OXFORD JOURNAL
OF STUDENT
SCHOLARSHIP

# Sustainability in the Sky: Analyzing Customer Perception in Response to Environmentally Sustainable Onboard Products in U.S. Airlines

Steven Chan
paperworksteven@gmail.com

## ABSTRACT

With the issue of climate change continuing to influence global policy and development, large U.S. airlines are currently under pressure to address their significant environmental impacts. However, while airlines have made efforts to improve their overall environmental sustainability, onboard products consumed by passengers (meals, utensils, bedding, amenity kits, toiletries, etc.) contribute to airlines' environmental impacts and have only recently been targeted by airline sustainability initiatives. This study investigates the effects of sustainable supply chains for onboard products on customers' perceptions of U.S. airlines' brand image. It uses a mixed-methods approach, including a literature review, a case study, and a survey of customer perceptions, to identify customer attitudes towards U.S. airlines' sustainability initiatives related to onboard products. Findings show that there are some, albeit insignificant, impacts of the quality and marketing of sustainable onboard products on customer perception, although customers who are aware of sustainable onboard products generate positive responses towards airline brand image through a higher perception of efficiency.

***Keywords:*** *aviation industry, onboard products, sustainability, supply chain, customer perception*

## INTRODUCTION

In today's interconnected and globalized world, aviation plays an essential role in connecting people and facilitating international commerce and business, yet it also contributes significantly to severe environmental damage and other climate change-related issues. This is not limited to carbon dioxide emissions; in 2017 alone, the airline industry produced 5.7 million tons of cabin waste, including food and beverage waste, utensils, headphones, and single-use packaging (1). This situation is exacerbated by airlines' shift in recent years towards more premium cabins with elevated amenities and service, as onboard products such as toiletries and amenity kits are distributed to, and expected by, high-paying customers (2). A large number of used, or even new, onboard products are quickly disposed of after a

flight, leading to a substantial buildup of waste. Considering that a single medium-haul flight generates an average of 209 kilograms of cabin waste (3), the continued consumption of onboard products across the airline industry remains a significant problem with serious ramifications for the global environment, exacerbating the ongoing issue of climate change.

The issue of cabin waste is especially significant, as the three largest airlines in the world in late 2025 by fleet size were U.S. carriers: United Airlines, Delta Airlines, and American Airlines, with 1,056, 1,010, and 1,002 aircraft, respectively (4). These airlines, which operate hundreds of aircraft per day on regional short-haul and long-haul international flights, struggle to manage the significant waste generated by their flights (1). The waste these airlines generate, coupled with other environmental issues attributed to them, has led to widespread criticism and scrutiny from governments and the traveling public. Consequently, U.S.-based airlines have shifted toward more sustainable onboard products, particularly in their production and supply chains (5). While airline sustainability efforts, such as the development of sustainable aviation fuel (SAF) and the reduction of carbon emissions, have been thoroughly studied, there has been limited exploration of passenger-facing product development.

This study examines the development of environmentally friendly onboard products for U.S.-based airlines and their relationship to airlines' perspectives, to thoroughly address the question: *What are the effects of sustainable supply chains for onboard products on customers' perceptions of U.S. airlines' brand image?* This study aims to explore recent shifts in how customers respond to sustainability efforts, a topic that is not extensively covered in academia. It also aims to analyze the strategies that U.S. airlines have adopted to increase the sustainability of their supply chain networks for onboard products; examining both allows for important insights for airlines engaging in their own sustainability efforts related to in-flight services. The behavior of customers, especially in the context of the increasing implementation of sustainable onboard products to which they are typically exposed, is also an essential variable in future airline planning, but has not been thoroughly explored (6).

To explore this question in a multifaceted manner, this study employs a mixed-methods approach, combining both quantitative and qualitative analyses to examine the various directions airlines took towards sustainability in the cabin and customers' responses. A thorough literature review of prior papers related to airline environmental sustainability, along with a survey, is used to understand patterns between airline sustainability efforts focused on in-flight services and resulting customer behaviors. An in-depth case study of U.S. airlines' initiatives toward eco-friendly onboard products is also conducted to investigate the diverse approaches that airlines have taken. A survey of U.S. airline customers to gain first-hand perspectives and attitudes towards sustainability efforts is juxtaposed with the case study and the literature review to obtain an accurate and well-rounded viewpoint on customer perceptions of the ongoing inclusion of environmentally sustainable onboard products on U.S. airline flights.

By analyzing the correlations between airlines' implementation of eco-friendly supply chains to improve the environmental sustainability of onboard products and the resulting shifts in customer perception, this study makes a preliminary empirical contribution to the limited body of literature on the impact of

sustainability efforts across the global aviation industry. It focuses on the often-overlooked factors of customer perception and brand image, adding to existing studies examining the operational sustainability and environmental performance of airlines. With the insights from this study, airlines and policymakers can develop innovative strategies to plan future sustainability efforts in the airline industry while keeping customers in mind, creating operational benefits for airlines, environmental benefits for the planet, and positive outcomes for customers.

## METHODS AND MATERIALS

An airline's onboard product, such as food and drink, bedding, headphones, and amenity kits, is a significant factor in customers' experience and perception when flying. However, the widespread consumption and disposal of onboard products represent a large factor in U.S. airlines' overall waste contribution. In recent years, in response to growing awareness of the airline industry's negative environmental impacts, U.S. airlines—some of the largest in the world—have increasingly adopted more sustainable supply chain networks for their onboard products that incorporate environmental and ethical considerations.

The research methodology in this study seeks to analyze shifts in customer perceptions of U.S. airlines' brand image resulting from their pivot toward more sustainable onboard product supply chains. A mixed-methods approach, combining quantitative and qualitative analyses, is used in this research to reliably capture, examine, and compare customers' diverse responses as well as statistical trends and relationships between recent moves towards sustainable onboard products and customer perception. This approach allows for data triangulation to ensure validity and reliability. This explanatory study focuses on the relationship between airline customers and U.S. airline policies, as well as customers' reactions to onboard sustainability efforts for products.

The target population is U.S. airline customers in general, as this study does not aim to analyze differences in perception by race, gender, region, or age. Due to the considerable size of the target population and the difficulty of obtaining data, voluntary responses were used to capture the diverse views of U.S. airline customers across regions nationwide. Primary data were collected through an online survey of 101 respondents via Google Forms and the analysis of airline onboard product imagery. Surveys were shared via Gmail, Outlook, messaging, and social media platforms such as Facebook. Respondents were adults aged 18 or older, as they were explicitly asked to confirm their age group and that they were at least 18 years old. Secondary data was obtained from customer satisfaction forums and websites, U.S. airline sustainability reports, and industry trend reports.

Ethical guidelines and considerations were taken into account and adhered to by ensuring informed consent of participants in the survey and the anonymity and confidentiality of their responses. A school-level Institutional Review Board (IRB) approved the study and survey. This research employs a mixed-methods approach, using literature reviews, case studies, and a survey questionnaire to

comprehensively and reliably analyze customer responses and perceptions of U.S. airlines following the implementation of more sustainable supply chain networks for their onboard products.

## LITERATURE REVIEW

Existing research on customer perception offers insights into the behavioral patterns of airline customers regarding travel and the ongoing challenges of diffusing eco-friendly practices in flights. This comprehensive literature review compiles pivotal research on airline food waste management, customer perceptions and expectations, and airlines' environmental sustainability challenges. This review examines studies published between 2012 and 2026, reflecting the relevance of ongoing developments in airline sustainability worldwide and the importance of customer perception and behavior for airline planning and strategy. Relevant publications and studies were identified and reviewed through Google Scholar searches and citation tracking. Searches combined topics of environmental sustainability with customer behavior and the airline industry in the United States, employing keywords like 'customer perception', 'sustainability', 'airline catering', 'airline industry', 'US airlines', 'food waste management', 'environmental challenges', 'brand image', and 'sustainable supply chain'.

Studies were excluded if they analyzed the development and impact of sustainable aviation fuels and carbon emissions, as these factors result from aircraft operations and do not pertain to the onboard cabin products. Studies pertaining to airports were also excluded, as airport supply chains and products differ; many airports are developing with shopping-mall characteristics, featuring restaurants and large commercial spaces (7). Studies were additionally excluded from the literature review if they were published before 2011, as the topic of sustainability has only recently begun to gain widespread traction in the cabin, particularly through eco-friendly online products. Meanwhile, studies were prioritized if they focused on customer perception and environmental sustainability related to any of the wide variety of onboard products served on flights. Typically, studies focused on onboard food products and correlated them with airline cabin waste and waste generated in the airline catering supply chain. Studies with a global or U.S. focus were typically prioritized, though studies from other nations were included if they incorporated a global perspective or examined international airlines, such as Mayer et al. (2012) and Baumeister et al. (2022).

