy the present needs and guarantee the preservation of resources for future generations (Boons et al., 2013). Social innovation, on the other hand, deals with the creation

⁵ The European Commission defined CSR as the responsibility of enterprises for their impact on society https://single-market-economy.ec.europa.eu/industry/sustainability/corporate-social-responsibility-responsible-business-conduct_en

of innovative solutions to address social challenges (Phills, 2009). All three types of innovation are critical in the quest for sustainable development, and companies must carefully balance the three to achieve the desired social and environmental outcomes (Lubberink et al., 2017).

Drawing on these principles, this paper explores several theoretical and literature notions (including (ATAG), 2021; Ahmad et al., 2022; Amankwah-Amoah et al., 2023; De Bruycker & Beyers, 2019; Dichter et al., 2022; Edwards et al., 2011; Hassan et al., 2021; Henderson, 1970; Lind et al., 2017; Network, 2023; Oancea, 2016; Pereira et al., 2021; Raisch et al., 2009; Su et al., 2021; Wade et al., 2020; Wernerfelt, 1984; West & Bogers, 2014), alongside insights from industry practitioners, with the aim to evaluate managerial actions to facilitate the transition towards the IATA Net Zero Challenge.

After this introductory chapter, the research focuses on expanding the theoretical concepts that have been used as a basis for the qualitative interviews with aviation practitioners. The following chapter explains the methodology (Gioia et al., 2013) used for conducting the interviews and provides an explanation of the questions posed to the participants. After conducting the interviews with the industry practitioners, the corresponding findings and the impact on the industry (airlines and stakeholders) and on society are discussed. Eventually conclusions, limitations and future research directions will be drawn.

Chapter 2: Theoretical Background

In this section we provide literature review of the theoretical managerial concepts that could be applied in relation to each one of the measures IATA suggests undertaking to reach Net Zero.

2.1 The Intersection of Sustainable, Social, and Responsible Innovation: Navigating the IATA Net Zero Challenge

At the core of the IATA challenge is the willingness by governments and regulatory bodies to address the issue of environmental pollution caused by CO₂ emissions. As such, the IATA resolution can be classified as a social innovation challenge.

Social innovation refers to innovative activities and services that are motivated by the goal of meeting a social need and that are predominantly diffused through organizations whose primary purposes are social. Business innovation, instead, is generally motivated by profit maximization and diffused through organizations that are primarily motivated by profit maximization (Mulgan, 2006).

Given Mulgan's definitions of social and business innovation and the considerable investment required for the IATA challenge, it is evident that without regulatory bodies' external imposition, only a few or no airlines would have embarked on this journey.

To conform to the principles of sustainable development, firms are increasingly anticipated to generate sustainable innovations that balance economic, environmental, and social objectives (Cillo et al., 2019). Sustainable innovation is an essential concept linked to the IATA challenge, and it is defined as “the renewal or improvement of products, services and processes that not only delivers an improved economical performance, but also an enhanced

environmental and social performance, in both the short and long term” (Bos-Brouwers, 2010).

Given that sustainable innovation, hence the IATA Net Zero resolution, implies a collective commitment of care for the future (Owen et al., 2013), airlines face the challenge of creating novel managerial and organizational capabilities to promote sustainability, while concurrently achieving their immediate corporate goals.

Both concept of sustainable and social innovation link with the triple bottom line. The triple bottom line expands the traditional focus on financial performance to include social and environmental performance. This concept encourages airline managers to consider the impact of their actions on people, planet, and profit. By considering the impact of their operations on all three dimensions, managers can identify opportunities to reduce environmental impact, improve social outcomes, and enhance financial performance (Harvard Business School Online, 2020).

While a company's commitment to sustainability is an internal matter, about the IATA challenge it is necessary for external stakeholders⁶, including governments, to work collaboratively with airlines airports, aircraft manufacturers, and all entities involved in the aviation supply chain.

This concept is encompassed in the notion of responsible innovation which is defined as a “transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view to the ethical acceptability, sustainability and societal desirability of the innovation process and its marketable products” (Van Den Hoven, 2014). Without such collective action, the desired outcomes of the IATA challenge may not be realized.

⁶ Regulatory bodies, civil society organizations, communities as well as others are affected by aviation activities.

Although IATA's Net Zero Resolution outlines several means to achieve the net-zero target by 2050, it does not provide specific managerial actions to facilitate responsible, sustainable, and social innovation in the aviation industry. This gap in knowledge is particularly crucial in achieving the IATA's net-zero target, and there is no prior research that has highlighted the impact of managerial practices in promoting such core concepts. Thus, this thesis aims to address this research gap by conducting preliminary studies to investigate the role of managerial actions to facilitate the Net Zero challenge, keeping in mind the key concepts of responsible, sustainable, and social innovation.

The pie chart, Figure 4, illustrates the array of measures included in IATA's potential base scenario which outlines the planned contribution of various measures towards the achievement of the 2050 Net Zero objective (IATA, 2022b).

The measures aimed at achieving carbon neutrality in the airline industry include:

- Sustainable aviation fuel (SAF).
- New Technologies, specifically those related to the development of more fuel-efficient aircraft.
- Operational and infrastructural improvements.
- Carbon Offsetting.

The use of SAF and carbon offsetting are also key components of the CORSIA scheme.

Contribution to achieving Net Zero Carbon in 2050

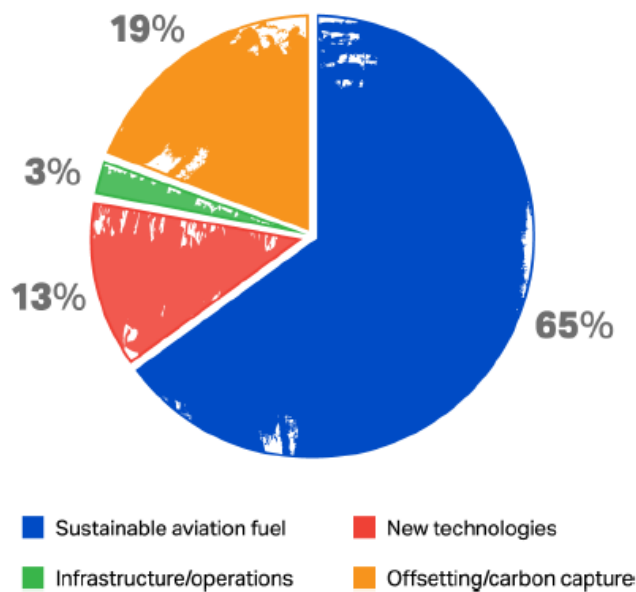


Figure 3: Contribution to achieving Net Zero Carbon in 2050

Source: (IATA, 2022b)

2.2 Sustainable Aviation Fuel (SAF): SWOT analysis and theoretical implications

Sustainable aviation fuel (SAF) is expected to play a crucial role in achieving the International Air Transport Association's (IATA) net zero challenge, as it is projected to account for 65% of the potential base scenario's set of measures. SAF⁷ has several strengths, such as the fact that every airline can use it without requiring fleet changes or changes in procedures at the organizational level. Additionally, SAF can enhance airlines' brand image and reputation as environmentally responsible companies. However, SAF also faces some

⁷ Airlines are starting to offer passengers the option to pay extra for Sustainable Aviation Fuel (SAF) to compensate the emissions from their flights. This option is usually presented during the booking process, where passengers can choose to offset their emissions by purchasing a certain amount of SAF. Airlines such as United, KLM and the Lufthansa Group are among those that offer this option.

