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Planning Catalonia's Airport System Based on Econometric Analysis

Document:
Annexos

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ANNEX A: Sustainable Development Goals for the UN 2030 Agenda

The need for a sustainable development to shift the actual trend on climate change and growing inequalities called for a new plan to be implemented on a worldwide scale. In 2015, the United Nations took the reigns and created a series of recommendations (without implementing courses to action and a breakdown of goals) intended to revert and reconduct the world into a more sustainable, responsible and equative one. Nevertheless, these goals have been for some time now a polemic affair, as they do not impose- only recommend- and as such there is no true will on changing the ways of the world.

IT is through these goals, however, that we intend to articulate our thesis, to protect the people and environment surrounding the different scenarios in the planning of Catalonia's airport system. As they are very different topics and not all count on the aviation industry as a key game-changer, the inclusion to the thesis was out of scope. Therefore, we present here the definition and aims for each and every of the 17 proposed goals, for a better understanding of the criteria that later will be used when ensuring a fair comparison between scenarios.

1.1 The 17 goals

1. End poverty in all its forms everywhere: The covid pandemic has led to the first rise in extreme poverty in a generation. More than 120 million people have been pushed to this condition in 2020 and forecast project a 7% of poverty in 2030 [1]. Until April 2021, 118 countries passed reduction strategies through their governments to tackle the rise.

2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture [2]. Over 70 million people have experienced hunger due to the pandemic, adding up to a total of 720 million unnourished people. But food scarcity is not the only problem: access to a healthy balanced diet has been proved to be more difficult, as almost 6% of the children are overweight [2] and the mass exploitation of lands for agriculture are fatal for the local ecosystems. Nevertheless, the list of countries affected by high priced food has decreased from 2014 to 2019.

3. Ensure healthy lives and promote well-being for all at all ages: Life-expectancy and health services are on the spot in this item. The decade of progress in reproductive, maternal and child health could be torn away with the pandemic, and so this goal strives to reduce maternal and new-born mortality, AIDS, tuberculosis, and other diseases, prevent the harmful use of alcohol and tobacco, etc. [3].

4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all: Because of COVID, a further 9% of children fell behind the minimum reading proficiency levels [4]. The school completion rates are growing but are doing so at a very low pace, with high risk of reverting. Furthermore, school basic infrastructure does not reach 40% of facilities worldwide, preventing to build back better a future for everyone.

5. Achieve gender equality and empower all women and girls: Women still are represented less than a 30% in political powers but add up to 50% of the population. Violence against women has peaked through the pandemic and has reached one in three women, an unacceptable rate. Domestic and care work are pushing women away from the labour force, as they spend 2,5 hours more on that task than men [5].

6. Ensure availability and sustainable management of water and sanitation for all: Water scarcity has sadly been a recurring debate over the las few years. More than 25% of the population lack a reliable source of clean water and basic hygiene infrastructure [6]. Working towards a universal access is fundamental, when the natural wetlands have shrunk by 35% in the last 50 years (3x faster than deforestation processes).

7. Ensure access to affordable, reliable, sustainable, and modern energy for all: While 759 million people on the world lack electricity in their households [7], renewable energies are still not developing at the rate required, despite the improvement of the that last decade. The skyrocketing prices of some type of energies have made the goal more difficult to achieve it, and it is fundamental to put all efforts in shifting to sustainable sources.

8. Promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all: The world economy's average growth had already decreased before the commencement of the COVID-19 pandemic in 2020. The epidemic has triggered the largest worldwide economic crisis since the Great Depression. The 1,6 billion informal workers, not covered by a social safety net, have deeply struggled with the outburst of the pandemic, and an increase on unemployment – especially diminishing prospects for young women- is more than likely to occur [8].

9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation: The huge drop on manufacturing production that the world experienced this last year has proved catastrophic for every industry, especially the air travel demand, where passengers have dropped a rate of 60%. It is then fundamental to build back infrastructure to win productivity. Rural road connectivity is proven to be a major catalyst in reducing poverty, high-tech products are pushing the economy back and R&D have powered the vaccines to overcome the current crisis [9].

10.Reduce inequality within and among countries: The pandemic has put in evidence the differences in between countries. The inefficient share of vaccine shots around the world have triggered the appearance of new variants of COVID that won't end until the vaccination rate is high and equal around the world. Moreover, the inequality of opportunities has been responsible for the doubling of the world refugees since 2010. Within a same country, the current crisis is likely to tip the scales toward a less shared wealth (6% of increase of the average GINI index) [10].

11. Make cities and human settlements inclusive, safe, resilient, and sustainable: The increase of slums dwellers during the pandemic – believed to be around 1 billion people [11] - has worsen the global share of urban area. The national urban policies are being stuck prior to their implementation stage throughout the world, and the little access to public transport (only half of the urban population) weighs down the opportunity to reduce poverty.

12. Ensure sustainable consumption and production patterns: With the single-use products on the rise during the last few decades, the biodiversity of the earth has been seriously threatened by the material footprint of those material not recycle-friendly. Energy sources continue to struggle with the green reconversion, as fossil fuels and non-renewable sources of energy continue to drive the economic interest and to power the industries, especially in the developing countries. This production patterns are ultimately in charge for the triple crisis our planet is experiencing: climate change, biodiversity diminishment and rise of pollution episodes [12].

13. Take urgent action to combat climate change and its impacts: The 2015 Paris Agreement specified that the average temperature increase to be tolerated by the blue planet would not exceed 1,5ºC, which is considered critical for sustainability, although it is currently 1,2ºC higher than pre-industrial periods. Nonetheless, different institutions are finally supporting this issue, investing 10% more in climate change reversing technology in 2017-2018 than in 2015-2016. 125 of the 154 developing countries have established national climate adaptation plans [13], but more work is needed to move economies toward carbon neutrality.

14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development: Multiple factors are threatening the marine ecosystem, all of which have one enemy in common: humankind. Plastic pollution, acidification, fishery collapse, ocean warming, and eutrophication are all putting pressure on the marine ecosystems and species, even though over 3 billion people rely on the ocean for their lives [14]. To reverse the current disruption, effort must be taken to create a sustainable cycle that includes the conservation of biodiversity regions, a move toward small-scale fishing, and more resources for ocean study.

15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss: More than 25% of the species assessed by the IUCN are in extinction threat [15], and while the deforestation rate has been steadily climbing down, there is still work ahead. Increasing protected forests areas is one of the main improvements that the world has seen in the last decade, and countries are developing policies for sustainably manage the different ecosystems.

16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels. With trafficking and child labour intensified risk of exploitation by the pandemic, it is necessary to become inflexible with the promotion of justice and peace. Bribery is five times more likely to happen in low-income countries, and in 2020 331 human rights defenders were killed [16]. Therefore, the need of powerful independent institutions is needed to prevent the overseeing of the actions.

17. Strengthen the means of implementation and revitalize the global partnership for sustainable development. With the unprecedented intercommunication halt caused because of the pandemic, foreign investment (a catalyst for less developed regions) has dropped by a 40%. Nevertheless, the expected crash on net ODA did not happen, but it is still far from the target. Connectivity can simply not happen nowadays without internet access, and 3,7 billion people are still not online [17]. It is necessary, then, to foster communication and enhance relationships to tackle all the other SDGs together, to obtain better results and become more resilient.

ANNEX B: Prognosis methodology additional explanatory graphs and tables

For the construction of the prognosis, numerous data sources were researched. The challenge to find open data from reliable sources that accurately could characterize the airports studies became an arduous work, and therefore the thesis had to create reliable and complex prognosis based on simple data.

To ensure the minimum requirements were always applied, the need for a backup programme was needed. To do so, several spreadsheets were created to support the predictions and to become the tool in which develop them. The Excel tool used enabled for the development of different prognosis techniques and the display of their results, becoming a huge asset for defining the most efficient and sustainable airport system in Catalonia.

As the data collected was big enough to overshadow the rest of the thesis, all breakdown structure for the prognosis was held apart from the main document. This is the reason why we are presenting it here, to help understand better the processes in which the prognosis has been developed and to ensure the independent and truthful creation of knowledge from the author.

2.1 Historic data tables

Data has driven the whole prognosis concept and as such it deserved a specific section. Given the fact that it is distributed in numerous tables and presents a big collection of specific items, the need for wide spaces to present them is a requirement rather than a recommendation.

For this section, it is aimed to present the recollection of historical data for the three airports studied (Josep Tarradellas Barcelona-El Prat, Girona-Costa Brava and Reus) in which later the prognosis will be built. It is important to acknowledge that the following tables are the core of the work, and that without them there would not be reliable data for the sources and prognosis models[1].

As the tables are in need for horizontal orientation, they are presented in the next pages.