**Table 1: Selected literature review on studies focused on sustainable onboard products and customer perceptions in the airline industry.**

| Study | Methods | Country / Global | Factors | Findings |
|---|---|---|---|---|
| (8) Hwang et al. 2023 | Quantitative | U.S. | -Customer perception<br>-Sustainability | -Most participants reserved flights online and were willing to reserve meals online as well.<br>-Sustainability did not significantly |

| | | | | |
|---|---|---|---|---|
| | | | awareness<br>-Willingness to pay<br>-Convenience and efficiency<br>-Age groups and ethnicity | change the willingness to pay more, but younger populations (students) liked the idea of reducing waste through pre-ordering food.<br>-A main motivator for customers was convenience, like guaranteed meal availability and the convenience of ordering in advance.<br>-Quality of the meal, taste, variety of meals, and freshness greatly influenced the decisions of customers to pre-order or pay more. |
| (9) Jainudeen Nawas 2025 | Qualitative | Global | -Customer expectations<br>-Customer preference<br>-Operational efficiency<br>-Waste management | -Passengers expect airlines to offer meal customization with better food quality, but safety regulations and cost concerns make this difficult<br>-Passengers increasingly want eco-friendly catering options.<br>- Pre-order meal systems and efficient supply chain strategies reduce inefficiency and improve customer satisfaction.<br>-Regulations and cost constraints make sustainability difficult, coupled with the issue of food waste and packaging. |
| (10) Ban and Kim, 2019 | Quantitative | Global | -Current airline brand image<br>-Perceived convenience<br>-Perceived costs<br>-Customer perception<br>-Customer trust<br>-Age and usage frequency | -The value for money, the current brand image, and service contribute significantly to customer perception of an airline.<br>-Online media is also a meaningful and legitimate way to capture customer perception and opinion.<br>-Passengers assess airline experience largely through the value for money, meaning that they care about the cost of the airline and what they receive in return. |
| (11) Mayer et al. 2012 | Quantitative | U.K. | -Airline green image<br>-Passenger environmental perceptions<br>-Airline differentiation<br>-Influence of | -Many passengers perceived airlines' green image differently, believing some airlines were more environmentally friendly than others.<br>-Previous experience with airlines influences customer perception of airlines, including environmental ratings.<br>-Low-cost airlines were not viewed in a |

| | | | | |
|---|---|---|---|---|
| | | | travel experience | significantly different way in the context of environmental sustainability compared to larger commercial carriers. |
| (12) Crouse et al. 2024 | Quantitative | U.S. | -Customer perception of climate change<br>-Customer perception of the value of aviation<br>-Customer consideration of environmental implications<br>-Emotional response to environmental issues | -Support for sustainability efforts in the airline industry is influenced by the emotional engagement of customers and the cognitive consideration of environmental issues.<br>-Green initiatives were typically supported more by customers who viewed aviation favorably and valued it.<br>-Environmental awareness and value perceptions are both essential for policymakers and airlines to consider when developing sustainable aviation efforts and policies. |
| (13) Abdullah et al. 2016 | Quantitative | Global | -Environmental impact of airlines<br>-Regulatory and stakeholder pressure<br>-Influence of airlines' economic significance<br>-Sustainability as a competitive factor | -Sustainability is partly motivated by competition between airlines, as it allows them to differentiate and appear responsible to customers.<br>-Sustainability performance between airlines differs significantly, and there is still plenty of room for improvement towards more sustainable practices.<br>-Sustainable practices help create greater operational efficiency for airlines. |
| (14) Pennington et al. 2025 | Quantitative | U.K./ Global | -Waste treatment pathways<br>-Emissions from treating in-flight waste<br>-Composition of in-flight waste<br>-Drivers of waste volume<br>-Regulatory constraints for food disposal | -Airline waste management contributes to a large amount of greenhouse gas emissions, especially organic waste in landfills and during incineration.<br>-A major barrier to airline sustainability efforts is regulatory constraints, especially biosecurity regulations, which force the use of landfill and incineration to dispose of airline waste.<br>-Waste generation is positively associated with the duration of flights.<br>-Despite being U.K. based, it is likely that the patterns in this research are true worldwide. |

| | | | | |
|---|---|---|---|---|
| (15) Chen and Hidalgo, 2022 | Mixed-methods | Global | -Alternative waste management options<br>-Economic impact of waste<br>-Scalability constraints<br>-Operational inefficiencies in catering | -A large amount of airline catering food waste originates from operational stages, like the production and packing of food.<br>-There is not a single universal solution to the issue of airline catering waste due to the difficulties of scaling, therefore waste management depends on the local infrastructure and characteristics.<br>-Data-driven and standardized operational processes can help reduce waste during the production of food for airline catering. |
| (16) Baumeister et al. 2022 | Quantitative | Finland/ Global | -Customer satisfaction and loyalty with airline<br>-Perceived environmental responsibility of the airline<br>-Perceived value for money<br>-Brand image<br>-Word-of-mouth (WOM) behavior | -Airlines that are perceived as environmentally responsible generally generate higher levels of customer satisfaction.<br>-Customer loyalty to an airline, especially long-term loyalty, can be driven by an airline's environmental responsibility by increasing satisfaction.<br>-Despite the effects of sustainability on customer satisfaction, the brand image and value for money of an airline are still major determinants of airline choice. |
| (17) Nakornkao and Mongkalig, 2022 | Qualitative | Global | -Volume of food waste in airline operations<br>-Economic costs<br>-Unsustainable consumption and production in catering<br>-Provisioning and logistics inefficiencies<br>-environmental effects | -Airline catering generates a substantial amount of food waste, as plenty of food inflight is discarded, wasting natural resources and exacerbating the environmental impacts of food waste.<br>-Current airline food provisioning in many airline catering services is systemically inefficient, following patterns of overproduction.<br>-Waste management that aligns with the three Rs (reduce, reuse, recycle) can be beneficial in minimizing food waste and improving sustainability. |

## SUMMARY OF LITERATURE REVIEW

Through a diverse analysis of existing academic research on customer perception and the environmental challenges and initiatives faced by the airline industry, key insights into airline onboard products, such as airline catering, and the resulting customer behavior have been obtained.

A crucial correlation between several of the studies examined was that there are severe environmental ramifications stemming from the continued production of cabin waste by airlines, especially related to the production, consumption, and disposal of food in in-flight catering. While many previous studies have examined carbon emissions stemming from the use of fossil fuels in aircraft and its effects on the global environment, Pennington et al. (2025), utilizing quantitative data like measuring waste volume and composition proportions, outlines that managing cabin waste after flights additionally contribute large numbers of greenhouse gases to be expelled, especially organic waste such as food waste from airline catering (14). This finding corroborates with the qualitative approach of Nakornkao and Mongkalig (2022), which emphasizes the substantial amount of food waste generated by airline catering, ultimately resulting in the waste of natural resources and negative environmental impacts (17). However, some studies note that waste and environmental impact also stem from crucial processes in the airline catering supply chain, such as production and packaging, where overproduction and inefficiency lead to food waste (15, 17). These two studies differ in that Nakornkao and Mongkalig (2022) supported a waste management strategy focused on reducing, reusing, and recycling to address food waste, whereas Chen and Hidalgo (2022) found that standardized, data-driven operational policies can instead help reduce waste (15, 17). Jainudeen Nawas (2025) approached this theme from a more consumer-focused perspective and found that, while efficient supply chain processes help address food waste in airline catering, a pre-order meal system can reduce inefficiency while satisfying customers (9).

While operational and supply chain issues remain key factors in the environmental impact of onboard product waste in the context of cabin food, several studies indicate that perceived sustainability or an airline's sustainability image can be used to differentiate or strategically benefit their brand, regardless of operational complications. While Abdullah et al. (2016) point out the operational benefits of sustainable practices in airlines, they also found that sustainability efforts result from competition among airlines, as these efforts allow them to differentiate or improve their brand image (13). This differentiation that airlines are attempting to achieve is confirmed by the customer-oriented viewpoint of Mayer et al. (2012), which reveals that sustainability efforts by airlines do make changes in customer perception, as many passengers had differences in their perception of airline sustainability based on the airline, seeing some as more eco-friendly than others (11). Jainudeen Nawas (2025) interestingly offers a different perspective, finding that passengers want eco-friendly catering options but also expect meal customization, though this is hindered by cost concerns and safety regulations (9).

When considering this customer perception of airline sustainability and how it motivates airline sustainability efforts in light of previous studies, it is interesting to note that while airline sustainability can result in greater customer satisfaction, this impact on customer perception varies significantly. This is

crucial because there is still uncertainty about how customer perception of airlines' brand image is affected by recent sustainability initiatives by airlines. For example, the value for money, current brand image, and the type of service contribute significantly to customer perception (10, 16); sustainability efforts can impact brand image and service, and thus boost customer satisfaction (16), yet are not pivotal factors in customer perception. This idea that service influences customer perception aligns with Hwang et al. (2023) and Jainudeen Nawas (2025), who both find that convenient service and food quality motivate customer behavior (8, 9). However, when the latter saw increasing passenger support for eco-friendly in-flight food, Hwang et al. (2023) found this support was weaker, with sustainability unlikely to significantly influence a customer's decision to pay more (8).

Despite this extensive exploration of how an airline's sustainability influences customer perception and the environmental complications of onboard products like catering, there remains a gap in understanding how the new implementation of environmentally sustainable onboard products, in particular, shapes customer perception. Many of the studies covered in the literature review focused on airline sustainability as a whole and analyzed in depth the challenges and sustainability characteristics of one aspect of airline onboard products: inflight catering. Additionally, few studies explored the sustainability aspects of major U.S. airlines, which have distinct international networks and attributes. The impact of a variety of sustainable onboard products on airline customers' perceptions of airlines, not just inflight catering, should be explored in future research, especially in specific countries or airline contexts whose customers and sustainability efforts differ and are constantly evolving with new developments.

## CASE STUDY

The major U.S. airlines that have begun implementing these sustainable supply chain practices for producing their onboard products have approached the onboard product waste issue in various ways. As such, a thorough case study analyzing the initiatives and practices these airlines have undertaken regarding eco-friendly onboard products and how customers responded is beneficial for addressing the research question in this study. The three largest airlines in the United States, United Airlines, American Airlines, and Delta Air Lines, often termed the "Big Three" U.S. airlines, capture a majority of the U.S. airline market share while operating at an enormous scale domestically and internationally. Their presence and impact on the U.S. and global airline industry additionally make their onboard product sustainability initiatives and shifts crucial. This case study delves into the histories and developments of the three airlines towards eco-friendly onboard products, while analyzing their customers' reactions in the years since, allowing for a comparison between the airlines.

