INVESTIGATION OF LONG-HAUL FLIGHT ATTRIBUTES INFLUENCING PASSENGER´S BOOKING DECISION USING SP DATA

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Abstract

For the success of future air transport concepts, it is vital to investigate the needs of airline operators and their customers, the passengers which directly influence the demand for such new concepts. It is clear that an economical feasible aircraft concept cannot be designed individually for each passenger. As a first step, four different passenger groups are defined based on travel purpose and price-sensitivity. Based on this passenger segmentation, differences in preferences, which influence passenger´s individual booking decision, were identified using stated-preference data as well as data from literature review. These flight attributes can be divided into four different groups namely, ticket conditions, schedule properties, airline reputation and comfort. It could be shown that with the segmentation of passenger´s in four different groups, each group shows significant different preferences regarding flight attributes.

1 Introduction and literature review

For the design and development of new civil aircraft concepts economical success has to be fulfilled by aircraft operators and manufactures. For the airlines, revenue and direct operating costs for new aircraft concepts are key assessment factors for the evaluation of economical success. With acquisition of new aircraft, airlines want to increase their market presence, trying to maximize the revenue by offering fares that match passengers´ price sensitivity. All together, future aircraft acquisition should match expected travel demand by seat capacity and market.

Passenger demand for air-carrier services is the foundation of the aviation industry. Understanding this demand is crucial for airlines, airport operators and their suppliers (Coldren 2005, p.2). The focus of this paper is the investigation and determination of long-haul flight attributes affecting passenger's choice and hence deamnd depending on aircraft parameters. Due to this fact, quite a few studies were done and researcher presented several models during the last years investigating passenger choice behavior. While some are closely related and build on each other, other scientists developed complete new model structures. There are also great differences in the number of evaluation criteria that were considered, varying from only two to far more than twenty. For giving an overview about flight attributes influencing passenger´s booking decision thirteen different studies, all together composed of twenty-three choice models, namely Proussaloglou and Koppelman (1995) as well as (1999), Wei (2006), Suzuki et al. (2001), Hess (2007), Hess et al. (2005) as well as (2007), Espino et al. (2006), Jou et al. (2008), Hensher et al. (2000), Rose et al. (2005) Yoo and Ashford (1996). Only studies were chosen which were derived from logit model family due to their mathematical formulation of linear regression for the deterministic part.
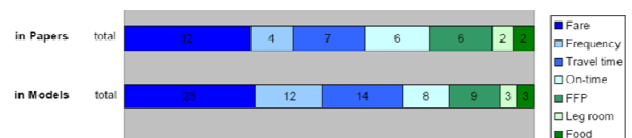

Figure 1: Summary of investigated logit models describing passenger booking behavior

Evaluation criteria are usually split into three segments. The first group contains ticket

attributes like fare, booking restrictions or mileage. To the second belongs all attributes concerning the itinerary, i.e. frequency, time of the day, travel time, number of connections etc. Finally the attributes of the airline, for example service, comfort, on-time performance or image, present the last group.
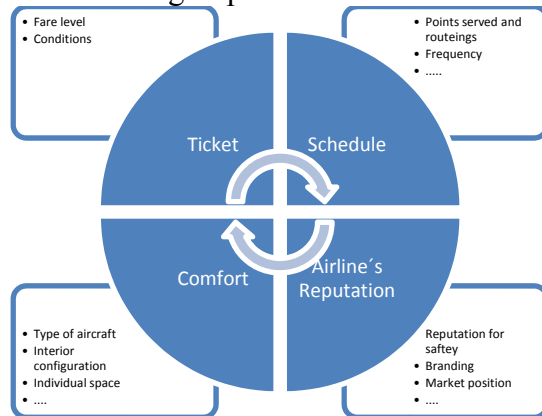

Figure 2: Key flight attributes affecting passenger choice according to Doganis (2002)

The criterion with the biggest impact is certainly the ticket price which is hence unsurprisingly taken into account in all the models. The importance of the other parameter, however, is often assessed differently by the authors and they exclude some of the factors to simplify their choice models.

