The perception of air transport service characteristics. Differences among latent air passengers' classes.

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Abstract

Air transport system has a fundamental role in the regional development. Good airline services contribute significantly to urban economic development of a region. Services offered by airlines are characterized by several attributes. For this reason, determining the importance given by the passengers to the various service attributes becomes fundamental. The objective of this work is investigating heterogeneity in air passengers' preferences. We propose a methodology based on the use of Stated Choice (SC) and discrete choice models. Specifically, we calibrated a Latent Class (LC) model based on data collected through a sample survey addressed to people studying or working in an Italian university campus. Model results suggest the presence of three classes of users: a first more exigent class, mainly interested to the quantitative service characteristics such as travel times and particularly sensitive to travel cost; a second class resulting more sensitive to aspects linked to temperature and space on board and not susceptible to the travel cost; a third class that is more directed to the services on board and cabin crew and not susceptible to travel cost. These findings could be useful for planners, who should define differentiated strategies to customize and/or attract various passengers' profiles.

Keywords: air transport service quality; passengers' perceptions; stated choice; latent class models.

1. Introduction

Air transport system is very important for the development of a region. The competitiveness of airlines is significantly influenced by the critical importance of service excellence and effective customer relationship management (Atalik et al., 2009). In the most recent years, airline service quality has assumed an important role in defining the business strategies (Tiernan et al., 2008). To maintain competitiveness, airlines must discern the requirements and anticipations of passengers to guarantee customer satisfaction (Chang and Yeh, 2002). Traditionally, transport passengers' opinions have been collected through sample surveys. As for the transportation systems in general, also in the airline industry, experts have extensively utilized various survey methodologies to

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create and validate novel tools for assessing service quality (Brochado et al., 2019). A comprehensive examination of research investigating air travel service excellence from the perspective of passengers is documented in Eboli et al. (2022) and Bellizzi et al. (2020a). Examining the state of the art, it becomes apparent that there is a wide range of methods for collecting data through surveys and a large variety of methods for analysing the data. A relevant part of research adopted random utility methods as instrument of analysis; particularly, this kind of models has increased steadily starting from 2000s in the realm of air travel decision-making processes. The bulk of these studies have relied on the use of classical survey data, typically gathered from air travellers at departure gate.

However, in various research endeavours, the lack of sufficient data pertaining to the actual choices confronted by participants hinders the ability to provide a dependable analysis of certain service aspects (Hess et al., 2007). This inconvenient, together with other disadvantages of Revealed Preference (RP) data, has stimulated the use of Stated Choice (SC) approach, which allows presenting to respondents hypothetical choice situations that can be characterized by service quality factors and levels of quality that are not available in the actual context (Louviere et al., 2000).

Our research aligns into the group of works analysing passengers' preferences with the objective of identifying the facets that are mostly important for them, through a methodology based just on the use of random utility models calibrated based on SC data.

More specifically, we propose to the users SC experiments where respondents have to make a choice between hypothetical services characterized by certain service quality factors. A more specific and ambitious objective of our research is comparing passengers' preferences, to discover groups of users who are more or less sensitive to the various service characteristics. Nevertheless, there is a paucity of research exploring this matter, and our study aims to make a valuable contribution to the sector's body of literature by offering insights that may prove beneficial to both academics and industry professionals.

Given our intention to avoid choosing a priori the characteristics discriminating the different groups of users, as it happens for the classic differentiation between business and leisure travellers, we decided to adopt an approach that is able to discover latent users' categories. To this aim, a Latent Class (LC) model approach clearly represents a suitable methodology for investigating heterogeneity in air passengers' preferences. LC models offer a method for addressing individual diversity by examining a population consisting of a limited number of categories of individuals (Hensher et al., 2015). These categories (classes) display unique attributes, and individuals belonging to the same class possess a shared array of parameters that delineate it. The word "latent" refers to the unknown way of distributing individuals among the different categories. LC models have been used in transportation studies to replicate various types of decision-making, including the selection of transportation modes (e.g., Bhat, 1997), to choice road types (Greene and Hensher, 2003), and for location choices (Walker and Li, 2007). In the most recent years, also the choice of airline services has been simulated by this kind of models, but the literature has still provided very few studies adopting LC model approach. Therefore, our study has the objective to give a useful contribution to the literature of analysis of air passengers' heterogeneity through sophisticated methods of collecting data such as SC experiments, and methods of analysing SC data such as LC models. Definitively, the original contribution of the paper consists in the desire to identify latent groups of travellers having in common preferences about some service aspects, avoiding investigating on predetermined groups of travellers such as people travelling for business or people travelling for leisure, who are the most investigated in the literature (e.g. Caliao et al., 2023). The next section provides a literature review, focused on the studies adopting survey data collected through SC experiments, and particularly studies investigating the heterogeneity in air passengers' perceptions and preferences; some examples of LC models are also described. Section 3 is intended to provide the case study that substantiates the research. In section 4, we present LC models providing a brief theoretical framework, the formulation of the proposed model, and the model results. In section 5, a deep discussion of the findings is provided, where we reported also some comparisons with the few similar literature studies. Finally, the paper ends with a brief conclusive section.

2. Literature Review

2.1 Studies adopting SC experiments

Our study seeks to make a contribution to the existing body of literature on analysing the preferences of air passengers by distinguishing between user profiles. The goal is to assist industry professionals in devising marketing strategies aimed at enhancing the appeal of air transport services for specific user segments. A fundamental task is to identify the service elements identified as most crucial for the users, which are the aspects mostly influencing their preferences. In addition to its traditional use in the simulation of choice of transport mode, routes, etc., SC technique is a viable method in the realm of service quality assessment from the perspective of passengers, enabling the comprehension of the relative significance of individual factors or combinations of factors in influencing passenger satisfaction. Gaining insights into these values provides airlines with a valuable instrument to optimize costs, maximize investment resources, and enhance passenger satisfaction (Whitaker et al., 2005). Complementary approaches have been proposed in the literature to explore how passengers perceive and assign value to service attributes in the air transport. More specifically, the airline industry encompasses various business models including low-cost carriers, while airports serve as essential gateways to tourism destinations (Papatheodorou and Zenelis, 2013, Papatheodorou, 2021). Information and communication technologies are increasingly important in air transport, influencing both operations and customer interactions (Papatheodorou and Zenelis, 2013). In this context, hedonic price analysis (HPA) emerges as a valuable tool to estimate passengers' willingness to pay for specific service features, including non-market characteristics such as proximity to natural environments or comfort-related factors (Papatheodorou et al., 2012). HPA provides managers with a means to identify which service elements are most valued, offering a basis for pricing strategies and service differentiation.

