

**ENHANCING THE SUSTAINABILITY OF THE AVIATION INDUSTRY:  
AIRLINES' COMMITMENT TO "GREEN" PRACTICES**Vera Amicarelli<sup>1</sup>, Giovanni Lagioia<sup>2</sup>, Antonio Patruno<sup>2</sup>,  
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**Abstract**

The aviation industry represents an important polluter, being responsible for increasing environmental impacts on global scale. Aiming to approach the adoption of suitable policies in the aviation industry towards the achievement of the national and international sustainability goals, the present research tackles airlines' commitment to aviation-related environmental issues, as well as their willingness to adopt sustainable aviation fuel (i.e., bio jet fuel) and sustainable development strategies, focusing on those companies operating flights in the Karol Wojtyła Airport (Bari, Italy). The paper adopts the  $\chi^2$  test and the logistic regression to investigate three different hypotheses related to airlines' headquarters, carriers' typology (i.e., low-cost or not, flag carriers or not) and years of service. Results outline that traditional airlines, either flag carriers or not, as well as South and North American companies, are more likely to be aware of aviation environmental consequences, publishing environmental reports and offering to passengers the chance to participate to climate change reduction (e.g., through online carbon offset programs or more expensive ticket to produce bio jet fuels). In addition, airlines transiting in Karol Wojtyła Airport show a small willingness to share information through environmental reports and are scarcely intentioned to make use of bio jet fuels, confirming that low-cost companies are still less attentive towards aviation environmental issues. The present research contributes to the empirical studies on sustainable aviation and carriers' commitment to environmental strategies, highlighting the need to enhance carbon offsets programs and digital technologies as the online compensation of CO<sub>2</sub> emissions.

**Keywords:** sustainability, sustainable tourism, aviation, environmental protection, airlines' commitment, bio jet fuels.

**JEL Classification:** Q01; Q5; Q56

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## Introduction

Currently, the global transport sector is responsible for the consumption of over 2.5 Giga toe (Gtoe) of energy (BP, 2019; International Energy Agency, 2020a, 2020b), producing an amount of more than 32.5 Gigaton (Gt) of CO<sub>2</sub> emissions each year (International Energy Agency, 2017), equal to approximately 24% of global CO<sub>2</sub> emissions, on global scale. Of the total amount, aviation requires more than 11% of the transport sector energy consumption, being responsible for more than 3% of the global CO<sub>2</sub> emissions (Gutiérrez-Antonio et al., 2017; BP, 2019). Therefore, considering the expected growth of the air travel emissions from 40% in 2005 to 52% in 2035, national and international authorities have established severe targets to prevent and/or reduce aviation's negative environmental impact (i.e., introduction of alternative propulsion technologies for aircrafts such as electricity or hydrogen), implementing objectives of climate change mitigation and carbon neutral growth, and requiring that sustainable aviation fuels account for at least 5% of total aviation fuels by 2030 and 63% by 2050 (Air Transport Action Group, 2020; European Commission, 2021; International Civil Aviation Organization, 2010). Indeed, as discussed within the "ReFuel EU Aviation" program (European Commission, 2021), in order to decrease its emissions, the aviation sector needs to reduce its reliance on fossil fuels and accelerate its transition towards innovative and sustainable fuels and technologies. In addition, the International Civil Aviation Organization (2021) has proposed several Strategic Objectives, which are strongly linked to 15 of the 17 United Nations Sustainable Development Goals (SDGs) within the Agenda 2030 (United Nations, 2021). Among them, the safety program, the air navigation capacity and the efficiency contribution, the security and facilitation contribution, the economic development of air transport and the environmental protection contribution should be accounted. Each year, airlines transport more than 4.3 billion passengers, of which approximately 20% for tourism and leisure, as well as more than 60 Million tons (Mt) of freight handled (Air Transport Action Group, 2018; UNWTO, 2019; Statista, 2020), consuming approximately 275 Mt of jet fuel. Under the financial perspective, the value of international trade has been estimated in more than 5.5 trillion dollars in 2018, of which roughly 650 billion dollars only for tourism purposes (Air Transport Action Group, 2018; International Energy Agency, 2020a). In addition, it is expected a growth in air-transport demand by high rates, being estimated a peak of 8 billion passengers by 2040 (+86% in twenty years) (International Air Transport Association, 2019), imposing increasing concerns and hard challenges towards sustainability and environmental protection (Rice et al., 2020). Indeed, as instance, it is estimated that a return flight from London to Los Angeles (8,400 km) produces more than 1 t of CO<sub>2</sub> emissions per passenger (more than 0.12 kg of CO<sub>2</sub>/km per passenger) (Klauber et al., 2017), confirming aviation as one of the most damaging travel activities in terms of environmental impact (Gössling et al., 2009).

In such a context, the present paper aims at discussing airlines' commitment to aviation-related environmental issues, as well as at exploring their inclination towards the adoption of sustainable strategies, such as the use of sustainable aviation fuels (i.e., bio jet fuels) or online digital technologies (e.g., CO<sub>2</sub> emissions calculator), focusing on national and international companies operating flights in the Karol Wojtyła Airport (Bari, Italy). Through the adoption of the  $\chi^2$  test and the logistic regression analysis, and the development of three different hypothesis investigating geographical areas, carriers' typology (i.e., low-cost or not, flag carriers or not) and years of service on 62 air carriers operating flights on global scale, the present research contributes to the empirical studies on sustainable aviation and carriers' commitment to environmental strategies, offering useful insights either for academics,

managers or policy makers, and highlighting the need to enhance carbon offsets programs and digital technologies as the online compensation of CO<sub>2</sub> emissions. The focus on a single airport, together with the analysis of several air carriers operating on global scale, allows to define research strategies and directions which can be undertaken at local scale, and then spread to wider geographical areas.