Another important issue, which should be included for predicting passenger choice correctly is the knowledge about the traveler's personal attributes, like travel frequency, trip purpose or income. Choice models, therefore, ideally distinguish between business and leisure travelers, possibly also between people visiting friends and relatives (VFR). If adequate data is available a segmentation of infrequent and frequent traveller might also improve the quality of the predicting results. However, while the majority of the studies indeed take into account a segmentation for trip purpose, almost none include the other two traveler attributes. The one exception for income is Hensher et al. (2000) considering the household income and the number of household members while the only one taking travel frequency into account is Jou et al. (2008).

Neglecting other effects and focusing only on aircraft related attributes which affect passenger's individual booking decision, main attributes are offered ticket fares, schedule properties and onboard-comfort.

One example of changing attributes significantly on long-haul flights are today's ultra-long haul services providing non-stop services, improved cabin comfort but at higher air fares. Therefore, these services have higher utility for some passenger groups than conventional services.

The same refers to the Concord as a good example of highly improved schedule (mainly travel time savings) but at high fares and less comfort onboard comparing it to today's comfort standards in First and Business Class long-haul aircraft.

2 RESEARCH DESIGN AND METHODOLOGY

2.1 Survey methodology

For the investigation of passenger´s preference, stated preference (SP) data from an online questionnaire were used. This online questionnaire was built up out of the Analytic Hierarchy Process methodology as a method for a decision making process. The Analytic Hierarchy Process (AHP) enables single decision-makers or groups to build a model to structure decisions hierarchically with the overall goal of the decision at the top of the model (Saaty, 2006). The Analytic Hierarchy Process (AHP) provides a structured framework for setting priorities on each level of the hierarchy using pair wise comparisons, a process of comparing each pair of decision factors at a given level of the model for their relative importance with respect to their parent.

Through this process, the AHP helps decision-makers create a model of their priorities where the weight of the decision is distributed from the goal downwards (the goal is 100% of the decision, the top level of objectives share this 100% weight between them, and the weight continues to be distributed down to the bottom of the decision model where alternatives can be weighted based on their total percentage value out of 100%). Because synthesis of AHP models is a linear multiplication and addition

process (all influence flows downward), the mathematics associated with doing sensitivity ("what-if") analysis are fairly straight forward. If a user increases the weight of a criterion, the alternatives that performed well on that criterion will always get increasingly higher scores. Strength of the AHP is the built-in consistency check. The inconsistency measure is useful for identifying possible errors in judgments as well as actual inconsistencies in the judgments themselves by answering the online questions. Inconsistency measures the logical inconsistency of participant's judgments. For example, if a participant says that A is more important than B and B is more important than C and then say that C is more important than A, the participant rates inconsistently. A somewhat less inconsistent situation would arise if a participant would say that A is 3 times more important than B, B is 2 times more important than C, and that C is 8 times more important than A. In general, the inconsistency ratio should be less than 0.1 to get reasonable results.

2.2 Survey design

Doganis (2002) defined key product features of a flight as price including fare levels and conditions, schedule-based features including frequency, timings or connections, comfort-based features, convenience features and image features. According to the above-mentioned models and definitions, passenger choice is influenced by ticket, schedule, airline and comfort conditions. A summary of the features which were rated by survey participants is shown in Figure 3 below:
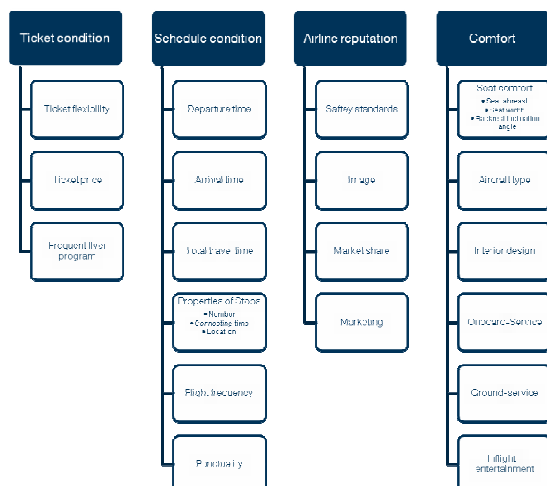

