Transportation Research Part D 126 (2024) 104013

Contents lists available at ScienceDirect

Transportation Research Part D

journal homepage: www.elsevier.com/locate/trd

Will people prefer future travel with battery-powered airplanes?

Knut Veisten [a,*], Paal Brevik Wangsness [a], Eivind Farstad [a], Inga Margrete Ydersbond [a]

[a] *Institute of Transport Economics, Gaustadalléen 21, NO-0349 Oslo, Norway*

A R T I C L E I N F O

Keywords:
Electric airplanes
Discount
Range
Safety
Technology attitudes
Willingness to pay

A B S T R A C T

Various small battery-powered airplane models have been developed over the last years and are approaching the stage of being included in commercial flights. However, there are relatively few studies on potential customers' preference for flying with electric airplanes. Some insights can be drawn from the literature on electric vehicles and other technology adaption, but choices between air travel services differ from choices involving technologically advanced durables.

A sample of transport users travelling between the Norwegian cities Bergen and Stavanger were asked about their willingness to choose flying with a future battery-electric airplane instead of a standard kerosene-based one. A majority would consider flying electric, some are also willing to pay a premium, but a substantial share was reluctant and would require a discount. Age was the strongest observable characteristic explaining willingness to pay. Latent technology attitudes also co-varied positively with preference for electric airplanes against conventional airplanes.

1. Introduction

The aviation sector contributes to about 2% of global CO_2 emissions, and when the non-CO_2 effects (such as contrail cirrus clouds) are included, aviation represents around 3.5% of the warming impact caused by humans presently (Lee et al., 2021). In the EU, the aviation sector in 2019 was responsible for 4.9% of total green-house gas (GHG) emissions (TE, 2022). As a response to these challenges, various producers are developing airplanes with propulsion based on other energy than standard kerosene stored in tanks, e.g., electricity stored in batteries (Schäfer et al., 2019; Rendón et al., 2021). The weight of batteries adds a particular challenge to electric airplanes compared to electric vehicles, trains, or ferries (e.g., Epstein & O'Flarity, 2019; Sripad et al., 2021). However, some battery-electric airplane prototypes are approaching the stage where they can be applied in commercial flight transport (e.g., EUROCONTROL, 2022). One battery-driven two-seater is certified for commercial operations (EASA, 2020). The introduction of smaller short-haul electric airplanes might advance the development of larger electric airplanes (Nakano et al., 2022).

In Norway, large part of aviation routes is short haul (<1500 km). Domestic routes, comprising about half of routes originating in Norway, had average distance of <550 km, in 2019; routes to and from the EU had an average flight distance of 1250 km (Buus Kristensen & Thune-Larsen, 2022). One of the ongoing electric-airplane projects is aiming for a demonstration case for commercial flights with small battery-driven airplanes between the cities Bergen and Stavanger, in the second half of the 2020s (Minge, 2022; Wangsness et al., 2021). These two cities represent relatively large urban areas, with airports distant by only 160 km.

Battery electric airplanes represent a possible technology for reducing emissions from the aviation sector, but a key question is to what degree this could be financially viable for suppliers in the medium-term without very supporting regulation and/or very strict

* Corresponding author.
E-mail address: kve@toi.no (K. Veisten).

https://doi.org/10.1016/j.trd.2023.104013
Received 30 November 2022; Received in revised form 24 October 2023; Accepted 5 December 2023
Available online 12 December 2023
1361-9209/© 2023 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).

regulation of the polluting alternatives. We want to approach this question from the angle of the would-be passengers. Whether passengers in fact will be willing to travel with battery-powered airplanes or not, is a topic that so far has received relatively little research attention. To our knowledge, only Han et al. (2019a,b,c, 2020) have scientifically assessed attitudes and behavioural intentions of potential customers of future electric air travel. Choices between transport service alternatives may involve other aspects than choices between durables, e.g., electric vehicles. Thus, more knowledge about air travellers' preferences regarding new propulsion technology seems warranted. This provides the main motivation for this paper. Our primary research question was therefore the following: To what extent can we expect positive attitudes and additional willingness to pay for travel with first-generation commercial battery electric airplanes among Norwegian air travellers in a few years from now? Moreover, we specify an electric aviation model on a specific section between two main cities of Norway, in a survey including recent travellers between these cities, thus enhancing the realism of the potential passengers' choice.

Our data are based on an online survey of Norwegian airline customers in the Bergen-Stavanger region. We included questions about attitudes and about behavioural intentions regarding the proposed battery-driven airplanes between Bergen and Stavanger. The respondents were presented the future battery-electric airplane alternative and stated their interest in using that new technology. If they expressed an interest, they were asked their willingness to pay (WTP) a price premium; if not, they were asked about accepting a compensation for flying electric instead of conventional. Responses to sets of attitudinal statements were applied as measurements of latent variables, including technology optimism and innovativeness (Parasuraman & Colby, 2015); more specific statements about electric airplanes and transport measured two latent variables, one expressing concern, in particular safety concern, and another expressing supportive opinions about GHG-reducing policies and choices. The latent variables, together with standard demographic/socio-economic variables and transport behaviour variables, enable an assessment of what observable and unobservable individual characteristics associate with stated behavioural intentions.

We add to the limited set of published studies (Han et al., 2019a,b,c), providing new estimates regarding the future market for battery-driven electric airplanes, from a population in a different region of the World. The novelty of this research lies in providing the first credible estimates of the economic preferences of those who would constitute the potential users of the first generation of small battery-powered short-haul airplanes in commercial passenger transport. In addition, we provide new insights into the anatomy and drivers of these preferences. To our knowledge this is the first attempt of conducting such analysis on this topic. This new knowledge can have important implications for both governments and airlines. Holding a deeper understanding of these preferences will also be important for governments in their consideration of tax and subsidy schemes or other regulations, and for airlines in their marketing and setting of ticket prices, as well as for airport infrastructure and airplane fleet investments. This may again help reducing the cost of the transition to a more environmentally friendly aviation sector.

2. Literature review

2.1. Former studies on attitudes towards electric airplanes

The introduction of electric planes can be seen as a new technological feature to the existing product, that improves the product's environmental profile. The extent to which a new product feature will yield increased WTP is an empirical question. Technological changes might affect various features that affect demand, of which some might be considered positively by most potential users, e.g., improved environmental features (Sundt & Rehdanz, 2015; Greene et al., 2018). Yet, the overall impact of the new technology might be considered negatively by some, e.g., if the new technology adversely affects safety or reliability, or is perceived by many as less safe or less reliable (Hidrue et al., 2011). In some cases, the divided opinions / preferences may follow observable individual traits, e.g., age or gender (Hidrue et al., 2011).

Han et al. (2019a) investigated travellers' decision-making process when deciding whether to buy tickets with an electric airplane, based on a survey of US airline customers (n = 309). They found that a positive attitude towards buying tickets with electric airplane co-varied with female gender, being younger, and having stronger social norms, as well as personal norms towards conducting "green acts". In a follow-up study, Han et al. (2019b) concluded that if respondents (n = 321) perceived electric airplanes to involve various types of risk, they were negative to flying with them; but attitudes were susceptible to new product knowledge. In yet another follow-up survey of US airline customers, Han et al. (2019c) sought to identify which factors could predict intention to use and recommend electric airplanes, observing that concerns for the environment, social norms, positive anticipated effects, and a sense of obligation to make pro-environmental actions positively influenced the respondent's intentions (n = 285).

2.2. Literature on predicting uptake of new technology

Han et al. (2019c, 2020) applied a structural equation model (Bollen, 1989) that included elements from structural modelling based on psychological theory of reasoned action and of planned behaviour (Fishbein and Ajzen, 1975; Ajzen, 1985). Venkatesh et al. (2003, 2012) integrated that modelling framework from psychology with models on technology adaption, termed a Unified Theory of

Acceptance and Use of Technology (UTAUT). The common structure of the modelling proposed by Ajzen (1985) and that proposed by Venkatesh et al. (2003, 2012), as well as the application by Han et al. (2019c), is that an estimated/measured behavioural intention is the output, predicting future behaviour. The behavioural intention, a variable or construct, has a modelled relationship with a construct of attitudes and other constructs, e.g., social norms/influence. Parasuraman and Colby (2015) also proposed sets of technology attitude constructs, as part of their Technology Readiness Index (TRI); such that those with higher scores on constructs like “technology innovativeness” or “technology optimism” would be expected to be more “ready” to apply new technology.[1]

Korkmaz et al. (2022) applied UTAUT to future autonomous public transport. They found that they had to modify the UTAUT to make it fit the public service context, as it primarily had been applied to technologically advanced consumer goods, like personal computers (Mathieson, 1991; Venkatesh et al., 2003, 2012). Thus, Korkmaz et al. (2022) included questions (scales/constructs) on trust and safety, perceived risk, and perceived usefulness. Assessing future choices of flying with a future electric battery-driven airplane is also a choice about public transport services; a type of service that is already familiar for those currently flying with conventional kerosene-based airplanes. Air travellers will not need any new knowledge regarding usage, but they might not have the same perception of trust in the new technology (Han et al., 2019b; Korkmaz et al., 2022).

The difference between public services and private durables may also limit the transferability of experiences from electric car adaption to future electric airplanes. The perceived risks of taking flight with an electric airplane will be different from the perceived risk in electric car purchase (e.g., Featherman et al., 2021, Table 1). While, for example the financial risk is relatively (much) higher for expensive durable goods like electric cars, the physical safety risk might be perceived as relatively higher for a flight with the first generation of commercial electric airplanes (Sierzchula et al., 2014; Han et al., 2019b; Featherman et al., 2021). However, although different, there might be an element of “early adoption” related both to the usage of technologically advanced private durables and technologically advanced services (Hardman et al., 2016).

Economic theory primarily establishes an expectation of a relationship between wealth/income and WTP, a positive relationship in the case of normal economic goods (Hanemann & Kanninen, 1999). A broader set of demographic characteristics is however regularly included in analyses of stated preference data (Carson, 2000; Martín et al., 2008; Haboucha et al., 2017), as they are in technology adaptation modelling (Venkatesh et al., 2003, 2012). Demographic variables also represent core observables, characteristics that are actionable, whether for policy or marketing (Steenkamp and ter Hofstede, 2002; Venkatesh et al., 2012). Sierzchula et al. (2014) summarised early findings on electric vehicle adoption, pointing to income and education level as significant characteristics. Haboucha et al. (2017) found that early autonomous vehicle adopters would likely be young and more educated; and Han et al. (2019a) found that females and younger were more positive to electric airplanes.