The present paper is structured into four main parts, besides introduction and conclusions. Therefore, the next section outlines a review of the scientific literature on the approached topic. The second section presents the research methodology, the third section highlights the main findings of the research, while the fourth one focuses on the research's implications.

## **1. Literature review**

Air travelling and transportation represent one of the most impacting activities under the environmental perspective (Gössling et al., 2009), imposing critical challenges in terms of sustainability, environmental protection and climate change mitigation (Rice et al., 2020). However, although national and international authorities have established significant targets to reduce aviation environmental impacts, aiming at improving fuel efficiency and at achieving a carbon neutral growth (International Civil Aviation Organization, 2010; Air Transport Action Group, 2020), the issue still remains under-researched.

Several works outlined by the scientific literature investigate the role of consumers (passengers) in the area of decreasing aviation's environmental impact (Lynes and Dredge, 2010; McLachlan et al., 2019; Cui and Li, 2020), analysing their perception and attitude towards environmental issues (Amicarelli et al., 2020a), their willingness to pay for carbon offset programs and greenhouse gases reduction (Rice et al., 2020) or their attitude towards the adoption of bio jet fuels (Amicarelli et al., 2020b). However, switching from the consumer to the business perspective, only a limited number of pieces of research examine the significant role of airlines, as well as their financial and social perspective, in the field of environmental and climate change mitigation (Yan et al., 2016; Xu et al., 2021). Indeed, although academia and authorities have recognized the crucial importance of sustainable transportation and aviation, its application in the field of airlines remains under-researched. Among the scarce empirical studies carried out at global scale, several authors have discussed the introduction of smart mobility technologies (Allen, 2020) and autonomous vehicles (Franklin and Potcovaru, 2021), as well as the development of sensor-based big data applications (Cohen, 2021; Gibson, 2021) towards the enhancement of smart sustainable cities, whereas a few (Dou, 2020; Odarchenko et al. 2019) have highlighted the need to rely on big data in order to improve smart aviation industry and aircrafts' safety and performances. However, specific studies addressed to explore sustainable aviation, as well as to investigate the introduction of environmental reports, carbon offsets programs and digital technologies such as the online compensation of CO<sub>2</sub> emissions or the CO<sub>2</sub> emission calculator are still missing.

In addition, in the context of the COVID-19 pandemic and the related measures for moderating its diffusion (e.g., lockdown, travel restrictions, etc.), different papers emerged on topics related to the social, financial and environmental issues specific to the airline industry during the pandemic (Suau-Sanchez et al., 2020). An important finding of such studies reveals that flights restrictions in the long terms are not likely to reduce airlines' environmental impact (Hotle and Mumbower, 2021). Thus, it emerges a need for an

environmental policy which regulates the number of commercial flights per year and mitigate their related CO<sub>2</sub> emissions. However, as proposed by Calderon-Tellez and Herrera (2021), a strategy based on mobility reduction to reduce air pollution and environmental impacts is not easy, requiring integrated transport policies which could balance social, environmental, and economic dimensions.

## **2. Research methodology**

Aiming at analysing airlines commitment to aviation-related environmental issues, sustainable aviation fuel efficiency (i.e., adoption of bio jet fuels) and sustainable development strategies towards SDGs, the present research was developed following three major steps, as further outlined in the paper: (i) hypothesis development; (ii) data collection through a systematic analysis of the International Air Transport Association report; (iii) data analysis based on a statistical approach.

### **2.1. Hypotheses development**

Grounded on findings of preliminary studies outlined by the scientific literature (Yan et al., 2016; Xu et al., 2021) and targeting the investigation of novel standpoints in the aviation industry (e.g., correlation between environmental commitment and geographic area, seniority, airline typology), the present research was developed considering three hypotheses.

Firstly, based on the assumption that the business model of each airline company determines its behaviour and environmental commitment and performance (Pérez-Valls et al., 2017), and considering that flag carriers are more likely to offer a wide variety of amenities and loyalty programs to customers (Cook and Billig, 2017), whereas low-cost companies offer simple and basic services (Vidović et al., 2013), the subsequent hypothesis has been developed:

- H1. Airlines show statistically significant differences in their commitment to “green practices”, according to their geographic area and their typology (low-cost or not, flag carriers or not).

The first hypothesis aims at understanding if and how the geographical area of airlines’ headquarters, the cultural and social related background and the carriers’ typology (e.g. low-cost or traditional, flag carriers or not) impact on airlines’ orientation to environmental-related practices and sustainable development strategies (e.g. use of biofuels).

Secondly, considering that senior companies are more likely to deal with non-economic problems, such as those related to aviation-environmental issues, whereas younger companies are more likely to define long-term objectives, which could regard environmental concerns (Payán-Sánchez et al., 2019), the second hypothesis has been formulated, as follows:

- H2. Airlines’ years of service (so-called “seniority”) do not have a significant impact on airlines’ commitment to “green practices”.

To this extent, the second hypothesis refers to airlines’ orientation towards environmental reporting and airlines’ use of bio jet fuels.