Figure 3: Included flight attributes for pair wise comparison

Ticket condition: In the survey, ticket conditions included besides ticket price also flexibility (possibility to be booked on a different flight without a penalty) and benefits from frequent flyer programs. For further investigations of influences of ticket conditions onto booking decision behavior, only ticket price will be taken into account. Even if there are no direct correlations between ticket price and direct operating cost (DOC) (Hollmeier, 2008), DOC are directly influencing airline´s profit and hence their aircraft acquisition behavior.

Schedule properties: This class includes attributes of departure time, total travel time, frequency, aircraft type, properties of stops (number, connecting time and location of stops) and airport properties.

Airline reputation: Focusing on aircraft related attributes which might affect passenger´s booking decision, only fleet properties like manufacture, fleet size and fleet age will take into account.

Comfort: This group mainly consists of aircraft onboard comfort attributes. Subclasses are in this class cabin layout, cabin environment, flight status, catering and in-flight entertainment. Regarding cabin layout, this class can be subdivided again into:

- seat properties (seat pitch, seat width and backrest inclination angle)
- sanitary facilities (number an size)
- additional comfort features (e.g. self-service snack bar)

Due to high complexity and high number of choices due to pair wise rating, the online survey was designed in two parts. The first part was mandatory for each participants ensuring that data of socio-demographics and first level rating (ticket vs. schedule vs. airline reputation vs. comfort conditions) are available.

After that part, participants were presented different blocks of flight attributes like seat comfort or properties of stops for rating randomly. During this part, participants had the possibility to stop after each block and continuing the survey later on.

3 SURVEY RESULTS-PARTICIPANTS

The survey was conducted from January 2006 to March 2006 where 2,010 participants take part in.

3.1 Participant profile

Nearly 70% of all participants marked travelling during the last long-haul flight in Economy Class, whereas 14% flew in Premium Economy Class, 13% in Business Class and 3% in First Class. The following table shows a distribution of number of undertaken flights since the last 12 months for all participants.
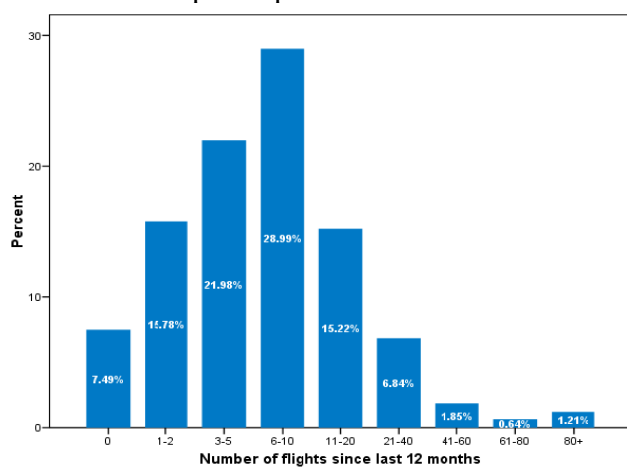

Figure 4: Distribution of flights since last 12 month of all participants

In order to maintain proper results, participants were asked about their experiences of long-haul flights. Therefore, passengers had to mark number of undertaken long-haul flights ever. The distribution is shown in figure below.
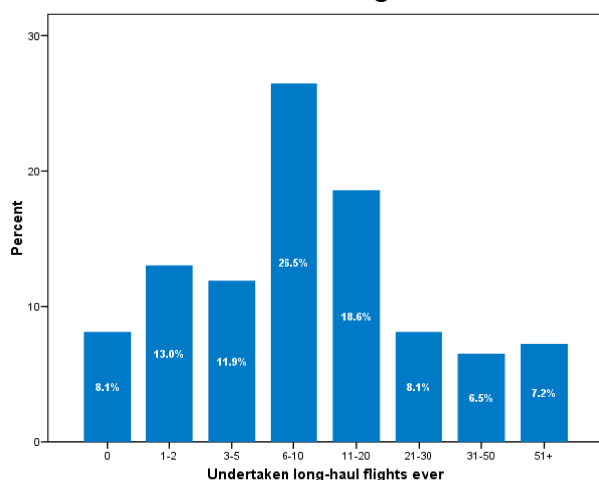

