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Airlines Performance and Efficiency Evaluation using an MCDA Methodology: MACBETH

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Este trabalho não seria possível sem um conjunto de fatores que muito fizeram pelas conquistas presentes neste trabalho.

Obrigado à cidade neve que me ensinou a evoluir enquanto Profissional e Pessoa.

Resumo

O Transporte Aéreo sofreu uma transformação notável durante a última década. A forma como viajamos hoje é bastante diferente da forma como o fazíamos há dez anos atrás. Devido ao aumento das Companhias aéreas *Low Cost*, o Mercado do Transporte Aéreo tem sofrido mudanças constantes e presentemente assiste-se a uma modificação das Companhias Aéreas de Bandeira "*Legacy*" de forma a continuarem a ser competitivas neste mercado.

O objetivo principal deste trabalho é estudar a eficiência de dez Companhias Aéreas, *Legacy* e *Low Cost, nomeadamente*: Ryanair, Lufthansa Group, International Airlines Group, Air France-KLM, EasyJet, Norwegian, Air Berlin Group, SAS, TAP Portugal and Finnair, compreendidas num determinado caso de estudo, ao longo de nove anos em diferentes áreas de desempenho, utilizando uma ferramenta multicritério de apoio à decisão (MCDA) que mede a atratividade através da mitologia MACBETH - *Measuring Attractiveness by a Category Based Evaluation Technique*.

Através dos resultados obtidos neste estudo, foi desenvolvido um modelo que mede a eficiência de Companhias Aéreas num determinado período de tempo, utilizando um conjunto de indicadores de performance, aos quais especialistas na área atribuíram os respetivos pesos.

Palavras-chave

Companhias Aéreas, Desempenho, Eficiência, MCDA-MACBETH, Transporte Aéreo.

Abstract

The Air Transport has suffered a remarkable transformation over the past decade. The way we travel today is quite different from how we did ten years ago. Due to the rise of Low-Cost carriers, the market of air transportation has been constantly changing and presently witnessing the transformation of legacy carriers to manage to continue operating.

The main purpose of this work is to assess the efficiency for different Key Performance Areas (KPA) on a case study comprised of ten different airline carriers, Legacy and Low Cost, namely: Ryanair, Lufthansa Group, International Airlines Group, Air France-KLM, EasyJet, Norwegian, Air Berlin Group, SAS, TAP Portugal and Finnair, during a nine-year period, using a Multi Criteria Decision Making (MCDA) tool - Measuring Attractiveness by a Category Based Evaluation Technique (MACBETH).

With the results obtained in this study, it was developed a model that measures the efficiency of Airline carriers in a defined period of time, using a set of performance indicators, to which are given weights by area specialists.

Keywords

Airlines, Air Transport, Efficiency, MCDA-MACBETH, Performance.

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List of Acronyms

AB	Air Berlin
ACT/ROU	Aircraft per Route
AK	Air France – KLM
AY	Finnair
CASK	Cost per Available Seat Kilometre
DEA	Data Envelopment Analysis
DY	Norwegian
EBITDA	Earnings Before Interest, Taxes, Depreciation and Amortisation
EMP/ACT	Employees per Aircraft
EMP/PAX	Employees per Passenger
FC/PAX	Fuel Consumption per Passenger
FR	Ryanair
IAG	International Airlines Group
IATA	International Air Transport Association
INC	Income
JAAPAI	Judgement Analysis of Airline Performance Areas and Indicators
KPA	Key Performance Area
KPI	Key Performance Indicator
LC	Legacy Carrier
LCC	Low-Cost Carrier
LF	Load-Factor
LH	Lufthansa
MACBETH	Measuring Attractiveness by a Category Based Evaluation Technique
MCDA	Multi Criteria Decision Analysis
PAX/ACT	Passengers per Aircraft
PAX/ROU	Passengers per Route
RASK	Revenue per Available Seat Kilometre
REV/EMP	Revenue per Employee
RP	Revenue per Passenger
RPK	Revenue per Passenger-Kilometre
SK	SAS
TP	Tap Portugal
U2	Easyjet
YM	Yield Management

Chapter 1

Introduction

This chapter consists of the introduction to the theme. It is composed by four sub-chapters: motivation, object and objectives, previous work and dissertation structure.

1.1. Motivation

The air transport has suffered a remarkable transformation over the past decade. The way we travel today is quite different from how we did ten years ago.

Due to the rise of Low-Cost Carriers (LCC), the air transport market has been constantly changing and presently witnessing the transformation of Legacy Carriers (LC) in order to manage to continue operating.

The International Air Transport Association (IATA) expects 7.2 billion passengers to travel in 2035, a near doubling of the 3.8 billion air travellers in 2016 [1].

Benchmarking techniques help airlines to identify and develop efficient solutions, improving their overall operational structure and maintaining or improving service performance levels.

1.2. Object and Objectives

The objective of this work is to assess Airlines' efficiency for different performance areas on a case study comprised of ten different Airline Carriers, Legacy and Low Costs – the object, using a Multi Criteria Decision Making (MCDA) tool – Measuring Attractiveness by a Category Based Evaluation Technique (MACBETH).

It is also expected with this work to understand the variations on the performance of each Airline, in a globally competitive environment, obtaining a global variation for the airline market over the defined period.

The efficiency evaluation over a defined period helps airlines to identify and develop efficient solutions as improving their overall operational structure and maintaining or improving service performance levels. With the results obtained in this study, it is proposed a model that measures the efficiency of any Airline carrier over a defined period, using a set of performance indicators, to which specialists in the area previously have given weights.

1.3. Previous Work

Previous works using Data Envelopment Analysis (DEA) had already been used to assess differences in efficiency, however using a Multi Criteria Decision Making (MCDA) tool is now possible to perform the assessment on different performance areas altogether, accomplishing a global score of efficiency.

A previous study: "Airlines Performance and Efficiency evaluation using an MCDA Methodology. The case for Low-Cost Carriers Vs Legacy Carriers" [2], was published in 2015 to test the model proposed in this dissertation for carriers efficiency, both Legacy and Low-Cost. However, that study was focused in only one Key Performance Area (KPA). The results of this work could have been different if it were simulated different scenarios with more KPAs so it was left for future work the intention to include all KPAs in order to understand how these areas may have influenced the overall performance of a carrier's performance. The article is available on Annexe E.

Other studies regarding benchmarking techniques using a Multi Criteria Decision Making (MCDA) tool – Measuring Attractiveness by a Category Based Evaluation Technique (MACBETH) are also being done by other authors [3] [4] regarding airports efficiency. Nevertheless, this method was never applied in the past to a complex environment comprehended by a multiple airline case-study.

1.4. Dissertation Structure

This dissertation has a five chapters' structure.

Chapter 1 consists of the introduction to the theme. It is composed by four sub-chapters: motivation, object and objectives, previous work and structure.

Chapter 2 consists of the literature review performed to contextualise and enclosure the relevance and the goals of this dissertation. The chapter is divided into nine subchapters: introduction, air transport deregulation, rising of low-cost carriers, differences of strategies, future trends, airline pricing, alliances, an increase of demand and conclusion. All the referred topics are extremely important to the purpose of this study since they show how air transport market evolved in the way it did for the last decades.

Chapter 3 consists of the presentation of the methodology used to assess carrier's efficiency for different performance areas on a defined case study comprised of ten different airline carriers, Legacy and Low-Cost, by means of a Multi Criteria Decision Analysis (MCDA) tool – Measuring Attractiveness by a Category Based Evaluation Technique (MACBETH).

Chapter 4 consists of two main groups: The Self-Benchmarking and the Peer-Benchmarking, followed by a conclusion. The goal of this chapter, as in chapter 3, is to assess the efficiency of ten carriers that compose the case study. The Case study was presented and defined. Then it was discussed regarding the results obtained through the JAAPAI model for the two mentioned types of

Benchmarking. The Chapter ends with the main conclusions obtained from the results as a synthesis of the model outputs.

Finally, Chapter 5 consists of the dissertation conclusion. It is composed by three sub-chapters: dissertation synthesis, concluding remarks and prospect of future work.

Chapter 2

The Air Transport Evolution

This chapter consists of the bibliography research performed in order to contextualise and enclose the goals of the work.

This chapter is divided into nine subchapters: introduction, air transport deregulation, rising of low-cost carriers, differences of strategies, future trends, airline pricing, alliances, an increase of demand and conclusion.

The referred topics are extremely important to the purpose of this study since they show how air transport market evolved in the way it did for the last decades.

2.1. Introduction

The Global Air Traffic has shown a continuous growth in the last decade. It is expected that by 2035 the number of transported passengers will reach 7.2 billion passengers [1].

Also, the competition between airlines has been increasing. The LCC have had a major role in this. In Europe, LCC has put an additional pressure on LC operating costs by offering flights at reduced fares [5].

The LCC entry into large-scale market has increased competition and affected the fares charged by LC. The relative efficiency of the world's airlines has changed [6]. Increasing the aircraft utilisation, the crew productivity, operating from secondary airports, using a young and homogeneous fleet and reducing airport charges allow LCC to practice cheaper fares for their flights [7].

2.2. Air Transport Deregulation

By the end of the 90s started in Europe the air transport market deregulation process, two decades after the USA. This allowed the introduction of concepts such as the code-share, the free fares system and a greater freedom to establish routes and frequencies [8].

After the Airline deregulation, numerous LCC successfully entered the markets. One interesting observation in the U.S. market is that LCCs essentially entered into "non-hub" city-pair markets [9].

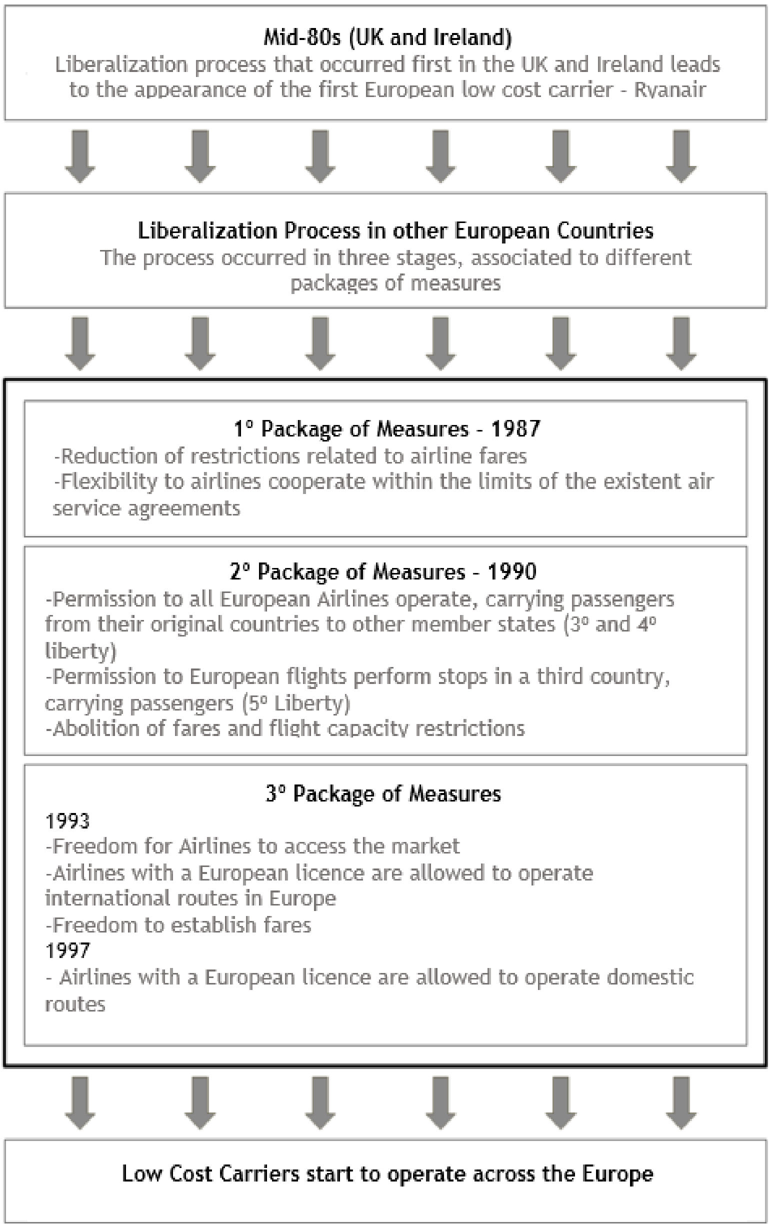


Figure 2. 1 – Deregulation Process in Europe [8]

As unveiled on Figure 2.1, liberalisation's third package effectively created an open skies policy that included *cabotage*, which opened markets to competition from airlines of other member states and allowing new airlines to establish their operation in a free market.