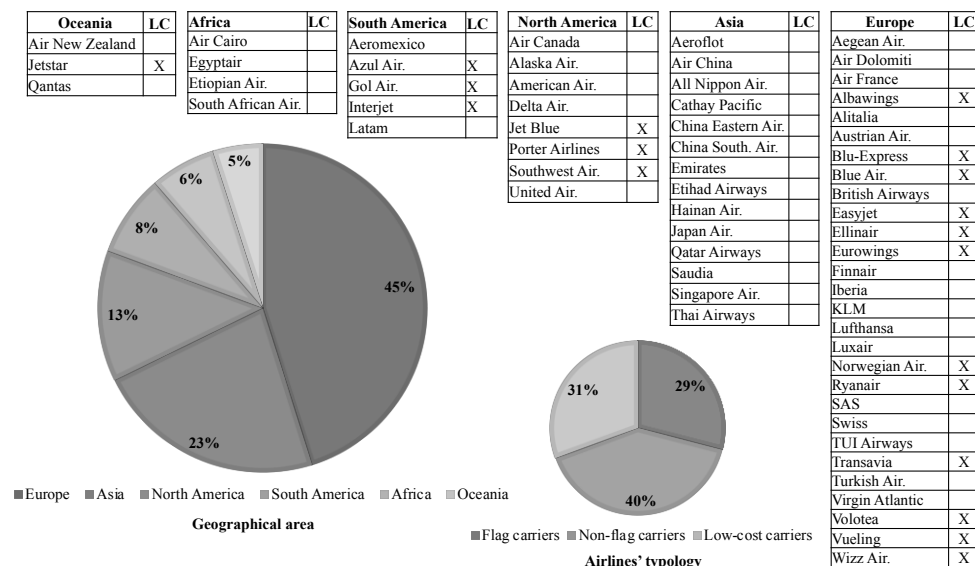
Lastly, considering that Bari Karol Wojtyła Airport has been elected as the best Italian airport by passengers in 2018 (Altroconsumo, 2021), the third hypothesis has been developed, as follows:

- H3. There are no significant differences in the commitment to "green practices" among airlines operating flights within the Bari Karol Wojtyła Airport.

The third hypothesis aims at assessing whether there are some differences, in terms of aviation-related environmental issues, between companies operating flights to and from Bari Karol Wojtyła Airport and those which do not.

**2.2. Data collection and sample characteristics**

A sample of airlines among those listed in the International Air Transport Association (2017) report (Figure no. 1) was randomly selected and systematically analysed, focusing on their policies in the field of environmental protection, climate change mitigation and sustainable fuel efficiency. In order to reflect the top hundred companies in terms of number of passengers transported and Revenue Passenger-Kilometer (RPK), the authors applied a confidence level of 95% (Hair et al., 2016), obtaining a suitable sample size of 62 companies. The selected sample identifies more than half of the global air traffic, considering the numbers of passengers and the RPK, as presented in the International Air Transport Association (2017) report.



Note: LC = Low-cost company; Air. = Airlines

**Figure no. 1. Selected airlines by geographical area and carriers' typology**

Data and information related to airlines' environmental-related issues have been collected from companies' official websites. As far as concerns low-cost companies, they represent the

majority of low-cost companies operating worldwide (51%) either in terms of passengers or RPK, whereas traditional carriers represent more than 60% in terms of travellers and approximately 72% according to RPK. Among the selected airlines ( $n = 62$ ), considering as geographical areas the companies' headquarters, it emerged that more than 45% airlines ( $n = 28$ ) are located in Europe, 23% ( $n = 14$ ) in Asia, 13% ( $n = 8$ ) in North America, 8% ( $n = 5$ ) in South America, whereas less than 6% ( $n = 4$ ) and 5% ( $n = 3$ ) respectively in Africa and Oceania. As far as concerns companies' typology, more than 69% is represented by traditional airlines, of which 18 are flag carriers and 25 non-flag carriers, whereas 19 are low-cost carriers. In terms of airlines' seniority, selected airlines have been operating on average for about 49 years ( $SD \pm 31$  years). In particular, as far as concerns companies operating at Karol Wojtyła Airport (Bari, Italy), 21 airlines have been identified, accounting for 34% of the selected sample.

### 2.3. Data analysis

As far as concerns the airlines' environmental-related issues (i.e., strategies and policies towards green practices), in line with previous studies on the topic (Adler and Gellman, 2012; Baumeister, 2020), the present research focuses on: a) drafting of environmental reports (i.e., environmental reporting practices); b) environmental dedicated chapters and/or statistics within the company's annual report; c) environmental-related sections on the official websites of the companies; d) interest in the use of bio jet fuels; e) concrete use of bio jet fuels; f) use of CO<sub>2</sub> emissions calculator; g) monetary contribution to CO<sub>2</sub> emissions offset. In terms of data analysis, after a preliminary step of descriptive statistics to understand the composition of the sample and to detect any disturbing bias, the difference between groups analysis, with reference to the H1 and H3, has been conducted according to the  $\chi^2$  test, whereas the investigation of the H2 has been carried out according to the logistic regression. The adoption of the  $\chi^2$  test allows verifying the statistical power of the sample, validating its representativeness with reference to the global airlines' population, as well as studying possible opportunities of generalization (McHugh, 2013). The logistic regression, so-called "binary response model", aims to determine the probability of response of given variables, precisely binary, with respect to a series of regressors. The adoption of such statistical tests is essential to evaluate differences between groups and understanding airlines' commitment to environmental issues and/or the adoption of environmental strategies in a probabilistic way, certifying a comprehensive and systematic investigation of the issue and ensuring a suitable inference to the final results. Data have been collected in Microsoft Excel Sheets (Microsoft Corp., Redmond, WA, USA) and have been processed using STATA15 software (Stat Corp., College Station, Texas, USA).