Figure 5: Distribution of undertaken long-haul flights ever of all participants

The Participant´s mean age of 33.5 years with a standard deviation of 10.9 years lead to comparable results to actual flying population (ONS, 2008).

3.2 Participant segementation

In common literature, passengers are mainly segmented by their travel purpose like business, leisure and visiting friends and relatives (VFR) (Pompl, 2002). Proussaloglou et al (1994) clustered air travel passengers into five different types of travelers depending on number of business trips, travel frequency, destination visited and income. The five traveler types range from infrequent leisure traveler (51%) with 2-3 trips per year to a very intense business traveler with more than 20 trips per year (6%). For the short-haul European business travel market, Mason et. al (1995) segmented business travelers in three different groups regarding schedule sensitivity and on-ground services (19%), corporate policies (40%) and price sensitivity (41%).

According to the IATA Airline Marketing Report, a business traveler is divided into six different groups. Two groups are mainly focus on the price sensitivity; the other four groups have a focus on the trip's purpose and itinerary. The IATA split business travelers in two different groups regarding their attitude towards ticket price. The first group is the "Hard Money Traveler", which represents an independent business man travelling on his own expenses. The second group is the "Soft Money Traveler". Passengers out of this group are corporate business men travelling on an expense account**.** For these passengers, the ticket price is sometimes more important than the schedule. Plötner (2005) segmented passenger in four different groups regarding their travel purpose and price-sensitivity (Lindenmeier, 2005). For the ongoing investigation of passenger´s preferences participants were segmented into four different passenger groups namely:

- Private traveler
- Premium private traveler
- Business traveler
- Price-sensitive business traveler

3.2.1 Private Traveler (PT)

To the group of Private Travelers belong for example students, singles or young families. These travelers mainly travel in the Economy Class, because ticket price is one of the most important booking decision factors. Nearly 56% of all travelers belong to this group (Ploetner, 2007). Private Travelers travel mainly due to leisure purposes. The average of flights in 2005 is for Private Travelers 6.3. A flight is defined as one segment between take-off and landing. Hence a return flight will be counted as two flights. This number of flights is the lowest one, compare to the other three traveler groups. Furthermore, average long-haul flights per year are for Private Traveler 1.1 times. The definition of long-range flights is a flight of more than six hours. A Private Traveler travels mainly alone; 54% percent of all Private Travelers travel alone. 31% of all Private Travelers travel with somebody else, 10% with two other people. Only 3% of all interviewed Private Travelers travelled with three other people. Travelling with more than three can be summarized into one group with less than 2%.

3.2.2 Premium Private Traveler (PPT)

With the analysis and investigations of the participants, a small percentage of participants indicated travelling mainly in higher classes than Economy Class or Premium Economy Class, whereas the purpose of travel is more leisure than business. This behavior leads to the assumption that people, who travel for leisure purposes and in higher classes, can be summarized to another group, further called Premium Private Traveler. These travelers, as mentioned above, are less price-sensitive and more comfort-orientated which will be shown in chapter 4. The percentage of this group according to all passengers is 4%. Comparing to the Private Traveller, Premium Private Traveller undertake more flights per year (6.3 for PT and 14.4 for PPT). The same refers to the undertaken long-haul flights. Premium Private Travelers undertake in average a long-haul trip nearly once per year (two flights). Comparing the travel group size of Premium Private

Traveler, 49% of all passengers travelled with somebody else, 20% marked that they travelled alone and 17% travelled with two other people. 12 % indicated that they travelled with three other people and only 2% of all passengers travelled with more than three other people.

