An Assessment of the Role of Carbon Offsets Programs as an Airline Carbon Footprint Mitigation Strategy

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Abstract

An important environmental related development in the global airline industry has been the implementation by airlines of voluntary carbon offset programs, which enable their passengers to offset their carbon emissions from their flights. This study aimed to 1) empirically examine the full-service network airlines and low-cost carriers operating around the world that have introduced carbon offset programs for their passengers and 2) to examine the types of carbon emissions reduction projects that are being supported by the various airline's voluntary carbon offset programs. The study was based on an in-depth qualitative instrumental case study research design. The case study revealed that airlines located in Abu Dhabi, Australia, Belgium, Canada, Chile, Finland, throughout Europe, France, Germany, Hong Kong, Hungary, Iceland, Ireland, Japan, Kuwait, New Zealand, Qatar, Singapore, Spain, Switzerland, Taiwan, Thailand, United States, and the United Kingdom have introduced carbon offset programs to help mitigate their carbon footprint. Voluntary passenger carbon offset programs are now being offered by both the full-service network carriers (FSNCs) as well as by some of the major low-cost carriers (LCCs). British Airways, Brussels Airlines, Eurowings, Finnair, Lufthansa, and Swiss International Airlines have also expanded their carbon offset programs to include the option for customers to purchase the use of sustainable aviation fuel (SAF). The case study also revealed that there was a total of 83 carbon offset projects that were being supported by the monies raised from the airlines carbon offset programs. These projects include biogas plant improvements, sustainable cook stoves, clean drinking water, forestry protection and reforestation, geothermal energy, heating technology, the use of hydro, photovoltaic (PV) and wind power, landfill gas capture and diversion, a nut concession project, the protection, and restoration of peatlands in Germany and Indonesia, and two waste-related projects.

Keywords: airlines, airline carbon offset programs, carbon offsets, case study

Introduction

In the global air transport industry, passenger transportation services are provided by the full-service network carriers (FSNCs), low-cost carriers (LCCs), regional airlines, and holiday/charter airlines (Whyte & Lohmann, 2017). The global airline industry delivers both

economic and social benefits. The industry facilitates tourism, trade, connectivity, generates economic growth and provides key air links to remote communities (Air Transport Action Group, 2022). However, in providing both passenger and air cargo services, the global airline industry has various adverse impacts on the environment and the climate. These include the impacts of emissions on local air quality and on climate change (Dessens, 2016; Pamplona & Pinto Alves, 2020), aircraft noise (Envia, 2017; Soeta & Kagawa, 2020; Xie, Li & Kang, 2014), energy consumption (Baxter, Srisaeng & Wild, 2021; Budd, Intini & Volta, 2020), the production of wastes (Baxter, 2020; Baxter, Srisaeng & Wild, 2018; Budd & Budd, 2013), and the consumption of very large volumes of water. Furthermore, the global air transport industry generates a substantial carbon footprint. The air transport industry has acknowledged the requirement to reduce its carbon footprint (McKercher, Prideaux, Cheung & Law, 2010). Considering this, an important development in the global airline industry in recent times has been the commitment by airlines to becoming more "green," or environmentally friendly (Hagmann, Semeijn & Vellenga, 2015; Jalalian, Gholami & Ramezanian, 2019; Migdadi, 2020; Zhou & Zhang, 2020). The key concept of a “green airline” is the initiatives by the airline to support sustainable social and economic development whilst at the same time not having an adverse impact on the local and global environment (Sarkar, 2012). The key aim of a “green airline” is to provide the green society with a transport system that reduces its carbon footprint, uses renewable energy, and produces less carbon dioxide (CO_2) as well as other harmful pollutants (Abdullah, Chew & Hamid, 2016). The concept of “greening” aviation can be best linked to their reduction of the level of emissions into the atmosphere, to the point where they achieve near carbon neutrality (Sarkar, 2012).

Like many other businesses operating around the world, airlines have now implemented carbon offset programs as part of their effort to mitigate their carbon footprint (Lu & Shon, 2012; Ritchie, Kemperman & Dolnicar, 2021; Otley, 2022b; Zhang, 2022). Voluntary carbon offset programs have played a key role in the aviation industry response to addressing climate change (Choi & Ritchie, 2014). Carbon offsetting provides a way for airline passengers and corporate customers, to “neutralize” their proportion of an aircraft’s carbon emissions on a particular journey through the investment in carbon reduction projects (International Air Transport Association, 2022). The key objective of this study is to empirically examine the airlines that are operating throughout the world that have implemented carbon offset programs as part of their strategy to mitigate their carbon footprint. A secondary objective is to examine the business model of those airlines that have implemented a voluntary carbon offset program for their customers. A final aim is to examine the types of carbon emissions reduction projects that are being supported by the various airline’s voluntary carbon offset programs.