### 3. Results

Under the first hypothesis (H1), that assumes significant differences in the commitment to "green practices" according to airlines' geographic area and typology, it results that environmental reports are more likely to be published by North American (87%), Asian (85%), South American and Oceanian (66%) companies (Table no. 1). On average, it emerged that more than 50% of selected airlines are involved in environmental reporting practices. To the contrary, African airlines seem not to be committed to environmental reporting. In what concerns European companies, which result as the oldest companies on global scale, approximately 40% of airlines are used to draft environmental reports,

compared to younger ones which demonstrate a greater likelihood of participating in environmental reporting practices. Results show statistically significant differences between geographical areas [ $\chi^2(6) = 18.6434, p < 0.001$ ]. The power test, as proposed by Acock (2014), reports a value of 0.9334 within the 62 companies.

**Table no. 1. Differences in airlines per geographic area and typology**

Airlines' environmental-related practices		Environmental reports	Environmental dedicated chapter and/or statistics	Environmental section on official website	Reference to the use of bio jet fuels	Flights operated with bio jet fuels	Use of CO <sub>2</sub> emissions calculator	Monetary contribution to CO <sub>2</sub> emissions offset
<b>Airlines' groups</b>		%						
<b>Geographical area</b>	<b>Europe</b>	39.29	50.00	71.43	35.71	35.71	39.29	39.29
	<b>Asia</b>	85.71	64.29	64.29	42.86	64.29	35.29	35.71
	<b>North America</b>	87.50	25.00	75.00	75.00	50.00	62.50	62.50
	<b>Central America</b>	50.00	0	100.00	0	100.00	0	50.00
	<b>South America</b>	66.67	33.33	66.67	100.00	66.67	0	0
	<b>Africa</b>	0	0	50	25	25	0	25
	<b>Oceania</b>	66.67	0	100	100	100	100	100
	<b><math>\chi^2</math> test</b>	18.64 ***	11.15	3.29	13.36 ***	9.76	12.39	8.53
<b>Typology</b>	<b>Traditional</b>	72.09	48.84	76.74	53.49	58.14	48.84	51.16
	<b>LC</b>	21.05	26.32	57.89	31.58	31.58	15.78	21.05
	<b><math>\chi^2</math> test</b>	13.96 ***	2.74	2.27	2.54	3.71	6.06 **	4.90 **

Notes: \* = significance at 10%; \*\* = significance at 5%; \*\*\* = significance at 1%

As far as concerns the intention to use bio jet fuels, another statistical difference is recorded [ $\chi^2(6) = 13.3690, p < 0.001$ ]. It emerges that South American and Oceanian airlines have indicated, on their official websites, their intention/interest to adopt bio-jet-fuels and convert part of their traditional flights (i.e., operated with traditional fossil fuels) towards sustainable ones. Further, high percentages have been estimated in North American airlines (75%), while lower ones in Asian (43%) and European (36%). The power test records a value of 0.8825.

Under the companies' typology perspective, the  $\chi^2$  test reveals significant statistical differences with reference to the drafting of environmental reports, the use of CO<sub>2</sub> emissions calculators and the monetary contribution to carbon offset programs. It results that traditional companies (i.e., flag and non-flag airlines) are more likely to be interested in aviation environmental issues compared to low-cost ones. Indeed, environmental reports are drafted by more than 72% of traditional carriers, whereas low-cost companies are engaged for less than 21% [ $\chi^2(1) = 13.9640, p < 0.001$ ]. Further, as concerns the traditional companies (n = 12) and low-cost ones (n = 16) not publishing their environmental report, roughly 25% of them provide at least environmental chapters and/or environmental statistics in their annual report (1 company out of 4). As far as concerns the CO<sub>2</sub> emissions calculator per passenger per route, this is offered by over 48% of traditional companies, whereas lower values have been recorded by low-cost ones (16%), recording statistically significant differences [ $\chi^2(1) = 6.0660, p < 0.05$ ]. The same applies for the opportunity to contribute by carbon offset programs, which is available for more than 50% of traditional companies and less than 21% for low-cost ones [ $\chi^2(1) = 4.9064, p < 0.05$ ]. Considering the previously outlined information, H1 has been accepted.

Under the second hypothesis (H2), which assumes that airlines' seniority does not have a significant impact on airlines' commitment to "green practices", it emerges that airlines' year of service is likely to have a negative impact on environmental reporting practices (Table no. 2). Furthermore, the analysis reveals that long-lasting companies are less likely to adopt environmental reports (98%,  $p < 0.05$ ), confirming the idea that such companies are less sensitive towards environmental issues, due to their long presence on the market, which makes them less inclined to innovation and to the adoption of sustainable technologies, and due to their financial and structural issues, which make investment in *green* research and development areas more difficult compared to "younger" companies. Indeed, senior companies tend to adopt market-oriented policies, focusing on price and product approaches instead of innovation and *green* technology ones. Therefore, the higher the seniority, the lower the attention paid to the development of environmental reports.