2.3. Rising of Low-Cost Carriers

The effective low-cost service business model was developed by Southwest Airlines in the early 1970s. The company initially operated in Texas and began to spread its service to the rest of the United States with the 1978 deregulation of air transport [10]. Several LCC were established in Europe later in the 1990s to the early 2000s. The incentive to the progress of LCC's in Europe came from the liberalising effects of the European Third Package in 1993 and Ryanair was remarkable in initially replicating Southwest's mode of operation within Europe. During the 2000s, LCC business model entered the Asian market, first in Southeast Asia, and after in China and India [11].

LCC have rewritten the competitive environment within liberalised markets and have made substantial impacts on the world's domestic passenger markets, which had previously been largely controlled by LC [12].

Prior to deregulation, the majority of international European routes had only two carriers resulting of the restrictive bilateral agreements. As a result of deregulation, the balance of power in European Air Transport had moved from the governments towards Airlines and letting new Airlines enter the market.

A study conducted by the UK Civil Aviation Authority in 1998 [1]described the emergence in the 1990's of a third-way mode of travel in European Aviation, showing that LCC had brought together the costs of charter airlines and the convenience of scheduled carriers. This trend can be seen in Figure 2.2. This led to a major shift in the industry, offering new travel opportunities to customers as well as threatening LC with high-cost operating structures.

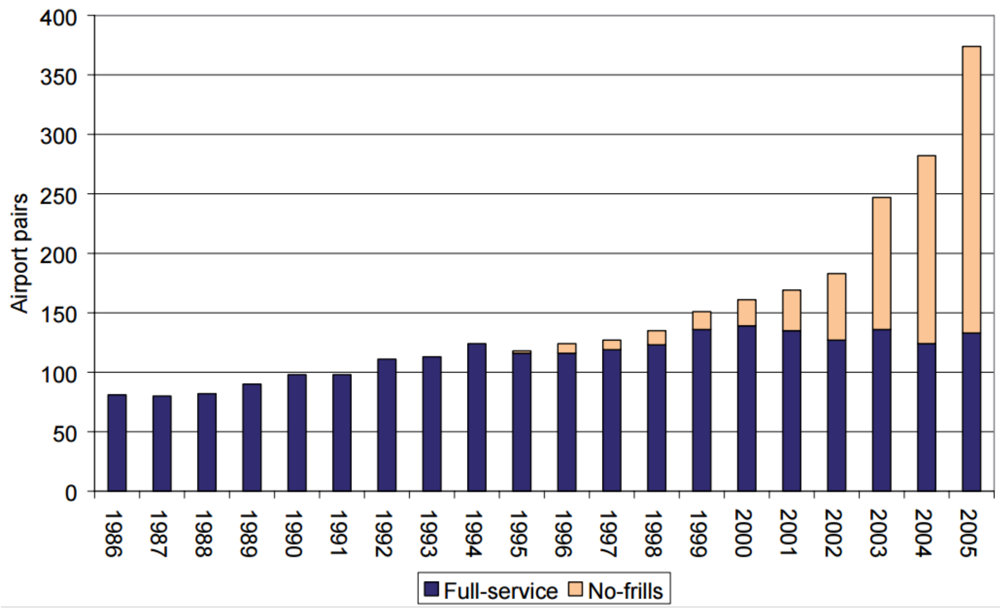


Figure 2. 2 - Airport pairs served by LCC's and LC's between the UK and EU [13]

[1] Study shared by Professor Julien Style -Iberia's Head of Joint Venture Business during an attended conference session in Uiversitat Autònoma de Barcelona, Barcelona, Spain.

It had become evident that the European market produced, even more, an opportunity than that in the United States of America. A large amount of charter carriers operating on short-haul European routes, fares on both aircraft and trains in Europe were very expensive and high-density cities are closer together in Europe than they are in the United States of America.

In 1996, EasyJet operated a small number of international services from Luton to Amsterdam, Barcelona and Nice. Ryanair operated a mere handful of routes, all between the UK and Ireland. Air Berlin operated only between Gatwick and Shannon. Debonair, an airline which claimed to offer a Low Cost but quality service, operated to six major continental cities. As it can be seen in Figure 2.2, it had occurred an *explosion* of LCC operation after the start of the 21st century. For example, figures 2.3 and 2.4 show the explosion in the number of European destinations served by LCC in Europe between 2000 and 2006 [13].

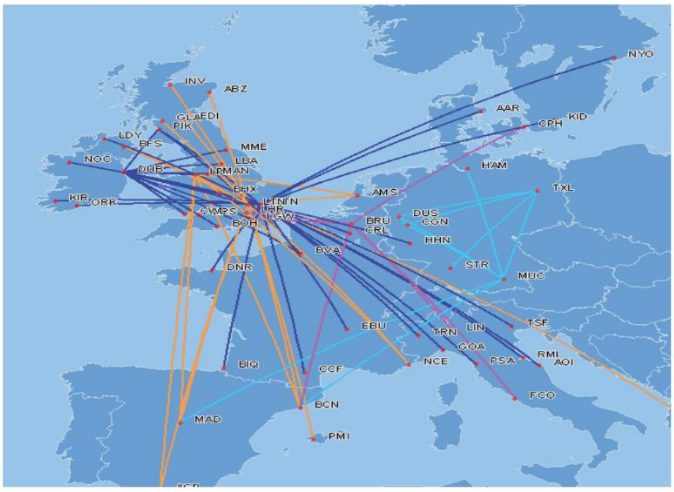


Figure 2. 3 - European LCC route network in 2000 [13].

Figure 2. 4 - European LCC route network in 2006 [13].

As can be seen in Figure 2.3, in 2000, most LCC traffic was centred around the UK and Ireland (and particularly around London and Dublin) and on certain routes to and from the UK and Europe. By 2006, this had changed considerably, showing customers' preferences towards cheap air travel to short and medium-haul destinations and away from holiday packages. This rising of passenger demand was stimulated by heavy advertising campaigns and easy online booking access by LCC.

LCC have changed people's leisure and travel habits opened up direct services between European Union city pairs that were not available through the LC, forcing airlines and tour operators to change their business models, popularised regional airports by breathing life into otherwise underutilised airports and changed the dynamics of the industry.

2.4. Differences of Strategies

The performance of the LCC and LC changes depending on the area upon which they are compared.

Table 2. 1 provides a summary of the main differentiating characteristics between incumbent network carriers, or LC and no-frills scheduled airlines, or LCC.

Table 2. 1 - Product features of Low Cost and full-service carriers [12].

Product Features	Low-Cost Carrier	Full-Service Carrier
Brand	One Brand: low fare	Brand Extensions: Fare + service
Fares	Simplified	Complex
Distribution	Online and Direct Booking	Online, Direct and Travel Agent
Check-in	Ticketless	Ticketless, IATA Ticket Contract
Airports	Secondary Mostly	Primary
Connections	Point to Point	Code Share, Global Alliances
Class segmentation	One Class	Two Classes
Inflight	Pay for Amenities	Complimentary Extras
Aircraft utilisation	Very High	Medium to High
Turnaround Time	25 minutes	Low Turnaround
Product	One Product: Low Fare	Multiple Integrated Products
Ancillary Revenue	Advertising, Onboard Sales	Focus on the Primary Product
Aircraft	Single Type	Multiple Types
Seating	Small Pitch	Generous Pitch
Customer Service	Generally, Under Performs	Full Service
Operational Activities	Focus on Core	Extensions

While Low-Cost Carriers have core common denominators, such as disruptive innovation adoption, efficiency, productivity and cost leadership, which lead to inexpensive fares, Legacy carriers are usually focused on drawing more and more traffic to their hubs, since they could create a disproportional increase in connections at incremental cost. The main advantages of this are: a coverage of as many demand categories as possible (in terms of O&D and customer segment) and connectivity in the hub [14], [15] [16].

One interesting point is that LCC usually operate between non-hub city-pair markets [9].

While LCC bases their model by carefully managing costs, increasing ancillary revenues, and choosing routes based on what's attractive to travellers and not where hubs are located, LC are still trying to figure out the best path forward. If replicating LCC or hang on to their models [17].

EasyJet and Ryanair began to establish themselves in the low-fare sector in the mid 90's, however, it took time for the Low-Cost carriers to get recognised by their model as it differ substantially from LC.

2.5. Future Trends

In Europe, LCC share of traffic varies significantly by the airport, due to local regulations, slot availability, and development priorities. Some markets like Spain, the United Kingdom, Portugal, and Italy, have been stabilising respecting to the LCC sector growth. And in places such as France, Germany, and Benelux where LC still lead by a strong market to explore, LCC are expected to continue to grow in the coming years [17].

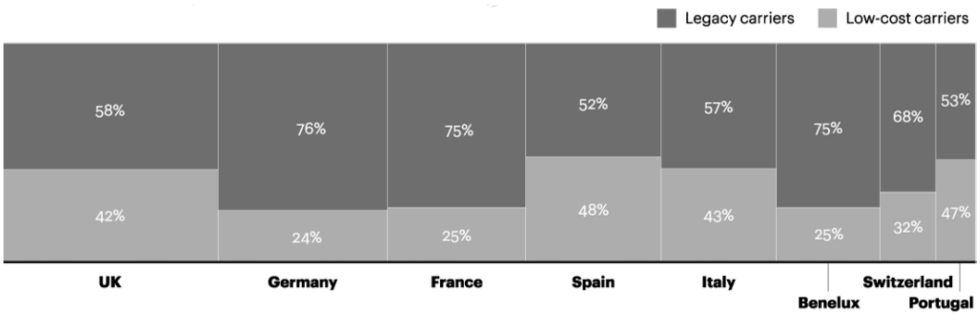


Figure 2. 5 – Percentage of offered seats, short and medium hole flights [17]

Thanks to LCC, the accessibility of many destinations in Spain and France has dramatically improved in both time and monetary terms. Thus, a significant number of relatively affluent British, Irish and Germans have decided to buy properties abroad, as they can now afford to visit them on a regular basis.

This new type of derived demand for airline services relatively prices inelastic as consumers are effectively locked-in due to the location of their asset. In the future, these travellers may constitute a key element of demand for LCC in Europe. A recent survey by the UK Civil Aviation Authority has shown that the socio-economic profile of travellers today is not significantly different compared to ten years ago in the United Kingdom [9].

Every traffic flow, airline and route has a different optimum value and they are all evolving differently. One size doesn't fit all even within a single airline. Over time the scenery is even more varied. Over a 20-year period, even LCC with their single type business model and more dynamic network management are likely to migrate across model boundaries as their markets evolve. Airbus forecast shows that the highest proportion of demand is focused on airlines with demand across multiple single-aisle size aircraft [18].

Over the past decade, the global single-aisle market has changed substantially due to many factors, including the significant growth and development of LCC, consolidation in European and North American markets, the impact of fuel prices, and continued market fragmentation. Boeing's average single-aisle units' demand is more than 110 aeroplanes per month. Production levels are currently below 90 units per month [19].