The remainder of the paper is organized as follows: The literature review is presented in Section 2. The study’s research method is outlined in Section 3. The case study is presented in Section 4. Section 5 presents the key findings of the study.

Background

Carbon offsets: A background note

Downie (2007) has observed that "a 'carbon offset' is used to describe the process whereby individuals, businesses, or governments purchase 'credits' generated from projects that claim to reduce greenhouse gas (GHG) emissions in the atmosphere". The key concept that underpins the use of carbon offsets is that the removal of greenhouse gases (GHGs) via such projects counterbalances emissions that are produced from other sources (Downie, 2007). Carbon offsetting is one environmental related strategy that can be used to mitigate the effects of climate change (Abeyratne, 2012). Over the past twenty years or so, a greenhouse gas (GHG) emissions market has developed. The origins of this emissions market lie in the negotiations from the United Nations Framework Convention on Climate Change (UNFCCC) and the subsequent inclusion in the Kyoto Protocol, in recognition for the requirement for mechanisms to drive cooperation between countries as well as lowering emissions costs (Harris, 2007). According to Lovell (2010), "carbon offsets are produced and sold under the international climate change regime (the United Nations Kyoto Protocol) and also within an expanding voluntary offset market in which companies and individuals can voluntarily opt to compensate for their greenhouse gas emissions". Voluntary carbon markets provide firms and individuals with the opportunity to offset all or part of their carbon footprints (Kuhn & Uler, 2019). Carbon offset schemes can deliver significant environmental benefits as they enable businesses to invest in environmental projects around the world. These projects subsequently enable the firm to balance out their own carbon footprints. A carbon offset program may involve the implementation of clean energy technologies or alternatively the purchase of carbon credits from an emissions trading scheme. Other carbon offset schemes include the capture of carbon dioxide (CO_2) directly from the air from the planting of trees (Clark, 2011). The direct link between atmospheric carbon dioxide (CO_2) levels and terrestrial ecosystems has resulted in governments and private entities exploring the possibility of increasing the rate of growth in forests to convert existing carbon dioxide (CO_2) emissions into sequestered carbon stocks (Neil Sampson & Sedjo, 1997).

Carbon offsets may be imposed by national or intergovernmental regulations, or alternatively they may be voluntary in nature (Green, 2011). The voluntary carbon offset market is comprised of firms, governments, organizations, organizers of international events, together with individuals, who take responsibility for their carbon emissions through the voluntary purchase of carbon offsets (Taiyab, 2006). Importantly, voluntary carbon offsets (VCO) programs have been implemented that are designed to compensate the personal carbon emissions related to travelling (Kerner & Brudermann, 2021). Voluntary carbon offsets now offer the potential for participants to meet their greenhouse gas emissions targets, and hence, enable these participants to reduce anthropogenic climate change. Furthermore, certain types of voluntary carbon offset projects may also deliver co-benefits including safeguarding or promoting biodiversity, supporting human development and poverty reduction, and enabling market and technology development in low-carbon sectors (MacKerron, Egerton, Gaskell, Parpia & Mourato, 2009).

Carbon offsets are typically organized as projects that contain discrete timetables and the related activities. Carbon offset projects include the building of renewable energy capacity, the capture of methane from organic sources, increasing the energy generation systems efficiency, and planting or re-planting of forested areas (Green, 2011, p. 49). Carbon offset programs potentially deliver sustainability co-benefits, these projects also stimulate technology development and transfer, and the carbon offset programs can also develop human and institutional capacity for reducing emissions in sectors and locations that are not included in a cap-in-trade or a mandatory government policy (Kolmuss, Lazarus, LeFranc & Polycarp, 2010).

Offsetting of carbon emissions by airline customers

Carbon offsetting has become an integral element of the airline industry strategy to reduce carbon emissions (Becken & Mackey, 2017). Consequently, as previously noted, airlines are now offering carbon offset schemes for their passengers to reduce their carbon footprint (Chen, 2013; Ritchie, Sie, Gössling & Dwyer, 2020; Zhang, Ritchie & Mair, 2019). The principle of carbon offsetting is that the emissions for each flight are allocated amongst the passengers. Each passenger can therefore pay to offset the emissions caused by their portion of the flight's emissions. Passengers can offset their emissions through an investment in carbon reduction projects that generate carbon credits (International Air Transport Association, 2016).

