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Sustainable Flying Behavior: Green Economy Class, Sustainable Aviation Fuel, Offsetting, or Taking the Train?

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Abstract

The aviation industry's environmental impact is large and is forecasted to increase. To counteract this, airlines have adopted a number of sustainable measures such as green economy class, contributions to Sustainable Aviation Fuel (SAF), offsetting and promoting train travel as an alternative to flying. The purpose of this paper is to compare airlines' approaches to motivate passengers to reduce or offset their journey's CO2 emissions. A survey was developed with three scenarios (short-, mid- and long-haul flights) and six sustainable measures. The 185 collected responses were analyzed using t-tests and McNemar tests. The results indicate that airlines' strategies providing more freedom of choice regarding donation amount and more information on the SAF/offsetting scheme can acquire more funds for reducing or offsetting emissions. Further, the train-flight mix is a promising approach to reducing emissions, especially for short- and mid-haul flights, and could be combined with SAF approaches for the largest emission savings.

Keywords
air travel, sustainable consumer behavior, environmental sustainability, sustainable flying, aviation.

1. Introduction

Air travel CO2 emissions have been increasing over the years, and with that there are growing concerns over climate change, pollution, and the well-being of upcoming generations (Pratt 2023). It is estimated that by 2050, the amount of CO2 emissions from air travel will triple, and passengers have started to become more aware of the impact of their behavior and the importance of decreasing their carbon footprint (Graver et al. 2019).

Accordingly, companies such as Airbus, also started looking into different alternatives to current polluting fuels, with their revolutionary ZEROe project, which aims to guarantee a zero emissions flight, powered by hydrogen, ideally by 2035 (Airbus 2023). Further, governments put in place measures to limit the growing amount of emissions, targeting principally domestic flights. France, for example, implemented a ban on short-haul domestic flights between cities that can be reached by train in less than 2.5 hours (Limb 2022), and Air France implemented a scheme to encourage passengers to choose rail journeys when traveling within the country, rather than flying (Damiani 2020). Other airlines such as Lufthansa also started taking more sustainable initiatives by using Sustainable Aviation Fuels (SAF), whose production is expected to meet 100% of the needs by 2050, and reduce emissions by 63% (Abrantes et al. 2021).

Such projects promise a brighter future with a big decrease in emissions by 2050 (Abrantes et al. 2021). Yet, while the aviation sector awaits a more concrete implementation of these plans, CO2 emissions are still increasing, calling for urgent actions to take place (Graver et al. 2019). Accordingly, airlines have adopted strategies targeting customers' behavior. With several possibilities such as offsetting their carbon footprint, contributing to SAF use, or flying in "green economy", customers are made aware of their environmental impact and encouraged to limit it (Cole 2024). Carbon offsetting is a mechanism that enables passengers to compensate for their environmental impact by investing in projects that reduce emissions elsewhere, whereas SAF is an alternative fuel that reduces emissions from air travel directly. For example, Ryanair offers flyers the option to partially or fully offset the emissions of their flight (Ryanair 2023), while Cathay Pacific runs a "fly greener" program that enables passengers to offset emissions by contributing

with a "lump sum" of their choice (Cathay Pacific 2023). Further, KLM is providing its passengers with an overview of the amount of CO2 emissions that will result from their trip, and offers a choice between several set payable amounts that can be used to offset and/or reduce emissions by using SAF (KLM 2023). Lufthansa also offers a mix of offsetting and SAF-emission reductions as part of their "Green" economy and business classes. Passengers flying in these Green classes reduce their flight-related CO2 emissions by 20% through SAF use, and the remaining 80% of emissions get offset through contribution in climate protection projects (Lufthansa 2023a).

While airlines are introducing various strategies to encourage passengers to offset or reduce CO2 emissions, it still remains unclear to what extent air passengers will use those new options for more sustainable flying. Moreover, it is unclear which strategy works best in terms of encouraging customers towards more sustainable behavior.