<https://www.united.com/en/us/fly/company/responsibility/sustainable-aviation-fuel.html#you-can-help>

<https://www.klm.com/information/sustainability/sustainable-aviation-fuel>

<https://www.lufthansagroup.com/en/newsroom/releases/green-fares-lufthansa-group-is-the-worlds-first-airline-group-to-offer-an-own-fare-for-more-sustainable-travel.html>

weaknesses, such as its high cost, which currently is up to eight times higher than regular jet fuel (Reuters, 2021), and limited availability due to limited production capacity. Sustainable aviation fuel production will need to ramp up from around 0.05 million tonnes today to as much as 445 million tonnes per year by 2050 ((ATAG), 2021)((ATAG), 2021). Nevertheless, there are opportunities to increase SAF production, using incentives from governments and collaborations between airlines (Edwards et al., 2011) for an assured procurement from fuel producers. On the other hand, SAF faces procurement threats such as competition from other industries, i.e., automotive⁸, and uncertain future regulations that may impact its adoption and demand.

<p>Strenght</p> <ul style="list-style-type: none"> • No radical changes is required for usage (nor fleet or organizational level) • SAF adoption can enhance airline's brand reputation 	<p>Weaknesses</p> <ul style="list-style-type: none"> • SAF is more expensive than regular jet fuel • Limited Availability
<p>Opportunities</p> <ul style="list-style-type: none"> • Collaboration between airlines in the procurement process • Governmental incentives can increase SAF production 	<p>Threats</p> <ul style="list-style-type: none"> • Competition from other industries • Uncertain future regulation

Figure 4: SAF - SWOT Analysis

Source: Personal Elaboration

⁸ The European Union has established a goal of achieving climate neutrality in the road transportation industry by 2050. To achieve this goal, the EU has provided incentives for electric vehicles and has prohibited the selling of fuel-powered cars from 2035 onwards.

<https://www.europarl.europa.eu/news/en/headlines/economy/20221019STO44572/eu-ban-on-sale-of-new-petrol-and-diesel-cars-from-2035-explained>

However, for heavy-duty freight road vehicles that require long-distance capacity and quick refueling, this target may be difficult to attain. Therefore, Sustainable Aviation Fuel (SAF) could be viewed as a possible solution to meet the demand for long-distance and quick refueling road freight transportation. As a result, the demand for SAF could increase, potentially raising its price.

2.3 Offsets and Carbon Capture: SWOT analysis and theoretical implications

Offsets and Carbon Capture is expected, by IATA, to be the second main driver of the net zero challenge, as it should account for 19% of the set of measures in the potential baseline scenario.

Carbon offsetting has several strengths, such as its immediacy in addressing carbon emissions and its potential to improve an airline's reputation as environmentally responsible, attracting eco-conscious customers. However, it also has weaknesses, such as its high cost, which airlines often try to pass to customers. Moreover, technically offsetting actions do not address the root cause of carbon emissions as the industry may need to invest in alternative fuels and new technologies.

Although passengers are aware of the harmful impact of aviation on the environment, they tend to prioritize factors like price and time convenience over sustainability when making their travel bookings (Ahmad et al., 2022). Nevertheless, there is evidence that consumers do care about their carbon footprint, with third-party organizations that track airline sustainability influencing their choices and encouraging them to select flights with lower CO₂ emissions. In fact, in 2019, Skyscanner influenced the purchasing decisions of millions of consumers in this way (Wade et al., 2020), despite the fact that the vast majority of passengers are unwilling to bear the full cost of sustainability-related measures.

<p>Strenght</p> <ul style="list-style-type: none"> • Offsetting is a quick and easy way to address carbon emissions • Offsetting can, in the short term improve airlines reputation 	<p>Weaknesses</p> <ul style="list-style-type: none"> • Offsetting does not address the root cause of carbon emission • Offsetting is expensive and its cost is often passed onto the customers
<p>Opportunities</p> <ul style="list-style-type: none"> • Development in the field could improve cost-efficiency and effectiveness of offsetting • Government incentives to airlines for the implementation of offsetting measures 	<p>Threats</p> <ul style="list-style-type: none"> • Offsetting legitimacy may be doubted • Lack of transparency and regulation in the offsetting market which can lead to fraud and greenwashing

Figure 5: Offsets and Carbon Capture - SWOT Analysis

Source: Personal Elaboration

2.4 New Technologies: SWOT analysis and theoretical implications

One of the most effective ways for airlines to address the issue of emissions is by embracing innovative technologies that tackle the problem at its core rather than treating it as an afterthought. The Open Innovation concept play a critical role in this regard, as it involves collaborations with external partners such as academic institutions, suppliers, and other airlines to develop and implement new ideas. By leveraging external expertise and resources, airline managers can accelerate their innovation efforts and achieve their sustainability goals more efficiently (West & Bogers, 2014).

For instance, collaborating with academic institutions can facilitate research into new technologies, while partnering with other airlines can facilitate the joint development and testing of sustainable practices. This approach can enable airlines to effectively achieve their Net Zero goals, as emphasised further by IATA's Net Zero Resolution, which highlights new technological development as a third major factor. New technologies can be conceptualized in

two categories: incremental and disruptive technological innovations. Incremental innovations involve refinements of current technologies, such as higher efficiency engines, use of innovative materials like AeroSHARK⁹, innovative airplane shapes like retrofitting winglets¹⁰ and the use of lightweight materials to reduce fuel consumption and emissions.

Incremental innovation enables airlines to procure airplanes with greater efficiency without significantly disrupting their existing model. It is a path which in a short period of time allows airlines to make small but steady and meaningful improvements to their operations.

Moreover, it provides airlines with a cost advantage, while meeting sustainability-related regulatory requirements. However, incremental innovation alone is not sufficient to reduce to zero greenhouse gas emissions of the industry.

Disruptive innovation, instead, refers to new technologies, that involve changes to the whole ecosystem. Those are, as an example, electric or hydrogen powered planes which to be realized would impact the infrastructure worldwide but are recognized as the potential solutions to bring to zero CO₂ emissions. Their practical application is expected to commence only by 2035/2040, limited to short-haul routes and with a maximum capacity of 100 passengers ((ATAG), 2021) but will require a focused effort of industries and legislators.

While the technology represents a long-term measure for achieving a definitive reduction in emissions, there are opportunities for airlines to differentiate themselves as leaders in sustainable aviation, potential cost savings in the long term, and compliance with future emissions regulations. However, airlines face challenges such as high initial costs, the need for infrastructure adaptation, uncertainty about the technology's long-term viability, and competition from other modes of transportation such as high-speed rail. Airlines should consider forming strategic alliances with other companies in the industry as a mean of

⁹ <https://www.lufthansa-technik.com/en/aeroshark>

¹⁰ <https://aviationbenefits.org/environmental-efficiency/climate-action/operational-improvements/>

accelerating the development and implementation of new technologies; this approach can also help to reduce transaction costs and mitigate risk (Jolink & Niesten, 2016).

Other industries, such as the automotive or technology industries, may be able to develop and implement new innovations that could disrupt the aviation industry, this can be considered as both a threat and an opportunity as the airline industry would receive the new or improved technology, but adaptation would be needed as it was originally thought for other businesses.

Hybrid electric jet engines for airplanes can be an example of this cross contamination (Rendón et al., 2021).

Lastly, it is important to consider that the implementation of new technologies may be constrained by the resources and expertise available within the airline industry, especially for smaller or regional airlines.

Strength <ul style="list-style-type: none">• Leveraging external expertise through open innovation• Incremental and disruptive innovation lead to cost savings in the long term	Weaknesses <ul style="list-style-type: none">• Incremental innovation alone is not sufficient• Disruptive innovation requires high investments• Limited resources may hinder adoption
Opportunities <ul style="list-style-type: none">• Strategic alliances to mitigate risks and reduce costs• Cross-industry innovation opportunities• Compliance with future regulations	Threats <ul style="list-style-type: none">• Competition from other modes of transportation• Cross-industry innovation threats

Figure 6: New Technologies – SWOT Analysis

Source: Personal Elaboration

2.5 Operational and Infrastructural Efficiencies: SWOT analysis and theoretical implications

The varied options for Operation/Infrastructural measures, which are anticipated to contribute 3% of the overall Net Zero objective, pose a challenge in establishing a clear classification. However, there are technology advancements from other industries¹¹ that can be leveraged or customized, as well as intra-industry¹² development, to address this issue.