### 1. UNITED AIRLINES, INC.

United Airlines is a major U.S. and international airline headquartered in Chicago, Illinois, and is the world's largest airline by fleet size, with 1,066 aircraft in service as of December 31, 2025 (18). United Airlines has publicly committed to sustainability efforts over the last ten years and has positioned itself as

an industry leader in environmental sustainability, implementing sustainable aviation fuel (SAF) in regular operations in 2016, becoming the first airline globally to do so (19). Due to United's commitment to sustainability in the air and in the cabin, including onboard products, in addition to its global reach and significant market share in the U.S. airline industry, it was selected to be analyzed in this study in order to gain unique insights into the customer response to sustainable onboard products.

United has faced both successes and challenges in its sustainability efforts over the past few years, as reflected in a SWOT (strengths, weaknesses, opportunities, and threats) analysis of its current sustainability situation. United benefits from already having a strong eco-friendly focus, having advertised its significant commitments to developing and utilizing SAF on its aircraft. By shifting to eco-friendly products across food, utensils, and packaging, United's sustainability efforts are more visible to customers and align with its environmental, social, and governance (ESG) strategy. This is especially crucial considering the hundreds of thousands of customers that United serves every day. However, the same scale at which United operates leads to weaknesses in consistency and trade-offs in its onboard products. United's hubs and aircraft differ in their routes and systems, which can result in limitations in waste management for onboard products. The quality and quantity of onboard products also differ, especially when considering eco-friendly alternatives and the removal of some products, all of which can affect customer perception. However, as outlined in Mayer et al. (2012), Hwang et al. (2023), and Jainudeen Nawas (2025), customers do consider the environmental sustainability of airlines, and younger populations view eco-friendly initiatives positively in the context of airline food and onboard products in general (8, 9, 11). This presents an opportunity for United to increase its sustainability efforts while maintaining alignment with its existing sustainable branding. However, studies such as Ban and Kim (2019) show that value for money, brand image, and convenience remain major customer priorities (10). United has struggled with its brand image in the last ten years, with highly publicized events such as the dragging of a passenger in 2017 becoming controversial. United points out that "greenwashing" claims by customers are also a risk (20). Industry rivals American Airlines and Delta Air Lines have also ramped up their sustainability efforts, posing a threat to United's widespread advertising that it is at the forefront of airline sustainability.

United Airlines' environmental sustainability strategy for onboard products, in particular, is integrated with its larger ESG strategy, which focuses on sustainability and social responsibility (20). Keeping with its slogans of "good leads the way" and "Connecting people. Uniting the world.", United's strategy has focused on minimizing cabin waste while also utilizing eco-friendly onboard products, particularly products' sustainable production in the supply chain. In 2016, United began major sustainability efforts by serving coffee and cookies from companies that engaged in sustainable practices (19). The airline also outlines how it became the first U.S. airline to turn partially used amenity kits into donations, working with the nonprofit organization Clean the World to keep over 60,000 pounds of waste out of landfills every year. United's efforts towards eco-friendly onboard products, part of its broader sustainability initiative, Eco-Skies, remain central to the airline's environmental sustainability goals, as detailed in the airline's own Corporate Impact Report 2024 (20).

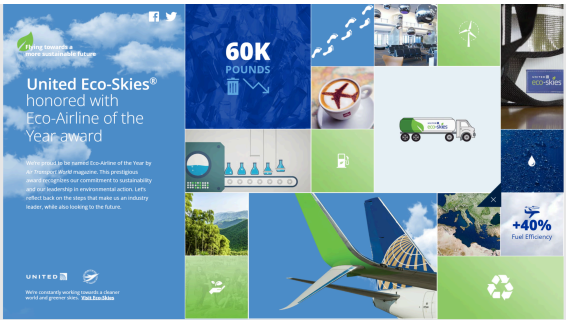



Fig. 1 - United's Eco-Skies interactive site. (19)




Fig. 2 - United's Corporate Impact Report 2024. (20)

In 2024, United made further moves toward onboard product sustainability by replacing single-use plastic-bottled wine with canned wine and by transitioning its *Hemispheres* magazine to a digital format to reduce paper waste (20). In August, United revamped its economy cutlery packet, using FSC 100% certified bamboo cutlery, a napkin with over 70% recycled content, and a paper wrapper to replace the previous plastic-based packet (21). Since United launched its Polaris business-class product in 2016, it has provided bedding and amenity kits to customers that have increasingly been packaged in recyclable materials, contain eco-friendly amenities, and are made from recycled plastic, especially since 2023 (21). Toothbrushes are made from bamboo; skincare does not contain petroleum; and eye masks and amenity pouches from luxury brands like Therabody and Brooks Brothers are made from recycled materials and can be reused (22). Much of this has been widely advertised through physical advertisements at United's hubs and on billboards, as well as online through articles and reports on their website (21). Amenity kits themselves sometimes feature sustainable branding, particularly on Hawaii-bound flights, which showcase nature-inspired designs (22).




Fig. 3 - New canned wine served on United. (20)



United's recycled 2026 Brooks Brothers amenity kit. (22)

The overall impact of United's strategy for onboard product sustainability was generally positive; United reported a gradual increase in recycled waste between 2019 and 2024, with declines in 2020 and 2021 as air travel declined during the COVID-19 pandemic (20). United's reported passenger numbers in 2024 increased significantly from 2023 levels, with the airline carrying 173.6 million passengers, up from 164.9 million in 2023 (23). This passenger growth continued in 2025, with United carrying 181 million passengers (24). Customer responses on independent forums and reviews were generally positive, with many supporting United's in-cabin sustainability initiatives. However, some customers, especially airline reviewers, questioned the quality of the onboard products, particularly the amenity kits, which the airline advertised as reusable (25). Customers and reviewers on forums felt that some products were cheap or less luxurious than those of competitors, especially those from international carriers (25).

This case seems to support prior academic literature and studies on sustainability initiatives, which report increased customer satisfaction and a positive brand image, especially when accompanied by substantial advertising and publicity for sustainability efforts. This was reflected in the United Airlines case. United had made information on sustainability initiatives and the environmental sustainability of its onboard products easily accessible to customers on its website and in its reports, while maintaining a track record of eco-friendly efforts. Overall, the United Airlines case reflects how widespread sustainability initiatives for onboard products and across the board can have significant implications on customer perception and satisfaction, especially if they continue over an extended period. It suggests that the overall sustainable aspects of onboard products, associated with their production in the supply chain, have a generally positive impact on customer perception, though other factors shape customer perception, rather than sustainability in the products they are served doing so singlehandedly.

## 2. AMERICAN AIRLINES, INC.

American Airlines is another major U.S. airline headquartered in Fort Worth, Texas, with a large fleet of 1013 aircraft as of December 31, 2025, and a diverse international and domestic route network (26). American Airlines has outlined its sustainability goals and initiatives over the past 19 years, publishing reports on sustainability and corporate responsibility nearly every year since 2007 (27). In 2007, American Airlines was already involved in initiatives to recycle cans and solid waste generated not only in the cabin but in maintenance facilities, operations centers, and lounges—in fact, American flight attendants started the first onboard recycling program in 1989 (28). 2010 saw more large-scale efforts to reduce waste sent to landfill, including goals to increase recycling and the creation of the Waste Minimization Team, as outlined in America's 2010 Corporate Responsibility Report (CRR) (29). At this point, flight attendants' efforts in the cabin resulted in the recycling of 15 million aluminum cans each year (29). Sustainability efforts to minimize, reduce, reclaim, and recycle cabin waste continued throughout the 2010s and continue in the 2020s, according to American's CRRs (27). American's differing approach towards onboard product sustainability, in addition to its different market presence and large size, justifies its selection for this case study.

Conducting a SWOT analysis of American Airlines' onboard product sustainability highlights key strengths and threats in American's initiatives. The airline benefits from a history of reducing onboard product waste, and has collaborated with numerous organizations to recycle products and bring positive outcomes to communities as a result of environmental efforts (27). American's onboard product initiatives do have weaknesses, as onboard products lack sustainable design and often appear indistinguishable from previous products, especially in amenity kits and bedding for Flagship Business and First Class. American Airlines' sustainability efforts often go unnoticed online, as much of their initiatives, especially those pertaining to onboard products, are difficult to access, as information is primarily found in newsroom and corporate reports (30). There is an opportunity, though, for American to increase customer awareness of its sustainability efforts, such as through branding, marketing, or onboard product design. Onboard product sustainability aligns with American's current marketing strategy, which highlights efficiency, caring for people, and improving passenger experiences through a modern fleet and expansive network (31). However, the U.S. airline industry as a whole has placed an emphasis on eco-friendly operations, coupled with financial and operational challenges in the past six years, poses a threat to American's sustainability goals. American outlines that shifts in public sentiment about climate change and stakeholder concerns are a medium-to-high-level risk (31).

Despite COVID-19 struggles, American's CRRs document how the airline introduced major revamps to a multitude of onboard products starting in 2021. American introduced sustainable meal boxes made from compostable materials for regional flights, while also creating sustainable cutlery made from bamboo (32). Other improvements that year included new amenity kits by Shinola and D.S. & Durga, which contained biodegradable paper packaging and a dental kit with a non-plastic toothbrush (33). The sustainable cutlery implementation expanded in 2022, alongside an initiative focused on the supply chain for onboard food, in which the airline worked with suppliers to review food provisioning and analyze waste reduction opportunities during production (34). American Airlines also analyzed ways to implement meals with little to no food waste and sustainably sourced seafood. In 2023 and 2024, American further expanded its efforts to reduce food waste by redistributing unused snacks (31). In its revamp of inflight bedding, American collaborated with textile company John Horsfall to make pillows, duvets, and blankets with recycled fibers and recycled fill (35). American also updated their sustainable supply chain policy in 2024, which outlines American's operational ideology of assessing and engaging upstream suppliers for ESG risks, which include climate change and operational impact (36).