Fuel prices, airport taxes and increased competition on the aviation market, have led to the creation of hybrid airline business model that combines the best features of the LCC and LC business models. Ticket prices will be increasing with the service increase on board, which will continue to be attractive to business travellers, and less for the "leisure" ones. This model has been widely accepted and it combines cost savings methodology which is a characteristic of the LCC base model, with service, flexibility, and en-route structure of LC business model. The emergence of this model does not imply the disappearance of the already established business models of traditional carriers and LCC from the market, but due to the adjustment to new market conditions. Nevertheless, LCC will still remain the dominant carrier in a point-to-point network model for the destinations up to three hours of flight, even though there are some cases long-haul flights, also based on the hybrid air transport model, which is introducing further competitiveness to the already weakened group of network air carriers [20].

2.6. Airline Pricing

Airline pricing is a very complex field of the air transport business, where a good is offered for sale to an uncertain demand, only for a limited period of time and which its capacity is set in advance. It comes from revenue management, which is a concept that dates back to the deregulation of the fares in the airline industry in the late 1970s. Through instruments like capacity control, dynamic pricing and overbooking, airlines try to maximise their profit generated from a limited seat capacity in deciding which fares to charge and how many seats to reserve for each customer segment [21].

In order to handle this in a competitive environment, airlines have developed a dynamic capacity pricing approach, commonly known as Yield Management (YM), which allows them to maximise Load Factor (LF) and profits.

The majority of carriers base their prices in one of two strategies of segmentation: inter-temporal segmentation and implicit segmentation. The first one is related to time before departure the ticket is bought. The second one is based on the duration of the stay. In general, LCC practices the intertemporal pricing strategy, once they sell each leg separately, on the other hand, LC tends to use more complex ways of defining their prices and try to practice both strategies [22].

Carriers charge different fares depending on each route demand. Routes with more demand will change highly than routes with low demand. Additionally, most carriers, especially LC, charge different fares on the same route, depending on the product mixes that will generate the highest level of demand.

Another differentiating point between carriers is the interconnecting traffic prevenient from codeshare flights operated by partner carriers. This further increases the airline pricing strategy and it is most commonly seen on LC.

Therefore, it comes clearly that LC have a much more complex and restrictive pricing strategy than LCC, relying on different fares depending on several conditions that determine what will be charged to the client. Some examples of these conditions are the advance purchase requirements where passengers are required to purchase early in order to get the lowest fares available, minimum and maximum stays, where the fares vary according to the duration of the stay, peak pricing that is related with the time of day and day of week patterns of demand, among others.

In the last years and reinforced by the strong presence of LCC, passengers have been switching from LC to LCC regarding all these restrictions that determinate the fares. LC are now rethinking their strategies to modify the restrictions imposed on their tickets.

2.7. Alliances

Several airlines, particularly LC, are members of alliances to share resources and activities, stretching their competitive position. An airline alliance is aimed at increasing individual profit shares and added net contribution margins. Then, partnering in an airline alliance serve as a means to achieve a goal. It is evident that cooperation and partnering go along [23].

Although the Airline Industry has achieved high growth rates, it suffers from intrinsically low-profit margins. Consequently, carriers have had to look at a variety of strategies to improve performance. With global expansion constrained by restrictive air services agreements, strategic alliances are seen as a strategy for growth. Airlines participating in an alliance has several advantages such as access to new markets by tapping into a partner's under-utilised route rights or slots, traffic feed into established gateways to increase load factors and to improve yield, defence of current markets through seat capacity management of the shared operations or the costs and economies of scale through resource pooling across operational areas or cost centres, such as sales and marketing, station and ground facilities and purchasing [24].

There are at least two different kind of alliances. Strategic Alliances and Equity Partnerships. On the first one, different organisations share their resources in order to pursue a strategy. It is a very commercial based relationship where a joint product is marketed under a single commercial name. On the other hand, Equity Partnerships are comprehended by cross-border acquisitions of other airlines. The core of these alliances is to increase the joint value of the organisation.

Equity Partnerships may not be so easily identified as most of the times they are also under the umbrella of Strategic Alliances. Examples of these partnerships are the IAG Group, which is comprehended by British Airways (including BA CityFlyer and OpenSkies), IBERIA (including Iberia Express), British Midland International, Vueling Airlines, Aer Lingus and Aer Lingus Regional. Another one is the Lufthansa Group, comprehended by Lufthansa (including Lufthansa Regional, Lufthansa CityLine and Air Dolomiti), Eurowings, and Swiss International Air Lines (including Swiss Global Air Lines, Edelweiss Air and Austrian Airlines).

Turning back to Strategic Alliances, it is possible to find tree different major groups in the industry: Star Alliance, SkyTeam and OneWorld. Star Alliance is established by 28 member Airlines, flying over 1300 different destinations with 18450 daily departures. OneWorld brings together 30 affiliate Carriers flying towards 1000 destinations with 14000 daily departures. Finally, SkyTeam is comprehended by 20 member airlines flying to 1062 destinations with 17343 daily departures. According to IATA, in 2016 Star Alliance maintained its position as the largest airline alliance with 23 % of total scheduled traffic (in RPK), followed by SkyTeam (20.4%) and OneWorld (17.8%) [25].

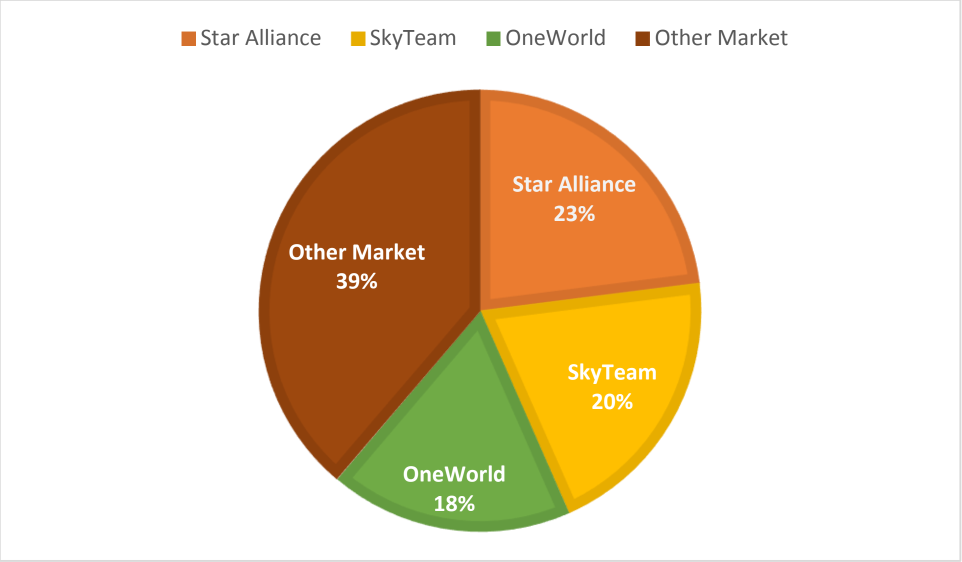


Figure 2. 6 – Airline Alliances distribution 2016 - Source: own elaboration based on [25]

Strategic Alliances allow carriers to extend their networks and increase the number of accessible destinations. One itinerary may consist of several flight legs, each one may be operated by different airlines. The branding goes so far that it even includes unified aircraft liveries among member airlines.

Membership of an international alliance has become a key component of the business strategy of most LC, and a means of differentiating them from LCC in terms of the quality of service provided [26].

2.8. Increase of Demand

The International Air Transport Association (IATA) announced global passenger traffic results for January 2016 showing a rise in demand (revenue passenger kilometres) of 7.1% compared to January 2015. This was ahead of the 2015 full year growth rate of 6.5%. January capacity rose 5.6%, with the result that load factor rose 1.1 percentage points to 78.8%, the highest load factor ever recorded for the first month of the year. For European carriers, international traffic climbed 4.2% in January compared to the same year-ago period. Capacity rose 2.6% and load factor rose 1.2 percentage points to 78.8% [1].

Airbus have registered a trend on demand towards larger aircraft. This can also be seen at the world's major airports where the average number of passengers per departure continues to rise. The productivity of aircraft is as important as understanding trends in aircraft size. Two factors are key drivers of this productivity: load factor, which is the proportion of the available seats on each flight that are occupied, and utilisation, the number of hours a day that the aircraft flies and generates revenue. In recent years, both of these parameters have risen to levels which would have been considered impossible 20 years ago.

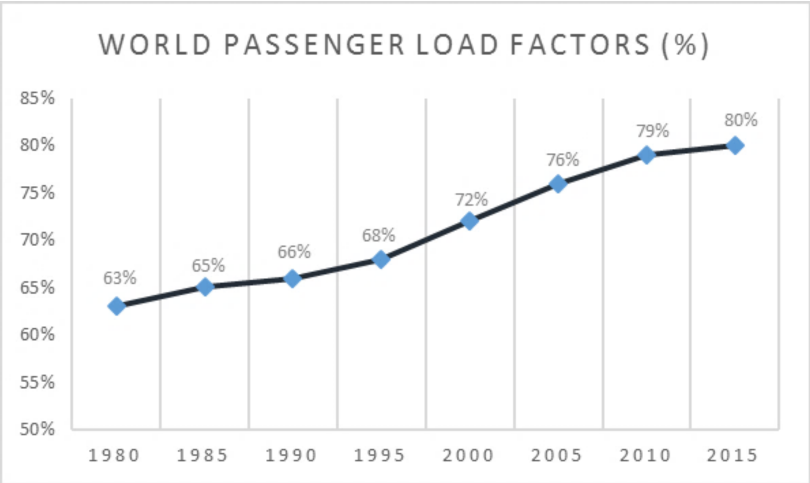


Figure 2. 7 – World Passenger load factor evolution - Source: own elaboration based on [1]

Typical LF values for an Airline in the 90's were in the mid 70% range. However, developments in Airline reservation systems, the advent of internet booking tools and the desire to minimise seasonality negative effects means that today many major network carriers report levels above 80% and with some LCC even reporting load factors regularly in above 90%. Additionally, aircraft utilisation also has risen. For example, an Airbus aircraft have increased in utilisation up 30% relative to 25 years ago [18].

2.9. Conclusion

LCC have changed people's leisure and travel habits, opened up direct services between European Union city pairs that were not available through the LC, forcing airlines and tour operators to change their business models, popularised regional airports by breathing life into otherwise underutilised airports and changed the dynamics of the industry.

In the last years and reinforced by the strong presence of LCC, passengers have been switching from LC to LCC regarding all these restrictions that determinate the fares. LC are now reconsidering their strategies in order to modify the restrictions imposed on their tickets.

Fuel prices, airport taxes and increased competition on the Aviation market are leading to the conception of hybrid airline business models that combines the best features of the LCC and LC. The key point on the uniformitarian of the global airline ticket model is that ticket prices will be increasing with the service increase on board. This model has been widely accepted and it combines cost savings methodology which is a characteristic of the LCC base model, with service, flexibility, and en-route structure of LC business model.

As stated on section 2.6, the emergence of this model does not imply complete the loss of the already established business models. LCC are expected to continue the dominant carrier in a point-to-point network model for the destinations up to three hours of flight. On the other hand, further competitiveness is being introduced by the emergence of long-haul flights also based on this hybrid model.

Chapter 3

Multi Criteria Decision Analysis

3.1. Introduction

This chapter consists on the methodology used in order to assess the efficiency for different performance areas on a case study comprised of ten different airline carriers, Legacy and Low Cost, using a Multi Criteria Decision Making (MCDA) tool – Measuring Attractiveness by a Category Based Evaluation Technique (MACBETH).

3.2. Methodologies - MACBETH

In this study, it was used a model called Judgement Analysis of Airline Performance Areas and Indicators (JAAPAI) based on MACBETH methodology. This decision-making method permits the evaluation of different options considering different conditions. The key distinction between MACBETH and other Multiple Criteria Decision Analysis (MCDA) methods is that MACBETH needs only qualitative judgements about the difference of attractiveness between two elements at a time, to generate numerical scores for the options in each criterion and to weight the criteria. The seven MACBETH semantic categories are: no, very weak, weak, moderate, strong, very strong, and the extreme difference in attractiveness.