3.2.3 Price-sensitive Business Traveler (PSBT)

The third different passenger group is further called Price-Sensitive Business Traveler (PSBT). As indicated in that name, this travel group uses the aircraft more because of business than leisure purposes. The second attribute of this group is the price sensitivity. This price-sensitivity was also shown by Mason (1995). As mentioned in the previous chapter, the Price-Sensitive Business Traveler is the Hard Money Traveler according to the IATA report. Therefore, this group prefers mainly the Economy Class for travelling. 24% of all passengers can be counted to that group.
Price-Sensitive Business Travelers travel slightly more per year than Premium Private Travelers (compare 14.4 to 16.2 trips). According to long-haul flights, the Price-Sensitive Business Traveler is more focused on short to medium haul flights less than 6h. Therefore, the average number of long-haul flights per year was stated with 1.3 trips, which is less compare to the Premium Private Traveler but more than for the Private Traveler. Comparing to the other leisure-orientated passenger groups, a Price-Sensitive Business Traveler travels mainly alone. 65% of all interviewed passengers in this group marked, that they travelled alone, whereas 27% travelled with somebody else. Only 1% of all Price-Sensitive Business Traveler marked in the survey that they travelled with more than three people. Therefore, one main difference between Private and Business travelers is the average travel group size.

3.2.4 Business Traveler (BT)

The fourth and last group is further called classic Business Traveler. 16% of all passengers can be summarized to group. According to the IATA definition, this group can be counted to

"Soft Money Traveler" group. This group travels more because of business than private purposes and is booked mainly in Business or First Class. A Business Traveler undertakes in average 46 flights per year (compare to Proussaloglou et al (1994) with more than 20 trips per year) , whereas 5.7 flights per year are long-haul flights with more than 6h flight duration. Similar to the Price-Sensitive Business Traveler, Business Traveler mainly travels alone (63%). Only 26% percent of all business traveler travel with somebody else, whereas 5% of the participants travelled with two other people. Only 6% of all business travelers travelled in this survey with more than two other people.

4 SURVEY RESULTS-PASSENGER PREFERENCE

4.1 First level comparison

For the design of future passenger driven aircraft concepts, it is vital to understand drivers during booking decision for different passenger groups. It is clear that an economical feasible aircraft concept cannot be designed individually for each passenger. As a first step, differences between these four passenger groups will be investigated here in detail. Taking only into account the first level of attributes influencing passenger´s individual booking decision, ticket condition, schedule, reputation and comfort, Table 1 shows the ratio of all possible combination.

Passenger type	Ticket vs. Schedule	Ticket vs. Comfort	Ticket vs. Reputation	Schedule vs. Comfort	Schedule vs. Reputation
PT	1.51	2.30	3.41	1.81	2.53
PPT	1.25	1.00	1.80	0.52	1.00
PSBT	1.00	2.04	3.07	1.98	2.97
BT	0.59	0.48	1.17	1.00	1.81

Table 1: Mean values of ratios between ticket, comfort, schedule and reputation attributes for traveler groups

As found in common literature, ticket condition, precisely air fare, is the most important factor for Private Traveler. This can also be obtained out of Table 1 where ticket conditions influence

PT´s booking decision 1.51 times more than schedule properties, 2.30 times more comfort attributes and 3.41 times more than reputation of an airline. On the other side, Business travelers are on the one side less price-sensitive but schedule- and comfort-sensitive. These sensitivities can also be obtained out of Table 1. For Business travelers, schedule attributes are influencing this group 1.7 times more than ticket conditions, taking into account that FFP and ticket flexibility is included in this attribute. Regarding comfort, Business travelers are more 2 times influenced by comfort attributes.The same behavior of preferring other flight attributes than ticket price was also observed for Premium Private Traveler regarding comfort.

4.2 Schedule related preferences

4.2.1 Preference on flight duration

Premium Private Travelers are higher sensitive regarding flight duration and aircraft than Price-sensitive Business Traveler. The ratio between flight duration and aircraft type is 1.42 and nearly 2 times lower than for Private Traveler and 2.5 times lower than for Price-sensitive Business Traveler.