Fig. 5 - Flagship Business sustainable bedding. (35)

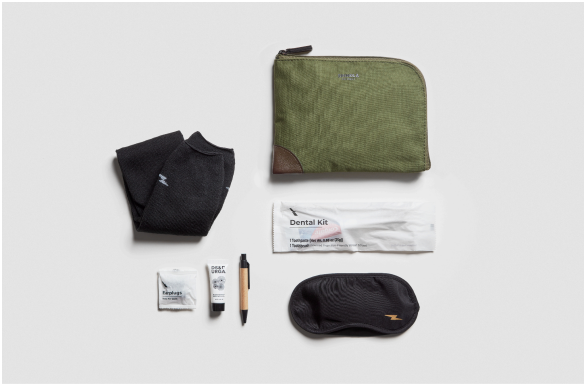



Fig. 6 - Flagship Business Shinola amenity kit. (33)

American's onboard product sustainability efforts had an impact on cabin waste, as the airline claimed that its 2024 effort addressing food waste saved over 293 tons of snacks (31). However, the impact on customer opinions of the airline was more significant, with mixed reactions on online forums towards American's new eco-friendly inflight offerings (37). Many passengers flying on the airline's Flagship first and business class products were unhappy when some flights were given recyclable cardboard boxes instead of the Shinola amenity kits (37). Other customers complained about the poor quality of amenity kits and thought they were still wasteful, as many passengers left used kits on flights (37). However, the response to more premium amenity kits, especially later kits in 2025, was more positive among customers in reviews and forums (37). While customers felt positive about American's sustainable onboard products, many customers were unaware of the eco-friendly aspects of American's onboard products, instead focusing on quality (37).

American Airlines' case reveals a wider pattern that connects to United Airlines' case and to prior literature. American's comparatively less amount of marketing around sustainability seemed to result in less positivity from customers, especially when product quality felt lackluster, suggesting that sustainability has positive repercussions on perception when quality remains high and customers are aware of it. American's case additionally reflects the breadth of airline efforts towards onboard product sustainability in recent years, as the airline made improvements in multiple areas, including amenity kits, food, and bedding.

## 3. DELTA AIR LINES, INC.

Delta Air Lines is a major U.S. and international airline with headquarters in Atlanta, Georgia. It operates 989 aircraft on a variety of international and domestic routes and remains one of the largest airlines in the world alongside American Airlines and United Airlines (38). Delta openly showcases its ESG strategy and sustainability efforts through its website and media presence, including sections for onboard product and supply chain sustainability (39). Similar to United Airlines' Corporate Impact Report 2024, Delta has developed the Delta Difference Report to outline ESG goals and initiatives (40). The report details Delta's sustainability approach: addressing "What We Fly," "How We Fly," and "The Fuel We Use" (39).

Onboard products and amenities are the central tenet of the "How We Fly" section of Delta's sustainability strategy, alongside the sustainability and climate impacts of the supply chain, which is a factor in all three sections (40).

A SWOT analysis of Delta Air Lines' onboard product sustainability reveals insights on the positives and negatives of Delta's strategy and room for improvement. The airline benefits from having a strong online presence and documentation of sustainability initiatives, allowing for increased exposure to the industry and customers (39). The airline also has a historically strong customer base and high employee satisfaction, with Delta's slogan "Keep Climbing" tying into themes of connecting people and improving the world, such as sustainability (40). Like its competitors, Delta is weakened by its immense scale, as sustainability efforts and products vary across its fleet and hubs. This same scale additionally makes cost an issue, as working with suppliers to develop sustainable products across the fleet typically have higher costs, which is exacerbated by recent rises in jet fuel prices. Like other airlines, Delta has an opportunity to increase its marketing of sustainable onboard products and expand its implementation, taking advantage of industry and public shifts towards preferring sustainability. However, this same public opinion can be a threat to Delta's sustainability goals, as a shift toward higher sustainability expectations can affect the airline's reputation in the long term (41). The two other airlines examined in this case study have implemented stronger sustainability initiatives into their operations, putting pressure on Delta.

As the airline industry recovered after the COVID-19 pandemic, Delta documents in its sustainability reports that it largely refreshed its onboard products from 2021 to 2022 (41, 42). The airline increasingly transitioned to biodegradable dishware and paper placemats for its food service, while using bamboo cutlery and offering aluminum-packaged wine on domestic flights (42). The airline also began using recycled polyester bedding with reusable packaging for its flights, while offering Delta One passengers amenity kits from apparel brand Someone Somewhere, which uses artisanal production to reduce plastic use and uses regenerated cotton (42). The brand is certified by the B Corporation, which verifies a company's environmentally sustainable and responsible supply chain and business practices (43). Another B Corporation-certified company, New Belgium/Bell's Brewery, was introduced on Delta flights in 2023, with beer in fiber packaging produced using climate-friendly farming practices (44). Overall, Delta has been increasingly onboarding upstream suppliers in its supply chain networks to the EcoVadis sustainability assessment, which enables Delta and its suppliers to collaborate and identify ways to improve environmental business standards across the supply chain (40).




Fig. 7 - Delta's new bamboo cutlery. (42)



Fig. 8 - Someone Somewhere amenity kit. (45)

In late 2023, Delta introduced plant-based paper cups on its flights to replace single-use plastic cups, and eventually implemented them across its operations in 2025 (40, 46). This involved the airline working with suppliers, flight crews, operations and catering teams, and sustainability and supply chain experts to create durable cups that complied with international regulations and could keep temperature (46). Delta greatly publicized this implementation, with branding, websites, and reports highlighting the paper cups (39, 40, 46). Additionally, the airline made major efforts to reduce onboard product cabin waste, donating bedding, amenity kits, and food to those in need (40, 44).




Fig. 9 - Delta's new inflight sustainable paper cups. (46)

Delta's efforts to create more sustainable supply chains through the EcoVadis assessment had a significant impact, with 256 suppliers assessed in 2022 growing to 1,051 assessed by 2025, according to Delta's data (40). The new sustainable onboard products led to a large decrease in plastic consumption of around 4.9 million pounds per year based on Delta's 2022 to 2023 metrics, with 2.4 million pounds saved through eco-friendly cutlery and dishware and 260,000 pounds saved by environmentally sustainable bedding (41). The airline claims that the new paper cups eliminate 7 million pounds of single-use plastics on board annually (46). Additionally, Delta's donation efforts between 2022 and 2024 were immense, with over 4.5 million pounds of bedding, amenity kits, food, and other supplies donated (44). Customer responses on independent online forums and reviews were generally positive about the paper cups, with many

customers supporting their environmental benefits, though some questioned their quality (47). Responses to amenity kits and bedding were more mixed, with many customers on the forums unhappy with the Someone Somewhere kits, thinking they were of lower quality (48). This sentiment seemed significant, as Delta decided to pivot towards more premium Missoni-branded amenity kits and bedding in 2025 and 2026 (49). Some customers' reactions to Delta's onboard product changes on online forums suggested that they were unaware of the environmental benefits of the new products (48).

Delta Air Lines' case suggests that there are large implications relating to the switch to environmentally sustainable onboard products, such as reductions in waste after flights or in the products' supply chains. However, customers who notice changes care about product quality, which aligns with previous academic literature and the cases of other airlines. However, the case also supports that customers respond positively to eco-friendly onboard products, with greater impact when aware of them.

## HYPOTHESIS DEVELOPMENT

The themes extracted from the literature review, together with information gathered from the case study, are used to shape four hypotheses aimed at understanding the effects of sustainable onboard products on customers' perceptions of U.S. airline brand images.

A core theme across multiple past studies analyzed in the literature review reflected that, despite some customers' positive views of sustainable onboard products such as airline catering, a large number of customers are still influenced by other factors such as quality and service (10, 16). In some cases, higher quality is expected, and customers were even willing to pay more when the quality and variety of food improved (8, 9). These findings in the literature are corroborated by the analysis of the major U.S. airlines in the case study, which suggested that some viewed eco-friendly onboard products, such as amenity kits, negatively due to a perceived drop in quality. Due to this pattern, the first hypothesis (H1) postulates that:

**H1: Customers are more supportive of sustainable onboard products when the perceived quality of the products is high.**

This fluctuation in responses to sustainable onboard product measures was also explained by customers' exposure to sustainability efforts and their views on sustainability as a whole. Customers perceived some airlines as more sustainable than others, leading to higher customer satisfaction (11, 16). Customers who valued aviation more and were more concerned about environmental issues also showed greater support for airline sustainability efforts (12). This forms the basis for the second hypothesis (H2):

**H2: Higher awareness of airlines' environmentally sustainable onboard products among customers leads to a more positive brand image for the airline.**

With this pattern of airlines being seen differently based on their perceived sustainability, a large section of this is sustainable marketing and awareness, especially in an airline's flights, advertising, marketing, and website. As seen through the case study, major U.S. airlines are motivated to showcase their sustainability efforts, how this sustainability is communicated to customers differs between airlines. United Airlines, for example, has painted aircraft in liveries that showcase its sustainability efforts (50). Therefore, the third hypothesis (H3) states:

**H3: Greater communication by airlines about sustainable onboard products leads to greater support of sustainable onboard products among customers.**

Onboard product supply chains generate waste and pollution, but shifting to sustainable supply chains for onboard products can result in operational inefficiencies. It was also found in prior literature that increasing the use of eco-friendly processes in production may improve operational efficiency (9, 13). The supply chain processes or operational backgrounds of airlines generally aren't considered by customers, nor is knowledge of these processes easily accessible. Thus, customers may associate airline efficiency with other metrics. In order to delve into this concept while tying in environmentally sustainable onboard products, the fourth hypothesis (H4) states:

**H4: Customers who support more environmentally sustainable onboard products are more likely to view the airline as operationally efficient.**

In the next section, the survey methodology for hypothesis testing is explained.

## SURVEY

To gain firsthand perspectives on customers' perceptions of the in-flight offerings provided by U.S. airlines, while including the independent variable of sustainability, a survey questionnaire was used to collect quantitative data. This survey was conducted in June 2026, gaining insights from 101 participants who are customers of major U.S. airlines. The participants' consent was obtained, and participant data remained confidential and secure, as reinforced by IRB approval. The survey was developed using simple, coherent language to reduce the likelihood of confusion or bias among respondents.

