UNIVERSITAT POLITÈCNICA DE CATALUNYA
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DEGREE IN AEROSPACE VEHICLES ENGINEERING

STUDY OF THE OPTIMUM FLEET FOR A LCC (LOW-COST-CARRIER)

ANNEXES

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Annex 1: Number of flights per week on different European destinations

According to the section *Selection of the flight routes*, it have been researched the nearest European cities to Barcelona (less than $2h\ 30min$ of flight in a typical airplane), so as to reduce the time flight as much as possible; and the number of flights from and to Barcelona, which are detailed in the following table, in order to make a final decision of the routes where the company will operate [9]:

Central airport	City	Route	Flights/week
Barcelona El Prat	Amsterdam (The Netherlands)	Barcelona-Amsterdam Amsterdam-Barcelona	77
	Athens (Greece)	Barcelona-Athens Athens-Barcelona	8
	Berlin (Germany)	Barcelona-Berlin Berlin-Barcelona	33
	Bern (Switzerland)	Barcelona-Bern Bern-Barcelona	2
	Bilbao (Spain)	Barcelona-Bilbao Bilbao-Barcelona	37
	Bratislava (Slovakia)	Barcelona-Bratislava Bratislava-Barcelona	2
	Brussels (Belgium)	Barcelona-Brussels Brussels-Barcelona	69
	Budapest (Hungary)	Barcelona-Budapest Budapest-Barcelona	10
	Dublin (Ireland)	Barcelona-Dublin Dublin-Barcelona	26
	Florence (Italy)	Barcelona-Florence Florence-Barcelona	8
	Hamburg	Barcelona-Hamburg Hamburg-Barcelona	16

Lisbon (Portugal)	Barcelona-Lisbon Lisbon-Barcelona	49
London (United Kingdom)	Barcelona-London London-Barcelona	189 187
Luxemburg (Luxemburg)	Barcelona-Luxemburg Luxemburg-Barcelona	8
Madrid (Spain)	Barcelona-Madrid Madrid-Barcelona	258 260
Mallorca (Spain)	Barcelona-Mallorca Mallorca-Barcelona	112
Milan (Italy)	Barcelona-Milan Milan-Barcelona	80
Munich (Germany)	Barcelona-Munich Munich-Barcelona	52
Naples (Italy)	Barcelona-Naples Naples-Barcelona	7
Paris (France)	Barcelona-Paris Paris-Barcelona	172
Prague (Czech Republic)	Barcelona-Prague Prague-Barcelona	12
Rome (Italy)	Barcelona-Rome Rome-Barcelona	75
Seville (Spain)	Barcelona-Seville Seville-Barcelona	57
Toulouse (France)	Barcelona-Toulouse Toulouse-Barcelona	2
Venice (Italy)	Barcelona-Venice Venice-Barcelona	23
Vienna (Austria)	Barcelona-Vienna Vienna-Barcelona	27
Zagreb (Croatia)	Barcelona-Zagreb Zagreb-Barcelona	2

Table 1. Possible destiny cities and the correspondent flights per week from and to the central airport

Annex 2: Leasing prices of the different airplanes obtaining

Following hypothesis from section *Aircraft price*, next table shows the aircrafts involved in the analysis and their leasing prices:

Airplane model	Range of leasing prices ($\$/month$)
AIRBUS Family	
Airbus A318	95.000-65.000
Airbus A319	300.000-75.000
Airbus A320	355.000-40.000
Airbus A321	410.000-185.000
BOEING Family	
Boeing 717	135.000-100.000
Boeing 737-300	73.000-35.000
Boeing 737-400	83.000-55.000
Boeing 737-500	55.000-40.000
Boeing 737-600	145.000-90.000
Boeing 737-700	250.000-130.000
Boeing 737-800	375.000-218.000
ATR Family	
ATR 72-200	80.000-45.000
ATR 72-210	800.00-45.000
ATR 42-500	140.000-70.000
ATR 72-500	160.000-75.000
ATR 42-600	160.000-150.000
ATR 72-600	190.000-165.000
EMBRAER Family	
ERJ 135	63.000-48.000
ERJ 140	52.000-50.000

ERJ 145	64.000-50.000
E 170	230.000-100.000
E 175	240.000-130.000
E 190	270.000-160.000
E 195	275.000-175.000
BOMBARDIER Family	
Q100	80.000-48.000
Q200	98.000-75.000
Q300	110.000-68.000
Q400	190.000-100.000
CRJ-100	45.000-30.000
CRJ-200	67.000-51.000
CRJ-700	200.000-90.000
CRJ-705	215.000-140.000
CRJ-900	230.000-133.000
CRJ-1000	245.000-215.000

*Data of leasing costs consulted from [19].

Table 2. Current airplanes and leasing prices ($/month)

As it is seen, leasing cost of a same model of aircraft can vary depending on, for instance, its age, total flight hours done or the leaser conditions. On the one hand, minimum leasing price could refer to the most used airplane, which for this reason could need more maintenance works and have a minor number of remaining flight hours than a newly one. On the other hand, maximum leasing costs could be from an expensive leaser, which not either interests to the company. Due to these two reasons, it will be done an average between the minimum and maximum lease market costs, so the company will probably be considering leasing airplanes with a compromise between a proper number of flight hours and leaser price conditions.

Next table shows the leasing costs that will be taken into account when carrying out the OWA method:

Airplane model	Average leasing cost ($\$/month$)	Average leasing cost ($€/month$)	Leasing cost ($€/month$)
AIRBUS Family			
Airbus A318	80.000	75.460,31	75.000
Airbus A319	187.500	176.860,10	177.000
Airbus A320	197.500	186.292,64	186.000
Airbus A321	297.500	280.618,02	281.000
BOEING Family			
Boeing 717	117.500	110.832,33	111.000
Boeing 737-300	54.000	50.935,71	51.000
Boeing 737-400	69.000	65.084,52	65.000
Boeing 737-500	47.500	44.804,56	45.000
Boeing 737-600	117.500	110.832,33	111.000
Boeing 737-700	190.000	179.218,23	179.000
Boeing 737-800	296.500	279.674,77	280.000
ATR Family			
ATR 72-200	62.500	58.953,37	59.000
ATR 72-210	62.500	58.953,37	59.000
ATR 42-500	105.000	99.041,65	99.000
ATR 72-500	117.500	110.832,33	111.000
ATR 42-600	155.000	146.204,35	146.000
ATR 72-600	177.500	167.427,56	167.000
EMBRAER Family			
ERJ 135	55.500	52.350,59	52.000
ERJ 140	51.000	48.105,95	48.000
ERJ 145	57.000	53.765,47	54.000
E 170	165.000	155.636,89	156.000
E 175	185.000	17.4501,96	175.000
E 190	215.000	202.799,58	203.000
E 195	101.250	95.504,45	96.000
BOMBARDIER Family			
Q100	64.000	60.368,25	60.000
Q200	86.500	81.591,46	82.000

Q300	89.000	83.949,59	84.000
Q400	145.000	136.771,81	137.000
CRJ-100	37.500	35.372,02	35.000
CRJ-200	59.000	55.651,98	56.000
CRJ-700	145.000	136.771,81	137.000
CRJ-705	177.500	167.427,56	167.000
CRJ-900	181.500	171.200,57	171.000
CRJ-1000	230.000	216.948,39	217.000

*Leasing costs will be given in Euros instead of American Dollars due to the study considers the incorporation of a European low cost company and the majority of the costs will be paid in Euros. Conversion rate applied: $1\$ = 0{,}943253848€$.

*Leasing costs will have to be approximated to an integer that represents in a realistic and proper way the values, due to there is no certainty of the decimal digits.

Table 3. Current airplanes leasing prices (€/month)

Annex 3: Block hours obtaining

Block hour is defined as the time an airplane needs to go from one airport to another, including its takeoff and landing, and so follows the next equation [20]:

$$t = \frac{R}{v} + 20' \ [h];$$

where R/v corresponds to the on-route time, and the added $20\,min$ correspond to an approximation of the time required to takeoff and landing.

As not all airplanes studied have the same cruise speed, it can be seen they will not require the same time to carry out their flight, and so this will result in a variation of block hours.

To compare costs between airplanes (see section *Costs depending on the number of block hours*) it will be enough to have knowledge of the costs on a single route.

At the time to select the route where the block hours and so the costs will be calculated, it will be chosen the longest route the company has to cover. In this way, the variation between costs will be better distinct.

The longest distance the company will have to fly is the route from Barcelona-El Prat to London-Stansted or vice versa, which is a route of $1185\,km$ [13] [21]. Then the different typical cruise speeds from all the analysed airplanes so as to finally find the block hours have been searched:

Airplane model	Cruise speed (km/h)	Range (km)	Block hours (h)
AIRBUS Family			
Airbus A318	828	1.185	1,76
Airbus A319	828	1.185	1,76
Airbus A320	828	1.185	1,76
Airbus A321	828	1.185	1,76
BOEING Family			
Boeing 717	811	1.185	1,79
Boeing 737-300	780	1.185	1,85
Boeing 737-400	780	1.185	1,85
Boeing 737-500	780	1.185	1,85
Boeing 737-600	823	1.185	1,77
Boeing 737-700	823	1.185	1,77
Boeing 737-800	823	1.185	1,77
ATR Family			
ATR 72-200	515	1.185	2,63
ATR 72-210	517	1.185	2,63
ATR 42-500	556	1.185	2,47
ATR 72-500	510	1.185	2,66
ATR 42-600	556	1.185	2,47
ATR 72-600	510	1.185	2,66
EMBRAER Family			
ERJ 135	828	1.185	1,76
ERJ 140	828	1.185	1,76
ERJ 145	828	1.185	1,76
E 170	850	1.185	1,73
E 175	850	1.185	1,73
E 190	850	1.185	1,73
E 195	890	1.185	1,67
BOMBARDIER Family			
Q100	500	1.185	2,70
Q200	537	1.185	2,54
Q300	528	1.185	2,58
Q400	667	1.185	2,11

CRJ-100	785	1.185	1,84
CRJ-200	785	1.185	1,84
CRJ-700	829	1.185	1,76
CRJ-705	829	1.185	1,76
CRJ-900	850	1.185	1,73
CRJ-1000	827	1.185	1,77

* Data of the cruise speed of each airplane model consulted from [34], [35], [60], [36], [37], [39], [51], [61], [62], [63], [64] and [65].

Table 4. Block hours on the route BCN-STN of the current airplanes

Annex 4: Fuel cost obtaining

Between the bibliography found about fuel costs, some of them were directly given in $\$/BH$, while others in $Imperial\ (UK)\ Gal/BH$ or lb/h and had to be converted to $\$/BH$.

A4.1 Converting from Gal/BH to $\$/BH$

Some of the data given provided the amount of fuel consumed by the airplane each hour, so it was necessary to know the actual fuel price in order to have this value in $\$/BH$.

Fuel price usually vary every day, so it will be important to use always the same value during all the study [66]:

Fuel cost in Europe ($/Gal)	1,79

Table 5. Current jet fuel price in Europe

In this way, it is only needed to do the next equation:

$$\frac{Fuel\ cost}{Block\ hours} = \frac{Fuel\ consumption\ (Gal)}{Block\ hour} \cdot \frac{Cost}{Gallon} \quad [\$/BH]$$

Some examples are shown in the next table:

Airplane model	Fuel consumption (Gal/BH)	Fuel cost $(\$/Gal)$	Fuel cost $(\$/BH)$
AIRBUS Family			
Airbus A318	655,50	1,79	1.174,66
Airbus A319	703,00	1,79	1.259,78
BOEING Family			
Boeing 737-400	715,35	1,79	1.281,91
Boeing 737-700	720,10	1,79	1.290,42
ATR Family			
ATR 42-500	223,00	1,79	399,62
ATR 72-500	220,35	1,79	394,87
EMBRAER Family			
ERJ 145	384,00	1,79	688,13
E 170	655,50	1,79	1.174,66
BOMBARDIER Family			
Q300	227,00	1,79	406,78
CRJ-200	395,00	1,79	707,84

* Data of the fuel consumption per block hour of each airplane model consulted from [22] and given in Imperial Gallons.

Table 6. Fuel consumption of some of the current airplanes and their corresponding cost of fuel

A4.2 Converting from lb/BH to $\$/BH$

Fuel consumption of the ATR family was given in each model of airplane brochure in lb/BH, so it was necessary converting these lbs in imperial gallons, to then carrying out the previous conversion to obtain the cost in $\$/BH$.

So as to carry out this conversion it will be necessary to know the density of the fuel. As it was found in $lbs/US\ Gal$ it will be necessary to know as well, the conversion rate from $US\ Gal$ to $Imp\ Gal$.

Aviation fuel conversion parameters	
Density	$6{,}71\ lb/US\ Gal$
Conversion factor	$0{,}83267\ Imp\ Gal/US\ Gal$

* Data consulted from [67] and [68]

Table 7. Aviation fuel conversion parameters

The operation that will be carried out so, will be the following:

$$(x)lb \cdot \frac{1\ US\ Gal}{6{,}71\ lb} \cdot \frac{0{,}83267\ imp\ Gal}{1\ US\ Gal} \quad [Imp\ Gal]\ ;$$

where (x) is the corresponding quantity of fuel of the different model of airplanes.

Airplane model	Fuel consumption (lbs/BH)	Fuel consumption (Gal/BH)
ATR Family		
ATR 72-200	1.587	196,94
ATR 72-210	1.675	207,86
ATR 42-500	1.788	221,88
ATR 72-500	1.680	208,48
ATR 42-600	1.788	221,88
ATR 72-600	1.680	208,48

* Data of the fuel consumption per block hour of each airplane model consulted from [34], [35], [60] and [36].

Table 8. Conversion from lbs to Imperial Gallons for airplanes of ATR family

Once this result is reached, the procedure to obtain the fuel cost in $\$/BH$ is the same as in the previous section.

In this way, fuel costs per block hour of each different airplane are the following:

Airplane model	Fuel cost ($\$/BH$)	Fuel cost ($€/BH$)	Fuel cost ($€/BH$)
AIRBUS Family			
Airbus A318	1.174,66	1.108,00	1108
Airbus A319	1.259,78	1.188,29	1188
Airbus A320	1.462,27	1.379,29	1379
Airbus A321	1.449,73	1.367,46	1367
BOEING Family			
Boeing 717	1.226,62	1.157,02	1157
Boeing 737-300	1.651,33	1.557,62	1558
Boeing 737-400	1.281,91	1.209,16	1209
Boeing 737-500	1.601,98	1.511,07	1511
Boeing 737-600	1.234,24	1.164,20	1164
Boeing 737-700	1.290,42	1.217,19	1217
Boeing 737-800	1.483,95	1.399,74	1400
ATR Family			
ATR 72-200	352,91	332,88	333
ATR 72-210	372,48	351,34	351
ATR 42-500	397,61	375,05	375
ATR 72-500	373,59	352,39	352
ATR 42-600	397,61	375,05	375
ATR 72-600	373,59	352,39	352
EMBRAER Family			
ERJ 135	845,00	797,05	797
ERJ 140	812,00	765,92	766
ERJ 145	688,13	649,08	649
E 170	854,78	806,28	806
E 175	854,78	806,28	806

E 190	1.277,00	1.204,54	1205
E 195	1.277,00	1.204,54	1205
BOMBARDIER Family			
Q100	276,90	261,18	261
Q200	276,90	261,18	261
Q300	406,78	383,70	384
Q400	672,54	634,37	634
CRJ-100	707,84	667,67	668
CRJ-200	707,84	667,67	668
CRJ-700	774,14	730,21	730
CRJ-705	784,50	739,99	740
CRJ-900	784,50	739,99	740
CRJ-1000	774,14	730,21	730

* Fuel costs per block hour are an average between all the costs found in the different consulted data.

* Fuel costs per block hour have to be approximated to an integer which represents properly the value, due to there is not enough certainty of the decimal digits, and in addition, these costs will have to be added to another ones which there is even less certainty about.

* Fuel costs will be given in Euros instead of American dollars due to the study considers the incorporation of a European low cost company and the majority of the costs will be paid in Euros. Conversion rate applied: $1\$ = 0{,}943253848€$.

* Data of the fuel costs per block hour of each airplane model consulted from [22] [23] [24] [25] [26] [27] [28] [29] [30] [31] [32] [33] [34] [35] [60] and [36].

Table 9. Total Fuel Cost per block hour of the current airplanes on the route BCN-STN

Annex 5: Aircrew costs per block hour obtaining

As mentioned before, crew costs are given by the data consulted in cost per year, so it will be necessary to know how many hours crew usually flies per year, as well as the number of aircrew required by each aircraft, so as to find the cost of crew per block hour. Taking into account EASA codes, it is found:

i. The total flight time of the sectors on which an individual crew member is assigned as an operating crew member shall not exceed 900 hours of flight time in any calendar year [69].
ii. There must be one cabin crew member for every 50, or fraction of 50 passenger seats [70].

Number of cabin crew and cockpit crew required for each of the different model of airplanes analysed will be:

Airplane model	Number of seats	Cabin crew members (minimum)	Cockpit members
AIRBUS Family			
Airbus A318	132	3	(1) First Officer (1) Captain
Airbus A319	156	4	(1) First Officer (1) Captain
Airbus A320	180	4	(1) First Officer (1) Captain
Airbus A321	236	5	(1) First Officer (1) Captain
BOEING Family			
Boeing 717	117	3	(1) First Officer

			(1) Captain
Boeing 737-300	149	3	(1) First Officer (1) Captain
Boeing 737-400	189	4	(1) First Officer (1) Captain
Boeing 737-500	149	3	(1) First Officer (1) Captain
Boeing 737-600	132	3	(1) First Officer (1) Captain
Boeing 737-700	149	3	(1) First Officer (1) Captain
Boeing 737-800	189	4	(1) First Officer (1) Captain
ATR Family			
ATR 72-200	74	2	(1) First Officer (1) Captain
ATR 72-210	74	2	(1) First Officer (1) Captain
ATR 42-500	50	1	(1) First Officer (1) Captain
ATR 72-500	74	2	(1) First Officer (1) Captain
ATR 42-600	50	1	(1) First Officer (1) Captain
ATR 72-600	74	2	(1) First Officer (1) Captain
EMBRAER Family			
ERJ 135	37	1	(1) First Officer (1) Captain
ERJ 140	44	1	(1) First Officer (1) Captain
ERJ 145	50	1	(1) First Officer (1) Captain
E 170	78	2	(1) First Officer (1) Captain
E 175	88	2	(1) First Officer

			(1) Captain
E 190	114	3	(1) First Officer (1) Captain
E 195	124	3	(1) First Officer (1) Captain
BOMBARDIER Family			
Q100	39	1	(1) First Officer (1) Captain
Q200	39	1	(1) First Officer (1) Captain
Q300	56	2	(1) First Officer (1) Captain
Q400	86	2	(1) First Officer (1) Captain
CRJ-100	50	1	(1) First Officer (1) Captain
CRJ-200	50	1	(1) First Officer (1) Captain
CRJ-700	78	2	(1) First Officer (1) Captain
CRJ-705	86	2	(1) First Officer (1) Captain
CRJ-900	90	2	(1) First Officer (1) Captain
CRJ-1000	104	3	(1) First Officer (1) Captain

* Low cost companies' seat configuration is normally the one with highest density as possible on the model of aircraft they operate with in order to reduce CASM's costs. In this way, all the aircraft analysed will be supposed to have their maximum number of passengers' seats.
* Data of the maximum seats of each airplane model consulted from [38], [40], [51], [61], [62], [71] and [72].

Table 10. Minimum cabin crew and cockpit crew members of the current airplanes

Taking into account the maximum $900\,h$ per year, both cockpit crew and cabin crew must work, it can be found the cost per block hour of cabin crew and cockpit crew of each analysed airplane.

A5.1 Cabin Crew Costs

Cabin crew costs which will be used in this study are an average between the maximum and minimum salary of a flight attendant. Cabin crew person costs usually remain constant between different airplanes, so the only thing that has to be taken into consideration is the total number of cabin crew attendants.

Airplane model	Cabin crew members	Cabin Crew Cost $(€/person \cdot year)$	Cabin crew Cost $(€/year)$
AIRBUS Family			
Airbus A318	3	25.000	75.000
Airbus A319	4	25.000	100.000
Airbus A320	4	25.000	100.000
Airbus A321	5	25.000	125.000
BOEING Family			
Boeing 717	3	25.000	75.000
Boeing 737-300	3	25.000	75.000
Boeing 737-400	4	25.000	100.000
Boeing 737-500	3	25.000	75.000
Boeing 737-600	3	25.000	75.000
Boeing 737-700	3	25.000	75.000
Boeing 737-800	4	25.000	100.000
ATR Family			
ATR 72-200	2	25.000	50.000
ATR 72-210	2	25.000	50.000
ATR 42-500	1	25.000	25.000
ATR 72-500	2	25.000	50.000
ATR 42-600	1	25.000	25.000
ATR 72-600	2	25.000	50.000
EMBRAER Family			
ERJ 135	1	25.000	25.000
ERJ 140	1	25.000	25.000

ERJ 145	1	25.000	25.000
E 170	2	25.000	50.000
E 175	2	25.000	50.000
E 190	3	25.000	75.000
E 195	3	25.000	75.000
BOMBARDIER Family			
Q100	1	25.000	25.000
Q200	1	25.000	25.000
Q300	2	25.000	50.000
Q400	2	25.000	50.000
CRJ-100	1	25.000	25.000
CRJ-200	1	25.000	25.000
CRJ-700	2	25.000	50.000
CRJ-705	2	25.000	50.000
CRJ-900	2	25.000	50.000
CRJ-1000	3	25.000	75.000

* Data of cabin crew attendants costs consulted from [32].

Table 11. Yearly cabin crew costs of the current airplanes

Cabin crew costs per block hour will be the next ones:

Airplane model	Cabin crew Cost $(€/year)$	Total Block Hours	Cabin Crew Cost $(€/BH)$
AIRBUS Family			
Airbus A318	75.000	900	83
Airbus A319	100.000	900	111
Airbus A320	100.000	900	111
Airbus A321	125.000	900	139
BOEING Family			
Boeing 717	75.000	900	83
Boeing 737-300	75.000	900	83
Boeing 737-400	100.000	900	111
Boeing 737-500	75.000	900	83

Boeing 737-600	75.000	900	83
Boeing 737-700	75.000	900	83
Boeing 737-800	100.000	900	111
ATR Family			
ATR 72-200	50.000	900	56
ATR 72-210	50.000	900	56
ATR 42-500	25.000	900	28
ATR 72-500	50.000	900	56
ATR 42-600	25.000	900	28
ATR 72-600	50.000	900	56
EMBRAER Family			
ERJ 135	25.000	900	28
ERJ 140	25.000	900	28
ERJ 145	25.000	900	28
E 170	50.000	900	56
E 175	50.000	900	56
E 190	75.000	900	83
E 195	75.000	900	83
BOMBARDIER Family			
Q100	25.000	900	28
Q200	25.000	900	28
Q300	50.000	900	56
Q400	50.000	900	56
CRJ-100	25.000	900	28
CRJ-200	25.000	900	28
CRJ-700	50.000	900	56
CRJ-705	50.000	900	56
CRJ-900	50.000	900	56
CRJ-1000	75.000	900	83

*Cabin crew costs per block hour have to be approximated to an integer which properly represents the value due to there is not enough certainty of the decimal digits.

Table 12. Cabin Crew Cost per Block Hour of the current airplanes

A5.2 Cockpit crew costs

Cockpit crew costs that will be used in this study are an average between the maximum and minimum salary of a first officer and a captain. First officer and captain salaries usually vary with the aircraft model, tending to be higher when aircrafts dimensions increase. There can be, however, families of airplanes where cockpit crew salaries remain constant.

Airplane model	First Officer Salary (€/year)	Captain salary (€/year)	Cockpit crew Cost (€/year)
AIRBUS Family			
Airbus A318	51.500	96.500	148.000
Airbus A319	51.500	96.500	148.000
Airbus A320	51.500	96.500	148.000
Airbus A321	51.500	96.500	148.000
BOEING Family			
Boeing 717	56.000	97.500	153.500
Boeing 737-300	61.500	114.500	176.000
Boeing 737-400	61.500	114.500	176.000
Boeing 737-500	61.500	114.500	176.000
Boeing 737-600	70.000	116.000	186.000
Boeing 737-700	70.000	116.000	186.000
Boeing 737-800	70.000	116.000	186.000
ATR Family			
ATR 72-200	40.000	75.000	115.000
ATR 72-210	40.000	75.000	115.000
ATR 42-500	38.000	73.000	111.000
ATR 72-500	40.000	75.000	115.000
ATR 42-600	38.000	73.000	111.000
ATR 72-600	40.000	75.000	115.000
EMBRAER Family			
ERJ 135	38.000	79.000	117.000

ERJ 140	40.000	83.700	123.700
ERJ 145	40.000	83.700	123.700
E 170	43.700	95.000	138.700
E 175	43.700	95.000	138.700
E 190	47.500	98.000	145.500
E 195	47.500	98.000	145.500
BOMBARDIER Family			
Q100	40.000	67.500	107.500
Q200	40.000	67.500	107.500
Q300	40.000	67.500	107.500
Q400	41.800	82.700	124.500
CRJ-100	38.000	80.800	118.800
CRJ-200	38.000	80.800	118.800
CRJ-700	43.700	96.000	139.700
CRJ-705	43.700	96.000	139.700
CRJ-900	47.500	98.000	145.500
CRJ-1000	47.500	98.000	145.500

* Data of cockpit crew salaries consulted from [32] and [73].