2.3. Stated preference methods applied to predicting choice of new/altered technology

In economics, stated preference methods have been applied for valuation of goods not traded in markets (Bateman et al., 2002; Johnston et al., 2017), but also for predicting payments for new products or new/amended product attributes (Dean et al., 2002; Martín et al., 2008; Collins et al., 2012). These methods resemble the choice-based version of conjoint analysis (Louviere & Woodworth, 1983), but have different theoretical underpinnings (Louviere et al., 2010).

Luzar and Cosse (1998) incorporated contingent valuation into a model structure that drew on the theories of reasoned action and planned behaviour. In various other contingent valuation studies, attitudes or self-reported behaviour have been included among the explanatory variables. Scales/constructs that measure attitudes towards technology are relevant candidates in stated preference of future technology options (Haboucha et al., 2017).

2.4. Research gaps and hypotheses

Based on this review, we propose two additional elements: (i) we opt for an economics approach, estimating economic preferences for a future battery-driven electric aviation option and (ii) we take a further step towards the estimation of attitudes and preferences with a more detailed introductory plan for electric airplanes (on a specific section, Bergen-Stavanger, only sampling among existing travellers on that section). It follows up on the specific topic, the potential consumer interest in flying electric airplanes, investigated (only) by Han et al. (2019a,b,c); but we endeavour into other theoretical/methodological approaches. Instead of the established UTAUT (Venkatesh et al., 2012), which has been less applied to public transport services (Korkmaz et al., 2022), we opted for a methodology that also produces a behavioural intention estimate, but in money-metrics (Carson & Groves, 2007; Louviere et al., 2010; Johnston et al., 2017). Based on the published studies and theory/methods, we propose the following hypotheses:

H_1: The sample of travellers will be split in their attitudes/preferences, such that the minimum WTP is not expected to be the current reference price of existing kerosene-driven airplanes (“indifference”), but a lower price (a discount, compensation), driven primarily by safety concerns (Sierzchula et al., 2014; Han et al., 2019b; Featherman et al., 2021; Korkmaz et al., 2022).

H_2: The estimated willingness to pay (WTP) function for an electric aviation option will show the theoretically correct pattern (Hanemann & Kanninen, 1999; Carson & Groves, 2007), decreasing in increasing price (differential), for electric aviation relative to

[1] Two other constructs in their TRI are “discomfort” and “insecurity” (Parasuraman & Colby, 2015, Table 2). Edison and Geissler (2003) proposed a general technology scale termed “affinity for technology”, measured by agreement to statements such as being comfortable learning new technology, knowing how to deal with technological malfunctions, and feeling as up to date on technology as their peers; having some resemblance to the “innovativeness” and “optimism” scales proposed by Parasuraman and Colby (2015).

Table 1
Distribution of respondents' characteristics.

Demographic and socio-economic variables	Median	Mean / Share	Max	N
Age	46	45.9	86	1000
Personal income (in NOK 1000; interval midpoints)	650	705	1250	831
Household income (in NOK 1000; interval midpoints)	1250	1113	2250	815
Number of people in the household	2	2.6	13	1000
Female gender		42%		1000
University degree or equivalent		70%		1000
Full-time job – working at least 32 h per week		71%		1000
Access to vehicle		90%		1000
Access to electric vehicle		47%		1000
Flights abroad in 2019	4	5.2	200	1000
Domestic flights in 2019	6	11.5	560	1000
Flights between Bergen and Stavanger in 2019	1	3.7	480	1000
Trips by bus between Bergen and Stavanger in 2019	0	0.4	20	1000
Trips by car/MC between Bergen and Stavanger in 2019	0	1.9	120	1000
Trips by ferry/boat between Bergen and Stavanger in 2019	0	0.3	12	1000

Note: Among participants, 67.3% had travelled by airplane between the two areas in the period from 2019 to May 2021; while the flight is about 40 min., we can add access plus egress time of more than an hour, as well as additional time in the airports, approx. 3 hrs. and 15 min in total; 60.2% had travelled by car (or MC), which takes about 5 hrs., including ferry on part of the section; 16.5% had travelled by bus, also including ferry, with travel time close to that by car; and 16.1% had travelled by ferry (or boat), which has a travel time of about 7 hrs. Various respondents had applied more than one of these four transport modes during the last 2.5 years.

existing non-electric.

H_3: The estimated WTP function will show a positive association with measures of technology adaption or technology readiness individual characteristics as those found for electric aviation by Han et al. (2019a), relatively higher WTP for younger and for females.

H_4: The estimated WTP function will indicate similar associations with individual characteristics as those found for electric aviation by Han et al. (2019a), relatively higher WTP for younger and for females.

3. Methodology

3.1. Economic stated preference – contingent valuation

In this study, we apply economic stated preference methods, that rest on the axioms of rational behaviour and the assumption of utility maximisation (Hanemann & Kanninen, 1999; Bateman et al., 2002; Carson & Groves, 2007). As stated-preference methods also are survey-based, they draw on inputs from psychology and survey research (Hanemann, 1994; Johnston et al., 2017). Stated hypothetical choices and WTP also represent behavioural intentions (Luzar & Cosse, 1998).

The stated preference method can be cast as a single choice between a new alternative that differs in price and quality from a reference alternative, termed a single-bounded discrete choice, or as repeated choices between two or more alternatives that differ in various qualities as well as price, known as discrete choice experiments (Bateman et al., 2002; Carson & Groves, 2007; Louviere et al., 2010; Carson & Louviere, 2011; Johnston et al., 2017). The choice model might be combined with a structural equation model, a so-called integrated choice and latent variable model, or hybrid choice model (Ben-Akiva et al., 2002). If the structural part (the construct, or latent variable) is estimated before (not simultaneously with) the choice, it is referred to as sequential estimation, which is a second-best approach that might not have any significant impact on the estimates (Bahamonde-Birke and Ortúzar, 2014; Bouscasse, 2018).

Estimates from of WTP-based on stated preference methods can be prone to so-called "hypothetical bias", probably most often an overstatement bias (Harrison & Rutstrom, 2008). The extent of hypothetical bias is difficult to evaluate though, as demand is not revealed for non-exiting product features and not necessarily revealed for existing public good features (Poe et al., 2002). Carson and Groves (2007, p. 188) argue that a single-bounded discrete choice version of contingent valuation is expected to be incentive compatible; meaning that the respondent finds truthful answering his/her best strategy (p. 184). That is, if Y is the price of the market good with the new (or altered) attribute and X is the price of the market good without the new attribute, the best answer in the interest of the respondent should be "yes" if he/she really would pay a price premium of Y-X (or accept a compensation X-Y) and "no" otherwise. Furthermore, Carson and Groves (2007, p. 194) specify that a change in an existing private (market) good (changing airplanes from kerosene-powered to battery-powered, in our case) will be "incentive compatible, but the choice does not reveal information about quantities". Another basic premise is that the choice context is credible, such that the survey-responses are perceived as being consequential (p. 183); that they are perceived as yielding input to policy and that, e.g., a "yes" would be a "vote" for the new technology. If the respondent does not perceive the choice context as realistic and consequential, he/she may not provide any wellfounded answer, contributing to unprecise or biased estimates (Carson & Groves, 2007; Harrison & Rutstrom, 2008).[2]

Alternative formats of stated preference methods, to single-bounded discrete choice, could comprise more product features that are varied between alternatives (Carson & Louviere, 2011), such that respondents would choose among flights with varying travel time or other quality/service levels, in addition to the propulsion type and the price (Park et al., 2006; Martín et al., 2008; Hess, 2010; Collins et al., 2012). If the primary interest is to assess the economic preference for electric-powered alternatives to standard kerosene-powered airplanes, everything else equal, a choice only involving propulsion type and price will suffice and be easier to answer.

3.2. Our applied type of choice questions

We apply a single-bounded discrete choice version of the contingent valuation method to a novel product feature, battery-powered airplane instead of fossil fuel-powered airplane. A single-bounded discrete choice question will then be cast as a choice between an electric-powered airplane at fare Y instead of a standard kerosene-powered airplane at fare X (Y>=<X). But first, the survey participants were presented with the following future scenario, with an initial preference question (following, e.g., Kriström, 1997):

> *After 2025, the first airplanes with only battery-electric propulsion (electric airplanes) are expected to be deployed on the route between Bergen (Bergen Airport, Flesland) and Stavanger (Stavanger Airport, Sola). The electric airplanes that are put into operation will have been through extensive testing and will be as safe as conventional airplanes.*

Will you consider electric airplanes as a transport option between the Bergen area and the Stavanger area when this becomes available?

The response to the question above allocated the respondents to either a question about willingness to pay extra for flights with electric airplanes instead of fossil-fuel airplanes (if "yes, absolutely" or "yes, probably"), or a question about willingness to accept compensation (if "no, absolutely not", "no, probably not", "uncertain" or "don't know"). In our follow-up question about WTP, we applied a two-way split, placing the uncertain with the negative (Hanemann and Kanninen, 1999), such that the latter group faced an electric airplane flight price that was lower than the price for conventional airplanes. This two-way split is indicated by [wording and amounts] in brackets:

Suppose that the tickets for an electric airplane flight would be 50% [higher][lower] than for a flight with conventional airplane, that is, NOK [1500][500] instead of NOK 1000.[3]

> *If electric airplanes were an option today, would you choose the electric airplane instead of the conventional airplane if the electric airplane flight had a 50% [higher][lower] ticket price?*

Respondents received (randomly) either a 10%, 50% or 90% price change, in similar ratios for those facing a price decrease as for those facing a price increase. The response they ticked, "yes", "no", or "don't" (which we treated as "no"), was expected to depend on this percentage change in prices.