From a theoretical perspective, the Gorman-Lancaster theory of characteristics provides an insightful framework to explain how demand arises from the valuation of individual product characteristics, rather than the product itself (Goodovitch, 1996; Papatheodorou, 2001). According to this theory, products may yield multiple characteristics simultaneously, allowing for a multidimensional analysis of consumer preferences. This contrasts with Becker's model, where each good is associated with a single commodity.

In air transport, this approach can be used to investigate how characteristics such as frequency, comfort, or route availability influence demand distribution and market share among carriers.

On the contrary, SC is a tool utilized in market research and transportation planning, to comprehend decision-making patterns and consumer choice frameworks (Louviere et al., 2000; Ortuzar, 2000). As well known, SC analysis is grounded in mathematical models of decision-making and the principles of discrete-choice analysis (Ben-Akiva and Lerman, 1985). In the realm of researching air travel decision-making, the utilization of SC data commenced in the early 2000s. Among the pioneering studies advocating for the use of SC data is Bradley's (1998) research, which employed binary logit models to analyse the selection of departure airport and route. Proussaloglou and Koppelman (1999) simulated the selection of carrier, flight, and fare class, while Algers and Beser (2001) deliberated on the modelling of flight and booking class preferences. These studies, and many others that were proposed successively, had simulated the choice of routes, or flights, or carriers, but they had not focused on service quality aspects yet. Some studies, which started to simulate the choices between different airline services, analysed the main traditional characteristics of the service, such as times and costs, such as the paper by Bliemier and Rose (2011), who illustrate the outcomes of various SC experimental design methodologies and compare the corresponding estimation results. One of the first attempts to insert other service characteristics was made by Hess et al. (2007), who integrated qualitative variables into the utility of the RP alternative, including the respondent's expressed satisfaction level with the service, yet none of these variables were deemed statistically significant. In the most recent years, ever more authors have proposed studies analysing air transport service quality, including more qualitative service aspects, in addition to characteristics such as time and cost, which represent quantitative service attributes. The examination of service quality commenced within alternative transportation sectors, including urban rail and bus services. Subsequently, the knowledge and insights garnered from these other modes of transportation have been applied to the realm of air travel.

2.2 Studies investigating air passengers' heterogeneity

Being air transport characterized by many kinds of services, due to the length of flight, the types of carriers, etc., and being also very different among them the passengers travelling by air, the literature studies analysing service quality have been often oriented to an analysis based on the differences between the kinds of service or the kinds of passengers. As an example, the study proposed by Whitaker et al. (2005) examined two case studies to investigate the utilization of SC data in assessing passenger preferences and priorities. They differentiated the preferences in terms of length of travel (long haul, with a flight time higher than 6 hours; short haul, with a flight time between 2 and 6 hours; ultrashort haul, with a flight time lower than 2 hours) and class of travel (economy classes, business, and first). They also introduced service qualitative attributes such as seat comfort and staff service. Chen and Wu (2009) analysed preference differences in attributes between classes of travellers. They introduced service attributes linked to service on board such as meal and entertainment. The heterogeneity among passengers can be investigated also by introducing in the analysis the differences in terms of users' characteristics. As an example, Warburg et al. (2006) investigated on demographic and unobserved heterogeneity in air passengers' sensitivity to service attributes in itinerary choice through standard and mixed-multinomial logit models. These above-mentioned examples of studies belong to the group of works introducing differences among users based on specific sources of heterogeneity, or linked to different kinds of services or products, or to the socio-economic characteristics of the users or their travel habits. In these cases, the analyst itself selects the categories and makes an analysis differentiated by predefined groups of users or introduces specific variables representing users' or services' characteristics in the models. This way to proceed implies *a priori* hypotheses, according to which the analyst supposes that there could be differences of preferences according to predefined characterizations. As an example, Weber (2005) explore heterogeneity in travellers' perceptions considering international travellers departing from Hong Kong, travellers from Western countries, travellers from Asian countries, and also travellers who value convenience over factors like frequent flyer points and route networks. On the other hand, the study by Archana and Subha (2012) examines factors of in-flight service quality that impact passenger satisfaction across different seat classes, including in-flight service, in-flight digital service, and back-office operations. Curtis et al. (2012) explore the differences between the following groups: passengers with 1-5 flights per year (occasionalists); passengers with 6-10 flights per year (regular); passengers with 11 or more flights per year (road warriors). Singaravelu and Amuthanayaki (2017) explore the differences between economy, business, and premium passengers. Finally, in Hawlena et al. (2019) the two main discussed user classes are passengers travelling by traditional carriers and passengers travelling by low-cost carriers.

On the other hand, other kinds of models are able to discover heterogeneity among groups of users that is not due to specific characteristics, but it is unknown, or latent. In this context, the LC models represent finite mixture models for classification of choice data, generating a specific quantity of latent classes comprising individuals who are presumed to exhibit homogeneity in their choice behaviour or preferences (Wedel and Kamakura, 1998). These frameworks are grounded in the theory of random utility maximization, which posits that individuals select the flight offering the greatest utility. Additionally, they operate on the premise that each individual pertains to a distinct latent class (Swait, 1994; Boxall and Adamowicz, 2002). Wen and Lai (2010) proposed an LC model based on data collected by an SC experiment where they introduced both quantitative (e.g. flight frequency, fare, on-time performance) and qualitative variables (e.g. check-in service, cabin crew, in-flight seat space).

LC models demonstrated superior performance compared to the multinomial logit model as a more effective method for examining airline choice behaviour. Wen et al. (2013) introduced an LC model with a generalized nested logit formulation to enhance the methodology of market segmentation analysis, accommodating heterogeneity in individuals' preferences across multiple segments while concurrently identifying segment sizes and individual profiles. They analysed both qualitative and quantitative attributes: preferred departure time, fare, punctuality and frequency are the quantitative attributes, cabin crew service, while check-in service, and in-flight seat space the qualitative ones.