**Table no. 2. Environmental reports and use of bio-jet-fuels among airlines**

	Environmental reports	Reference to the use of bio jet fuels
Airlines' seniority (%)	1.023383 **	1.013463
Constant (%)	0.430435	0.5176952
LR $\chi^2(1)$	7.04 ***	2.57
Number of observations	62	62
Pseudo R <sup>2</sup>	8.29	2.99

Notes: Logistic regression with odds ratio: \* = significance at 10%; \*\* = significance at 5%; \*\*\* = significance at 1%

Considering that airlines' seniority has been assessed to be, on average, of 49 years (SD  $\pm$  31 years), the dataset has been divided within two sub-samples corresponding to low-cost and traditional airlines. In the light of such a distinction, it emerged that low-cost companies are less likely to adopt *green* strategies (97%), whereas traditional companies, although their seniority, are more likely to improve their environmental-related policies, since the high probability (90%) of finding environmental reports on their official website. Lastly, according to the intention/interest in using bio jet fuels, no significant results have been recorded, highlighting the lack of probabilistic relationship between seniority (years of service) and attitude towards the use of bio jet fuels. In such a context, H2 has been rejected. Our analysis revealed that seniority negatively impacts an airline's orientation towards "green practices".

Under the third hypothesis (H3), which refers to those airlines operating continuative flights (daily or weekly) to and from Bari Karol Wojtyła Airport, some statistical differences have been recorded in terms of environmental reporting practices, as well as in terms of intention/interest in the use of bio jet fuels and concrete use of bio jet fuels (Table no. 3). Indeed, over 75% of the companies not operating flights to and from Bari develop such reports, whereas less than 20% of those flying to and from Bari do so [ $\chi^2(1) = 12.072$ ,  $p < 0.01$ ]. In addition, as far as concerns the intention/interest to adopt bio jet fuels, more than 63% of the companies not operating at Bari Karol Wojtyła Airport refer to bio jet fuels on their official websites, whereas less than 15% of those transiting the airport do so [ $\chi^2(1) = 13.463$ ,  $p < 0.01$ ]. In terms of flights operated using bio jet fuels, more than 70% are performed by companies not transiting through the Karol Wojtyła Airport, whereas less than 10% by those airlines operating flights in Bari [ $\chi^2(1) = 20.810$ ,  $p < 0.01$ ]. H3 has been rejected



since several differences have been recorded among airlines operating flights to and from Bari Karol Wojtyła Airport.

**Table no. 3. Differences in airlines operating flights to and from Karol Wojtyła Airport in Bari**

Airlines' environmental-related issues	Environmental reports	Environmental dedicated chapter and/or statistics	Environmental section on official website	Reference to the use of bio jet fuels	Flights operated with bio jet fuels	Use of CO <sub>2</sub> emissions calculator	Monetary contribution to CO <sub>2</sub> emissions offset
<b>Airlines' groups</b>	%						
<b>No flights (Bari)</b>	76.51	51.22	78.05	63.41	70.73	46.34	49.78
<b>Flights (Bari)</b>	19.05	28.57	57.14	14.29	9.52	23.81	28.57
$\chi^2$ test	12.072 ***	2.8975	2.9458	13.463 ***	20.810 ***	2.9716	2.3292

Notes: \* = significance at 10%; \*\* = significance at 5%; \*\*\* = significance at 1%

**4. Discussions**

From the first hypothesis (H1), it emerged that traditional airlines (either flag or non-flag carriers) are more likely to provide environmental-related information and statistics on their official websites, trying to make passengers aware of their environmental initiatives and to communicate their intention to mitigate aviation's negative environmental impact. Specifically, traditional companies are more likely to: (i) draft and publish environmental reports; (ii) provide to passengers the chance to calculate the CO<sub>2</sub> emissions related to their flights; and (iii) offer the opportunity to monetary contribute to environmental sustainability, specifically through digital technologies such as the online compensation of CO<sub>2</sub> emissions within the carbon offset programs. In addition, traditional airlines tend to be more competitive through the adoption of environmental strategies, trying to project their competitive advantage on the basis of environmental purposes and concentrating not only on pricing strategies (e.g., reduction in the cost of tickets). Further, based on the geographical area analysis, North and South American, Asian and Oceanian airlines have been identified as more interested in environmental-related issues. Most of these companies have published official environmental reports, except for Asian companies, and currently promote the concrete use of bio jet fuel by explicitly referring to it on their website. As far as the second hypothesis (H2) is concerned, it resulted that senior airlines – those that are operating for a longer period of time on the market – are more likely, over time, to reduce their focus and orientation towards aviation environmental issues (e.g., they do not develop environmental reports). The analysis revealed that such companies are more interested in pricing and market strategies, with higher attention to price reduction policies instead of environmental ones. Thoroughly, such a trend has been attributed, with high likelihood, to low-cost carriers, whereas an opposite inclination has been confirmed by traditional companies, which try to achieve competitive advantage on the basis of research and development, innovation and green strategies. Under the third hypothesis (H3), it was outlined that airlines transiting to and from Bari Karol Wojtyła Airport are barely likely to provide data and information about their engagement in aviation environmental issues. These companies are less likely to draft

environmental reports and to make reference to their intention/interest to use bio jet fuels, confirming that such policies do not represent a key point within their business strategies.