Two features of the expected first generation of electric airplanes on the Bergen-Stavanger section were assessed in follow-up questions, the size of the airplane and the relative travel times. The respondents were shown an illustration of an electric airplane model similar to a model that was likely to be tested between Bergen and Stavanger (a Heart Aerospace ES-19, https://heartaerospace.com/), and then asked:

> *You answered ['Yes'] ['No', ' Don't know'] to the question whether you would be willing to pay 50% [higher][lower] ticket price to travel by electric airplane instead of a conventional airplane. Would you choose an electric airplane instead of a conventional airplane and pay 50% [higher][lower] fare given that this was the only type of electric airplane available?*

And then, if the answer was 'yes':

> *The 19-seater electric airplane that you have seen illustrated will have approximately 10 min longer flight time between Bergen Airport and Stavanger Airport (*ca. *45* min*. instead of* ca. *35* min*.). Would you choose an electric airplane instead of a conventional airplane and pay a 50% [higher][lower] fare given that a 19-seater airplane with a 10-minute longer flight time was the only electric airplane type available?*

3.3. Other survey questions

3.3.1. Demographic/socio-economic variables and reported travel behaviour

Demographic variables are observables that are regularly included in stated preference surveys (Carson, 2000; Johnston et al., 2017). In addition to income, we included age, gender, educational level, and employment.

[2] Another issue is whether WTP might be zero or negative for the new product relative to the old, e.g., that the respondent is either indifferent, or prefers flying with kerosene-based airplanes instead of battery-electric ones and would request a compensation to accept the electric. Kriström (1997) proposed a so-called spike model, whereby the respondent would first be asked if he/she would have any interest in a specific public good provision or a new/altered (private) product; and Nahuelhual-Muñoz et al. (2004) extended the approach to also cover the negative group.

[3] The average exchange rate of Norwegian kroner (NOK) in 2021 was 10.1648 NOK/EUR and 8.5991 NOK/USD (https://www.norges-bank.no/en/topics/Statistics/exchange_rates/); thus, 1000 NOK was equivalent to ca. 98.40 EUR and ca. 116.30 USD.

A potentially important feature in the response to an electric airplane option is the actual travel behaviour. We asked about trip purpose (of the last flight), their use of selected airlines (as two of them, SAS and Norwegian, operate larger airplanes between Bergen and Stavanger, while Widerøe operates smaller airplanes), and their use of other transport modes, private car, bus, or ferry, on the Berge-Stavanger section. Other questions included their flight frequency before the pandemic, in 2019, on the Bergen-Stavanger route, domestically, and abroad.

3.3.2. Attitudinal statements

After the electric airplane choice questions, the respondents faced sets of attitudinal statements. First, they were asked about their agreement to statements about technology. We chose to apply the "technology innovativeness" and "technology optimism" from the Technology Readiness Index proposed by Parasuraman and Colby (2015). Innovativeness is measured by statements such as: keeping up with the latest technological developments, being able to figure out new high-tech products and services; and providing advice on new technologies to others. The optimism is measured by statements about what new technology provides, such as: giving people more control over their daily lives, more convenient products and services, and more freedom of mobility. We applied five of their proposed statements for measuring each of the two scales; the response scale was a five-point Likert scale.

After the technology statements, the respondents were asked about their agreement with various statements related to the introduction of electric airplanes. One set of the statements covered concern about safety and comfort, applied to measure a latent variable termed "Concern". Another set of the statements related to policy support for electric aviation and stated concern about environmental impacts of transport, measuring a latent variable termed "Supportive". Each of these two case-specific constructs we developed, were measured by three items, one item was overlapping.[4] The response scale was a five-point Likert scale.

3.3.3. Logit models of 'yes' answers

The main numerical analysis that we carry out is the estimation of a parametric (logistic) model of WTP. A general WTP model can be specified as the following (linear-in-parameter):

$$WTP_i(z_i, \varepsilon_i) = z_i\beta + \varepsilon_i \tag{1}$$

such that individual i's WTP for electric aviation (or any other new/altered good/service) is a function of individual characteristics, z_i (that have some association with the preferences), is a vector of parameters, β, and ε_i is an error term. Applying single-bounded discrete choice contingent valuation, what is obtained from the individual is only a 'yes' ($y = 1$) or 'no' ($y = 0$) to a proposed price (change), p^j. The p^j is drawn from a so-called bid vector; $p^1 \ldots p^m$; the price must be varied across respondents to enable estimation of WTP. Thus, it is WTP of a sample, or sub-sample, for a given combination of individual characteristics, z_i, that can be estimated from the survey information (Hanemann & Kanninen, 1999):

$$Pr(y_i = 1|z_i) = Pr\left(WTP_i > p^j\right) = Pr(z_i\beta + \varepsilon_i > p^j) = Pr(\varepsilon_i > p^j - z_i\beta) \tag{2}$$

A logistic specification yields a logit model:

$$Pr(y_i = 1|z_i) = 1/(1 + e^{-z_i\beta}) = 1/(1 + exp(-\alpha + \beta_0 p + \beta_1 z_1 + \ldots + \beta_n z_n)) \tag{3}$$

Our hypotheses 2–4 will be tested by the estimated parameters, the null hypotheses being $\beta_1 \ldots \beta_n = 0$. For the non-parametric estimation (Kriström, 1990), we apply the 'yes' share to different price levels to estimate WTP curve (π^j):

$$WTP_{Ayer-Kriström} = 1/2\sum_{j=0}^{J}\left(p^{j+1} - p^j\right)\left(\pi^{j+1} - \pi^j\right) \tag{4}$$

In case that our first null hypothesis is rejected, such that part of the respondents are reluctant to fly electric, we might opt for split models. That is, one WTP model is estimated for those willing to pay a premium for electric aviation options (minimum the existing reference price of 1000 NOK) and one for those who would only fly with a discount (the existing reference price of 1000 NOK being the maximum). Thus, for the latter group, p^0 is the zero price and p^J is the choke price, while for the first group, p^0 is the reference price of 1000 NOK, while the choke p^J is empirically derived (extrapolated).

Regarding the inclusion of attitudinal variables in the WTP model, for example Martínez-Espiñeira and Lyssenko (2011) stress the potential endogeneity problem, if a presumed exogenous explanatory variable happens to be affected by the same individual characteristics that affect WTP. Thus, an attitudinal variable in a WTP model should be distinguishable from the WTP itself; and preferably a latent variable that is measured by other items than the variables that are included into the WTP model. To avoid leaning on one all-inclusive model that might have specification problems, we will present models both without latent attitudinal variables and with different subsets of the four latent variables.

[4] The statements for all four latent variables are presented in the Results section, in 5.1; the distributions of Likert scale responses are shown in the Supplementary Material.

4. Data

The data was collected in May 2021 through an online survey with a selection of travellers between destinations in the Bergen and Stavanger area. The participants were recruited from the opinion bureau Norstat's pre-recruited internet panel, designed by the bureau to be representative in terms of population gender and age.[5] The requirement for inclusion in the survey was age above 18 years and residency in the two city municipalities Stavanger and Bergen or some neighbouring municipalities within the catchment area for the two city airports. Another requirement was having completed at least one trip, by airplane, car, bus, or ferry, between the two urban areas during the period from January 2019 to May 2021. The sample can be considered as representative for the adult population travelling between the two urban regions of study.

The final sample includes one thousand respondents who completed the survey. Table 1 presents descriptive statistics on the respondents' characteristics.

The respondents had a somewhat higher average household income than the national average, their household size was slightly larger, and as implied from the recruiting rules, they travelled more by air than the general population. For comparison, the annual median and mean gross household income in Norway were about 725 and 960 thousand NOK, in 2021, but slightly higher in Bergen and Stavanger; the average household size was below 2.2 persons, nationally as well as in the two urban areas. There is also a slight overrepresentation of males; the education level was higher; and the vehicle access as well as electric vehicle access were above national averages. The average age matches the adult population in the greater Bergen and Stavanger areas. Although differing from the overall population, the sample is expected to be more representative of the part of the sub-population we sought, those travelling between these two urban areas.[6]

5. Results

5.1. Confirmatory factor analysis of attitude constructs

The confirmatory factor analysis results of the four attitudinal constructs are shown in Table 2.

The goodness-of-fit was somewhat better for the Technology optimism latent variable model than for Technology innovativeness, when including the five selected items for each (Table 2a). For both constructs the "perfect" latent variable model is rejected, based on the χ^2 test. For Technology innovativeness, also the root mean square error of approximation (RMSEA) test statistic is on the high end; RMSEA should preferably be less than about 0.08 ($<$0.05 indicating close fit), and at least not above 0.1 (Browne & Cudeck, 1992). The reliability is relatively high for both constructs (on the 0–1 interval). However, discriminant validity of the constructs (Optimism, Innovativeness) is not supported (Table 2b), as the AVEs (about 0.6, for both constructs) are lower than the squared correlation of the two constructs ($\sim$0.7).

Regarding the electric-aviation attitude constructs, these included only three items, such that we lack degrees-of-freedom to estimate some of the measures of goodness-of-fit. The reliability scores are relatively high, although slightly lower for Concern, (Table 2a). Discriminant validity of the two electric-aviation attitude constructs (Concern, Supportive) is supported, the squared correlation of the two constructs ($\sim$0.4) falls well below the AVEs ($>$0.6).[7] Discriminant validity is supported for all other pairwise construct combinations (Table 2b).

We will test all four latent technology-attitude variables in models of electric airplane preference and WTP; however not apply Technology optimism and Technology innovativeness in the same model (Table 2b). We retain both for analysis, however, as both are more appropriate than the electric airplane attitudes; they are tested by other authors and do not measure electric airplane preference.

5.2. Stated choice of an electric airplane option, without any cost variation

The respondents were asked to consider an electric airplane introduction on the trip between Bergen and Stavanger. The distribution of responses to whether the respondents would consider electric airplanes a relevant transport option is shown in Fig. 1.

A clear majority (72%) of the respondents would consider electric airplanes as a transport option when this becomes available. However, there is a considerable share of respondents that show reluctance to transport by electric airplanes, i.e., opinions are split.

Table 3 shows two alternative logistic regression models where both "Yes, absolutely" and "Yes, probably" equal 1 ("Yes") and the remainder are coded as 0; thus, adding the "Uncertain" and "Don't know" to the "No" side (28%). As indicated, due to the correlation of the latent technology variables, optimism and innovativeness, we estimate separate models, with each added sequentially to the logistic model.[8] This is model of preference, but without price differential, not a WTP model.

Regarding demographic/socio-economic characteristics, the oldest respondents were relatively more negative, and the youngest respondents were relatively more positive, as found by Han et al. (2019a), with "middle-aged" as the in-between reference; the

[5] The Norstat Group operates in several European countries (https://norstatgroup.com/).

[6] The questionnaire (translated from Norwegian) is included in the Supplementary Material.