Previous studies on air travel behavior have examined consumer willingness to pay for reducing or offsetting emissions in air travel (Wendt 2023; Rotaris et al. 2020). Higham et al. (2014) studied the "The Flyer's Dilemma", i.e. the tension between the personal benefits of tourism and the detrimental environmental impact of flying. McDonald et al. (2015) explored the narratives flyers create to explain the differences between their green attitudes and their flying behaviors. Núñez Alfaro and Chankov (2022) studied to what extent consumers value environmental sustainability when selecting flights in terms of the trade-off between cost, time, comfort, and CO2 emissions. Nevertheless, until now no research has been conducted on the airlines' newly created strategies and it is still undetermined how consumers would react to them, presenting a research gap.

Investigating those new strategies is important for both theory and practice. On the one hand, such an investigation will help fill in the research gap and create a better understanding on which sustainable option offered by airlines is more welcomed by consumers. On the other hand, it will provide airlines with insights on consumers' behavior towards current strategies, and thus help airlines improve their current approaches and reach their sustainability targets.

1.1 Objectives

The purpose of this paper is to compare airlines' approaches to motivate passengers to reduce or offset their journey's CO2 emissions. Accordingly, we develop five hypotheses and design a survey with three scenarios (short-, mid- and long-haul flights) and six sustainable measures: 2 offsetting approaches (Ryanair and Cathay Pacific), 1 pure SAF approach (inspired by Air France and Cathay Pacific), 2 combined approaches for SAF and offsetting (KLM and Lufthansa's Green Economy) and 1 approach promoting train travel for part of the journey (inspired by Lufthansa's Rail&Fly and Google Flights). The gathered data is analyzed using t-tests and McNemar tests.

The paper is organised as follows. Section 2 presents the hypotheses development. The research design is described in section 3. The findings are presented in section 4 and discussed in section 5. Finally, section 6 concludes the paper.

2. Hypotheses Development

Gagné and Deci (2005) have explored human behavior through the self-determination theory (SDT), which proposes that customers' motivation to adopt a certain behavior is more likely to be stronger when it results from intrinsic motivation. One key factor that enhances intrinsic motivation is autonomy, or the ability to make self-directed choices. Applying this to passenger contributions to offset emissions or reduce emissions via SAF, providing travelers with the freedom to choose how much they wish to contribute may increase their willingness to pay and thus lead to more funds being collected. Hence, the following hypothesis is formulated:

H1: Passengers contribute more to offsetting/SAF initiatives when given greater freedom of choice than when presented with predefined options.

Based on the Social Cognitive Theory, individuals are more likely to take action when their personal beliefs, behaviors, and environmental context are aligned (Bandura 1986). Offsetting is more familiar to people and can be considered more as a social and personal responsibility with a direct positive outcome and impact on the environment since each traveler is offsetting their own CO2 emissions on the flight. On the other hand, contributing to SAF can be seen more as donating to the airline for research purposes on new alternative fuels, and not as passengers' own responsibility for their emissions. Since people are more likely to engage in behaviors they perceive as personally relevant and impactful, we expect spending on offsetting to be higher than contributions to SAF:

H2: Passengers spend more on offsetting their CO2 emissions than on contributing to SAF.

According to the Information-Motivation-Behavior (IMB) model (Steg and Vlek 2009), providing individuals with sufficient information can encourage pro-environmental behavior, especially when social motivators and norms are present. Further, information search is an important aspect of buyer decision process and increased access to relevant information influences purchasing behavior (Kotler and Lee 2008). In the context of aviation, providing more detailed information about both the flight's environmental impact and the allocation of contributions (offsetting and SAF) may lead to a higher number of passengers choosing to participate. Hence, the following hypothesis can be formulated:

H3: The more information provided on the environmental impact and the allocation of donations (e.g., SAF vs. offsetting), the higher the number of passengers who choose to participate.

When it comes to taking the train, several factors are to be considered: the price, the duration, and the comfort. Under their Rail&Fly program, Lufthansa offers the option of taking the train to the layover location instead of flying there for roughly the same price. However, taking the train often increases the overall trip duration and decreases comfort. Núñez Alfaro and Chankov (2022) have shown that duration is a key factor in travel decisions with shorter trips generally preferred. Hence, it is expected that as the total trip duration increases with the train-flight mix, fewer passengers will choose this option compared to a two-flight trip with a layover. The following hypothesis is derived:

H4: The longer the trip duration with train-flight combination, the fewer the number of passengers who choose it over flying only.