Also in this case, the LC model performed better than the traditional models. Araghi et al. (2016) introduced a latent class model utilizing survey data obtained from a SC experiment, incorporating a single attribute for ticket price and three attributes pertaining to three passenger-oriented policies (CO2 offsetting contribution, luggage allowance, ecoefficiency). A particular study was conducted by Molesworth and Koo (2016) who applied the LC logit approach to a case study represented by a remotely piloted commercial flight, to identify the crucial factors influencing individuals' decision-making for a remotely piloted commercial passenger aircraft in comparison to a traditional aircraft. The SC experiment designed for collecting data was based on the following service attributes: cabin staff experience, aircraft age, punctuality, price, inflight service quality. Finally, the work by Zhou et al. (2020) analysed travellers' decision between different travel modes (car, bus, and air) introducing in the set of choice two different airlines; they considered attributes such as cost, travel time, service frequency, accessibility and seat comfort. Our study differs from the cited literature studies that adopted a LC model approach for several reasons. As an example, the two last cited studies proposed LC models that are very different from our studies, in terms of context and kind of choice simulated. In fact, Zhou et al. (2020) inserted in the choice set other travel modes in addition to air mode, while Molesworth and Koo (2016) compared remotely piloted commercial aircraft with a conventional one. Also, Wen et al. (2013) choose to make comparison between two different travel modes. Indeed, their objective was to pinpoint potential traveler preference segments concerning air and bus carriers. The previous study by Wen and Lai (2010) proposed LC models calibrated on data collected through the same SC experiment adopted by Wen et al. (2013), but in this case only air passengers were involved, as in our study. Finally, also the work by Araghi et al. (2016) refers to only air passengers' choices, but it is specifically oriented to environmental policies. The study by Wen and Lai (2010) is surely the most comparable to our study, but also in this case there are relevant differences. As an example, regarding SC experiment, they introduced eight attributes in the same experiments, while we decided to differentiate between attributes experienced during the before and after flight travel phases, and others experienced during the flight. This decision was based on the consideration that air services are characterized by several attributes experienced in very different flight phases, being the permanence in the airport quite relevant as regards the permanence in a train station or a bus stop. Therefore, we retain that it is more convenient to separate the service aspects in two different groups: before/after flight and during flight. This differentiation allows proposing to users SC experiments characterized by not many attributes, to mitigate the fatigue of the survey respondents, and to present to users contemporaneously attributes belonging to the same travel phase, and not to the whole travel.

3. Case study

3.1. Survey instrument and data

Our sample primarily consists of people who have travelled by air at least one time. The sample is made up of people who have a high academic qualification, being people working in an academic place and university students. More specifically, the survey was addressed to the students and workers of the University of Calabria (South of Italy). The choice of the population was based on a convenience reason, linked to the facility of reaching people to be interviewed and the practicableness to realize the interviews. Although the population belongs to a university context, it can be considered as a quite representative population, involving both students and different kinds of workers (professors, researchers, technical staff, etc.). It covers a complete age range (from 18 to 70 years), and also different income classes. Also, the travel purposes are quite variegated (work, study, pleasure, etc.). More specifically, about 29,000 people among students, academicians, administrative and technical staff were contacted through the institutional email, during the period from March to July 2019, observing the ethics guidelines of the university to guarantee protection of anonymity and confidentiality. They were asked to compile a quite articulated questionnaire, aimed to register the opinions of the passengers regarding their last flight, and also their preferences on airline services in general.

The design of the questionnaire involved several stages. Firstly, a deep study of the literature was made for defining the service attributes to submit to passengers' judgement, for establishing the evaluation scales, and for defining the data collection process. Secondly, the designed questionnaire was revised and refined by a panel of experts. Successively, the questionnaire was tested by conducting a pilot survey. Finally, the definitive questionnaire has been implemented and proposed to the sample (Bellizzi et al., 2020b).

The first part of the questionnaire aims at the collection of passengers' opinions about the services managed by the airline providing the flight described by the respondent. Specifically, users are requested to evaluate the overall experience, and the various service aspects regarding their experience before, during, and after the flight. In this first part, opinions were asked to the customer according to verbal and numerical scales. The second part of the questionnaire regards the SC experiment. Specifically, blocks of scenarios were proposed to the users who had to choose between two different alternatives (A and B) for each scenario. We differentiated between people who travelled by air transport within the six months before the interview and people who travelled less recently. To the first group of passengers we addressed more questions concerning their perceptions about the last flight, and for this reason they were requested to make only 8 SC experiments. On the other hand, people who have travelled more than six months before the interview were supposed to have not a clear memory of the flight to provide perceptions about the last flight; for this reason, they had more time during the interview for making all the 24 designed SC experiments.

Table 1- SC experiment service attributes and levels

Phase	Attributes	Levels
Before/after the flight	Waiting time at check-in	0 (check-in online); 5; 20 minutes
	Time spent for boarding operations	15; 60; 120 minutes
	Terminal-aircraft transfer mode	shuttle bus; finger; on foot
	Delay of flight departure	0 (on time); 20; 60 minutes
	Time spent for luggage delivery	0 (no luggage); 10; 30 minutes
	Cost of the ticket	20; 60; 180; 360; 720; 1440 €
During the flight	Space available on board	more than enough; less than enough
	Temperature on board	too warm; too cold
	Cleanliness on board	environment rather dirty; environment quite clean
	Cabin crew	quite courteous; rather rude
	Services on board	fully adequate quality; adequate quality, low quality
	Cost of the ticket	20; 60; 180; 360; 720; 1440 €

SC experiment refers to different phases of the air travel, and specifically the phases "before and after the flight", and "during the flight". In addition, the questions could refer to long-haul flights (more than 6 flight hours), medium-haul flights (from 2 to 6 flight hours) or short-haul flights (less than 2 flight hours). The selected attributes cover different aspects of the service, such as aspects related to the time taken by passengers during the journey (e.g. check-in time, boarding time, baggage drop-off time and delay time), aspects concerning comfort on board (e.g. available space, temperature, cleanliness, services), and other characteristics related to cost, crew, terminal-to-aircraft transfer mode, and so on. The service attributes characterizing the alternatives are reported in table 1, differentiated according to the travel phases.