[7] Highly correlated variables might cause multicollinearity problems in regression analysis, and thus for the mere correlation we would restrain from including both constructs in a common regression model (Harrell, 2015; Cheung et al., 2023).

[8] We also tested a logistic model for "Yes, absolutely" (42%) vs. the other responses, showing the same pattern for the covariates, but that model had somewhat lower goodness-of-fit indicators, compared to the "Yes" logit model in Table 3.

Table 2a
Confirmatory factor analysis (CFA) of four attitudinal constructs.

Latent variable	Measurements	CFI	TLI	RMSEA	SRMR	p-value (χ^2)	CR	C's α
Technology optimism	i) New technology makes me more productive in my personal life (0.732) ii) New technology gives people more control over their daily lives (0.741) iii) Products and services that use the newest technologies are much more convenient to use (0.706) iv) New technology gives me more freedom of mobility (0.746) v) New technologies contribute to a better quality of life (0.705)	0.999	0.998	0.042	0.020	0.018	0.848	0.848
Technology innovativeness	i) Other people come to me for advice on new technologies (0.758) ii) I can usually figure out new high-tech products and services without help from others (0.623) iii) I prefer to use the most advanced technology available (0.727) iv) I keep up with the latest technological developments in my areas of interest (0.762) v) In general, I am among the first in my circle of friends to acquire new technology when it appears (0.774)	0.996	0.991	0.086	0.038	0.000	0.851	0.850
Concerned about electric airplanes' safety and comfort	i) Worried about safety in flying electric airplanes (0.881) ii) (Not) trusting certification and safety guarantee (0.575) iii) Worried about potential range problems for electric airplanes even on shorter sections (0.756)						0.787	0.777
Supportive of electric airplane introduction and environmental consciousness	i) Supporting Norway's position in initiating commercial use of electric airplanes (0.846) ii) Choosing electric will better environmental consciousness (0.750) iii) Electric airplanes should be subsidised in the same way as electric cars are subsidised (0.807)						0.844	0.842

Note: The confirmatory factor analysis was carried out in R applying the packages lavaan (Rosseel, 2023) and measureQ (Cheung et al., 2023). Factor loadings for the measurements are included in parentheses. The test measures comprise the Comparative Fit Index (CFI), the Tucker-Lewis Index (TLI), the Root Mean Square Error of Approximation (RMSEA), the Standardized root Mean Square Residual (SMSR), the significance of the Chi square test of the specified model, the Construct Reliability (CR), and Cronbach's Alpha.

Table 2b
Discriminant validity test.

	Optimism	Innovativeness	Concern	Supportive
Optimism	0.5989			
Innovativeness	0.697	0.6101		
Concern	0.068	0.040	0.6654	
Supportive	0.193	0.041	0.384	0.6977

Note: The discriminant validity test was carried out in R applying the package semTools (Jorgensen, 2022). The test measures comprise the Average Variance Extracted (AVE), on the main diagonal cells, and the squared construct correlations, on the off-diagonal cells (Fornell & Larcker, 1981).

relationship is strongest for the elderly. Those having a university degree are also more prone to stating "Yes", while we find no significant association for gender (different from Han et al., 2019a). We find no statistically significant relationship between income and stated interest in using electric airplanes between Bergen and Stavanger. Missing income was set to zero, while including a dummy for this group to check for any effect.

Regarding travel behaviour, there is no statistically significant association between air travel frequency (in 2019) and "Yes" vs. "No" response to the question about considering an electric airplane as a transport mode option. The same applies to existing use of smaller airplanes (that are most common in the fleet of the airline Widerøe). However, a positive relationship is found for business/leisure purpose in the last flight between Bergen and Stavanger, where commuting is common reference. There is a weak positive relationship between having access to an electric car and indicating a positive preference for the future electric airplane option.

As expected, both Technology optimism and Technology innovativeness demonstrate a strong positive relationship with the "Yes"

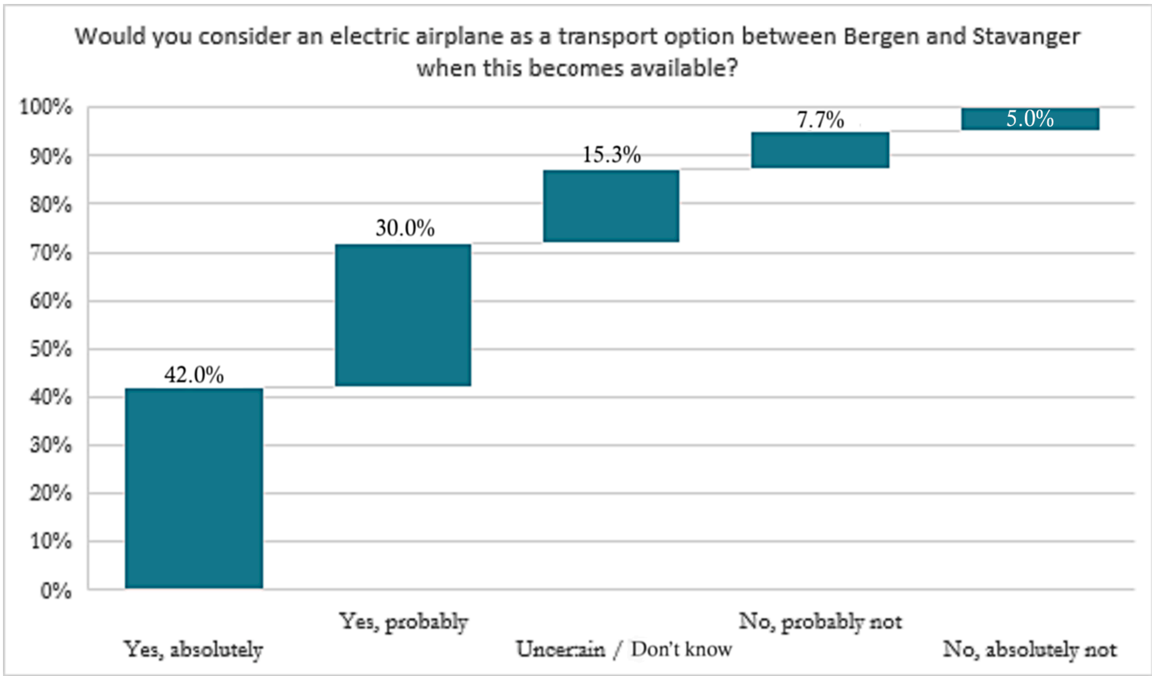

Fig. 1. The stated consideration of electric airplanes as a relevant transport option.

response to an electric airplane option; it is relatively stronger for optimism than for innovativeness. Technology optimism is not much affected by the inclusion of Concern, which conveys an expected negative association with the consideration of electric airplanes as a relevant transport option between Bergen and Stavanger. Last, the construct Supportive shows the expected strong positive association with "Yes" (Table 3). The latent variables have themselves a statistical association with the observable individual characteristics.[9]

5.3. Willingness to pay for an electric flight compared to a conventional flight – non-parametric analysis

In a follow-up question, those who had answered "Yes" ("Yes, absolutely" or "Yes, probably") were asked whether they would choose the electric airplane option if it was more expensive than flying with a conventional airplane (720 respondents). Those who had answered either "No, absolutely not", "No, probably not", "Uncertain", or "Don't know" were asked whether they would choose the electric airplane option if it was less expensive than flying with a conventional airplane (280 respondents). The following figure shows the distribution of electric airplane choices, for different discount levels (for the 280 reluctant towards using electric airplanes), and for different markup levels (for the 720 considering using electric airplane). Fig. 2 displays the distributions for the two separate sub-samples.

The distributions in Fig. 2 are between-subject; each respondent faced only one monetary amount, either 10%, 50% or 90% price increase/decrease compared to NOK 1000 for a conventional airplane flight. The distributions are theoretically valid; the shares decrease for increasing amounts, in both sub-samples.

The distributions for the two sub-samples could be presented in an alternative way. We assume that all the 720 respondents considering flying electric airplanes would choose this option if it had a discount; thus, for amounts below 1000 NOK we can add them to the shares from the 280 reluctant respondents. Moreover, we assume that the 280 reluctant respondents would not choose an electric airplane option for a higher price than for conventional airplane; thus, the distribution for higher prices than 1000 NOK remains the same. This will provide distributions as shown in Fig. 3.

The intersection between the two curves in Fig. 3 could be thought of as a "spike at zero", a share of indifferent air travellers when both options cost around 1000 NOK, although we have made a strict division between positive and negative to electric airplane in our analysis. For the estimation it will not matter very much whether a connecting line which joins the two sub-sample distributions, in Fig. 3, has a vertical section or is just a steep-sloping curve. If we linearly extrapolate the curve to the left, in Fig. 3, we derive that 84.2% would choose the electric airplane option if its fare were zero. The remaining 15.8% (of the entire sample) might then represent the maximum estimate of the share of air travellers that, supposedly due to lack of confidence in electric airplane safety, would not at all accept flying an electric airplane. If we linearly extrapolate the curve to the right, we derive a maximum markup WTP for the

[9] Regression models for latent variables and for transport behaviour are presented in the Supplementary Material, as well as an overview of the responses to the measurement items for the latent variables.

Table 3
Logistic regression models of considering electric airplanes as an option for transport between Bergen and Stavanger; all "Yes"=1, all other responses = 0.