Table 13. Yearly cockpit crew costs of the current airplanes

Cockpit crew costs per block hour will be the following:

Airplane model	Cockpit crew Cost $(€/year)$	Total Block Hours	Cockpit Crew Cost $(€/BH)$
AIRBUS Family			
Airbus A318	148.000	900	164
Airbus A319	148.000	900	164
Airbus A320	148.000	900	164
Airbus A321	148.000	900	164
BOEING Family			
Boeing 717	153.500	900	171
Boeing 737-300	176.000	900	196
Boeing 737-400	176.000	900	196
Boeing 737-500	176.000	900	196

Boeing 737-600	186.000	900	207
Boeing 737-700	186.000	900	207
Boeing 737-800	186.000	900	207
ATR Family			
ATR 72-200	115.000	900	128
ATR 72-210	115.000	900	128
ATR 42-500	111.000	900	123
ATR 72-500	115.000	900	128
ATR 42-600	111.000	900	123
ATR 72-600	115.000	900	128
EMBRAER Family			
ERJ 135	117.000	900	130
ERJ 140	123.700	900	137
ERJ 145	123.700	900	137
E 170	138.700	900	154
E 175	138.700	900	154
E 190	145.500	900	162
E 195	145.500	900	162
BOMBARDIER Family			
Q100	107.500	900	119
Q200	107.500	900	119
Q300	107.500	900	119
Q400	124.500	900	138
CRJ-100	118.800	900	132
CRJ-200	118.800	900	132
CRJ-700	139.700	900	155
CRJ-705	139.700	900	155
CRJ-900	145.500	900	162
CRJ-1000	145.500	900	162

* Cockpit crew costs per block hour have to be approximated to an integer which properly represents the value due to there is not enough certainty of the decimal digits.

Table 14. Cockpit Crew Costs per Block Hour of the current airplanes

Annex 6: Average cargo per passenger permitted and available cargo for invoicing obtaining

A6.1 Average cargo per passenger permitted obtaining

The average of cargo permitted per passenger follows the next equation:

$$Cargo\ permitted = \frac{Total\ Cargo}{Number\ of\ passengers}\ \ [kg/pax]$$

So as to obtain the total cargo permitted by the airplane, it is necessary to have knowledge of the MPL of each airplane, and then subtracting to this value, the weight corresponding to passengers:

$$Total\ Cargo = MPL - Passengers'\ Weight\ \ [kg]$$

It will be considered an average weight of $77kg$ per passenger [74], so:

$$Total\ Cargo = MPL - 77(number\ of\ passengers)\ \ [kg]$$

However, between the data consulted, it had not been possible to find the MPL of all the analysed airplanes and it was needed then, the MZFW and the OEW, in order to find the cargo.

Having knowledge of the MZFW and the OEW of an airplane, it is also possible to find the MPL and then the weight of cargo, following the equation:

$$MZFW = OEW + MPL \;\rightarrow\; MPL = MZFW - OEW$$

Cargo obtaining from MPL

In order to obtain the cargo from a MPL given, it will only be necessary to know the maximum number of passengers each airplane can carry.

Airplane model	MPL (kg)	Passengers	Total cargo (kg)	Cargo permitted (kg/pax)
BOEING Family				
Boeing 717	12.020	117	3.011	25,7
Boeing 737-300	15.404	149	3.931	26,4
Boeing 737-400	19.881	189	5.328	28,2
Boeing 737-500	15.182	149	3.709	25,0
Boeing 737-600	15.558	132	5.394	40,9
Boeing 737-700	17.554	149	6.081	40,8
Boeing 737-800	21.319	189	6.766	35,8
ATR Family				
ATR 72-200	7.000	74	1.302	17,6
ATR 72-210	7.000	74	1.302	17,6
ATR 42-500	5.300	50	1.450	29,0
ATR 72-500	7.200	74	1.502	20,3

ATR 42-600	5.300	50	1.450	29,0
ATR 72-600	7.500	74	1.802	24,3
EMBRAER Family				
ERJ 135	4.198	37	1.349	36,5
ERJ 140	5.284	44	1.896	43,1
ERJ 145	5.786	50	1.936	38,7
E 170	9.100	78	3.094	39,7
E 175	10.080	88	3.304	37,5
E 190	13.080	114	4.302	37,7
E 195	13.650	124	4.102	33,1
BOMBARDIER Family				
Q100	4.215	39	1.212	31,1
Q200	4.647	39	1.644	42,2
Q300	6.124	56	1.812	32,3
Q400	8.670	86	2.048	23,8
CRJ-100	6.124	50	2.274	45,5
CRJ-200	5.942	50	2.092	41,9
CRJ-700	8.527	78	2.521	31,3
CRJ-705	10.319	86	3.697	43,0
CRJ-900	10.319	90	3.389	37,7
CRJ-1000	11.975	104	3.967	38,1

* Data of the fuel costs per block hour of each airplane model consulted from [34], [35], [60], [36], [37], [38], [39], [41], [42], [43], [44] and [45].

Table 15. Cargo per passenger permitted in some of the current airplanes

Cargo obtaining from MZWF and OEW

Operating with the MZFW and the OEW given from the different airplanes, MPL can be obtained following the equation mentioned above:

Airplane model	MZFW (kg)	OEW (kg)	MPL (kg)
AIRBUS Family			
Airbus A318	54.500	39.500	15.000
Airbus A319	58.500	40.800	17.700
Airbus A320	62.500	42.600	19.900
Airbus A321	73.800	48.500	25.300

* Data of the MZFW and OEW of each airplane model consulted from [63].

Table 16. MZFW and OEW from the Airbus family

Once MPL is found, the procedure is the same as in section above:

Airplane model	MPL (kg)	Passengers	Total cargo (kg)	Cargo permitted (kg/pax)
AIRBUS Family				
Airbus A318	15.000	132	4.836	36,6
Airbus A319	17.700	156	5.688	36,5
Airbus A320	19.900	180	6.040	33,6
Airbus A321	25.300	236	7.128	30,2

Table 17. Cargo per passenger permitted in the different models of the Airbus family

A6.2 Available cargo for invoicing

The available cargo for invoicing is calculated to have knowledge of the cargo that would provide benefits to the company in each flight, as this cargo could be used to carry luggage which is heavier than the permitted on the passenger cabin, and this would suppose an additional charge in the ticket price.

First step to obtain the available cargo is to establish the maximum weight of cargo permitted for free to passengers. This weight will be fixed at $10\ kg$, due to it is the typical weight permitted to passengers of the majority of airliners, and so, the expected by passengers when buying a flight.

In this way, in order to know the remaining cargo which the company could take advantage of and have so, more earnings, it will be carried out the following equation:

$$Invoicing = Total\ Cargo - 10 \cdot Number\ of\ passengers \quad [kg]$$

Carrying out the equation above for every model of airplane, it is obtained the following table:

Airplane model	Total cargo (kg)	Free cargo (kg/pax)	Passengers	Invoicing (kg)
AIRBUS Family				
Airbus A318	4.836	10	132	3.516
Airbus A319	5.688	10	156	4.128
Airbus A320	6.040	10	180	4.240
Airbus A321	7.128	10	236	4.768
BOEING Family				
Boeing 717	3.011	10	117	2.798
Boeing 737-300	3.931	10	149	2.441
Boeing 737-400	5.328	10	189	3.438
Boeing 737-500	3.709	10	149	2.219
Boeing 737-600	5.394	10	132	4.074
Boeing 737-700	6.081	10	149	4.591
Boeing 737-800	6.766	10	189	4.876
ATR Family				
ATR 72-200	1.302	10	74	562
ATR 72-210	1.302	10	74	562

ATR 42-500	1.450	10	50	950
ATR 72-500	1.502	10	74	762
ATR 42-600	1.450	10	50	950
ATR 72-600	1.802	10	74	1.062
EMBRAER Family				
ERJ 135	1.349	10	37	979
ERJ 140	1.896	10	44	1.456
ERJ 145	1.936	10	50	1.436
E 170	3.094	10	78	2.314
E 175	3.304	10	88	2.424
E 190	4.302	10	114	3.162
E 195	4.102	10	124	2.862
BOMBARDIER Family				
Q100	1.212	10	39	822
Q200	1.644	10	39	1.254
Q300	1.812	10	56	1.252
Q400	2.048	10	86	1.188
CRJ-100	2.274	10	50	1.774
CRJ-200	2092	10	50	1.592
CRJ-700	2.521	10	78	1.741
CRJ-705	3.697	10	86	2.837
CRJ-900	3.389	10	90	2.489
CRJ-1000	3.967	10	104	2.927

Table 18. Available cargo destined to invoicing of the different airplanes

Annex 7: Number of existing airplanes in the European airlines

First step to know the number of existing airplanes, and so, possible airplanes that could be borrowed in case of necessity as well as spare parts that could be used, will be making a search of the European airlines that usually work on the five airports the new company will operate at (see section *2.2.1*).

European Airlines operating in the same airports as the new LCC

Airport Barcelona-El Prat	Airport Madrid-Barajas	Airport London-Stansted	Airport Paris-Orly	Airport Mallorca-Son Sant Joan
Adria Airways	Aegean Airlines	Aegean Airlines	Aigle Azur	Adria Airways
Aegean Airlines	Aer Lingus	Air Berlin	Air Berlin	Air Berlin
Aer Lingus	Aeroflot	Air Moldova	Air Europa	Air Europa
Aeroflot	Air Berlin	Aurigny	Air France	Air Nostrum
Air Baltic	Air Europa	EasyJet	Alitalia	BA Cityflyer
Air Berlin	Air France	FlyBe	British Airways	British Airways
Air Europa	Air Moldova	FreeBird Airlines	EasyJet	Bulgaria Air
Air France	Air Nostrum	Germanwings	Finnair	easyJet
Air Moldova	Alitalia	Pegasus Airlines	FlyBe	Evelop
Air Nostrum	BA Cityflyer	Ryanair	Iberia	Germanwings
Alitalia	Blue Air	Thomas Cook	Jetairfly	Iberia
Austrian Airlines	British Airways	Thomson Airways	KLM	Jet2.com
BA Cityflyer	Brussels Airlines		Norwegian Airlines	Jetairfly
Belavia	Bulgaria Air		Pegasus Airlines	Lufthansa

Blue Air	EasyJet		TAP Portugal	Luxair
British Airways	EasyJet Switzerland		Transaero Airlines	Monarch Airlines
Brussels Airlines	Enter Air		Transavia France	Ryanair
Bulgaria Air	Evelop		Vueling	Swiss International Airlines
Croatia Airlines	Finnair			Thomas Cook
EasyJet	Germanwings			Thomson Airways
EasyJet Switzerland	Iberia			Transavia
Enter Air	KLM			Vueling
Evelop	Lufthansa			
Finnair	Luxair			
Germanwings	Norwegian Airlines			
Iberia	Pegasus Airlines			
Jet2.com	Rojal Jordanian Airlines			
Jetairfly	Ryanair			
KLM	Swiss International Airlines			
Lufthansa	TAP Portugal			
Luxair	Tarom			
Monarch Airlines	Transavia			
Nordwind Airlines	Transavia France			
Norwegian Airlines	Turkish Airlines			
Pegasus Airlines	Ukraine International Airlines			
Rojal Jordanian	Vueling			

Airlines	
Ryanair	WizzAir
Smartwings	
Swiss International Airlines	
TAP Portugal	
Tarom	
Transaero Airlines	
Transavia	
Turkish Airlines	
Ukraine International Airlines	
Vueling	
WizzAir	

* Data of airlines operating in the airports consulted from from [75], [76], [77], [78] and [79].

Table 19. European airlines operating in the same airports as the new LCC

Next, it will be studied the fleet of each of these airlines, from [4], [80] and [81], in order to know how many active or in storage airplanes of the different models analysed they have.

As companies' fleets vary very frequently, it is important to note that according to the data consulted, next fleets correspond to the ones of March 2015, date of the last actualization of the web pages at the moment when they were consulted.

Fleet of Adria Airways

Airplane model	Active	Stored
Airbus A319	2	-
Airbus A320	-	2
CRJ-100	-	1
CRJ-200	2	2
CRJ-900	6	-

Table 20. Fleet of Adria Airways

Fleet of Aegean Airlines

Airplane model	Active	Stored
Airbus A319	-	1
Airbus A320	28	-
Airbus A321	6	-

Table 21. Fleet of Aegean Airlines

Fleet of Aer Lingus

Airplane model	Active	Stored
Airbus A319	4	-
Airbus A320	29	-
Airbus A321	3	-
ATR 42-600	11	-

Table 22. Fleet of Aer Lingus

Fleet of Aeroflot

Airplane model	Active	Stored
Airbus A319	7	-
Airbus A320	63	-
Airbus A321	26	1
Boeing 737-800	8	-

Table 23. Fleet of Aeroflot

Fleet of Aigle Azur

Airplane model	Active	Stored
Airbus A319	3	1
Airbus A320	7	-

Table 24. Fleet of Aigle Azur

Fleet of Air Baltic

Airplane model	Active	Stored
Boeing 737-300	7	1
Boeing 737-500	5	1
Q400	12	-

Table 25. Fleet of Air Baltic

Fleet of Air Berlin

Airplane model	Active	Stored
Airbus A319	4	-
Airbus A320	31	-
Airbus A321	15	-
Boeing 737-700	3	-
Boeing 737-800	25	-

Table 26. Fleet of Air Berlin

Fleet of Air Europa

Airplane model	Active	Stored
ATR 72-210	1	-
ATR 72-500	2	
Boeing 737-800	20	-
ERJ 145	1	-
E 195	11	-

Table 27. Fleet of Air Europa

Fleet of Air France

Airplane model	Active	Stored
Airbus A318	18	-
Airbus A319	39	1
Airbus A320	43	34
Airbus A321	18	1

Table 28. Fleet of Air France

Fleet of Air Moldova

Airplane model	Active	Stored
Airbus A320	2	1
Airbus A321	1	1
E 190	2	34

Table 29. Fleet of Air Moldova

Fleet of Air Nostrum

Airplane model	Active	Stored
ATR 72-600	5	-
CRJ-100	13	-
CRJ-200	7	9
CRJ-900	12	-
CRJ-1000	10	-

Table 30. Fleet of Air Nostrum

Fleet of Alitalia

Airplane model	Active	Stored
Airbus A319	22	-
Airbus A320	48	6
Airbus A321	12	10
ATR 72-500	-	1

Table 31. Fleet of Alitalia

Fleet of Aurigny

Airplane model	Active	Stored
ATR 72-210	1	-
ATR 72-500	2	
E 195	1	-

Table 32. Fleet of Aurigny

Fleet of Austrian Airlines

Airplane model	Active	Stored
Airbus A319	7	-
Airbus A320	16	-
Airbus A321	3	-
Boeing 737-600	-	2
Boeing 737-700	-	2
CRJ-100	-	1
Q400	17	-

Table 33. Fleet of Austrian Airlines

Fleet of BA Cityflyer

Airplane model	Active	Stored
E 170	6	-
E 190	11	-

Table 34. Fleet of BA Cityflyer

Fleet of Belavia

Airplane model	Active	Stored
Boeing 737-300	9	-
Boeing 737-500	6	-
Boeing 737-800	2	-
CRJ-200	5	-
E 175	2	-
E 195	2	-

Table 35. Fleet of Belavia

Fleet of Blue Air

Airplane model	Active	Stored
Boeing 737-300	1	-
Boeing 737-400	8	-
Boeing 737-500	1	-

Table 36. Fleet of Blue Air

Fleet of British Airways

Airplane model	Active	Stored
Airbus A318	2	-
Airbus A319	44	-
Airbus A320	61	5
Airbus A321	18	-
Boeing 737-300	-	2
Boeing 737-400	4	15

Table 37. Fleet of British Airways

Fleet of Brussels Airlines

Airplane model	Active	Stored
Airbus A319	18	-
Airbus A320	6	-
Boeing 737-400	-	1
Q400	3	-

Table 38. Fleet of Brussels Airlines

Fleet of Bulgaria Air

Airplane model	Active	Stored
Airbus A319	3	-
Airbus A320	2	-
Boeing 737-300	-	2
E 190	4	-

Table 39. Fleet of Bulgaria Air

Fleet of Croatia Airlines

Airplane model	Active	Stored
Airbus A319	4	-
Airbus A320	2	1
Q400	6	-

Table 40. Fleet of Croatia Airlines

Fleet of EasyJet

Airplane model	Active	Stored
Airbus A319	135	-
Airbus A320	67	-
Boeing 737-700	-	3

Table 41. Fleet of EasyJet

Fleet of EasyJet Switzerland

Airplane model	Active	Stored
Airbus A319	12	-
Airbus A320	11	-

Table 42. Fleet of EasyJet Switzerland

Fleet of Enter Air

Airplane model	Active	Stored
Boeing 737-400	6	2
Boeing 737-800	7	-

Table 43. Fleet of Enter Air

Fleet of Evelop

Airplane model	Active	Stored
Airbus A320	1	-

Table 44. Fleet of Evelop

Fleet of Finnair

Airplane model	Active	Stored
Airbus A319	9	-
Airbus A320	10	-
Airbus A321	11	-
E 170	6	-
E 190	12	-

Table 45. Fleet of Finnair

Fleet of FlyBe

Airplane model	Active	Stored
ATR 72-500	2	-
Q400	42	4
ERJ 145	-	3
E 175	11	-
E 195	4	5

Table 46. Fleet of FlyBe

Fleet of FreeBird Airlines

Airplane model	Active	Stored
Airbus A320	7	2
Airbus A321	-	1

Table 47. Fleet of FreeBird Airlines

Fleet of Germanwings

Airplane model	Active	Stored
Airbus A319	43	-
Airbus A320	17	-

Table 48. Fleet of Germanwings

Fleet of Iberia

Airplane model	Active	Stored
Airbus A319	12	-
Airbus A320	13	2
Airbus A321	17	1

Table 49. Fleet of Iberia

Fleet of Jet2

Airplane model	Active	Stored
Boeing 737-300	29	3
Boeing 737-800	15	-

Table 50. Fleet of Jet2

Fleet of Jetairfly

Airplane model	Active	Stored
Boeing 737-700	4	-
Boeing 737-800	9	-
E 190	2	-

Table 51. Fleet of Jetairfly

Fleet of KLM

Airplane model	Active	Stored
Boeing 737-300	-	6
Boeing 737-400	-	5
Boeing 737-700	18	-
Boeing 737-800	25	-

Table 52. Fleet of KLM

Fleet of Lufthansa

Airplane model	Active	Stored
Airbus A319	30	-
Airbus A320	51	1
Airbus A321	44	-
Boeing 737-300	9	22
Boeing 737-500	12	18

Table 53. Fleet of Lufthansa

Fleet of Luxair

Airplane model	Active	Stored
Boeing 737-700	2	1
Boeing 737-800	3	-
Q400	7	-
ERJ 145	6	-

Table 54. Fleet of Luxair

Fleet of Monarch Airlines

Airplane model	Active	Stored
Airbus A320	8	3
Airbus A321	24	1

Table 55. Fleet of Monarch Airlines

Fleet of Nordwind Airlines

Airplane model	Active	Stored
Airbus A320	-	1
Airbus A321	8	-
Boeing 737-800	5	-

Table 56. Fleet of Nordwind Airlines

Fleet of Norwegian Airlines

Airplane model	Active	Stored
Boeing 737-300	-	12
Boeing 737-800	85	-

Table 57. Fleet of Norwegian Airlines

Fleet of Pegasus Airlines

Airplane model	Active	Stored
Airbus A320	5	-
Boeing 737-400	-	1
Boeing 737-800	48	-

Table 58. Fleet of Pegasus Airlines

Fleet of Royal Jordanian Airlines

Airplane model	Active	Stored
Airbus A319	4	-
Airbus A320	6	-
Airbus A321	2	-
E 175	3	-
E 195	4	1

Table 59. Fleet of Royal Jordanian Airlines

Fleet of Ryanair

Airplane model	Active	Stored
Boeing 737-800	304	-

Table 60. Fleet of Ryanair

Fleet of Smartwings

Airplane model	Active	Stored
Airbus A320	1	2
Boeing 737-500	-	2
Boeing 737-700	2	-
Boeing 737-800	1	-

Table 61. Fleet of Smartwings

Fleet of Swiss International Airlines

Airplane model	Active	Stored
Airbus A319	5	-
Airbus A320	23	-
Airbus A321	2	-

Table 62. Fleet of Swiass International Airlines

Fleet of TAP Portugal

Airplane model	Active	Stored
Airbus A319	21	-
Airbus A320	19	1
Airbus A321	3	-

Table 63. Fleet of TAP Portugal

Fleet of Tarom

Airplane model	Active	Stored
Airbus A318	4	-
ATR 42-500	7	-
ATR 72-500	2	-
Boeing 737-300	3	2
Boeing 737-700	4	-
Boeing 737-800	1	-

Table 64. Fleet of Tarom

Fleet of Thomas Cook

Airplane model	Active	Stored
Airbus A319	1	-
Airbus A320	3	3

Table 65. Fleet of Thomas Cook

Fleet of Thomson Airways

Airplane model	Active	Stored
Boeing 737-800	24	-

Table 66. Fleet of Thomson Airways

Fleet of TransAero Airlines

Airplane model	Active	Stored
Boeing 737-300	3	1
Boeing 737-400	5	-
Boeing 737-500	14	1
Boeing 737-700	7	-
Boeing 737-800	17	-

Table 67. Fleet of TransAero Airlines

Fleet of Transavia Airlines

Airplane model	Active	Stored
Boeing 737-700	9	-
Boeing 737-800	21	-

Table 68. Fleet of Transavia Airlines

Fleet of Transavia France

Airplane model	Active	Stored
Airbus A320	2	-
Boeing 737-800	11	-

Table 69. Fleet of Transavia France

Fleet of Turkish Airlines

Airplane model	Active	Stored
Airbus A319	14	-
Airbus A320	33	-
Airbus A321	44	-
Boeing 737-700	3	-

Table 70. Fleet of Turkish Airlines

Fleet of Ukraine International airlines

Airplane model	Active	Stored
Boeing 737-300	4	1
Boeing 737-400	1	2
Boeing 737-500	7	2
E 190	5	-

Table 71. Fleet of Ukraine International Airlines

Fleet of Vueling

Airplane model	Active	Stored
Airbus A319	5	-
Airbus A320	84	6

Table 72. Fleet of Vueling

Fleet of WizzAir

Airplane model	Active	Stored
Airbus A320	53	-

Table 73. Fleet of WizzAir

It can be then known, the total number of each different model of airplanes that exist in Europe:

Airplane model	Number of existences in Europe
AIRBUS Family	
Airbus A318	24
Airbus A319	450
Airbus A320	822
Airbus A321	214
BOEING Family	
Boeing 717	0
Boeing 737-300	117
Boeing 737-400	50
Boeing 737-500	63
Boeing 737-600	2
Boeing 737-700	33
Boeing 737-800	602
ATR Family	
ATR 72-200	0
ATR 72-210	2
ATR 42-500	7
ATR 72-500	9
ATR 42-600	11
ATR 72-600	5
EMBRAER Family	
ERJ 135	0
ERJ 140	0
ERJ 145	10
E 170	12
E 175	16
E 190	36
E 195	28
BOMBARDIER Family	
Q100	0
Q200	0
Q300	0
Q400	91
CRJ-100	15

CRJ-200	25
CRJ-700	0
CRJ-705	0
CRJ-900	18
CRJ-1000	10

Table 74. Number of existences of each model of airplane in Europe

Annex 8: Ordered Weighted Average (OWA)

The Ordered Weighted Average (OWA) is the most commonly used method of decision taking because of its simplicity and robustness, and follows the next steps [50]:

i. Define the factors to consider in the method.
ii. Weight each of the defined factors by assigning a weight (W_i).
iii. Rate each of the factors (P_i).
iv. Calculate the relative weight by carrying out the next operation:

$$Relative\ Weight = P_i \cdot W_i$$

v. Add all weighted marks for each aspect and divide it by the sum of weights and the highest possible rating:

$$OWA = \frac{\sum_{i=1}^{n} P_i \cdot W_i}{P_{max} \cdot \sum_{i=1}^{n} W_i}$$

A8.1 Aspects to consider in the OWA method

The aspects which will be considered in the method in order to find the most suitable model of airplane will be the ones analysed in the section *Selection of the most suitable model of airplane.*

Aspects of the OWA method	
(1) Direct Operational Costs	
(1.1)	Aircraft leasing cost
(1.2)	Fuel cost
(1.3)	Maintenance cost
(1.4)	Crew cost
(1.5)	Airport charges
(1.6)	On-route fees
(2) Invoicing	
(3) Flight duration	
(4) Number of existences in the operating geographical area	

Table 75. Aspects taken into account in the OWA method

A8.2 Weight of the aspects

Once aspects have been defined, next step will be giving them a weight according to their importance to the company.