Table 1: BCN airport historic data (2021 until November). In red and yellow, the peak month for operations and passengers in the years 2019 and 2020. (Source: ANEA, Own Elaboration)

Table 2: GRO airport historic data (2021 until November). In red and yellow, the peak month for operations and passengers in the years 2019 and 2020. (Source: ANEA, Own Elaboration)

Table 3: REU airport historic data (2021 until November). In red and yellow, the peak month for operations and passengers in the years 2019 and 2020. (Source: ANEA, Own Elaboration)

[1] Data extracted from [24].

OPS BCN	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
January	21589	20747	18306	18364	18317	19332	20846	22403	24005	23445	5572
February	21251	19057	17276	17609	17508	19843	20175	21348	22696	22992	3984
March	24532	22424	20645	20962	21697	23379	24207	25797	25966	13846	5293
April	25473	24577	23703	24305	24926	26572	27619	28545	29763	1499	6360
May	27724	26787	25896	26506	26883	28403	30087	30704	31164	1777	9342
June	27563	27492	26239	27360	27709	28868	30587	31331	32078	2753	13359
July	28617	29024	28065	29191	29442	30929	32128	32594	33232	10369	19747
August	27546	28204	27514	28964	29257	30462	31495	32060	32673	14045	21857
September	27534	27270	25828	27121	27271	29230	30583	31611	32111	10497	20838
October	26590	25258	24087	25095	25349	27317	29235	30616	30786	8939	20044
November	22703	19911	19702	19403	20580	21926	23465	23742	24938	5324	17.837
December	21932	19253	19236	18971	19940	21602	23108	24901	25151	7152	
TOTAL	303054	290004	276497	283851	288879	307863	323535	335652	344563	122638	144233
Variación		-4,31%	-4,66%	2,66%	1,77%	6,57%	5,09%	3,75%	2,65%	-64,41%	17,61%

PAX BCN	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
January	2006841	2164075	1997231	2100648	2203277	2517214	2803948	3058260	3274938	3396470	411486
February	2086097	2101807	2011982	2140628	2218651	2672189	2801585	3034097	3267695	3280932	286650
March	2592509	2605612	2541386	2700188	2892410	3301423	3466740	3834787	3967540	1417147	423774
April	2880065	2994778	2868707	3178569	3329318	3622362	4114128	4241905	4522810	25307	481682
May	3072750	3154819	3218707	3397023	3604942	4049108	4325968	4549769	4681994	46961	852251
June	3234352	3402837	3495146	3716516	3815345	4197822	4585286	4809324	5106242	148903	1374717
July	3607572	3824658	3840387	4027571	4257518	4668322	5041481	5166397	5361321	872924	2271991
August	3623889	3874131	3906955	4243977	4399719	4701329	4944029	5149418	5410994	1110578	2853548
September	3338101	3497748	3526385	3800802	3974601	4359940	4637662	4843853	5106950	844410	2634229
October	3064552	3054224	3119185	3369084	3621777	4018769	4174467	4542398	4645979	712283	2680992
November	2466411	2279699	2383090	2473568	2788922	3043644	3195505	3444398	3674584	341496	2.343.661
December	2425087	2190115	2307667	2410407	2604757	3002600	3193648	3498083	3667408	541358	
TOTAL	34398226	35144503	35216828	37558981	39711237	44154722	47284447	50172689	52688455	12738769	16614981
Variación		2,17%	0,21%	6,65%	5,73%	11,19%	7,09%	6,11%	5,01%	-75,82%	30,43%

OPS GRO	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
January	2060	1401	1096	922	801	796	751	726	556	922	725
February	1987	1369	1048	994	849	915	914	588	663	1274	505
March	2561	1644	1452	1081	1149	1110	1115	929	586	515	806
April	2752	2500	2580	2045	1769	1439	1798	1511	1443	70	686
May	2702	3064	2931	2332	2341	1963	2192	1975	2002	97	898
June	2677	3013	3052	2283	2269	2453	2263	2281	2151	330	1134
July	2910	3785	3573	2668	2596	2663	2838	2447	2439	1235	1796
August	2791	3211	3323	2742	2258	2412	2406	2431	2366	1685	1955
September	2366	2828	2969	1978	2045	1868	1885	2131	2019	1186	1518
October	2378	2545	2833	2046	1736	1600	1830	1701	1668	1060	1521
November	1252	1231	1223	764	994	912	693	602	1386	866	976
December	1363	1085	970	775	722	684	569	552	974	719	
TOTAL	27799	27676	27050	20630	19529	18815	19254	17874	18253	9959	12520
Variación		-0,44%	-2,26%	-23,73%	-5,34%	-3,66%	2,33%	-7,17%	2,12%	-45,44%	25,72%

PAX GRO	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
January	189796	88029	79046	59229	49333	47284	40742	41718	37413	36126	863
February	197228	91025	78587	57669	48500	51681	39552	40719	34374	35090	463
March	269697	136196	140955	74418	69776	76025	63805	72885	40173	12753	711
April	305522	279376	252570	210219	169408	140128	183292	178095	175376	70	648
May	277291	301153	294723	235194	201979	176136	219688	227229	229321	95	1987
June	298107	329057	323015	261767	215985	205739	259252	281357	273998	748	19624
July	352891	391163	384187	317116	253564	258766	303258	310140	294820	35590	52195
August	358356	410326	407535	339882	255076	257894	297668	315410	305203	37565	80672
September	305621	345117	333885	269065	217884	200199	254348	280660	258753	8603	69028
October	262652	282810	284179	221266	182853	161369	196308	196293	199598	3497	65283
November	96077	98802	91830	64961	62622	50246	46133	38326	46355	942	7.107
December	94739	91517	66355	49959	48346	39389	42648	37306	37665	1092	
TOTAL	3007977	2844571	2736867	2160745	1775326	1664856	1946694	2020138	1933049	172171	298581
Variación		-5,43%	-3,79%	-21,05%	-17,84%	-6,22%	16,93%	3,77%	-4,31%	-91,09%	73,42%

OPS REU	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
January	1126	863	766	675	776	761	663	745	756	1164	977
February	1284	806	751	950	619	885	711	806	1141	1103	1081
March	1664	958	974	879	688	758	979	928	1155	368	1575
April	1995	1077	1469	1187	915	954	1087	1274	1233	54	1124
May	2543	1864	1736	1655	1520	1317	1825	1687	1909	336	1039
June	2393	2079	2184	2131	1677	1656	1966	1970	2226	1256	1090
July	2647	2002	2240	2164	1662	1952	2182	2227	2214	1948	1535
August	2219	1752	1709	1613	1427	1709	1778	1687	1785	1532	1164
September	2124	1529	1840	1678	1361	1499	1750	1947	1897	1497	1286
October	1885	1456	1607	1640	1291	1381	1555	1493	1683	1350	1687
November	941	1001	889	760	870	868	885	1061	1052	1201	1.239
December	673	725	812	654	727	733	642	1030	628	694	
TOTAL	21494	16112	16977	15986	13533	14473	16023	16855	17679	12503	13797
Variación		-25,04%	5,37%	-5,84%	-15,34%	6,95%	10,71%	5,19%	4,89%	-29,28%	10,35%

PAX REU	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
January	23793	927	14501	8063	8807	5549	9483	6612	5834	1669	313
February	22553	496	15444	8048	7875	5561	7315	6777	3895	2946	356
March	42997	10264	29839	10487	10511	11148	11613	16428	4782	1301	562
April	126114	63551	61043	43178	27540	27692	42323	43750	54356	163	386
May	177193	112692	114252	104057	83647	90687	116140	122969	135741	226	577
June	195329	153433	154000	134095	123705	135265	176627	185574	189263	429	7855
July	226128	165873	166984	156760	130409	167641	192145	194422	193143	14513	25070
August	227923	163022	167136	162496	130818	156129	190940	185240	196893	9680	45477
September	186407	136980	133000	135657	106555	125757	159578	169108	160594	4774	40233
October	131735	90772	89263	69047	59322	74831	95663	90451	94385	2983	37491
November	1917	23153	16525	10755	7980	9730	8060	9671	4852	380	317
December	594	16178	9033	7849	7869	7775	9002	6763	2511	396	
TOTAL	1362683	937341	971020	850492	705038	817765	1018889	1037765	1046249	39460	158637
Variación		-31,21%	3,59%	-12,41%	-17,10%	15,99%	24,59%	1,85%	0,82%	-96,23%	302,02%

2.2 Historic data additional graphics

With the given data from the previous tables, we are now able to structure and give visual aid to all this information. Whereas the most important graphics are indeed attached in the main document, there is still additional information to be disclosure to give complementary understanding to the current situation that the civil and commercial aviation is experiencing and, in some cases, enduring.