	Model w/ only demographic / socio-economic variables	Model including (observable) transport behavio	Model w/ technology innovativeness	Model w/ technology optimism	Model w/ technology optimism and concern	Model w/ technology optimism, concern, supportive
Household income (gross annual, 1000 NOK)	0.0003 (0.0002)	0.0001 (0.0002)				
Income non-response	−0.26 (0.25)	−0.42 (0.26)				
No. of flights Bergen-Stavanger in 2019		0.003 (0.004)				
No. of flights abroad in 2019		0.01 (0.01)				
Age < 30 years	0.63* (0.25)	0.59* (0.26)	0.32 (0.25)	0.3 (0.25)	0.27 (0.27)	0.19 (0.28)
Age > 50 years	−0.6*** (0.16)	−0.65*** (0.17)	−0.52** (0.16)	−0.52** (0.17)	−0.59** (0.19)	−0.42* (0.2)
Female gender	−0.25 (0.16)	−0.25 (0.16)				
University degree (or equivalent)	0.75*** (0.16)	0.68*** (0.16)				
Full-time job	−0.27 (0.18)	−0.33° (0.18)	−0.18 (0.17)	−0.2 (0.18)	−0.34° (0.2)	−0.31 (0.21)
Access to electric car		0.38* (0.16)				
Last flight Bergen-Stavanger was a business trip		0.69*** (0.19)	0.73*** (0.18)	0.73*** (0.18)	0.82*** (0.21)	1.02*** (0.22)
Last flight Bergen-Stavanger was a leisure trip		0.87*** (0.2)	0.89*** (0.2)	0.87*** (0.2)	1.07*** (0.23)	0.96*** (0.24)
Has applied Widerøe in flight Bergen-Stavanger after 1 Jan 2019		−0.33 (0.2)	−0.31 (0.2)	−0.26 (0.2)	−0.05 (0.23)	0.04 (0.25)
Technology innovativeness			0.49*** (0.1)			
Technology optimism				0.76*** (0.11)	0.7*** (0.13)	0.37** (0.14)
Concerned					−1.67*** (0.13)	−1.4*** (0.14)
Supportive						1.1*** (0.14)
Constant	0.73** (0.27)	0.47 (0.29)	0.95*** (0.2)	1*** (0.2)	1.35*** (0.22)	1.31*** (0.23)
Akaike's information criterium (AIC)	1140.2	1117.9	1124.5	1098	879.7	817.6
Hosmer & Lemeshow (χ^2)	14.45 (p-value = 0.0708)	7.19 (p-value = 0.5167)	11.84 (p-value = 0.1585)	6.04 (p-value = 0.6433)	23.61 (p-value = 0.0027)	10.85 (p-value = 0.2099)
Number of observations	1000	1000	1000	1000	1000	1000

Note: The models were estimated in R using glmmML (Venables et al., 2023), the glm command, with binomial distribution of the dependent variable; coefficients' standard errors in parentheses; and level of significance, p-values, marked as: ***<0.001, **<0.01, *<0.05, °<0.1.

electric airplane option equal to 2216 NOK. Applying a non-parametric method, we can estimate an average WTP for the electric airplane relative to the conventional (Kriström, 1990). The estimate then equals 1018 NOK. It is close to 1000 NOK due to the combination of flatness at the left (discount) part of the distribution and steepness to the right (markup) part of the distribution.[10]

5.4. Willingness to pay for an electric flight compared to a conventional flight – parametric analysis

We have also estimated parametric models of the electric airplane choice, linear-logistic regression models with the hypothetical fare (of the electric option) and individual characteristics. These include the same covariates as the logistic model for the first question about electric airplane preference (Table 3). As before, we estimate separate models for technology innovativeness and technology optimism, due to their correlation. Moreover, we run split models for those having expressed an interest in using electric airplanes (n =

[10] The 15.8% of the entire sample represents more than half of those 28% of the sample that did not consider electric airplane as a transport mode option between Bergen and Stavanger. That implies that the estimated average discount is considerable in the sub-sample of the 280. If we apply the same type of linear extrapolation to the separated curves in Fig. 2, we find that only 43.6% of them would accept an electric airplane for zero cost; and we have already assumed that 0% will choose the electric airplane option for a price equal to that of a conventional airplane (1000 NOK). That yields an average WTP of 305 NOK, using Kristöm's (1990) non-parametric method, for the electric airplane option if a flight with the conventional airplane costs 1000 NOK. Regarding the sub-sample of the 720 interested, we assume, for simplicity, that 100% choose electric when its price is 1000 NOK and, as already found above, linear extrapolation to the right yields 2216 NOK, which is the choke price estimate for an electric airplane option. That yields an average WTP of 1237 NOK for the electric airplane option if a flight with the conventional airplane costs 1000 NOK. The weighted average WTP of the reluctant and the interested is then just 976 NOK.

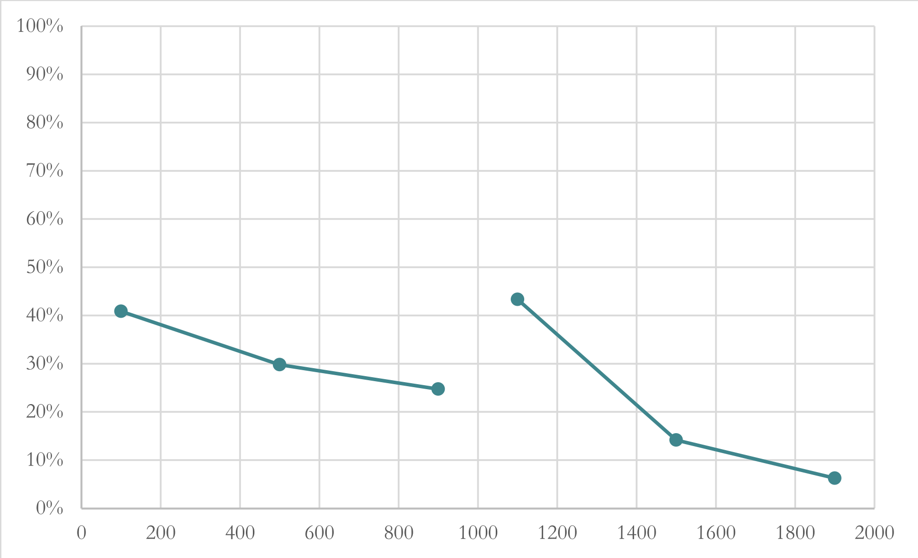

Fig. 2. Shares of electric airplane choices; for those who initially did not consider electric airplanes a relevant transport option (left graph, n = 280), with three discount levels relative to the fare for conventional airplane, 1000 NOK (100, 500, 900); and for those who initially did consider electric airplane a relevant transport option (right graph, n = 720), with three markup levels relative to the fare for conventional airplane, 1000 NOK (1100, 1500, 1900).

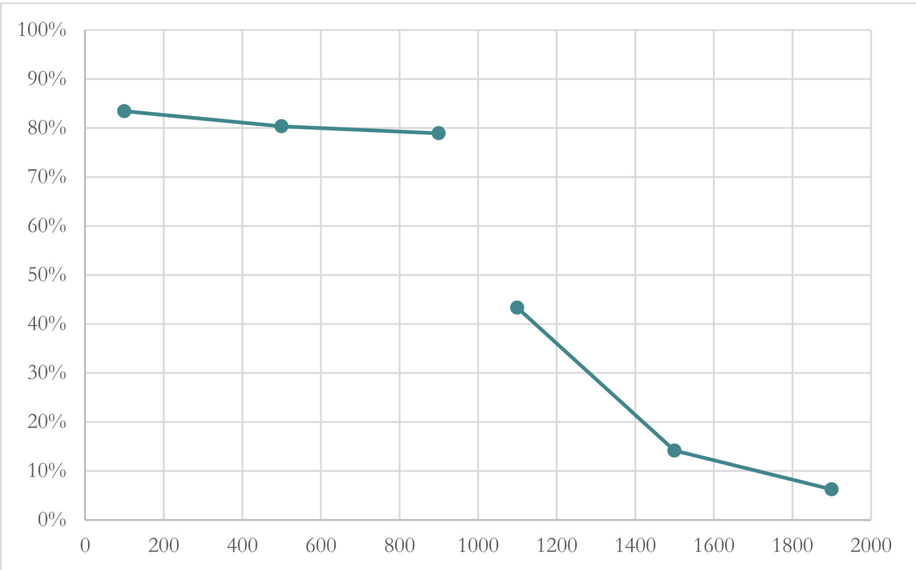

Fig. 3. Shares of electric airplane choices, assumed for the entire sample; none of the reluctant 280 would choose the electric airplane option for a fare > 1000 NOK and all the 720 electric-airplane interested respondents would choose the electric airplane option for a fare < 1000 NOK, when 1000 NOK is the fare for a flight with a conventional kerosene-based airplane.

720) and those reluctant (n = 280).

First of all, for those interested in using electric airplanes (n = 720) as well as for those reluctant (n = 280), the fare (price) coefficient shows a clear price sensitivity in the hypothetical yes–no choices, which is consistent with theoretically valid choice behaviour (Tables 4a and 4b). That relationship was already indicated in the non-parametric analysis (Figs. 2 and 3).

Beyond that, there is limited co-variation between the hypothetical choice of an electric airplane option and the respondents' characteristics. For those who had expressed an interest in using electric airplane (n = 720), there is a negative relationship between choosing a more expensive electric airplane option and being in a full-time job (Table 4a). For the reluctant sub-sample (n = 280), we find the same relationship with age as found in the model of expressed interest for electric airplanes (Table 3); a positive coefficient for

Table 4a
Logistic regression models of choosing an electric airplane between Bergen and Stavanger when its fare differs from that of a conventional airplane; the interested (n = 720).

	Model w/ only demographic / socio-economic variables	Model including (observable) transport behaviour	Model w/ technology innovativeness	Model w/ technology optimism	Model w/ technology optimism and concern	Model w/ technology optimism, concern, supportive
Household income (gross annual, 1000 NOK)	0.0002 (0.0002)					
Income non-response	−0.17 (0.36)					
No. of flights Bergen-Stavanger in 2019		0.004 (0.004)				
No. of flights abroad in 2019		−0.04* (0.02)				
Age < 30 years	−0.08 (0.3)	−0.02 (0.31)	−0.19 (0.3)	−0.19 (0.3)	−0.19 (0.3)	−0.17 (0.31)
Age > 50 years	−0.13 (0.23)	−0.04 (0.24)	−0.07 (0.23)	−0.07 (0.23)	−0.09 (0.23)	0.03 (0.24)
Female gender	−0.07 (0.21)	−0.08 (0.22)				
University degree (or equivalent)	0.29 (0.24)	0.3 (0.25)				
Full-time job	−0.62* (0.24)	−0.59* (0.24)	−0.59* (0.24)	−0.61* (0.24)	−0.63** (0.24)	−0.6* (0.25)
Access to electric car		0.35° (0.21)	0.37 (0.24)	0.38 (0.24)	0.36 (0.24)	0.5* (0.25)
Last flight Bergen-Stavanger was a business trip		0.43. (0.25)	0.17 (0.26)	0.15 (0.26)	0.15 (0.26)	0.12 (0.27)
Last flight Bergen-Stavanger was a leisure trip		0.2 (0.26)	0.06 (0.27)	0.1 (0.27)	0.13 (0.27)	0.2 (0.29)
Has applied Widerøe in flight Bergen-Stavanger after 1 Jan. 2019		0.01 (0.28)				
Technology-innovativeness			0.21 (0.14)			
Technology-optimism				0.34* (0.15)	0.33* (0.15)	0.03 (0.16)
Concerned					−0.19 (0.15)	−0.01 (0.16)
Supportive						1.12*** (0.19)
Price	−0.003*** (0.0004)	−0.003*** (0.0004)	−0.003*** (0.0004)	−0.003*** (0.0004)	−0.003*** (0.0004)	−0.004*** (0.0004)
Intercept	3.54*** (0.62)	3.4*** (0.61)	3.64*** (0.56)	3.63*** (0.56)	3.63*** (0.56)	3.55*** (0.58)
Median WTP	1005	997	1005	1004	1004	995
Mean WTP	1016	1008	1015	1015	1014	1002
Log-likelihood	−314.9	−310.3	−314.3	−312.8	−312	−292.2
Bayesian information criterion (BIC)	689	706.1	687.8	684.8	689.8	656.8
Likelihood ratio statistic	115.1	124.3	116.2	119.2	120.8	160.4
Adj. McFadden pseudo-R square	0.1304	0.132	0.1319	0.1359	0.1353	0.1858
No. of obs.	720	720	720	720	720	720

Note: The models were estimated in R package DCchoice, sbchoice command with (linear-)logistic distribution (Aizaki et al., 2014, 2022); coefficients standard errors in parentheses; level of significance, p-values: ***<0.001, **<0.01, *<0.05, °<0.1.

the youngest and a negative for the oldest; but the statistical relationship is somewhat weaker when price differences are included (Table 4b).