A range of operational and infrastructural improvements can be made, such as the deployment of advanced air traffic management technologies and the design of airspace infrastructure, increasing load factor¹³ ((ATAG), 2021), the implementation of regulations such as the Single European Skies (SES) and airport traffic optimization¹⁴ among others.

Improving load factor numbers for airlines is not solely limited to software optimization, which is a routine aspect of daily operations. The critical aspect lies in strategic decision-making with respect to routes. Airlines have routes in their portfolio that exhibit varying load factors and profitability. To reduce CO₂ emissions on schedules with lower load factors, airlines can pursue two main approaches: further enhanced dynamic fleet management or adjusting their strategic choices accordingly.

To support innovation processes such as the IATA challenge, airlines should match their innovation goals within their strategic objectives (Lind et al., 2017). This may entail making

¹¹ Examples include Big Data analytic, predictive maintenance and RFID technologies.

<https://www.linkedin.com/pulse/big-data-airline-industry-busam-divya-prakash/>
<https://toolsense.io/maintenance/why-predictive-maintenance-in-aviation-can-save-lives/>
<https://www.iata.org/en/programs/ops-infra/baggage/rfid/>

¹² Examples include lightweight cabin equipment, tablet computers replacing pilot manuals and slimline seats.

¹³ The load factor is an indicator that measures the percentage of available seating capacity that is filled with passengers.
<https://www.investopedia.com/ask/answers/041515/how-can-i-use-load-factor-indicator-profitability-airline-industry.asp>

¹⁴ i.e., aircraft waiting for clearance to take off or experiencing unexpected delays can result in unnecessary CO₂ emissions that are not commensurate with the intended purpose of the flight.

difficult decisions such as closing certain routes or adjusting schedules to reduce CO₂ emissions.

However, it is worth noting that any significant changes to current operational and infrastructural practices may involve high costs and potential disruptions to current operations.

On the other side, a simple and fast way to reduce CO₂ emission is the much-debated Single European Sky initiative. According to an interview conducted by IATA with José Ramón Bauzá, a member of the Renew Europe parliamentary group, the initiative has been moved without progression from one legislature to another. Implementing the SES and liberalizing restricted airspaces could lead to a reduction in CO₂ emissions from 10 to 15%, depending on the route. This would not only result in lower fuel consumption and costs, but also improve operations through optimized routes and shorter flight times (IATA, 2023).

To achieve the implementation of SES airlines can pursue a peculiar, but effective strategy: lobbying. Research has indicated that outside lobbying tends to be more successful when advocating for a position that has broad public support (De Bruycker & Beyers, 2019). One way to achieve this is through is by forming coalitions and launching mass campaigns to gain approval and exert pressure on institutions.

<p>Strenght</p> <ul style="list-style-type: none"> • Variety of different measures can be implemented • Simple and fast way to reduce Co₂ emission are already possible 	<p>Weaknesses</p> <ul style="list-style-type: none"> • Limited ability to control external factors • Alignment of innovation goals with short term objectives.
<p>Opportunities</p> <ul style="list-style-type: none"> • Coalitions and campaigns can aid SES lobbying • Cross and intra-industry technological advancements 	<p>Threats</p> <ul style="list-style-type: none"> • Regulatory barriers and slow decision-making processes • Significant operational/infrastructural changes may involve high costs and potential disruptions

Figure 7: Operational/Infrastructural – SWOT Analysis

Source: Personal Elaboration

2.6 Enhancing Managerial Practices: Additional Theoretical Concepts for Airlines

In light of the IATA Net Zero challenge and the factors involved, the previous section outlined theoretical concepts to facilitate the transition. In this regard, the following section explores additional academical findings that can assist in easing the transition and provide readers with a comprehensive overview of the managerial actions that could help achieve the IATA's goal of carbon neutrality.

Despite their differences, airlines have the potential to implement various management concepts, such as organizational ambidexterity, the resource-based view of the firm, and joint financing of projects.

Organizational ambidexterity can help airline managers balance current and future sustainability goals by creating separate structures for managing operations and innovation.

On one hand, ambidexterity involves exploiting current resources and capabilities to achieve short-term goals and improve current operations, while on the other hand, it involves

exploring new opportunities and developing new resources and capabilities to achieve long-term goals and remain competitive in the future (Raisch, Birkinshaw, Probst, & Tushman, 2009).

This may enable airlines to improve their existing operations while investing in new technologies that align with the Net Zero challenge.

The resource-based view of the firm can aid airline managers in leveraging their existing resources and capabilities to achieve sustainability goals. Airlines can use their existing relationships with suppliers and expertise in specific areas to support the adoption of sustainable practices. Project alliances, while useful for achieving aligned commercial interests and superior outcomes, should only be considered for appropriate projects that are compatible with project finance and the ongoing viability of the alliance model. Being part of a holding group, such as IAG¹⁵, Lufthansa Group¹⁶, AirFrance-KLM¹⁷ can also provide airlines with significant advantages in pursuing these goals (Edwards et al., 2011; Raisch et al., 2009; Wernerfelt, 1984).

Overall, integrating these theoretical concepts into managerial actions can help airlines to facilitate the transition toward the IATA Net Zero challenge. Airline managers can potentially meet the IATA's Net Zero challenge and create value for their organization by adopting various actions. These actions include balancing short-term goals with long-term sustainability ambitions, leveraging existing resources and capabilities, considering stakeholder interests, expanding the focus to include social and environmental performance, and collaborating with external partners.

¹⁵ <https://www.iairgroup.com/>

¹⁶ <https://www.lufthansa.com/it/en/lufthansa-group-star-alliance-and-partner-airlines>

¹⁷ <https://www.airfranceklm.com/en>

Chapter 3: Research Methodology

The following chapter presents the research methodology adopted in this thesis, which aims to investigate industry practitioners' perspectives on managerial practices aimed at facilitating the accomplishment of the Net Zero challenge.

The methodology includes an overview of the research design, research participants, data collection procedures, and data analysis techniques.

Due to the novelty of the phenomenon under investigation, to try to derive new knowledge, the data collection comprises only primary data through qualitative interviews with industry practitioners. The approach adopted for this qualitative research is based on the semi-structured interview method to allow for greater flexibility in deriving additional topics and steering the conversation towards the perspectives of both the interviewer and interviewees. The interview questions are designed to explore the participants' perceptions of the impact of managerial practices on promoting responsible, sustainable, and social innovation in the aviation industry.

3.1 Research Design

The inquiries were formulated utilizing a conventional structure, commencing with a request for an evaluation of the addressed topic in a broader context, followed by a more in-depth analysis.

Certain questions emphasize theoretical elements, whereas others focus on practical components. This approach is applied with the desire to effectively merge both aspects,

thereby arriving at the most comprehensive findings and establishing a framework for further studies.

The questions addressed to practitioners are outlined below:

1. In the paper “Net-zero aviation: Time for a new business model?” by Gössling and Humpe, it has been argued that a carbon tax reflecting on the cost of emissions needs to be introduced for air passenger travellers. The overall effect is that the transition to net zero becomes more credible and achievable, though it comes at the cost of curbing growth rates. The authors’ further state that this carbon tax is not necessarily an issue, given that much air travel is characterized by wants rather than needs, induced by low airfares.

What is your take in relation to the findings of Gössling and Humpe’s paper? Do you think Net Zero in aviation, which is a consequence of the UN sustainability goals, is achievable?