Judgements between indicators (criterion) are made by the evaluator on the M-MACBETH software. In this work, these judgements were obtained from a set of specialists through an online survey.

Judgements consistency is automatically verified and suggestions are offered to correct any inconsistency. The MACBETH decision aid process then evolves into the construction of a quantitative evaluation model. Using the functionalities offered by the software, a value scale for each criterion and weights for the criteria are constructed from the specialist's semantic judgements. The value scores of the options are subsequently aggregated additively to calculate the overall value scores that reflect their attractiveness taking all the criteria into account [2], [27].

<u>The MACBETH Procedure:</u>

The mathematical foundations of MACBETH are explained in several publications referenced in this dissertation. The procedure encloses the critical information in order to understand the used methodology and can be consulted on Annexe A.

3.3. Survey

In order to build the KPI and KPA judgement matrixes, it was necessary to obtain weights for the differences in attractiveness between them.

A survey [28] was sent to 340 aviation specialists, obtaining a sample of 34 answers for a confidence level of 87% with 12.5% error, according to a sample size calculator [29]. Answers details can be found on Annexe B. On Figure 3.1 is the survey's front page.

Judgement Analysis of Airline Performance Areas and Indicators

Welcome!

This is a survey conducted by the Transportation Research Team of the Aerospace Sciences Department at the University of Beira Interior (Covilhã, Portugal) in the field of Air Transport Economy and Management.

The goal is to apply a model to assess the Airline Performance and Efficiency Evaluation through an innovative Multi-criteria Decision Analysis (MCDA) methodology. The analysis is performed by the use of a set of indicators within different areas.

Therefore we would appreciate your contribution with your knowledge and expertise to judge differences of attractiveness between each area and related indicators.

Your collaboration will require 10 minutes of your time.

Thank you so much in advance for your attention.

Best regards,

The Transportation Research Team!

Figure 3. 1 – Survey: Judgement Analysis of Airline Performance Areas and Indicators [28]

The survey followed 6 main steps:

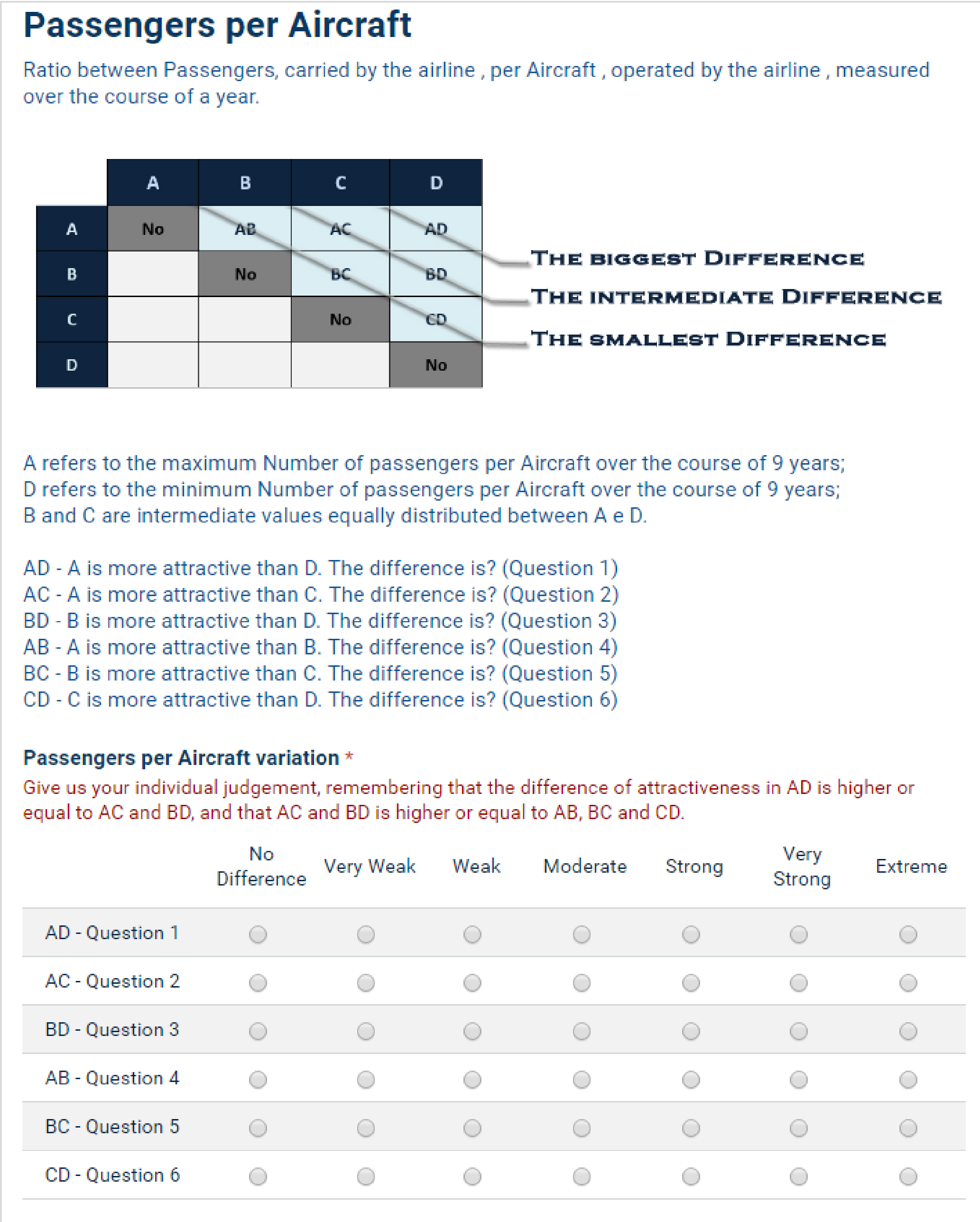
The first step consisted on selected the KPA more relevant to the specialist.

The second step consisted in rank the KPA in order of relevance. It should be noticed that It was possible to give the same rank to different areas, being 1 the least relevant and 6 the most relevant.

The third step asked the specialist to select the KPA in which he/she has expertise, to centre the next steps of the survey towards that KPA.

The fourth step aimed the selection of the most relevant KPI from the selected KPA.

On the fifth step, the specialist was asked to rank the KPI's in order of relevance, being 1 the least relevant and 6 the most relevant (it was possible to give the same rank to different areas).



Passengers per Aircraft

Ratio between Passengers, carried by the airline , per Aircraft , operated by the airline , measured over the course of a year.

	A	B	C	D
A	No	AB	AC	AD
B		No	BC	BD
C			No	CD
D				No

THE BIGGEST DIFFERENCE
THE INTERMEDIATE DIFFERENCE
THE SMALLEST DIFFERENCE

A refers to the maximum Number of passengers per Aircraft over the course of 9 years;
D refers to the minimum Number of passengers per Aircraft over the course of 9 years;
B and C are intermediate values equally distributed between A e D.

AD - A is more attractive than D. The difference is? (Question 1)
AC - A is more attractive than C. The difference is? (Question 2)
BD - B is more attractive than D. The difference is? (Question 3)
AB - A is more attractive than B. The difference is? (Question 4)
BC - B is more attractive than C. The difference is? (Question 5)
CD - C is more attractive than D. The difference is? (Question 6)

Passengers per Aircraft variation *

Give us your individual judgement, remembering that the difference of attractiveness in AD is higher or equal to AC and BD, and that AC and BD is higher or equal to AB, BC and CD.

	No Difference	Very Weak	Weak	Moderate	Strong	Very Strong	Extreme
AD - Question 1	○	○	○	○	○	○	○
AC - Question 2	○	○	○	○	○	○	○
BD - Question 3	○	○	○	○	○	○	○
AB - Question 4	○	○	○	○	○	○	○
BC - Question 5	○	○	○	○	○	○	○
CD - Question 6	○	○	○	○	○	○	○

Figure 3. 2 – Survey 6th Step

On the sixth and last step, as per Aircraft KPI is depicted in figure 3.2, the specialist had to fill the judgement matrix for all KPI answering to the 6 questions where A referred to the best option of the

KPI over the course of 9 years, D to the worst option of the KPI over the course of 9 years and B and C were intermediate values equally distributed between A and D [30].

3.4. JAAPAI Model

JAAPAI stands for Judgement Analysis of Airline Performance Areas and Indicators. Figure 3.3 shows through a flowchart all steps of the model.

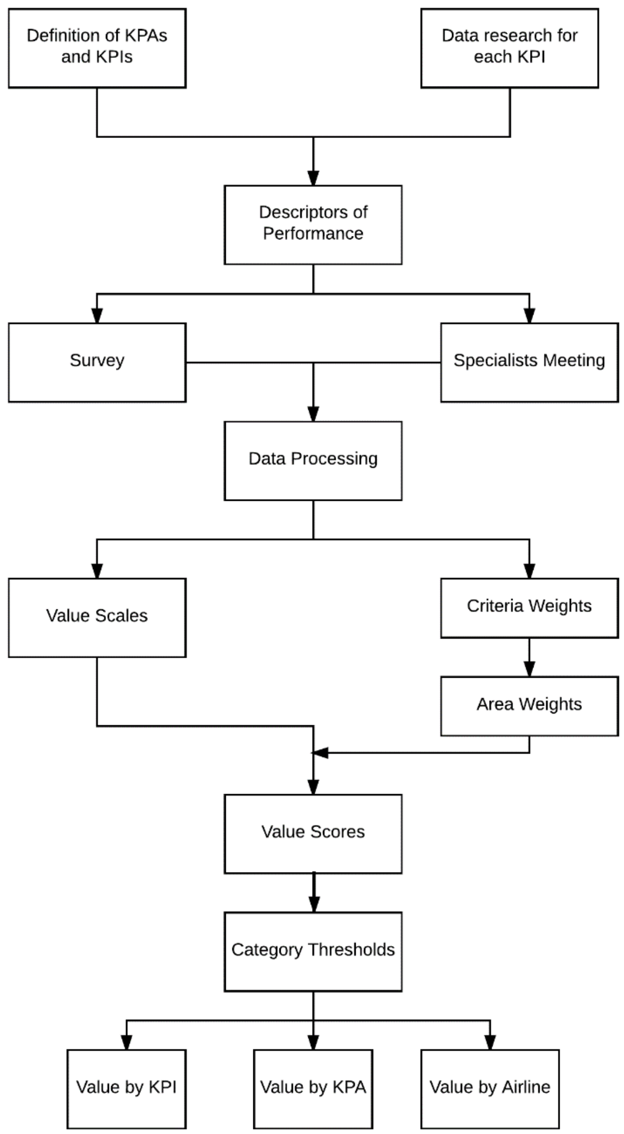


Figure 3. 3 – JAAPAI model flowchart - Source: own elaboration

The first stage of the model comprised a quantitative documentary research to get data for the KPI defined for each KPA. Four main KPAs were chosen: transport performance, business performance, personnel and environmental performance.

Transport Performance

This KPA is related with the fundamental transportation indicators and groups four KPI, namely: Passengers per Aircraft, Passengers per Route, Aircraft per Route and Load Factor – Figure 3.4.

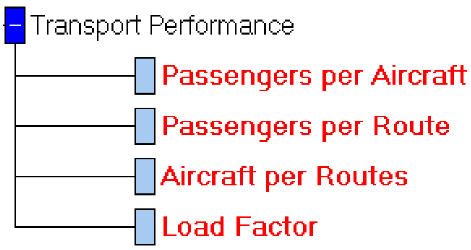


Figure 3. 4 - Transport performance decision tree - Source: M-MACBETH

- **Passengers per Aircraft** - Ratio between Passengers, carried by airline, per Aircraft, operated by the airline, measured over the course of a year.
- **Passengers per Route** - Ratio between Passengers, carried by airline, per Routes, operated by the airline, measured over the course of a year.
- **Aircraft per Route** - Ratio between Aircraft, operated by the airline, per Routes, operated by the airline, measured over the course of a year.
- **Load Factor** - Ratio between passenger-kilometres travelled per seat-kilometres available.