The most suitable airplane tends to be the more profitable for the company in terms of costs. In this sense, costs of the analysed airplanes will be a determinant aspect when taking the decision, and so given a greater weight than the rest of aspects.

In order to rate each of the *DOC's* properly, some data has been consulted to find the importance of each of them inside an airline [82]. Next figure shows the percentages each *DOC* represents to the company:

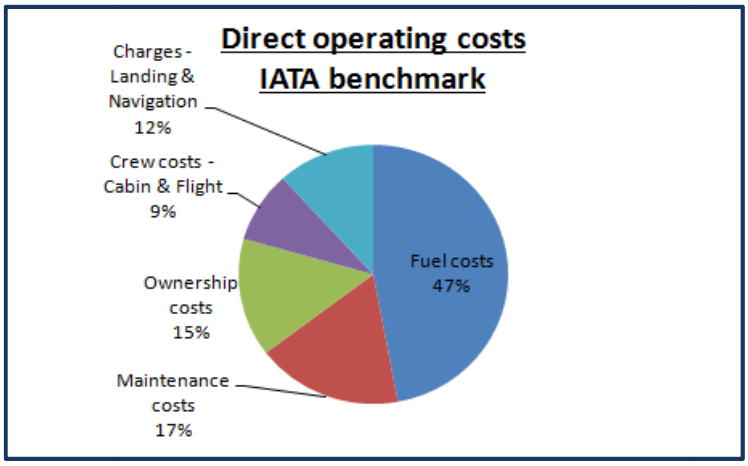


Figure 1. LCC airlines costs breakdown

In this way, it can be seen that the order of importance between all the *DOC's* will be:

$$Fuel > Maintenance > Leasing > Taxes > Crew$$

Between the remaining aspects, the company will suppose to give the following order of importance:

$$Invoicing > Existences > Duration$$

Giving numbers to these weights:

Aspects of the OWA method		Weight (W_i)
(1) Direct Operational Costs		(240)
(1.1)	Aircraft leasing cost	43
(1.2)	Fuel cost	75
(1.3)	Maintenance cost	37
(1.4)	Crew cost	45
(1.5)	Airport charges	20
(1.6)	On-route fees	20
(2) Invoicing		8
(3) Flight duration		3
(4) Number of existences in the operating geographical area		6
Total Weight		**257**

*Weight of $DOC's$ maintain the difference between percentages of the *Figure 1. LCC airlines costs breakdown*. The percentages of the figure have been increased in order to be able to contemplate the rest of aspects which are not costs.

Table 76. Weight of each aspect of the OWA method

A8.3 Rate of the aspects

Following, it will be given a rate to each of the aspects of every model of airplane taken into account on the OWA method.

In order to rate each model of airplane according to each aspect, it will be necessary:

i. Identifying the best aircraft according to the company interests.
ii. Giving to the best aircraft the highest rate. This rate will have to be normalised to a maximum value. In this case, it is chosen a highest rate of 100.
iii. Finding the rest of the airplanes rates by carrying out a simple direct or inverse rule of three. It will have to have knowledge of the value which is

being analysed of the best airplane (corresponding to a rate of 100) and the value of the different airplanes:

$$\left.\begin{matrix} A_1 \_\_\_\_\_ 100 \\ A_2 \_\_\_\_\_ x \end{matrix}\right\} \; x = \frac{A_2 \cdot 100}{A_1} \rightarrow Direct$$

$$\left.\begin{matrix} A_1 \_\_\_\_\_ 100 \\ A_2 \_\_\_\_\_ x \end{matrix}\right\} \; x = \frac{A_1 \cdot 100}{A_2} \rightarrow Inverse\,;$$

where, A_1 corresponds to the best value according to the company interests, A_2 to the value which its rating is wanted and x the mentioned rating.

Aircraft leasing cost

As mentioned in the section *Aircraft price*, the most suitable airplane for the company will be the one with the lowest leasing cost. In this way, this cost will be rated with $P_i = 100$, and rest of the ratings will have to be found by carrying out a rule of three.

Airplane model	Leasing cost $(€/month)$	Rate (P_i)
CRJ-100	35.000	100

Table 77. Best model of airplane according to leasing costs

The rule of three that will be made is an inverse one, due to at a lowest leasing cost, highest rate.

The rating of the different model of airplanes according to their leasing costs will be the following:

Airplane model	Leasing cost $(€/month)$	Rate (P_i)
AIRBUS Family		
Airbus A318	75.000	46,667
Airbus A319	177.000	19,774
Airbus A320	186.000	18,817
Airbus A321	281.000	12,456
BOEING Family		
Boeing 717	111.000	31,532
Boeing 737-300	51.000	68,627
Boeing 737-400	65.000	53,846
Boeing 737-500	45.000	77,778
Boeing 737-600	111.000	31,532
Boeing 737-700	179.000	19,553
Boeing 737-800	280.000	12,500
ATR Family		
ATR 72-200	59.000	59,322
ATR 72-210	59.000	59,322
ATR 42-500	99.000	35,354
ATR 72-500	111.000	31,532
ATR 42-600	146.000	23,973
ATR 72-600	167.000	20,958
EMBRAER Family		
ERJ 135	52.000	67,308
ERJ 140	48.000	72,917
ERJ 145	54.000	64,815
E 170	156.000	22,436
E 175	175.000	20,000
E 190	203.000	17,241
E 195	96.000	36,458

BOMBARDIER Family		
Q100	60.000	58,333
Q200	82.000	42,683
Q300	84.000	41,667
Q400	137.000	25,547
CRJ-100	35.000	100,000
CRJ-200	56.000	62,500
CRJ-700	137.000	25,547
CRJ-705	167.000	20,958
CRJ-900	171.000	20,468
CRJ-1000	217.000	16,129

Table 78. Rate of the airplanes according to their leasing cost

Fuel cost

Similar to the previous section and having a look to the section *Fuel costs*, the most suitable model of airplane according to fuel costs can be found and given the maximum rating.

Airplane model	**Fuel costs (€)**	**Rate (P_i)**
Q200	663	100

Table 79. Best model of airplane according to fuel costs

In order to find the ratings of the other airplanes, the utilised rule of three will be an inverse one, due to as lower fuel costs, the better, and so a higher rating. In this manner, it is obtained:

Airplane model	Fuel costs (€)	Rate (P_i)
AIRBUS Family		
Airbus A318	1.955	33,913
Airbus A319	2.097	31,617
Airbus A320	2.434	27,239
Airbus A321	2.413	27,476
BOEING Family		
Boeing 717	2.076	31,936
Boeing 737-300	2.886	22,973
Boeing 737-400	2.240	29,598
Boeing 737-500	2.799	23,687
Boeing 737-600	2.064	32,122
Boeing 737-700	2.158	30,723
Boeing 737-800	2.482	26,712
ATR Family		
ATR 72-200	877	75,599
ATR 72-210	922	71,909
ATR 42-500	924	71,753
ATR 72-500	936	70,833
ATR 42-600	922	71,909
ATR 72-600	936	70,833
EMBRAER Family		
ERJ 135	1.406	47,155
ERJ 140	1.351	49,075
ERJ 145	1.145	57,904
E 170	1.393	47,595
E 175	1.393	47,595
E 190	2.081	31,860
E 195	2.005	33,067
BOMBARDIER Family		
Q100	706	93,909
Q200	663	100,000
Q300	989	67,037
Q400	1.338	49,552

CRJ-100	1.230	53,902
CRJ-200	1.230	53,902
CRJ-700	1.287	51,515
CRJ-705	1.304	50,844
CRJ-900	1.278	51,878
CRJ-1000	1.290	51,395

Table 80. Rate of the airplanes according to their fuel cost

Maintenance costs

Similar to the two previous sections and taking into account the table from the section *Maintenance costs*:

Airplane model	Maintenance Cost (€)	Rate (P_i)
Airbus A318	451	100

Table 81. Best model of airplane according to maintenance costs

As a lower maintenance cost, the highest the rate of the airplane, it will be carried out an inverse rule of three to obtain the ratings of the other airplanes:

Airplane model	Maintenance Cost (€)	Rate (P_i)
AIRBUS Family		
Airbus A318	451	100,000
Airbus A319	1.093	41,263
Airbus A320	1.174	38,416
Airbus A321	1.176	38,350
BOEING Family		
Boeing 717	1.202	37,521

Boeing 737-300	1.178	38,285
Boeing 737-400	1.384	32,587
Boeing 737-500	1.062	42,467
Boeing 737-600	1.051	42,912
Boeing 737-700	1.051	42,912
Boeing 737-800	1.051	42,912
ATR Family		
ATR 72-200	1.155	39,048
ATR 72-210	1.152	39,149
ATR 42-500	928	48,599
ATR 72-500	1165	38,712
ATR 42-600	928	48,599
ATR 72-600	1.165	38,712
EMBRAER Family		
ERJ 135	666	67,718
ERJ 140	715	63,077
ERJ 145	669	67,414
E 170	600	75,167
E 175	599	75,292
E 190	832	54,207
E 195	786	57,379
BOMBARDIER Family		
Q100	1.020	44,216
Q200	958	47,077
Q300	1.289	34,988
Q400	1.103	40,888
CRJ-100	716	62,989
CRJ-200	716	62,989
CRJ-700	592	76,182
CRJ-705	582	77,491
CRJ-900	536	84,142
CRJ-1000	549	82,149

Table 82. Rate of the airplanes according to their maintenance costs

Crew costs

Equal to the previous sections and taking into account the crew costs obtained in the section *Aircrew costs*:

Airplane model	Crew Cost (€)	Rate (P_i)
ERJ 135	279	100

Table 83. Best model of airplane according to crew costs costs

Another time, the rule of three has to be an inverse one, for the same reason as in all the costs. In this way, the rating of each airplane will be the following:

Airplane model	Crew Cost (€)	Rate (P_i)
AIRBUS Family		
Airbus A318	436	63,991
Airbus A319	485	57,526
Airbus A320	485	57,526
Airbus A321	535	52,150
BOEING Family		
Boeing 717	456	61,184
Boeing 737-300	517	53,965
Boeing 737-400	569	49,033
Boeing 737-500	517	53,965
Boeing 737-600	514	54,280
Boeing 737-700	514	54,280
Boeing 737-800	564	49,468
ATR Family		
ATR 72-200	485	57,526
ATR 72-210	483	57,764

ATR 42-500	372	75,000
ATR 72-500	489	57,055
ATR 42-600	372	75,000
ATR 72-600	489	57,055
EMBRAER Family		
ERJ 135	279	100,000
ERJ 140	291	95,876
ERJ 145	291	95,876
E 170	363	76,860
E 175	363	76,860
E 190	423	65,957
E 195	408	68,382
BOMBARDIER Family		
Q100	397	70,277
Q200	373	74,799
Q300	451	61,863
Q400	409	68,215
CRJ-100	295	94,576
CRJ-200	295	94,576
CRJ-700	372	75,000
CRJ-705	372	75,000
CRJ-900	377	74,005
CRJ-1000	433	64,434

Table 84. Rate of the airplanes according to their crew costs

Airport and on-route charges

Similar to the previous sections and having a look to the table from section *Airport and on-route fees,* where different MTOW are given:

Airplane model	MTOW (kg)	Rate (P_i)
Q100	16.470	100
Q200	16.470	100

Table 85. Best airplanes according to their MTOW

Remember that in this case costs are not yet given due to it is an initial study and it will only be necessary having knowledge of each airplane's MTOW, as airport taxes and on route fees vary in a proportional way with the MTOW (see annexes *14* and *15*).

As a higher MTOW the aircraft has, the higher airport and on-route fees, and so the lower rating, the carried out rule of three will have to be an inverse one.

In this way:

Airplane model	MTOW (kg)	Rate (P_i)
AIRBUS Family		
Airbus A318	68.000	24,221
Airbus A319	75.500	21,815
Airbus A320	78.000	21,115
Airbus A321	93.500	17,615
BOEING Family		
Boeing 717	49.845	33,042
Boeing 737-300	61.235	26,896

Boeing 737-400	68.039	24,207
Boeing 737-500	60.555	27,198
Boeing 737-600	66.000	24,955
Boeing 737-700	70.080	23,502
Boeing 737-800	79.010	20,845
ATR Family		
ATR 72-200	21.500	76,605
ATR 72-210	21.500	76,605
ATR 42-500	18.600	88,548
ATR 72-500	22.800	72,237
ATR 42-600	18.600	88,548
ATR 72-600	23.000	71,609
EMBRAER Family		
ERJ 135	19.000	86,684
ERJ 140	21.000	78,429
ERJ 145	22.000	74,864
E 170	36.000	45,750
E 175	37.500	43,920
E 190	47.790	34,463
E 195	48.790	33,757
BOMBARDIER Family		
Q100	16.470	100,000
Q200	16.470	100,000
Q300	19.500	84,462
Q400	29.260	56,288
CRJ-100	24.041	68,508
CRJ-200	23.133	71,197
CRJ-700	33.000	49,909
CRJ-705	36.505	45,117
CRJ-900	36.505	45,117
CRJ-1000	40.084	41,089

Table 86. Rate of the airplanes according to their MTOW

Available cargo destined to invoicing

Having a look to the section *Passengers facilities and invoicing* and carrying out the same procedure as the previous sections, but analysing now the available cargo destined to invoicing:

Airplane model	Available cargo for invoicing (kg)	Rate (P_i)
Boeing 737-800	4.876	100

Table 87. Best airplane according to its available cargo destined to invoicing

Opposite to all the previous sections, now as higher the weight destined to invoicing is, the higher the rate of the airplane. In this sense, the rule of three that will be used to find the rest of ratings will be a direct one:

Airplane model	Invoicing weight (kg)	Rate (P_i)
AIRBUS Family		
Airbus A318	3.516	72,108
Airbus A319	4.128	84,660
Airbus A320	4.240	86,957
Airbus A321	4.768	97,785
BOEING Family		
Boeing 717	2.798	57,383
Boeing 737-300	2.441	50,062
Boeing 737-400	3.438	70,509
Boeing 737-500	2.219	45,509
Boeing 737-600	4.074	83,552
Boeing 737-700	4.591	94,155
Boeing 737-800	4.876	100,000

ATR Family		
ATR 72-200	562	11,526
ATR 72-210	562	11,526
ATR 42-500	950	19,483
ATR 72-500	762	15,628
ATR 42-600	950	19,483
ATR 72-600	1.062	21,780
EMBRAER Family		
ERJ 135	979	20,078
ERJ 140	1.456	29,861
ERJ 145	1.436	29,450
E 170	2.314	47,457
E 175	2.424	49,713
E 190	3.162	64,848
E 195	2.862	58,696
BOMBARDIER Family		
Q100	822	16,858
Q200	1.254	25,718
Q300	1.252	25,677
Q400	1.188	24,364
CRJ-100	1.774	36,382
CRJ-200	1.592	32,650
CRJ-700	1.741	35,705
CRJ-705	2.837	58,183
CRJ-900	2.489	51,046
CRJ-1000	2.927	60,029

Table 88. Rate of the airplanes according to their available weight for invoicing

Flight duration

By having a look to the different cruise speeds of the different airplanes from the section *Flight duration* and following the same procedure as in the previous sections, the highest cruise speed can be found:

Airplane model	Cruise speed (km/h)	Rate (P_i)
E 195	890	100

Table 89. Best model of airplane according to the cruise speed

At a higher cruise speed, the less flight time required, and so the higher rate. The rule of three which will be used is then, a direct one.

Airplane model	Cruise speed (km/h)	Rate (P_i)
AIRBUS Family		
Airbus A318	828	93,034
Airbus A319	828	93,034
Airbus A320	828	93,034
Airbus A321	828	93,034
BOEING Family		
Boeing 717	811	91,124
Boeing 737-300	780	89,213
Boeing 737-400	780	91,348
Boeing 737-500	780	89,326
Boeing 737-600	823	95,730
Boeing 737-700	823	95,730
Boeing 737-800	823	95,730

ATR Family		
ATR 72-200	515	57,865
ATR 72-210	517	58,090
ATR 42-500	556	62,472
ATR 72-500	510	57,303
ATR 42-600	556	62,472
ATR 72-600	510	57,303
EMBRAER Family		
ERJ 135	828	93,034
ERJ 140	828	93,034
ERJ 145	828	93,034
E 170	850	95,506
E 175	850	95,506
E 190	850	95,506
E 195	890	100,000
BOMBARDIER Family		
Q100	500	56,180
Q200	537	60,337
Q300	528	59,326
Q400	667	74,944
CRJ-100	785	88,202
CRJ-200	785	88,202
CRJ-700	829	93,146
CRJ-705	829	93,146
CRJ-900	850	95,506
CRJ-1000	827	92,921

Table 90. Rate of the airplanes according to their cruise speed

Number of existences in the operating geographical area

Equal to the previous sections and having a look to the table from section *Number of airplane existences on the selected area*:

Airplane model	Number of existences in Europe	Rate (P_i)
Airbus A320	822	100

Table 91. Best airplane model according to the existences

As a higher number of existences, a higher rate, it will be carried out a direct rule of three. In this way:

Airplane model	Number of existences in Europe	Rate (P_i)
AIRBUS Family		
Airbus A318	24	2,920
Airbus A319	450	54,745
Airbus A320	822	100,000
Airbus A321	214	26,034
BOEING Family		
Boeing 717	0	0,000
Boeing 737-300	117	14,234
Boeing 737-400	50	6,083
Boeing 737-500	63	7,664
Boeing 737-600	2	0,243
Boeing 737-700	33	4,015
Boeing 737-800	602	73,236
ATR Family		

ATR 72-200	0	0,000
ATR 72-210	2	0,243
ATR 42-500	7	0,852
ATR 72-500	9	1,095
ATR 42-600	11	0,000
ATR 72-600	5	0,608
EMBRAER Family		
ERJ 135	0	0,000
ERJ 140	0	0,000
ERJ 145	10	1,217
E 170	12	1,460
E 175	16	1,946
E 190	36	4,380
E 195	28	3,406
BOMBARDIER Family		
Q100	0	0,000
Q200	0	0,000
Q300	0	0,000
Q400	91	11,071
CRJ-100	15	1,825
CRJ-200	25	3,041
CRJ-700	0	0,000
CRJ-705	0	0,000
CRJ-900	18	2,190
CRJ-1000	10	1,217

Table 92. Rate of the airplanes according to their existences

A8.4 Relative weights obtaining

Airbus family

A318

Aspect taken into account	Weight (W_i)	Rate (P_i)	Relative weight ($P_i \cdot W_i$)
Aircraft leasing cost	43	46,667	2.006,667
Fuel costs	75	33,913	2.543,478
Crew costs	37	63,991	2.367,661
Maintenance costs	45	100,000	4.500,000
Airport charges	20	24,221	484,412
On-route fees	20	24,221	484,412
Invoicing	8	20,749	165,993
Flight duration	3	93,034	279,101
Number of existences	6	2,920	14,599
Relative weight ($\sum_{i=1}^{n} P_i \cdot W_i$)			**12.849,241**

Table 93. Relative weight of A318

A319

Aspect taken into account	Weight (W_i)	Rate (P_i)	Relative weight ($P_i \cdot W_i$)
Aircraft leasing cost	43	19,774	850,282
Fuel costs	75	31,617	2.371,245
Crew costs	37	57,526	2.128,454
Maintenance costs	45	41,263	1.856,816
Airport charges	20	21,815	436,291

On-route fees	20	21,815	436,291
Invoicing	8	20,645	165,161
Flight duration	3	93,034	279,101
Number of existences	6	54,745	273,723
Relative weight $(\sum_{i=1}^{n} P_i \cdot W_i)$			**8.852,109**

Table 94. Relative weight of A319

A320

Aspect taken into account	Weight (W_i)	Rate (P_i)	Relative weight $(P_i \cdot W_i)$
Aircraft leasing cost	43	18,817	809,140
Fuel costs	75	27,239	2.042,933
Crew costs	37	57,526	2.128,454
Maintenance costs	45	38,416	1.728,705
Airport charges	20	21,115	422,308
On-route fees	20	21,115	422,308
Invoicing	8	17,631	141,047
Flight duration	3	93,034	279,101
Number of existences	6	100,000	500,000
Relative weight $(\sum_{i=1}^{n} P_i \cdot W_i)$			**8.573,995**

Table 95. Relative weight of A320

A321

Aspect taken into account	Weight (W_i)	Rate (P_i)	Relative weight $(P_i \cdot W_i)$
Aircraft leasing cost	43	12,456	535,587
Fuel costs	75	27,476	2.060,713
Crew costs	37	52,150	1.929,533
Maintenance costs	45	38,350	1.725,765

Airport charges	20	17,615	352,299
On-route fees	20	17,615	352,299
Invoicing	8	14,097	112,774
Flight duration	3	93,034	279,101
Number of existences	6	26,034	130,170
Relative weight $(\sum_{i=1}^{n} P_i \cdot W_i)$			**7.504,277**

Table 96. Relative weight of A321

Boeing family

Boeing 717

Aspect taken into account	Weight (W_i)	Rate (P_i)	Relative weight $(P_i \cdot W_i)$
Aircraft leasing cost	43	31,532	1.355,856
Fuel costs	75	31,936	2.395,231
Crew costs	37	61,184	2.263,816
Maintenance costs	45	37,521	1.688,436
Airport charges	20	33,042	660,849
On-route fees	20	33,042	660,849
Invoicing	8	9,419	75,355
Flight duration	3	91,124	273,371
Number of existences	6	0,000	0,000
Relative weight $(\sum_{i=1}^{n} P_i \cdot W_i)$			**9.373,762**

Table 97. Relative weight of 717

Boeing 737-300

Aspect taken into account	Weight (W_i)	Rate (P_i)	Relative weight ($P_i \cdot W_i$)
Aircraft leasing cost	43	68,627	2.950,980
Fuel costs	75	22,973	1.722,973
Crew costs	37	53,965	1.996,712
Maintenance costs	45	38,285	1.722,835
Airport charges	20	26,896	537,928
On-route fees	20	26,896	537,928
Invoicing	8	10,147	81,176
Flight duration	3	89,213	267,640
Number of existences	6	14,234	71,168
Relative weight ($\sum_{i=1}^{n} P_i \cdot W_i$)			**9.903,573**

Table 98. Relative weight of 737-300

Boeing 737-400

Aspect taken into account	Weight (W_i)	Rate (P_i)	Relative weight ($P_i \cdot W_i$)
Aircraft leasing cost	43	53,846	2.315,385
Fuel costs	75	29,598	2.219,866
Crew costs	37	49,033	1.814,236
Maintenance costs	45	32,587	1.466,402
Airport charges	20	24,207	484,134
On-route fees	20	24,207	484,134
Invoicing	8	12,018	96,143
Flight duration	3	91,348	274,045
Number of existences	6	6,083	30,414
Relative weight ($\sum_{i=1}^{n} P_i \cdot W_i$)			**9.190,841**

Table 99. Relative weight of 737-400

Boeing 737-500

Aspect taken into account	Weight (W_i)	Rate (P_i)	Relative weight ($P_i \cdot W_i$)
Aircraft leasing cost	43	77,778	3.344,444
Fuel costs	75	23,687	1.776,527
Crew costs	37	53,965	1.996,712
Maintenance costs	45	42,467	1.911,017
Airport charges	20	27,198	543,968
On-route fees	20	27,198	543,968
Invoicing	8	8,692	69,534
Flight duration	3	89,326	267,978
Number of existences	6	7,664	38,321
Relative weight $(\sum_{i=1}^{n} P_i \cdot W_i)$			**10.500,134**

Table 100. Relative weight of 737-500

Boeing 737-600

Aspect taken into account	Weight (W_i)	Rate (P_i)	Relative weight ($P_i \cdot W_i$)
Aircraft leasing cost	43	31,532	1.355,856
Fuel costs	75	32,122	2.409,157
Crew costs	37	54,280	2.008,366
Maintenance costs	45	42,912	1.931,018
Airport charges	20	24,955	499,091
On-route fees	20	24,955	499,091
Invoicing	8	25,219	201,749
Flight duration	3	95,730	287,191
Number of existences	6	0,243	1,217
Relative weight $(\sum_{i=1}^{n} P_i \cdot W_i)$			**9.192,978**

Table 101. Relative weight of 737-600

Boeing 737-700

Aspect taken into account	Weight (W_i)	Rate (P_i)	Relative weight ($P_i \cdot W_i$)
Aircraft leasing cost	43	19,553	840,782
Fuel costs	75	30,723	2.304,217
Crew costs	37	54,280	2.008,366
Maintenance costs	45	42,912	1.931,018
Airport charges	20	23,502	470,034
On-route fees	20	23,502	470,034
Invoicing	8	25,115	200,918
Flight duration	3	95,730	287,191
Number of existences	6	4,015	20,073
Relative weight ($\sum_{i=1}^{n} P_i \cdot W_i$)			**8.536,647**