2. How do you balance short-term operational goals with long-term sustainability ambitions?
3. In relation to the aviation industry, do you think that the concept of organizational ambidexterity may help in reaching such long-term goals? - Strategies to achieve ambidexterity include creating separate units or departments for exploration, providing employees with resources and incentives to pursue innovation and experimentation, and establishing a culture that values both exploitation and exploration.
4. To what extent do you utilize your existing internal resources and capabilities to advance your sustainability objectives, and to what degree do you depend on external partners for support in achieving these goals?
5. Considering the balance between the necessary resource investment and the level of emissions reduction achieved, which scenario proposed by ATAG¹⁸ do you find to be the most effective in achieving the net-zero emissions goal by 2050?

¹⁸ By market-based measures the paper (ATAG, 2021) refers to carbon offsetting.

Scenario 1

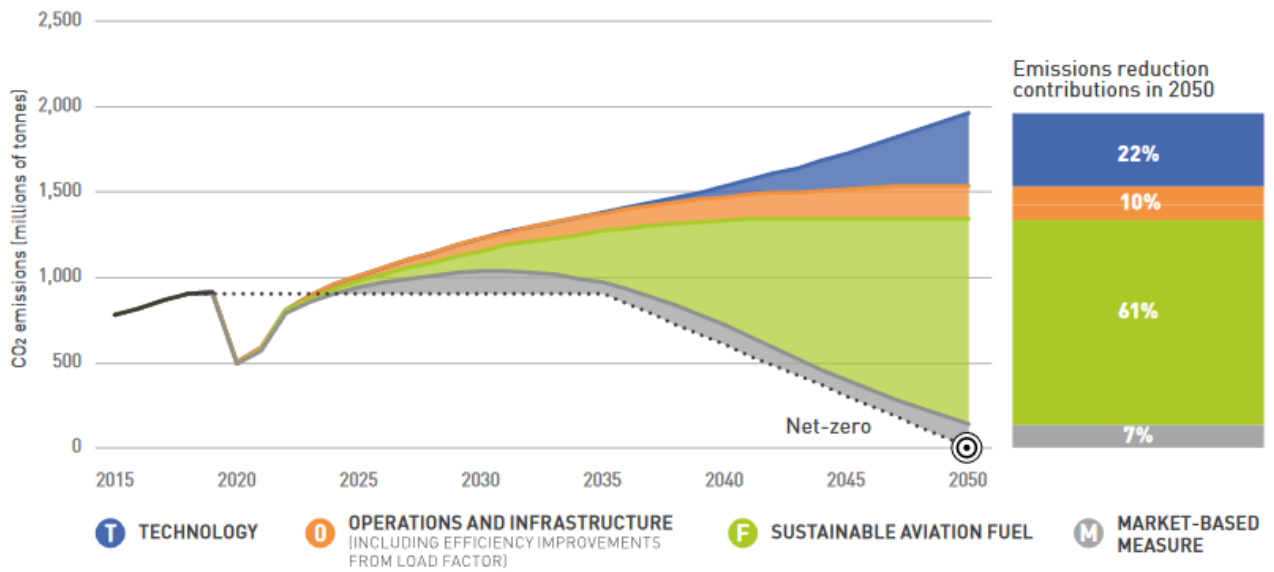


Figure 8: pushing technology and operations

Source: (ATAG, 2021).

Scenario 2

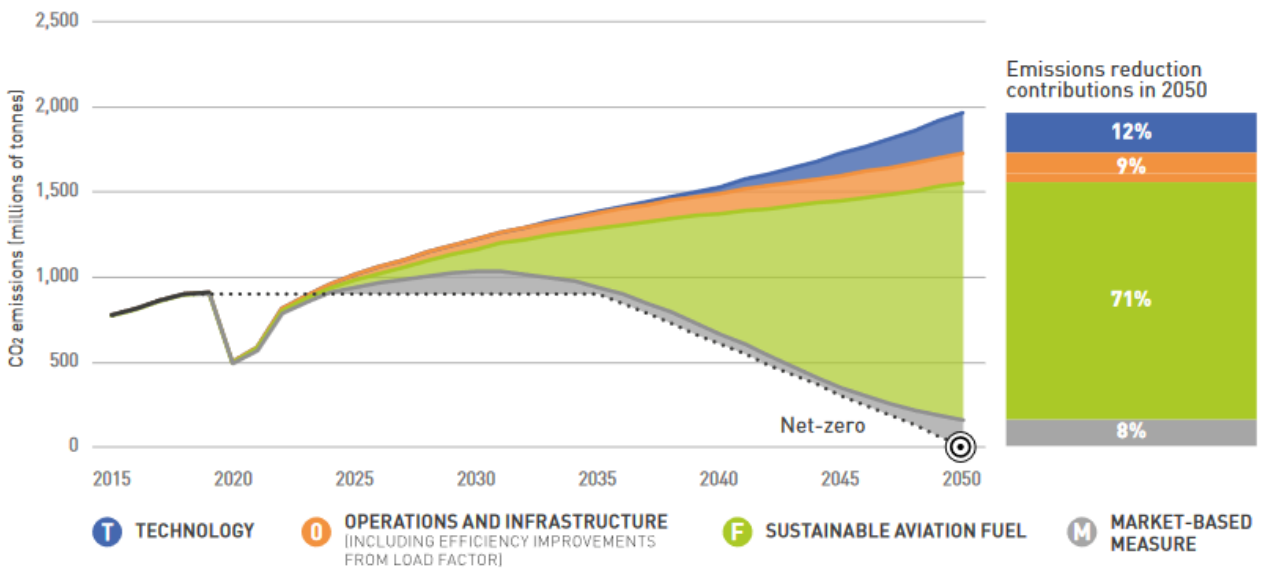


Figure 9: aggressive sustainable fuel deployment

Source: (ATAG, 2021).

Scenario 3

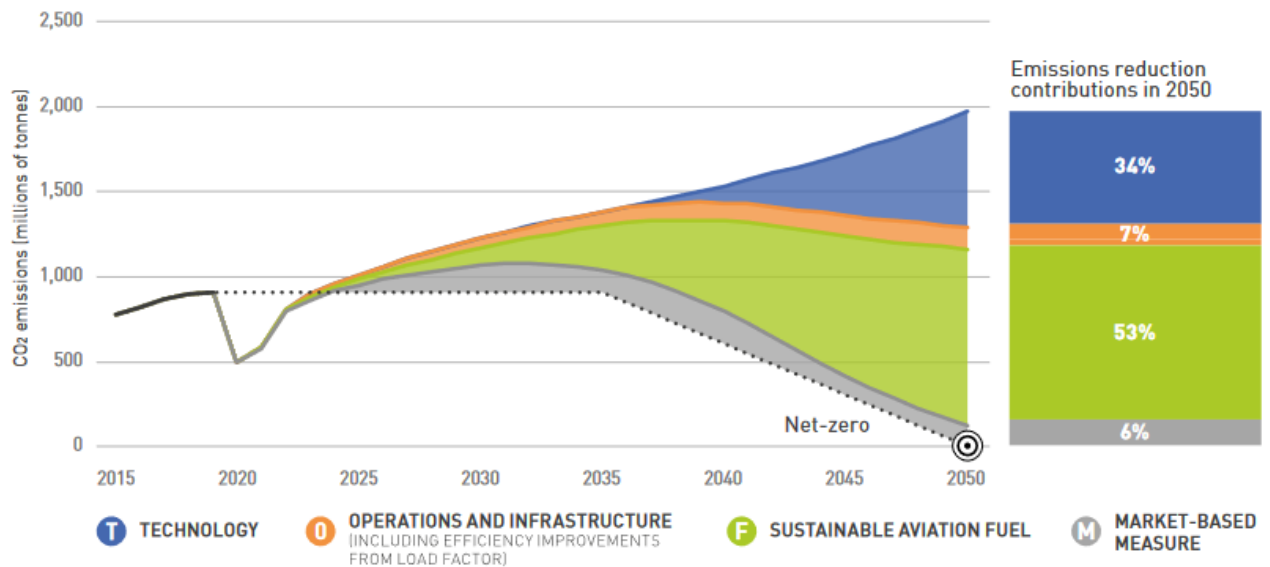


Figure 10: aspirational and aggressive technology perspective

Source: (ATAG, 2021).