In figure 1, two examples of SC experiments are shown.

H2.2 If you had to travel on a **MEDIUM-HAUL flight** (BETWEEN 2 AND 6 HRS), which of these alternatives would you choose?

	A	B
Waiting time at check-in	20 minutes	0 minutes (online check-in)
Time spent for boarding operations	10 minutes	40 minutes
Terminal-Aircraft transfer mode	by jet-way	by external path
Delay of flight departure	60 minutes	0 minutes
Time spent for luggage delivery	0 minutes (no luggage to claim)	30 minutes
Cost of the ticket	180 €	360 €

H4.1 If you had to travel on a **SHORT-HAUL flight** (LESS THAN 2 HRS), which of these alternatives would you choose?

	A	B
Space available on board	adequate	not fully adequate
Temperature on board	too warm	too cold
Cleanliness on board	quite dirty	quite dirty
Cabin crew	quite rude	kind enough
Services on board	not fully adequate	fully adequate
Cost of the ticket	20 €	60 €

Figure 1- Examples of SC experiment

At the end of the questionnaire, information about socio-economic characteristics are requested to the respondents, and the sample characterization is reported in the next subsection.

3.2 Sample characteristics

A sample of 1,907 respondents completed the questionnaire anonymously. The characteristics of the sample are shown in Table 2.

Table 2 – Socio-economic characteristics of the sample.

Passenger's socio-economic characteristics	
Gender	male (60.0%), female (38.7%), no response (1.3%)
Age (years)	18-25 (60.2%), 26-30 (17.5%), 31-40 (6.7%), 41-50 (7.2%), 51-60 (6.0%), >65 (2.5%)
Occupation	technical and administrative staff (8.8%), professors and researchers (10.8%), students (80.4%)
Monthly family income (Euros)	< 1,000 (17.0%), 1,000-2,000 (35.2%), 2,000-3,000 (16.5%), 3,000-5,000 (13.2%), > 5,000 (18.1%)
Education level	lower-secondary (3%), upper-secondary (54.2%), degree (21.9%), master degree (11.6%), PhD (9.2%)

Being the survey addressed to university students and personnel, more than 60% of respondents are aged from 18 to 25 years old, and 17.5% by people aged from 26 to 30 years old. 54.2% of the sample has the upper-secondary education (ISCED 3) and more than 20% a degree, being most of the sample composed of university students aiming to a bachelor's or a master's degree (80.4%), and about 20% has a master degree or a PhD, represented by academicians (10.8%) and also technical staff. Concerning income, most of the sample has a monthly family income between 1,000 € and 2,000 €, while the other income classes show similar percentages.

4. Methodology and results

4.1 Theoretical framework

LC models have been adopted to describe user behaviour when choosing among multiple alternatives. Greene (2001) offers an initial overview of the literature. Swait (1994) and Bhat (1997) present several applications of such models.

The LC model assumes that an individual's choice behaviour is determined not only by the attributes but also by a latent heterogeneity due to an unobserved variation of individual-specified characteristics. Specifically, the model classifies the respondents into a discrete number of latent segments, and a parameter vector is estimated for each segment (Greene and Hensher, 2003). In this way, the unobserved preference heterogeneity can be captured. The latent class model operates under the premise that there are several segments that display a degree of uniformity within each segment but demonstrate heterogeneity across segments. With a predetermined and constant quantity of segments, the LC model calculates segment-specific parameter sets. The probability of individuals belonging to a segment is a probabilistic function that may be influenced by individual attributes (Gupta and Chintagunta 1994). The magnitude of each segment represents the mean of individual membership probabilities.

Based on this remarks, the probability of choosing alternative j belonging to the set of alternatives Ji for an individual i in a t choice situation belonging to the set Ti of choice situations (assuming we are working with SC survey data as is the case), belonging to class q, will be:

$$P_{it|q}(j) = \frac{\exp(x'_{it,j}\beta_q)}{\sum_{j-1}^{J_i}\exp(x'_{it,j}\beta_q)}$$

Where the number of observations and the size of the choice set may vary depending on the individual and the choice situation. If Ti are assumed to be independent of each other, for a specific class assignment, the contribution of individual i to the likelihood will be as follows:

$$P_{i|q} = \prod_{t=1}^{T_i} P_{it|q}$$

Class Assignment being unknown, if we denote with Hiq the a priori probability for class q of individual i:

$$H_{iq} = \frac{\exp(z\prime_i\theta_q)}{\sum_{q=1}^{Q}\exp(z\prime_i\theta_q)} \quad \text{q=1,.., Q,} \qquad \theta_q = 0$$

Where z'i is a group of measurable variables which enter the model for class membership.
The likelihood is calculated as follows:

$$ln\ L = \sum_{i=1}^{N} ln\left[\sum_{q=1}^{Q} H_{iq}\left(\prod_{t=1}^{T_i} P_{it|q}\right)\right]$$

Applying Bayes' theorem, we obtain the a posteriori probability:

$$\hat{H}_{q|i} = \frac{\hat{P}_{i|q}\hat{H}_{iq}}{\sum_{q=1}^{Q}\hat{P}_{i|q}\hat{H}_{iq}}$$

The selection of the number of classes in LC models is typically determined based on estimated goodness-of-fit criteria, such as the Bayesian Information Criterion (BIC) and the Akaike Information Criterion (AIC), as outlined in Hensher et al. (2015). LC models with lower BIC and AIC values are favored over those with higher values. The adjusted likelihood ratio, which ranges between 0 and 1, indicates the model's fit to the data, with a value closer to 1 signifying a better fit. Additionally, the interpretability of the segments is crucial (Bucklin and Gupta, 1992).

4.2 Model formulation

As specified in the description of the questionnaire, the service attributes inserted in the SC experiment refer to different phases of the travel by air, and specifically the phases before and after the flight, and during the flight.

The variables included in the model derive from the service attributes shown in table 1. There are variables expressed in unit of measure such as minutes or euros, and dichotomous variables created for such attributes that are more qualitative and expressed on qualitative levels.