Business Performance

This KPA is related to the economic indicators and groups six KPI, namely: Operational Result, EBITDA Margin, Revenue per Seat Kilometre, Revenue per Passenger, Revenue per Available Seat Kilometre and Costs Per Available Seat Kilometre– Figure 3.5.

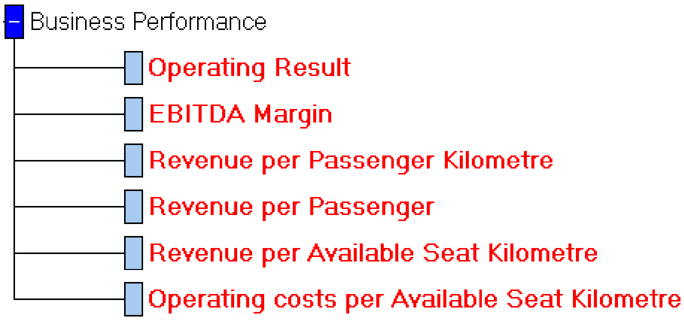


Figure 3. 5 - Business performance decision tree - Source: M-MACBETH

- **Operating Result** – is the difference between Revenues and Costs (Expenses), measured over the course of a year.

- **EBITDA Margin** - Earnings before interest, tax, depreciation and amortisation (EBITDA), measured over the course of a year, divided by total Revenue.
- **RPK - Revenue Per Passenger Kilometre** – is the number of revenue passengers carried, measured over the course of a year, multiplied by the distance flown.
- **Revenue Per Passenger** - Ratio between Revenues, per the total number of Passengers, carried by airline, measured over the course of a year
- **RASK - Revenue Per Available Seat Kilometres** - Ratio between total Revenues, per Available Seat-Kilometres, measured over the course of a year.
- **CASK - Costs Per Available Seat Kilometres** - Ratio between total Costs, per Available Seat-Kilometres, measured over the course of a year.

Personnel and Environmental Performance

This KPA is related with the Sustainability indicators and groups four KPI, namely: Employees per Passenger, Employees per Aircraft, Revenues per Employee and Fuel Consumed per Passenger – Figure 3.6.

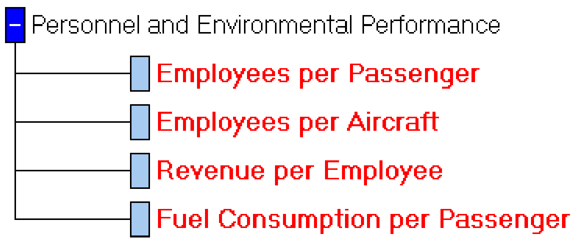


Figure 3. 6 - Personnel and environmental performance decision tree - Source: M-MACBETH

- **Number of Employees per Passenger** - Ratio between Total Number of Employees of the airline, per Passengers, carried by airline, measured over the course of a year.
- **Number of Employees per Aircraft** - Ratio between Total Number of Employees of the airline, per Aircraft, operated by the airline, measured over the course of a year.
- **Revenue per Employee** - Ratio between Revenues, per the total number of Employees of the airline, measured over the course of a year
- **Fuel Consumption per Passenger** - Ratio between Fuel Consumed, measured over the course of a year by Passengers, carried by the airline, measured over the course of a year.

It was defined a nine-year time space from 2007 to 2015 since this had to be conciliated with the public data provided by Carriers' Annual Reports and Sustainability Reports. This step of the model was very time-consuming and involved a considerable research skills to get reliable data. Is was possible to obtain authentic data for all KPI defined on the ten carriers which compose the related case study.

All data was processed and inserted into M-MACBETH table of performance for each airline – Step two of the model. One example of the Table of Performances can be seen in Figure 3.7. All tables of performances are available on Annexe C that comes along with this dissertation.

Table of performances

Options	PAX/ACT	PAX/ROU	ACT/ROU	LF	INC	EBITDA	RPK	RP	RASK	CASK	EMP/PAX	EMP/ACT	REV/EMP	FC/PAX
'07	134482.76	42391.3	0.32	71	79.31	13	19135	24.62	0.0712	0.06822	0.00139	186.66	17735.08	0.10122
'08	124285.71	51176.47	0.41	67	-61.73	2.1	21908	27.59	0.0734	0.07526	0.00159	197.53	17235.34	0.11017
'09	116666.67	50000	0.43	69	52.18	12.7	21076	26.18	0.0714	0.06974	0.00159	186.07	16414.12	0.08694
'10	128169.01	52298.85	0.41	74	-421	3.4	23944	25.84	0.0732	0.08625	0.00144	184.69	17928.77	0.08524
'11	138028.17	34628.98	0.25	76	-18.1	6.4	25970	25.29	0.0728	0.07332	0.00126	174.58	19995.16	0.09439
'12	143661.97	26020.41	0.18	77	40.8	7.8	27226	26.3	0.0757	0.07451	0.00123	176.14	21448.9	0.09359
'13	150704.23	27020.2	0.18	81.1	44.1	8.1	28152	25.91	0.0782	0.07698	0.0012	180.11	21683.61	0.08972
'14	148051.95	32022.47	0.22	70.6	2.6	6.4	30119	24.61	0.075	0.07497	0.00116	171.34	21266.58	0.08939
'15	146753.25	25111.11	0.17	80.3	-105.7	5.3	32197.21	23.61	0.0676	0.07024	0.00116	170.16	20361.01	0.09213

Figure 3. 7 – Table of Performances - Source: M-MACBETH

For every KPI there is a performance descriptor, in which are established two reference levels: the "Good" and the "Neutral". The "Good" is the best level of performance of the collected data in the defined period, and indicates that no improvement is required in the respective criteria. The "Neutral" is the worst level of the collected data in the defined period and that is neutral in terms of seek for improvement. However, performances below this level action are recommended to improve the performance at least until the "Neutral" level is achieved [4].

After all tables of performances were inserted on M-MACBETH it was necessary to fill the criteria judgement matrix for all KPI in each KPA, in accordance with the qualitative judgments of difference in attractiveness obtained on the survey. Figures 3.8, 3.9 and 3.10 shows an example of the criteria judgement matrix for each KPA. The data and steps used for the fill of the following matrices can be found on Chapter 3.3. Additionally, it was necessary at this stage to define the Good and the Neutral values. These references are the superior and inferior boundaries defined of intrinsic value. This comprised the steps three, four and five of the model.

<u>Transport Performance:</u>

Passengers per Aircraft

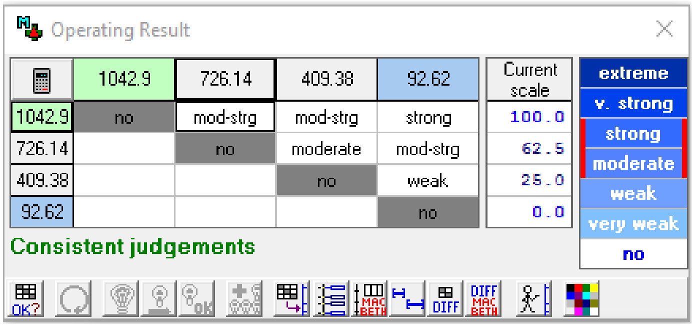
	394737	349099	303461	257823	Current scale
394737	no	moderate	mod-strg	strong	100.0
349099		no	moderate	mod-strg	62.5
303461			no	weak-mod	25.0
257823				no	0.0

extreme
v. strong
strong
moderate
weak
very weak
no

Consistent judgements

Figure 3. 8 – Criteria Judgement Matrix: Passengers per Aircraft - Source: M-MACBETH

Business Performance:

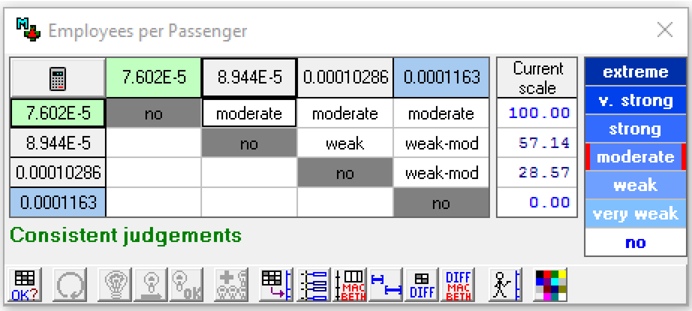


Operating Result

	1042.9	726.14	409.38	92.62	Current scale
1042.9	no	mod-strg	mod-strg	strong	100.0
726.14		no	moderate	mod-strg	62.5
409.38			no	weak	25.0
92.62				no	0.0

Figure 3. 9 - Judgement Matrix: Operating Result - Source: M-MACBETH

Personnel and Environmental Performance:

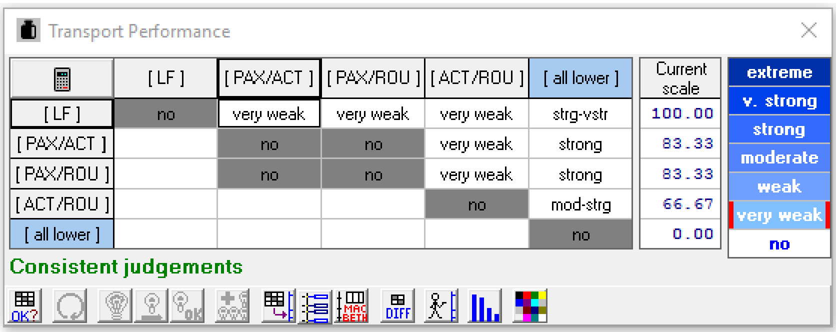


Employees per Passenger

	7.602E-5	8.944E-5	0.00010286	0.0001163	Current scale
7.602E-5	no	moderate	moderate	moderate	100.00
8.944E-5		no	weak	weak-mod	57.14
0.00010286			no	weak-mod	28.57
0.0001163				no	0.00

Figure 3. 10 - Judgement Matrix: Employees per Passenger - Source: M-MACBETH

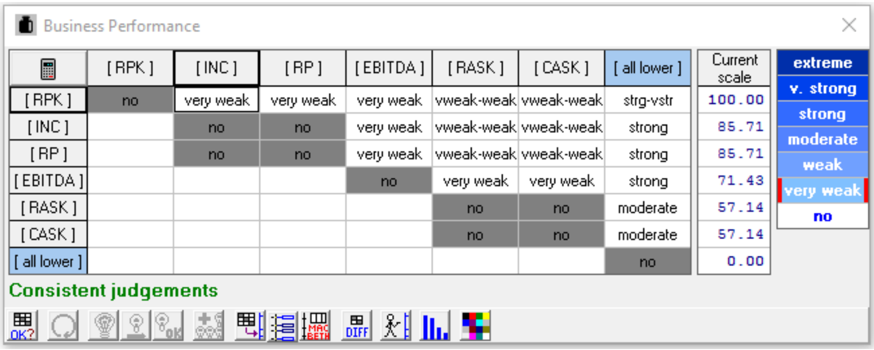
With all Judgement Matrixes now filled, it is necessary to follow to the next step and give weights for each KPI inside each KPA – step six of the model. The fill of these matrixes came from the relevance judgements provided by the specialists in the survey. The procedure was the same for all the carriers defined for the case study, as the specialists' judgements were carriers independent one and can be applied to any carrier type in the study.