The survey was divided into three sections, each designed to gain a deeper understanding of respondents' perceptions and behaviors. Section 1 focuses on general information about their preferences as air travelers and aims to assess their knowledge of airlines' environmental impacts and cabin sustainability efforts. Section 2 uses a Likert scale, where 1 is "Strongly disagree" and 5 is "Strongly agree," and delves further into respondents' preferences, specifically when considering the use of onboard products, the brand image of an airline's sustainability, and the inclusion of environmentally sustainable onboard products. Likert-scale data is treated statistically as a mean based on the numerical values (1-5) assigned to each of the response options (strongly disagree to strongly agree) and is used to reflect the average

level of agreement or disagreement to the statement in each question. The distance between each of the five values was assumed to be equal, and the size of the sample was large enough to take into account the Central Limit Theorem. As such, data were treated as interval-level data, allowing for statistical comparison of the Likert scale means.

These ideas are continued in Section 3, which incorporates branding and images of onboard products from major U.S. airlines, such as United Airlines and American Airlines, to examine the impact of airline sustainability on customer perception and whether factors such as sustainable design or sustainable branding influence participants' responses. Each question displays two onboard product images, and the proportions of respondents which selected either of the two onboard products in the question were compared in the statistical analysis.

The selected images of amenity kits, bedding, and advertisements in Section 3, minus Question 1,5 were labeled as "comparable" in order to account for possible bias by respondents assuming the level of quality of the onboard products shown. However, onboard products selected were chosen to be as similar as possible in terms of quality, such as a similar number of toiletries in amenity kits and a shared selection of amenities like slippers and pillows in airline bedding. Onboard products selected also were released to customers within a few years of each other. Images shown in each question originated from the same airline to prevent airlines' differing design and product philosophies from affecting respondents' opinions. Onboard products came from either the same or similar seat class, such as the two First Class amenity kits on American Airlines in Question 13.

## SURVEY QUESTIONNAIRE

**Table 2: Selected survey questions and response distribution from an online survey conducted in June 2026 (N=101). Questions covered customer awareness of environmentally sustainable onboard products, opinions on onboard products, and customer preferences towards airlines. Questions about demographics and consent are omitted.**

| | | |
|---|---|---|
| Hello! I'm Steven Chan, an eleventh-grade student in New Jersey, currently conducting research to examine the impact of U.S. airlines' sustainability strategies for onboard products, such as food and amenity kits, on customers' perceptions of the airline.<br><br>Please fill out the survey form for academic purposes. I assure you that your data will remain confidential and secure. As such, emails will not be collected, and a copy of responses will not be provided. This survey was created in compliance with standards outlined by a school-level IRB and was approved. Thank you so much! | | |
| **Questions** | **Options** | **Frequency (%)** |

| | | **N=101** |
|---|---|---|
| **Section 1: General Questions** | | |
| Q1: What major U.S. airline are you mainly a customer of? | 1. American Airlines<br>2. Delta Airlines<br>3. United Airlines<br>4. Southwest<br>5. JetBlue<br>6. Alaska/Hawaiian<br>7. Other | 1. 19.8%<br>2. 15.8%<br>3. 38.6%<br>4. 7.9%<br>5. 9.9%<br>6. 3%<br>7. 5% |
| Q2: What seat category do you typically fly on? | 1. Economy<br>2. Economy Plus/Premium Economy<br>3. Business<br>4. First | 1. 56.4%<br>2. 37.6%<br>3. 6%<br>4. 0% |
| Q3: Are you aware of the environmental impacts of the airline industry? | 1. Yes<br>2. No<br>3. Maybe | 1. 63.4%<br>2. 19.8%<br>3. 16.8% |
| Q4: Are you aware that environmentally sustainable onboard products are available on airlines? | 1. Yes<br>2. No<br>3. Maybe | 1. 23.8%<br>2. 68.3%<br>3. 7.9% |
| **Section 2: Please answer questions depending on how likely you agree with the statement.**<br>Onboard products = amenity kits, bedding, toiletries, food, utensils, etc.<br><br>Sustainability = products created with environmentally friendly or conscious materials, utilize reused materials, not made of single-use plastic, less waste after use | | |
| Q5: I choose an airline for its onboard product sustainability, even if it costs significantly more. | 1. Strongly Disagree<br>2. Disagree<br>3. Neutral<br>4. Agree<br>5. Strongly Agree | Mean: 2.307 |
| Q6: I consider the quality of the onboard products served when booking a flight. | 1. Strongly Disagree<br>2. Disagree<br>3. Neutral<br>4. Agree | Mean: 2.624 |

| | | |
|---|---|---|
| | 5. Strongly Agree | |
| Q7: I use/consume the onboard products I am served on a flight. | 1. Strongly Disagree<br>2. Disagree<br>3. Neutral<br>4. Agree<br>5. Strongly Agree | Mean: 3.911 |
| Q8: I associate airline sustainability with airlines being more efficient. | 1. Strongly Disagree<br>2. Disagree<br>3. Neutral<br>4. Agree<br>5. Strongly Agree | Mean: 3.099 |
| Q9: I think it is more expensive for an airline to be sustainable. | 1. Strongly Disagree<br>2. Disagree<br>3. Neutral<br>4. Agree<br>5. Strongly Agree | Mean: 3.703 |
| Q10: I think onboard product sustainability greatly reflects an airline's commitment to sustainability. | 1. Strongly Disagree<br>2. Disagree<br>3. Neutral<br>4. Agree<br>5. Strongly Agree | Mean: 3.911 |
| Q11: I think of an airline more highly when its onboard products are environmentally sustainable. | 1. Strongly Disagree<br>2. Disagree<br>3. Neutral<br>4. Agree<br>5. Strongly Agree | Mean: 3.446 |
| **Section 3:** Based on the following images of the advertisements from the airlines regarding their onboard services, please answer the questions. | 1. Picture 1<br>2. Picture 2 | |

| | | |
|---|---|---|
| Q12: If you were given these two amenity kits with the same toiletries inside, which would have interested you more?<br><br>*Both amenity kits have comparable amenities and quality. |   | 1. 46.5%<br>2. 53.5% |
| Q13: If you saw these two amenity kit advertisements, which one would have caught your eye?<br><br>*Both amenity kits have comparable amenities and quality. |   | 1. 48.5%<br>2. 51.5% |
| Q14: If this bedding was served to you on a flight, which one would you prefer?<br><br>*The bedding quality is similar. |   | 1. 29.7%<br>2. 70.3% |
| Q15: If you had the choice between these two amenity kits, which one would you choose?<br><br>*Picture 1 features more premium amenities while Picture 2 is sustainable but with less amenities. |   | 1. 59.4%<br>2. 40.6% |
| Q16: Do you have any personal | (Open-ended question.) | Responses vary. |

| | | |
|---|---|---|
| opinion about airline sustainability and sustainable onboard products that you would like to share? If so, please explain below.<br><br>This question is OPTIONAL. | | |

## RESULTS

In order to analyze the responses from the survey and associate relationships with the hypotheses, statistical analysis through correlation and regression is utilized. Google Sheets was used to display and organize respondents' answers, in addition to its use to calculate statistical results.

| | **Not sustainable option** | **Sustainable option** | **Row total** |
|---|---|---|---|
| **Non-sustainable option** | 34 | 26 | 60 |
| **Sustainable option** | 18 | 23 | 41 |
| **Column total** | 52 | 49 | 101 |

### (1) Sustainable onboard products and perceived quality

For the first hypothesis (H1), a McNemar test was utilized to compare proportions. This test was selected instead of a standard two-proportion z-test due to data being paired, as the same respondents answered the two questions used in this statistical analysis. Specifically, Questions 13 and 15 are used as the former stipulates that quality is equal between the two onboard products depicted, while the latter indicates a difference in quality between the sustainable (lower quality) and non-sustainable (higher quality) options. The proportion of respondents who selected the more sustainable option was compared. Instead of the standard McNemar test, the Edwards correction is used as a continuity correction to reduce Type I error.

**H1: Customers are more supportive of sustainable onboard products when the perceived quality of the products is high.**

**Table 3: Contingency table used to discern the data utilized for the test statistic.**

Onboard products with same quality

Onboard products

with
different
quality

**Table 4: Statistical results comparing the level of support for sustainable onboard products when accounting for the quality and value for money of products.**

| | |
|---|---|
| Degrees of freedom (df) | 1 |
| Test statistic ($\chi^2$) | 1.4545 |
| p-value | p=0.2278 |
| Edwards-corrected test statistic ($\chi^2$) | 1.1136 |
| p-value | p=0.2913 |
| Significance ($\alpha$=0.05) | 0.2913>0.05 Not significant |

Results from Tables 3 and 4 revealed that there was no statistically significant difference between the proportion of airline customer respondents who selected the sustainable onboard product with a comparable level of quality and the proportion of respondents who selected the sustainable onboard product with a lower level of quality. These results suggest that the quality variable does not seem to have a large impact on whether airline customers select a sustainable onboard product, meaning that the level of support is similar. However, when viewing the proportions of respondents who selected the sustainable option without conducting statistical analysis, it does appear that quality matters to some extent, with 40.6% of respondents selecting a lower-quality sustainable onboard product while a larger 48.5% selected a sustainable onboard product with a standard level of quality.

For this section of statistical analysis, several limitations could have affected the data and conclusions of this study. Due to constraints, two separate surveys that could have measured responses for each question independently were not conducted. Doing so would have prevented the use of McNemar's chi-squared test, as the data would have been independent rather than paired; instead, a standard two-proportion z-test would have been used, and the results would differ. A relatively small sample size may have affected results. While effort was made to find onboard products that were as similar as possible (same airline, similar era), onboard products and branding shown were not identical, thus making confounding by other variables such as appearance possible.