Table 2- Model variables

Phase	**Attributes**	**Name**	**Levels**
Before/after the flight	Waiting time at check-in (min.)	CHECKTIME	0; 5; 20
	Time spent for boarding operations (min.)	BOARDTIME	15; 60; 120
	Terminal-aircraft transfer mode (on foot)	FOOT	1 (yes); 0 (no)
	Terminal-aircraft transfer mode (shuttle bus)	SHUTTLE	1 (yes); 0 (no)
	Terminal-aircraft transfer by jet bridge	JETBRIDGE	1 (yes); 0 (no)
	Delay of flight departure (min.)	DEPDELAY	0; 20; 60
	Time spent for luggage delivery (min)	LUGGTIME	0; 10; 30
	Cost of the ticket (€)	COST	20; 60; 180; 360; 720; 1440
During the flight	Space available on board (fully adequate)	FULLSPACE	1 (yes); 0 (no)
	Space available on board (adequate)	MEDSPACE	1 (yes); 0 (no)
	Space available on board (not adequate)	NOSPACE	1 (yes); 0 (no)
	Temperature on board (adequate)	TEMPADEQ	1 (yes); 0 (no)
	Temperature on board (too cold)	TEMPCOLD	1 (yes); 0 (no)
	Temperature on board (too warm)	TEMPWARM	1 (yes); 0 (no)
	Cleanliness on board	CLEAN	1(clean enough); 0(quite dirty)
	Courtesy of cabin crew	CREW	1 (kind enough); 0 (quite rude)

Services on board (fully adequate)	FULLSERV	1 (yes); 0 (no)
Services on board (adequate)	MEDSERV	1 (yes); 0 (no)
Services on board (not adequate)	NOSERV	1 (yes); 0 (no)
Cost of the ticket (€)	COST	20; 60; 180; 360; 720; 1440

We can observe in table 2 that, while the quantitative attributes are represented each by a sole variable, some qualitative attributes are expressed through three variables.

As an example, for the attribute linked to temperature on board, two dichotomous variables were inserted in the model: one referred to a too cold temperature, and the other one to a too warm temperature. The levels of each variable are reported in table 2, differentiated according to the travel phases, being the SC choices referred to the before/after flight phase, or to the during the flight phase.

4.2 Model results

The model results are reported in table 3, and specifically the values of the coefficients and the significance of each service attribute; in addition, the statistics on the goodness of fit, together with criteria adopted for establishing the number of segments, are reported.

Particularly, according to the values of AIC, we selected the LC model that suggests the presence of three classes of passengers. More specifically, for the model with two classes the AIC was 31,661.60, for the model with three classes was equal to 31,390.10, and for the model with four classes 31,841.40. Therefore, referring to the criterion that a model with a lower AIC is better than a model with a higher AIC, the model with three classes was chosen. The estimated latent class probabilities (or latent class prevalence) are similar among the classes, each around 30%. This probability represents the likelihood that an individual is correctly classified, so that each individual is categorized into the best-fitting class.

Table 3- LC model results

	Class 1		Class 2		Class 3	
	Coeff.	z	Coeff.	z	Coeff.	z
CHECKTIME	-0.988	-8.57	-0.218	-5.16	-0.222	-4.66
BOARDTIME	-0.046	-5.43	-0.035	-10.59	-0.045	-9.76
FOOT	-3.902	-6.50	-1.246	-10.90	-1.271	-8.64
SHUTTLE	1.538	10.84	0.120	1.97	-0.429	-4.31
DEPDELAY	-0.079	-16.94	-0.024	-26.48	-0.030	-15.05
LUGGTIME	-0.506	-8.10	-0.113	-5.24	-0.075	-2.98
FULLSPACE	0.160	1.63	0.051	0.68	0.055	0.76
NOSPACE	-0.470	-3.21	-0.940	-10.58	-0.816	-9.01
TEMPCOLD	-1.115	-11.63	-1.228	-16.86	-0.602	-8.36
TEMPWARM	-1.137	-6.94	-1.578	-17.23	-0.881	-10.84
CLEAN	6.143	6.94	1.413	9.54	2.713	10.62
CREW	0.391	4.23	0.258	4.96	0.549	12.00
FULLSERV	0.156	1.23	0.214	2.90	0.634	7.72
MEDSERV	0.136	0.92	0.439	4.97	0.887	8.58
COST	-0.054	-14.20	-0.002	-7.29	-0.006	-10.78
Class Probabilities	0.334	25.88	0.369	8.99	0.297	7.12
N. of observations			30,696			
Degree of freedom			47			
AIC			31,390.1			
Log Likelihood			-15,648.054			
LL Constant Only			-21,276.846			
McFadden Pseudo R-squared			0.264			

By observing the z values, we can state that all the variables are statistically significant at 95 % of the confidence level, except one of the variables relating to space on board for all the classes, and the variables concerning services on board for the first class. Regarding the expected signs of the coefficients, we can say that they are congruent with the meaning of the variables. More specifically, we can observe negative signs for all the coefficients of the variables representing time and cost attributes, meaning that an increase of their value causes a decrease of the utility associated with the flight, and consequently the probability to choice it. In addition, the variables linked to temperature on board present negative coefficients, meaning that the users do not prefer both too cold and too warm temperatures, as well as having a not adequate space on board and walking to the terminal-to-aircraft. All the other coefficients have a positive sign, meaning that an increase of their value produces an increase of the utility and therefore the probability to prefer the flight. Users appreciate the presence of the shuttle bus as terminal-to-aircraft transfer mode, a fully adequate space on board, a clean cabin and a kind cabin crew, and adequate on board services.

The model highlights interesting differences of perceptions among the classes. More specifically, by observing the model results we are able to identify the importance assigned by the passengers to each service attribute, and consequently to identify classes of passengers who are more sensitive to a certain service aspect rather than to another one. From a careful examination of the coefficient values, interesting interpretations of the results can be made. A discussion is reported in the following section.