Lufthansa's Rail&Fly program relies on trains operated by German Railway, whose trains emit less than one gram of CO2 per person per kilometer, while the average plane emits 297 grams per person per kilometer (Deutsche Bahn 2023). This makes the train-flight mix an eco-friendlier option in terms of direct CO2 savings. Social Cognitive Theory (SCT) suggests that individuals are more likely to engage in behaviors they believe will lead to tangible, immediate results (Bandura 1986). In the case of transportation, passengers may view taking the train as an immediate and concrete action to reduce their carbon footprint. On the other hand, contributions to SAF are more abstract, as they support long-term research and development of sustainable fuel technologies but do not provide direct reductions in emissions for the individual passenger. Further, Lufthansa's Rail&Fly program leads to emission reduction at roughly the same price, while SAF contributions are quite expensive. The following hypothesis is formulated:

H5: The train-flight combination leads to greater CO2 emission saving than SAF approaches.

3. Research Design

A survey was designed to gather data to test the hypotheses. Three scenarios were used in the survey: short-, mid-, and long-haul (See Table 1). Bremen, Germany was used as the starting location for all scenarios as the research team is based in Bremen. The price, duration and CO2 emissions were derived from Google Flights (2023).

Table 1. Survey Scenarios

Scenario	Type	Route (one-way)	Layover	Price	Duration	CO2
1	short-haul	Bremen, GER – Paris, FRA	Frankfurt	150 Euro	3 hours	100 kg
2	mid-haul	Bremen, GER – Casablanca, MAR	Frankfurt	200 Euro	5 hours	180 kg
3	long-haul	Bremen, GER – Los Angeles, USA	Frankfurt	700 Euro	15 hours	700 kg

For each scenario, respondents were asked if they are willing to contribute some amount to offsetting or reducing their flight's emissions using six sustainable measures (Table 2). Two pure offsetting approaches were based on Ryanair's tiered approach (0%, 50% or 100%) (Ryanair 2023) and Cathay Pacific's lump-sum approach, where passengers are given the option to donate an amount of their choice, which is invested in offsetting projects (Cathay Pacific 2023). One pure SAF approach was inspired by Air France and Cathay Pacific. Air France adopts a tiered SAF approach (Air France 2023), but following Cathay Pacific lump-sum offsetting approach, we derived a new SAF lump-sum approach. Further, we used two combined approaches for SAF and offsetting (KLM and Lufthansa). KLM offers a choice between four set packages with fixed amounts to contribute to offsetting and/or SAF (KLM 2023). Lufthansa offers passengers to upgrade to "Green Economy" Class by paying a fixed amount which is used to reduce 20% of the flight's emissions through SAF and offset the other 80% (Lufthansa 2023a). Finally, we applied one approach promoting train travel for part of the journey (inspired by Lufthansa's Rail&Fly and Google Flights). Lufthansa gives passengers the option to take a train to the layover stop while keeping the price roughly the same (Lufthansa 2023b). Next to flights, the flight search engine Google Flights (2023) also shows train alternatives and displays the CO2 emissions

transparently for flights and trains so passengers can see the emission reductions offered by train travel. We mix both approaches to create a new approach where passengers are given a train-flight mixed option, where they take the train for part of their journey and flight for the rest, and are informed about the resulting emission savings.

Table 2. Airlines' Sustainable Measures Used in Survey

No	Type	Name	Airline	Details
1	offset	Tiered offset	Ryanair	Offset 0%, 50% or 100% of emissions
2	offset	Lump-sum offset	Cathay Pacific	Offset emissions for donated amount
3	SAF	Lump-sum SAF	Air France / Cathay Pacific	SAF emission reduction for donated amount
4	SAF-offset mix	Tiered SAF-offset mix	KLM	Offset 100%, 2 % SAF & 98% offset, 15% SAF & 85% offset, SAF 100%
5	SAF-offset mix	Green Economy Class	Lufthansa	20% SAF & 80% Offset
6	train	Train-Flight mix	Lufthansa / Google Flights	Reduced emissions due to train travel.