Considering that sustainable development and climate change mitigation depend either on companies' commitment or consumers' behaviour, environmental-related issues should be investigated under both airlines and passengers' side in a holistic and systematic way. Indeed, as previously outlined by Amicarelli et al. (2020a), more than 64% of passengers purchase tickets on airlines' official websites, relying on their credibility. Therefore, several efforts should be done towards the implementation of environmental reporting, which seems to be still not diffused among companies on global scale, as well as towards the enhancement of digital technologies such as the use of CO<sub>2</sub> emissions calculators, being it still under-applied among low-cost companies (less than 15% on global scale) (Payán-Sánchez et al., 2019). Further, as already discussed by the European Commission (2021), companies should decrease their reliance on fossil fuels and accelerate their transition towards the use of bio jet fuels. However, our analysis revealed that the investigated European airlines, along with the ones from Central America, Africa and Asia are still reluctant in referring to these issues. Although the use of green technologies is still complex and requires innovation, financial investments and time, companies should start to raise awareness through specialized communication campaigns and clarify aviation environmental-related issues, considering the important difference between education *about* sustainable development and education *for* sustainable development, where '*for*' has to be intended as a purpose (Oto et al., 2012). Though it seems simple to improve environmental information within the airlines' websites, the improvement in the environmental reporting practices is not always easy (Hooper and Greenall, 2005; Baumeister, 2020). One of the main challenges concerns the creation of environmental reports which are easily comprehensible to any type of passengers, as to let them understand in a clear and transparent way their role towards the sustainability of airlines and airports. Therefore, if passengers are oriented towards the choice of sustainable airlines which make responsible and reliable use of green technologies and sustainable jet fuels, the correct information on sustainability within airlines' official website and official reports can represent a key strategy for ensuring company's competitive advantage (Hermundsdottir and Aspelund, 2021). Indeed, airlines are profit making companies, and for this reason, by leveraging compliance with environmental legislation they can in the medium-long term acquire a competitive advantage and improve environmental conditions at the same time.

To this extent, it is possible to design the profile of a "green airline", identified as a traditional carrier founded in South or North America and not operating in Karol Wojtyła Airport (Bari, Italy). Traditional carriers seem to be more aware of airlines' environmental consequences, publishing environmental reports and offering to passengers several concrete opportunities to mitigate climate change or greenhouse gases emission (e.g., online carbon offset and/or more expensive tickets to produce and use sustainable jet-fuels), whereas airlines transiting through Karol Wojtyła Airport show a slight willingness to share information through environmental reports and are scarcely intentioned to make use of bio-jet-fuels, therefore not matching with the strategic objectives of transparent communication, safety, navigation capacity, fuel efficiency, economic development and environmental protection as proposed by the International Civil Aviation Organization and the United Nations. Further, it is possible to define low-cost companies as less attentive towards aviation environmental issues.

## Conclusions

The present research, analysing a sample of 62 air carriers operating flights on global scale, suggests that the improvement of airlines' sustainability could be achieved through different strategies, such as the implementation of carbon offsets programs or the adoption of digital technologies like the online compensation of CO<sub>2</sub> emission. However, passengers' intervention towards the issue seems essential. Travellers should understand that they represent key players in the CO<sub>2</sub> emissions reduction not only in terms of monetary contribution and more expensive tickets purchase, but also through communication and environmental sensitivity. If airlines tend not to finance *green* research and development strategies not considering this as a crucial investment to achieve competitive advantage, then passengers can intervene to subvert this current "unsustainable" trend through the selection of companies more oriented towards environmental issues.

Under a theoretical perspective, the present research contributes to the enrichment of the literature on sustainable aviation and airlines' commitment to green practices, confirming past trends and discussing possible strategies to reach either economic growth or sustainable development. However, it presents some limitations. First, it only explores the issue from airlines' side, not providing a cross-checking with passengers travelling with the selected companies. The analysis of the companies' side does not allow to evaluate how (and if) airlines' strategies are perceived by passengers. Furthermore, if our research had been oriented on investigating passengers' perception, as well, it would have been more likely to identify some opportunities for improvement, such as, for example, in the reports' drafting and layout, in the websites' usability or in the online tickets' purchase. In addition, the data collection process raises an important limitation, as well: our research was based only on official, published data on the websites of the analyzed airlines, not considering the "hidden" (i.e., unpublished) data. There might be the case when airlines did not reveal fundamental information through their websites.

In the light of previous results and considering that unpublished data, as well as passengers' information, could represent a crucial step towards the holistic and systematic comprehension of the aviation sustainable development, future research directions are intended to cross-check current results with passengers and companies' perspective. Airlines' sustainability investigation should be expanded to further managerial, economic, financial and social variables, as to increase comprehension on the entire aviation industry.

## References

- Acock, A.C., 2014. *A Gentle Introduction to Stata*. Texas: Stata Press, College Station.
- Adler, N. and Gellman, A., 2012. Strategies for managing risk in a changing aviation environment. *Journal of Air Transport Management*, [e-journal] 21, pp.24-35. <https://doi.org/10.1016/j.jairtraman.2011.12.014>.
- Air Transport Action Group, 2018. *Aviation Benefits Beyond Borders, 1215, Geneva 15 Airport*. Switzerland: Air Transport Action Group.
- Air Transport Action Group, 2020. *Domestic Air Transport Action and the NDCS*. [online] Available at: <<https://www.atag.org/our-publications/latest-publications.html>> [Accessed 17 April 2021].
- Allen, M., 2020. Connected and Networked Driving: Smart Mobility Technologies, Urban Transportation Systems, and Big Data-driven Algorithmic Decision-Making.