To ensure a tidy and correct order for the graphics the intention is to split the section for the three studied aviation infrastructures, to then give better context to the information that it is seen.

2.2.1 Josep Tarradellas Barcelona-El Prat airport

The main airport in Catalonia presents the following behaviour over the outburst of the covid pandemic and the recuperation rate that it is experiencing so far within its facilities. This first figure explains the increase or diminishment of passengers and operations with respect to the year before in hundred per cent (%).

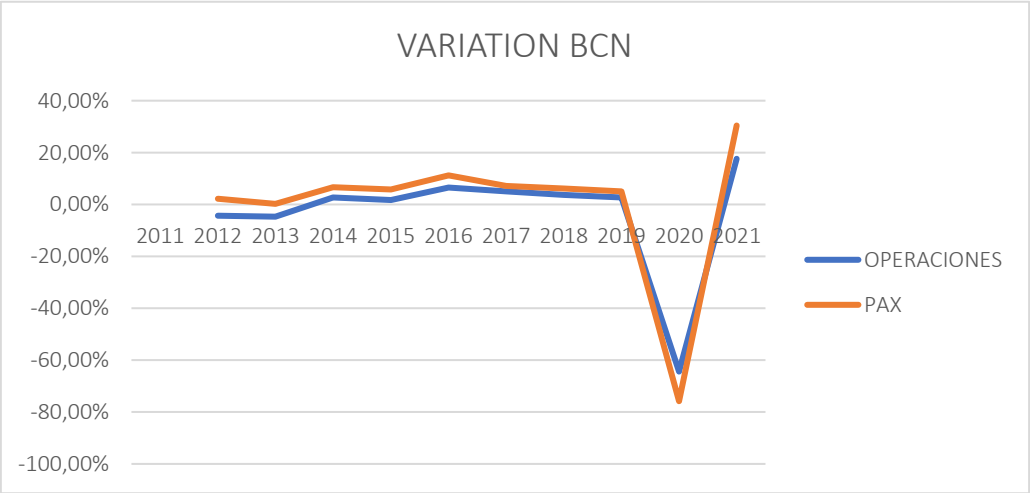

Figure 1: Variation rates for the BCN airport (Source: AENA, Own Elaboration)

In the next page the evolution of the airport's activity (operations and passengers) through the years 2019 (no covid), 2020 (covid outburst) and 2021 (recovery year) is presented, to give a better understanding of the evolution that the mentioned infrastructure has endured.

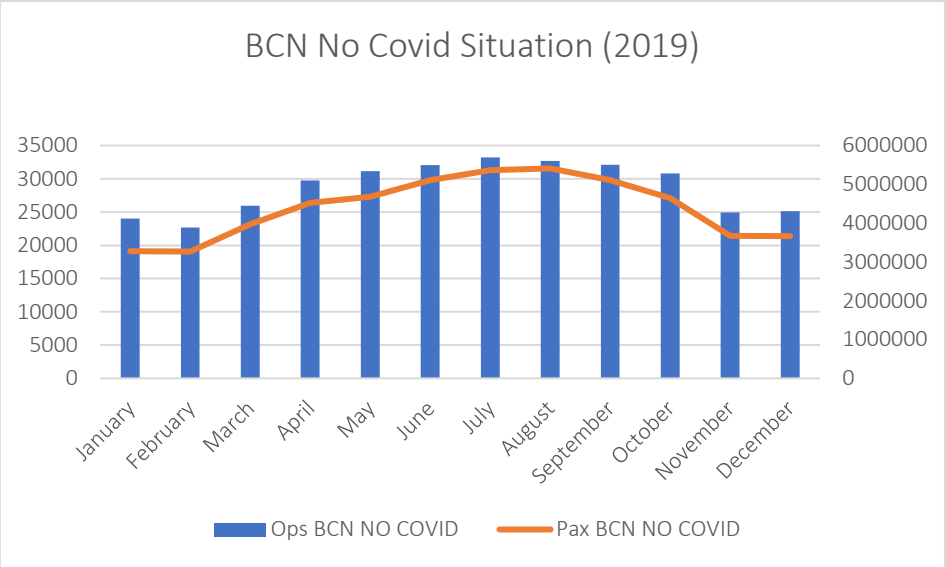

Figure 2: BCN no covid situation (Source: AENA, Own Elaboration)

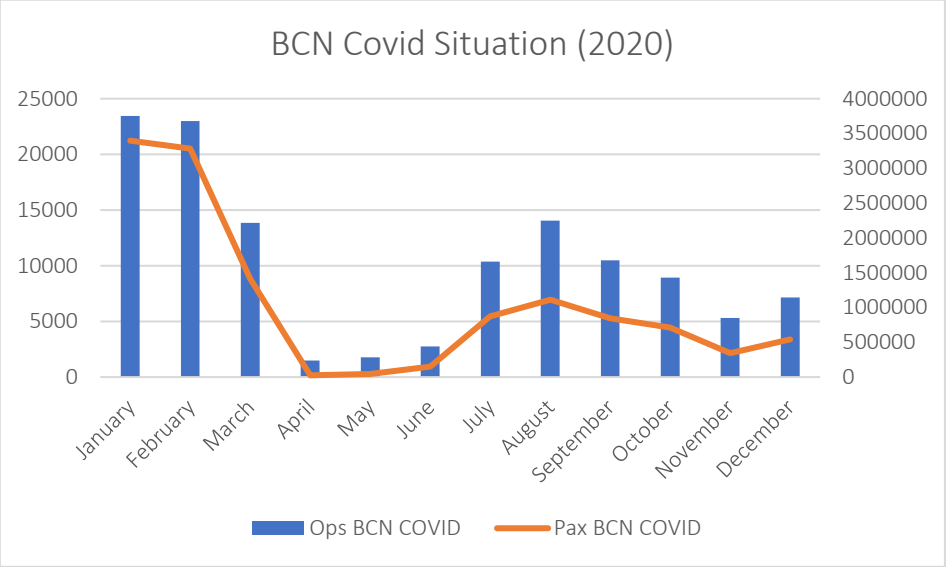

Figure 3: BCN covid situation (Source: AENA, Own elaboration)

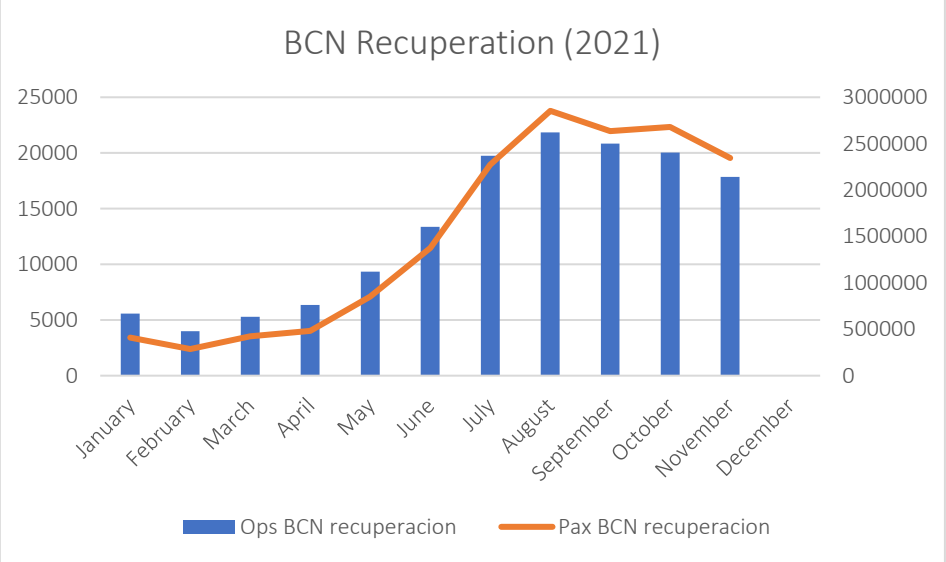

Figure 4: BCN recovery situation (Source: AENA, Own Elaboration)

2.2.2 Girona-Costa Brava airport

The second airport in Catalonia presents the following behaviour over the outburst of the covid pandemic and the recuperation rate that it is experiencing so far within its facilities. This first figure explains the increase or diminishment of passengers and operations with respect to the year before in hundred per cent (%).