The target sample was set to be respondents above the age of 18 who have previously booked a flight for themselves or for somebody else to/from Bremen airport. We applied voluntary response sampling. Thus, the survey was open for 24 days (April 26 – May 20, 2023) and advertised on social media and survey sharing platforms as well as a German university's mailing list. 185 participants took part in the survey on a voluntary basis.

4. Results

4.1 Sample Description

46% of the 185 participants were female, 52% were male and 2% identified with a different gender. A large portion of participants were 18-25 years old at 48% of the sample, followed by participants of 26-35 years of age at 29%, 36-45 years at 19%, 46-55 at 4%, and 1% were above the age of 55. 35% of the respondents earned less than 1000 Euro a month, 20% earn between 1000 and 3000 Euro, 31% earn over 3000 Euro and 14% preferred not to disclose their income level. 34% of respondents are currently attending college, 36% had an undergraduate degree, 20% had a graduate degree, while 11% had attended high school. Finally, about 57% of respondents are European residents followed by 25% being North American residents and 18% live in the rest of the world.

In terms of participants flying behavior, 43% indicated that they fly once or twice a year, while 31% and 23% fly three to four, or more than five times a year, respectively. 38% of the participants never offset the emissions of their flight, 19% rarely offset, 30% sometimes offset and 14% always offset.

4.2 H1: Funds Gathered Depending on Freedom of Choice

To test hypothesis H1, we compare the amounts gathered using lump sum measures and tiered measures by using one-tailed paired-samples t-tests. The effect size is measured using r as suggested by Field (2013) with $r < 0.1$ indicating no effect, r between 0.1 and 0.3 a small effect, r between 0.3 and 0.5 a medium effect and $r > 0.5$ a large effect.

Table 3: T-test Results for H1 on Funds Gathered Depending on Freedom of Choice

Lump-Sum Offset vs Tiered Offset	**Mean 1**	**Mean 2**	**t value**	**Effect size (r)**
Short-haul	17.39	1.74	13.21***	0.70 large
Mid-haul	19.45	3.35	8.76***	0.54 large
Long-haul	30.01	9.15	5.19***	0.36 medium
Lump-Sum SAF vs Tiered SAF-offset mix	**Mean 1**	**Mean 2**	**t value**	**Effect size (r)**
Short-haul	30.76	13.89	7.28***	0.47 medium
Mid-haul	39.24	23.63	5.48***	0.37 medium
Long-haul	72.84	59.64	1.20	
Lump-Sum SAF vs Green Economy Class	**Mean 1**	**Mean 2**	**t value**	**Effect size (r)**
Short-haul	30.76	18.16	5.38***	0.37 medium
Mid-haul	39.24	17.35	7.37***	0.48 medium
Long-haul	72.84	46.05	2.88**	0.21 medium

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3 displays the results. First, we compare the lump sum offset with the tiered offset approach of Ryanair and find that the lump sum approach is able to collect significantly higher amounts than the tiered approach in all scenarios with strong effect size in the short-haul and mid-haul scenarios, and medium effect in the long-haul scenario. Second, we compare the lump sum SAF approach with the tiered SAF-offset mix of KLM and find that the lump-sum approach is able to gather significantly more funds in the short-haul and mid-haul scenarios (medium effect), while the long-haul scenario shows no significant difference (lump sum still has higher result, just not significant). Third, we compare the lump sum SAF approach with Lufthansa's tiered approach of "Green Economy" class, in all three scenarios the lump sum SAF approaches performs better (medium effect).

It can be concluded that the lump sum approaches that give participants full freedom of choice on how much to donate towards offsetting or SAF reductions lead to higher amounts being collected and thus H1 is supported.

4.3 H2: Funds Gathered through Offsetting vs SAF

To test hypothesis H2, we compare the amounts gathered using the lump sum offset and lump sum SAF approaches using one-tailed paired-samples t-test (see Table 4). In all scenarios, the lump sum SAF approach leads to significantly more funds being collected (medium effect), thus rejecting H2.