Table 102. Relative weight of 737-700

Boeing 737-800

Aspect taken into account	Weight (W_i)	Rate (P_i)	Relative weight ($P_i \cdot W_i$)
Aircraft leasing cost	43	12,500	537,500
Fuel costs	75	26,712	2.003,425
Crew costs	37	49,468	1.830,319
Maintenance costs	45	42,912	1.931,018
Airport charges	20	20,845	416,909
On-route fees	20	20,845	416,909
Invoicing	8	19,918	159,341
Flight duration	3	95,730	287,191
Number of existences	6	73,236	366,180
Relative weight ($\sum_{i=1}^{n} P_i \cdot W_i$)			**8.022,028**

Table 103. Relative weight of 737-800

ATR family

ATR 72-200

Aspect taken into account	Weight (W_i)	Rate (P_i)	Relative weight ($P_i \cdot W_i$)
Aircraft leasing cost	43	59,322	2.550,847
Fuel costs	75	75,599	56.69,897
Crew costs	37	57,526	2.128,454
Maintenance costs	45	39,048	1.757,143
Airport charges	20	76,605	1.532,093
On-route fees	20	76,605	1.532,093
Invoicing	8	1,000	8,000
Flight duration	3	57,865	173,596
Number of existences	6	0,000	0,000
Relative weight $(\sum_{i=1}^{n} P_i \cdot W_i)$			**15.352,123**

Table 104. Relative weight of ATR 72-200

ATR 72-210

Aspect taken into account	Weight (W_i)	Rate (P_i)	Relative weight ($P_i \cdot W_i$)
Aircraft leasing cost	43	59,322	2.550,847
Fuel costs	75	71,909	5.393,167
Crew costs	37	57,764	2.137,267
Maintenance costs	45	39,149	1.761,719
Airport charges	20	76,605	1.532,093
On-route fees	20	76,605	1.532,093
Invoicing	8	1,000	8,000
Flight duration	3	58,090	174,270

Number of existences	6	0,243	1,217
Relative weight $(\sum_{i=1}^{n} P_i \cdot W_i)$			**15.090,916**

Table 105. Relative weight of ATR 72-210

ATR 42-500

Aspect taken into account	Weight (W_i)	Rate (P_i)	Relative weight $(P_i \cdot W_i)$
Aircraft leasing cost	43	35,354	1.520,202
Fuel costs	75	71,753	5.381,494
Crew costs	37	75,000	2.775,000
Maintenance costs	45	48,599	2.186,961
Airport charges	20	88,548	1.770,968
On-route fees	20	88,548	1.770,968
Invoicing	8	12,849	102,796
Flight duration	3	62,472	187,416
Number of existences	6	0,852	4,258
Relative weight $(\sum_{i=1}^{n} P_i \cdot W_i)$			**15.700,913**

Table 106. Relative weight of ATR 42-500

ATR 72-500

Aspect taken into account	Weight (W_i)	Rate (P_i)	Relative weight $(P_i \cdot W_i)$
Aircraft leasing cost	43	31,532	1.355,856
Fuel costs	75	70,833	5.312,500
Crew costs	37	57,055	2.111,043
Maintenance costs	45	38,712	1.742,060
Airport charges	20	72,237	1.444,737
On-route fees	20	72,237	1.444,737
Invoicing	8	3,806	30,452

Flight duration	3	57,303	171,910
Number of existences	6	1,095	5,474
Relative weight $(\sum_{i=1}^{n} P_i \cdot W_i)$			**13.619,864**

Table 107. Relative weight of ATR 72-500

ATR 42-600

Aspect taken into account	Weight (W_i)	Rate (P_i)	Relative weight $(P_i \cdot W_i)$
Aircraft leasing cost	43	23,973	1.030,822
Fuel costs	75	71,909	5.393,167
Crew costs	37	75,000	2.775,000
Maintenance costs	45	48,599	2.186,961
Airport charges	20	88,548	1.770,968
On-route fees	20	88,548	1.770,968
Invoicing	8	12,849	102,796
Flight duration	3	62,472	187,416
Number of existences	6	1,338	8,029
Relative weight $(\sum_{i=1}^{n} P_i \cdot W_i)$			**15.226,126**

Table 108. Relative weight of ATR 42-600

ATR 72-600

Aspect taken into account	Weight (W_i)	Rate (P_i)	Relative weight $(P_i \cdot W_i)$
Aircraft leasing cost	43	20,958	901,198
Fuel costs	75	70,833	5.312,500
Crew costs	37	57,055	2.111,043
Maintenance costs	45	38,712	1.742,060
Airport charges	20	71,609	1.432,174
On-route fees	20	71,609	1.432,174

Invoicing	8	7,964	63,713
Flight duration	3	57,303	171,910
Number of existences	6	0,608	3,041
Relative weight $(\sum_{i=1}^{n} P_i \cdot W_i)$			**13.170,421**

Table 109. Relative weight of ATR 72-600

Embraer family

ERJ 135

Aspect taken into account	Weight (W_i)	Rate (P_i)	Relative weight $(P_i \cdot W_i)$
Aircraft leasing cost	43	67,308	2.894,231
Fuel costs	75	47,155	3.536,629
Crew costs	37	100,000	3.700,000
Maintenance costs	45	67,718	3.047,297
Airport charges	20	86,684	1.733,684
On-route fees	20	86,684	1.733,684
Invoicing	8	20,645	165,161
Flight duration	3	93,034	279,101
Number of existences	6	0,000	0,000
Relative weight $(\sum_{i=1}^{n} P_i \cdot W_i)$			**17.089,788**

Table 110. Relative weight of ERJ 135

ERJ 140

Aspect taken into account	Weight (W_i)	Rate (P_i)	Relative weight ($P_i \cdot W_i$)
Aircraft leasing cost	43	72,917	3.135,417
Fuel costs	75	49,075	3.680,607
Crew costs	37	95,876	3.547,423
Maintenance costs	45	63,077	2.838,462
Airport charges	20	78,429	1.568,571
On-route fees	20	78,429	1.568,571
Invoicing	8	27,505	220,043
Flight duration	3	93,034	279,101
Number of existences	6	0,000	0,000
Relative weight ($\sum_{i=1}^{n} P_i \cdot W_i$)			**16.838,195**

Table 111. Relative weight of ERJ 140

ERJ 145

Aspect taken into account	Weight (W_i)	Rate (P_i)	Relative weight ($P_i \cdot W_i$)
Aircraft leasing cost	43	64,815	2.787,037
Fuel costs	75	57,904	4.342,795
Crew costs	37	95,876	3.547,423
Maintenance costs	45	67,414	3.033,632
Airport charges	20	74,864	1.497,273
On-route fees	20	74,864	1.497,273
Invoicing	8	22,953	183,622
Flight duration	3	93,034	279,101
Number of existences	6	1,217	6,083
Relative weight ($\sum_{i=1}^{n} P_i \cdot W_i$)			**17.175,454**

Table 112. Relative weight of ERJ 145

E 170

Aspect taken into account	Weight (W_i)	Rate (P_i)	Relative weight ($P_i \cdot W_i$)
Aircraft leasing cost	43	22,436	964,744
Fuel costs	75	47,595	3.569,634
Crew costs	37	76,860	2.843,802
Maintenance costs	45	75,167	3.382,500
Airport charges	20	45,750	915,000
On-route fees	20	45,750	915,000
Invoicing	8	23,971	191,771
Flight duration	3	95,506	286,517
Number of existences	6	1,460	7,299
Relative weight $(\sum_{i=1}^{n} P_i \cdot W_i)$			**13.077,726**

Table 113. Relative weight of E 170

E 175

Aspect taken into account	Weight (W_i)	Rate (P_i)	Relative weight ($P_i \cdot W_i$)
Aircraft leasing cost	43	20,000	860,000
Fuel costs	75	47,595	3.569,634
Crew costs	37	76,860	2.843,802
Maintenance costs	45	75,292	3.388,147
Airport charges	20	43,920	878,400
On-route fees	20	43,920	878,400
Invoicing	8	21,685	173,477
Flight duration	3	95,506	286,517
Number of existences	6	1,946	9,732
Relative weight $(\sum_{i=1}^{n} P_i \cdot W_i)$			**12.890,055**

Table 114. Relative weight of E 175

E 190

Aspect taken into account	Weight (W_i)	Rate (P_i)	Relative weight ($P_i \cdot W_i$)
Aircraft leasing cost	43	17,241	741,379
Fuel costs	75	31,860	2.389,476
Crew costs	37	65,957	2.440,426
Maintenance costs	45	54,207	2.439,303
Airport charges	20	34,463	689,266
On-route fees	20	34,463	689,266
Invoicing	8	21,892	175,140
Flight duration	3	95,506	286,517
Number of existences	6	4,380	21,898
Relative weight $(\sum_{i=1}^{n} P_i \cdot W_i)$			**9.877,049**

Table 115. Relative weight of E 190

E 195

Aspect taken into account	Weight (W_i)	Rate (P_i)	Relative weight ($P_i \cdot W_i$)
Aircraft leasing cost	43	36,458	1.567,708
Fuel costs	75	33,067	2.480,050
Crew costs	37	68,382	2.530,147
Maintenance costs	45	57,379	2.582,061
Airport charges	20	33,757	675,138
On-route fees	20	33,757	675,138
Invoicing	8	17,111	136,889
Flight duration	3	100,000	300,000
Number of existences	6	3,406	17,032
Relative weight $(\sum_{i=1}^{n} P_i \cdot W_i)$			**10.967,570**

Table 116. Relative weight of E 195

Bombardier family

Q100

Aspect taken into account	Weight (W_i)	Rate (P_i)	Relative weight ($P_i \cdot W_i$)
Aircraft leasing cost	43	58,333	2.508,333
Fuel costs	75	93,909	7.043,201
Crew costs	37	70,277	2.600,252
Maintenance costs	45	44,216	1.989,706
Airport charges	20	100,000	2.000,000
On-route fees	20	100,000	2.000,000
Invoicing	8	15,032	120,258
Flight duration	3	56,180	168,539
Number of existences	6	0,000	0,000
Relative weight $(\sum_{i=1}^{n} P_i \cdot W_i)$			**18.430,290**

Table 117. Relative weight of Q100

Q200

Aspect taken into account	Weight (W_i)	Rate (P_i)	Relative weight ($P_i \cdot W_i$)
Aircraft leasing cost	43	42,683	1.835,366
Fuel costs	75	100,000	7.500,000
Crew costs	37	74,799	2.767,560
Maintenance costs	45	47,077	2.118,476
Airport charges	20	100,000	2.000,000
On-route fees	20	100,000	2.000,000
Invoicing	8	26,570	212,559
Flight duration	3	60,337	181,011

Number of existences	6	0,000	0,000
Relative weight $(\sum_{i=1}^{n} P_i \cdot W_i)$			**18.614,973**

Table 118. Relative weight of Q200

Q300

Aspect taken into account	Weight (W_i)	Rate (P_i)	Relative weight $(P_i \cdot W_i)$
Aircraft leasing cost	43	41,667	1.791,667
Fuel costs	75	67,037	5027,806
Crew costs	37	61,863	2.288,914
Maintenance costs	45	34,988	1.574,476
Airport charges	20	84,462	1.689,231
On-route fees	20	84,462	1.689,231
Invoicing	8	16,280	130,237
Flight duration	3	59,326	177,978
Number of existences	6	0,000	0,000
Relative weight $(\sum_{i=1}^{n} P_i \cdot W_i)$			**14.369,538**

Table 119. Relative weight of Q300.

Q400

Aspect taken into account	Weight (W_i)	Rate (P_i)	Relative weight $(P_i \cdot W_i)$
Aircraft leasing cost	43	25,547	1.098,540
Fuel costs	75	49,552	3716,368
Crew costs	37	68,215	2.523,961
Maintenance costs	45	40,888	1.839,982
Airport charges	20	56,288	1.125,769
On-route fees	20	56,288	1.125,769

Invoicing	8	7,444	59,556
Flight duration	3	74,944	224,831
Number of existences	6	11,071	55,353
Relative weight $(\sum_{i=1}^{n} P_i \cdot W_i)$			**11.781,199**

Table 120. Relative weight of Q400

CRJ 100

Aspect taken into account	Weight (W_i)	Rate (P_i)	Relative weight $(P_i \cdot W_i)$
Aircraft leasing cost	43	100,000	4.300,000
Fuel costs	75	53,902	4042,683
Crew costs	37	94,576	3.499,322
Maintenance costs	45	62,989	2.834,497
Airport charges	20	68,508	1.370,159
On-route fees	20	68,508	1.370,159
Invoicing	8	30,000	240,000
Flight duration	3	88,202	264,607
Number of existences	6	1,825	9,124
Relative weight $(\sum_{i=1}^{n} P_i \cdot W_i)$			**17.932,376**

Table 121. Relative weight of CRJ 100

CRJ 200

Aspect taken into account	Weight (W_i)	Rate (P_i)	Relative weight $(P_i \cdot W_i)$
Aircraft leasing cost	43	62,500	2.687,500
Fuel costs	75	53,902	4042,683
Crew costs	37	94,576	3.499,322
Maintenance costs	45	62,989	2.834,497

Airport charges	20	71,197	1.423,940
On-route fees	20	71,197	1.423,940
Invoicing	8	26,258	210,065
Flight duration	3	88,202	264,607
Number of existences	6	3,041	15,207
Relative weight $(\sum_{i=1}^{n} P_i \cdot W_i)$			**16.404,801**

Table 122. Relative weight of CRJ 200

CRJ 700

Aspect taken into account	Weight (W_i)	Rate (P_i)	Relative weight $(P_i \cdot W_i)$
Aircraft leasing cost	43	25,547	1.098,540
Fuel costs	75	51,515	3863,636
Crew costs	37	75,000	2.775,000
Maintenance costs	45	76,182	3.428,209
Airport charges	20	49,909	998,182
On-route fees	20	49,909	998,182
Invoicing	8	15,240	121,921
Flight duration	3	93,146	279,438
Number of existences	6	0,000	0,000
Relative weight $(\sum_{i=1}^{n} P_i \cdot W_i)$			**13.563,109**

Table 123. Relative weight of CRJ 700

CRJ 705

Aspect taken into account	Weight (W_i)	Rate (P_i)	Relative weight ($P_i \cdot W_i$)
Aircraft leasing cost	43	20,958	901,198
Fuel costs	75	50,844	3813,267
Crew costs	37	75,000	2.775,000
Maintenance costs	45	77,491	3.487,113
Airport charges	20	45,117	902,342
On-route fees	20	45,117	902,342
Invoicing	8	27,401	219,211
Flight duration	3	93,146	279,438
Number of existences	6	0,000	0,000
Relative weight $(\sum_{i=1}^{n} P_i \cdot W_i)$			**13.279,912**

Table 124. Relative weight of CRJ 705

CRJ 900

Aspect taken into account	Weight (W_i)	Rate (P_i)	Relative weight ($P_i \cdot W_i$)
Aircraft leasing cost	43	20,468	880,117
Fuel costs	75	51,878	3890,845
Crew costs	37	74,005	2.738,196
Maintenance costs	45	84,142	3.786,381
Airport charges	20	45,117	902,342
On-route fees	20	45,117	902,342
Invoicing	8	21,892	175,140
Flight duration	3	95,506	286,517
Number of existences	6	2,190	10,949
Relative weight $(\sum_{i=1}^{n} P_i \cdot W_i)$			**13.575,019**

Table 125. Relative weight of CRJ 900

CRJ 1000

Aspect taken into account	Weight (W_i)	Rate (P_i)	Relative weight ($P_i \cdot W_i$)
Aircraft leasing cost	43	16,129	693,548
Fuel costs	75	51,395	3854,651
Crew costs	37	64,434	2.384,065
Maintenance costs	45	82,149	3.696,721
Airport charges	20	41,089	821,774
On-route fees	20	41,089	821,774
Invoicing	8	22,308	178,466
Flight duration	3	92,921	278,764
Number of existences	6	1,217	6,083
Relative weight $(\sum_{i=1}^{n} P_i \cdot W_i)$			**12.737,063**

Table 126. Relative weight of CRJ 1000

A8.5 OWA obtaining

As mentioned before, in order to obtain the OWA it will be necessary to carry out the following equation:

$$OWA = \frac{\sum_{i=1}^{n} P_i \cdot W_i}{P_{max} \cdot \sum_{i=1}^{n} W_i}$$

The only value that is still not known is P_{max}, which corresponds to the highest rate between all the treated aspects, in this case:

$$P_{max} = 100$$

Carrying out the equation of the OWA it is obtained the next table:

Airplane model	OWA
AIRBUS Family	
Airbus A318	0,5000
Airbus A319	0,3444
Airbus A320	0,3336
Airbus A321	0,2920
BOEING Family	
Boeing 717	0,3647
Boeing 737-300	0,3854
Boeing 737-400	0,3576
Boeing 737-500	0,4086
Boeing 737-600	0,3577
Boeing 737-700	0,3322
Boeing 737-800	0,3121
ATR Family	
ATR 72-200	0,5974
ATR 72-210	0,5872
ATR 42-500	0,6109
ATR 72-500	0,5300
ATR 42-600	0,5925
ATR 72-600	0,5125
EMBRAER Family	
ERJ 135	0,6650
ERJ 140	0,6551
ERJ 145	0,6683
E 170	0,5089
E 175	0,5016
E 190	0,3843
E 195	0,4268
BOMBARDIER Family	
Q100	0,7171

Q200	0,7243
Q300	0,5591
Q400	0,4584
CRJ-100	0,6978
CRJ-200	0,6383
CRJ-700	0,5277
CRJ-705	0,5167
CRJ-900	0,5282
CRJ-1000	0,4856

Table 127. OWA of the different analysed airplanes

Annex 9: Number of flights per day obtaining

A9.1 Current flight schedule on the different routes

First step in order to analyse the existent traffic between the selected cities, it will be searching the number of flights per day in each of the routes.

Route Barcelona-Madrid

Departure	Arrival	Flight	Timetable							Airport
6:50	8:10	Iberia 2739	-	Mo	Tu	We	Th	-	-	BCN-MAD
6:50	8:10	Iberia 651	-	Mo	Tu	We	Th	-	-	BCN-MAD
7:00	8:15	Vueling 1001	-	Mo	Tu	We	Th	-	-	BCN-MAD
7:25	8:45	Iberia 2703	-	Mo	Tu	We	Th	Fr	-	BCN-MAD
7:25	8:45	Iberia 725	-	Mo	Tu	We	Th	Fr	-	BCN-MAD
7:30	8:50	Vueling 1003	-	Mo	Tu	We	Th	Fr	-	BCN-MAD
8:00	9:20	Vueling 1005	-	Mo	Tu	We	-	-	Sa	BCN-MAD
8:05	9:25	Iberia 805	-	Mo	Tu	We	Th	-	-	BCN-MAD
8:05	9:25	Iberia 2741	-	Mo	Tu	We	Th	-	-	BCN-MAD
8:30	9:50	Vueling 1007	-	Mo	Tu	-	-	-	-	BCN-MAD
8:45	10:05	Iberia 2723	Su	Mo	Tu	We	Th	Fr	Sa	BCN-MAD
8:45	10:05	Iberia 845	Su	Mo	Tu	We	Th	Fr	Sa	BCN-MAD
8:50	10:10	Vueling 1007	-	-	-	-	Th	-	-	BCN-MAD
9:15	10:40	Iberia 2725	-	-	Tu	We	Th	Fr	-	BCN-MAD
9:15	10:40	Iberia 915	-	-	-	We	Th	Fr	-	BCN-MAD
9:30	10:50	Vueling 1009	-	Mo	-	We	-	Fr	-	BCN-MAD
9:45	11:05	Iberia 2727	Su	Mo	Tu	We	Th	Fr	Sa	BCN-MAD

9:45	11:05	Iberia 945	Su	Mo	Tu	-	Th	-	Sa	BCN-MAD
10:10	11:35	Iberia 1011	-	Mo	Tu	We	-	Fr	-	BCN-MAD
10:10	11:35	Iberia 2729	-	Mo	Tu	We	Th	Fr	-	BCN-MAD
11:30	12:55	Iberia 2737	Su	Mo	Tu	We	Th	Fr	Sa	BCN-MAD
11:30	12:55	Iberia 1131	Su	Mo	Tu	We	Th	Fr	Sa	BCN-MAD
12:00	13:20	Vueling 1007	-	-	-	-	-	-	Sa	BCN-MAD
12:15	13:35	Air Europa 2057	Su	Mo	Tu	We	Th	Fr	Sa	BCN-MAD
12:30	13:50	Vueling 1007	-	-	-	We	-	-	-	BCN-MAD
12:30	13:50	Vueling 1009	-	-	-	-	Th	-	-	BCN-MAD
13:15	14:40	Iberia 2731	Su	Mo	Tu	We	Th	Fr	Sa	BCN-MAD
13:15	14:40	Iberia 1315	Su	Mo	Tu	We	Th	Fr	Sa	BCN-MAD
14:00	15:20	Vueling 1011	Su	Mo	-	-	-	Fr	-	BCN-MAD
14:45	16:05	Iberia 2709	-	Mo	Tu	We	Th	-	-	BCN-MAD
14:45	16:05	Iberia 1445	-	Mo	Tu	We	Th	-	-	BCN-MAD
15:30	16:50	Vueling 1013	-	-	-	-	Th	-	-	BCN-MAD
15:35	16:55	Vueling 1025	Su	-	-	-	-	-	-	BCN-MAD
16:00	17:20	Vueling 1013	Su	Mo	Tu	We	-	Fr	-	BCN-MAD
16:10	17:35	Iberia 1611	Su	Mo	Tu	We	Th	Fr	-	BCN-MAD
16:10	17:35	Iberia 2705	Su	Mo	Tu	We	Th	Fr	-	BCN-MAD
17:00	18:20	Vueling 1025	-	-	Tu	We	-	-	-	BCN-MAD
17:10	18:35	Iberia 1711	-	-	-	We	Th	-	-	BCN-MAD
17:10	18:35	Iberia 2711	-	-	-	We	Th	-	-	BCN-MAD
17:30	18:50	Vueling 1025	-	Mo	-	-	Th	-	-	BCN-MAD
17:30	18:50	Vueling 1081	-	-	-	-	-	-	Sa	BCN-MAD
17:45	19:05	Vueling 1031	Su	-	-	-	-	-	-	BCN-MAD
17:45	19:10	Iberia 2735	-	Mo	Tu	We	Th	Fr	Sa	BCN-MAD
17:45	19:10	Iberia 1745	-	Mo	Tu	We	Th	Fr	Sa	BCN-MAD
18:10	19:30	Vueling 1081	Su	-	Tu	-	-	-	-	BCN-MAD
18:10	19:35	Iberia 2713	Su	-	Tu	We	Th	-	-	BCN-MAD
18:10	19:35	Iberia 1811	Su	-	Tu	We	Th	-	-	BCN-MAD
18:50	20:10	Vueling 1017	Su	Mo	-	-	Th	-	-	BCN-MAD
19:00	20:20	Vueling 1023	-	-	-	-	-	Fr	-	BCN-MAD
19:10	20:35	Iberia 1911	-	Mo	Tu	We	-	Fr	-	BCN-MAD
19:10	20:35	Iberia 2717	-	Mo	Tu	We	-	Fr	-	BCN-MAD
19:25	20:45	Vueling 1029	-	-	-	-	Th	-	-	BCN-MAD
19:30	20:50	Vueling 1031	-	-	-	We	-	-	-	BCN-MAD

19:45	21:05	Vueling 1019	Su	-	-	-	Th	-	-	BCN-MAD
20:10	21:35	Iberia 2011	Su	-	Tu	We	-	-	-	BCN-MAD
20:10	21:35	Iberia 2719	Su	-	Tu	We	Th	-	-	BCN-MAD
20:35	21:55	Air Europa 2159	Su	Mo	Tu	We	Th	Fr	Sa	BCN-MAD
20:35	21:55	Vueling 1015	Su	-	Tu	We	-	-	-	BCN-MAD
20:50	22:10	Vueling 1023	-	Mo	-	-	-	-	-	BCN-MAD
20:50	22:10	Vueling 1021	-	-	-	-	Th	-	-	BCN-MAD
21:15	22:35	Vueling 1023	-	-	-	-	Th	-	-	BCN-MAD
21:30	22:55	Iberia 2131	-	Mo	Tu	We	Th	-	Sa	BCN-MAD
21:30	22:55	Iberia 2733	-	Mo	Tu	We	Th	-	Sa	BCN-MAD
22:30	23:50	Vueling 1023	-	-	Tu	We	-	-	-	BCN-MAD
23:35	0:55+1	Vueling 1021	Su	-	-	-	-	-	-	BCN-MAD

* Data of the timetable on the route Barcelona-Madrid consulted from [83].