6. British Airway's "flightpath to net zero" strategy, as shown by Figure 11, stands out for not including customer offsetting as part of their Net Zero strategies. Instead, they view customer offsetting as an additional benefit, allowing them to reach their 2050 Net Zero target ahead of schedule. This approach is consistent with reports from McKinsey and BCG, which suggest that while customers are concerned about the environment, they are often reluctant to pay more. In light of this, if your organization currently views customer compensation as a means of achieving Net Zero goals, would you consider revising your approach? If not, which strategies do you think would be the most effective in promoting customer involvement in sustainability efforts?

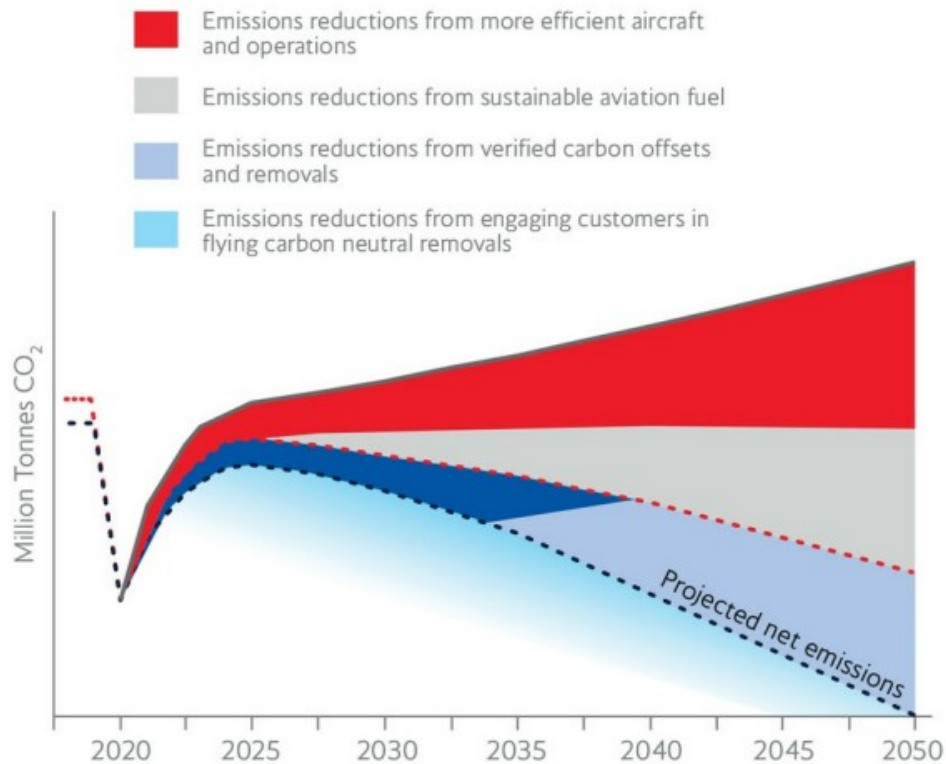


Figure 11: Our Flightpath to Net Zero by 2050

Source: (British Airways, 2023)

7. How do you believe regulatory bodies can support the airline industry in its transition towards achieving net zero emissions?
8. Could the implementation of regulations such as the Single European Skies (SES) initiative be core for the industry?

3.2 Research Participants

The research participants will include a sample of three industry managers, which are all part of the Lufthansa Group (LHG).

The LHG is a prominent aviation conglomerate which comprises several airlines, including Lufthansa, Austrian Airlines, SWISS, Brussels Airlines, Eurowings, Air Dolomiti, and

Edelweiss Air carrying 102 million passengers in 2022 with 826,379 flights to over 400 destinations (Group, 2022).

These airlines operate with distinct business models, highlighting the breadth and importance of the group, thus having interviewees from Austrian Airlines, Eurowings Discover and the Lufthansa Group provides a solid foundation for this study.

Conducting interviews with industry practitioners, specifically airline managers and directors, is crucial for the thesis as they hold critical knowledge and insights into the aviation industry's managerial practices. The knowledge and experiences of the industry experts are key when trying to derive conclusion, by combining theoretical and practical wisdom. By conducting interviews with practitioners, the thesis can obtain first hand information about the strategies, policies, and practices currently in place, their effectiveness, and potential areas for improvement. This information will provide a rich understanding of the challenges and opportunities facing the aviation industry in achieving the IATA's net-zero target, ultimately contributing to the development of more effective managerial practices in this critical sector. Participants were presented with the option to disclose varying levels of personal information during the research study. They had the choice to share their complete identification, including their name, role, and the company they represent. Alternatively, they could opt to disclose only their role and company, or they could choose not to share any personal information at all.

In this research took part: Julia von Schmeling-Diringshofen – Corporate Responsibility Manager & Environmental Officer at Austrian Airlines, Jule Klein – Sustainability Manager at Eurowings Discover and one Sustainability Manager at Lufthansa Group.

3.3 Data Collection Procedures

The interview was presented by introducing the general aim of the study, without making any presumptions on the topic, and on average for the three interviewees 30/40 minutes.

The semi-structured interviews have been conducted in May 2023 via three Microsoft Teams meetings.

3.4 Data Analysis Techniques

The GIOIA methodology was utilized as the primary method for data analysis. This methodology involves a comprehensive and systematic process of analysing qualitative data to identify patterns and themes.

Firstly, the data obtained from the interviews was transcribed and carefully read through multiple times to ensure familiarity with the data. This step was essential to develop an understanding of the participants' perspectives and identify key themes and patterns within the interviews.

Subsequently, a coding scheme was developed based on the identified themes and patterns.

The coding scheme aimed to categorize and organize the data into meaningful segments to facilitate analysis.

Chapter 4: Research Findings

In this section, we will present the findings derived from interviews conducted with industry practitioners. The outcomes are to be reported, highlighting the results obtained and acknowledging potential divergent perspectives expressed by the participants.

Question 1:

In the paper “Net-zero aviation: Time for a new business model?” by Gössling and Humpe, it has been argued that a carbon tax reflecting on the cost of emissions needs to be introduced for air passenger travellers. The overall effect is that the transition to net zero becomes more credible and achievable, though it comes at the cost of curbing growth rates. The authors’ further state that this carbon tax is not necessarily an issue, given that much air travel is characterized by wants rather than needs, induced by low airfares.

What is your take in relation to the findings of Gössling and Humpe’s paper? Do you think Net Zero in aviation, which is a consequence of the UN sustainability goals, is achievable?

The research findings indicate that the introduction of a carbon tax is not seen as a potential solution to curb emissions, as carbon taxes already exist. Concerns about potential loopholes and challenges in implementing a worldwide carbon tax were raised, along with the consequences for non-contributing airlines. The role of low fares airlines (i.e., Ryanair) in driving air travel and the need to regulate "opportunity flights," and their role to “to attract passengers with low fares” was highlighted, raising questions about whether Ryanair can be considered a good airline in terms of emissions. In fact, Ryanair and overall, the low-cost carriers, emit less CO₂ than other airlines on a per-passenger basis but they are among the highest emitters in absolute numbers as they are able to attract a wide number of passengers with below variable costs fares.