Passenger type	Flight duration vs. Departure properties	Flight duration vs. Frequency	Flight duration vs. Aircraft type	Flight duration vs. Properties of stops
PT	1.59	2.08	2.50	1.49
PPT	1.36	1.23	1.42	0.92
PSBT	2.05	2.30	3.44	1.62
BT	1.72	2.24	2.31	1.29

Table 2: Ratio of flight duration and other flight attribute for traveler groups

This leads to the conclusion that Premium Private Travelers are highly comfort-sensitive which can also be shown in Table 1. Furthermore, the ratio of 0.92 for flight duration and properties of stops leads to the assumption that this passenger group rated inconvenience of stops including changing aircraft higher than additional flight time. For the Price-sensitive

Business travelers time is the most import choice factor. This can be found in the ratio of 3.44 for flight duration and aircraft type as well as in Table 1, where Price-sensitive Business Travelers have a four times higher preference to schedule than to comfort.

4.2.2 Preference on departure time

The utility coming from departure time is not constant during day. It varies with day time and passenger group (Parker, 2005). In this study only the main influence onto passenger´s should be investigated. In Table 3, it can again be shown high sensitivity of Premium Private Travelers regarding aircraft type and stops. This leads also to the result that Premium Private Traveler rated stops more than two times higher than departure time. Comparing the ratios of departure time and frequency, Price-sensitive and Business Travelers rated frequency higher than Private Travelers.

Passenger type	Departure time vs. Frequency	Departure time vs. Aircraft type	Departure time vs. Properties of stops
PT	1.28	1.52	1.00
PPT	0.92	0.66	0.47
PSBT	1.16	1.55	0.81
BT	1.12	1.12	0.81

Table 3: Ratio of departure time and other schedule attributes for traveler groups

4.2.3 Comparison of ticket price versus flight duration

As described in chapter 3.2, the price-sensitivity of PT and PSBT regarding ticket´s flexibility can also be shown in Table 4 below. For PT and PSBT, ticket price is 4 times more important than ticket flexibility, whereas for PPT and BT this values decreases to 2.5 and 1.0 respectively.

Passenger type	Ticket price vs. flight duration
PT	4.00
PPT	2.50
PSBT	4.00
BT	1.00

Table 4: Mean values of ticket price and ticket´s flexibility for traveler groups

The models developed by Hess et. al (2005 and 2007) and Rose at el. indicate an importance between fare [$] and flight time [min] of 1.68 for Business travelers and 3.5 for private traveler with an maximum of 78.7 for highly price-sensitive passengers.

4.2.3 Comparison of ticket price versus stops

The high sensitivity of Premium Private Traveler regarding stops can also be shown in Table 5. For this group, stops are rated more than 2 times higher than ticket price. The same behavior can be seen for Business Travelers. A complete other behavior can be observed for Private Traveler where ticket price was rated 2.33 higher than stop properties.

Passenger type	Ticket price vs. stops
PT	2.33
PPT	0.49
PSBT	1.67
BT	0.54

Table 5: Mean values of ticket price and properties of stops for traveler groups

4.1 Airline reputation related preference

The main attributes influencing airline reputation of all passenger groups are those which the passenger directly affected. The preferences of these attributes are crew appearance and fleet properties followed by airline recognition. Airline size and the airline´s origin were ranked less important. Regarding fleet properties-especially high ranked by Business Travelers-, main driver are fleet age, followed by manufacturer and size of the entire fleet.

Passenger type	Airlines origin country	Airline size	Crew appearance	Airline recognition	Fleet properties
PT	0.10	0.11	0.25	0.13	0.35
PPT	0.10	0.10	0.24	0.10	0.37
PSBT	0.09	0.10	0.25	0.11	0.36
BT	0.07	0.09	0.29	0.09	0.44

Table 6: Mean values of airline reputation related preferences

4.1 Comfort related preference

The group of comfort-related flight attributes mainly cabin properties have been investigated. Cabin properties can be divided in overall cabin, single seat properties (including among other things seat pitch and seat width) and seat-cabin interaction properties like distances to service facilities.