Transport Performance

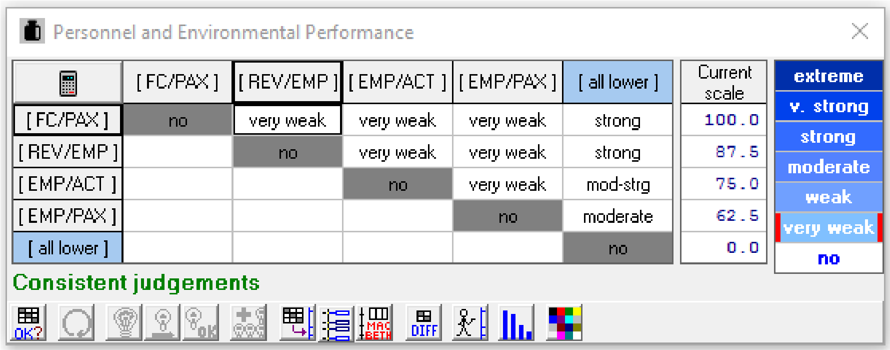
	[LF]	[PAX/ACT]	[PAX/ROU]	[ACT/ROU]	[all lower]	Current scale
[LF]	no	very weak	very weak	very weak	strg-vstr	100.00
[PAX/ACT]		no	no	very weak	strong	83.33
[PAX/ROU]		no	no	very weak	strong	83.33
[ACT/ROU]				no	mod-strg	66.67
[all lower]					no	0.00

Figure 3. 11 – Weight Judgement Matrix: Transport Performance - Source: M-MACBETH



	[RPK]	[INC]	[RP]	[EBITDA]	[RASK]	[CASK]	[all lower]	Current scale
[RPK]	no	very weak	very weak	very weak	vweak-weak	vweak-weak	strg-vstr	100.00
[INC]		no	no	very weak	vweak-weak	vweak-weak	strong	85.71
[RP]		no	no	very weak	vweak-weak	vweak-weak	strong	85.71
[EBITDA]				no	very weak	very weak	strong	71.43
[RASK]					no	no	moderate	57.14
[CASK]					no	no	moderate	57.14
[all lower]							no	0.00

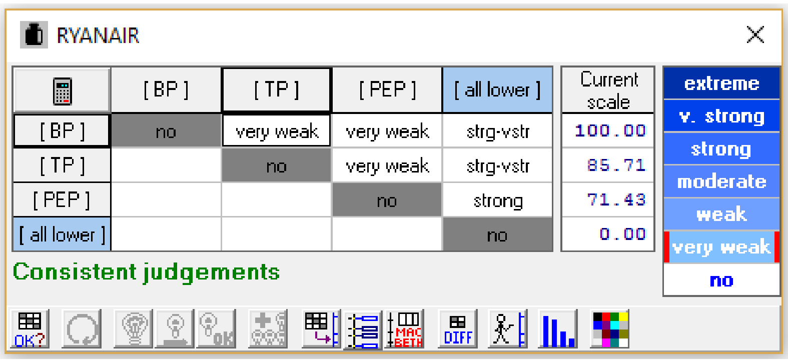
Figure 3. 12 - Weight Judgement Matrix: Business Performance - Source: M-MACBETH



	[FC/PAX]	[REV/EMP]	[EMP/ACT]	[EMP/PAX]	[all lower]	Current scale
[FC/PAX]	no	very weak	very weak	very weak	strong	100.0
[REV/EMP]		no	very weak	very weak	strong	87.5
[EMP/ACT]			no	very weak	mod-strg	75.0
[EMP/PAX]				no	moderate	62.5
[all lower]					no	0.0

Figure 3. 13 - Weight Judgement Matrix: Personnel and Environmental Performance - Source: M-MACBETH

The next step, as in Figure 3.14, aims to give weights for each KPA. As in the previous step, the fill of these matrixes came from the relevance judgements provided by these specialists in the survey, as stated on Chapter 3.3 and the procedure was the same for the ten carriers defined for the case study, as the specialists' judgements can apply in a general way in the study – step seven of the model, available on the beta version of M-MACBETH through the hierarchical weighting.



	[BP]	[TP]	[PEP]	[all lower]	Current scale
[BP]	no	very weak	very weak	strg-vstr	100.00
[TP]		no	very weak	strg-vstr	85.71
[PEP]			no	strong	71.43
[all lower]				no	0.00

Figure 3. 14 – Global Weights Judgement Matrix (Ryanair Case) - Source: M-MACBETH

On Figure 3.15 it can be seen all KPIs of each KPA after all the Judgement Matrixes were filled. Also, on the left stands the difference in weight for each KPA. It becomes evident that the strongest KPA is the Business Performance followed by Transport Performance and Personnel and Environmental Performance, which corroborates the fact that the Economics plays a big part on the Airline Management Industry since the Air Transport market deregulation.

Regarding Transport Performance, the strongest KPI is the Load Factor and the weakest is the Aircraft per Route, acknowledging that the Load Factor is the main indicator of general airline performance analysis. On the Business Performance, the EBITDA is the strongest KPI and RASK and CASK is the weakest. Finally, on Personnel and Environmental Performance the strongest KPI is the Fuel Consumption per Passenger, which is one of the main carrier's concerns nowadays and the weakest is the Employees per Passenger.

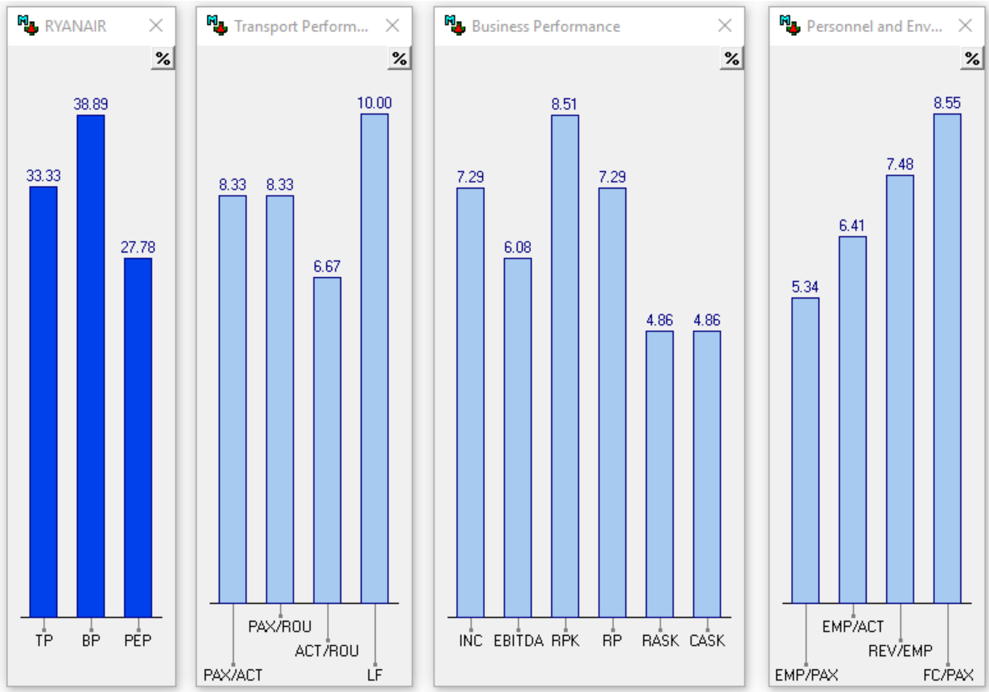


Figure 3. 15 – Difference of KPIs Weight - Source: M-MACBETH

3.5. Conclusion

As stated on the previous sub-chapter the strongest KPA is the business performance followed by transport performance and personnel and environmental performance. These results caused no surprise since the economic factor plays a big part on the Airline Management Industry since the Air Transport market deregulation.

The strongest KPI of transport performance is the load factor and the weakest is the aircraft per route. This also can be observed as a no surprise result as the load factor is the main indicator of general airline performance analysis.

On the business performance, the EBITDA is the strongest KPI. This can cause some astonishment since it would be expected that the main indicator in this field would be operating result. However, since we are evaluating carriers established in different countries and with different state taxes, the EBITDA can give a much more impartial information.

Finally, on personnel and environmental performance the strongest KPI is the fuel consumption per passenger. This is a confirmation of the expectations since fuel costs are one of the main carrier's concerns nowadays.

Chapter 4

Case Study

The goal of this chapter is to assess the efficiency of ten carriers, consisting of two main groups: The Self-Benchmarking and the Peer-Benchmarking.

First, the Case studied will be presented and defined. Afterwards, it will be discussed the results obtained through the JAAPAI Model for the two mentioned types of Benchmarking. The Chapter ends with the main conclusions obtained from the results as a synthesis of the model outputs.

4.1. Introduction

A set of ten European airlines were chosen among Legacy and Low-Cost Carriers: Ryanair, Lufthansa Group, International Airlines Group, Air France-KLM, EasyJet, Norwegian, Air Berlin Group, SAS, TAP Portugal and Finnair. These are the largest airlines in Europe by total scheduled passengers carried over the past ten years, which cover the case study timeframe.

It should be noticed that some of the mentioned airlines are Airline Groups, including several subsidiaries under their umbrella.

The Lufthansa Group Includes Lufthansa, Lufthansa Regional, Lufthansa CityLine, Air Dolomiti, Eurowings, Swiss International Airlines, Swiss Global Airlines, Edelweiss Air and Austrian Airlines.

The International Airlines Group Includes British Airways, BA CityFlyer, OpenSkies, Iberia, Iberia Express, British Midland International, Vueling Airlines, Aer Lingus and Aer Lingus Regional.

The Air France-KLM Group Includes Air France, HOP!, Transavia France, KLM, KLM cityhopper and Transavia.

Other Airlines are not part of Airline Groups nevertheless, include other company's brands which are no longer present in the market, which is the case of Air Berlin which includes Belair and Niki; SAS which includes Scandinavian Airlines, Blue1 and Widerøe; Easy jet which includes EasyJet Switzerland and Tap Portugal which includes Tap Express (named Portugalia Airlines until 2016).

4.2. Self-Benchmarking

Every airline present on the case study was analysed regarding its performance. All table of scores can be found in the Annexe D that comes along with this dissertation.

The goal of this sub-chapter comprises an analysis of performance between two cases. Case study I stand for the largest carrier operating in Europe – Ryanair. Case II stands for the third largest European carrier – International Airlines Group.

A self-benchmarking study is an efficient assessment tool which gives the possibility of compare efficiency values of a given carrier over a span of several years. In this study, each carrier measures its own performance over time [31]. Additionally, it can be an excellent management tool to monitor performance improvements [32].

4.2.1. Case I - Ryanair

Ryanair is an Irish low-cost airline headquartered in Swords - Dublin, Ireland. It has is primary operational bases at Dublin and London Stansted Airports. In 2016, Ryanair was both the largest European airline by scheduled passengers carried and the busiest international airline by passenger numbers.

Ryanair did not begin as an LCC. It started with the primary purpose of breaking the duopoly held by British Airways and Aer Lingus on the Dublin – London route. The following five years saw intense competition between the three companies operating on this route. Ryanair, with its smaller planes, charged fares that were half of what British Airways and Aer Lingus were charging. In its beginning years, while still run by Tony Ryan, Ryanair offered services such as a business class and a frequent flyer program. Ryan saw that his airline was not profitable, so he sent Michael O'Leary, who at the time was working as an accountant and manager, to investigate and analyse the situation. O'Leary saw that Ryanair was losing money on these extra amenities that it was giving away to passengers and saw the need to change strategies before losses took over the company.

Inspired by the North American carrier Southwest Airlines, which had been profiting from airline deregulations since the 1970s, O'Leary decided that Ryanair could use this strategy and become an LCC in Europe, and so in 1991, the company changed its strategy and has had continuous growth ever since [33].

Nowadays, Ryanair is Europe's favourite airline, carrying 119 million passengers per year on more than 1800 daily flights from 86 bases, connecting over 200 destinations in 33 countries on a fleet of over 360 Boeing 737 aircraft, with a further 305 Boeing 737's on order, which will enable the carrier to lower fares and grow traffic to 200million passengers per year [34].

4.2.1.1. JAAPAI Outputs

A decision tree was built with the three main KPA: transport performance, business performance and personnel and environmental performance (Figure 4.1).