In the eventual case of a further carbon tax adoption, the issue of differentiation was raised by one of the speakers, highlighting the variations among travelers based on their purposes of

travel. For instance, passengers flying in Business Class to Africa for a safari or business purposes may need to be treated differently than other travelers with different travel objectives (i.e., visiting family). However, the challenge lies in the ability to effectively differentiate between these categories.

Furthermore, investment in research and development (R&D) for technological advancements and the utilization of tax revenue were highlighted as important considerations as a potential tax would involve diverting funds from the industry to governments, whose allocation decisions might not align with the industry's objectives.

Instead, it was proposed that airlines should retain the funds and invest them in technological innovations that facilitate the transition of the aviation industry. This approach would enable airlines to proactively drive the necessary changes while maintaining control over the allocation of resources.

Differences in approaches between the European and US regulatory models (IATA, n.d.), along with the significance of international collaboration and consistent carbon accounting standards, were also recognized: the US system is considered to be preferred as the objective is to make fossil fuel slightly more expensive than SAF, encouraging carriers to transition to greener alternatives by offering tax rebates for green products while the European approach focuses on penalizing undesirable behaviors.

The importance of an international system and unified carbon accounting standards was also stressed to overcome inconsistencies in recognizing emissions across countries.

Question 2:

How do you balance short-term operational goals with long-term sustainability ambitions?

The speakers stressed the need for a strategic approach that considers the interests of investors and the long-term viability of the company. They emphasized the importance of integrating sustainable practices into core business operations “we need to help people understand the risk people would face when it comes to sustainability, trying as well to quantify it”.

In fact, all the interviewees that it is key to invest in sustainable technologies, such as Sustainable Aviation Fuel (SAF), to contribute to net-zero emissions goals.

Additionally, the discussions highlighted the potential for airlines to engage in partnerships and collaborations to support sustainability initiatives without significant financial investments. This can generate positive publicity and enhance the airline's reputation.

However, concerns were raised about the current level of investment in sustainability, Suggestions to make stronger commitments and ensure effective implementation through binding agreements and contractual terms with external players were made as well as the introduction of environmental Key Performance Indicators¹⁹ (KPIs) as part of executives' bonus-based contracts, alongside financials ones.

The importance of setting priorities correctly and quantifying the risks associated with choices was emphasized in one of the discussions. Compliance with regulations and clear, science-based targets were identified as valuable tools for prioritizing sustainability. Data management, transparency, and the reliability of long-term goals were also recognized as crucial factors in achieving the desired balance between short-term operational goals and long-term sustainability ambitions.

In addition, the third speaker focused on the topic of organizational age, highlighting how younger companies are adopting sustainability strategies. It was explained that these companies work on short-term sustainability goals as they still don't have the financial

¹⁹ This has already been implemented at Lufthansa Group.

capabilities to tackle the sustainability challenge with a long-term view. In the first years companies strive to survive within the industry.

Question 3:

In relation to the aviation industry, do you think that the concept of organizational ambidexterity may help in reaching such long-term goals? - Strategies to achieve ambidexterity include creating separate units or departments for exploration, providing employees with resources and incentives to pursue innovation and experimentation, and establishing a culture that values both exploitation and exploration.

The concept of organizational ambidexterity emerged in all discussions as a potential strategy for balancing short-term operational needs with long-term sustainability ambitions. The speakers recognized the importance of investing in people and resources to ensure economic sustainability in the present and the future. They emphasized the need for a forward-thinking mindset and encouraged strategic thinking, innovation, and adaptation to future challenges. However, it is important to note that there were variances in the themes addressed by the speakers. Nevertheless, these differences hold inherent value as they contribute to a comprehensive and well-rounded understanding of the topic. One interviewee focused more on the HR department and how organizational ambidexterity can attract and retain talented individuals by aligning their work with long-term goals. On the other hand, the other respondent discussed the practical application of organizational ambidexterity in operations, specifically addressing CO₂ reduction and the trade-off between cost and benefit. The speaker highlighted the utilization of the marginal abatement cost curve (MACC²⁰) but acknowledged its limitations and the need for technological advancements. 2

²⁰ A MACC curve presents the costs or savings expected from different opportunities, alongside the potential volume of emissions that could be reduced if implemented. MACCs measure and compare the financial cost and abatement benefit of individual action.

<https://www.climateworkscentre.org/resource/how-to-read-a-marginal-abatement-cost-curve/>

The concept of "multidexterity" was introduced as a pivotal element during the discussion. Multidexterity encompasses the integration of not only strategic goals but also social and financial aspects. This approach recognizes the interconnectedness and interdependence of these dimensions, emphasizing the need to consider and align all three to achieve comprehensive and sustainable outcomes.

The last interviewees highlighted that while it may come naturally for young enterprises to embrace ambidexterity concepts in their early years, strategies must be developed to effectively navigate the challenges that arise as the company grows.

To sum up, the importance of budget constraints and trade-offs (between short- and long-term goals) was acknowledged, but the speaker advocated for continuous learning and improvement, allowing people to make mistakes and gain competence in sustainability.

Question 4:

To what extent do you utilize your existing internal resources and capabilities to advance your sustainability objectives, and to what degree do you depend on external partners for support in achieving these goals?

The interviewees have acknowledged the internal capabilities of airlines in operational aspects, particularly in Operational (OPS) related areas. They recognize that these capabilities can be developed and enhanced internally, as the airlines possess the necessary expertise in these domains.

The significance of internal stakeholders' motivations and competences in driving sustainability initiatives. The companies should effectively utilize their internal resources and capabilities in operational areas, while allowing them to work together towards sustainability objectives.

Nevertheless, all the participants recognized as well the importance of external collaboration and partnerships in achieving sustainability objectives.

“Airbus Boeing and all Original Equipment Manufacturers (OEMs) should be leading the technological process” as carriers can’t really do much apart from leveraging their own communication capabilities to make their key partners work toward their interests.

External stakeholders such as government and investors are crucial to the transition. The significance of policy makers was consistently emphasized by the interviewees in terms of investing in sustainable technologies and the role of lobbying in guiding their decision-making processes. The interviewees stressed the importance of policymakers being well-informed about the challenges and complexities airlines are facing in relation to sustainability. Additionally, investors and gaining investors' confidence, which involves providing them with solid results through reports, is key as they are one of the sources of findings for airlines.

Question 5:

Considering the balance between the necessary resource investment and the level of emissions reduction achieved, which scenario proposed by ATAG do you find to be the most effective in achieving the net-zero emissions goal by 2050? – To look at the scenarios please refer to the previous chapter.

The SAF scenario was considered the most realistic by the interviewed industry practitioners as, being a scalable solution, it offers a good trade-off balance between its actual implementation and the economical expense. It was further specified by one speaker that “we should focus on power to liquid and not biogenic SAF”.

On the flip side, according to all interviewees, emerging disruptive technologies have raised and will continue to raise concerns regarding their feasibility and the necessary infrastructural changes.

Question 6:

British Airway's "flightpath to net zero" strategy stands out for not including customer offsetting as part of their Net Zero strategies. Instead, they view customer offsetting as an additional benefit, allowing them to reach their 2050 Net Zero target ahead of schedule. This approach is consistent with reports from McKinsey and BCG, which suggest that while customers are concerned about the environment, they are often reluctant to pay more. In light of this, if your organization currently views customer compensation as a means of achieving Net Zero goals, would you consider revising your approach? If not, which strategies do you think would be the most effective in promoting customer involvement in sustainability efforts?