Table 4: T-test Results for H2 on Funds Gathered through Offsetting vs SAF

Lump-Sum Offset vs Lump-Sum SAF	**Mean 1**	**Mean 2**	**t value**	**Effect size**
Short-haul	17.39	30.76	-6.84***	0.45 medium
Mid-haul	19.45	39.24	-7.42***	0.48 medium
Long-haul	30.01	72.84	-5.22***	0.36 medium

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

4.4 H3: Number of Participants Based on Information Amount

To test hypothesis H3, we compare the number of survey respondents who chose to participate in KLM's tiered SAF-offset mix and Lufthansa's Green Economy. While KLM's approach transparently provides detailed information about the flight's emissions as well the split between CO2 emissions being reduced by using SAF and emissions being offset, Lufthansa relies on a less-information heavy approach that only mentions "Green Economy" class that does 80% offset and 20% SAF without giving details on the actual CO2 emissions.

To do the comparison, we conduct McNemar's tests (as applied by Ignat and Chankov (2020)). The McNemar's Test is a statistical method used for binary data especially when analyzing changes in participants' scores. The effect size is measured using Odds Ratio (OR) with OR < 1.49 indicating no effect, OR between 1.49 and 3.45 a small effect, OR between 3.45 and 9 a medium effect and OR > 9 a large effect.

We want to test if there are participants who chose to donate to KLM's approach, but not to donate to Lufthansa's approach. For KLM's approach, we only consider if people choose to donate regardless of the amount being donated. The results are shown on Table 5. In all three scenarios, a significant result can be established with large effect size indicating that KLM's detailed approach is able to convince significantly more people to donate than Lufthansa's Green Economy class. Thus, H3 can be confirmed.

Table 5. McNemar Test results for H3 on Number of Participants Based on Information Amount

Short-haul		Green Economy		Mid-haul		Green Economy		Long-Haul		Green Economy	
		yes	no			yes	no			yes	no
Tiered SAF-offset mix	yes	112	63	Tiered SAF-offset mix	yes	107	62	Tiered SAF-offset mix	yes	70	88
	no	0	10		no	0	16		no	1	26
χ^2		61.02***				60.02***				83.10***	
Odds Ratio		127 large				125 large				59 large	

* p < 0.05, ** p < 0.01, *** p < 0.001

4.5 H4: Trip Duration Prolongation Through Train-Flight Mix

To test hypothesis H4, we compare the number of survey respondents who opted for taking the train for part of their journey among the three scenarios. In the short-haul scenario, participants were told that the train-flight mix will not prolong their journey (same travel time), while in the mid-haul and long-haul scenarios they were told that taking the train for part of the journey will elongate the trip by 3 hours. In all scenarios, the train-flight mix had the same price as flying which is often the case with Lufthansa's Rail&Fly program.

Accordingly, we conduct two McNemar's tests to compare the number of people taking the train in the short-haul vs the number of people taking the train in the mid- and long-haul scenarios. For reference we also conduct a McNemar's test comparing the mid- and long-haul scenarios. Results are shown on Table 6. Significantly more people opted for taking the train for part of the journey in the short-haul scenario (no prolongation) compared to the mid-haul and long-haul scenarios (both with 3 hours prolongation), the effect size is medium. There is no significant difference between the mid-haul and long-haul scenarios (both having 3 hours prolongation). Thus, H4 can be confirmed.

Table 6. McNemar Test results for H4 on Trip Duration Prolongation Through Train-Flight Mix

No prolongation vs 3 hours		Mid-haul		No prolongation vs 3 hours		Long-Haul		3 hours vs 3 hours		Long-Haul	
		yes	no			yes	no			yes	no
Short-haul	yes	118	40	Short-haul	yes	115	43	Mid -haul	yes	106	17
	no	5	22		no	11	16		no	20	42
χ^2		25.69***				17.80***				0.11	
Odds Ratio		8.0 medium				3.9 medium					

* p < 0.05, ** p < 0.01, *** p < 0.001

4.6 H5: Emission Saving through Train-Flight Combination

To test hypothesis H5, we compare the emission reductions resulting from taking the train for part of the journey vs emission reductions achieved through SAF (lump sum SAF, KLM's tiered SAF-offset mix and Lufthansa's Green Economy class) by using one-tailed paired-samples t-tests. Results are shown on Table 7.