When comes to the latent variables, for both sub-samples there is a positive association between Technology optimism and the hypothetical choice of the electric airplane option, but not so for Technology innovativeness. The construct Concerned (about safety and range) is strongly negatively associated with the electric airplane choice in the sub-sample of reluctant (n = 280), but not so for those who would consider flying electric (n = 720). The construct Supportive (politically and in environmental consciousness) obtains a positive coefficient sign for all cases (Tables 4a and 4b).

Regarding the follow-up questions, about the choice of the electric airplane when shown an illustration of a 19-seat model and then, afterwards, being informed about a slightly longer travel time, we can summarise the following: The presentation of the actual electric airplane prototype yielded a slight increase in the share choosing the electric airplane, for a given increase in relative fare. The information about increased travel time when using the illustrated electric airplane yielded a drop in the share choosing the electric airplane, but not offsetting entirely the increase due to the illustration of the prototype.[11]

[11] Model results for the altered choices, after being shown the illustration and being informed about the increased travel time, are presented in the Supplementary Material.

Table 4b
Logistic regression models of choosing an electric airplane between Bergen and Stavanger when its fare differs from that of a conventional airplane; the reluctant (n = 280).

	Model w/ only demographic / socio-economic variables	Model including (observable) transport behaviour	Model w/ technology innovativeness	Model w/ technology optimism	Model w/ technology optimism and concern	Model w/ technology optimism, concern, supportive
Household income (gross annual, 1000 NOK)	0.0002 (0.0003)					
Income non-response	−0.53 (0.47)					
No. of flights Bergen-Stavanger in 2019		0.02 (0.03)				
No. of flights abroad in 2019		−0.02 (0.02)				
Age < 30 years	0.93* (0.46)	0.96* (0.46)	0.93* (0.45)	0.94* (0.45)	0.92 (0.48)	0.84° (0.48)
Age > 50 years	−0.73* (0.31)	−0.72* (0.31)	−0.8** (0.31)	−0.77* (0.31)	−0.91* (0.33)	−0.87* (0.34)
Female gender	0.47 (0.29)	0.02 (0.32)				
University degree (or equivalent)	0.21 (0.29)	0.17 (0.28)				
Full-time job	−0.05 (0.33)	0.03 (0.35)	−0.01 (0.32)	−0.02 (0.32)	−0.11 (0.34)	−0.05 (0.35)
Access to electric car		0.17 (0.28)				
Last flight Bergen-Stavanger was a business trip		0.03 (0.35)	0.06 (0.34)	−0.02 (0.34)	0.33 (0.37)	0.48 (0.38)
Last flight Bergen-Stavanger was a leisure trip		−0.2 (0.4)	−0.11 (0.39)	−0.11 (0.39)	0.29 (0.43)	0.28 (0.44)
Has applied Widerøe in flight Bergen-Stavanger after 1 Jan. 2019		−0.69 (0.46)	−0.72° (0.41)	−0.68° (0.41)	−0.62 (0.45)	−0.53 (0.45)
Technology-innovativeness			−0.1 (0.19)			
Technology-optimism				0.36° (0.19)	0.29 (0.22)	0.02 (0.24)
Concerned					−1.18** (0.21)	−1.02*** (0.22)
Supportive						0.74** (0.25)
Price	−0.001** (0.0004)	−0.001** (0.0004)	−0.001** (0.0004)	−0.001** (0.0004)	−0.002* (0.0005)	−0.002** (0.0005)
Intercept	−0.25 (0.54)	−0.12 (0.5)	0.21 (0.41)	0.35 (0.42)	1.01 (0.47)	1.11* (0.48)
Median WTP	−136	−187	−197	−174	−151	−188
Mean WTP	447	468	479	461	384	374
Log-likelihood	−158.8	−159.5	−161	−159.4	−140.1	−135.5
Bayesian information criterion (BIC)	368.3	392.3	372.7	369.4	336.5	332.9
Likelihood ratio statistic	32.5	31.1	28.2	31.4	69.9	79.2
Adj. McFadden pseudo-R square	0.0415	0.0145	0.029	0.0383	0.1427	0.1634
No. of obs.	280	280	280	280	280	280

Note: The models were estimated in R package DCchoice, sbchoice command with (linear-)logistic distribution (Aizaki et al., 2014, 2022); coefficients standard errors in parentheses; level of significance, p-values: ***<0.001, **<0.01, *<0.05, °<0.1.

6. Discussion

6.1. A first stated-preference survey of potential passengers

In this paper we have analysed the stated preferences towards flying with a future electric battery-powered airplane. Our survey was applied to one thousand individuals who had been travelling between Bergen and Stavanger during the last 2.5 years. We included 2019, the last pre-pandemic year, to ensure that the recruiting of respondents was not deranged by transport suspensions due to COVID-19 regulations. Our sample is representative of a sub-population with relatively high levels of travel between these two urban areas. The sample represents those who are most likely to face actual choices involving electric airplanes in the near future.

We have applied a relatively simple stated-preference methodology, leaning on presented premises for theoretically valid survey-based economic valuation (Carson & Groves, 2007). Even if the method as such is valid, the extent to which an implementation in a survey is valid will depend on various circumstances. It is important that the respondents find the scenario credible. In our case, about half the sample agreed to statements about electric airplane options between Bergen and Stavanger being available in 2025 and all other Norwegian airports in 2035, while ca. 20% disagreed. >70% of the respondents ticked a “yes” answer to the question about whether electric airplanes would represent a transport option. It is indicated that the market of travellers is split with respect to new electric airplane options (corroborating hypothesis H_1).

6.2. Theoretically valid responses from a divided air-travel segment

A clear indication of theoretical validity of our results was the significantly negative coefficient of the price coefficient (Hanemann & Kanninen, 1999), in the parametric model of electric airplane choice (Tables 4a and 4b). This implies a downward sloping WTP / demand curve (supporting hypothesis H_2). When comes to the willingness to pay an addendum or markup for a flight with an electric airplane relative to a conventional airplane, we estimate an average that is close to zero. What drives this result is that the sample is split between "electric airplane interested" (n = 720) and "electric airplane reluctant" (n = 280); and the latter group would request a discount to accept an electric airplane instead of a conventional one.[12] Overall, in our sample, the required discount and the price premium cancel out. However, even if our sample is drawn from a sub-population of those traveling between Bergen and Stavanger, any discrepancy (or non-representativeness) between our sample and the sub-population might tilt the overall average in the sub-population.

Like Han et al. (2019a), we also found a tendency of the youngest segment being more positive towards electric airplanes. University degree also tended to co-variate with electric airplane choice, but we found no gender difference. Regarding WTP, the youngest were not more willing to pay extra for electric airplane options (not supporting hypothesis H_4); the youngest were only relatively more eager to accept it for a discount, if hesitant at the outset (n = 280). Among those who would consider flying electric (n = 720), there is a negative relationship between electric airplane choice for a price premium and working full-time. We find two inter-related explanations; that commuting by air is relatively high on the Bergen-Stavanger segment, thus part of those employed are commuting by air and they have presumably perceived the survey as consequential, such that their "Yes" would be a vote for more expensive commuting by electric airplanes. The high share of commuting by air between Bergen and Stavanger is partly driven by the petroleum industry-related employment; this sector has had the highest share of commuting by air on the Bergen-Stavanger segment (Denstadli et al., 2014).

In a similar vein as Han et al. (2019b), we also found a relationship between reluctance towards electric airplanes and safety/range concerns (see also Sierzchula et al., 2014; Han et al., 2019b; Featherman et al., 2021; Korkmaz et al., 2022). A construct measured by statements about concern for safety and range was negatively associated with the electric airplane choice for a discount (n = 280). This result might to some extent reflect that safety is a fundamental issue and a challenge for electric airplane introduction (Courtin & Hansman, 2018; Sripad et al., 2021). Some of the reluctant travellers are susceptible to discounts, but a minority will supposedly remain reluctant even when discounts are huge. The relationship between discounted ticket price and choice of electric airplane was theoretically correct, in the sub-sample of reluctant travellers, but the curve was not steep. Thus, the divide of the market of transport users between Bergen and Stavanger seems to be driven primarily by safety (and range) concerns (H_1).

6.3. Technology readiness in preferences for a new transport service

We have argued that the choice between services based on different technologies might involve other considerations than the choice between durables (Han et al., 2019b; Korkmaz et al., 2022). However, we did find positive association between Technology innovativeness and considering flying electric; thus, there is most probably an element of adaption and readiness that also applies to a technologically new public transport service (Venkatesh et al., 2012; Parasuraman & Colby, 2015). The relationship was however somewhat stronger between Technology optimism and considering flying electric, and only Technology optimism, not innovativeness, showed an association with the choice of the electric airplane option for a price difference (only partly corroborating hypothesis H_3). As indicated, that might well be due to the nature of the service that we have evaluated, that Technology optimism is more encompassing than Technology innovativeness (Parasuraman & Colby, 2015).