Research Methodology

Research approach

To achieve the study objectives, this study used an in-depth instrumental case research design. An instrumental case study is the study of a case, for example, a firm, that provides insights into a specific issue, redraws generalizations, or builds theory (Stake, 2005). A key benefit of the instrumental case study research approach is that this approach enables researchers to gain an enhanced understanding of a specific phenomenon. An instrumental case study is designed around established theory of the phenomenon that is being empirically examined (Grandy, 2010). The present study was underpinned by the established theory of carbon offsetting (Brohé, Eyre & Howarth, 2009; Kollmuss, Lazarus, Lee, LeFranc & Polycarp, 2010; Zhou, 2020).

Data collection

The data used in the study was obtained from a range of company materials that were available on the internet and these records formed the source of the case study evidence. An extensive search of the leading air transport journals, airline and travel industry magazines and textbooks were also conducted in the study. This study used secondary data. The three principles of data collection as suggested by Yin (2018) were followed, that is, the case study used multiple sources of case evidence, a database was created on the subject, and the study ensured that there was a chain of case study evidence.

Data analysis

The data collected for the case study was examined using document analysis. Document analysis is quite commonly used in case studies. Document analysis focuses on the information and data from formal documents and a firm's records that are collected by a researcher(s)

when conducting their study (Andrew, Pedersen & McEvoy, 2011; Yin, 2018). Following the guidance of Scott (2014) and Scott and Marshall (2009), the documents gathered in the present study were examined according to four criteria: authenticity, credibility, representativeness and meaning.

The document analysis was undertaken in six distinct phases:

- Phase 1: The first phase involved planning the types and required documentation and their availability for the study.
- Phase 2: The data collection phase involved sourcing the documents and developing and implementing a scheme for the document management.
- Phase 3: The collected Documents were examined to assess their authenticity, credibility and to identify any potential bias.
- Phase 4: The content of the collected documents was carefully examined, and the key themes and issues were identified.
- Phase 5: This phase involved the deliberation and refinement to identify any difficulties associated with the documents, reviewing sources, as well as exploring the documents content.
- Phase 6: In this phase the analysis of the data was completed (O'Leary, 2004, p. 179).

Following the recommendation of Yin (2018), the present study's documents were downloaded and stored in a case study database. All the documents gathered for the study were written in English. Each document was carefully read, and key themes were coded and recorded in the case study research framework (Baxter, 2021; Baxter & Srisaeng, 2022).

Results

Aer Lingus has partnered with the charity "Pure Leapfrog" to allow their customers to offset the carbon emissions from their flight(s). The monies raised from the carbon offset program are contributed to three projects. These emission reduction projects are forest protection in Cardamom, Cambodia, the use of sustainable cook stoves in Darfur, Sudan, and forest protection in Cordillera Azul, Peru. Passengers have the option of selecting one of the three emission reduction projects or they can also contribute an equal amount to each of the projects (Pure Leapfrog, 2022).

Air Canada has implemented a passenger carbon offsets program whereby its customers can choose to purchase offsets to mitigate the carbon dioxide (CO_2) emissions associated with their travel whilst at the same time supporting carbon reduction programs in developing countries and in Canada (Air Canada, 2022). Since 2017, Air Canada has partnered with "Less Emissions" to provide the highest quality carbon offsets to individuals and organizations that are seeking to reduce the environmental impact of their flights. Air Canada has an exclusive project, the Waste Diversion Project in Chemainus, BC, which is a waste diversion project that utilizes aerobic composting methods to turn municipal waste (for example, yard waste, residential food decay) into nutrient-rich compost. Air Canada's carbon offset program also supports the Essex-

Windsor Regional Landfill Gas Capture and Destruction Project. This project is designed to collect landfill gas from twenty-three vertical wells spread throughout the closed landfill cells. Both projects are CSA Group Standard-certified Canadian projects. In addition, the airline's passenger carbon offsets program supports the Vietstar municipal solid waste treatment plant in Vietnam, and the San Miguel Biogas Project in Thailand. The Vietstar municipal solid waste treatment plant project involves the pre-sorting and classification of municipal solid waste, recycling plastic, and treating organic matter with LEMNA composting technology. The San Miguel Biogas Project captures biogas from wastewater from the Thai San Miguel Liquor distillery (TSML), and converts it into electricity (Less Emissions, 2022).