5. Discussion

A first difference in passengers' preferences emerges for waiting time at check-in, which is more important for the passengers belonging to the first class than the other two classes. The same passengers are far more sensitive regards other service aspects, such as the transferring from terminal to aircraft, cleanliness, and cost, but also the flight departure delay, or time for luggage delivery, or the possibility to have more space than enough on board. In other words, the first latent class identified by the model is composed of passengers for which the operations needed before the flight, such as check-in, transferring to aircraft, and delivering luggage, have a certain relevance. Particularly, regarding transferring operations, results suggest that passengers prefer to move from terminal to aircraft by shuttle bus, while they suffer the transferring on foot. In addition, the first latent class of users are particularly sensitive to the ticket cost. Also more qualitative aspects, linked to comfort on board in terms of cleanliness and space, are relevant for the passengers of this class. All these evidences would suggest that this first latent class of users is composed of people who are more exigent in terms of comfort on board, having to stay on board for more time, but also forced to spend a relevant time at airport before flight, for delivering luggage, as an example. These same users result also more sensitive to the ticket cost and to the delay at departure, maybe because they have already spent a certain amount of time at airport in the preliminary operations. Finally, the results also suggest that for this first latent class of users the presence of fully adequate or adequate services on board is welcome but less than for the other two classes, the courtesy of cabin crew is important on average, and a too cold or too hot temperature on board is not appreciated.

By comparing all the classes among them it clearly emerges that the first class is very different from the other two ones. On the other hand, the second and third class present certain differences, but less marked as regards with the first class. Anyway, interesting observations can be made. The main differences emerge for the attributes relating to temperature on board. Particularly, users belonging to the second latent class are the most sensitive to the temperature; they suffer in a too cold or too hot cabin more than the passengers belonging to the other two classes. At the same time, they are the least sensitive passengers to cleanliness and courtesy of the cabin crew. In general, the major part of the coefficients of the second latent class are the lowest ones, even if slightly lower in some cases. We can state that they are the least exigent passengers in general, except for the temperature and the little availability of space on board, which is more relevant for them than the other users. They are sensitive on the average to the services on board and time for delivering luggage. We could conclude that this second class of passengers are the least exigent users, but particularly annoyed by too much heat or cold, and too little space. In other word, the model identified a second class of users who are more sensitive to aspects relating comfort on board, while they have a very low consideration for peculiar travel characteristics such as time and cost.

The third latent class, instead, present the major part of coefficient with values between the second and the first class. Anyway, a certain peculiarity emerges also for this last class of users, who resulted more sensitive to the courtesy of cabin crew and the quality of the services on board. Like the second class, also this last class is less sensitive to aspects relating to travel times and cost. Specifically, this last group of users represent the passengers more oriented towards the services on board.

Recent studies have examined the factors influencing perceived service quality and passenger satisfaction in air transport. Price and time are no longer the determinants of consumer choice, with service quality becoming increasingly important (Fageda et al., 2014).

Definitively, it seems that there is a latent class of passengers who are more exigent in general, giving the highest importance to many aspects such as waiting time at check-in, transferring from terminal to aircraft, cleanliness, cost, flight departure delay, time for luggage delivery (including about 33% of users); another class gives more relevance to comfort in terms of temperature and space (37%); finally, a third class is most oriented to the courtesy of cabin crew and the quality of the services on board (including almost 30% of users). As we have above specified, the relevance of our study is that these identified classes are latent classes. This means that classes are defined by data, they are not defined a priori. We observe that the probability of belonging to a class is equally distributed among the three classes, which shows a heterogeneity in passengers' perceptions that is difficult to trace between pre-defined categories as students or professors.

As specified in the literature review section, there are no studies, belonging to the group proposing LC models, that are comparable with our study, some of them because of the different investigated situations or model variables (e.g. Zhou et al., 2020; Molesworth and Koo, 2016; Araghi et al., 2016). Only with the study proposed by Wen and Lai (2000) a comparison can be made. The authors discovered two latent classes. Particularly, attributes as fare, schedule time difference, and on-time performance were more relevant for passengers of a first segment than those of a second segment. On the contrary, the respondents of the second segment were more sensitive to flight frequency. In addition, the respondents in segment 1 ignored cabin crew service. This result shows some similarities with our results. In fact, in both the studies, passengers that are more sensitive to fare and time are less sensitive to other factors such as cabin crew. Anyway, in the study by Wen and Lai, only two latent classes were defined. Therefore, few differences were discovered as regards our model.

6. Conclusions

The general objective of this work was analysing differences in air passengers' preferences. Specifically, an approach aimed to identify latent classes of users was adopted. Analysing perceptions differentiating among class of users is a great opportunity, because discovering differences can support in defining the correct strategies to improve airline services and incentivize the use of air transport services. Moreover, the scarcity of similar studies in the literature induced to the development of such a work.

The proposed methodology, based on the use of LC models, allowed the discovering of interesting findings. More specifically, the LC model suggested the presence of three classes of passengers. There is a group of more practical people who pay attention to the peculiarities of a travel, which are times and costs. This first class is the class of users with the lowest purchasing power. They would be users who give great importance to cost, probably due to their level of income, and give a little importance to variables related to on-board service, but a highly value to cleanliness and are very exigent with check-in and baggage pick-up times, probably not being frequent flyers. Class 1 can be named as "Time sensitive passengers with low purchasing power".

There is another group of passengers, who are the people who are more sensitive to comfort. This second class is the class of users with the highest purchasing power who are most sensitive to in-flight temperature and space on board. They give less importance to cost, but perceive very negatively the adverse effects of temperature on board. They give little importance to the friendliness of cabin staff and boarding time. Class 2 can be named as "Comfort sensitive passengers with high purchasing power".

The last group is composed by people who are most interested in the services on board. This third class is the class of users with the highest purchasing power and the most exigent one. Passengers belonging to this class give less importance to cost (although more than those in class 2) and even value negatively (unlike the rest of the users) access to the aircraft with a bus (they only value positively access with the finger), they give less importance to the temperature on board, but highly value the services on board and the friendliness of the cabin staff. Class 3 can be named as "Service sensitive passengers with high purchasing power".

The identification of these latent groups suggests that there is a heterogeneity in passengers' perceptions and preferences that could be considered in the planning and design of airline services. We could state that our work represents a practical contribution, which can be very useful for practitioners in identifying specific strategies differentiated for the various groups of users. The findings from the model provide valuable suggestions to planners, who could invest on different service aspects in order to attract certain categories of users. As an example, airlines could concentrate their efforts to offer more services on board and characterized by high levels of quality or services providing high levels of comfort, as the model suggest two out three classes of users who sacrifice the price for receiving quality products. Groups of passengers satisfied with quality of flight can increase airline's reputation and, consequently, its economic success. This can determine the future of airlines, and air transport in general, increasing connectivity and opportunities among the various world countries.