Table 128. Timetable of the flights on the route Barcelona-Madrid

Route Madrid-Barcelona

Departure	Arrival	Flight	Timetable							Airport
6:50	8:00	Iberia 2712	-	Mo	Tu	We	Th	-	-	MAD-BCN
6:50	8:00	Iberia 650	-	Mo	Tu	We	Th	-	-	MAD-BCN
7:00	8:15	Vueling 1020	-	-	-	-	Th	-	-	MAD-BCN
7:15	8:30	Iberia 2748	-	-	Tu	We	Th	-	-	MAD-BCN
7:15	8:30	Iberia 716	-	-	-	We	Th	-	-	MAD-BCN
7:30	8:45	Vueling 1008	-	Mo	-	We	Th	Fr	-	MAD-BCN
7:30	8:55	Air Europa 2001	Su	Mo	Tu	We	Th	Fr	Sa	MAD-BCN
7:45	9:00	Iberia 746	Su	Mo	Tu	-	Th	-	Sa	MAD-BCN
7:45	9:00	Iberia 2730	Su	Mo	Tu	We	Th	-	Sa	MAD-BCN
8:00	9:15	Vueling 1022	-	Mo	Tu	We	-	-	-	MAD-BCN
8:10	9:25	Iberia 810	-	Mo	Tu	We	-	Fr	-	MAD-BCN
8:10	9:25	Iberia 2702	-	Mo	Tu	We	Th	Fr	-	MAD-BCN
8:55	10:10	Vueling 1002	-	Mo	Tu	We	Th	-	-	MAD-BCN
9:30	10:45	Iberia 930	Su	Mo	Tu	We	Th	-	Sa	MAD-BCN
9:30	10:45	Iberia 2704	Su	Mo	Tu	We	Th	Fr	Sa	MAD-BCN
9:30	10:45	Vueling 1004	-	-	Tu	We	Th	Fr	-	MAD-BCN

10:00	11:15	Vueling 1024	-	Mo	Tu	We	-	-	Sa	MAD-BCN
10:30	11:45	Vueling 1006	Su	-	-	-	-	-	-	MAD-BCN
11:00	12:15	Vueling 1006	-	Mo	-	-	Th	Fr	-	MAD-BCN
11:15	12:30	Iberia 1116	Su	Mo	Tu	We	Th	Fr	Sa	MAD-BCN
11:15	12:30	Iberia 2708	Su	Mo	Tu	We	Th	Fr	Sa	MAD-BCN
11:30	12:45	Vueling 1010	Su	-	-	-	-	-	-	MAD-BCN
12:00	13:15	Vueling 1020	-	Mo	-	-	-	-	-	MAD-BCN
12:10	13:25	Vueling 1010	-	-	Tu	-	-	Fr	-	MAD-BCN
12:45	14:00	Iberia 1246	Su	Mo	Tu	We	Th	-	-	MAD-BCN
12:45	14:00	Iberia 2714	Su	Mo	Tu	We	Th	-	-	MAD-BCN
14:10	15:25	Vueling 1010	-	Mo	-	-	-	-	Sa	MAD-BCN
14:15	15:25	Iberia 1416	-	Mo	Tu	We	Th	Fr	-	MAD-BCN
14:30	15:45	Vueling 1012	-	-	-	We	Th	-	-	MAD-BCN
14:45	16:05	Iberia 2718	Su	Mo	Tu	We	Th	Fr	-	MAD-BCN
15:10	16:25	Air Europa 2006	Su	Mo	Tu	We	Th	Fr	Sa	MAD-BCN
15:10	16:25	Iberia 2722	-	-	-	We	Th	-	-	MAD-BCN
15:10	16:25	Iberia 1510	-	-	-	We	Th	-	-	MAD-BCN
15:25	16:40	Vueling 1020	-	-	-	We	-	-	-	MAD-BCN
15:45	17:00	Iberia 1546	Su	Mo	Tu	We	Th	Fr	Sa	MAD-BCN
15:45	17:00	Iberia 2720	Su	Mo	Tu	We	Th	Fr	Sa	MAD-BCN
16:00	17:15	Vueling 1012	Su	Mo	Tu	-	-	Fr	-	MAD-BCN
16:10	17:25	Iberia 2734	-	-	Tu	We	Th	-	-	MAD-BCN
16:10	17:25	Iberia 1610	-	-	Tu	We	Th	-	-	MAD-BCN
17:10	18:25	Iberia 2732	Su	Mo	Tu	We	-	Fr	Sa	MAD-BCN
17:10	18:25	Iberia 1710	Su	Mo	Tu	We	-	Fr	Sa	MAD-BCN
17:30	18:40	Vueling 1024	Su	-	-	-	-	-	-	MAD-BCN
17:30	18:45	Vueling 1014	-	-	-	-	Th	-	-	MAD-BCN
17:35	18:50	Iberia 1736	-	-	-	-	Th	-	-	MAD-BCN
17:35	18:50	Iberia 2732	-	-	-	-	Th	-	-	MAD-BCN
18:00	19:15	Vueling 1014	Su	-	Tu	We	-	-	-	MAD-BCN
18:10	19:25	Iberia 1810	-	-	Tu	We	-	-	-	MAD-BCN
18:10	19:25	Iberia 2750	-	-	Tu	We	-	-	-	MAD-BCN
18:45	20:00	Iberia 2736	Su	Mo	Tu	We	Th	Fr	-	MAD-BCN
18:45	20:00	Iberia 1846	Su	Mo	Tu	We	Th	Fr	-	MAD-BCN
18:55	20:10	Vueling 1026	-	-	Tu	-	-	-	-	MAD-BCN
19:10	20:25	Iberia 2744	-	-	Tu	We	Th	-	-	MAD-BCN

19:10	20:25	Iberia 1910	-	-	Tu	We	Th	-	-	MAD-BCN
19:25	20:40	Vueling 1026	-	Mo	-	-	Th	-	-	MAD-BCN
19:40	20:55	Vueling 1022	Su	-	-	-	-	-	Sa	MAD-BCN
19:55	21:10	Iberia 1956	-	Mo	-	-	-	-	Sa	MAD-BCN
19:55	21:10	Iberia 2738	-	Mo	-	-	-	-	Sa	MAD-BCN
20:00	21:15	Vueling 1082	-	-	Tu	We	-	-	-	MAD-BCN
20:20	21:35	Iberia 2020	Su	-	Tu	We	Th	-	-	MAD-BCN
20:20	21:35	Vueling 1082	Su	-	-	-	-	-	-	MAD-BCN
20:20	21:35	Iberia 2738	Su	-	Tu	We	Th	-	-	MAD-BCN
20:45	22:00	Vueling 1016	Su	-	-	-	Th	-	-	MAD-BCN
20:45	22:00	Iberia 2046	-	Mo	-	-	-	-	-	MAD-BCN
20:45	22:00	Iberia 2742	-	Mo	-	-	-	-	-	MAD-BCN
21:00	22:15	Vueling 1082	-	Mo	-	-	-	-	-	MAD-BCN
21:20	22:35	Iberia 2740	-	-	Tu	-	-	-	-	MAD-BCN
21:25	22:40	Vueling 1030	-	-	-	We	-	-	-	MAD-BCN
21:30	22:45	Iberia 2130	-	-	-	We	Th	-	-	MAD-BCN
21:40	22:55	Iberia 2742	-	-	-	-	Th	-	-	MAD-BCN
21:45	23:00	Iberia 2146	Su	Mo	-	-	-	-	-	MAD-BCN
21:45	23:00	Iberia 2740	Su	Mo	-	We	Th	-	-	MAD-BCN
21:50	23:05	Vueling 1018	-	-	-	-	Th	-	-	MAD-BCN
22:35	23:45	Vueling 1018	Su	-	-	-	-	-	-	MAD-BCN
22:45	23:59	Vueling 1022	-	-	-	-	Th	-	-	MAD-BCN

* Data of the timetable on the route Madrid-Barcelona consulted from [84].

Table 129. Timetable of the flights on the route Madrid-Barcelona

Route Barcelona-London

Departure	Arrival	Flight	Timetable							Airport
6:20	7:50	Ryanair 9811	Su	Mo	Tu	We	Th	Fr	Sa	BCN-STN
6:45	8:00	Vueling 7822	Su	Mo	Tu	We	Th	Fr	Sa	BCN-LGW
7:10	8:35	British Airways 477	Su	Mo	Tu	We	Th	Fr	Sa	BCN-LHR
7:20	8:35	easyJet 8570	Su	Mo	Tu	We	Th	Fr	Sa	BCN-LGW
9:55	11:05	Norwegian 5162	Su	-	-	-	-	-	-	BCN-LGW
10:15	11:35	British Airways 473	Su	Mo	Tu	We	Th	Fr	Sa	BCN-LHR
10:20	11:35	Vueling 7820	-	-	-	-	-	-	Sa	BCN-LGW

10:30	11:50	British Airways 2707	Su	-	-	We	Th	-	-	BCN-LGW
10:40	11:55	easyJet 8572	-	-	-	-	-	-	Sa	BCN-LGW
10:45	12:15	Ryanair 9045	Su	Mo	Tu	We	Th	Fr	Sa	BCN-STN
10:50	12:25	Monarch 279	-	Mo	Tu	We	Th	Fr	Sa	BCN-LGW
11:10	12:20	British Airways 2707	-	-	-	-	-	-	Sa	BCN-LGW
11:10	12:25	easyJet 8572	Su	Mo	Tu	We	Th	Fr	-	BCN-LGW
11:30	12:50	British Airways 2707	-	-	-	-	-	Fr	-	BCN-LGW
11:40	13:00	British Airways 479	Su	Mo	Tu	We	Th	Fr	Sa	BCN-LHR
12:25	13:40	Vueling 7826	Su	-	-	-	-	-	-	BCN-LGW
12:50	14:05	Vueling 7826	-	Mo	Tu	We	Th	Fr	-	BCN-LGW
13:15	14:40	British Airways 485	Su	Mo	Tu	We	Th	Fr	Sa	BCN-LHR
14:00	15:30	Ryanair 9015	Su	Mo	Tu	We	Th	Fr	Sa	BCN-STN
14:05	15:20	easyJet 2264	Su	-	-	-	-	-	-	BCN-LTN
14:25	15:40	easyJet 2264	-	Mo	Tu	We	Th	Fr	Sa	BCN-LTN
14:45	16:00	easyJet 8574	-	-	-	-	-	-	ds	BCN-LGW
14:50	16:10	British Airways 2709	Su	-	-	-	-	-	ds	BCN-LGW
15:10	16:25	easyJet 8574	-	Mo	Tu	We	Th	Fr	-	BCN-LGW
15:15	16:35	British Airways 2709	-	Mo	Tu	-	-	-	-	BCN-LGW
15:40	17:00	easyJet 8574	Su	-	-	-	-	-	-	BCN-LGW
16:00	17:20	British Airways 475	Su	Mo	Tu	We	Th	Fr	Sa	BCN-LHR
16:45	18:00	easyJet 8576	-	Mo	Tu	We	Th	Fr	Sa	BCN-LGW
17:10	18:25	easyJet 8576	Su	-	-	-	-	-	-	BCN-LGW
17:25	18:40	Norwegian 5164	-	Mo	Tu	We	Th	Fr	Sa	BCN-LGW
17:30	18:45	Vueling 7824	Su	Mo	Tu	We	Th	Fr	-	BCN-LGW
18:20	19:35	British Airways 481	Su	Mo	Tu	We	Th	Fr	Sa	BCN-LHR
18:40	20:10	Ryanair 9815	Su	Mo	Tu	We	Th	Fr	Sa	BCN-STN
18:45	20:10	easyJet 8578	Su	-	-	-	-	-	Sa	BCN-LGW
19:05	20:25	Vueling 7820	Su	Mo	Tu	We	Th	Fr	-	BCN-LGW
20:20	21:40	easyJet 8578	-	Mo	Tu	We	Th	Fr	-	BCN-LGW
20:35	21:45	British Airways 487	Su	Mo	Tu	We	Th	Fr	Sa	BCN-LHR
21:00	22:35	Monarch 275	Su	-	-	-	-	-	-	BCN-LGW
21:20	22:30	British Airways 471	-	Mo	Tu	We	Th	Fr	Sa	BCN-LHR
21:25	22:40	easyJet 2268	Su	Mo	Tu	We	Th	Fr	Sa	BCN-LTN
21:50	23:10	British Airways 2711	-	-	Tu	-	-	-	-	BCN-LGW
22:10	23:35	British Airways 2711	-	-	-	-	-	Fr	-	BCN-LGW
22:15	23:30	easyJet 8580	Su	Mo	Tu	We	Th	Fr	Sa	BCN-LGW

22:35	23:45	British Airways 2711	Su	Mo	-	-	Th	-	-	BCN-LGW
22:50	0:05+1	British Airways 2705	-	-	-	We	-	-	-	BCN-LGW

* Data of the timetable on the route Barcelona-London consulted from [85].

Table 130. Timetable of the flights on the route Barcelona-London

Route London-Barcelona

Departure	Arrival	Flight	Timetable							Airport
6:25	9:25	British Airways 472	Su	Mo	Tu	We	Th	Fr	Sa	LHR-BCN
6:40	9:45	British Airways 2706	Su	-	-	We	Th	-	-	LGW-BCN
6:40	9:50	Monarch 278	-	Mo	Tu	We	Th	Fr	Sa	LGW-BCN
7:00	10:05	easyJet 8571	-	-	-	-	-	-	Sa	LGW-BCN
7:25	10:25	British Airways 2706	-	-	-	-	-	-	Sa	LGW-BCN
7:25	10:30	easyJet 8571	Su	Mo	Tu	We	Th	Fr	-	LGW-BCN
7:35	10:45	British Airways 2706	-	-	-	-	-	Fr	-	LGW-BCN
7:50	10:55	British Airways 478	Su	Mo	Tu	We	Th	Fr	Sa	LHR-BCN
8:15	11:30	Ryanair 9810	Su	Mo	Tu	We	Th	Fr	Sa	STN-BCN
8:50	11:55	Vueling 7823	Su	Mo	Tu	We	Th	Fr	Sa	LGW-BCN
9:20	12:30	British Airways 484	Su	Mo	Tu	We	Th	Fr	Sa	LHR-BCN
10:20	13:30	easyJet 2263	Su	-	-	-	-	-	-	LTN-BCN
10:40	13:50	easyJet 2263	-	Mo	Tu	We	Th	Fr	Sa	LTN-BCN
11:05	14:05	British Airways 2708	Su	-	-	-	-	-	Sa	LGW-BCN
11:20	14:25	easyJet 8573	-	Mo	Tu	We	Th	Fr	Sa	LGW-BCN
11:20	14:25	British Airways 474	Su	Mo	Tu	We	Th	Fr	Sa	LHR-BCN
11:30	14:30	British Airways 2708	-	Mo	Tu	-	-	-	-	LGW-BCN
11:35	14:35	Norwegian 5163	Su	-	-	-	-	-	-	LGW-BCN
11:50	14:55	easyJet 8573	Su	-	-	-	-	-	-	LGW-BCN
12:25	15:25	Vueling 7821	-	-	-	-	-	-	Sa	LGW-BCN
12:45	16:00	Ryanair 9044	Su	Mo	Tu	We	Th	Fr	Sa	STN-BCN
13:05	16:10	easyJet 8575	-	Mo	Tu	We	Th	Fr	Sa	LGW-BCN
13:30	16:35	easyJet 8575	Su	-	-	-	-	-	-	LGW-BCN
14:20	17:20	Vueling 7827	Su	-	-	-	-	-	-	LGW-BCN
14:30	17:35	British Airways 480	Su	Mo	Tu	We	Th	Fr	Sa	LHR-BCN
14:45	17:45	Vueling 7827	-	Mo	Tu	We	Th	Fr	-	LGW-BCN
15:05	18:10	easyJet 8577	Su	-	-	-	-	-	Sa	LGW-BCN

16:10	19:25	Ryanair 9014	Su	Mo	Tu	We	Th	Fr	Sa	STN-BCN
16:35	19:45	British Airways 486	Su	Mo	Tu	We	Th	Fr	Sa	LHR-BCN
16:40	19:45	easyJet 8577	-	Mo	Tu	We	Th	Fr	-	LGW-BCN
17:00	20:10	Monarch 274	Su	-	-	-	-	-	-	LGW-BCN
17:20	20:25	British Airways 470	-	Mo	Tu	We	Th	Fr	Sa	LHR-BCN
17:45	20:50	easyJet 2267	Su	Mo	Tu	We	Th	Fr	Sa	LTN-BCN
18:00	21:05	British Airways 2710	-	-	Tu	-	-	-	-	LGW-BCN
18:20	21:25	British Airways 2710	-	-	-	-	-	Fr	-	LGW-BCN
18:35	21:40	easyJet 8579	Su	Mo	Tu	We	Th	Fr	Sa	LGW-BCN
18:40	21:50	British Airways 2710	Su	-	-	-	Th	-	-	LGW-BCN
19:00	22:05	British Airways 2710	-	Mo	-	We	-	-	-	LGW-BCN
19:05	22:10	British Airways 482	Su	Mo	Tu	We	Th	Fr	Sa	LHR-BCN
19:15	22:25	Norwegian 5165	-	Mo	Tu	We	Th	Fr	Sa	LGW-BCN
19:25	22:25	Vueling 7825	Su	Mo	Tu	We	Th	Fr	-	LGW-BCN
19:55	23:00	easyJet 8581	-	Mo	Tu	We	Th	Fr	Sa	LGW-BCN
20:35	23:50	Ryanair 9814	Su	Mo	Tu	We	Th	Fr	Sa	STN-BCN
20:40	23:45	easyJet 8581	Su	-	-	-	-	-	-	LGW-BCN
21:05	0:10+1	Vueling 7821	Su	Mo	Tu	We	Th	Fr	-	LGW-BCN

* Data of the timetable on the route London-Barcelona consulted from [86].

Table 131. Timetable of the flights on the route London-Barcelona

Route Barcelona-Paris

Departure	Arrival	Flight	Timetable							Airport
6:00	7:45	Vueling 8010	Su	Mo	-	We	Th	Fr	-	BCN-ORY
6:30	8:30	Ryanair 6374	Su	Mo	Tu	We	Th	Fr	Sa	BCN-BVA
6:45	8:40	Air France 1449	Su	Mo	Tu	We	Th	Fr	Sa	BCN-CDG
7:00	8:45	Vueling 8012	Su	Mo	Tu	We	Th	Fr	Sa	BCN-ORY
7:20	9:20	Vueling 8242	Su	Mo	Tu	We	Th	Fr	Sa	BCN-CDG
8:25	10:10	Vueling 8024	Su	Mo	Tu	We	Th	Fr	-	BCN-ORY
9:05	10:40	Transavia 3133	-	Mo	Tu	We	Th	Fr	-	BCN-ORY
9:10	10:55	Vueling 8008	Su	Mo	Tu	We	Th	Fr	Sa	BCN-ORY
9:20	11:25	easyJet 3916	-	-	-	-	-	-	Sa	BCN-CDG
9:45	11:50	easyJet 3916	Su	Mo	Tu	We	Th	Fr	-	BCN-CDG
10:15	12:10	Air France 1149	Su	Mo	Tu	We	Th	Fr	Sa	BCN-CDG

10:55	12:40	Vueling 8016	Su	Mo	Tu	We	Th	Fr	Sa	BCN-ORY
12:00	14:00	Vueling 8246	Su	Mo	Tu	We	Th	Fr	-	BCN-CDG
12:35	14:30	Air France 1349	Su	-	Tu	We	Th	Fr	Sa	BCN-CDG
13:00	14:45	Vueling 8014	Su	Mo	Tu	We	Th	Fr	-	BCN-ORY
14:20	15:55	Transavia 3135	-	Mo	Tu	We	Th	-	-	BCN-ORY
15:00	16:45	Vueling 8018	Su	Mo	Tu	We	Th	Fr	Sa	BCN-ORY
15:15	17:10	Air France 1649	Su	Mo	-	We	Th	Fr	Sa	BCN-CDG
16:50	18:50	easyJet 3920	Su	Mo	Tu	We	Th	Fr	Sa	BCN-CDG
16:55	18:55	Vueling 8244	Su	Mo	Tu	We	Th	Fr	Sa	BCN-CDG
17:35	19:20	Vueling 8020	Su	Mo	Tu	We	Th	Fr	Sa	BCN-ORY
18:00	19:55	Air France 1549	Su	Mo	Tu	We	Th	Fr	Sa	BCN-CDG
18:35	20:20	Vueling 8028	-	Mo	-	-	-	-	-	BCN-ORY
19:10	21:10	Ryanair 6355	Su	Mo	Tu	We	Th	Fr	Sa	BCN-BVA
19:25	21:10	Vueling 8022	Su	-	Tu	We	Th	Fr	Sa	BCN-ORY
19:25	21:20	Air France 1049	Su	Mo	Tu	We	Th	Fr	Sa	BCN-CDG
19:55	21:30	Transavia 3139	Su	Mo	Tu	We	Th	-	-	BCN-ORY
20:20	21:55	Transavia 3139	-	-	-	-	-	Fr	-	BCN-ORY
20:25	22:20	Air France 1249	Su	Mo	Tu	We	Th	Fr	-	BCN-CDG
20:40	22:25	Vueling 8028	Su	-	-	-	Th	Fr	-	BCN-ORY
20:50	22:50	easyJet 3922	Su	Mo	Tu	We	Th	Fr	Sa	BCN-CDG

* Data of the timetable on the route Barcelona-Paris consulted from [87].

Table 132. Timetable of the flights on the route Barcelona-Paris

Route Paris-Barcelona

Departure	Arrival	Flight	Timetable							Airport
6:45	8:20	Transavia 3132	-	Mo	Tu	We	Th	Fr	-	ORY-BCN
7:00	8:35	Vueling 8007	Su	Mo	Tu	We	Th	Fr	Sa	ORY-BCN
7:00	8:45	easyJet 3915	-	-	-	-	-	-	Sa	CDG-BCN
7:20	9:05	easyJet 3915	Su	Mo	Tu	We	Th	Fr	-	CDG-BCN
7:40	9:20	Air France 1148	Su	Mo	Tu	We	Th	Fr	Sa	CDG-BCN
8:20	9:55	Vueling 8011	Su	Mo	-	We	Th	Fr	-	ORY-BCN
8:55	10:45	Ryanair 6375	Su	Mo	Tu	We	Th	Fr	Sa	BVA-BCN
9:25	11:00	Vueling 8013	Su	Mo	Tu	We	Th	Fr	Sa	ORY-BCN
9:55	11:40	Vueling 8243	Su	Mo	Tu	We	Th	Fr	Sa	CDG-BCN

10:00	11:40	Air France 1348	Su	-	Tu	We	Th	Fr	Sa	CDG-BCN
10:50	12:25	Vueling 8015	Su	Mo	Tu	We	Th	Fr	-	ORY-BCN
12:00	13:35	Transavia 3134	-	Mo	Tu	We	Th	-	-	ORY-BCN
12:40	14:20	Air France 1648	Su	Mo	-	We	Th	Fr	Sa	CDG-BCN
13:25	15:00	Vueling 8017	Su	Mo	Tu	We	Th	Fr	Sa	ORY-BCN
14:30	16:15	easyJet 3919	Su	Mo	Tu	We	Th	Fr	Sa	CDG-BCN
14:35	16:20	Vueling 8247	Su	Mo	Tu	We	Th	Fr	-	CDG-BCN
15:25	17:00	Vueling 8027	Su	Mo	Tu	We	Th	Fr	-	ORY-BCN
15:25	17:05	Air France 1548	Su	Mo	Tu	We	Th	Fr	Sa	CDG-BCN
16:55	18:35	Air France 1048	Su	Mo	Tu	We	Th	Fr	Sa	CDG-BCN
17:25	19:00	Vueling 8019	Su	Mo	Tu	We	Th	Fr	Sa	ORY-BCN
17:35	19:10	Transavia 3138	Su	Mo	Tu	We	Th	Fr	-	ORY-BCN
17:55	19:35	Air France 1248	Su	Mo	Tu	We	Th	Fr	-	CDG-BCN
18:20	19:55	Vueling 8029	Su	-	-	-	Th	Fr	-	ORY-BCN
18:30	20:15	easyJet 3921	Su	Mo	Tu	We	Th	Fr	Sa	CDG-BCN
19:35	21:20	Vueling 8245	Su	Mo	Tu	We	Th	Fr	Sa	CDG-BCN
19:55	21:30	Vueling 8021	Su	Mo	Tu	We	Th	Fr	Sa	ORY-BCN
20:55	22:30	Vueling 8029	-	Mo	-	-	-	-	-	ORY-BCN
21:00	22:40	Air France 1448	Su	Mo	Tu	We	Th	Fr	Sa	CDG-BCN
21:40	23:30	Ryanair 6356	Su	Mo	Tu	We	Th	Fr	Sa	BVA-BCN
21:45	23:20	Vueling 8023	Su	-	Tu	We	Th	Fr	Sa	ORY-BCN

* Data of the timetable on the route Paris-Barcelona consulted from [88].