**(2) Customer awareness of sustainable onboard products and brand image**

For the second hypothesis (H2), a two-sample t-test was used to compare differences in means. Out of the survey responses, one group "Group 1" was created from respondents who responded "Yes" to Question 4 (Are you aware that environmentally sustainable onboard products are available on airlines?) while the other group "Group 2" was created from respondents who responded "No" to Question 4. The corresponding responses from these two groups to Question 11 (I think of an airline more highly when its onboard products are environmentally sustainable.) were collected, reflecting brand image. Question 11 uses a typical Likert scale, allowing the means for both groups to be calculated and analyzed.

**H2: Higher awareness of airlines' environmentally sustainable onboard products among customers leads to a more positive brand image for the airline.**

**Table 5: Statistical results comparing awareness of sustainable onboard products and the corresponding views on airline brand image when sustainable onboard products are offered.**

| Variable/Statistic | Group 1 - Is aware of sustainable onboard products (n=23) | Group 2 - Is unaware of sustainable onboard products (n=69) |
|---|---|---|
| Mean | 3.435 | 3.493 |
| Standard Deviation | 0.946 | 0.871 |
| Test Statistic (*t*) | *t*=-0.26 | |
| p-value | p=0.797 | |
| Significance (α=0.05) | 0.797>0.05 Not significant | |

Results from Table 5 showed no significant difference in the level of airline brand image between customers aware of sustainable onboard products and those unaware (t=-0.26, p=0.797), indicating that airline brand image is not significantly affected by awareness of sustainable onboard products. As the analysis fails to reject the null hypothesis, this data suggests that the impact of sustainable onboard products on customers' perceptions of airlines may not be influential.

There are limitations to the statistical analysis that could have affected the results. A much smaller proportion of respondents were aware of sustainable onboard products, and this smaller sample size could have influenced the mean compared with the larger sample of individuals unaware of sustainable onboard products. The voluntary nature of obtaining responses may have affected data as well.

When analyzing this hypothesis, other interesting insights emerged from the survey data. Namely, while over 68% of survey respondents were unaware of eco-friendly onboard products served by U.S. airlines (Question 4), 63.4% were aware of the environmental impacts of airlines in general (Question 3). Among customers of the three largest U.S. airlines (United, American, Delta), 66.67% of primarily United Airlines customers (n=39) were aware of airline environmental impacts, 60% of American Airlines customers (n=20) were aware, and 75% of Delta Air Lines customers (n=16) were aware. When focusing on sustainable onboard product awareness in particular (Question 4), 25.64% of United customers, 20% of American customers, and 25% of Delta customers were aware. This pattern seems to align with insights gathered from the case study, as Delta and United had substantial online public data and updates on their sustainability efforts, which were more easily accessible to customers than those of American. This relates to the second hypothesis and has implications for the third hypothesis.

**(3) Airline communication of sustainable onboard products and customers' support of sustainable onboard products**

For the third hypothesis (H3), a McNemar test with an Edwards correction was used to compare differences in proportions. Survey questions in Section 3 displayed branding and imagery of U.S. airline onboard products, with sustainable and nature-like branding accompanying the more sustainable option. For this statistical analysis, the proportion distribution of United Airlines' sustainable and standard amenity kit (Question 12) was compared with the proportions of American Airlines' inflight bedding (Question 14), which showed no noticeable differences in branding despite one option being sustainable. Branding, such as sustainable design in amenity kits, serves as a key indicator of an airline's communication to customers. The proportions of respondents who selected the more sustainable option were compared and analyzed.

**H3: Greater communication by airlines about sustainable onboard products leads to greater support of sustainable onboard products among customers.**

**Table 6: Contingency table used to discern data utilized for the test statistic.**

Sustainable onboard product with sustainable branding

| Sustainable onboard product without sustainable branding | | **Not sustainable option** | **Sustainable option** | **Row total** |
|---|---|---|---|---|
| | **Non-sustainable option** | 13 | 17 | 30 |
| | **Sustainable option** | 41 | 30 | 71 |
| | **Column total** | 54 | 47 | 101 |

**Table 7: Statistical results comparing the level of support of sustainable onboard products when accounting for the sustainable branding of products.**

| | |
|---|---|
| Degrees of freedom (df) | 1 |
| Test statistic ($\chi^2$) | 9.931 |
| p-value | p=0.00163 |
| Edwards-corrected test statistic ($\chi^2$) | 9.121 |
| p-value | p=0.00253 |
| Difference in proportions | -0.238 |
| Significance ($\alpha$=0.05) | 0.00253<0.05 Significant |

Results from Tables 6 and 7 show a statistically significant difference in the proportion of respondents who chose the sustainable onboard product with sustainable branding and those who chose the sustainable onboard product without distinguishable branding. However, survey data reveals that a large majority of respondents selected the sustainable onboard product option in Question 14, which showed no recognizable branding difference compared to the standard onboard product option. As such, the statistical analysis rather surprisingly suggests that airlines that don't communicate the eco-friendliness of their onboard products are likely to see greater support.

This conclusion may be the result of a variety of factors. While both onboard products shown in Question 14 were explicitly stated to be of comparable quality, thus ensuring that quality does not confound with results, the design and appearance of the two onboard products did differ, albeit without any indication of sustainability. A possible confounding variable could arise from IRB suggestions and fair use statutes, which necessitated crediting the source of each onboard product photo. The credit consequently included the date of the onboard products. As the more sustainable onboard product in Question 14 was seven years newer, this could have influenced responses. The results could also suggest that airlines have not made significant efforts to communicate sustainability to their customers, or that sustainable branding on onboard products could even undermine the message of sustainability that airlines intend to convey. This possibility is justified by the personal perceptions of individual respondents who decided to share their opinions (Question 16). Respondents have stated that they felt like the sustainable amenities were more of a marketing strategy and a gimmick, while others noted that airlines have not made significant efforts to raise customers' awareness of sustainability.

**(1) Customer support for sustainable onboard products and perceived airline efficiency**

For the fourth hypothesis (H4), a Spearman correlation is used to test the statistical significance of the correlation coefficient ρ, which, for this specific statistical analysis, measures the correlation between the level of support for sustainable onboard products among survey respondents (Question 11) and how efficiently respondents perceived sustainable airlines (Question 8). As the data were paired, a Pearson correlation was not appropriate, and a Spearman correlation was used instead. Question 11 was used as the independent variable, and Question 8 was used as the dependent variable.

**H4: Customers who support more environmentally sustainable onboard products are more likely to view the airline as operationally efficient.**

**Fig. 10 - Spearman rank correlation graph between the level of support for sustainable onboard products and views of airline efficiency (n=101).**

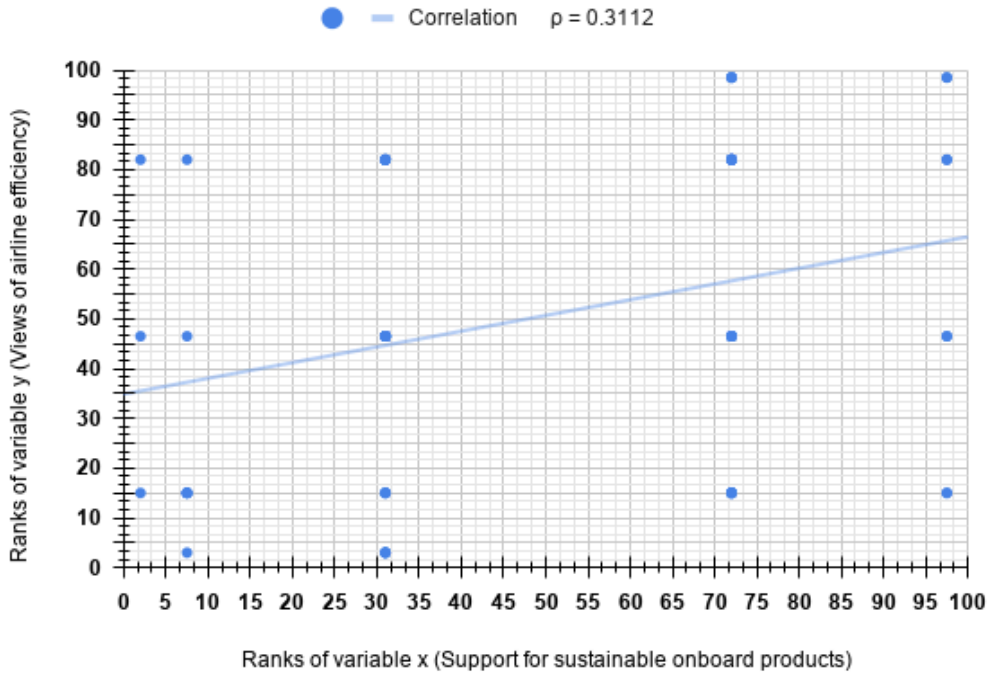


**Table 8: Statistical results comparing the level of airline efficiency perceived by customers when accounting for customers' support for sustainable onboard products.**

| | |
|---|---|
| Degrees of freedom (df) | 99 |
| *t*-statistic | 3.2585 |
| p-value | 0.000768 |
| Correlation coefficient (ρ) | 0.3112 |
| Significance (α=0.05) | 0.00077<0.05 Significant |

Results of the statistical analyses in Tables 7 and 8 show a statistically significant positive correlation between customers' level of support for sustainable onboard products and their perceptions of airline efficiency. Specifically, a moderate positive correlation was found (ρ=0.3112), suggesting that customers who tend to support sustainable onboard products are more likely to view airlines offering such products as more efficient, thereby benefiting airlines' brand image. However, this does not definitively suggest that greater support for sustainable onboard products will result in higher perceptions of efficiency and, thus, a more positive brand image. This conclusion is reinforced by a general consensus among respondents that environmentally sustainable onboard products greatly reflect airline sustainability as a whole (Question 10), with a Likert scale mean of 3.911.