In this question the topic of customers offsetting was addressed. It was noted that different airlines adopt different approaches: AirFrance has implemented a 2% SAF price surcharge on passenger tickets, making it obligatory for customers to contribute, the Lufthansa Group and British Airways instead, take a voluntary approach, allowing customers to decide whether they want to support sustainability efforts through compensation. In this regard British Airways (BA) stands out within the industry as they don't consider consumers contributions in their Net Zero strategy. It was also noted that BA not being in the EU does not need to comply to the "Fit for 55" regulations which results in a different regulatory landscape for them. Moreover, the interviewee raised concerns about the credibility and feasibility of BA's report, noting that "it is not easy to prove its legitimacy" as it lacks third-party²¹ verification. The speakers recognized the importance of addressing customer demands for sustainability while also considering educating passengers on the costs and outputs associated with sustainable options. This factor holds increasing importance as sustainability continues to be a prevalent societal trend globally, particularly among European citizens. Consequently, passengers are becoming increasingly conscientious about environmental considerations.

²¹ The Interviewee suggested as one mechanism the European Green Claim Act.
https://environment.ec.europa.eu/topics/circular-economy/green-claims_en

Question 7:

How do you believe regulatory bodies can support the airline industry in its transition towards achieving net zero emissions?

In all answers the crucial role of regulatory bodies in facilitating the Net Zero transition is emphasized.

According to one interviewee the lack of investment in projects that would enable the production of Sustainable Aviation Fuel (SAF) is what is crucially missing.

The interviewee further delved into the European context, noting that Europe tends to invest in the initial startup phase of technology but lacks follow-through in scaling up infrastructural projects. This creates opportunities for other world regions to benefit from European technology and expertise, potentially resulting in revenues from SAF production not flowing back to Europe.

Question 8:

Could the implementation of regulations such as the Single European Skies (SES) initiative be core for the industry?

All respondents emphasize that the implementation of the Single European Skies (SES) regulation is crucial as it would cut emissions by around 10% but that the challenge lies more in the political scope rather than the technological issues. It was further mentioned that the eventual approval of the SES initiative it is, “core for the industry but only this measure would not solve the situation”.

Government bodies are still lagging behind as desire independence in managing their own airspace for civil aviation even though this implies higher CO₂ emissions.

Chapter 5: Conclusions

This thesis has delved into the multifaceted realm of sustainability in the airline industry, combining theoretical knowledge with insights from industry practitioners to provide a comprehensive understanding of the challenges, strategies, and potential pathways towards a more sustainable aviation sector. Through an extensive literature review, interviews with professionals, and analysis of industry trends, this research has shed light on key aspects of sustainability and its implications for airlines.

This research has highlighted the importance of adopting a comprehensive and integrated approach to sustainability, encompassing environmental, social, and economic dimensions. It has become evident that sustainability is not only a responsibility but also an opportunity for airlines to enhance their competitiveness, improve their brand image, and contribute to a more sustainable future.

While significant progress has been made in promoting sustainable practices within the airline industry, several major limitations and challenges remain. This research has identified some of these limitations, including the need for greater collaboration among stakeholders, the reliance on external factors such as policymakers and regulation, and the trade-offs between short-term profitability and long-term sustainable goals.

The theoretical foundation of this thesis encompassed various frameworks and models, including the Triple Bottom Line approach, stakeholder theory, ambidexterity, responsible social and sustainable innovation, and many other concepts. These theoretical perspectives have served as valuable frameworks for understanding the intricate interplay between environmental, social, technological, and economical dimensions in the context of the airline industry. Moreover, they have emphasized the importance of taking a holistic and integrated

approach to sustainability, recognizing the interdependencies and trade-offs between different aspects.

Conversations with industry practitioners have provided invaluable insights into the practical realities of implementing sustainability measures within airlines. The interviews have highlighted both shared challenges and unique perspectives. Key themes that emerged from the discussions include the significance of collaboration and partnerships (forging alliances for project financing purposes and risk sharing), the role of regulations and policy frameworks, the need for technological advancements, a scaled up SAF production and the importance and reliance from stakeholders. Therefore, as described in the research findings chapter, it is advisable for airlines, investors, and governmental bodies to actively pursue this pathway.

Collaborative efforts with other industry stakeholders can facilitate the implementation of sustainability initiatives and overcome financial barriers. Additionally, airlines can leverage their communication capabilities to educate and involve customers and OEMs in adopting sustainable practices. In this regard, the approach adopted by British Airways to achieve net-zero emissions without an active role from passenger to compensate their flights deserves recognition. However, to enhance the credibility of their sustainability report, it is advisable for BA to seek validation from a reputable third-party. By undergoing this validation process, BA would set a benchmark for other airlines to follow; this factor is enhanced when considering the current trend among passengers as the vast majority of them are not inclined to compensate their emissions.

By employing strategic lobbying strategies, airlines should persist in their efforts to engage with policymakers, regulatory bodies, and other relevant stakeholders. This engagement serves the purpose of leveraging their expertise and industry insights to advocate for the implementation of appropriate policies and regulations that foster sustainability within the

aviation sector.

The synthesis of theoretical knowledge and industry insights has revealed areas of convergence as well as areas where differing perspectives exist. For instance, there is a consensus among both academia and industry practitioners about the importance of sustainable practices in the airline industry, the concept of ambidexterity which was further stretched to “multidexterity”, lobbying initiatives, further inclusion of environmental KPIs, the triple bottom line approach, stakeholder theory, common project financing, the need for fuel efficiency and technology improvements, stakeholders and community engagement as well as other key areas.

However, some discrepancies arise when considering specific strategies and priorities. While the theoretical perspective emphasizes the integration of environmental, social, technological and economic aspects, industry practitioners often face practical limitations and trade-offs in implementing sustainable practices. Factors such as cost considerations, operational limitations, short-term orientation, and regulatory frameworks can impact the feasibility and prioritization of sustainability initiatives within the aviation industry. Furthermore, it is essential to acknowledge that not all stakeholders exhibit full commitment to sustainability, as short-term objectives are often prioritized in airlines’ board decisions. To address this issue, there is a need to signal a stronger industry-wide commitment to sustainability. Airlines internally could prioritize sustainability indicators (KPIs) of top managers, emphasizing their significance in decision-making processes. By doing so, airlines can effectively drive their organizations towards a more sustainable future. However, when considering the external landscape, the challenges become even more intricate and multifaceted.

Furthermore, it should be noted that there is a need for common legislation as airlines operate in diverse regulatory environments. This diversity can result in disparities and an uneven playing field among competing carriers due to legislative rulings.

5.1 Sustainability Decision-Making Matrix for Aviation

To establish a systematic framework for making sustainable decisions in the airline industry, the utilization of a matrix-based method can be adopted. While this approach takes inspiration from the BCG "Share-Growth" Matrix (Henderson, 1970)²², the variables, axes, and quadrants used in this Sustainability Decision Making-Matrix are original to this paper.

This matrix is intended to highlight the two main variables for an airline when it comes to Net Zero and outline some "best practices" that, depending on the quadrant in which one falls, might be implemented. Future research could, based on this matrix, expand, and integrate the sustainability matrix concept in a way that also involves industry professionals, with a minimum of one per quadrant.

As depicted by Figure 12, the matrix consists of two axes: the x-axis represents an airline's investment capabilities, while the y-axis considers the external environment in which the airline operates, including its country and associated factors.