The lump sum SAF approach leads to significantly more emission reductions than the train-flight mix in all three scenarios (with small effect for short- and mid-haul and medium effect for the long-haul), which contradicts H5. The

train-flight mix leads to significantly more emission savings than KLM's tiered SAF-Offset mix and Lufthansa's Green Economy class in the short-haul scenario (medium and large effect) and the mid-haul scenario (small and medium effect), which confirms H5. For the long-haul scenario, the opposite effect can be observed with the train-flight mix leading to significantly fewer emissions being reduced than the KLM and Lufthansa's approaches (small effect), which contradicts H5. Thus, the results for H5 are different for the different scenarios and measures.

Table 7. T-test Results for H5 on Emission Saving through Train-Flight Combination

Train-Flight Mix vs Lump-Sum SAF	**Mean 1**	**Mean 2**	**t value**	**Effect size (r)**
Short-haul	34.16	42.73	- 2.49**	0.18 small
Mid-haul	33.24	50.46	- 4.15***	0.29 small
Long-haul	34.05	98.05	- 5.17***	0.36 medium
Train-Flight Mix vs Tiered SAF-offset mix	**Mean 1**	**Mean 2**	**t value**	**Effect size (r)**
Short-haul	34.16	17.56	6.93***	0.45 medium
Mid-haul	33.24	26.96	1.75*	0.13 small
Long-haul	34.05	68.37	- 2.58**	0.19 small
Train-Flight Mix vs Green Economy Class	**Mean 1**	**Mean 2**	**t value**	**Effect size (r)**
Short-haul	34.16	12.11	19.66***	0.82 large
Mid-haul	33.24	20.82	6.86***	0.45 medium
Long-haul	34.05	53.73	- 4.26***	0.30 small

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

4.7 Hypotheses Support Summary

Table 8 shows the outcomes of the five hypotheses. Hypotheses H1, H3 and H4 were confirmed in all cases, while H2 was rejected. H5 showed different results for the different measures. In the short-haul and mid-haul scenarios, H5 could be supported when comparing the train-flight mix with KLM's and Lufthansa's approaches. In the long-haul scenario, H5 was rejected as the train-flight mix couldn't outperform KLM and Lufthansa SAF reductions. When using the SAF lump sum, H5 was rejected in all scenarios. Thus, we can conclude partial support for H5 for the short-haul and mid-haul scenarios, and rejection for H5 for long-haul.

Table 8. Overview of Hypotheses Support

No	**Area**	**Short-haul**	**Mid-haul**	**Long-Haul**
H1	Funds gathered depending on freedom of choice	Yes	Yes	Yes
H2	Funds gathered through Offsetting vs SAF	No	No	No
H3	Number of Participants Based on Information Amount	Yes	Yes	Yes
H4	Trip Duration Prolongation Through Train-Flight Mix	-	Yes	Yes
H5	Emission Saving through Train-Flight Combination	Partial	Partial	No

5. Discussion

5.1 Freedom of Choice, Information Amount and Pro-environmental Behavior

The findings for hypothesis H1 further support the self-determination theory suggesting that the more freedom individuals are allowed and the more control they think they have over their decision, the more likely they are to make pro-environmental choices (Gagné and Deci 2005). Indeed, regardless of the duration of the trip, the lump sum strategy or visualization generated, on average, more funds and contributions for both offsetting and SAF. As such, looking at Ryanair's tiered offset approach for example, it consisted of offering a possibility to either fully or partially offset emissions for a rather low price, while the lump sum offset allowed people to donate an amount they desire, which led to more donations. The same phenomenon could be observed when comparing the lump sum SAF amounts with the generated money from KLM and Lufthansa's tiered SAF approaches. As the lump sum approaches are not widely used, this finding is interesting. Further research is needed to validate it and study in detail the best way to utilize lump sum donations.