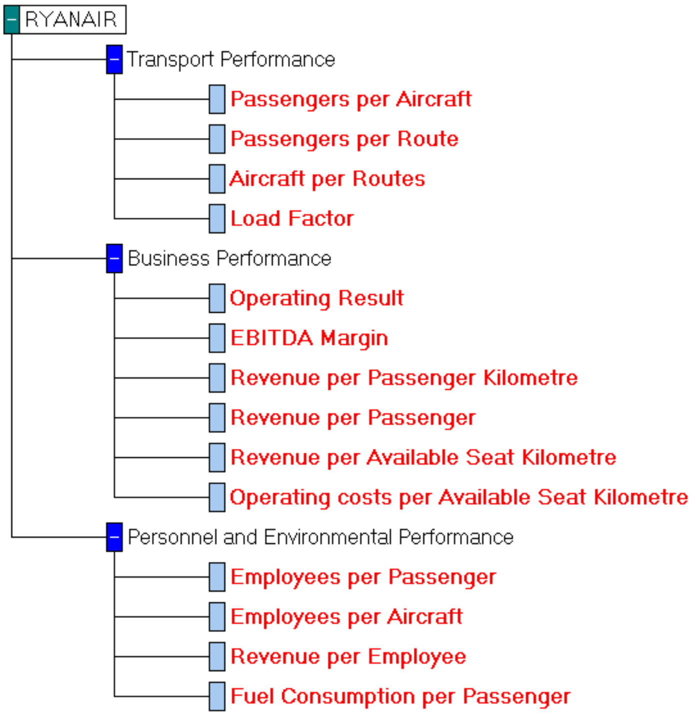


Figure 4. 1 – Decision Tree – Ryanair - Source: M-MACBETH

Through the quantitative documentary research performed to get data for the KPI defined for each KPA the results are presented in table 4.1.

Data showed in table 4.1 represents complex indicators, which were calculated from single indicators as stated on sub-chapter 3.4, using statistics from carrier's annual reports. Several documents from 2007 to 2015 were accessed to get results to conduct the study.

Table 4. 1 – Table of performances (Ryanair)

		2007	2008	2009	2010	2011	2012	2013	2014	2015
Transport performance	Passengers per Aircraft	394737	312270	323757	286638	265074	257823	260000	275084	294156
	Passengers per Routes	95455	67776	69349	70745	55462	50533	49563	51063	56625
	Aircrafts per Routes	0,24	0,22	0,21	0,25	0,21	0,20	0,19	0,19	0,19
	Load Factor	82%	82%	81%	82%	83%	82%	82%	83%	88%
Business performance	Operating result (income) (million €)	471,7	537,1	92,6	402,1	488,2	683,2	718,2	658,6	1042,9
	EBITDA Margin	19,47%	16,17%	-6,13%	11,41%	11,60%	14,42%	13,33%	11,74%	17,38%
	Revenue per Passenger Kilometre RPK (million €)	51457	55434	63076	72149	85690	94262	96324	103733	113163
	Revenue per Passenger RP (€)	4,26	5,33	5,02	4,49	5,03	5,79	6,16	6,17	6,24
	Revenue per ASK RASK (€)	0,0434	0,0408	0,0388	0,0347	0,0356	0,0384	0,0417	0,0402	0,0441
	Operating costs per ASK CASK (€)	0,0342	0,0327	0,0376	0,0301	0,0308	0,0324	0,0355	0,0349	0,0360

Personnel	Employees per Passengers	7,60E-05	1,03E-04	1,09E-04	1,06E-04	1,12E-04	1,11E-04	1,15E-04	1,16E-04	1,06E-04
	Employees per Aircrafts	30,01	32,28	35,19	30,31	29,64	28,53	29,96	31,99	31,12
	Revenue per employee (€)	56048	51574	46192	42493	45014	52339	53453	53015	58982
	Fuel consumption per Passenger (tons)	2,26E-02	2,90E-02	2,85E-02	2,54E-02	2,37E-02	2,28E-02	2,20E-02	2,16E-02	1,97E-02

Based on the table of performances information for the selected timeframe, and with the weights for each KPI already defined, as stated in section 3.4, M-MACBETH software attributed the efficiency scores for Case I (Figure 4.2), considering all steps evidenced on Figure 3.3, corresponding to the hierarchical model, as stated on chapter 3.4. For example, the sum of the weighs of the four indicators of the Transport Performance has a total of 0.33 – which is the weight of the KPA where they are enclosed.

It can be noticed that the first indicator of the TP KPA: Passengers per Aircraft, has a total weight on the model of 8.33%. We already know that the total weight of the TP KPA is 33%. Therefore, to know the weight of this KPI within the respective KPA it is necessary to divide his weight by the total weight of the KPA, resulting in a weight of 25%. Doing the same for the remaining KPI of the TP it is obtain a weight of 25% for the Passengers per Route KPI, 30% for the Load Factor KPI and finally 20% for the Aircraft per Route KPI. As it would be expected, the sum of this weights gives a total of 100%.

Table of scores

Options	Overall	PAX/ACT	PAX/ROU	ACT/ROU	LF	INC	EBITDA	RPK	RP	RASK	CASK	EMP/PAX	EMP/ACT	REV/EMP	FC/PAX
[all upper]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
'15	66.63	19.90	11.54	12.09	100.00	100.00	89.53	100.00	100.00	100.05	18.60	13.39	33.33	100.24	100.00
'07	55.91	99.99	100.00	92.16	13.89	32.38	100.00	0.00	0.00	91.52	38.16	87.29	19.05	77.24	62.17
'14	42.60	9.46	2.45	0.65	27.78	54.50	61.13	82.81	96.02	52.95	30.43	-7.87	44.53	54.68	75.72
'13	39.23	1.19	0.00	8.82	13.89	61.56	69.10	69.30	95.45	70.98	23.27	-7.87	18.40	56.97	70.22
'12	36.60	0.00	1.59	16.99	13.89	57.42	74.58	65.54	74.43	30.97	60.23	13.39	1.29	51.15	60.38
'08	36.21	32.24	32.15	51.31	13.89	40.12	83.55	4.83	48.30	60.40	55.45	34.66	48.26	47.15	0.00
'11	30.76	3.97	9.64	38.23	27.78	34.33	60.63	49.91	31.25	6.95	87.18	13.39	14.29	13.03	51.47
'10	29.76	15.78	39.43	100.33	13.89	24.43	59.63	25.23	8.71	-0.02	99.97	-7.87	22.91	0.00	34.98
'09	22.65	41.68	36.00	46.40	0.00	0.00	0.00	14.12	30.68	36.61	-0.04	-7.87	100.00	19.12	5.19
[all lower]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Weights :		0.0833	0.0833	0.0667	0.1000	0.0729	0.0608	0.0851	0.0729	0.0486	0.0486	0.0534	0.0641	0.0748	0.0855

Figure 4. 2 - Table of scores (Ryanair) - Source: M-MACBETH

The best results correspond to the most recent years, with exception of 2007, which was the second-best year for the company in terms of efficiency. This is explained mainly by a large number of passengers transported and reduced size of the fleet, compared with the last years. For example, in 2007 Ryanair's fleet was composed of 133 aircraft, 57% less than in 2015. Also, the number of routes in 2007 was 66% less than in 2015, so the ratios related to Passengers per Aircraft and Passengers per Route was very high for this year.

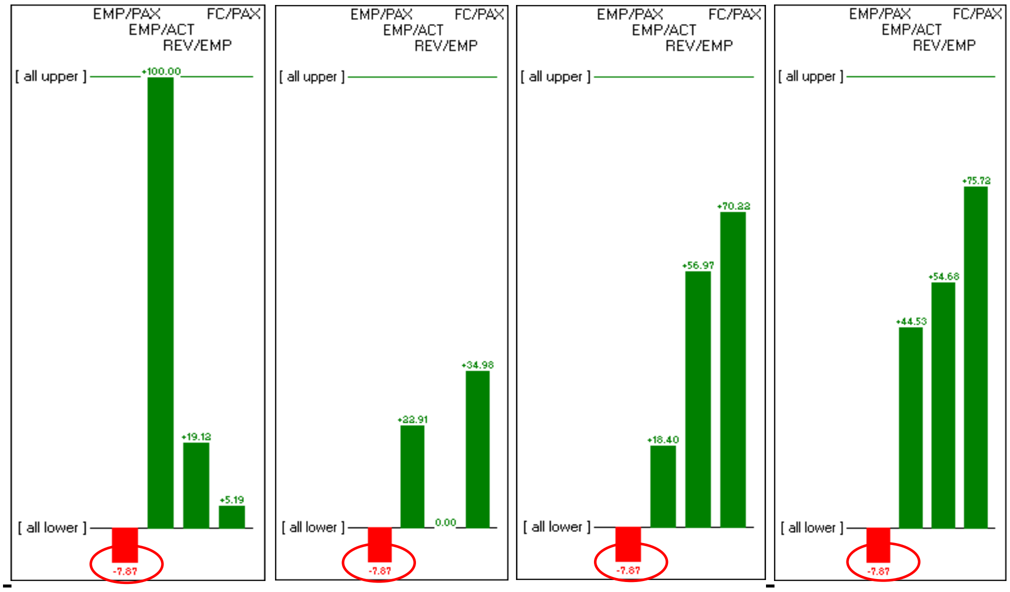


Figure 4. 3 - Value profile for Personnel and Environmental Performance KPA (2009, 2010, 2013 and 2014) - Source: M-MACBETH

Furthermore, in some cases, we've got negative values. For example, as showed on Figure 4.3, the scores of "-7.87" obtained for Employees per Passengers for the years of 2009, 2010, 2013 and 2014. This means a worse value than the neutral one, which was the inferior defined reference of intrinsic value. These results cause no surprise since it is standard in LCC to have a smaller index of employees against a large number of transported passengers (mostly due to a higher number of flights performed in one day).

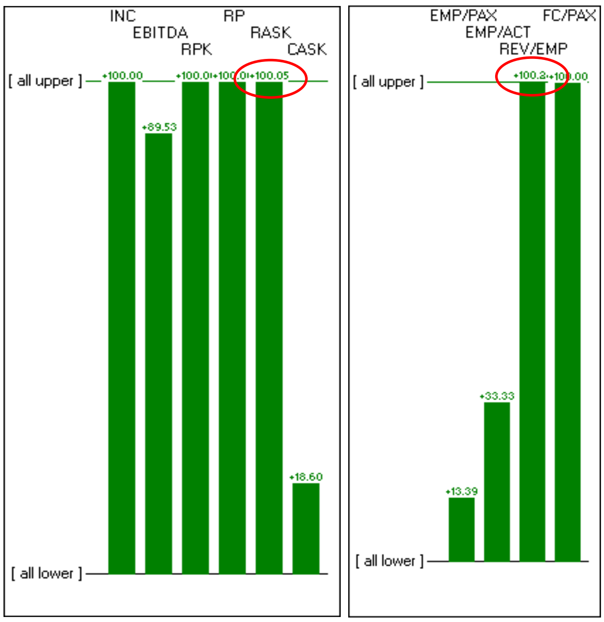


Figure 4. 4 - Value profile for Business Performance and Personnel and Environmental Performance KPA (2015) - Source: M-MACBETH

Also, we've got scores over 100.00 points – the case of the score of "100.24" for Revenue per Employee or "100.05" for Revenue per Available Seat Kilometre, both cases in 2015, as evidenced in Figure 4.4. This means better values than the good one, which was the superior defined reference of intrinsic value. These results can be understood by the high revenue levels of the company on the referred years.