- Contemporary Readings in Law and Social Justice*, [e-journal] 12(2), pp.79-87. doi:10.22381/CRLSJ12220209.
- Altroconsumo, 2021. *Aeroporti*. [online] Available at: <<https://www.altroconsumo.it/cerca?keyword=aeroporto+bari&pageIndex=1&startFrom=0>> [Accessed 24 August 2021].
- Amicarelli, V., Patruno, A., Bux, C. and Lagioia, G., 2020a. Passengers' perception on aviation environmental issues and its effect on sustainable tourism. *International Journal of Digital Culture and Electronic Tourism*, [e-journal] 3(3/4), pp.382-400. 0.1504/IJDCET.2021.10036111.
- Amicarelli, V., Patruno, A., Lagioia, G. and Bux, C., 2020b. I semi di tabacco per la produzione di Sustainable Aviation Fuel. In: Atti di Convegno, *AIMSME2020 – XXIX Congresso Nazionale di Scienze Merceologiche 2020 – Le scienze merceologiche nell'era 4.0*. Rome, Italy, 13-14 February 2020. Milan: FrancoAngeli.
- Baumeister, S., 2020. Mitigating the Climate Change Impacts of Aviation through Behavioural Change. *Transportation Research Procedia*, 48, pp.2006-2017.
- BP, 2019. *BP Energy Outlook*. [online] Available at: <<https://www.bp.com/en/global/corporate/energy-economics/energy-outlook/introduction/overview.html>> [Accessed 14 April 2021].
- Calderon-Tellez, J.A. and Herrera, M.M., 2021. Appraising the impact of air transport on the environment: Lessons from the COVID-19 pandemic. *Transportation Research Interdisciplinary Perspectives*, [e-journal] 10, 100351. <https://doi.org/10.1016/j.trip.2021.100351>.
- Cohen, S., 2021. Interconnected Sensor Networks and Digital Urban Governance in Data-driven Smart Sustainable Cities. *Geopolitics, History, and International Relations*, [e-journal] 13(1), pp.97-107. doi: 10.22381/GHIR13120219.
- Cook, G.N. and Billig, B., 2017. *Airline Operations and Management: A Management Textbook*. Abingdon, UK: Routledge.
- Cui, Q. and Li, Y., 2020. A cross efficiency distinguishing method to explore the cooperation degree in dynamic airline environmental efficiency. *Transport Policy*, [e-journal] 99, pp.31-43. <https://doi.org/10.1016/j.tranpol.2020.08.010>.
- Dou, X., 2020. Big data and smart aviation information management system. *Cogent Business & Management*, [e-journal] 7(1), 1766736. DOI: 10.1080/23311975.2020.1766736
- European Commission, 2021. *Regulation of the European Parliament and of the Council on ensuring a level playing field for sustainable air transport*. [online] Available at: <[https://ec.europa.eu/info/sites/default/files/refueleu\\_aviation\\_-\\_sustainable\\_aviation\\_fuels.pdf](https://ec.europa.eu/info/sites/default/files/refueleu_aviation_-_sustainable_aviation_fuels.pdf)> [Accessed 24 August 2021].
- Franklin, K. and Potcovaru, A.M., 2021. Autonomous Vehicle Perception Sensor Data in Sustainable and Smart Urban Transport Systems. *Contemporary Readings in Law and Social Justice*, [e-journal] 13(1), pp.101-110. doi: 10.22381/CRLSJ131202110.
- Gibson, P., 2021. Internet of Things Sensing Infrastructures and Urban Big Data Analytics in Smart Sustainable City Governance and Management. *Geopolitics, History, and International Relations*, 13(1), pp.42-52. doi: 10.22381/GHIR13120214.
- Gössling, S., Haglund, L., Kallgren, H., Revahl, M. and Hultman, J., 2009. Swedish air travellers and voluntary carbon offsets: towards the co-creation of environmental value?. *Current Issues in Tourism*, [e-journal] 12(1), pp.1-19. <https://doi.org/10.1080/13683500802220687>.

- Gutiérrez-Antonio, C., Gomez-Castro, F.I., De Lira-Fores, J.A. and Hernández, S., 2017. A review on the production processes of renewable jet fuel. *Renewable and Sustainable Energy Reviews*, [e-journal] 79(C), pp.709-729. <https://doi.org/10.1016/j.rser.2017.05.108>.
- Hair, J., Hult, G., Tomas, M., Ringle, C. and Sarstedt, M., 2016. *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)*. 2<sup>nd</sup> ed. New York: SAGE Publication Inc.
- Hermundsdottir, F. and Aspelund, A., 2021. Sustainability innovations and firm competitiveness: A review. *Journal of Cleaner Production*, 280(1), 124715.
- Hooper, P.D. and Greenall, A., 2005. Exploring the potential for environmental performance benchmarking in the airline sector. *Benchmarking International Journal*, [e-journal] 12, pp.151-165. <https://doi.org/10.1108/14635770510593095>.
- Hotle, S. and Mumbower, S., 2021. The impact of COVID-19 on domestic U.S. air travel operations and commercial airport service. *Transportation Research Interdisciplinary Perspectives*, [e-journal] 9, 100277. <https://doi.org/10.1016/j.trip.2020.100277>.
- International Air Transport Association, 2017. *World Air Transport Statistics 2017*. [online] Available at: <[www.airlines.iata.org](http://www.airlines.iata.org)> [Accessed 20 April 2021].
- International Air Transport Association, 2019. *IATA Forecast Predicts 8.2 Billion Air Travelers in 2037*. [online] Available at: <<https://www.iata.org/pressroom/pr/Pages/2018-10-24-02.aspx>> [Accessed 14 April 2021].
- International Civil Aviation Organization, 2010. *Provisional Edition November 2010 – Resolutions Adopted by the Assembly*. [online] Available at: <[https://www.icao.int/Meetings/AMC/Assembly37/Documents/ProvisionalEdition/a37\\_res\\_prov\\_en.pdf](https://www.icao.int/Meetings/AMC/Assembly37/Documents/ProvisionalEdition/a37_res_prov_en.pdf)> [Accessed 14 April 2021].
- International Civil Aviation Organization, 2021. *ICAO and the United Nations Sustainable Development Goals*. [online] Available at: <<https://www.icao.int/about-icao/aviation-development/pages/sdg.aspx>> [Accessed 27 June 2021].
- International Energy Agency, 2017. *Global Energy and CO2 Status Report 2017*. [pdf] Paris: International Energy Agency. Available at: <<https://www.iea.org/publications/freepublications/publication/GECO2017.pdf>> [Accessed 16 April 2021].
- International Energy Agency, 2020a. *CO2 Emissions from Fuel Combustion Overview*. [online] Available at: <<https://www.iea.org/reports/co2-emissions-from-fuel-combustion-overview>> [Accessed 26 June 2021].
- International Energy Agency, 2020b. *Data and statistics. Explore Energy Data by Category, Indicator, Country or Region*. [online] Available at: < <https://www.iea.org/data-and-statistics> > [Accessed 2 April 2021].
- Klauber, A., Toussie, I., Csonka, S. and Bramble, B., 2017. *Opinion: Biofuels Sustainable, Essential to Aviation's Future*, *Aviation Week and Space Technology*. [online] Available at: <<https://advancedbiofuelsusa.info/opinion-biofuels-sustainable-essential-to-aviations-future/>> [Accessed 29 March 2021].
- Lynes, J.K. and Dredge, D., 2010. Going Green: Motivations for Environmental Commitment in the Airline Industry. A Case Study of Scandinavian Airlines. *Journal of Sustainable Tourism*, [e-journal] 14(2), pp.116-138. 10.1080/09669580608669048.
- McHugh M. L., 2013. The chi-square test of independence. *Biochemia medica*, [e-journal] 23(2), pp.143–149. <https://doi.org/10.11613/bm.2013.018>.