Table 133. Timetable of the flights on the route Paris-Barcelona

Route Barcelona-Mallorca

Departure	Arrival	Flight	Timetable							Airport
7:00	7:50	Vueling 3902	-	Mo	Tu	We	Th	Fr	Sa	BCN-PMI
7:40	8:30	Vueling 3900	-	Mo	Tu	We	-	-	-	BCN-PMI
8:00	9:00	Ryanair 6362	Su	Mo	Tu	We	Th	Fr	Sa	BCN-PMI
8:35	9:25	Vueling 3916	-	-	Tu	We	Th	Fr	-	BCN-PMI
8:40	9:25	Air Europa 6007	Su	Mo	Tu	We	Th	Fr	Sa	BCN-PMI
9:10	10:00	Vueling 3924	-	Mo	Tu	We	Th	-	-	BCN-PMI
9:45	10:35	Vueling 3904	Su	Mo	Tu	We	Th	Fr	Sa	BCN-PMI
11:25	12:15	Vueling 3916	-	Mo	-	-	-	-	Sa	BCN-PMI

11:50	12:35	Air Europa 6037	Su	Mo	Tu	We	Th	Fr	Sa	BCN-PMI
13:00	13:50	Vueling 3906	Su	-	-	-	-	-	-	BCN-PMI
13:00	13:50	Vueling 3926	-	-	-	-	Th	-	-	BCN-PMI
14:30	15:30	Ryanair 6578	Su	Mo	Tu	We	Th	Fr	Sa	BCN-PMI
15:00	15:45	Air Europa 6071	Su	Mo	Tu	We	Th	Fr	Sa	BCN-PMI
15:40	16:30	Vueling 3912	Su	-	Tu	We	Th	Fr	Sa	BCN-PMI
16:00	16:45	Air Europa 6105	Su	-	-	-	Th	Fr	Sa	BCN-PMI
17:00	17:50	Vueling 3908	Su	Mo	Tu	We	Th	Fr	-	BCN-PMI
18:00	18:50	Vueling 3920	-	Mo	Tu	We	Th	Fr	-	BCN-PMI
18:10	18:55	Air Europa 6073	Su	Mo	Tu	We	Th	Fr	Sa	BCN-PMI
19:30	20:15	Air Europa 6015	-	-	-	-	-	Fr	-	BCN-PMI
19:40	20:30	Vueling 3910	Su	Mo	Tu	We	Th	Fr	-	BCN-PMI
20:30	21:15	Air Europa 6105	-	Mo	-	-	-	-	-	BCN-PMI
20:35	21:25	Vueling 3914	-	-	-	-	Th	Fr	-	BCN-PMI
21:05	21:55	Vueling 3910	-	-	-	-	-	-	Sa	BCN-PMI
21:25	22:15	Vueling 3916	Su	-	-	-	-	-	-	BCN-PMI
21:25	22:15	Vueling 3914	Su	Mo	Tu	We	Th	Fr	Sa	BCN-PMI
21:25	22:15	Vueling 3922	Su	Mo	Tu	We	Th	Fr	Sa	BCN-PMI
21:30	22:15	Air Europa 6103	-	Mo	-	-	-	-	-	BCN-PMI
21:55	22:45	Vueling 3914	Su	-	-	-	-	-	-	BCN-PMI
22:00	23:00	Ryanair 6368	Su	Mo	-	We	Th	Fr	Sa	BCN-PMI
22:30	23:30	Ryanair 6368	-	-	Tu	-	-	-	-	BCN-PMI
22:40	23:25	Air Europa 6015	Su	-	-	-	-	-	-	BCN-PMI

* Data of the timetable on the route Barcelona-Mallorca consulted from [89].

Table 134. Timetable of the flights on the route Barcelona-Mallorca

Route Mallorca-Barcelona

Departure	Arrival	Flight	Timetable							Airport
7:00	7:50	Vueling 3902	-	Mo	Tu	We	Th	Fr	Sa	BCN-PMI
7:40	8:30	Vueling 3900	-	Mo	Tu	We	-	-	-	BCN-PMI
8:00	9:00	Ryanair 6362	Su	Mo	Tu	We	Th	Fr	Sa	BCN-PMI
8:35	9:25	Vueling 3916	-	-	Tu	We	Th	Fr	-	BCN-PMI
8:40	9:25	Air Europa 6007	Su	Mo	Tu	We	Th	Fr	Sa	BCN-PMI
9:10	10:00	Vueling 3924	-	Mo	Tu	We	Th	-	-	BCN-PMI

9:45	10:35	Vueling 3904	Su	Mo	Tu	We	Th	Fr	Sa	BCN-PMI
11:25	12:15	Vueling 3916	-	Mo	-	-	-	-	Sa	BCN-PMI
11:50	12:35	Air Europa 6037	Su	Mo	Tu	We	Th	Fr	Sa	BCN-PMI
13:00	13:50	Vueling 3906	Su	-	-	-	-	-	-	BCN-PMI
13:00	13:50	Vueling 3926	-	-	-	-	Th	-	-	BCN-PMI
14:30	15:30	Ryanair 6578	Su	Mo	Tu	We	Th	Fr	Sa	BCN-PMI
15:00	15:45	Air Europa 6071	Su	Mo	Tu	We	Th	Fr	Sa	BCN-PMI
15:40	16:30	Vueling 3912	Su	-	Tu	We	Th	Fr	Sa	BCN-PMI
16:00	16:45	Air Europa 6105	Su	-	-	-	Th	Fr	Sa	BCN-PMI
17:00	17:50	Vueling 3908	Su	Mo	Tu	We	Th	Fr	-	BCN-PMI
18:00	18:50	Vueling 3920	-	Mo	Tu	We	Th	Fr	-	BCN-PMI
18:10	18:55	Air Europa 6073	Su	Mo	Tu	We	Th	Fr	Sa	BCN-PMI
19:30	20:15	Air Europa 6015	-	-	-	-	-	Fr	-	BCN-PMI
19:40	20:30	Vueling 3910	Su	Mo	Tu	We	Th	Fr	-	BCN-PMI
20:30	21:15	Air Europa 6105	-	Mo	-	-	-	-	-	BCN-PMI
20:35	21:25	Vueling 3914	-	-	-	-	Th	Fr	-	BCN-PMI
21:05	21:55	Vueling 3910	-	-	-	-	-	-	Sa	BCN-PMI
21:25	22:15	Vueling 3916	Su	-	-	-	-	-	-	BCN-PMI
21:25	22:15	Vueling 3914	Su	Mo	Tu	We	Th	Fr	Sa	BCN-PMI
21:25	22:15	Vueling 3922	Su	Mo	Tu	We	Th	Fr	Sa	BCN-PMI
21:30	22:15	Air Europa 6103	-	Mo	-	-	-	-	-	BCN-PMI
21:55	22:45	Vueling 3914	Su	-	-	-	-	-	-	BCN-PMI
22:00	23:00	Ryanair 6368	Su	Mo	-	We	Th	Fr	Sa	BCN-PMI
22:30	23:30	Ryanair 6368	-	-	Tu	-	-	-	-	BCN-PMI
22:40	23:25	Air Europa 6015	Su	-	-	-	-	-	-	BCN-PMI

* Data of the timetable on the route Mallorca-Barcelona consulted from [90].

Table 135. Timetable of the flights on the route Mallorca-Barcelona

A9.2 Number of flights per week of the current airlines

easyJet

easyJet, as mentioned in section *State of the art*, is the second largest European low cost company. It serves many destinations, including Barcelona, London and Paris at low fares.

Number of flights per week offered by easyJet						
Route Barcelona-London						
Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
8	8	8	8	8	8	8
Total number of flights per week						**56**
Route London-Barcelona						
Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
8	8	8	8	8	8	8
Total number of flights per week						**56**
Route Barcelona-Paris						
Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
3	3	3	3	3	3	3
Total number of flights per week						**21**
Route Paris-Barcelona						
Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
3	3	3	3	3	3	3
Total number of flights per week						**21**

Table 136. Number of flights per week offered by easyJet on the different destinations

Iberia

Iberia is the Spanish airline that offers the major number of flights per day between the destinations Barcelona and Madrid. It offers, as well as low cost flight fares, the biggest shuttle service in Europe between these two cities.

Number of flights per week offered by Iberia						
Route Barcelona-Madrid						
Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
13	16	17	16	10	6	8
Total number of flights per week						**86**
Route Madrid-Barcelona						
Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
14	16	19	19	8	6	10
Total number of flights per week						**92**

Table 137. Number of flights offered by Iberia

Ryanair

Ryanair, as said in section *State of the art*, is the Europe's largest low-cost company, offering very low fares in all the destinations it serves. Between all these destinations, this company flights from Barcelona-El Prat to London, Paris and Mallorca.

Number of flights per week offered by Ryanair						
Route Barcelona-London						
Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
4	4	4	4	4	4	4
Total number of flights per week						**28**
Route London-Barcelona						
Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
4	4	4	4	4	4	4
Total number of flights per week						**28**
Route Barcelona-Paris						
Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
2	2	2	2	2	2	2
Total number of flights per week						**14**
Route Paris-Barcelona						
Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
2	2	2	2	2	2	2
Total number of flights per week						**14**
Route Barcelona-Mallorca						
Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
3	3	3	3	3	3	3
Total number of flights per week						**21**
Route Mallorca-Barcelona						
Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
3	3	3	3	3	3	3
Total number of flights per week						**21**

Table 138. Number of flights offered by Ryanair on the different routes

Transavia

Transavia is a French low cost company that offers, between others, daily flights between Barcelona and Paris.

Number of flights per week offered by Transavia						
Route Barcelona-Paris						
Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
3	3	3	3	2	0	1
Total number of flights per week						**15**
Route Paris-Barcelona						
Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
3	3	3	3	2	0	1
Total number of flights per week						**15**

Table 139. Number of flights offered by Transavia on the different routes

Vueling

Vueling, as mentioned in section *State of the art,* is the first Spanish low cost airline and it serves many destinations, including the four destinations the new company has in mind to do.

Number of flights per week offered by Vueling						
Route Barcelona-Madrid						
Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
10	9	10	11	5	3	9
Total number of flights per week						**57**

Route Madrid-Barcelona						
Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
10	9	10	11	5	3	9
Total number of flights per week						**57**
Route Barcelona-London						
Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
4	4	4	4	4	2	4
Total number of flights per week						**26**
Route London-Barcelona						
Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
4	4	4	4	4	3	4
Total number of flights per week						**27**
Route Barcelona-Paris						
Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
12	11	12	13	13	8	13
Total number of flights per week						**82**
Route Paris-Barcelona						
Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
12	11	12	13	13	8	13
Total number of flights per week						**82**
Route Barcelona-Mallorca						
Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
9	9	9	10	9	5	7
Total number of flights per week						**58**
Route Mallorca-Barcelona						
Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
9	9	9	10	9	5	7
Total number of flights per week						**58**

Table 140. Number of flights offered per week by Vueling on the different routes

Annex 10: Number of AVE trips per week obtaining

AVE

AVE (translating to English, *Spanish High Speed*) is the Spanish high speed train service that connects many of the most important cities in Spain. It is the most used ground service to travel between the cities Barcelona and Madrid, and it offers the following number of trips per week:

Number of trips per week offered by AVE						
Route Barcelona-Madrid						
Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
32	32	32	32	22	19	23
Total number of trips per week					**192**	
Route Madrid-Barcelona						
Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
32	32	32	32	22	19	23
Total number of trips per week					**192**	

Table 141. Number of trips offered by AVE on the different routes consulted from [91]

Annex 11: Number passengers carried per week by each company and in total on the selected routes

Taking into account the hypotheses made in section *Analysis of the number of passengers carried on the selected routes*, the steps that will be carried out in order to know the total number of passengers carried on each route will be the following:

i. First step will be having knowledge of the model of airplane, or train in case of AVE, used by each company to cover the selected routes so as to know the number of offered seats.
ii. Giving an approximation of the occupied seats of each company on each route according to their ticket price.
iii. By knowing the number of flights per week of each model of airplane of each company it will be finally obtained the number of passengers carried.

A11.1 Number of seats offered by the different companies

In this section it will be analysed the number of seats offered by each company to carry out each route, by knowing the model of airplane or train used on these routes.

AVE's trains capacity on the selected routes

AVE's capacity will be analysed taking into account the supposition that it is only important to know the number of seats destined to the tourist class. In this way, it will only be necessary to obtain the model of airplane that covers the routes from Barcelona to Madrid and vice versa, and the number of seats it has.

Characteristics of the model of AVE

Route	Model of train	Number of seats
Barcelona-Madrid	AVE 103	262
Madrid-Barcelona	AVE 103	262

* Data of the model of AVE and its number of seats consulted from [92] and [93].

Table 142. Characteristics of the model of train of AVE on the selected routes

easyJet's fleet capacity on the selected routes

Characteristics of the fleet of easyJet

Route	Model of airplane	Number of seats
Barcelona-London	A319	156
	A320	180
London-Barcelona	A319	156
	A320	180
Barcelona-Paris	A319	156
	A320	180
Paris-Barcelona	A319	156
	A320	180

* Data of the model of airplane and its number of seats consulted from [85], [86], [94] and [95] .

Table 143. Characteristics of easyJet's fleet on the selected routes

Iberia's fleet capacity on the selected routes

Similarly to AVE, Iberia airplanes are divided in 2 classes (business and tourist), so it will be only taken into account the capacity of the fleet destined to the low cost class.

Characteristics of the fleet of Iberia

Route	Model of airplane	Number of seats
Barcelona-Madrid	A319	90
	A320	144
	A321	124
Madrid-Barcelona	A319	90
	A320	144
	A321	124

* Data of the model of airplane and its number of seats consulted from [83], [84] and [96].

Table 144. Characteristics of Iberia's fleet on the selected routes

Ryanair's fleet capacity on the selected routes

Ryanair's fleet, as it can be seen in *Fleet of Ryanair* is based in one model of airplane, the Boeing 737-800.

Characteristics of the fleet of Ryanair

Route	Model of airplane	Number of seats
Barcelona-London	737-800	189
London-Barcelona	737-800	189
Barcelona-Paris	737-800	189
Paris-Barcelona	737-800	189
Barcelona-Mallorca	737-800	189

Mallorca-Barcelona	737-800	189

* Data of the model of airplane and its number of seats consulted from [97].

Table 145. Characteristics of Ryanair's fleet on the selected routes

Transavia's fleet capacity on the selected routes

Characteristics of the fleet of Transavia		
Route	Model of airplane	Number of seats
Barcelona-Paris	737-800	186
Paris-Barcelona	737-800	186

* Data of the model of AVE and its number of seats consulted from [87], [88] and [98].

Table 146. Characteristics of Transavia's fleet on the selected routes

Vueling's fleet capacity on the selected routes

Characteristics of the fleet of Vueling		
Route	Model of airplane	Number of seats
Barcelona-Madrid	A320	180
Madrid-Barcelona	A320	180
Barcelona-London	A320	180
London-Barcelona	A320	180
Barcelona-Paris	A320	180
Paris-Barcelona	A320	180
Barcelona-Mallorca	A320	180
Mallorca-Barcelona	A320	180

* Data of the model of AVE and its number of seats consulted from [83], [84] and [99].

Table 147. Characteristics of Vueling's fleet on the selected routes

A11.2 Analysis of the current typical fares on the selected routes

In the next lines, it will be shown the typical flight prices of the different companies on the selected routes, in order to have knowledge of the range of fares so as to estimate the number of passengers they carry per flight in each route. In addition, these fares will be then used to establish competitive prices for the new company and estimate the target of passengers it will have.

As ticket price can vary depending on the month or day of the flights, the days left before the flight, company facilities, etc, it will be chosen the three most typical fares of each company.

AVE

Route	Typical fares (€)		
Barcelona-Madrid	41,8	57,9	84,3
Madrid-Barcelona	41,8	57,9	84,3

* Data consulted from [91].

Table 148. Typical ticket prices from AVE

easyJet

Route	Typical fares (€)		
Barcelona-London	30,99	36,99	52,99
London-Barcelona	30,99	42,67	48,67
Barcelona-Paris	36,99	43,99	49,99
Paris-Barcelona	46,23	53,23	55,23

* Data consulted from [100].

Table 149. Typical ticket prices from easyJet

Iberia

Route	Typical fares (€)		
Barcelona-Madrid	35	49	63
Madrid-Barcelona	35	49	63

* Data consulted from [101].

Table 150. Typical ticket prices from Iberia

Ryanair

Route	Typical fares (€)		
Barcelona-London	24,99	29,99	42,99
London-Barcelona	24,99	29,99	42,99
Barcelona-Paris	22,99	32,99	39,99
Paris-Barcelona	22,99	32,99	39,99
Barcelona-Mallorca	23,69	30,57	37,79
Mallorca-Barcelona	20,39	23,69	27,61

* Data consulted from [102], [103] and [104].

Table 151. Typical ticket prices from Ryanair

Transavia

Route	Typical fares (€)		
Barcelona-Paris	28	36	46
Paris-Barcelona	35	46	56

* Data consulted from [105].

Table 152. Typical ticket prices form Transavia

Vueling

Route	Typical fares (€)		
Barcelona-Madrid	29,99	39,99	49,99
Madrid-Barcelona	29,99	39,99	49,99
Barcelona-London	29,99	39,99	49,99
London-Barcelona	39,99	44,99	49,99
Barcelona-Paris	29,99	39,99	49,99
Paris-Barcelona	39,99	49,99	
Barcelona-Mallorca	29,99	34,99	39,99
Mallorca-Barcelona	29,99	34,99	39,99

* Data consulted from [106].

Table 153. Typical ticket prices from Vueling

A11.3 Number of occupied seats per flight on the selected routes

Following the hypotheses given previously that all the companies should have at least a 95% of their seats occupied, and taking the typical prices from section above to estimate the number of seats sold of each company it is obtained the next table:

Number of sold seats per trip of the different companies						
AVE sellings per trip						
Route	Model	Seats	Typical fares (€)			Sold seats
Barcelona-Madrid	AVE 103	262	41,8	57,9	84,3	250
Madrid-Barcelona	AVE 103	262	41,8	57,9	84,3	250
easyJet sellings per flight						
Route	Model	Seats	Typical fares (€)			Sold seats

Barcelona-London	A319	156	30,99	36,99	52,99	153
	A320	180				176
London-Barcelona	A319	156	30,99	42,67	48,67	153
	A320	180				175
Barcelona-Paris	A319	156	36,99	43,99	49,99	151
	A320	180				175
Paris-Barcelona	A319	156	46,23	53,23	55,23	149
	A320	180				171

Iberia sellings per flight

Route	Model	Seats	Typical fares (€)			Sold seats
Barcelona-Madrid	A319	90	35	49	63	89
	A320	144				140
	A321	124				121
Madrid-Barcelona	A319	90	35	44	63	89
	A320	144				140
	A321	124				121

Ryanair sellings per flight

Route	Model	Seats	Typical fares (€)			Sold seats
Barcelona-London	737-800	189	24,99	29,99	42,99	188
London-Barcelona	737-800	189	24,99	29,99	42,99	188
Barcelona-Paris	737-800	189	22,99	32,99	39,99	188
Paris-Barcelona	737-800	189	22,99	32,99	39,99	188
Barcelona-Mallorca	737-800	189	23,69	30,57	37,79	188
Mallorca-Barcelona	737-800	189	20,39	23,69	27,61	188

Transavia sellings per flight

Route	Model	Seats	Typical fares (€)			Sold seats
Barcelona-Paris	737-800	186	28	36	46	182
Paris-Barcelona	737-800	186	35	46	56	180

Vueling sellings per flight

Route	Model	Seats	Typical fares (€)			Sold seats
Barcelona-Madrid	A320	180	29,99	39,99	49,99	179
Madrid-Barcelona	A320	180	29,99	39,99	49,99	179
Barcelona-London	A320	180	29,99	39,99	49,99	176

London-Barcelona	A320	180	39,99	44,99	49,99	171
Barcelona-Paris	A320	180	29,99	39,99	49,99	176
Paris-Barcelona	A320	180	39,99	49,99		171
Barcelona-Mallorca	A320	180	29,99	34,99	39,99	178
Mallorca-Barcelona	A320	180	29,99	34,99	39,99	175

Table 154. Number of sold seats per trip of the different companies

A11.4 Number of passengers carried by each company and in total on the selected routes

Once it is known the number of passengers carried per flight (or trip, in the case of AVE), it can be then calculated the total movement of passengers of each company and in total on the different routes. This value will be obtained by multiplying the passengers carried per trip by the total number of trips done in a week.

Number of passengers carried per week on the selected routes				
Route Barcelona-Madrid				
Company	Model	Sold seats	Days/week	Passengers/week
AVE	AVE 103	250	192	48.000
Iberia	A319	89	6	11.069
	A320	140	45	
	A321	121	35	
Vueling	A320	179	57	10.203
Total number of passengers (Barcelona-Madrid)				69.272
Route Madrid-Barcelona				

Company	Model	Sold seats	Days/week	Passengers/week
AVE	AVE 103	250	192	48.000
Iberia	A319	89	7	11.858
	A320	140	50	
	A321	121	35	
Vueling	A320	179	57	10.203
Total number of passengers (Madrid-Barcelona)				70.061
Route Barcelona-London				
Company	Model	Sold seats	Days/week	Passengers/week
easyJet	A319	153	42	8.890
	A320	176	14	
Ryanair	737-800	188	28	5.264
Vueling	A320	176	26	4.576
Total number of passengers (Barcelona-London)				18.730
Route London-Barcelona				
Company	Model	Sold seats	Days/week	Passengers/week
easyJet	A319	153	49	8.722
	A320	175	7	
Ryanair	737-800	188	28	5.264
Vueling	A320	171	26	4.446
Total number of passengers (London-Barcelona)				18.432
Route Barcelona-Paris				
Company	Model	Sold seats	Days/week	Passengers/week
easyJet	A319	151	7	3.507
	A320	175	14	
Ryanair	737-800	188	14	2.632
Transavia	737-800	182	15	2.730
Vueling	A320	176	82	14.432
Total number of passengers (Barcelona-Paris)				23.301
Route Paris-Barcelona				
Company	Model	Sold seats	Days/week	Passengers/week

easyJet	A319	149	14	3.283
	A320	171	7	
Ryanair	737-800	188	14	2.632
Transavia	737-800	180	15	2.700
Vueling	A320	171	82	14.022
Total number of passengers (Paris-Barcelona)				22.637
Route Barcelona-Mallorca				
Company	Model	Sold seats	Days/week	Passengers/week
Ryanair	737-800	188	21	3.948
Vueling	A320	178	58	10.324
Total number of passengers (Barcelona-Mallorca)				14.272
Route Mallorca-Barcelona				
Company	Model	Sold seats	Days/week	Passengers/week
Ryanair	737-800	188	21	3.948
Vueling	A320	175	58	10.150
Total number of passengers (Mallorca-Barcelona)				14.098

Table 155. Movement of passengers per company and in total on the different routes

Percentage of the market carried by each company

Having knowledge of the passengers carried by each company on the different routes, and the total number of existent passengers on these routes, it can be obtained the percentage of the carried demand corresponding to each company, by carrying out a direct rule of three.

$$\left.\begin{matrix} A_1 \_\_\_\_\_ 100 \\ A_2 \_\_\_\_\_ \ x \end{matrix}\right\} \ x = \frac{A_2 \cdot 100}{A_1} \ ;$$

where A_1 corresponds to the total number of passengers on the analysed route, and A_2, to the number of passengers carried by the analysed company on the same route.

% of the market taken by each company		
Route Barcelona-Madrid		
Total number of passengers (Barcelona-Madrid)		69.272
Company	Passengers/week	% of the market
AVE	48.000	69
Iberia	11.069	16
Vueling	10.203	15
Route Madrid-Barcelona		
Total number of passengers (Madrid-Barcelona)		70.061
Company	Passengers/week	% of the market
AVE	48.000	69
Iberia	11.858	17
Vueling	10.203	14
Route Barcelona-London		
Total number of passengers (Barcelona-London)		18.730
Company	Passengers/week	% of the market
easyJet	8.890	48
Ryanair	5.264	28
Vueling	4.576	24
Route London-Barcelona		
Total number of passengers (London-Barcelona)		18.432
Company	Passengers/week	% of the market
easyJet	8.722	47
Ryanair	5.264	29
Vueling	4.446	24
Route Barcelona-Paris		

Total number of passengers (Barcelona-Paris)		23.301
Company	Passengers/week	% of the market
easyJet	3.507	15
Ryanair	2.632	11
Transavia	2.730	12
Vueling	14.432	62
Route Paris-Barcelona		
Total number of passengers (Paris-Barcelona)		22.637
Company	Passengers/week	% of the market
easyJet	3.283	14
Ryanair	2.632	12
Transavia	2.700	11
Vueling	14.022	62
Route Barcelona-Mallorca		
Total number of passengers (Barcelona-Mallorca)		14.272
Company	Passengers/week	% of the market
Ryanair	3.948	28
Vueling	10.324	72
Route Mallorca-Barcelona		
Total number of passengers (Mallorca-Barcelona)		14.098
Company	Passengers/week	% of the market
Ryanair	3.948	28
Vueling	10.150	72

Table 156. Percentage of the market taken by each company on the different routes

Annex 12: Number of airplanes required obtaining

A12.1 Establishment of the ticket price and target of passengers

First step to obtain the number of airplanes required is to establish a feasible target of passengers according to ticket price. In order to do that, some aspects will be taken into account:

i. Prices will be supposed to remain constant between hours of the days, days of the week and months in order to facilitate the study.
ii. The target of passengers will be estimated from the % of the existent market the new company can take. This means that the % of passengers is supposed to be taken out from the % of passengers of the current companies, as it is considered that for the moment, total demand remains constant.
iii. The % of the market taken by the new company will not surpass the % of the already existent companies unless it can offer prices significantly below them. It is supposed that already known companies will be preferred in front of a new company because they transmit more confidence to clients.
iv. The % of the market will be transformed to number of passengers per week in order to facilitate the operations that will be carried out after.