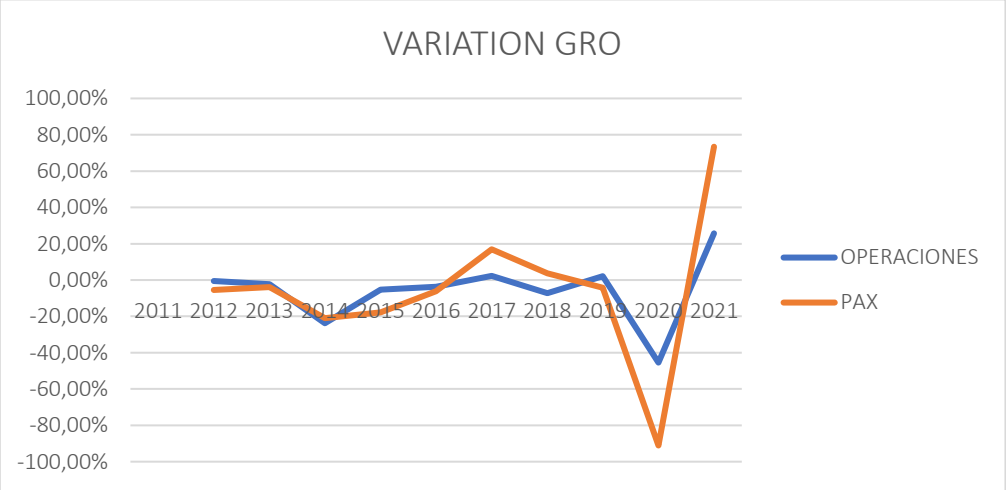

Figure 5: Variation rates for the GRO airport (Source: AENA, Own Elaboration)

Next is the evolution of the airport's activity (operations and passengers) through the years 2019 (no covid), 2020 (covid outburst) and 2021 (recovery year) is presented, to give a better understanding of the evolution that the mentioned infrastructure has endured.

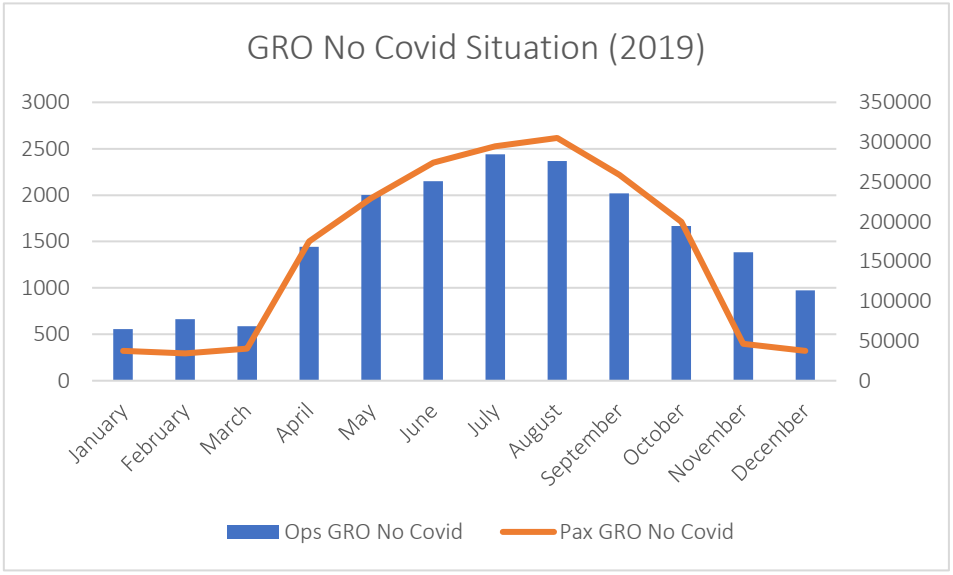

Figure 6: GRO no covid situation (Source: AENA, Own Elaboration)

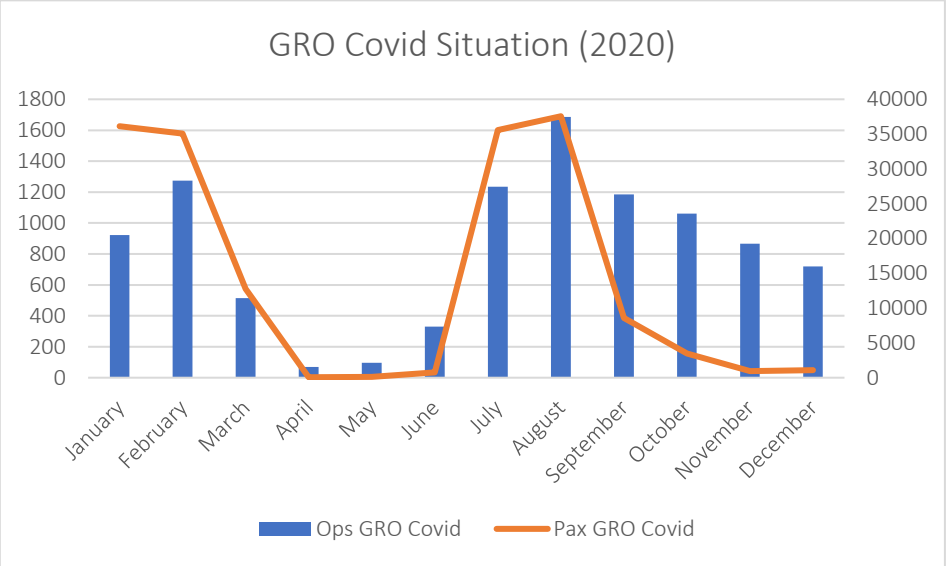

Figure 7: GRO covid situation (Source: AENA, Own Elaboration)

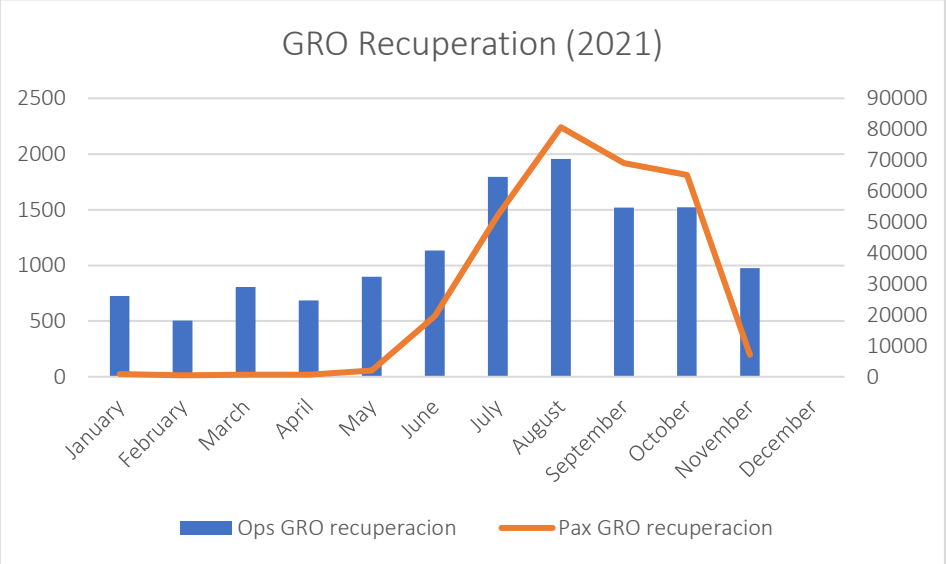

Figure 8: GRO recovery situation (Source: AENA, Own Elaboration)

2.2.3 Reus airport

The third airport and las studied airport in Catalonia presents the following behaviour over the outburst of the covid pandemic and the recuperation rate that it is experiencing so far within its facilities. This first figure explains the increase or diminishment of passengers and operations with respect to the year before in hundred per cent (%).

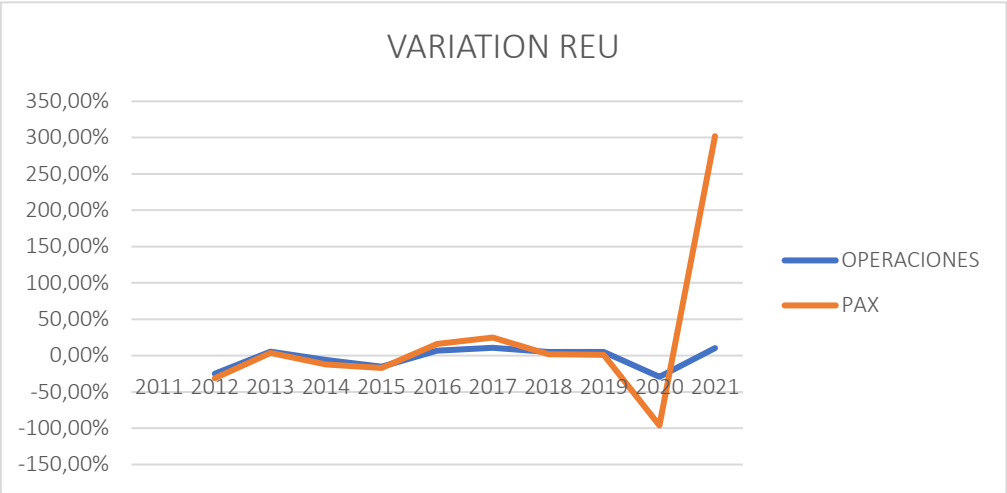

Figure 9: Variation rates for the REU airport (Source: AENA, Own Elaboration)

Next is the evolution of the airport's activity (operations and passengers) through the years 2019 (no covid), 2020 (covid outburst) and 2021 (recovery year) is presented, to give a better understanding of the evolution that the mentioned infrastructure has endured.