- McLachlan, J., Kieran, J. and Hampson, B., 2018. Assessing whether environmental impact is a criterion of consumers when selecting an airline. *International Journal of Advanced Research*, [e-journal] 6(3), pp.740-755. 10.21474/IJAR01/6727.
- Odarchenko, R., Hassan, Z. and Zaman, A., 2019. Use of Big Data in Aviation: New Opportunities, Use Cases, and Solutions. In: T. Shmelova, Y. Sikirda, N. Rizun, D. Kuchеров and K. Dergachov. *Automated Systems in the Aviation and Aerospace Industries*. S.I: IGI Global, pp.436-452. DOI:10.4018/978-1-5225-7709-6.ch017
- Oto, N., Cobanoglu, N. and Geray, C., 2012. Education for Sustainable Airports. *Procedia - Social and Behavioral Sciences*, [e-journal] 47, 1164-1173. doi:10.1016/j.sbspro.2012.06.795.
- Payán-Sánchez, B., Pérez-Valls, M. and Plaza-Úbeda, J.A., 2019. The Contribution of Global Alliances to Airlines' Environmental Performance. *Sustainability*, [e-journal] 11(17), 4606. <https://doi.org/10.3390/su11174606>.
- Pérez-Valls, M., Céspedes-Lorente, J., Martínez-del-Río, J. and Antolín-López, R., 2017. How organizational structure affects ecological responsiveness. *Business and Society*, 58(8), pp.1634-1670.
- Rice, C., Ragbir, N.K., Rice, S. and Barcia, G., 2020. Willingness to pay for sustainable aviation depends on ticker price, greenhouse gas reductions and gender. *Technology in Society*, [e-journal] 60, p.101224. 10.1016/j.techsoc.2019.101224.
- Statista, 2020. *Number of Scheduled Passengers Boarded by the Global Airline Industry from 2004 to 2021 (in Millions)*. [online] Available at: <<https://www.statista.com/statistics/564717/airline-industry-passenger-traffic-globally/>> [Accessed 29 March 2021].
- Suau-Sanchez, P., Voltes-Dorta, A. and Cugueró-Escofet, N., 2020. An early assessment of the impact of COVID-19 on air transport: Just another crisis or the end of aviation as we know it?. *Journal of Transport Geography*, [e-journal] 86, 102749. 10.1016/j.jtrangeo.2020.102749.
- United Nations, 2021. *The Sustainable Development Goals Report 2021*. [online] Available at: <<https://unstats.un.org/sdgs/report/2021/The-Sustainable-Development-Goals-Report-2021.pdf>> [Accessed 24 August 2021].
- UNWTO, 2019. *International Tourism Highlights*. [online] Available at: <<https://www.e-unwto.org/doi/pdf/10.18111/9789284421152>> [Accessed 14 April 2021].
- Vidović, A., Štimac, I. and Vince, D., 2013. Development of business models of low-cost airlines. *Journal of Traffic Transportation Engineering*, 3, pp.69–81.
- Xu, Y., Park, Y.S., Park, J.D. and Cho, W., 2021. Evaluating the environmental efficiency of the U.S. airline industry using a directional distance function DEA approach. *Journal of Management Analytics*, [e-journal] 8(1), pp.1-18. <https://doi.org/10.1080/23270012.2020.1832925>.
- Yan, W., Cui, Z. and Alvarez Gil, M.J., 2016. Assessing the impact of environmental innovation in the airline industry: An empirical study of emerging market economies. *Environmental Innovation and Societal Transitions*, [e-journal] 21, pp.80-94. <https://doi.org/10.1016/j.eist.2016.04.001>.