New LCC target of passengers and prices per week			
Route	Price (€)	Target of passengers (%)	Target of passengers
Barcelona-Madrid	40	6	4.156
Madrid-Barcelona	40	6	4.203
Barcelona-London	45	5	936
London-Barcelona	45	5	921
Barcelona-Paris	39	8	1.864
Paris-Barcelona	39	8	1.811
Barcelona-Mallorca	32	9	1.284
Mallorca-Barcelona	30	9	1.268

Table 157. New low cost company prices and target of passengers per week

Calculation of the number of required flights per day

The number of airplanes can be easily obtained by having knowledge of the model of airplane of the company (see *Airplane model obtaining: OWA*) and making the supposition that airplanes are in active service the seven days of the week, due to economical reasons. An active airplane gives more benefits than a stored one, which does not provide any.

The total number of passengers per week will be divided by the number of seats the model of airplane has to know the required flights per week, and then, this result will be divided by the number of days per week when the route will be covered to know the required flights per day.

New LCC required number of flights				
Model of airplane			Number of seats	
Q 200			39	
Route	Passengers/week	Flights/week	Days/week	Flights/day
Barcelona-Madrid	4.156	106,56	7	15,22
Madrid-Barcelona	4.203	107,77	7	15,40
Barcelona-London	936	24	3	8
London-Barcelona	921	23,62	3	7,87
Barcelona-Paris	1.864	47,79	4	11,95
Paris-Barcelona	1.811	46,41	4	11,60
Barcelona-Mallorca	1.284	32,92	7	4,70
Mallorca-Barcelona	1.268	32,51	7	4,64

* However having decimals in the number of flights per week and per day has not physical sense, these values have not been approximated to an integer because they are an average, and so as to not to accumulate an error to obtain the final number of airplanes required. In addition, tourist class is not very demanding with the dates of their flights so they do not have inconvenient to fly one day before or after.

Table 158. Number of flights per week and per day required by the new company

Number of airplanes required obtaining

Number of airplanes required by the company to cover the selected routes and accomplish with the target of passengers established will be obtained by dividing the number of flights per day required by the number of flights a single airplane can do in a specific route.

Number of flights per day covered by a single airplane

The number of flights a single airplane can cover of a same route will be estimated by having knowledge of the flight time of each route, and the typical range of hours when there is more demand of flights. In this way, it will be estimated the number of times a single airplane can go and return on the same route in the whole day.

Flight time on the different routes

So as to obtain the duration of each flight, it will be necessary to know the distance between the destinations covered by each route and the cruise speed of the airplane. Then, following the same procedure as in *Annex 3*, time of each flight can be obtained.

Route	Range (km)	Cruise speed (km/h)	Flight duration (h)	Flight duration $(h\ and\ min)$
BCN-MAD	490,78	537	1,25	1h 15min
MAD-BCN	494,484	537	1,25	1h 15min
BCN-STN	872,292	537	1,96	1h 58min
STN-BCN	831,548	537	1,88	1h 53min
BCN-ORY	1.263,064	537	2,69	2h 42min
ORY-BCN	1.220,468	537	2,61	2h 37min
BCN-PMI	201,868	537	0,71	43min
PMI-BCN	214,832	537	0,73	44min

* Data of the range of each route consulted from [107]. Range can vary between go and back routes due to they do not have to follow exactly the same aerial path.

Table 159. Duration of the flight on the different routes

Range of more demanded service hours

Having a look to the typical flights timetable (see *Annex 9*), the range of hours when the new company will offer flights will be between 06:00h and 00:01h.

Taking into account a waiting time (or handling time) between flights of approximately one hour in all the airports, it is finally obtained the number of flights a same airplane can cover. In addition, it will have to take into account this number of flights per day is a reasonable one according to the existent demand on the route, which means that, for instance, although the airplane can make 8 flights per day from Barcelona to Mallorca, there is no sense to carry out such a high number of them if there is not enough demand.

Route	Daily flights/airplane
BCN-MAD / MAD-BCN	(4) BCN-MAD (4) MAD-BCN
BCN-STN / STN-BCN	(3) BCN-STN (3) STN-BCN
BCN-ORY / ORY-BCN	(2) BCN-ORY (2) ORY-BCN
BCN-PMI / PMI-BCN	(5) BCN-PMI (5) PMI-BCN

* Note that as the company uses a star-type network with Barcelona as the hub airport and it is supposed all airplanes return to Barcelona, the flights per day an airplane can make has to be an even number. An airplane will not end in another airport different from Barcelona-El Prat.

Table 160. Number of flights per day a single airplane can do on the different routes

Then it can be calculated the number of required airplanes by the company.

Route	Flights/day	Daily flights per airplane	Number of airplanes
BCN-MAD	15,22	4	3,81 → 4
MAD-BCN	15,40	4	3,85 → 4
BCN-STN	8	3	3,98 → 4
STN-BCN	7,87	3	3,87 → 4
BCN-ORY	11,95	2	4
ORY-BCN	11,60	2	3,94 → 4
BCN-PMI	4,70	5	0,94 → 1
PMI-BCN	4,64	5	0,93 → 1
Total number of airplanes required			**13**

Table 161. Number of airplanes required by the company on the different routes

Annex 13: Economical feasibility study

In order to carry out the economical feasibility study of the new company, it will be necessary to take into account the following parameters:

i. Initial investment
ii. Income of the company per year
iii. Costs of the company per year
iv. Cash flow
v. Updated cash flow
vi. Breakeven point
vii. Payback time
viii. Net Present Value (NPV)
ix. Internal Rate of Return (IRR)

Feasibility study will be carried to analyse if the company will have benefits, and so if it will be a feasible inversion. So as to evaluate the economical feasibility of the company, it will be analysed the first 10 years of existence.

A13.1 Initial investment

The initial investment of the company, which will be the total amount of money required of the investors of the company to set it up, will consist on the next parameters:

i. Installations costs
ii. Bureaucratic aspects

iii. First payment of the leased airplanes

iv. Study cost

v. Contingencies

Installation costs

Installation costs refer to the cost of having an initial space destined to the offices of the company, which could be its headquarters. This includes the purchasing price of this property as well as any initial building reform it needs so as to adequate the space to the company necessities.

The headquarters of the company will be situated near its hub airport, so, in El Prat de Llobregat. Making the supposition that it will have an area of approximated $1000\,m^2$ and that the price per m^2 is around $400€$, this gives a total of $400000€$ [108].

Initial building reforms which include utilities installations, change in the distribution of the space, necessary materials for the office like computers, etc., will be considered a 5% of the total cost of the property.

Installation costs	
Establishment cost (€)	400.000
Reforms cost (€)	20.000
Total installation costs (€)	**420.000**

Table 162. Installation costs

Bureaucratic aspects

Bureaucratic aspects include all the legal formalities required to set up a new enterprise (in this case an airline) such as the Air Operator Certificate (AOC) or other licenses, certificates, royalties, etc.

According to [109], in order to obtain the AOC for the company it will be required 22000 €. Rest of the possible bureaucratic formalities will be recorded as a 10% of the AOC cost.

Bureaucratic aspects	
AOC (€)	22000
Other formalities (€)	2200
Bureaucratic costs (€)	**24.200**

Table 163. Bureaucratic costs

First payment of airplanes

Inside the initial investment the company will contemplate the first year payment of all its leased airplanes so as to be able to commence operations.

Initial cost of airplanes cost	
Airplane prive $(€/month)$	82.000
Number of airplanes	5
Number of months	12
Total airplanes costs (€)	**4.920.000**

Table 164. Initial airplane's cost

Study cost

Study cost corresponds to the expenses that come from the realization of the whole study carried out during the project, in other words, the value corresponding to the hours worked.

In order to establish this cost, it is necessary to know the typical cost per hour of a junior consultant, due to the carried out study is typical from consultancies and it will be considered to have been carried out by an inexperienced person in this area.

Study cost	
Junior consultant cost $(€/hour)$	45
Number of worked hours	580
Total study cost (€)	**26.100**

* Data consulted from BOE (*Boletín Oficial del Estado*), corresponding to a junior consultant working on determinate interventions in the city of Barcelona (same characteristics as these *TFG*) [110].

Table 165. Study cost

Contingencies

Contingencies correspond to a % of money reserved which takes into account any possible initial loss which was not contemplated. This cost will represent a 5% of total initial costs.

Contingencies (€)	41900

Table 166. Contingencies

Initial investment

Finally, initial investment will be of 5.633.605 €.

Initial investment	
Installation cost (€)	420.000
Bureaucratic aspects (€)	24.200
First payment of airplanes (€)	4.920.000
Study cost (€)	26.100
Contingencies (€)	269.405
Total initial investment (€)	**5.633.605**

Table 167. Initial investment

A13.2 Income

The income of the company per year will correspond to the number of sold tickets and the possible cargo invoicing (especially luggage). Having knowledge of the number of passengers carried per week and the ticket's price on each route (see *Annex 12*), and supposing around a 15% of the passengers carry a hold luggage, the total income can be easily obtained.

Income of the company per year				
Income corresponding to the tickets sold				
Route	Fare (€)	Passengers/week	Weeks/year	Income (€)
Barcelona-Paris	39	1.864	48	3.489.408
Paris-Barcelona	39	1.810	48	3.388.320
Barcelona-London	45	936	48	2.021.760

London-Barcelona	45	921	48	1.989.360
Barcelona-Mallorca	32	1.284	48	1.972.224
Mallorca-Barcelona	30	1.268	48	1.825.920

Income corresponding to invoicing					
Route	Fare (€)	Suitcases	Flights/week	Weeks/year	Income (€)
Barcelona-Paris	20	5	47,79	48	229.415
Paris-Barcelona	20	5	46,41	48	222.769
Barcelona-London	20	5	24	48	115.200
London-Barcelona	20	5	23,62	48	113.353
Barcelona-Mallorca	20	5	32,92	48	158.030
Mallorca-Barcelona	20	5	32,51	48	156.061

Total income $(€/year)$	**15.681.820**

Table 168. Total income of the company per year

A13.3 Costs

Between all the costs the company will have each year, it can be divided into Direct Costs or Indirect Costs [20].

Direct costs

Direct costs include all the costs that depend in a direct way of the airplane of the company:

i. Leasing price of the airplanes
ii. Fuel costs
iii. Aircrew costs
iv. Maintenance costs

v. Airport taxes and on-route fees

vi. Other costs, which include services to passengers, handling of the airplane, insurances associated to the airplane and interests, depreciation and amortisation.

Leasing costs

Leasing costs	
Airplane price $(€/month)$	82.000
Number of airplanes	5
Total leasing costs $(€/year)$	**4.920.000**

* First annual payment of the airplanes will be already taken into account in the initial investment, so during the first year total leasing costs will be a 4.920.000€ lower.

Table 169. Total leasing costs of the company per year

Fuel costs

Fuel costs are obtained by having knowledge of the fuel costs per block hour of the model of airplane (see *Fuel costs*), the total number of block hours on each route (see *Annex 3*) and the number of flights per week.

Fuel costs per year				
Route	Fuel cost $(€/flight)$	Flights/week	Weeks/year	Fuel costs $(€/year)$
Barcelona-Paris	511	47,79	48	1.172.228
Paris-Barcelona	491	46,41	48	1.094.154
Barcelona-London	701	24	48	807.427

London-Barcelona	680	23,62	48	771.020
Barcelona-Mallorca	185	32,92	48	292.538
Mallorca-Barcelona	191	32,51	48	298.726
Total fuel costs $(€/year)$				**4.436.093**

Table 170. Total fuel costs of the company per year

Aircrew costs

Similarly to fuel costs, but now knowing the aircrew costs per block hour of the model of airplane of the company (see *Aircrew costs*), these costs per year will be the following:

Aircrew costs per year				
Route	Crew cost $(€/flight)$	Flights/week	Weeks/year	Crew costs $(€/year)$
Barcelona-Paris	288	47,79	48	660.220
Paris-Barcelona	277	46,41	48	616.248
Barcelona-London	395	24	48	454.758
London-Barcelona	383	23,62	48	434.252
Barcelona-Mallorca	104	32,92	48	164.763
Mallorca-Barcelona	108	32,51	48	168.248
Total aircrew costs $(€/year)$				**2.498.489**

Table 171. Total aircrew costs of the company per year

Maintenance costs

Similar to fuel and crew costs, maintenance costs are obtained by having knowledge of the maintenance costs of the model of airplane per block hour (see *Maintenance costs*).

Maintenance costs per year				
Route	Maintenance cost $(€/flight)$	Flights/week	Weeks/year	Maintenance costs $(€/year)$
Barcelona-Paris	738	47,79	48	1.693.218
Paris-Barcelona	709	46,41	48	1.580.444
Barcelona-London	1012	24	48	1.166.283
London-Barcelona	982	23,62	48	1.113.695
Barcelona-Mallorca	267	32,92	48	422.555
Mallorca-Barcelona	276	32,51	48	431.493
Total aircrew costs $(€/year)$				**6.407.689**

Table 172. Total maintenance costs of the company per year

Airport taxes

Airport taxes include landing fees, parking of aircraft fees and other services the company takes from the airport like on-ground services, invoicing stands, etc.

Landing and parking fees will be directly obtained by having knowledge of the number of landings each airplane does, as well as the number of hours during the week it is parked at the hub airport of Barcelona.

Rest of possible taxes the company should pay will be supposed as a 4% of each airport total taxes.

In this way, in order to obtain the total airport taxes per year, it will be analysed each airplane separately to find the number of landings per week carried out on each airport and the total number of fractions of 15min it has been parked at Barcelona-El Prat (see *Annex 14*). These parameters will be found by having a look on the timetable of each airplane (see section *Flight schedule*).

Total airport costs	
Airplane	Airport costs
Airplane 1	309.442
Airplane 2	307.193
Airplane 3	307.663
Airplane 4	304.999
Airplane 5	440.853
Total airport costs $(€/year)$	**1.670.150**

Table 173. Total airport costs per year

On route fees

On route fees will be calculated according to the following equation:

$$C = AWF \cdot Df \cdot u\,;$$

where AWF corresponds to the Aircraft Weight Factor, Df corresponds to the distance factor and u to the unit rate of charge (see *Annex 15*).

Overflight costs per year				
Route	On-route cost $(€/flight)$	Flights/week	Weeks/year	On-route costs $(€/year)$
Barcelona-Paris	353	47,79	48	808.703
Paris-Barcelona	336	46,41	48	747.952
Barcelona-London	560	24	48	645.276
London-Barcelona	542	23,62	48	613.832
Barcelona-Mallorca	83	32,92	48	131.461
Mallorca-Barcelona	89	32,51	48	138.160
Total on-route costs $(€/year)$				**3.085.384**

Table 174. Total on-route costs of the company per year

Other costs

Rest of the direct costs of a company: services to passengers, handling of the airplane, insurances, interests, depreciation and amortisation can be supposed as a 5% of the already known direct costs.

Other direct costs per year		
First year		
Type of cost	Percentage (%)	Cost (€)
Services to passengers	1	189.978
Handling of the airplane	1	189.978
Insurances of the airplane	2	361.956
Interests, depreciation and amortisation	1	189.978
Total costs $(€/year)$		**904.890**
Following years		

Type of cost	Percentage (%)	Cost (€)
Services to passengers	1	230.178
Handling of the airplane	-	-
Insurances of the airplane	2	460.356
Interests, depreciation and amortisation	1	230.178
Total costs $(€/year)$		**920.712**

* Handling of the airplane refers to the costs of carrying the airplane from the place where the leaser/seller has it to the desired place, and so will be only taken into account the years when an airplane is leased/bought.

Table 175. Total other direct costs of the company per year

Total direct costs per year

Total direct costs per year			
First year		**Following year**	
Type of cost	Cost (€)	Type of cost	Cost (€)
Aircraft cost	-	Aircraft cost	4.920.000
Fuel costs	4.436.093	Fuel costs	4.436.093
Crew costs	2.498.489	Crew costs	2.498.489
Maintenance costs	6.407.689	Maintenance costs	6.407.689
Airport charges	1.670.150	Airport charges	1.670.150
On-route charges	3.085.384	On-route charges	3.085.384
Other costs	904.890	Other costs	920.712
Total direct costs $(€/year)$	**19.002.696**	**Total direct costs** $(€/year)$	**23.017.805**

Table 176. Total direct costs of the company per year

Indirect costs

Indirect costs are those which depend of the airline and are divided in:

i. Publicity and commercialisation
ii. General and administration expenses
iii. Handling of the payload

All these costs will represent a 5% of the total direct costs.

Indirect costs per year		
First year		
Type of cost	Percentage (%)	Cost (€)
Publicity and commercialisation	3	570.081
General and administration expenses	1	190.027
Handling of the payload	1	190.027
Total indirect costs $(€/year)$		**950.135**
Following years		
Type of cost	Percentage (%)	Cost (€)
Publicity and commercialisation	3	718.156
General and administration expenses	1	239.385
Handling of the payload	1	239.385
Total indirect costs $(€/year)$		**1.196.926**

Table 177. Total indirect direct costs of the company per year

A13.4 Cash flow

Cash flow is an indicator for money movements in the way that when cash flow is positive means the enterprise incomes are higher than the expenses, and so, when cash flow is negative, means expenses are higher and there is a deficit on the company.

It can be simply calculated by subtracting the already calculated expenses, which correspond to the yearly costs calculated in last section, to the yearly incomes:

$$Cash\ Flow\ = Incomes - Expenses \quad \rightarrow \quad CF = I - E$$

Cash flow per year

Year	Income (€)	Expenses (€)	Cash Flow (€)
2015	-	5.633.605	-5.633.605
2016	15.681.820	19.952.830	-4.271.010
2017	15.681.820	25.135.443	-9.453.623
2018	15.681.820	25.135.443	-9.453.623
2019	15.681.820	25.135.443	-9.453.623
2020	15.681.820	25.135.443	-9.453.623
2021	15.681.820	25.135.443	-9.453.623
2022	15.681.820	25.135.443	-9.453.623
2023	15.681.820	25.135.443	-9.453.623
2024	15.681.820	25.135.443	-9.453.623
2025	15.681.820	25.135.443	-9.453.623

* Note that it is being considered that during the first year the company only works on the installations, licences obtaining and other aspects (web page, publicity, etc.) and does not start operations until next year.

* Note that the first year of operations the expenses are a bit lower due to the first year lease of the airplanes is covered on the initial investment. In addition, next of the year will not have costs on handling of the airplane.

Table 178. Cash flow of the company per year

As it is seen, costs of the company will be always higher than benefits if nothing changes, and so the company will not be feasible and will have to close.

In this way, there will have to be made some iterations where the company strategy of routes and number of airplanes will be changing until it is reached a configuration that gives benefits to the company (see *Annex 16*).

Annex 14: Airport charges corresponding to each airplane obtaining

Every airport has its own policy of landing and parking fares, so it will have to be searched the fares on each of the airports the company will operate:

Main airport taxes

Airport	Landing fee	Parking fee
Barcelona-El Prat	7,45535 €/$MTOW$ $MTOW$ in Tm 122,27 €	$E = e \cdot MTOW \cdot t$ e = 0,122978 €/15min t on fractions of 15min $MTOW$ in Tm 2,0168392 €/t
Mallorca-Son Sant Joan	7,072182 €/$MTOW$ 116 €	Not necessary
London-Stansted	162 £	Not necessary
Paris-Orly	178,92 €	Not necessary

* Data consulted from [11], [12] and [15].

* No charges per noise due to the characteristics of the model of airplane according to ICAO.

Table 179. Main airport taxes

Taking into account each airport charges and the timetables of the 5 airplanes of the company (see section *Flight schedule*), it can be known the number of landings per week, and so per year of each airplane on each airport and its corresponding cost, as well as the number of hours each airplane is parked at Barcelona-El Prat and its corresponding cost.

Airplane 1

Airport taxes Airplane 1					
Landing costs					
Airport	Cost/Landing (€)	Landings/week	Weeks/year	Landing costs (€)	
Barcelona-El Prat	122,27	18	48	105.639	
London-Stansted	224	6	48	64.512	
Paris-Orly	178,92	12	48	103.057	
Parking costs					
Airport	Parking cost $(€/15min)$	Minutes/week	Fractions of 15/week	Weeks/year	Parking costs (€)
Barcelona-El Prat	2,0168392	3770	251,3	48	24.331
Rest of airport taxes					
Percentage of the main airport taxes (%)				4	
Airport				Rest of taxes costs (€)	
Barcelona-El Prat				5.199	
London-Stansted				2.580	
Paris-Orly				4.122	
Total airport costs airplane 1 $(€/year)$				**309.442**	

Table 180. Total airport costs on taxes of airplane 1

Airplane 2

Airport taxes Airplane 2					
Landing costs					
Airport	Cost/Landing (€)	Landings/week	Weeks/year	Landing costs (€)	
Barcelona-El Prat	122,27	18	48	105.639	
London-Stansted	224	6	48	64.512	
Paris-Orly	178,92	12	48	103.057	
Parking costs					
Airport	Parking cost $(€/15min)$	Minutes/week	Fractions of 15/week	Weeks/year	Parking costs (€)
Barcelona-El Prat	2,0168392	3435	229	48	22.169
Rest of airport taxes					
Percentage of the main airport taxes (%)				4	
Airport				Rest of taxes costs (€)	
Barcelona-El Prat				5.112	
London-Stansted				2.580	
Paris-Orly				4.122	
Total airport costs airplane 2 $(€/year)$				**307.193**	

Table 181. Total airport costs on taxes of airplane 2

Airplane 3

Airport taxes Airplane 3					
Landing costs					
Airport	Cost/Landing (€)		Landings/week	Weeks/year	Landing costs (€)
Barcelona-El Prat	122,27		18	48	105.639
London-Stansted	224		6	48	64.512
Paris-Orly	178,92		12	48	103.057
Parking costs					
Airport	Parking cost ($€/15min$)	Minutes/week	Fractions of 15/week	Weeks/year	Parking costs (€)
Barcelona-El Prat	2,0168392	3505	233,7	48	22.621
Rest of airport taxes					
Percentage of the main airport taxes (%)				4	
Airport				Rest of taxes costs (€)	
Barcelona-El Prat				5.130	
London-Stansted				2.580	
Paris-Orly				4.122	
Total airport costs airplane 3 ($€/year$)				**307.663**	

Table 182. Total airport costs on taxes of airplane 3

Airplane 4

Airport taxes Airplane 4				
Landing costs				
Airport	Cost/Landing (€)	Landings/week	Weeks/year	Landing costs (€)
Barcelona-El Prat	122,27	18	48	105.639
London-Stansted	224	6	48	64.512
Paris-Orly	178,92	12	48	103.057

Parking costs					
Airport	Parking cost ($€/15min$)	Minutes/week	Fractions of 15/week	Weeks/year	Parking costs (€)
Barcelona-El Prat	2,0168392	3490	232,7	48	22.524

Rest of airport taxes	
Percentage of the main airport taxes (%)	4

Airport	Rest of taxes costs (€)
Barcelona-El Prat	5.127
London-Stansted	2.580
Paris-Orly	4.122

Total airport costs airplane 4 ($€/year$)	**304.999**

Table 183. Total airport costs on taxes of airplane 4

Airplane 5

Airport taxes Airplane 5					
Landing costs					
Airport	Cost/Landing (€)		Landings/week	Weeks/year	Landing costs (€)
Barcelona-El Prat	122,27		35	48	205.410
Mallorca-Son Sant Joan	116		35	48	194.853
Parking costs					
Airport	Parking cost ($€/15min$)	Minutes/week	Fractions of 15/week	Weeks/year	Parking costs (€)
Barcelona-El Prat	2,0168392	3662	244,1	48	23.634
Rest of airport taxes					
Percentage of the main airport taxes (%)				4	
Airport				Rest of taxes costs (€)	
Barcelona-El Prat				9.162	
Mallorca-Son Sant Joan				7.794	
Total airport costs airplane 5 ($€/year$)				**440.853**	

Table 184. Total airport costs on taxes of airplane 5

Annex 15: Parameters of the on-route fees obtaining

On route fees will be calculated according to the following equation:

$$C = AWF \cdot Df \cdot u\ ;$$

where AWF corresponds to the Aircraft Weight Factor; Df to the distance factor and u to the unit rate of charge [111].