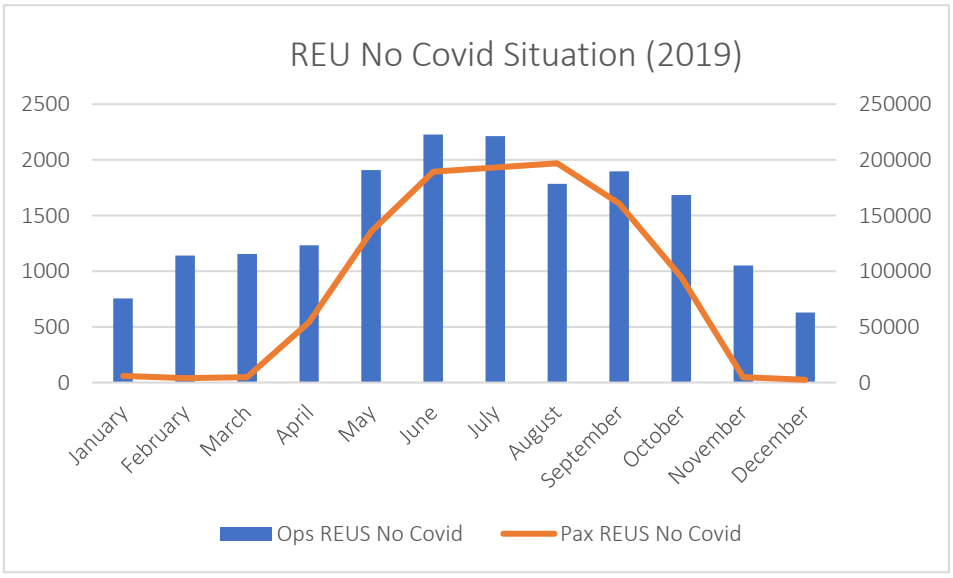

Figure 10: REU no covid situation (Source: AENA, Own Elaboration)

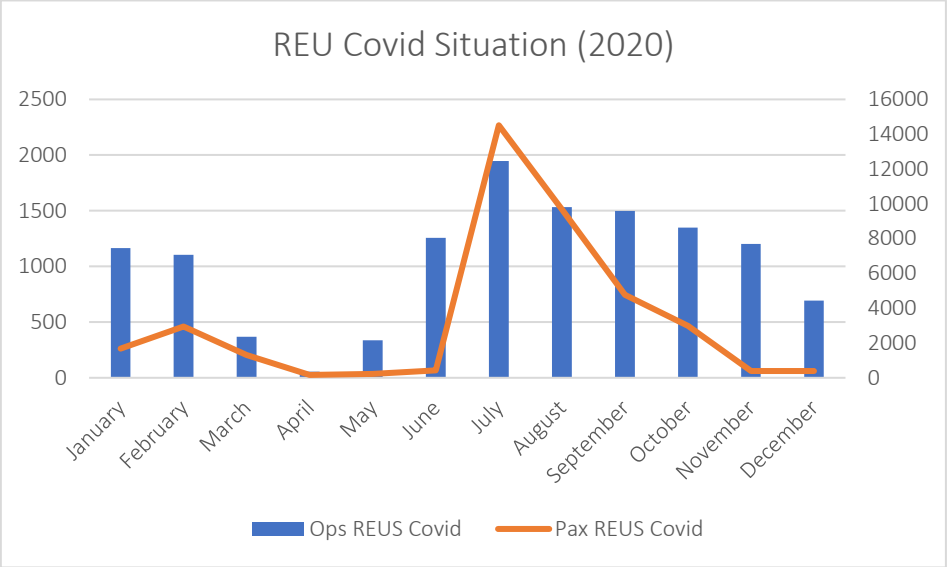

Figure 11: REU covid situation (Source: AENA, Own Elaboration)

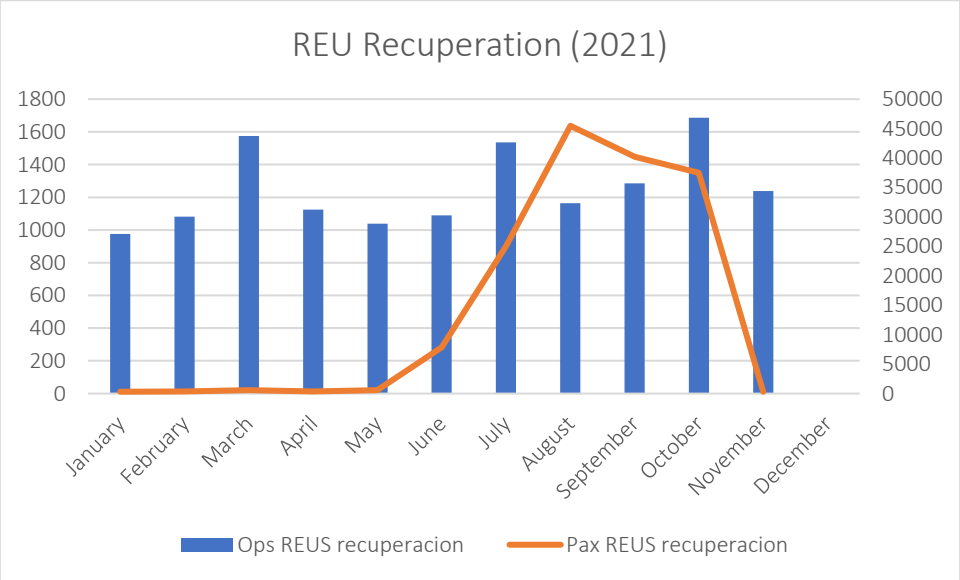

Figure 12: REU recovery situation (Source: AENA, Own Elaboration)

2.3 Eurocontrol data additional graphics

When presenting the Eurocontrol scenario in the main document, it is observed that only the trend for the three different Eurocontrol scenarios is displayed. Further work was made on the subject, but for remittance to the scope of the work reasons they were not displayed there. This is the reason why, with this section, it is aimed to clarify how would the scenarios forecasted by Eurocontrol adjust to the real data from the studied airports. It is with this goal that the graphics are presented next:

2.3.1 Josep Tarradellas Barcelona-El Prat airport

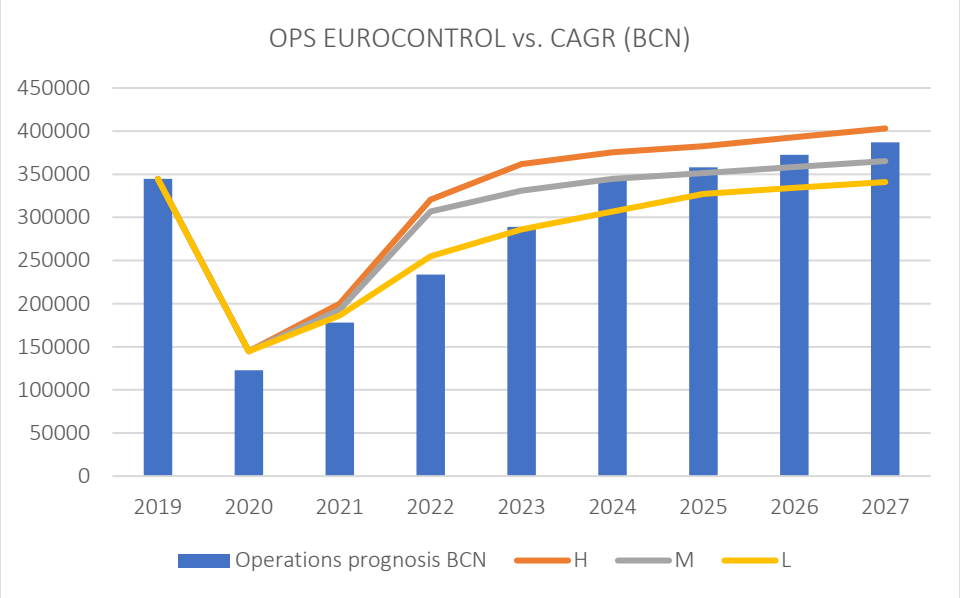

Figure 13: Graphic showing the adjustment of Eurocontrol forecast for the ops in the BCN airport (Source: AENA, Eurocontrol, Own Elaboration)