²² Further info can be found at the following link:
<https://www.bcg.com/about/overview/our-history/growth-share-matrix>

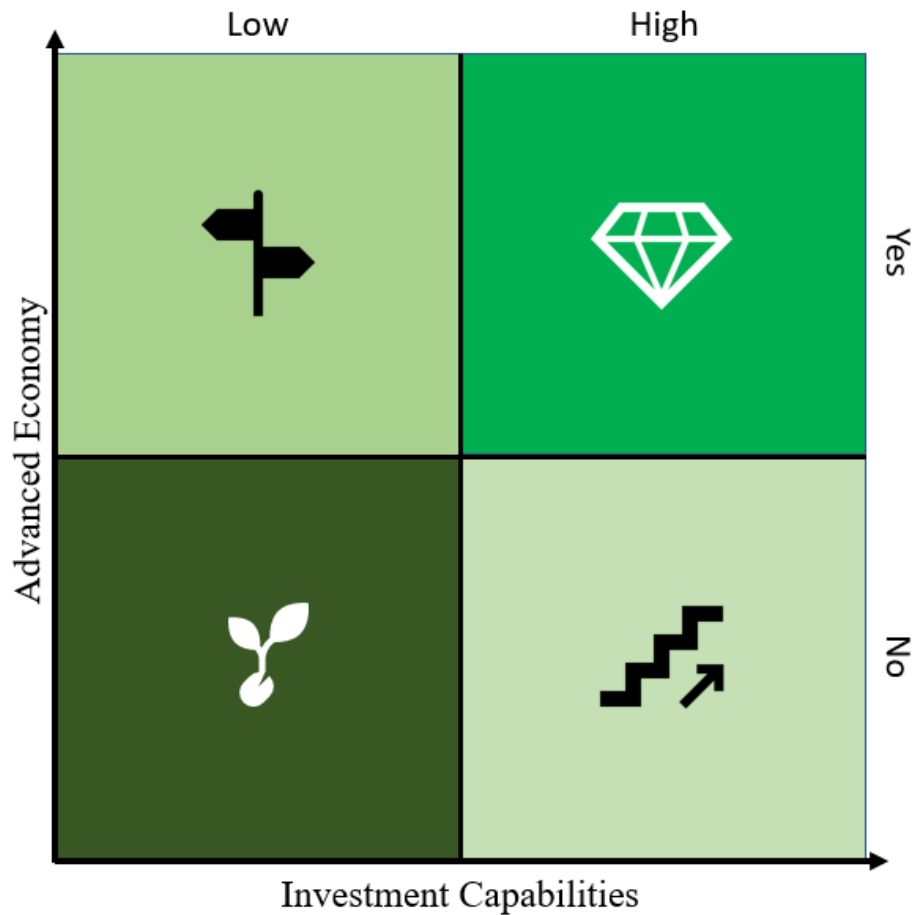


Figure 12: Sustainability Decision-Making Matrix for Aviation

Source: Personal Elaboration

The matrix is divided into four quadrants based on an airline's specific situation: limited investment capabilities and operating in a developing economy, limited investment capabilities and operating in an advanced economy, high investment capabilities and operating in a developing economy and high investment capabilities and operating in an advanced economy.

Each quadrant is associated with a recommended strategy that airlines can apply to address sustainability concerns.

1) Limited investment capabilities, developing economy: These airlines operate in developing economies with limited financial resources and infrastructure, which can make it challenging to prioritize sustainability initiatives.

For those types of airlines, a cost-effective strategy focusing on operational efficiency could be a viable option. This would involve optimizing routes to reduce fuel consumption, implementing sustainable practices in ground operations, and improving maintenance practices to increase the lifespan of aircraft.

An immediate operational strategy to improve efficiency is flying with engines at their optimal efficiency level; this is in fact very effective, as it does not require additional investments.

The airlines falling in this category should also explore offsetting options, such as investing in carbon credits or supporting reforestation projects.

Furthermore, airlines can focus on building sustainable infrastructure through strategic partnerships and securing funds from international organizations aimed at sustainable development.

2) Limited investment capabilities, advanced economy: These airlines may have limited resources to invest in sustainability initiatives, but they operate in advanced economies with environmental regulations.

An airline with low investment capabilities but operating in an advanced economy could consider investing first in Operations efficiency and SAF as a way to reduce emissions.

Airlines falling under this category should leverage the benefits of partnerships with local organizations that share a common goal of sustainability. By working together and pooling resources, these partnerships can help airlines in achieving their sustainability objectives while promoting sustainable development in the industry.

Additionally those airlines should try to secure funds from international institution. As an

example, airlines operating in the European Union (EU) may consider one of EU's offerings such as the Sustainable Finance, offered by the European Commission. The Sustainable Finance is understood as finance to support economic growth while reducing pressures on the environment and considering social and governance aspect (European Commission, n.d.). Once finances begin to improve, airlines in this category may also explore the possibility of upgrading their fleet with more fuel-efficient aircraft or by adopting new technologies such as electric or hybrid planes.

3) High investment capabilities, developing economy: These airlines have the financial resources to invest in sustainability, but they may face challenges in implementing sustainable practices due to a lack of infrastructure and governmental regulations.

An airline with high investment capabilities but operating in a developing economy could take a dual approach. Airlines in this area may prioritize operational efficiency by optimizing routes, reducing waste, and improving maintenance practices and once the external environment is ready, they need to be prepared to invest in new technologies such as electric or hybrid planes, and carbon capture technologies. Additionally, offsetting options such as carbon credits or financially supporting renewable energy projects should be pursued to further mitigate their carbon footprint.

As for the first case, airlines in this category should also focus on helping their country to develop its infrastructure and economy, either with direct investments or by trying to secure international funds.

4) High investment capabilities, advanced economy: These airlines have the resources and capital to invest in sustainable technology and initiatives.

Their strategy should focus on reducing carbon emissions by modernizing fleets²³, as well as

²³ Such as fully electric or hydrogen-powered aircraft.

trying to fully replace traditional fuel with SAF, and investing in alternative energy sources. In addition, those airlines should allocate resources towards sustainability marketing and creating carbon offset programs to attract environmentally conscious customers. Given that sustainability may be potential differentiator in their advanced economy, the airline could capture a greater market share by emphasizing their commitment to sustainable practices. As a last point, direct offsetting represents a viable complementary strategy that the airline could implement to offset all remaining CO₂ emissions and achieve carbon neutrality.

In situations where airlines face unfavourable circumstances, they may consider exploring innovative “out of the box” strategies to address carbon emissions. Investing in land and reforestation efforts to offset carbon footprint is an example of such a strategy. This approach entails procuring low-cost land and dedicating it to reforestation, leading to the absorption of carbon dioxide from the atmosphere. Although this investment incurs an initial cost, which is lower than that of purchasing new aircraft, the value of the land and the trees planted may appreciate over time, possibly generating a long-term return on investment.

5.2 Limitations

Despite the valuable insights obtained from this study, several limitations should be acknowledged. Firstly, the participants involved in the interviews were all managers from the Lufthansa Group. This may limit the generalizability of the findings to the broader airline industry. Future research should aim to expand the sample to include professionals from various companies in the airline industry, encompassing both full-service and low-cost carriers. This broader inclusion would provide a more comprehensive understanding of sustainability practices across different business models and enhance the applicability of the findings.

Secondly, the sample size of the interviewees in this study was relatively small. Although efforts were made to gather diverse perspectives within the Lufthansa Group, expanding the number of interviewees would contribute to a larger sample size, thus allowing a more robust basis for drawing conclusions and making well-founded counterarguments.

5.3 Future Research Opportunities

Based on the limitations identified, there are several directions for future research to address the gaps and expand knowledge in the field of sustainability in the airline industry.

Future studies could explore the potential impact of sustainability practices on the financial performance of airlines. Investigating the economic implications of sustainability initiatives, such as cost savings from fuel efficiency improvements or revenue benefits from attracting environmentally conscious passengers, would provide a more comprehensive understanding of the business case for sustainability in the airline industry. This analysis would help decision-makers in assessing the long-term benefits and trade-offs associated with sustainability investments.

Additionally, future research may delve into the role of consumer behaviour and the effectiveness of sustainability communication strategies. Understanding how passengers perceive and respond to sustainable initiatives is crucial for shaping effective strategies that promote sustainable travel choices. Investigating factors influencing consumer behaviour and identifying the most impactful communication methods will aid in developing tailored approaches to educate and engage passengers. This knowledge can support airlines in

effectively communicating their sustainability efforts and fostering positive behavioural changes among passengers.

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