Aircraft Weight Factor

The AWF (expressed to two decimals) is determined by the following equation [111]:

$$AWF = \sqrt{MTOW/50}\ ;$$

where the MTOW is expressed in metric tonnes.

In this way, the AWF of the Q200, which has an MTOW of $16400\ kg$ will be $0{,}57$.

AWF	0,57

Table 185. Q200 weight factor

Distance factor

The distance factor by charging area is obtained by dividing the number of kilometres in the great circle distance between the aerodrome of departure or entry point of the charge area and the aerodrome of arrival or the exit point of the

charge area, by 100. This operation has to be repeated for each charging zone overflown [111].

In order to know the kilometres flown over the different charging zones it will be necessary to have an idea of a typical flight plan of the route where it can be seen the point where the airplane enters to a different charging zone [112].

Route Barcelona-Paris

Distance factor		
Charging zone	Distance (km)	Distance factor
Spain	155,57	1,56
France	716,72	7,17

Table 186. Distance factor son the route Barcelona-Paris

Route Paris-Barcelona

Distance factor		
Charging zone	Distance (km)	Distance factor
France	713,02	7,13
Spain	118,53	1,19

Table 187. Distance factor son the route Paris-Barcelona

Route Barcelona-London

Distance factor		
Charging zone	Distance (km)	Distance factor
Spain	168,53	1,69
France	813,03	8,13
United Kingdom	281,50	2,82

Table 188. Distance factor son the route Barcelona-London

Route London-Barcelona

Distance factor		
Charging zone	Distance (km)	Distance factor
United Kingdom	275,95	2,76
France	826,00	8,26
Spain	118,53	1,19

Table 189. Distance factor son the route London-Barcelona

Route Barcelona-Mallorca

Distance factor		
Charging zone	Distance (km)	Distance factor
Spain	201,87	2,02

Table 190. Distance factor son the route Barcelona-Mallorca

Route Mallorca-Barcelona

Distance factor		
Charging zone	Distance (km)	Distance factor
Spain	214,83	2,15

Table 191. Distance factor son the route Mallorca-Barcelona

Unit Rate of Charge

The unit rate of charge is the charge in Euro applied by a charging zone to a flight operated by an aircraft of 50 metric tonnes (weight factor of 1,00) and flying 100 km (distance factor of 1.00) in the charge area of that state [111].

Adjusted unit rates	
Zone	Unit Rate
France	70,11
Spain	71,8
United Kingdom	101,22

* Data consulted from [113].

Table 192. Adjusted unit rates

Annex 16: Iteration of the feasibility study

Iteration on the economical feasibility study is necessary in order to find a configuration of routes and fleet the company becomes profitable with.

First step was eliminating the route that suppose major operational costs (route of London) and then a second route had to be eliminated too (route of Paris) due to the company was still not being economically feasible. In this way, in the following pages it will be carried out the feasibility study with the route of Mallorca and a single airplane on the fleet.

A16.1 Initial investment

Initial investment is obtained in the same way as *Annex 13*, with the difference that the cost represented by the first payment of airplanes will be lower, due to the company only has to lease one airplane now. This fact will change the investment destined to contingencies, and so the final initial investment (see *Budget*).

Initial investment	
Installation cost (€)	420.000
Bureaucratic aspects (€)	24.200
First payment of airplanes (€)	984.000
Study cost (€)	26.100
Contingencies (€)	72.715
Total initial investment (€)	**1.527.015**

Table 193. Recalculated initial investment

A16.2 Income

Similar to *Annex 13*, next table shows the income per year of the company:

Income of the company per year					
Income corresponding to the tickets sold					
Route	Fare (€)	Passengers/week		Weeks/year	Income (€)
Barcelona-Mallorca	32	1284		48	1.972.224
Mallorca-Barcelona	30	1268		48	1.825.920
Income corresponding to invoicing					
Route	Fare (€)	Suitcases	Flights/week	Weeks/year	Income (€)
Barcelona-Mallorca	20	5	32,92	48	158.030
Mallorca-Barcelona	20	5	32,51	48	156.061
Total income $(€/year)$					**4.112.235**

Table 194. Recalculated total income of the company per year

A16.3 Costs

Following the same procedure as in *Annex 13*, costs of the company per year can be easily obtained.

Direct costs

Leasing costs

Leasing costs	
Airplane price $(€/month)$	82.000
Number of airplanes	1
Total leasing costs $(€/year)$	**984.000**

* First annual payment of the airplanes will be already taken into account in the initial investment, so during the first year total leasing costs will be 984.000 € lower.

Table 195. Recalculated total leasing costs of the company per year

Fuel costs

Fuel costs per year				
Route	Fuel cost $(€/flight)$	Flights/week	Weeks/year	Fuel costs $(€/year)$
Barcelona-Mallorca	185	32,92	48	292.538
Mallorca-Barcelona	191	32,51	48	298.726
Total fuel costs $(€/year)$				**591.264**

Table 196. Recalculated total fuel costs of the company per year

Aircrew costs

Aircrew costs per year				
Route	Crew cost $(€/flight)$	Flights/week	Weeks/year	Crew costs $(€/year)$
Barcelona-Mallorca	104	32,92	48	164.763
Mallorca-Barcelona	108	32,51	48	168.248
Total aircrew costs $(€/year)$				**333.011**

Table 197. Total aircrew costs of the company per year

Maintenance costs

Maintenance costs per year				
Route	Maintenance cost $(€/flight)$	Flights/week	Weeks/year	Maintenance costs $(€/year)$
Barcelona-Mallorca	267	32,92	48	422.555
Mallorca-Barcelona	276	32,51	48	431.493
Total maintenance costs $(€/year)$				**854.048**

Table 198. Recalculated total maintenance costs of the company per year

Airport taxes

Total airport costs	
Airplane	Airport costs
Airplane 5	440.853
Total airport costs $(€/year)$	**440.853**

Table 199. Recalculated total airport costs per year

On route fees

Overflight costs per year				
Route	On-route cost $(€/flight)$	Flights/week	Weeks/year	On-route costs $(€/year)$
Barcelona-Mallorca	83	32,92	48	131.461
Mallorca-Barcelona	89	32,51	48	138.160
Total on-route costs $(€/year)$				**269.620**

Table 200. Recalculated total on-route costs of the company per year

Other costs

Other direct costs per year		
First year		
Type of cost	Percentage (%)	Cost (€)
Services to passengers	1	24.068
Handling of the airplane	1	24.068
Insurances of the airplane	2	48.136
Interests, depreciation and amortisation	1	24.068
Total costs $(€/year)$		**120.340**
Following years		
Type of cost	Percentage (%)	Cost (€)
Services to passengers	1	34.728
Handling of the airplane	-	-
Insurances of the airplane	2	69.456
Interests, depreciation and amortisation	1	34.728
Total costs $(€/year)$		**138.912**

* Handling of the airplane refers to the costs of carrying the airplane from the place where the

leaser/seller has it to the desired place, and so will be only taken into account the years when an airplane is leased/bought.

Table 201. Recalculated total other direct costs of the company per year

Total direct costs per year

Total direct costs per year			
First year		**Following year**	
Type of cost	Cost (€)	Type of cost	Cost (€)
Aircraft cost	-	Aircraft cost	984.000
Fuel costs	591.264	Fuel costs	591.264
Crew costs	333.011	Crew costs	333.011
Maintenance costs	854.048	Maintenance costs	854.048
Airport charges	432.375	Airport charges	432.375
On-route charges	269.620	On-route charges	269.620
Other costs	120.340	Other costs	138.912
Total direct costs $(€/year)$	**2.609.136**	**Total direct costs** $(€/year)$	**3.611.708**

Table 202. Recalculated total direct costs of the company per year

Indirect costs

Indirect costs per year		
First year		
Type of cost	Percentage (%)	Cost (€)
Publicity and commercialisation	3	78.274
General and administration expenses	1	26.091
Handling of the payload	1	26.091
Total indirect costs $(€/year)$		**130.457**

Following years		
Type of cost	Percentage (%)	Cost (€)
Publicity and commercialisation	3	108.351
General and administration expenses	1	36.117
Handling of the payload	1	36.117
Total indirect costs $(€/year)$		**180.585**

Table 203. Recalculated total indirect costs of the company per year

A16.4 Cash flow

Cash flow per year				
Year	Income (€)	Expenses (€)	Cash Flow (€)	Accumulated CF (€)
2015	-	1.527.015	-1.527.015	-1.527.015
2016	4.112.235	3.641.592	470.643	-1.056.372
2017	4.112.235	3.792.293	319.942	-736.430
2018	4.112.235	3.792.293	319.942	-416.488
2019	4.112.235	3.792.293	319.942	-96.546
2020	4.112.235	3.792.293	319.942	223.396
2021	4.112.235	3.792.293	319.942	543.338
2022	4.112.235	3.792.293	319.942	863.280
2023	4.112.235	3.792.293	319.942	1.183.222
2024	4.112.235	3.792.293	319.942	1.503.164
2025	4.112.235	3.792.293	319.942	1.823.106

* Note that it is being considered that during the first year the company only works on the installations, licences obtaining and other aspects (web page, publicity, etc.) and does not start operations until next year.

* Note that the first year of operations the expenses are a bit lower due to the first annual lease of the airplanes is covered on the initial investment. In addition, next of the years will not have costs on handling of the airplane, unless it decides to lease/buy a new one.

Table 204. Recalculated cash flow of the company per year

A16.5 Cash flow updated

Updated Cash Flow follows the next equation:

$$CFu = \frac{CF}{(1+d)^i};$$

where d is the discount rate and i is the number of years [114].

Discount rate takes into account the benefit given to the investor as well as a risk parameter, which corresponds to the insurance paid on property, personnel and merchandise in case any fire, theft, partial or total loss exists; and other not predictable situations like flight delays caused by aerial strikes (aircrew, aerial controllers...), bad weather conditions, temporary closing of an airport, breakdown of an airplane or part of it, etc. The study has been carried out with a percentage of discount rate which takes into account a 2% of risks, while the benefit given to the investor takes an 8%. In other words, total value of d corresponds to a 10%.

Having knowledge of the simple Cash Flow, parameter d and the years that have passed, updated Cash Flow can be easily calculated.

Updated Cash flow per year

Applied discount rate (%)			10	
Year	CF (€)	$nº\ years\ (i)$	CFu (€)	Accumulated CFu (€)
2015	-1.527.015	0	-1.527.015	-1.527.015
2016	470.643	1	427.857	-1.099.158
2017	319.942	2	264.415	-834.743
2018	319.942	3	240.377	-594.366
2019	319.942	4	218.525	-375.841
2020	319.942	5	198.659	-177.182

2021	319.942	6	180.599	3.416
2022	319.942	7	164.181	167.597
2023	319.942	8	149.255	316.853
2024	319.942	9	135.687	452.539
2025	319.942	10	123.351	575.891

Table 205. Updated cash flow of the company per year

A16.6 Breakeven point

Breakeven point is the number of passengers the company has to have so as to assure a positive cash flow. In order to find this target of passengers, percentage of the weekly demand will be modified until cash flow becomes negative, thing that occurs when demand is around 7,5%.

Breakeven point (number of passengers)		
Route	Target of passengers (%)	Number of passengers
BCN-PMI	7,5	1070
PMI-BCN	7,5	1057
Breakeven point (number of passengers)		**2127**

Table 206. Breakeven point in number of passengers

Another aspect that has to be taken into account is how far is the breakeven point from the maximum target of passengers admitted by the company's fleet, because as much far it is, less risks of having a negative cash flow. In order to analyse this aspect, it will be observed the target of passengers obtained when the airplane of the company flies full at every flight (it does not admit more

demand), in other words, the number of airplanes required by the company has to give exactly 1 (see *Annex 12*).

Maximum target of passengers admitted				
Route	Estimated occupation	Estimated target of passengers (%)	Maximum occupation	Maximum target of passengers (%)
BCN-PMI	0,941	9	1	9,5
PMI-BCN	0,929	9	1	9,6
Maximum target of passengers				**2708**

Table 207. Maximum target of passengers admitted

The company has a margin of 581 passengers, between its breakeven point and its maximum capacity of passengers.

A16.7 Payback time

Payback time is the number of years that have to pass until accumulated cash flow from the company becomes positive, in other words, how much time has to pass until the inversion is recovered [114].

Payback time will be analysed with accumulated updated cash flow because it takes into account the discount rate, and so it is more real than simple accumulated cash flow.

According to *Table 191*, the inversion will be recovered between years 2020 and 2021.

Accumulated updated cash flow	
Year	Accumulated CFu (€)
2020	-177.182
2021	3.416

Table 208. Accumulated updated cash flow between year 2020 and 2021

By carrying out a lineal regression it can be found the exact number of years at which the inversion is recovered.

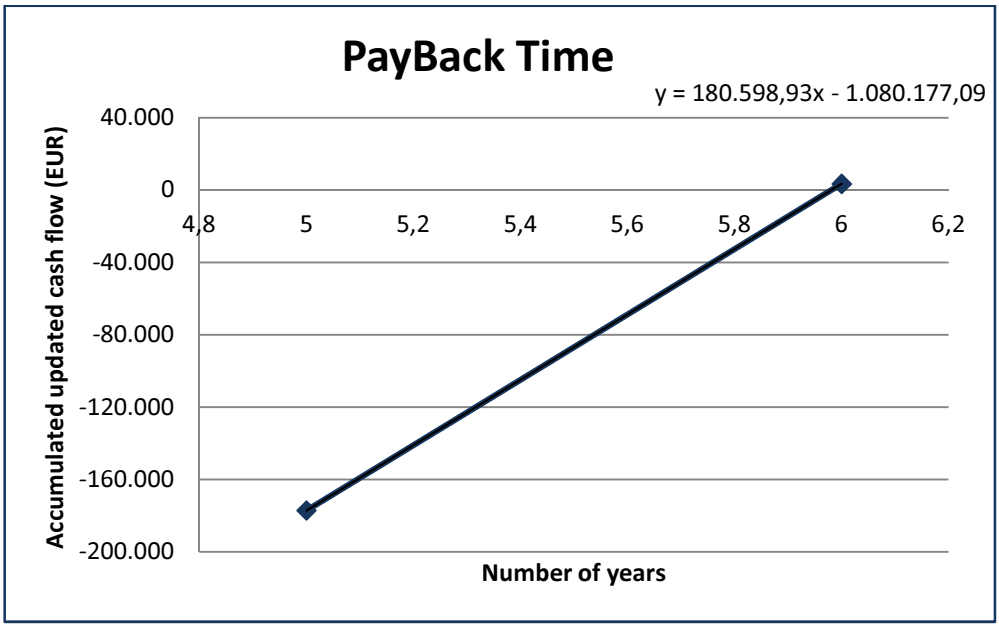


Figure 2. PayBack Time

Payback time is obtained when accumulated updated cash flow becomes cero:

$$CF_{u(Acc)} = 180.598{,}93 \cdot PBT - 1.080.177{,}09$$

$$0 = 180.598{,}93 \cdot PBT - 1.080.177{,}09$$

$$\boldsymbol{PBT = 5{,}98\ years}$$

A16.8 Net Present Value (NPV)

Net present value (NPV) is the amount of money the company has at the end of the years [114]. It corresponds to the accumulated updated cash flow at the last year of the project, which in this case reaches to 575.891 €.

NPV at the 10th year of the company (€)	575.891

Table 209. Net Present Value of the company

A16.9 Internal Rate of Return (IRR)

Internal rate of return (IRR) is the maximum discount rate that the company can permit itself in order that at the last year of the economical feasibility study accumulated updated cash flow stills being positive [113].

Internal Rate of Return	
Discount rate (%)	NPV (€)
18	38.544
19	-12.158

Table 210. Internal rate of return

As it is seen IRR reaches a percentage of 18%.

Annex 17: Characteristic parameters of the environmental impact of different ways of transport

A17.1 Aircraft engine emissions

Regarding the emission of the aircraft's engines, one of the main aspects in order to evaluate the environmental impact of an airplane is the quantity of polluting gases emitted by its engine. In this way, it will be analysed the emissions of hydrocarbon, oxides of nitrogen and carbon monoxide in the form of emission index, which is a ratio between the mass of the pollutant (HC, NOx or CO) in grams and the mass of fuel consumed in kilograms.

Following next three tables show the different kind of emissions:

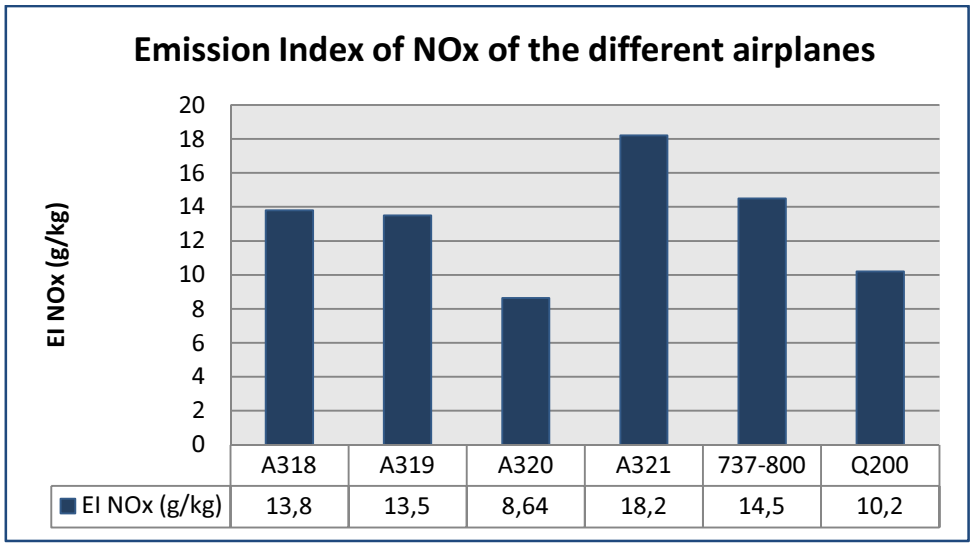


Figure 3. EI of NOx of the different airplanes (Data consulted from [115])

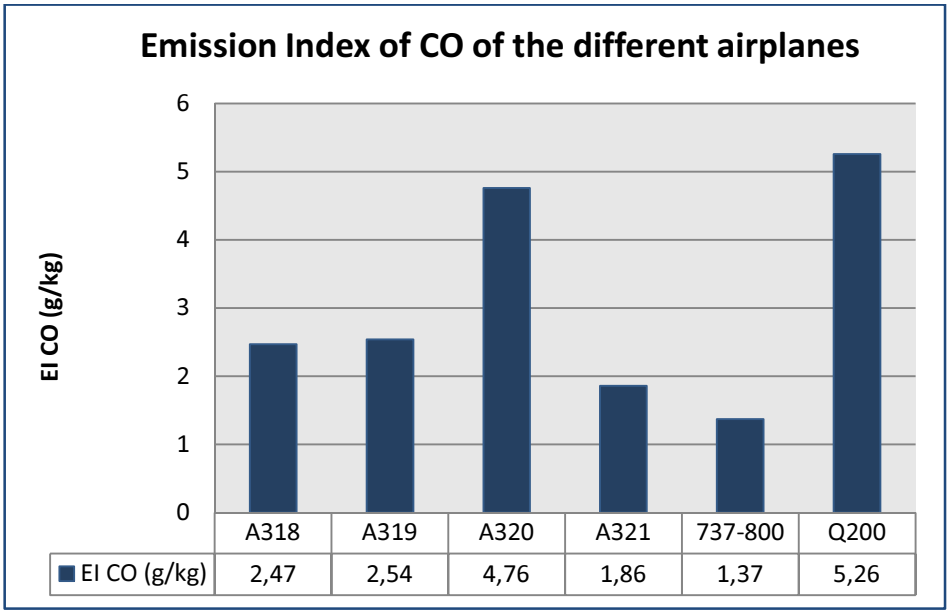


Figure 4. EI of CO of the different airplanes (Data consulted from [115])

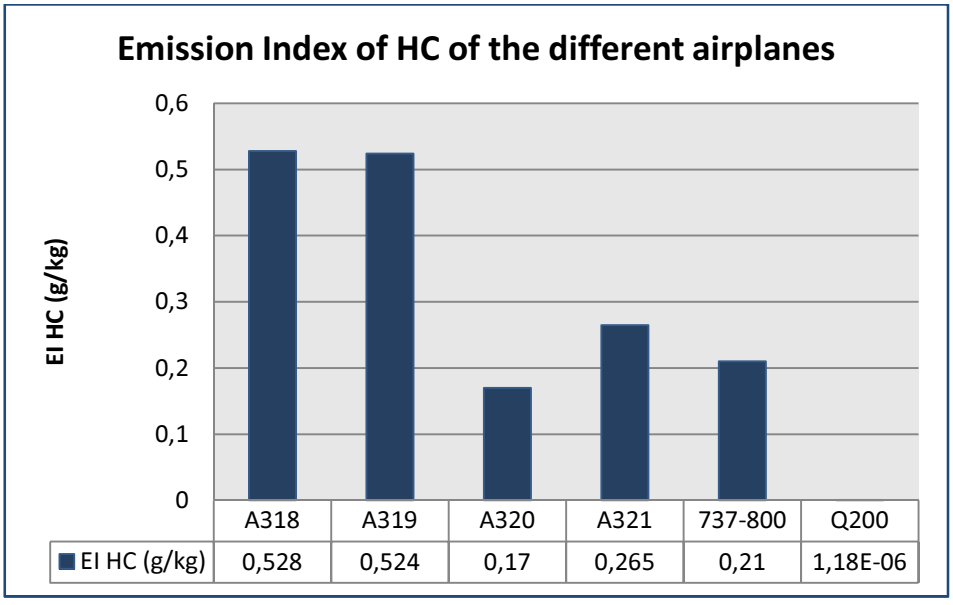
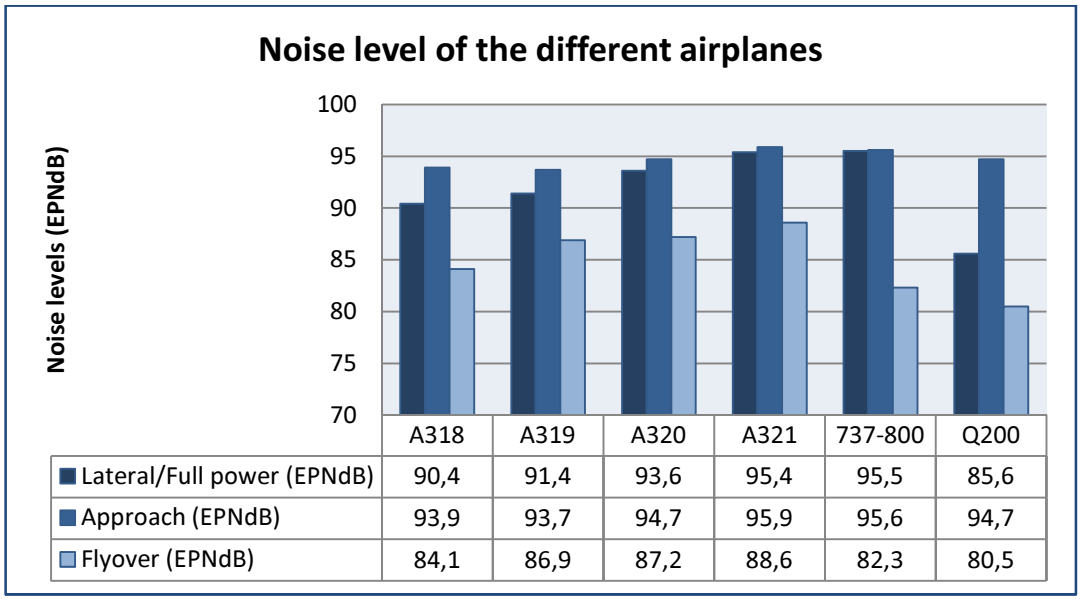


Figure 5. EI of HC of the different airplanes (Data consulted from [115])

A17.2 Aircraft noise pollution

In order to evaluate the noise pollution produced by the Q200 and its direct competitors, it will be had a look on the noise levels of each airplane in the three main manoeuvres: lateral/full power, approach and flyover.



	A318	A319	A320	A321	737-800	Q200
Lateral/Full power (EPNdB)	90,4	91,4	93,6	95,4	95,5	85,6
Approach (EPNdB)	93,9	93,7	94,7	95,9	95,6	94,7
Flyover (EPNdB)	84,1	86,9	87,2	88,6	82,3	80,5

Figure 6. Noise level of the different airplanes (Data consulted from [43], [116], [117], [118], [119] and [120])