Air France offers it passengers the opportunity to offset the emissions from their travel, both domestic and international, in conjunction with "A Tree for You", and through the "Tree and Trip" program (Otley, 2022b). The passenger donations support reforestation projects throughout the world (Air France, 2022). Since the start of 2020, Air France has offset the carbon emissions from its domestic flights (Air France, 2019; Otley, 2022b). This compensation will take the form of participation by Air France in certified projects, located in South America (Brazil, Peru), Africa (Kenya) and Asia (India, Cambodia). Air France is partnering with "EcoAct" in this program. In addition, Air France and "EcoAct" planned to develop two projects in France, with these projects falling within the framework of the new low-carbon label (Air France, 2019).

Air New Zealand's "FlyNeutral" carbon offset program calculates the passenger's flight's carbon emissions. The scheme then matches those carbon emissions with carbon credits to offset them. Air New Zealand purchased carbon credits from certified international projects that comply with international best practice. Air New Zealand has partnered with "Trees That Count" to connect with native tree planters located throughout New Zealand. The monies raised from the carbon offset program are spent on supplying additional native trees to projects around Aotearoa, thereby supporting the efforts of planting groups and supporting the restoration, regeneration, and protection of New Zealand's native biodiversity (Air New Zealand, 2022).

All Nippon Airways (ANA), which is headquartered in Tokyo, Japan, has also implemented a carbon offsets program for its customers. The program is offered in conjunction with "myclimate Japan Co., Ltd". Monies raised from the program go toward the Katingan Mentaya Project in Central Kalimantan, Indonesia, the Yamanashi forestry project in Japan, and the "REDD" project in Brazil nut concessions in Peru (All Nippon Airways, 2022).

American Airlines entered into a partnership agreement with "Cool Effect" in July 2020, in which the airline's passengers have options for offsetting the carbon emissions associated with their flights. Cool Effect is a nonprofit organization that sources high-quality, verified carbon reduction projects located around the world (American Airlines, 2020). The carbon offsets go towards one of three environmental-related projects: the prevention of deforestation in Mexico, the protection and restoration of the peatlands in Indonesia, and the use of clean cooking stoves in the Honduras (Otley, 2022b).

British Airways began to offset its carbon emissions on all its flights operating within the United Kingdom effective on 1 January 2020. This measure was part of the airline's commitment

to achieving net zero carbon emissions by 2050. Under this program, customers flying on British Airways services within the United Kingdom will have the carbon emissions from their flights offset by the airline and invested in the highest quality, verified carbon reduction projects located throughout the world. These will include quality assured projects such as renewable energy, protection of rainforests together with reforestation programs. Passengers flying beyond the United Kingdom can reduce their impact on the environment by using British Airways' carbon offsetting tool. This tool enables passengers to calculate their carbon emissions and make their flight carbon neutral by selecting from the highest quality, verified carbon reduction projects in Peru, Sudan and Cambodia through British Airways partnership with not-for-profit charity Pure Leapfrog (British Airways, 2020). In September 2021, British Airways added a sustainable aviation (SAF) fuel option to its carbon offset program. This carbon offsets program enhancement enables passengers at the time of their flight(s) booking passengers to not only offset their journey and donate to one of three offset projects, but also choose to pay an additional charge, which enables them to buy the equivalent of 10 per cent sustainable aviation fuel for their flight (Otley, 2021a). In recent times, an important development in the air transport industry has been the growing trend by airports and airlines to use aviation biofuel as a key environment sustainability measure (Baxter, Srisaeng & Wild, 2020). Accordingly, alternative jet fuel (AJF) technologies have gained strong interest, and consequently, are now being viewed as a way for the airline industry to achieve large, near-term carbon dioxide (CO_2) emissions reductions (Staples, Malina, Suresh, Hileman & Barrett., 2014).

Brussels Airlines, a subsidiary of the Lufthansa Group, offers its passengers a carbon offset program under which their passengers can offset the carbon emissions from their flight by contributing to high-quality climate protection projects, or by using sustainable aviation fuels, or a combination of both measures. The Lufthansa Group of airlines promotes and supports climate protection projects around the world in collaboration with "myclimate". These projects include the restoration of peatlands in Germany, the construction of biogas plants in Brazil, energy-saving cookers for people in Kenya, Peru and Burundi, and the protection of endangered forests in Tanzania (Brussels Airlines, 2022).