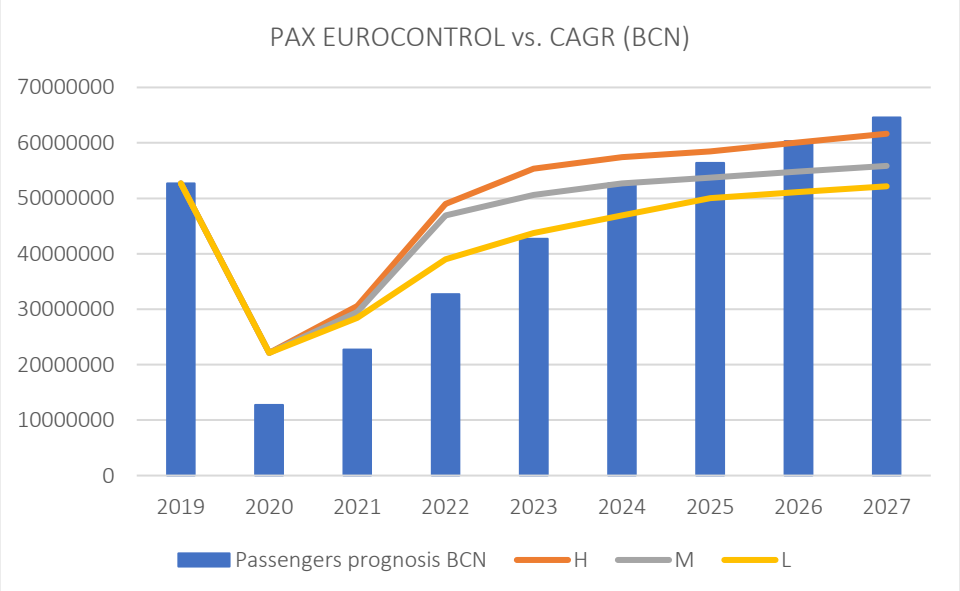

Figure 14: Graphic showing the adjustment of Eurocontrol forecast for the pax in the BCN airport (Source: AENA, Eurocontrol, Own Elaboration)

2.3.2 Girona-Costa Brava airport

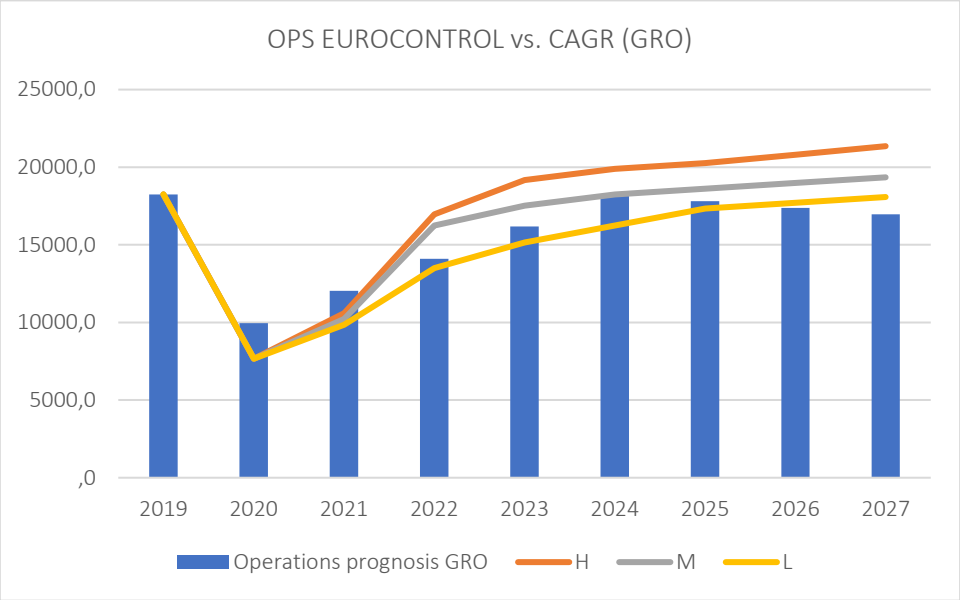

Figure 15: Graphic showing the adjustment of Eurocontrol forecast for the ops in the GRO airport (Source: AENA, Eurocontrol, Own Elaboration)

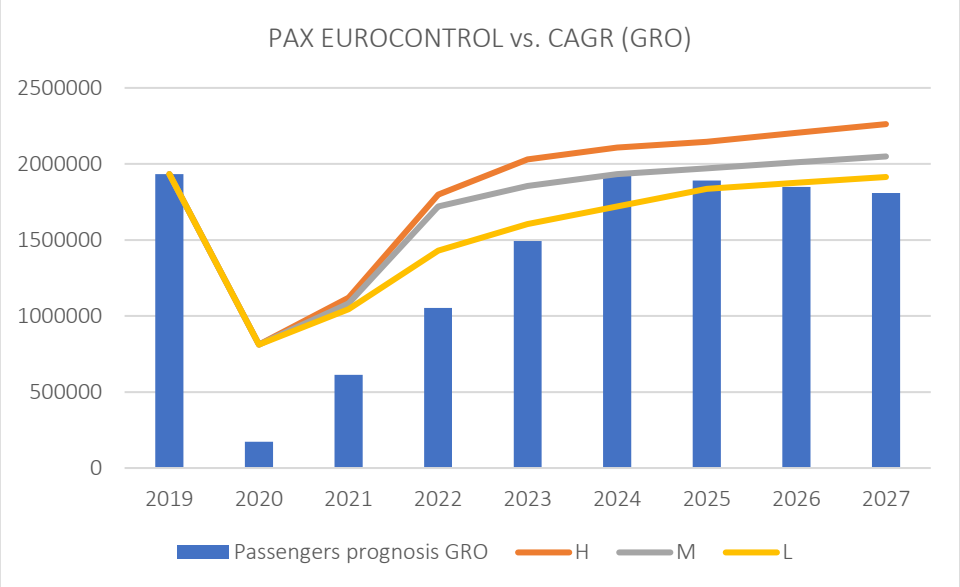

Figure 16: Graphic showing the adjustment of Eurocontrol forecast for the ops in the GRO airport (Source: AENA, Eurocontrol, Own Elaboration)

2.3.3 Reus airport

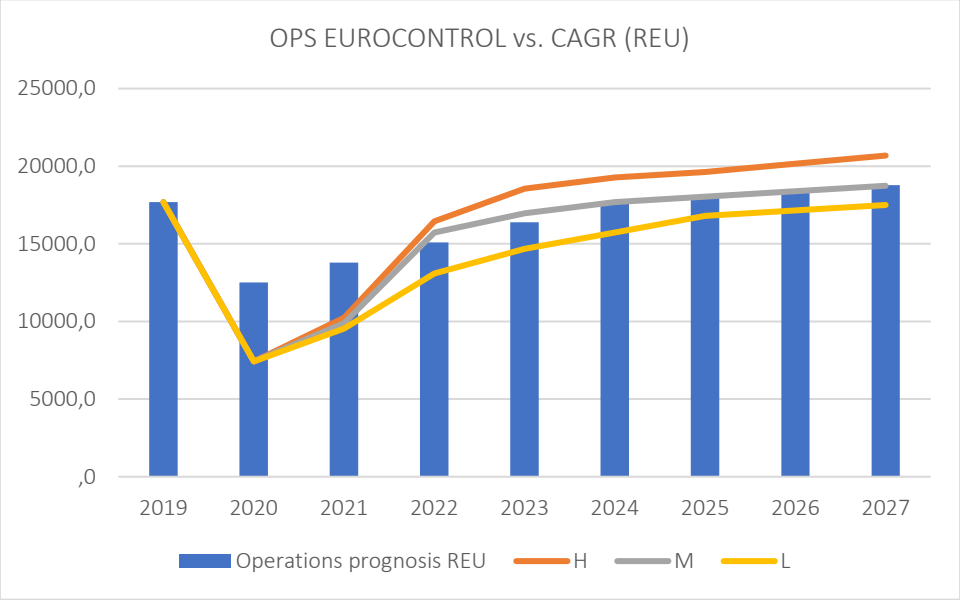

Figure 17: Graphic showing the adjustment of Eurocontrol forecast for the ops in the REU airport (Source: AENA, Eurocontrol, Own Elaboration)