We find that WTP estimates from stated-preference methodology provides an important addendum to attitudinal estimates. The hypothetical choice of an electric airplane option (vs. conventional) for a price differential is a type of behavioural intention that is expected to yield improved prediction of future choices compared to attitudinal measures (Ajzen & Fishbein, 1977; Carson & Groves, 2007). Our results have indicated that associations between individual characteristics and less specified attitudes/preferences towards electric airplanes ("consider" using it, in Table 3), might fade away when introducing payment (Tables 4a and 4b).

7. Conclusions

In addition to measuring the attitudes on important aspects of air travel with electric planes, such as safety concerns, our study is the first that we know of that has provided estimates of economic preferences of those who would constitute the potential users of the first generation of small battery-powered short-haul airplanes in commercial passenger transport. A clear majority (72%) of the respondents would consider electric airplanes as a transport option when this becomes available. Being young and/or highly educated correlates with a higher likelihood of considering electric airplanes as an option for transport. Among the respondents that would

[12] In our case however, there is hardly any indication of hypothetical overstatement (Harrison & Rutstrom, 2008), as the estimated WTP≈0. Regarding the modelling, one could alternatively estimate a common model for the positive (n=720) and the reluctant (n=280) towards electric airplanes (Nahuelhual-Muñoz et al., 2004); but we find that separate models might be relevant when there is a difference in what drives demand for a discount versus what drives willingness to pay a price premium. Another technicality is that the latent variable model could have been estimated simultaneously with the hypothetical choice model; but the statistical impact of applying a sequential approach might be limited (Bahamonde-Birke & Ortúzar, 2014); and we find no reason to suspect that a different estimation would alter our main results.

consider electric airplanes for transport when this becomes available, there is on average a willingness to pay a premium for traveling by electric plane over conventional plane, but the WTP drops sharply at higher premium levels. Among the respondents who did not consider electric airplanes as a transport option, there would on average be a need for large discounts to make them willing to accept to travel by electric airplanes over conventional airplanes.

In sum, our results do not show any extensive willingness to pay a price premium. However, the possibility for self-selection between electric and conventional alternatives can lead to higher consumer surpluses, and possibilities for achieving a price premium from some passenger segments. Suppliers of new electric aviation options might draw on that potential segment of eager consumers, but supposedly with limited scope for payback in the short to medium term. New battery-driven airplane technology will supposedly not be cheaper than the existing kerosene-based in the medium term. These findings have implications for policy makers if they want to influence on the rate of transition from kerosene-based to electric aviation. Regulations, like carbon taxes on fuel/kerosene or carbon taxes paid by passengers can contribute to advancing the technological shift (Fukui & Miyoshi, 2017); and regulatory policy might also be applied in supporting the development of electric airplane alternatives (Epstein & O'Flarity, 2019; Larsson et al., 2019; Ydersbond et al., 2020). In our sample there was considerable agreement to statements about public support in advancing electric airplane technology, also using subsidies (that have been applied for electric cars and ferries in Norway), but such support will eventually compete with other schemes for government funding. Besides taxes, regulations and direct monetary support, the appropriate government agencies can also strive to communicate the safety and reliability of the first electric passenger planes certified for commercial use. Though a minority, there was a non-negligible share of the respondents that stated that they were worried or somewhat worried about range issues and other safety issues with electric planes. This worry correlates negatively with the willingness to choose electric flight as a travel option and the willingness to pay a premium. Hence, documenting safety through extensive testing and certification procedures, and providing a truthful and convincing message about safety will be important for policy makers wanting to support the transition to electric aviation.

Our study has probed of peoples' considerations of electric airplane options, but our study has its limitations and there is still plenty of room for more research within this field. Replications of our approach in a different setting could provide more detailed insight into the potential markets. Results could differ in other geographical and socioeconomic contexts, as our sample consisting of travellers between the Bergen and Stavanger area is characterized by for example, relatively high levels of income, education, and electric vehicle ownership. Doing variations of this study with different methods could also provide important insights. As we discuss in Section 6, we have applied a relatively simple stated-preference methodology, which has its limitations compared to more sophisticated and data-intensive (and therefore costly) methods. Possible future improvements to this line of research could involve a type of discrete-choice experiment where more attributes are varied between airplane alternatives, like airplane size and flight travel time (Martín et al., 2008; Hess, 2010; Collins et al., 2012). Such choice sets will supposedly become more salient for respondents as we reach the stage of introducing the first generation of electric airplanes, which will improve the reliability of the data and the predictive qualities of the results. It will also be interesting to compare the findings from such later studies with the early-stage findings we present in this article, as it will feed our understanding of the developments of attitudes to emerging technologies in the years before introduction to the market.

CRediT authorship contribution statement

Knut Veisten: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Writing – original draft, Writing – review & editing. **Paal Brevik Wangsness:** Conceptualization, Methodology, Writing – original draft, Writing – review & editing, Visualization, Project administration, Funding acquisition. **Eivind Farstad:** Conceptualization, Methodology, Investigation, Writing – review & editing. **Inga Margrete Ydersbond:** Conceptualization, Writing – review & editing, Funding acquisition.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Acknowledgements

We are indebted to two anonymous reviewers to this journal. We are also grateful for comments received from participants at the *35th International Electric Vehicle Symposium and Exhibition* (EVS35). Arne Martin Gilberg and Arne Gytri provided valuable input to the survey development. The data collection and analyses were part of a project commissioned by Start Norge AS (https://www.startnorge.no/). The views expressed in this paper are those of the authors and do not necessarily represent those of the funder.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.trd.2023.104013.

References

Aizaki, H., Nakatani, T., Sato, K., 2014. Stated Preference Methods using R. Chapman & Hall/CRC Press.

Aizaki, H., Nakatani, T., Sato, K., Fogarty, J., 2022. R package DCchoice for dichotomous choice contingent valuation: a contribution to open scientific software and its impact. Japan. J. Statist. Data Sci. 5, 871–884.

Ajzen, I., Fishbein, M., 1977. Attitude-behavior relations: a theoretical analysis and review of empirical research. Psychol. Bull. 84 (5), 888–918.

Ajzen, I., 1985. From intentions to actions: a theory of planned behavior. Ch. 2. In: Kuhl, J., Beckmann, J. (Eds.) Action Control: From Cognition to Behavior. Springer Verlag, pp. 11–39.

Bahamonde-Birke, F., Ortúzar, J.de D., 2014. Is sequential estimation a suitable second best for estimation of hybrid choice models? Transp. Res. Rec. 2429 (1), 51–58.

Bateman, I.J., Carson, R.T., Day, B.H., Hanemann, W.M., Hanley, N., Hett, T., Jones-Lee, M., Loomes, G., Mourato, S., Özdemiroglu, E., Pearce, D.W., Sugden, R., Swanson, J., 2002. Economic Valuation with Stated Preference Techniques: A Manual. Edward Elgar Publishing.

Ben-Akiva, M., Mcfadden, D., Train, K., Walker, J., Bhat, C., Bierlaire, M., Bolduc, D., Boersch-Supan, A., Brownstone, D., Bunch, D.S., Daly, A., De Palma, A., Gopinath, D., Karlström, A., Munizaga, M.A., 2002. Hybrid choice models: progress and challenges. Mark. Lett. 13, 163–175.

Bollen, K.A., 1989. Structural Equations with Latent Variables. Wiley.

Bouscasse, H., 2018. Integrated choice and latent variable models: a literature review on mode choice. Archive ouverte HAL-01795630 (https://hal.archives-ouvertes.fr/hal-01795630/document).

Browne, M.W., Cudeck, R., 1992. Alternative ways of assessing model fit. Sociol. Methods Res. 21 (2), 230–258.

Buus Kristensen, N., & Thune-Larsen, H. (2022). Effekter av klimatiltak i norsk luftfart (Impacts of climate policy measures on Norwegian aviation). TØI Report 1878, Institute of Transport Economics, Oslo.

Carson, R.T., 2000. Contingent valuation: a user's guide. Environ. Sci. Tech. 34 (8), 1413–1418.

Carson, R.T., Groves, T., 2007. Incentive and informational properties of preference questions. Environ. Resour. Econ. 37 (1), 181–210.

Carson, R.T., Louviere, J.L., 2011. A common nomenclature for stated preference elicitation approaches. Environ. Resour. Econ. 49 (4), 539–559.

Cheung, G.W., Cooper-Thomas, H.D., Lau, R.S., & Wang, L.C. (2023). Reporting reliability, convergent and discriminant validity with structural equation modeling: a review and best-practice recommendations. Asia Pacific Journal of Management, online version (https://doi.org/10.1007/s10490-023-09871-y).

Collins, A.T., Rose, J.M., Hess, S., 2012. Interactive stated choice surveys: a study of air travel behaviour. Transportation 39 (1), 55–79.

Courtin, C., Hansman, J., 2018. Safety considerations in emerging electric aircraft architectures. Report No. ICAT-2018-07, June 2018. MIT International Center for Air Transportation (ICAT), Massachusetts Institute of Technology.

Dean, A., Morgan, D., Tan, T.E., 2002. Service quality and customers' willingness to pay more for travel services. J. Travel Tour. Mark. 12 (2–3), 95–110.

Denstadli, J.M., Farstad, E., Thune-Larsen, H., 2014. Pendling Med Fly. (Commuting by air.). TØI Report 1337, Institute of Transport Economics, Oslo.

EASA, 2020. EASA certifies electric aircraft, first type certification for fully electric plane world-wide. Press release, June 10, 2020 (https://www.easa.europa.eu/en/newsroom-and-events/press-releases/easa-certifies-electric-aircraft-first-type-certification-fully, last accessed 26 March 2023).

Edison, S.W., Geissler, G.L., 2003. Measuring attitudes towards general technology: antecedents, hypotheses and scale development. J. Target. Meas. Anal. Mark. 12 (2), 137–156.

Epstein, A.H., O'Flarity, S.M., 2019. Considerations for reducing aviation's CO_2 with aircraft electric propulsion. J. Propul. Power 35 (3), 572–582.

EUROCONTROL, 2022. Aviation outlook 2050. Main Report, April 2022, EUROCONTROL (https://www.eurocontrol.int/sites/default/files/2022-04/eurocontrol-aviation-outlook-2050-main-report.pdf, last accessed 26 March 2023).