Limitations could arise from the small distribution of ranks in the Spearman distribution, as both survey questions used in this statistical analysis were based on a 1-5 Likert scale. Likert scale responses are ordinal rather than continuous and may not be an appropriate basis for statistical tests such as a t-test, which may affect the validity and reliability of the results. A greater variation in responses would likely yield more accurate correlation results, and a nonparametric test rather than a t-test would be more appropriate for the second hypothesis (H2). Voluntary response and paired data may have affected results.

## DISCUSSION

This study suggests that while environmentally sustainable onboard products have some impact on customer perceptions of airlines' brand image, this impact is not as pronounced as previously hypothesized. Airlines and customers are still primarily focused on the environmental impacts of airlines, such as fossil fuel use, regardless of the impact that the production and consumption of onboard products have on the environment. However, customers, especially those who understand the environmental impacts of onboard products and the existence of sustainable onboard products, tend to respond more favorably to airlines. It seems that a portion of survey respondents were familiar with aviation and airline sustainability, as reflected in optional responses to Question 16, which asked for respondents' opinions.

This pattern was similarly visible in previous research, which found that customers who valued aviation better (and thus knew more about the industry) were more supportive of sustainability initiatives (12).

An important factor appears to be the impact of customer awareness regarding the environmental ramifications of onboard products and airlines' sustainability initiatives on brand image. Notably, 68% of survey respondents were unaware that environmentally sustainable onboard products were available on flights. Survey respondents felt that onboard product sustainability was not properly advertised or communicated, leaving them unaware of such initiatives. These survey findings were reinforced by the findings in the case study, which found that greater communication of eco-friendly onboard product efforts would be beneficial, as it was determined that all three airlines examined have an opportunity to improve customer awareness of their sustainability initiatives as a whole in order to generate more positive brand image results. Additional survey data seems to support the importance of customer awareness, as American customer respondents in the survey were about 5% less aware of sustainable onboard products than respondents who frequented United or Delta. This could be the result of Americans having somewhat less access to information about sustainability initiatives than the other two airlines.

It appears that the extent to which onboard product sustainability is communicated to customers is crucial to increasing customer awareness. Airline competition at least partially motivates sustainability efforts (13), and the case study found that airlines were worried about "greenwashing" claims and other critical public opinions regarding sustainability efforts. Some survey respondents questioned the reasoning behind the onboard product sustainability initiatives, believing them to be more of a marketing strategy.

A lack of communication may help explain the unusual results that appeared in the statistical analysis of Hypothesis 3. It was found that there was a statistically significant difference in the proportion of respondents who chose an eco-friendly onboard product with a sustainable design (Question 12) compared with those who chose an eco-friendly onboard product without such a design (Question 14). However, respondents more readily chose the more sustainable onboard product option without sustainable design. As most respondents were unaware of sustainable onboard products, this could have influenced the result.

While survey respondents agreed to using onboard products on a flight (mean: 3.911), they were generally opposed to considering the quality of onboard products (mean: 2.624), and the value for money decreased when choosing an airline with sustainable onboard products (mean: 2.307). This results in some connections with past research and the case study, as sustainability initiatives by the U.S. airlines in the case study and the airlines analyzed by past research saw higher levels of support when the value for money was high, as the value for money is a more significant factor that influences customer decisions (10, 16). Indeed, around 8% fewer survey respondents preferred a sustainable onboard product with an explicitly lower level of quality compared to a sustainable onboard product with a level of quality comparable to a non-sustainable option. Delta and United customer opinions explored in the case study displayed similar behavior, as many disliked the lower quality of some eco-friendly onboard products offered (25, 48). However, where the case study and literature review pointed to the large influence of

quality on customer preferences for onboard products, this was not reflected in the survey's statistical analysis, which did not find a statistically significant difference between respondents who preferred a lower-quality sustainable onboard product and those who preferred a standard sustainable onboard product.

The impact of sustainable onboard products on brand image, it seems, is that it results not only in greater efficiency on the airlines' side but also in more positive customer reactions regarding efficiency. Previous research found that sustainability efforts create greater operational efficiency (13), and efficient supply chain strategies reduce inefficiency while improving customer satisfaction (9). This improvement in customer satisfaction was reinforced by survey responses, which showed a positive correlation between respondents aware of sustainable onboard products and more positive perceptions of airlines, in the form of greater perceived efficiency. Importantly, a greater positive response from a wider group of customers seems more likely when airlines properly communicate sustainable onboard product initiatives, as a lack of customer awareness of such initiatives had a significant impact on survey responses about brand image. Ultimately, only Hypothesis 4 was supported by the data gathered in this study.

## CONCLUSION

This study aims to make a preliminary empirical contribution to ongoing and prior research on the supply chain and onboard products of commercial airlines. While the supply chain and development of sustainable aviation fuel (SAF), the supply chain of inflight catering, and the sustainable supply chain of aviation parts have been previously explored, there is an absence of research that analyzes the impact of multiple sustainable onboard products, especially amenity kits and bedding, on customer perception. As airlines continue to implement more sustainable practices across their operations, this study offers initial empirical contributions, revealing key insights into customers' reactions and perceptions of environmentally sustainable onboard products.

Past research has examined the impact of different supply chain practices on airline food and beverage, or focused on airlines' efforts towards sustainability through sustainable aviation fuel. Previous research has not extensively examined the impact of U.S. airlines' sustainability and supply chain efforts on their customers, particularly regarding the onboard products they experience. This research examines sustainable supply chain efforts for a variety of onboard products offered by U.S. airlines. It aims to describe airline customers' perspectives and responses to these efforts, especially their perceptions of airlines.

The statistical analysis of survey responses revealed that while the quality of sustainable onboard products and the communication of sustainability initiatives do have some impact, they are not significantly influential on customer perceptions. However, customers who were more aware of sustainable onboard products had more positive reactions to the airline brand image in terms of airline efficiency. In light of the case study and literature review, these findings suggest that environmentally sustainable onboard

product initiatives help airlines improve operational and supply chain efficiency while also resulting in higher levels of brand image. Regardless, insights from this study emphasize the need for strategic planning across multiple factors—marketing, design, production, and disposal—to successfully develop and implement environmentally sustainable onboard products.

Limitations of this study include a small sample size relative to the large number of U.S. airline customers and potential bias due to voluntary survey responses. The constraint of using a single survey, which necessitated statistical analyses that accounted for paired data, influenced the results. Results may also have been affected by confounding variables in Section 3 of the survey, as survey respondents may not have shared the assumption that the onboard products depicted in the questions were of similar quality, despite being told that the products were comparable. This study was also limited by its focus on U.S. airlines and U.S. airline customers, which may limit the applicability of the survey's insights to other regions. While respondents selected a wide range of their typical airline of choice, IRB guidelines prevented the collection of information pertaining to respondents' locations in the U.S., which may affect whether the sample reflects a broad spectrum of U.S. airline customers. Future research could explore, on a wider scale, the impacts of onboard product sustainability on different regional groups, and the extent to which the quality of eco-friendly onboard products and the communication about them influence customer perceptions. Continued inquiry into the impact of a multitude of onboard product sustainability initiatives on U.S. customer perceptions, rather than focusing on a single onboard product, is necessary to gauge the broader impact of sustainable onboard products.

The findings of this study aim to guide and inform the airline industry, firms involved in the supply chain network for airline onboard products, and other large businesses with substantial customer bases, such as the hospitality sector, seeking to incorporate sustainable supply chain practices. This research showcases customer behavior in response to sustainability-driven initiatives, not only enabling business executives and planners in the airline industry to understand their impact but also providing insights for future planning and the implementation of sustainable supply chain practices for onboard products and other consumables. Airlines can reshape their production, advertising, and marketing efforts based on the study's findings to increase communication of sustainability initiatives while taking into account customer preferences, ensuring that more sustainable onboard products help the environment and produce positive outcomes for customers and airlines.

By providing real-world data on customers’ perspectives and perceptions of airlines’ sustainability efforts, this research aligns with the broader global objective of improving environmental and ethical sustainability within the complex supply chains of businesses and services. This study also indicates current trends and the relationship between customer perception and brand image with sustainable products and initiatives—a relevant aspect of business development and planning. This addresses the key challenge of managing waste and enhancing customer experience in the airline industry, enabling airlines and other businesses to make better supply chain and product decisions.

## CONFLICT OF INTEREST

The author declares that there are no conflicts of interest related to this work.

## ACKNOWLEDGEMENTS

I would like to thank my mentor, Soniya Gupta-Rawal, for her invaluable guidance and support throughout the research process and in navigating the ethical approval process. I would also like to thank my economics teacher, Matt Pokoj, for showing me the importance of the environmental and social impacts of business, and my statistics teacher, Ghassan Nazi, for teaching me about statistical analyses and methodologies that I've since built upon and applied in this work. Many thanks to the faculty and administration of Fort Lee High School for their support in developing an official Institutional Review Board and ensuring ethical standards during the survey and research processes.

## REFERENCES

1. International Air Transport Association. IATA Cabin Waste Handbook. 2019. Available from: https://www.iata.org/contentassets/821b593dd8cd4f4aa33b63ab9e35368b/iata-cabin-waste-handbook.pdf (accessed on 2026-3-28).
2. Dong C. How Premium Air Travel Is Evolving In 2026 And Beyond. Forbes. 2026 Mar 9. Available from: https://www.forbes.com/sites/forbestravelguide/2026/03/09/how-premium-air-travel-is-evolving-in-2026-and-beyond/ (accessed on 2026-3-25).
3. International Air Transport Association. Airline cabin waste – progress towards a circular economy. 2025 Feb 21. Available from: https://www.iata.org/en/iata-repository/publications/economic-reports/airline-cabin-waste--progress-toward-a-circular-economy/ (accessed on 2026-3-29).
4. Green P. The World's Largest Airline By Fleet Size. Simple Flying. 2025 Oct 7. Available from: https://simpleflying.com/worlds-largest-airline-fleet-size/ (accessed on 2026-3-27).
5. Wenger T. The sustainability initiatives that each major US airline is taking to make flying greener. Matador Network. 2025 Apr 30. Available from: https://matadornetwork.com/read/airline-sustainability-initiatives/ (accessed on 2026-4-19).
6. Galhoz I, Ramos RF, Biscaia R. Airline environmental sustainability actions and CSR impact on customer behavior. Res Transp Bus Manag. 2024;53:101111.
7. Mejía V, et al. Is an Airport Like Any Other Mall? Identification of Passengers' Activity Patterns in an International Airport. In: Academy of Marketing Science World Marketing Congress. Cham: Springer International Publishing; 2019.