Cathay Pacific Airways "Fly Greener" program enables the airline's passengers to purchase "carbon offsets" that come from projects that reduce or prevent carbon dioxide (CO_2) emissions, such as those that are focused on renewable energy. Under the program, carbon emissions are calculated for the specified flights, and the attributable monetary contributions subsequently go directly to fund third-party validated projects that help to offset the carbon dioxide (CO_2) generated by the passenger's flights (Cathay Pacific Airways, 2022).

ECO TRAVEL is the Taiwan-based China Airlines carbon offset scheme. This scheme is delivered in partnership with "ClimateCare" and "Carbon Analytics" and allows the airline's passengers to measure the emissions generated by their flight, to offset these emissions with "ClimateCare" (China Airlines, 2022).

Etihad Airways has introduced a carbon offset program for their passengers wishing to offset their carbon emissions from their travel as part of Etihad Airways sustainability policy. Etihad Airways works in partnership with New Zealand based "CarbonClick". The funds raised

from the carbon offset program are contributed to the Sichuan Household Biogas Program in China. This project is helping less fortunate and needy Chinese farmers to recycle farm waste into clean energy. Importantly, the sustainable fuel (biogas) avoids the use of dirtier cooking fuel (coal and wood) and improves both air quality and health of households (Etihad Airways, 2022).

Eurowings, a subsidiary of the Lufthansa Group, has implemented a voluntary carbon offset program in which its passengers are able to decide whether they wish to offset the carbon dioxide (CO_2) emissions generated by their flight by paying a special fee (Poleri, 2022). The airline's customers can use the platform "Compensaid" to reduce the carbon dioxide (CO_2) emissions of their flight by purchasing sustainable aviation fuel (SAF) and through supporting climate protection projects with "myclimate" (Eurowings, 2022). Eurowings began offering carbon offsets for projects in Germany in January 2022. The two new climate protection projects are the Königsmoor, which is located near Hamburg where Eurowings is the largest airline and the "Gelliner Bruch" moorland in Mecklenburg-Vorpommern, Germany. The voluntary offsetting by the airline's passengers is organized through the Swiss non-profit climate protection organization company "Myclimate" together with local sustainability organizations and are certified in accordance with the recognized Moor Futures project standard (Otley, 2022a).

EVA Air became the first Taiwan-based airline to introduce a passenger carbon offsets program when it released its "Green Travel" Carbon Offset Program in 2017. Under this program, the airline's customers choose to donate equal or optional amounts to support ClimateCare's international carbon reduction project for "zero-carbon travel" (EVA Airways, 2021). The monies raised from the program are offset through "ClimateCare's" online portfolio of emissions reduction projects (EVA Air, 2017).

Finnair implemented a new carbon dioxide (CO_2) emissions program for its passengers in March 2022. This new program is a key part of its goal to reduce its climate footprint as the airline aims for carbon-neutral growth by 2045. Finnair passengers will be able to use the "Chooose" platform, which passengers can access on the airline's website, to calculate the share of their flight's carbon emissions for which each traveler is responsible for. Then passengers can offset their carbon dioxide (CO_2) emissions via money spent on sustainable aviation fuels (SAF) or alternatively on certified offset projects (Dykins, 2022; Karp, 2022).

Iberia Airlines, headquartered in Spain and a member of the International Airline Group (IAG), has implemented a carbon offset program for its passengers where they can offset their travel emissions. This program is offered in conjunction with their climate partner "CHOOOSE" (Iberia Airlines, 2022a). Monies raised from the program are used to support the Guatemalan Conservation Coast Project. The project is financing the establishment of new nature reserves and supports existing natural forest areas. The second project, Nii Kaniti Community Forest Management in Peru, is addressing the local economic drivers of deforestation and forest degradation by supporting the development of socially inclusive businesses, implementing proper use of communal land, as well as capacity building for the management of natural resources (Iberia Airlines, 2022b).

Icelandair offers its passengers a carbon offsets program whereby passengers can offset their flight and thereby reduce its environmental impact. At the time of the present study, all

carbon-offset contributions raised from the program are used to cultivate forests in Iceland in co-operation with the Icelandic Carbon Fund, Kolviður. Kolviður aims to sequester carbon in plants and soil in order to reduce the amount of carbon dioxide (CO_2) that is emitted into the atmosphere. Kolviður has plantations in Geitasandur and around Úlfljótsvatn in Iceland (Icelandair, 2022).