The proposed work has some limitations, due to the nature of the sample, which refers to university students and workers. Anyway, the literature is rich of studies based on data collected on university population. As highlighted by other literature studies, international students represent a relevant market for national tourism organizations, educational institutions, travel agencies and transport providers. Examples of similar studies can be found in Lim and Tkaczynski (2017), Grigolon et al. (2012). The work by Xiao et al. (2015) explains the importance of the university student segment for the tourism and leisure sectors. In addition, being our sample composed of both students and workers, it covers more groups of people in terms of age and professional condition. Definitively, our sample reflects the perception of passengers with high academic qualifications.

Future developments could concern the investigation of heterogeneity among passengers' groups according to specific characteristics of the users, such as socio-economic features or travel habits. Another interesting development of the work could start from the collection of new data, by addressing the same questionnaire to passengers in order to verify the differences in passengers' perceptions between the period before Covid-19 pandemic and the period after pandemic.

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Appendix. SC experiments.

H1.1 If you had to travel on a **SHORT-HAUL flight** (LESS THAN 2 HRS), which of these alternatives would you choose?

	A ○	B ○
Waiting time at check-in	0 minutes (online check-in)	5 minutes
Time spent for boarding operations	40 minutes	10 minutes
Terminal-Aircraft transfer mode	by external path	by jet-way
Delay of flight departure	60 minutes	0 minutes (in time)
Time spent for luggage delivery	10 minutes	10 minutes
Cost of the ticket	20 €	20 €

H1.2 If you had to travel on a **SHORT-HAUL flight** (LESS THAN 2 HRS), which of these alternatives would you choose?

	A ○	B ○
Waiting time at check-in	20 minutes	20 minutes
Time spent for boarding operations	20 minutes	20 minutes
Terminal-Aircraft transfer mode	by shuttle	by external path
Delay of flight departure	20 minutes	20 minutes
Time spent for luggage delivery	10 minutes	10 minutes
Cost of the ticket	20 €	60 €

H1.3 If you had to travel on a **MEDIUM-HAUL flight** (BETWEEN 2 AND 6 HRS), which of these alternatives would you choose?

	A ○	B ○
Waiting time at check-in	0 minutes (online check-in)	5 minutes
Time spent for boarding operations	20 minutes	20 minutes
Terminal-Aircraft transfer mode	by external path	by shuttle
Delay of flight departure	20 minutes	20 minutes
Time spent for luggage delivery	30 minutes	30 minutes
Cost of the ticket	360 €	360 €

H1.4 If you had to travel on a **LONG-HAUL flight** (MORE THAN 6 HRS), which of these alternatives would you choose?

	A ◯	B ◯
Waiting time at check-in	0 minutes (online check-in)	0 minutes (online check-in)
Time spent for boarding operations	20 minutes	20 minutes
Terminal-Aircraft transfer mode	by shuttle	by external path
Delay of flight departure	0 minutes	60 minutes
Time spent for luggage delivery	10 minutes	10 minutes
Cost of the ticket	1440 €	720 €

H2.1 If you had to travel on a **MEDIUM-HAUL flight** (BETWEEN 2 AND 6 HRS), which of these alternatives would you choose?

	A ◯	B ◯
Waiting time at check-in	5 minutes	20 minutes
Time spent for boarding operations	10 minutes	40 minutes
Terminal-Aircraft transfer mode	by external path	by jet-way
Delay of flight departure	60 minutes	0 minutes
Time spent for luggage delivery	30 minutes	0 minutes (no luggage to claim)
Cost of the ticket	360 €	180 €

H2.2 If you had to travel on a **MEDIUM-HAUL flight** (BETWEEN 2 AND 6 HRS), which of these alternatives would you choose?

	A ◯	B ◯
Waiting time at check-in	20 minutes	0 minutes (online check-in)
Time spent for boarding operations	10 minutes	40 minutes
Terminal-Aircraft transfer mode	by jet-way	by external path
Delay of flight departure	60 minutes	0 minutes
Time spent for luggage delivery	0 minutes (no luggage to claim)	30 minutes
Cost of the ticket	180 €	360 €

H2.3 If you had to travel on a **LONG-HAUL flight** (MORE THAN 6 HRS), which of these alternatives would you choose?

	A ◯	B ◯
Waiting time at check-in	0 minutes (online check-in)	0 minutes (online check-in)
Time spent for boarding operations	10 minutes	40 minutes
Terminal-Aircraft transfer mode	by shuttle	by jet-way
Delay of flight departure	0 minutes	60 minutes
Time spent for luggage delivery	10 minutes	0 minutes (no luggage to claim)
Cost of the ticket	720 €	1440 €

H2.4 If you had to travel on a **LONG-HAUL flight** (MORE THAN 6 HRS), which of these alternatives would you choose?

	A ◯	B ◯
Waiting time at check-in	20 minutes	20 minutes
Time spent for boarding operations	40 minutes	10 minutes
Terminal-Aircraft transfer mode	by jet-way	by shuttle
Delay of flight departure	0 minutes	60 minutes
Time spent for luggage delivery	0 minutes (no luggage to claim)	0 minutes (no luggage to claim)
Cost of the ticket	720 €	720 €

H3.1 If you had to travel on a **SHORT-HAUL flight** (LESS THAN 2 HRS), which of these alternatives would you choose?

	A ◯	B ◯
Waiting time at check-in	20 minutes	5 minutes
Time spent for boarding operations	20 minutes	40 minutes
Terminal-Aircraft transfer mode	by external path	by jet-way
Delay of flight departure	0 minutes	60 minutes
Time spent for luggage delivery	0 minutes (no luggage to claim)	30 minutes
Cost of the ticket	60 €	20 €

H3.2 If you had to travel on a **SHORT-HAUL flight** (LESS THAN 2 HRS), which of these alternatives would you choose?