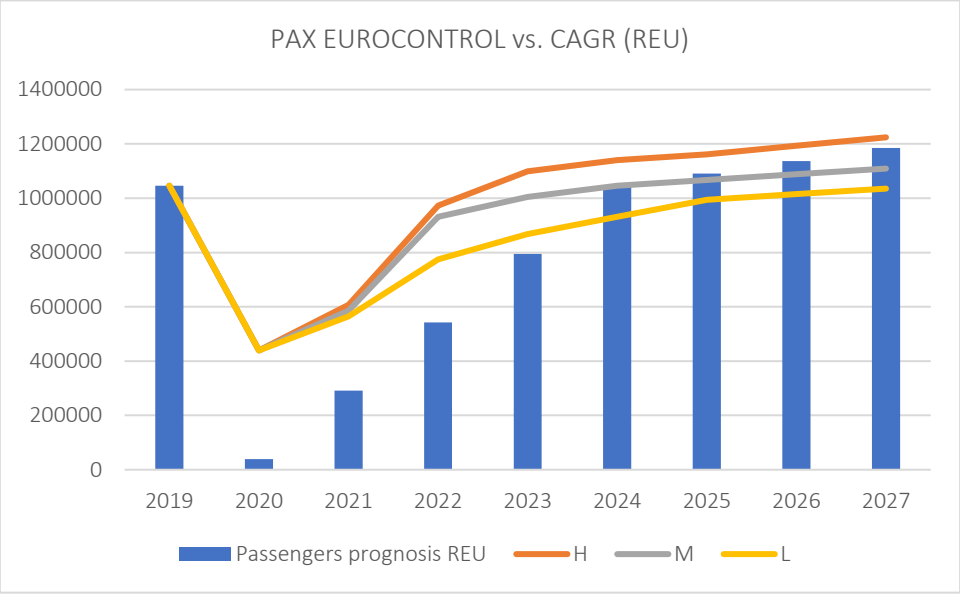

Figure 18: Graphic showing the adjustment of Eurocontrol forecast for the ops in the REU airport (Source: AENA, Eurocontrol, Own Elaboration)

2.4 Macroeconomic model explanation and data tables

The macroeconomic study it is been by far the most complicated task for the current prognosis. This methodology did not aim to forecast the studied infrastructures aviation activity through historical data, but base the entire prevision on macroeconomic factors, that would help develop a plan for the years to come until the design year in 2035.

The access to the macroeconomic data is wider and different institutions serve the same objective. Therefore, this method aimed to reduce the insecurity that the little access to aviation data revealed on the other methodologies. Nevertheless, for this prognosis to work, we were in need for the forecast of several chosen macroeconomic data, and here it is where we, again, found an issue. The macroeconomic long-term forecast is only given openly in few global institutions, and thus they did not study the case of Catalonia. This is the reason why in most of the selected criteria, we end up with Spanish forecast rather than Catalan ones (the preferrable option), because there are greater studies in the Spanish territory than in the Catalan one.

The selection of macroeconomic criteria had to ensure the high correlation factors with the aviation results in the historic part of the graphic, and at the same time count on long-term feasible forecast for the model to continue operating in the future and prognose the operations and passengers for the different airports.

The model, assembled using several statistical strategies (including the Granger method to see if the macroeconomic variables were redundant or not), also played with the display of such data. For instance, the GDP presented higher correlation when calculated as the Napierian logarithmic of the GDP. This case also appeared when displaying the results. For some airports, the correlation between actual passengers and model passengers was higher when the result displayed logarithmic values of operations and passengers, rather than the activity values itself.

In the following pages the data from which the model has been built is displayed.

Table 4: Macroeconomic data for the assembly of the model. Historic data recollection. In green are shown the final criteria selected for the study (Source: AENA, Own Elaboration from several statistics institutions [18]–[23])

Table 5: Macroeconomic data for the assembly of the model. Prognosis of macroeconomic factors. In green are shown the final criteria selected for the study (Source: AENA, Own Elaboration from several statistics institutions [18]–[23])

		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
OPS	BCN	303054	290004	276497	283851	288879	307863	323535	335652	344563	122638
	GRO	27799	27676	27050	20630	19529	18815	19254	17874	18253	9959
	REU	21494	16112	16977	15986	13533	14473	16023	16855	17679	12503
	ln(BCN)	12,62166629	12,57765	12,5299552	12,5562047	12,5737632	12,63741016	12,68706258	12,7238302	12,7500322	11,7169922
	ln(GRO)	10,23275533	10,2283209	10,2054423	9,93450161	9,87965582	9,842409703	9,86547411	9,79110242	9,81208473	9,20623194
	ln(REU)	9,975529105	9,68731961	9,73961477	9,67946862	9,51288643	9,580040124	9,681780469	9,73240263	9,78013277	9,43372389
PAX	BCN	34398226	35144503	35216828	37558981	39711237	44154722	47284447	50172689	52688455	12738769
	GRO	3007977	2844571	2736867	2160745	1775326	1664856	1946694	2020138	1933049	172171
	REU	1362683	937341	971020	850492	705038	817765	1018889	1037765	1046249	39460
	ln(BCN)	17,35351555	17,3749788	17,3770346	17,4414231	17,4971448	17,60321043	17,67169198	17,7309814	17,7799069	16,3601606
	ln(GRO)	14,91677832	14,8609228	14,8223244	14,5859636	14,3894946	14,32524919	14,48164311	14,5186764	14,4746091	12,0562434
	ln(REU)	14,12496611	13,7508024	13,7861023	13,6535703	13,466007	13,61433029	13,83422338	13,8525799	13,8607219	10,5830428
	PIB (corrientes)	208.341	201.768	201.531	204.896	213.746	222.514	232.187	241.670	249.900	224.125
	PIB (%)	-0,6%	-3,2%	-1,0%	1,6%	3,9%	3,5%	3,3%	2,8%	1,9%	-11,5%
	Inflation	3,2%	2,5%	1,4%	-0,2%	-0,5%	0,2%	2,0%	1,7%	0,7%	-0,3%
	PIB real (%)	-3,8%	-5,7%	-2,4%	1,8%	4,4%	3,3%	1,3%	1,1%	1,2%	-11,2%
	PIB (constantes)	201.674	196.825	198.689	205.203	214.815	222.069	227.636	237.610	248.151	224.842
	Deuda pública (ESP)	69,5%	85,7%	95,5%	100,4%	99,3%	99,2%	98,6%	97,5%	95,5%	119,9%
	IPC	95,5	98,3	100,0	100,1	99,9	100,0	102,2	104,1	105,0	104,5
	Desempleo (ESP)	21,4%	24,8%	26,1%	24,4%	22,1%	19,6%	17,2%	15,3%	14,1%	15,5%
	VAB	193.619	187.197	185.787	189.036	196.543	204.386	212.921	221.305	229.347	206.959
	ln(PIBreal)	12,2144	12,1901	12,1995	12,2318	12,2775	12,3107	12,3355	12,3784	12,4218	12,3232
	Inflation	3,20%	2,45%	1,41%	-0,15%	-0,50%	0,20%	1,96%	1,68%	0,70%	-0,32%
	DP	69,5%	85,7%	95,5%	100,4%	99,3%	99,2%	98,6%	97,5%	95,5%	119,9%
	Desempleo ESP	21,4%	24,8%	26,1%	24,4%	22,1%	19,6%	17,2%	15,3%	14,1%	15,5%

	2021	2022	2023	2024	2025	2026
GDP (constant prices)	236.983,7	252.150,6	258.706,6	263.880,7	268102,3	272.124,3
ln(GDP)	12,37574655	12,43778194	12,46344969	12,48325232	12,49912567	12,51401428
Inflation rate	2,24%	1,65%	1,38%	1,58%	1,71%	1,70%
Public Debt	120,2%	116,4%	116,2%	116,3%	116,8%	117,8%
Unemployment rate	15,4%	14,8%	14,1%	13,9%	13,8%	13,7%

2.4.1 JT Barcelona-El Prat airport

For the BCN airport, the linearization of the different macroeconomic criteria is shown next. It is observed that for this specific airport, both operations and passengers prognosis work best when the result refers to the resultant airport activity not being represented on a logarithmic scale (the R factor, outlined in green, is higher). The first-row data corresponds to the coefficients for every macroeconomic criteria.

OPS

SIN ln OPS				
2766414,52	-297486,879	1716553,77	1853473,65	-22775272,7
480582,7989	94526,4204	964918,138	262139,131	3341909,24
0,948606187	18927,0262	#N/A	#N/A	#N/A
23,07199379	5	#N/A	#N/A	#N/A
33060535369	1791161596	#N/A	#N/A	#N/A

Con ln OPS

13,86055739	-1,44191798	7,58518137	8,74649126	-96,4153421
2,410301566	0,47408517	4,83942352	1,31472529	16,7609184
0,943390717	0,09492608	#N/A	#N/A	#N/A
20,83118404	5	#N/A	#N/A	#N/A
0,750835906	0,0450548	#N/A	#N/A	#N/A

PAX

SIN ln PAX				
543261485,2	-35334450,6	338956963	383142589	-4747808908
88868931,27	17479739,1	178431779	48474528,2	617982798
0,94673581	3499968,35	#N/A	#N/A	#N/A
22,21792476	5	#N/A	#N/A	#N/A
1,08866E+15	6,1249E+13	#N/A	#N/A	#N/A

Con ln PAX

20,56056539	-1,54595905	10,9833	13,3430106	-149,296408
3,537918282	0,69587749	7,10346173	1,92979613	24,602216
0,933562867	0,13933556	#N/A	#N/A	#N/A
17,56477932	5	#N/A	#N/A	#N/A
1,364038422	0,09707199	#N/A	#N/A	#N/A

Table 6: Linearization results for the BCN airport. In green, the correlation factor (R) of the macroeconomic model between real passengers and operations and model ones. (Source: Own elaboration)

2.4.2 Girona-Costa Brava airport

For the GRO airport, the linearization of the different macroeconomic criteria observes a better correlation factor when the operation's outcome is on a logarithmic scale, whereas the passenger's outcome is not. The first-row data corresponds to the coefficients for every macroeconomic criteria.