In accordance with its "Eco-Skies® Carbon Choice" carbon offset sponsorship program, United States-based United Airlines purchases carbon offsets on behalf of its customers so all their corporate air travel with the airline is 100% carbon neutral. Through United Airlines partnership with Conservation International, these carbon offsets support projects help to reduce greenhouse gases (GHGs) and also provide social and economic benefits to communities around the world (United Airlines, 2021).

Kuwait-based Jazeera Airways launched its passenger carbon offsets program in December 2021. The airline has partnered with CHOOSE, whose projects contribute to the United Nations Sustainable Development goals (Time Aerospace, 2021).

LATAM Airlines, headquartered in Chile, has implemented a passenger carbon offset program whereby the airline's corporate clients are provided with the opportunity to choose from a portfolio of projects with high environmental value to offset the emissions generated from their air travel. As part of the program, LATAM Airlines matches the carbon emissions tonnage offset by its corporate clients through the 1+1 mechanism (LATAM Airlines, 2022). LATAM Airlines Group launched its "Vuela Neutral" carbon offsetting scheme on 18 November 2021. Donations from the scheme support conservation projects in the Peruvian and Brazilian Amazon (Centre for Aviation, 2021). Based on the development of a portfolio of conservation projects and other initiatives, the LATAM Group aims to offset 50% of its domestic emissions by 2030 and has set a goal to be carbon neutral by 2050 (Holbrook, 2021).

Lufthansa offers its passengers a carbon offset program whereby passengers can offset the carbon emissions from their flight by contributing to high-quality climate protection projects, or by using sustainable aviation fuels, or a combination of both measures. As previously noted, the Lufthansa Group promotes and supports climate protection projects throughout the world in collaboration with "myclimate". These projects include the restoration of peatlands in Germany, the construction of biogas plants in Brazil, energy-saving cookers for people in Kenya, Peru and Burundi, and the protection of endangered forests in Tanzania (Lufthansa, 2022).

Qantas Airways and its fully owned low-cost subsidiary Jetstar Airways have offered a voluntary carbon offset program since 2009 (Freed, 2016). The scheme enables the airline's passengers to calculate the per-passenger emissions of their flights and subsequently purchase carbon dioxide (CO_2) credits that are then paid to a variety of environmental projects (Los Angeles Times, 2007). Qantas also permits its corporate customers to offset carbon emissions from travel on the airline or even to offset other business-related emissions through a series of programs in Australia and overseas. The carbon offset projects include conserving Tasmanian wilderness and improving air quality in Cambodia through the introduction of new stoves (Freed, 2016). Since 2014, Qantas Airways has partnered with leading businesses to offset their carbon emissions through the Qantas "B2B Qantas Future Planet" program. This program provides a

carbon offsetting solution for corporate businesses that wish to offset their operational or unavoidable emissions, and hence, reduce their environmental impact. In 2019, Qantas enabled their Qantas Frequent Flyer members and Qantas Business Rewards customers to earn 10 Qantas Points for every dollar spent on carbon offsetting. Importantly, Qantas matches dollar-for-dollar every contribution a customer makes to offset their carbon emissions on a passenger flight, effectively doubling the size of the program. The Qantas carbon offset projects portfolio also reflects the strategic priorities of Qantas Group. This includes the airline's commitment to supporting Indigenous economic development through our Reconciliation Action Plan, and by supporting the employment of Indigenous rangers in northern Australia. These rangers use traditional practices to promote the regeneration of native vegetation (Qantas Airways, 2022).

Qatar Airways announced the official launch of its voluntary carbon offset program for its passengers in November 2020. Since 2020, the Qatar Airway's voluntary carbon offsetting program has been contributing to the Fatanpur Wind Farm project. This project is based in the central Indian state of Madhya Pradesh. In April 2022, Qatar Airways launched a new voluntary carbon offset program for its corporate customers. This scheme enables corporate and trade clients to offset their carbon emissions either before or following their flight. To commence with, carbon offset funds will go towards a leading renewable energy project, and it is envisaged that additional verified projects to be included in the airline's program (Tennant, 2022). Qatar Airways' carbon offset program is based upon a partnership with the International Air Transport Association's (IATA) Carbon Offset Programme (Töre, 2020).