4.2.1 Preferences regarding seat properties

Seat properties are one of the most important factors influencing passenger´s onboard situation especially on long-haul flights. Inside this class, seat properties are subdivided into seats geometry (including seat pitch and seat width), adjustability, suitability for working, eating and sleeping, location inside the cabin and design. Table 7 shows the ratio of seat pitch versus seat width and arm rest width. Out of that figure, it can be seen that all passenger groups rated seat properties against each other nearly equal. Only slight differences can be obtained regarding arm rest width which was rated higher by Premium and Business Traveler indicating their focus on comfort especially on privacy.

Passenger type	Seat pitch vs. seat width	Seat pitch vs. arm rest width
PT	1.72	3.20
PPT	1.71	2.17
PSBT	1.61	3.19
BT	1.57	2.62

Table 7: Ratios of preference for seat´s adjustability

Even if all passenger groups have rated inside that group seat properties fairly equal, price has to be taken into account again for booking decision. According to the results from Table 1, Business traveler rated comfort (including seat comfort) more than two times higher than price whereas Private traveler rated price/fare 2.3 times higher than comfort. Therefore, it can be seen that even with an improvement of seat pitch or seat width, price-sensitive passenger´s tend to book their flights mainly due to fare conditions. Beside geometrical seat properties like seat pitch, also participants rated the importance of additional seat properties like adjustability of seat back, foot rest, foldaway

tray and head rest. A summary is given in Table 8 below. Out of that table, it can be obtained that seat back and head rest adjustability is rated as the most important feature at a seat by all passenger types. Especially Business Travelers rated seat back adjustability higher than all other groups.

Passenger type	Head rest	Foldaway tray	Foot rest	Seat back
PT	0.25	0.18	0.18	0.39
PPT	0.24	0.15	0.18	0.43
PSBT	0.23	0.17	0.16	0.43
BT	0.19	0.13	0.22	0.47

Table 8: Rating of preferences for seat´s adjustability properties

5 CONCLUSIONS

Air traffic has been growing enormously during the last decades and forecasts predict still further increase for the future. Simultaneously, though, the competition among airlines is getting fiercer. For future planning of aircraft operators and manufactures, it is essential to gain a better knowledge about demand, precisely about the factors determining passenger choice of flight. It could be shown that based on common literature, passenger can be at least segmented into four different passenger groups depending on trip purpose and price-sensitivity. More than a half of all passengers could be segmented into the biggest group of Private Traveler with high price-sensitivity. The most demanding groups in terms of comfort and schedule attributes are Premium Private and Business Traveler. Furthermore, booking decision of a certain flight depends on various attributes. Summarizing in today´s aircraft cabin totally different demanding passenger groups have to be served in one aircraft or flight. Flight attributes which were investigated for these four different passenger groups are summarized in the table on the next page. In line with common literature, Private Travelers are mainly price-sensitive whereas Business Travelers are highly time- or schedule sensitive. This study also shows that for the defined passenger group of

Private Travelers, ticket price is the most important factor influencing their booking behavior.

Ticket condition	Schedule condition	Airline reputation	Comfort condition
Fare	Frequency Flight duration Departure properties Departure time Aircraft type Properties of stops	Airlines origin Airline size Crew appearance Ariline recognition Airline fleet	Seat pitch Seat width Arm rest width Adjustability

Table 9: Summary of investigated flight attributes

It could be shown that ticket price is four times more important for Private traveler than flight duration or 2.33 times more than stops. On the other side Premium Private and Business Traveler show less price-sensitivity but higher sensitivity for schedule and comfort issues. Business travelers rated stops or flight duration 2 times and equal respectively higher compare to ticket price. Giving here only a few examples of flight attributes influencing passenger´s booking decision in different ways, for the development of future transport concepts all four main attributes have to be taken into account. Only concepts with an increased overall utility for all or main target groups will ensure future demand as well as possible economical success.

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