OPS

Sin ln OPS

	-			-
133856,6733	16369,2595	178827,79	38163,6597	461284,686
22201,87354	4366,91375	44577,1062	12110,2542	154388,893
0,986136531	874,387186	#N/A	#N/A	#N/A
88,91502145	5	#N/A	#N/A	#N/A
271920968,1	3822764,75	#N/A	#N/A	#N/A

Con ln OPS				
	-			-
9,825223853	1,07883893	9,22206384	3,83590438	38,2677061
0,45284477	0,08907059	0,90922549	0,24700912	3,14902266
0,998057759	0,01783461	#N/A	#N/A	#N/A
642,3362894	5	#N/A	#N/A	#N/A
0,817239749	0,00159037	#N/A	#N/A	#N/A

PAX

Sin ln PAX				
	-			
25186784,87	2862275,87	30792760,5	10831693,2	-133702272
2855603,5	561672,156	5733504,44	1557620,09	19857489,2
0,98910163	112463,622	#N/A	#N/A	#N/A
113,4460499	5	#N/A	#N/A	#N/A
5,73949E+12	6,324E+10	#N/A	#N/A	#N/A

Con ln PAX

	-			-
37,21106862	3,57106212	25,2493152	19,4027548	228,379329
3,984424758	0,78370139	7,99996115	2,17334796	27,707163
0,980094972	0,15692054	#N/A	#N/A	#N/A
61,54820457	5	#N/A	#N/A	#N/A
6,062265597	0,12312028	#N/A	#N/A	#N/A

Table 7: Linearization results for the GRO airport. In green, the correlation factor (R) of the macroeconomic model between real passengers and operations and model ones. (Source: Own elaboration)

2.4.3 Reus airport

Finally, the REU airport macroeconomic linearization works best with all results (both operations and passengers) presented on a logarithmic scale (The R value, in green, is higher). As in the previous cases, the first-row data corresponds to the coefficients for every macroeconomic criteria.

OPS

Sin ln OPS

-	-			-
3486,482221	15412,0927	41938,0122	4740,70985	27025,9934
36240,48052	7128,18458	72763,938	19767,7655	252011,51
0,815081137	1427,27647	#N/A	#N/A	#N/A
5,509721441	5	#N/A	#N/A	#N/A
44895813,83	10185590,7	#N/A	#N/A	#N/A

Con ln OPS				
	-			-
0,854111738	0,83736293	3,86461446	0,85567115	0,24195552
2,179773704	0,42874236	4,37656776	1,18898135	15,1578581
0,81784355	0,08584709	#N/A	#N/A	#N/A
5,612232997	5	#N/A	#N/A	#N/A
0,1654424	0,03684861	#N/A	#N/A	#N/A

PAX

Sin ln PAX

	-			-
9195422,911	1904158,95	11077468,4	5951582,81	72387143,2
2558604,192	503254,998	5137186,76	1395618,57	17792195,3
0,952023481	100766,754	#N/A	#N/A	#N/A
24,80441235	5	#N/A	#N/A	#N/A
1,00745E+12	5,077E+10	#N/A	#N/A	#N/A

Con ln PAX				
				-
45,46429955	-5,0057927	28,473978	26,2501201	313,722139
7,138232907	1,40402779	14,3322034	3,89362702	49,6383279
0,958074747	0,2811285	#N/A	#N/A	#N/A
28,56496613	5	#N/A	#N/A	#N/A
9,030326495	0,39516616	#N/A	#N/A	#N/A

Table 8: Linearization results for the REU airport. In green, the correlation factor (R) of the macroeconomic model between real passengers and operations and model ones. (Source: Own elaboration)

Therefore, the models end up being:

$$OPS(BCN) = 1853473{,}65 \cdot \ln(\text{GDP}) + 1716553{,}77 \cdot \text{Inflation\_rate} - 297486{,}879 \cdot \text{Public\_debt} + 543261485{,}2 \cdot \text{Unemployment\_rate} - 22775272{,}7$$

$$PAX(BCN) = 383142589 \cdot \ln(\text{GDP}) + 338956963 \cdot \text{Inflation\_rate} - 35334450{,}6 \cdot \text{Public\_debt} + \cdot \text{Unemployment\_rate} - 4747808908$$

$$\ln(OPS(GRO)) = 3{,}83590438 \cdot \ln(\text{GDP}) + 9{,}22206384 \cdot \text{Inflation\_rate} - 1{,}0788389 \cdot \text{Public\_debt} + 9{,}825223853 \cdot \text{Unemployment\_rate} - 38{,}2677061$$

$$PAX(GRO) = 10831693{,}2 \cdot \ln(\text{GDP}) + 30792760{,}5 \cdot \text{Inflation}_{\text{rate}} - 2862275{,}87 \cdot \text{Public}_{\text{debt}} + 25186784{,}87 \cdot \text{Unemployment\_rate} - 133702272$$

$$\ln(OPS(REU)) = 0{,}85567115 \cdot \ln(\text{GDP}) + 3{,}86461446 \cdot \text{Inflation\_rate} - 0{,}83736293 \cdot \text{Public\_debt} + 0{,}854111738 \cdot \text{Unemployment\_rate} - 0{,}24195552$$

$$\ln(PAX(REU)) = 26{,}2501201 \cdot \ln(\text{GDP}) + 28{,}473978 \cdot \text{Inflation\_rate} - 5{,}0057927 \cdot \text{Public\_debt} + 45{,}46429955 \cdot \text{Unemployment\_rate} - 313{,}722139$$

And the results:

BARCELONA				
	Operaciones Reales	**Operaciones Modelo**	**Pasajeros Reales**	**Pasajeros Modelo**
2011	303054	303724	34398226	34543897
2012	290004	291602	35144503	35422905
2013	276497	298037	35216828	39110205
2014	283851	270826	37558981	35486895
2015	288879	287092	39711237	39297772
2016	307863	293739	44154722	41229515
2017	323535	304957	47284447	43801339
2018	335652	328406	50172689	48968602
2019	344563	366171	52688455	56736610
2020	122638	131983	12738769	14471115
2021	144233	269747	16614981	42649556
2022		369306		62501251
2023		393476		67688312
2024		427782		74831599
2025		455181		80634065
2026		476864		85408025

Table 9: Macroeconomic prognosis results for the BCN airport(Source: Own Elaboration)

GIRONA				
	Operaciones Reales	**Operaciones Modelo**	**Pasajeros Reales**	**Pasajeros Modelo**
2011	27799	27793	3007977	2983990
2012	27676	27703	2844571	2882067
2013	27050	26677	2736867	2710885
2014	20630	21088	2160745	2024099
2015	19529	19492	1775326	1844180
2016	18815	18621	1664856	1810295
2017	19254	19130	1946694	2030618
2018	17874	18325	2020138	1944188
2019	18253	18047	1933049	1880174
2020	9959	9923	172171	151898
2021	12520	15174	298581	1476084
2022		17907		1924001
2023		18032		1948303
2024		19411		2171148
2025		20563		2343616
2026		21308		2447996

Table 10: Macroeconomic prognosis results for the GRO airport(Source: Own Elaboration)

REUS				
	Operaciones Reales	**Operaciones Modelo**	**Pasajeros Reales**	**Pasajeros Modelo**
2011	21494	20619	1362683	1282728
2012	16112	17633	937341	1140385
2013	16977	15906	971020	1201089
2014	15986	14569	850492	663903
2015	13533	14782	705038	715568
2016	14473	15317	817765	695367
2017	16023	16488	1018889	757400
2018	16855	16791	1037765	930050
2019	17679	16896	1046249	1440689
2020	12503	12316	39460	45073
2021	13797	14175	158637	349777
2022		15006		1387377
2023		15114		1851651
2024		15453		2994906
2025		15664		4393442
2026		15713		5885968

Table 11: Macroeconomic prognosis results for the REU airport(Source: Own Elaboration)

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