Ryanair, Europe's major low-cost airline, launched its carbon calculator on 28 July 2021. The new digital tool enables their passengers to fully offset their emissions on their Ryanair flight. This tool will calculate the carbon emissions per passenger on every Ryanair route and will enable the airline's customers to pay the full carbon cost of their flight. Ryanair has also expanded its carbon offset program, which currently allows customers to contribute €2 towards carbon offset projects. These contributions support several environmental initiatives, including Renature Monchique – a reforestation project in the Algarve; the distribution of energy-efficient cookstoves in Uganda by First Climate; Balikesir's Wind Power Plant Project in Turkey and Improved Kitchen Regimes in Malawi powered by CO2 Balance (the latter two projects are in partnership with Shell) (Ryanair, 2021).

Singapore Airlines (SIA) and its low-cost carrier (LCC) Scoot subsidiary introduced a voluntary carbon offsets program in June 2021. This program enables the airline's passengers to offset their share of the flight's carbon emissions by contributing to environmental projects in Indonesia, India and Nepal. Under the program, passengers can purchase carbon offsets from dedicated microsites before or after a flight. From late 2021, the airline's passengers would be able to use their "KrisFlyer" miles and "HighFlyer" points to purchase carbon offsets (Surgenor, 2021; The Business Times, 2021). The airline's carbon offset environmental projects include the protection of forests in Indonesia, supporting renewable solar energy projects in India, and the provision of efficient, clean burning cookstoves for rural families in Nepal (Baker, 2021; Otley, 2021b; Surgenor, 2021).

Swiss International Airlines has introduced a carbon offsets program in partnership with "myclimate". The airline's passengers can offset their carbon dioxide (CO_2) emissions from their flight(s) by donating to climate protection projects, or by reducing their emissions through the purchase of sustainable aviation fuel (SAF) (Swiss International Airlines, 2022). The climate protection projects include a community reforestation project in Nicaragua, the renaturation of the Königsmoor in Germany, the Climate-Optimized Forest Management Project in the Canton of Graubünden, Switzerland, afforestation in Campotto, Italy, protection of the rainforest through efficient stoves in Kenya, the use of efficient cook stoves to save the habitat for the last of the mountain gorillas in Rwanda, the use of efficient and solar stoves for a green Island in Madagascar, the installation of a new solar power plant in the Dominican Republic, the generation of electricity from Forest Stewardship Council (FSC) wood waste in the Amazon, Brazil, the use of wood-based biomass powered boiler to meet the heat demands of a new paper machine at a pulp and paper mill in Caieiras, Sao Paulo, Brazil, the installation of efficient cook stoves that enable a reduction in emission in Nigeria, the installation of domestic biogas plants that are designed to substitute the use of firewood and chemical fertilizers in the Karnataka region, India, the protection of Tanzanian forests for the country's indigenous peoples, wildlife and the climate, and the use of efficient cook stoves for returnees in Burundi (Compensaid, 2021).

Taking effect on 6 April 2022, Hawaiian Airlines passengers booking travel within the Hawaiian Islands and between Hawaii and the continental United States, as well as Japan, South Korea, Australia, Auckland, Tahiti or American Samoa, can enter their origin and destination in the airline's carbon calculator, and thus, determine the carbon emissions of their itinerary. The airline's passengers can then choose to balance out their impact by contributing to forest carbon projects that reduce deforestation. The monies generated from the carbon offsets program will directly fund projects led by Conservation International that generate high-quality, independently verified carbon credits that protect forests and support local communities. These carbon credit investments advance the work projects such as the Chyulu Hills REDD+ project in southeast Kenya (Hawaiian Airlines, 2022).

Thai Airways International has opted to adopt the International Air Transport Association (IATA)-administered carbon offset program, as this program enables airlines to offer their passengers the ability to compensate for the carbon emissions from their flying. The monies raised from the Voluntary Carbon Offset Program are contributed to the Bangkok Kamphaeng Saen East: Landfill gas to electricity project. This is Thailand's first landfill gas project. The project converts methane emissions from landfill waste into electricity, channeling it into the country's national grid. By creating renewable electricity, the project is also helping to reduce Thailand's reliance on fossil fuel-generated electricity, and thereby lower its carbon emissions (Thai Airways International, 2022).

The Japan Airlines (JAL) Group, in collaboration with its partner "CHOOOSE AS", offers its passengers the option to offset their carbon dioxide (CO_2) emitted by the aircraft they fly on through the JAL Carbon Offset program (Japan Airlines, 2022a). Under the JAL Carbon Offset program, carbon offset supports projects that reduce, capture or avoid carbon emissions in an

amount equivalent to the passenger's calculated carbon footprint. The projects are carefully chosen by CHOOOSE carbon professionals and are verified by the most comprehensive certification standards. The airline's carbon offset projects also contribute to multiple Sustainable Development Goals (Japan Airlines, 2022b).