	A	B
Waiting time at check-in	5 minutes	5 minutes
Time spent for boarding operations	40 minutes	10 minutes
Terminal-Aircraft transfer mode	by shuttle	by external path
Delay of flight departure	60 minutes	0 minutes
Time spent for luggage delivery	30 minutes	30 minutes
Cost of the ticket	60 €	60 €

H3.3 If you had to travel on a **MEDIUM-HAUL flight** (BETWEEN 2 AND 6 HRS), which of these alternatives would you choose?

	A	B
Waiting time at check-in	5 minutes	0 minutes (online check-in)
Time spent for boarding operations	40 minutes	10 minutes
Terminal-Aircraft transfer mode	by jet-way	by shuttle
Delay of flight departure	20 minutes	20 minutes
Time spent for luggage delivery	0 minutes (no luggage to claim)	10 minutes
Cost of the ticket	180 €	180 €

H3.4 If you had to travel on a **LONG-HAUL flight** (MORE THAN 6 HRS), which of these alternatives would you choose?

	A	B
Waiting time at check-in	5 minutes	20 minutes
Time spent for boarding operations	10 minutes	20 minutes
Terminal-Aircraft transfer mode	by jet-way	by shuttle
Delay of flight departure	20 minutes	20 minutes
Time spent for luggage delivery	30 minutes	0 minutes (no luggage to claim)
Cost of the ticket	1440 €	1440 €

H4.1 If you had to travel on a **SHORT-HAUL flight** (LESS THAN 2 HRS), which of these alternatives would you choose?

	A	B
Space available on board	adequate	not fully adequate
Temperature on board	too warm	too cold
Cleanliness on board	quite dirty	quite dirty
Cabin crew	quite rude	kind enough
Services on board	not fully adequate	fully adequate
Cost of the ticket	20 €	60 €

H4.2 If you had to travel on a **MEDIUM-HAUL flight** (BETWEEN 2 AND 6 HRS), which of these alternatives would you choose?

	A	B
Space available on board	fully adequate	adequate
Temperature on board	adequate	too cold
Cleanliness on board	clean enough	clean enough
Cabin crew	quite rude	kind enough
Services on board	adequate	fully adequate
Cost of the ticket	180 €	180 €

H4.3 If you had to travel on a **LONG-HAUL flight** (MORE THAN 6 HRS), which of these alternatives would you choose?

	A	B
Space available on board	adequate	not fully adequate
Temperature on board	adequate	too warm
Cleanliness on board	clean enough	quite dirty
Cabin crew	kind enough	quite rude
Services on board	adequate	not fully adequate
Cost of the ticket	1440 €	720 €

H4.4 If you had to travel on a **LONG-HAUL flight** (MORE THAN 6 HRS), which of these alternatives would you choose?

	A	B
Space available on board	not fully adequate	fully adequate
Temperature on board	too warm	adequate
Cleanliness on board	quite dirty	clean enough
Cabin crew	kind enough	quite rude
Services on board	not fully adequate	adequate
Cost of the ticket	720 €	1440 €

H5.1 If you had to travel on a **SHORT-HAUL flight** (LESS THAN 2 HRS), which of these alternatives would you choose?

	A	B
Space available on board	not fully adequate	fully adequate
Temperature on board	adequate	too warm
Cleanliness on board	clean enough	clean enough
Cabin crew	quite rude	kind enough
Services on board	fully adequate	adequate
Cost of the ticket	60 €	60 €

H5.2 If you had to travel on a **SHORT-HAUL flight** (LESS THAN 2 HRS), which of these alternatives would you choose?

	A	B
Space available on board	not fully adequate	fully adequate
Temperature on board	too cold	too warm
Cleanliness on board	clean enough	clean enough
Cabin crew	kind enough	quite rude
Services on board	adequate	fully adequate
Cost of the ticket	20 €	20 €

H5.3 If you had to travel on a **MEDIUM-HAUL flight** (BETWEEN 2 AND 6 HRS), which of these alternatives would you choose?

	A	B
Space available on board	fully adequate	adequate
Temperature on board	too cold	adequate
Cleanliness on board	clean enough	clean enough
Cabin crew	kind enough	quite rude
Services on board	not fully adequate	fully adequate
Cost of the ticket	360 €	360 €

H5.4 If you had to travel on a **LONG-HAUL flight** (MORE THAN 6 HRS), which of these alternatives would you choose?

	A	B
Space available on board	fully adequate	adequate
Temperature on board	too cold	adequate
Cleanliness on board	quite dirty	quite dirty
Cabin crew	quite rude	kind enough
Services on board	fully adequate	not fully adequate
Cost of the ticket	720 €	720 €

H6.1 If you had to travel on a **SHORT-HAUL flight** (LESS THAN 2 HRS), which of these alternatives would you choose?

	A	B
Space available on board	adequate	fully adequate
Temperature on board	too warm	adequate
Cleanliness on board	quite dirty	quite dirty
Cabin crew	quite rude	kind enough
Services on board	fully adequate	not fully adequate
Cost of the ticket	60 €	20 €

H6.2 If you had to travel on a **MEDIUM-HAUL flight** (BETWEEN 2 AND 6 HRS), which of these alternatives would you choose?

	A	B
Space available on board	not fully adequate	adequate
Temperature on board	too warm	too cold
Cleanliness on board	clean enough	quite dirty
Cabin crew	kind enough	quite rude
Services on board	fully adequate	adequate
Cost of the ticket	360 €	180 €

H6.3 If you had to travel on a **MEDIUM-HAUL flight** (BETWEEN 2 AND 6 HRS), which of these alternatives would you choose?

	A	B
Space available on board	fully adequate	not fully adequate
Temperature on board	adequate	too cold
Cleanliness on board	quite dirty	clean enough
Cabin crew	kind enough	quite rude
Services on board	fully adequate	not fully adequate
Cost of the ticket	180 €	360 €

H6.4 If you had to travel on a **LONG-HAUL flight** (MORE THAN 6 HRS), which of these alternatives would you choose?

	A	B
Space available on board	adequate	not fully adequate
Temperature on board	too cold	too warm
Cleanliness on board	quite dirty	quite dirty
Cabin crew	quite rude	kind enough
Services on board	not fully adequate	adequate
Cost of the ticket	1440 €	1440 €