When comparing, Lufthansa's Green Economy Class and KLM's tiered SAF-offset mixed approach, it was established that more people opted to donate to KLM's approach. This confirmed hypothesis H3 and the importance of providing detailed information on the environmental impact of the measures as well as the specific allocation of donations (emissions reduced through SAF and emissions offset). Indeed, Kotler and Lee (2008) previously demonstrated the importance of the information aspect in decision making in purchasing and buying behavior). KLM provides detailed information about the equivalent amount of CO2 in kilograms which will be offset and the contribution to SAF for each option they offer, while Lufthansa only set the price of the "Green Economy" upgrade and presents percentages without providing further information.

Learning from these results, airlines should rely on approaches that offer both freedom of choice and provide detailed information.

5.2 Offsetting vs SAF

A comparison was made between the lump sum for offsetting and SAF. According to hypothesis H2, it was expected to collect a higher amount through the offsetting contributions, as passengers are more familiar with that concept, which is also presented as a direct social responsibility of travelers, while SAF contributions are advertised as funds collected by airlines to invest in the research for alternative fuels, and can be seen more as airlines' responsibility. Nevertheless, hypothesis H2 was rejected. A possible explanation for this could be the way SAF was presented to the respondents in the survey. Indeed, it was explained that this alternative fuel was more expensive and, unlike offsetting, would result in a direct impact on the environment since they reduce emissions instead of only trying to compensate for already emitted CO2 through carbon offsetting. It appears that respondents perceive the direct CO2 reductions through SAF as worth more than carbon offsets. Further research is needed to investigate this relation.

5.3 Flying vs Taking the Train

The results for hypothesis H4 show that passengers are reluctant to choose a flight-train mix when it makes the trip longer but are happy to combine train and flight when the total trip duration is not prolonged (like it was in the short-haul scenario in our survey). Further research should study the exact trade-offs passengers make considering price, duration and emissions of train-flight mix vs flying.

The results for hypothesis H5 showed that the largest CO2 reduction was achieved through the lump sum SAF contribution. Still, the train-flight mix led to more CO2 savings than KLM's and Lufthansa's approaches for short- and mid-haul, highlighting the potential of the train-flight combined approach. The reason why KLM and Lufthansa outperform the train-flight mix in the long-haul scenario is due to the fact that the biggest part of the journey (Frankfurt – Los Angelis) is done by flying. Taking the train from Bremen to Frankfurt can only reduce a small percentage of the total journey emissions. Based on these results, a possible option could be to combine train-flight mix with the lump-sum SAF approach. Passengers could be first offered to take the train for part of the journey resulting in fewer emissions, and then be asked to donate a lump sum towards SAF for their flight thus resulting in lowest emissions.
Finally, the train-flight mix approach introduced in this paper is currently not used by any airline or flight search engine, but certainly it has high potential. Showing passengers, various train-flight mixes and the resulting emissions can help them make an informed decision and ultimately lead to less emissions.

6. Conclusion

The purpose of this paper was to compare airlines' approaches to motivate passengers to reduce or offset their journey's CO2 emissions. The results indicate that airlines' strategies providing more freedom of choice regarding donation amount and more information on the SAF/offsetting scheme can acquire more funds for reducing or offsetting emissions. Moreover, SAF approaches appear to be able to generate more funds than pure offsetting approaches. Finally, the train-flight mix is a promising approach to reducing emissions, especially for short- and mid-haul flights, and could be combined with SAF approaches for the largest emission savings.

The main limitation of this study is the possible inconsistency between participants' intentions stated in the survey and their actual behavior in the real life. Moreover, the survey only considered three specific flight scenarios and the sample was not fully representative. Hence, further research is needed to validate our results. Specifically, it will be useful to conduct an extensive study with multiple flight alternatives for each scenario with varying parameters (price, duration, emissions). Further research should also study the lump-sum approaches for offset and SAF to derive the

best way they should be implemented as well as understand the relation between lump sum offset and lump sum SAF. Finally, further research should study the exact trade-offs passengers make considering price, duration and emissions of train-flight mix vs flying and explore options for combining the train-flight mixed approach with SAF approaches. The findings of this paper provide airlines and flight booking services, such as Skyscanner and Google Flights, with useful insights on consumers' behavior towards the current strategies, and thus help airlines improve their current approaches and reach their sustainability targets.

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