The major United States-based low-cost carrier (LCC) Southwest Airlines offers a carbon offset program for its customers. Under this program, the airlines customers can earn 10 Rapid Rewards® bonus points for every dollar spent. Passengers can earn up to 500 bonus points per month. The offsets support projects, such as, the Guatemalan Conservation Coast, the Los Santos wind power project in Costa Rica, and the Kootznoowoo improved forest management project in Alaska (Southwest Airlines, 2022).

The United Kingdom-based regional airline Loganair introduced a carbon offset scheme in June 2021 whereby a £1 charge is levied on every ticket sold. This mandatory ticket levy has enabled the airline to immediately mitigate the impact of the carbon emissions from every flight that it operates (Otley, 2022b; Payne, 2021).

Virgin Atlantic Airways carbon offsets program is offered in conjunction with its partner "ClimateCare". Monies raised from the program help to finance renewable energy and natural resource conservation projects that are located around the world, thereby helping people from poorer communities to have access to cleaner, safer, affordable energy and at the same time reduce their carbon emissions (Virgin Atlantic Airways, 2022).

Virgin Australia launched the world's first Government certified carbon offset scheme in 2007. This program offers the airline's passengers the opportunity to purchase carbon offsets through the "Fly Carbon Neutral" program. The "Fly Carbon Neutral" program is accredited under the Australian Government's National Carbon Offset Standard. The Virgin Australia passengers who offset their flights are directly supporting the "New Leaf Project, which is preserving Tasmania's native forests while also contributing to the protection of important species and ecosystems (Virgin Australia, 2022).

Westjet, a major Canada-based low-cost carrier (LCC) has partnered with "Carbonzero" to provide the airline's passengers with the ability to help reduce the effects of climate change by purchasing carbon-offset credits to help offset the emissions from their travel (Westjet, 2022). "Carbonzero" supports Canadian and International-based projects, such as, the Nanaimo LFG Capture Project in British Columbia, Canada (Carbonzero, 2022).

Wizz Air, a major European-based low-cost carrier (LCC), launched a carbon offsetting scheme in November 2020 as part of its wider commitment to reducing carbon dioxide (CO_2) emissions. The program enables passengers to calculate their flight's environmental impact and offset the carbon emissions thereof. The scheme, which is offered in partnership with climate-focused technology company, CHOOOSE, provides passengers with the option to offset their journey by supporting trusted, high impact climate projects around the world (Wizz Air, 2020). Wizz Air has partnered with" CHOOOSE", which is a Norwegian climate action company, to fund two carbon-reduction projects (Pande, 2020). These projects are the International Small Group and Tree Planting Program (TIST) in Uganda, and the Pichacay Landfill Gas to Renewable Energy

Project, which is a landfill site for the municipal wastes of Cuenca in the province of Azuay, in Ecuador. Both projects are certified by the Verified Carbon Standard (Otley, 2020)

Conclusions

This study has used an in-depth qualitative instrumental case study research approach to empirically examine the airlines operating around the world that have implemented carbon offset programs to mitigate their impact on the environment. The qualitative data gathered in the study was analyzed by document analysis.

The case study revealed that airlines located in Abu Dhabi, Australia, Belgium, Canada, Chile, Finland, throughout Europe, France, Germany, Hong Kong, Hungary, Iceland, Ireland, Japan, Kuwait, New Zealand, Qatar, Singapore, Spain, Switzerland, Taiwan, Thailand, United States, and the United Kingdom have introduced carbon offset programs to help mitigate their carbon footprint. Voluntary passenger carbon offset programs are now being offered by both the full-service network carriers (FSNCs) as well as by some of the major low-cost carriers (LCCs). British Airways, Brussels Airlines, Eurowings, Finnair, Lufthansa, and Swiss International Airlines have expanded their carbon offset programs to include the option for customers to purchase the use of sustainable aviation fuel (SAF). Both carbon offset programs and the use of sustainable aviation fuel (SAF) are key measures that airlines can implement in order to help mitigate their environmental impact.

The case study also revealed that carbon offsetting programs include reforestation, the protection and restoration of peatlands in Germany and Indonesia, the protection of endangered forests, renewable energy projects, and the treatment of wastes and wastewater in developing countries as well as the introduction of new sustainable cooking stoves.

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