Featherman, M., Jia, S. (Jasper), Califf, C.B., & Hajli, N. (2021). The impact of new technologies on consumers beliefs: reducing the perceived risks of electric vehicle adoption. *Technological Forecasting and Social Change*, 169: 120847 (https://doi.org/10.1016/J.TECHFORE.2021.120847).

Fishbein, M., Ajzen, I., 1975. Belief, Attitude, Intention, and Behavior: An Introduction to Theory and Research. Addison-Wesley.

Fornell, C., Larcker, D.F., 1981. Evaluating structural equation models with unobservable variables and measurement error. J. Mark. Res. 18 (1), 39–50.

Fukui, H., Miyoshi, C., 2017. The impact of aviation fuel tax on fuel consumption and carbon emissions: the case of the US airline industry. Transp. Res. D 50, 234–253.

Greene, D., Hossain, A., Hofmann, J., Helfand, G., Beach, R., 2018. Consumer willingness to pay for vehicle attributes: what do we know? Transp. Res. A 118, 258–279.

Haboucha, C.J., Ishaq, R., Shiftan, Y., 2017. User preferences regarding autonomous vehicles. Transp. Res. C 78, 37–49.

Han, H., Yu, J., Kim, W., 2019a. Investigating airline customers' decision-making process for emerging environmentally-responsible electric airplanes: influence of gender and age. Tour. Manag. Perspect. 31, 85–94.

Han, H., Yu, J., Kim, W., 2019b. An electric airplane: assessing the effect of travelers' perceived risk, attitude, and new product knowledge. J. Air Transp. Manag. 78, 33–42.

Han, H., Lee, M.J., Chua, B.-L., Kim, W., 2019c. Triggers of traveler willingness to use and recommend eco-friendly airplanes. J. Hosp. Tour. Manag. 38, 91–101.

Han, H., Chua, B.-L., Hyun, S.S., 2020. Consumers' intention to adopt eco-friendly electric airplanes: the moderating role of perceived uncertainty of outcomes and attachment to eco-friendly products. Int. J. Sustain. Transp. 14 (9), 671–685.

Hanemann, W.M., 1994. Valuing the environment through contingent valuation. J. Econ. Perspect. 8 (4), 19–43.

Hanemann, W.M., & Kanninen, B.J. (1999). Statistical considerations in CVM. In: Bateman, I.J., Willis, K.G. (Eds.). Valuing Environmental Preferences: The Theory and Practice of the Contingent Valuation Method in the US, EU and Developing Countries. Oxford University Press. pp. 302–441 (Ch. 11).

Hardman, S., Shiu, E., Steinberger-Wilckens, R., 2016. Comparing high-end and low-end early adopters of battery electric vehicles. Transp. Res. A 88, 40–57.

Harrell, F.E., 2015. *Regression Modeling Strategies*. Springer Series in Statistics. Springer (https://doi.org/10.1007/978-3-319-19425-7_10).

Harrison, G., & Rutstrom, E. (2008). Experimental evidence on the existence of hypothetical bias in value elicitation methods. Ch. 81 (752-767). In: Plott, C.R., & Smith, V.L. *Handbook of Experimental Economics Results*. vol. 1, Elsevier.

Hess, S. (2010). Modelling air travel choice behaviour. In: Forsyth, P., Gillen, D., Muller, J., & Niemeier, H.-M. (Eds.) *Airport Competition: The European Experience*. Ashgate/Routledge. Ch. 11, pp. 151–176.

Hidrue, M.K., Parsons, G.R., Kempton, W., Gardner, M.P., 2011. Willingness to pay for electric vehicles and their attributes. Resour. Energy Econ. 33 (3), 686–705.

Johnston, R.J., Boyle, K.J., Adamowicz, W., Bennett, J., Brouwer, R., Cameron, T.A., Hanemann, W.M., Hanley, N., Ryan, M., Scarpa, R., Tourangeau, R., Vossler, C. A., 2017. Contemporary guidance for stated preference studies. J. Assoc. Environ. Resour. Econ. 4 (2), 319–405.

Jorgensen, T.D., 2022. Package 'semTools'. Manual, Oct 14, 2022 (https://cran.r-project.org/web/packages/semTools/semTools.pdf, last accessed 24 Oct 2023).

Korkmaz, H., Fidanoglu, A., Ozcelika, S., Okumus, A., 2022. User acceptance of autonomous public transport systems: extended UTAUT2 model. Journal of Public Transportation 24, 100013. https://doi.org/10.5038/2375-0901.23.1.5.

Kriström, B., 1990. A non-parametric approach to the estimation of welfare measures in discrete response valuation studies. Land Econ. 66 (2), 135–139.

Kriström, B., 1997. Spike models in contingent valuation. Am. J. Agric. Econ. 79 (3), 1013–1023.

Larsson, J., Elofsson, A., Sterner, T., Åkerman, J., 2019. International and national climate policies for aviation: a review. Clim. Pol. 19 (6), 787–799.

Lee, D.S., Fahey, D.W., Skowron, A., Allen, M.R., Burkhardt, U., Chen, Q., Doherty, S.J., Freeman, S., Forster, P.M., Fuglestvedt, J., Gettelman, A., De León, R.R., Lim, L.L., Lund, M.T., Millar, R.J., Owen, B., Penner, J.E., Pitari, G., Prather, M.J., Sausen, R., Wilcox, L.J., 2021. The contribution of global aviation to anthropogenic climate forcing for 2000 to 2018. Atmos. Environ. 244, 117834 https://doi.org/10.1016/j.atmosenv.2020.117834.

Louviere, J.L., Flynn, T.N., Carson, R.T., 2010. Discrete choice experiments are not conjoint analysis. J. Choice Model. 3 (3), 57–72.

Louviere, J.J., Woodworth, G., 1983. Design and analysis of simulated consumer choice or allocation experiments: an approach based on aggregated data. J. Mark. Res. 20 (4), 350–367.

Luzar, E.J., Cosse, K.J., 1998. Willingness to pay or intention to pay: the attitude-behavior relationship in contingent valuation. J. Socio-Econ. 27 (3), 427–444.

Martín, J.C., Román, C., Espino, R., 2008. Willingness to pay for airline service quality. Transp. Rev. 28 (2), 199–217.

Martínez-Espiñeira, R., Lyssenko, N., 2011. Correcting for the endogeneity of pro-environment behavioral choices in contingent valuation. Ecol. Econ. 70 (8), 1435–1439.

Minge, H. (2022). Elektrisk i luften over Vestlandet. (https://www.elflyportalen.no/nyheter/elektrisk-i-luften-over-vestlandet/, last accessed 26 March 2023).

Nahuelhual-Muñoz, L., Loureiro, M., Loomis, J., 2004. Addressing heterogeneous preferences using parametric extended spike models. Environ. Resour. Econ. 27 (3), 297–311.

Nakano, Y., Sano, F., Akimoto, K., 2022. Impacts of decarbonization technologies in air transport on the global energy system. Transp. Res. D 110, 103417. https://doi.org/10.1016/j.trd.2022.103417.

Parasuraman, A., Colby, C.L., 2015. An updated and streamlined technology readiness index: TRI 2.0. J. Serv. Res. 18 (1), 59–74.

Park, J.-W., Robertson, R., Wu, C.-L., 2006. Modelling the impact of airline service quality and marketing variables on passengers' future behavioural intentions. Transp. Plan. Technol. 29 (5), 359–381.

Poe, G.L., Clark, J.E., Rondeau, D., Schulze, W.D., 2002. Provision point mechanisms and field validity tests of contingent valuation. Environ. Resour. Econ. 23 (1), 105–131.

Rendón, M.A., Sánchez, R.C.D., Gallo, M.J., Anzai, A.H., 2021. Aircraft hybrid-electric propulsion: development trends, challenges and opportunities. J. Control, Autom. Electr. Syst., 32, 1244–1268.

Rosseel, Y., 2023. The lavaan tutorial. Tutorial, January 9, 2023, Department of Data Analysis, Ghent University (https://lavaan.ugent.be/tutorial/tutorial.pdf, last accessed 26 March 2023).

Schäfer, A.W., Barrett, S.R.H., Doyme, K., Dray, L.M., Gnadt, A.R., Self, R., O'Sullivan, A., Synodinos, A.P., Torija, A.J., 2019. Technological, economic and environmental prospects of all-electric aircraft. Nat. Energy 4, 160–166.

Sierzchula, W., Bakker, S., Maat, K., Van Wee, B., 2014. The influence of financial incentives and other socio-economic factors on electric vehicle adoption. Energy Policy 68, 183–194.

Sripad, S., Bills, A., Viswanathan, V., 2021. A review of safety considerations for batteries in aircraft with electric propulsion. MRS Bull. 46, 435–442.

Steenkamp, J.-B.-E.-M., ter Hofstede, F., 2002. International market segmentation: issues and perspectives. Int. J. Res. Mark. 19 (3), 185–213.

Sundt, S., Rehdanz, K., 2015. Consumers' willingness to pay for green electricity: a meta-analysis of the literature. Energy Econ. 15, 1–8.

TE, 2022. Roadmap to climate neutral aviation in Europe. March 2022, Transport & Environment (https://www.transportenvironment.org/wp-content/uploads/2022/03/TE-aviation-decarbonisation-roadmap-FINAL.pdf, last accessed 26 March 2023).

Venables, W.N., Smith, D.M., the R Core Team, 2023. An Introduction to R. Version 4.2.3, 2023-03-15 (https://cran.r-project.org/doc/manuals/r-release/R-intro.pdf, last accessed 26 March 2023).

Venkatesh, V., Morris, M.G., Davis, G.B., Davis, F.D., 2003. User acceptance of information technology: toward a unified view. MIS Q. 27 (3), 425–478.

Venkatesh, V., Thong, J.Y.L., Xu, X., 2012. Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. MIS Q. 36 (1), 157–178.

Wangsness, P.B., Ydersbond, I.M., Veisten, K., & Farstad, E., 2021. Fremskyndet innfasing av elfly i Norge: mulige samfunnsmessige virkemidler og konsekvenser (Accelerating the phase in of electric aircraft in Norway: possible societal impacts and policy instruments). TØI Report 1851, Institute of Transport Economics, Oslo.

Ydersbond, I.M, Buus Kristensen, N., Thune-Larsen, H., 2020. Nordic sustainable aviation. TemaNord 2020:536, Nordic Council of Ministers (https://pub.norden.org/temanord2020-536/, last accessed 8 August 2023).