8. Hwang E, Kim YS, Song HG. Airline Passengers' Willingness to Reserve Inflight Meals Online and Their Willingness to Pay for Meal Upgrades: The Case Study of US Students. Sustainability. 2023;15(10):8071.
9. Jainudeen Nawas M. Optimizing In-Flight Catering: Balancing passenger expectations, operational efficiency, and sustainability. 2025.
10. Ban HJ, Kim HS. Understanding customer experience and satisfaction through airline passengers' online reviews. Sustainability. 2019;11(15):4066.
11. Mayer R, Ryley T, Gillingwater D. Passenger perceptions of the green image associated with airlines. J Transp Geogr. 2012;22:179-186.
12. Crouse SR, et al. Support for green initiatives in aviation: A case study across American aviation consumers. J Air Transp Res Soc. 2024;2:100020.
13. Abdullah MA, Chew BC, Hamid SR. Benchmarking key success factors for the future green airline industry. Procedia Soc Behav Sci. 2016;224:246-253.
14. Pennington L, et al. Beyond the runway — Quantifying the climate impact of international catering waste. Waste Management. 2025;203:114870.
15. Chen M, Hidalgo J. Trash or Treasure: An Analysis of Airline Catering Food Waste. Dissertation. 2022.
16. Baumeister S, et al. Do airlines' eco-friendliness matter? Customer satisfaction with an environmentally responsible airline. Transp Policy. 2022;128:89-97.
17. Nakornkao N, Mongkalig C. Food waste management from the airline caterers. Eng Access. 2022;8(1):74-79.
18. United States Securities and Exchange Commission. United Airlines Holdings, Inc. Form 10-K for the fiscal year ended December 31, 2025. Available from: https://www.sec.gov/ix?doc=/Archives/edgar/data/0000100517/000010051726000023/ual-20251231.htm (accessed on 2026-5-17).
19. United: Eco-Skies. Available from: https://view.ceros.com/ceros-inspire/eco-skies/p/1 (accessed on 2026-4-19).
20. United Airlines. Corporate Impact Report 2024. Available from: https://corporateimpact.united.com/ (accessed on 2026-4-18).
21. United Airlines. Our Commitment to Environmental Sustainability. Available from: https://www.united.com/en/us/fly/company/responsibility/our-environmental-commitment.html (accessed on 2026-4-17).
22. United Airlines. Amenity kits. Available from: https://www.united.com/en/us/fly/travel/inflight/amenity-kits.html (accessed on 2026-4-12).
23. United Airlines. Quarterly results. Available from: https://ir.united.com/financial-information/quarterly-results (accessed on 2026-4-18).
24. United Airlines. United Airlines Q4 and Full Year EPS Beat Wall Street Expectations, With Full Year EPS Up Year-Over-Year. 2026 Jan 20. Available from: https://www.united.com/en/us/newsroom/announcements/cision-125435 (accessed on 2026-4-17).

25. United Amenity Kit. Reddit. Available from: https://www.reddit.com/search/?q=united+amenity+kit&cId=8f393fbf-2f9b-4ca8-89a3-51d029c6f7c4&iId=32a5ede9-7295-46e0-836c-5722fafc86dd (accessed on 2026-4-19).
26. United States Securities and Exchange Commission. American Airlines Group Inc. Form 10-K for the fiscal year ended December 31, 2025. Available from: https://www.sec.gov/ix?doc=/Archives/edgar/data/0000006201/000000620126000014/aal-20251231.htm (accessed on 2026-5-17).
27. American Airlines. Corporate responsibility. Available from: https://news.aa.com/crr/ (accessed on 2026-5-15).
28. American Airlines. 2007 Environmental Responsibility Report. Available from: https://s202.q4cdn.com/986123435/files/doc_downloads/crr/ERR-Report-2007.pdf (accessed on 2026-5-13).
29. American Airlines. 2010 Corporate Responsibility Report. Available from: https://s202.q4cdn.com/986123435/files/doc_downloads/crr/CRR-Report-2010.pdf (accessed on 2026-5-13).
30. American Airlines. Sustainable operations. Available from: https://news.aa.com/sustainability/environment/sustainable-operations/ (accessed on 2026-5-9).
31. American Airlines. Environmental sustainability. Available from: https://news.aa.com/sustainability/environment/ (accessed on 2026-5-3).
32. American Airlines. ESG Report 2021. Available from: https://s202.q4cdn.com/986123435/files/images/esg/aag-esg-report-2021.pdf (accessed on 2026-5-13).
33. American Airlines. American revamps amenity kits with brands rooted in thoughtful design and creativity. Available from: https://news.aa.com/news/news-details/2021/American-Revamps-Amenity-Kits-with-Brands-Rooted-in-Thoughtful-Design-and-Creativity-MKG-OTH-05/default.aspx (accessed on 2026-5-15).
34. American Airlines. Sustainability Report 2022. Available from: https://s202.q4cdn.com/986123435/files/images/esg/aa-sustainability-report-2022.pdf (accessed on 2026-5-14).
35. American Airlines. Reimagined onboard experience with American Airlines takes off with the launch of new amenities, elevated dining, and more. Available from: https://news.aa.com/news/news-details/2024/Reimagined-onboard-experience-with-American-Airlines-takes-off-with-launch-of-new-amenities-elevated-dining-and-more-MKG-OB-04/default.aspx (accessed on 2026-5-13).
36. American Airlines. Sustainable supply chain policy. August 2024. Available from: https://news.aa.com/sustainability/resource-center/ (accessed on 2026-4-27).
37. American Airlines Amenity Kit. Reddit. Available from: https://www.reddit.com/search/?q=american+airlines+amenity+kit&cId=af913e61-2b38-4e70-aad6-12c96906bfb0&iId=2f59d056-f7ee-4b58-b660-a8d65aa071e4 (accessed on 2026-5-13).
38. United States Securities and Exchange Commission. Delta Air Lines, Inc. Form 10-K for the fiscal year ended December 31, 2025. Available from:

https://www.sec.gov/ix?doc=/Archives/edgar/data/0000027904/000002790426000013/dal-20251231.htm (accessed on 2026-5-17).
39. Delta Air Lines. Sustainability. Available from: https://www.delta.com/us/en/about-delta/sustainability (accessed on 2026-5-16).
40. Delta Air Lines. 2025 Delta Difference Report. Available from: https://esghub.delta.com/content/esg/en/2025/index.html (accessed on 2026-5-16).
41. Delta Air Lines. 2022 ESG Report. Available from: https://www.delta.com/content/dam/delta-www/about-delta/corporate-responsibility/delta-air-lines-ESGreport2022.pdf (accessed on 2026-5-16).
42. Delta Air Lines. Eco-conscious bedding, cutlery, and amenity kits: Delta's driving change for the earth and the people in it. Available from: https://news.delta.com/sites/default/files/2022-01/delta_esg_product_story_1.25.22_0.pdf (accessed on 2026-5-16).
43. B Corporation. About B Corp certification. Available from: https://www.bcorporation.net/en-us/certification/ (accessed on 2026-5-17).
44. Delta Air Lines. 2024 Delta Difference Report. Available from: https://esghub.delta.com/content/esg/en/2024/advancing-progress.html#the-travel-experience (accessed on 2026-5-16).
45. Delta Air Lines. Someone Somewhere Amenity Kit. Available from: https://news.delta.com/media/image/44716 (accessed on 2026-5-15).
46. Delta Air Lines. Sustainable science: How Delta is eliminating7 millionM pounds of single-use plastic on board with new paper cups. Available from: https://news.delta.com/sustainable-science-how-delta-eliminating-7m-pounds-single-use-plastic-board-new-paper-cups (accessed on 2026-5-17).
47. Delta Amenity Kit. Reddit. Available from: https://www.reddit.com/search/?q=delta+amenity+kit&cId=02d7a6db-25c8-42ec-8ef6-2813a9b38d87&iId=a07106bd-62f0-4c4e-887f-cd789913b6c3 (accessed on 2026-5-17).
48. Delta Sustainability. Available from: https://www.reddit.com/search/?q=delta+sustainability&cId=2e54fba7-1d5f-4a29-b620-8b678ecc3e9a&iId=f523e7d1-1a6a-4209-ba5d-a6e91efc3024 (accessed on 2026-5-17).
49. New Delta One Missoni amenity kits feature five seasonal colours and an exclusive Grown Alchemist skincare routine. Available from: https://news.delta.com/new-delta-one-missoni-amenity-kits-feature-five-seasonal-colors-exclusive-grown-alchemist-skincare (accessed on 2026-5-17).
50. Perfect Paint Schemes: A Closer Look At Some Of United Airlines' Best Special Liveries. Simple Flying. 2024 Oct 5. Available from: https://simpleflying.com/united-airlines-best-special-liveries/ (accessed on 2026-5-9).

## ABOUT THE AUTHOR

Steven Chan is a high school senior at Fort Lee High School in Fort Lee, New Jersey. He is captivated by the complex operations and supply chains of large businesses and organizations, especially their changes regarding sustainability. An avid aviation enthusiast and traveler, Steven plans to study operations and supply chain in college with a focus on sustainable business.