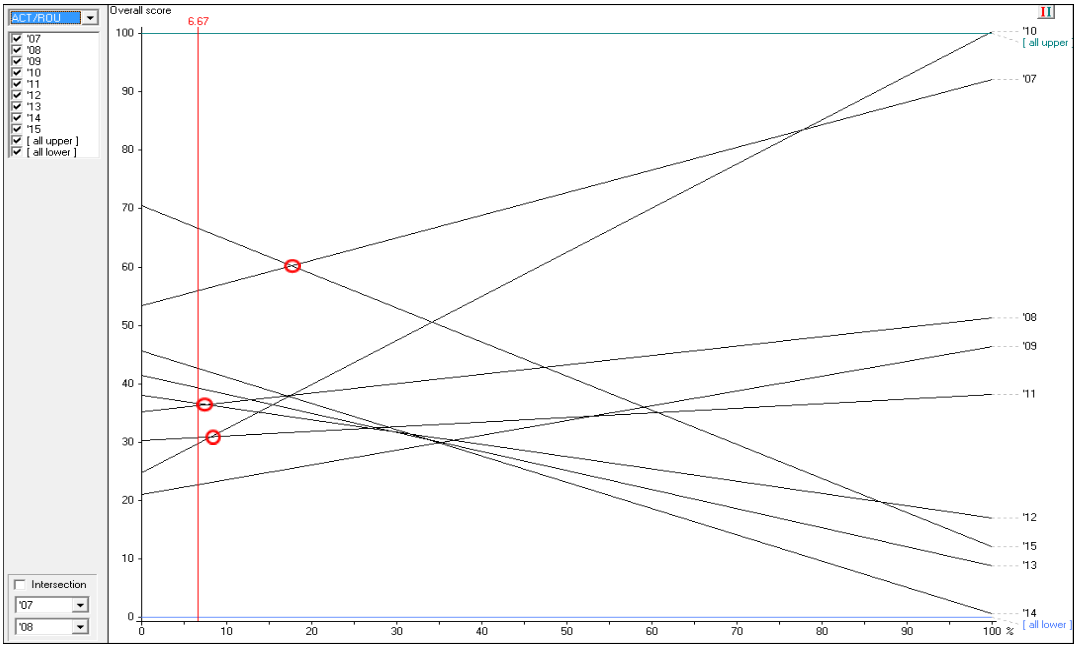


Figure 4.5 - Sensitivity analysis on weight: Aircraft per Route - Source: M-MACBETH

Figure 4.5 allows to performe a sensitivity analysis on the weight of the Aircraft per Route KPI from Transport Performance KPA. It is possible to perform a sensitivity analysis on weight for any KPI, however, it was chosen to perform this analysis for the KPI which the specialists had given the weakest weight in each KPA in order to see if any significant changes would occur if the results of the survey would be different.

The red line represents the actual weight (6.67%) assign to this indicator as explained in section 3.4 above. Thus, the year of 2015 has a better score than 2007, (left vertical axis). However, if the weight of this indicator changed from 6.67% to a value above 18.00% the score of 2007 would be better than that of 2015. The same occurs for the years of 2011 and 2010. However, for 2011 score to be better than 2010 score it would be necessary the weight of this indicator increased 1.44%. Also, if this would have occurred, the years of 2008 and 2012 had changed their position in the ranking too.

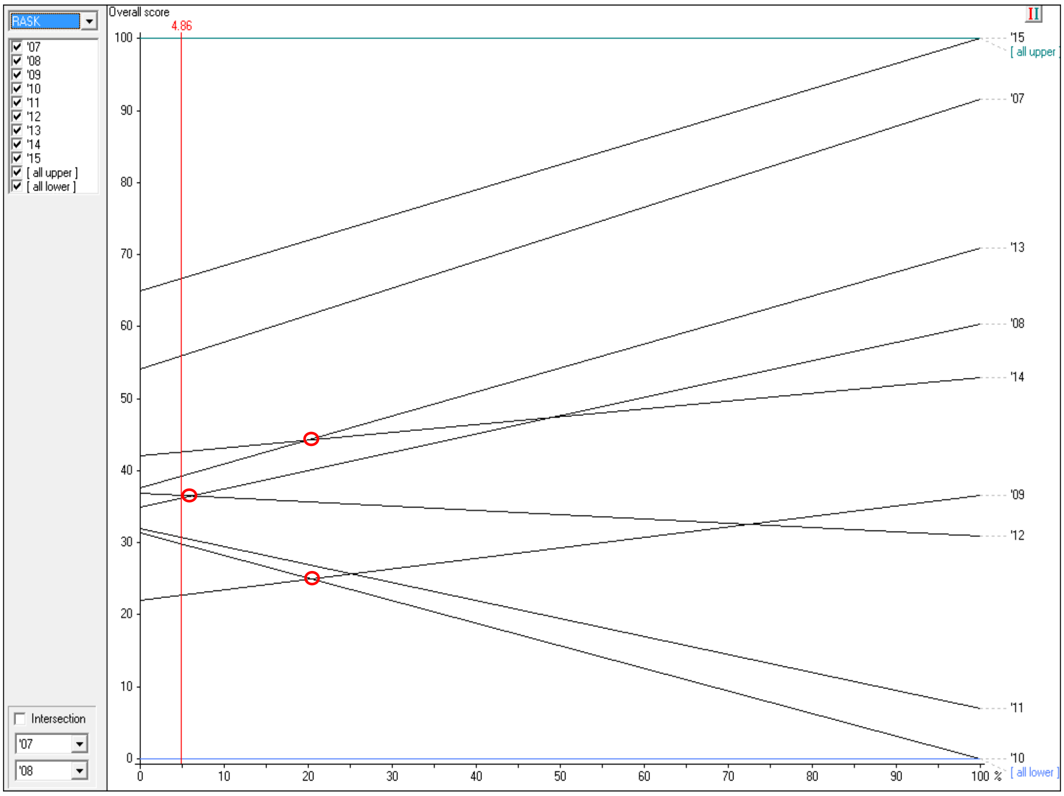


Figure 4. 6 - Sensitivity analysis on weight: Revenue per Available Seat Kilometre - Source: M-MACBETH

Let's now perform the sensitivity analysis on the weight of the Revenue per Available Seat Kilometre KPI from Business Performance KPA, as displayed on Figure 4.6, one of the two KPI which the specialists had given the weakest weight. The year of 2012 has a better score than 2008, however, it only is necessary to increase 1.24% to the weight of this indicator to switch the position of these two years in the ranking. Additionally, if the weight of this indicator changed to a value above 20.00%, the score of 2013 would better than 2014 and 2009 would be better than 2010.

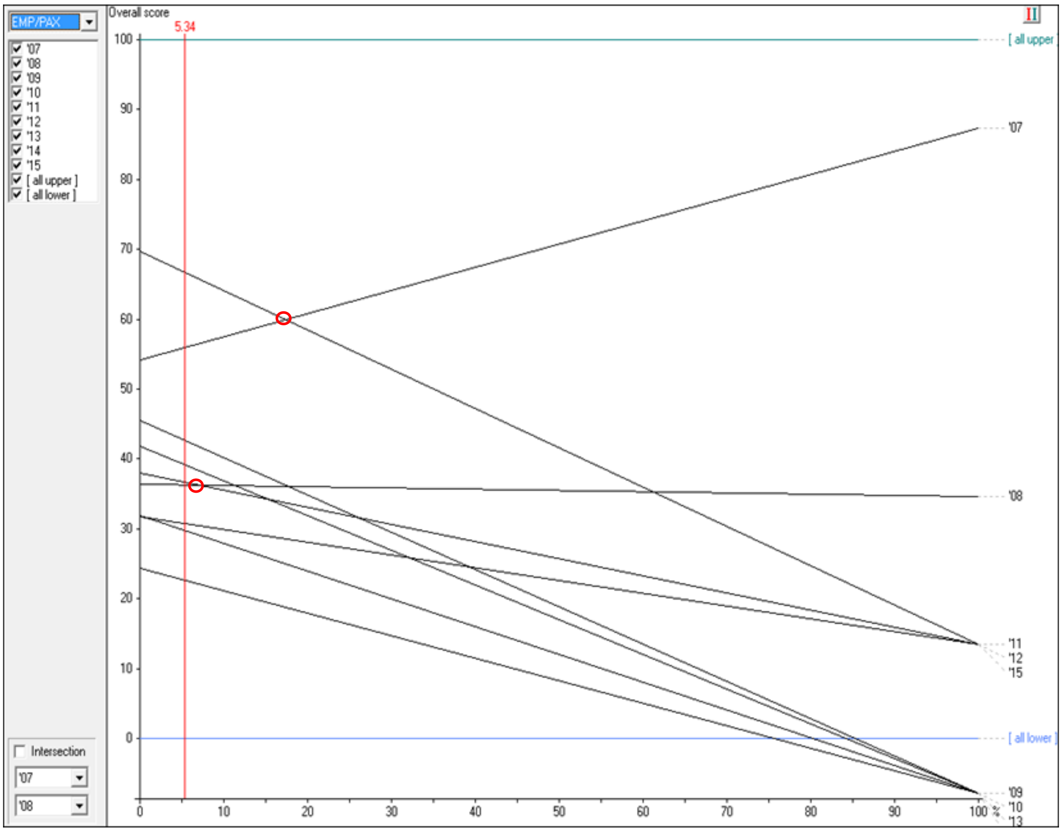


Figure 4. 7 - Sensitivity analysis on weight: Employees per Passenger - Source: M-MACBETH

Performing the sensitivity analysis on Employees per Passenger KPI weight, from Personnel and Environmental performance KPI (Figure 4.7), the year of 2015 has a better score than 2007, however, if the weight of this indicator changed to a value above 18.00% the score of 2007 would be better than that of 2015. Additionally, it only is necessary to increase 1.56% to the weight of this indicator to the year of 2008 has a better score than 2012.

4.2.1.2. Analysis of Results

The best results of efficiency correspond to the most recent years, with exception of 2007, which was the second-best year for Ryanair in terms of efficiency. This is explained mainly by a large amount of transported passengers and the reduced size of the fleet, compared with the last years.

In some years, it was obtained a worse score than the neutral one. Is that the case of the "-7.87" score obtained for employees per passengers KPI for the years of 2010, 2011, 2013 and 2014.

In some years Ryanair table of scores depicts better scores than the Good one as is the score of "100.24" for revenue per employee KPI and "100.05" for revenue per available seat kilometre KPI for the year of 2007.

A sensitivity analysis has been performed, and it was observed that the years 2008 and 2010 would have a better score than 2011 and 2012 respectively if the weight of aircraft per route KPI had increased 1.44%. it was also observed that the year 2008 would have a better score than 2012 if the weight of revenue per available seat kilometre KPI had increased 1.24%. Finally, the year of 2007 would have a better score than 2015 if the weight for employees per passenger KPI had increased 1.56%. If this happened, the year of 2007 would have the best year in the overall efficiency.

4.2.2. Case II - IAG

International Airlines Group, S.A., frequently shortened to IAG, is a British-Spanish multinational airline holding company with its operational headquarters in London, England, United Kingdom and registered in Madrid, Spain. It was formed in January 2011 by British Airways and Iberia, the United Kingdom and Spain legacy carriers merge, respectively. British Airways holds 55% of the new company.

Currently, IAG combines leading airlines in Ireland, the UK and Spain, enabling them to enhance their presence in the aviation market while retaining their individual brands and current operations. The airlines' customers benefit from a larger combined network for both passengers and cargo and a greater ability to invest in new products and services through improved financial robustness.

The airline industry is moving gradually towards consolidation through some regulatory restrictions still prevail. IAG's mission is to play its full role in future industry consolidation both on a regional and global scale. Nowadays the Group consists of Iberia, British Airways, Aer Lingus and Vueling. The subsidiaries operate under their separate brand names.

IAG is one of the world's largest airline groups with 548 aircraft flying to 274 destinations and carrying almost 95 million passengers each year. It is the third largest group in Europe and the sixth largest in the world, based on revenue [35].

4.2.2.1. JAAPAI Outputs

A Decision tree was built with the three main KPA: transport performance, business performance and personnel and environmental performance (Figure 4.8).

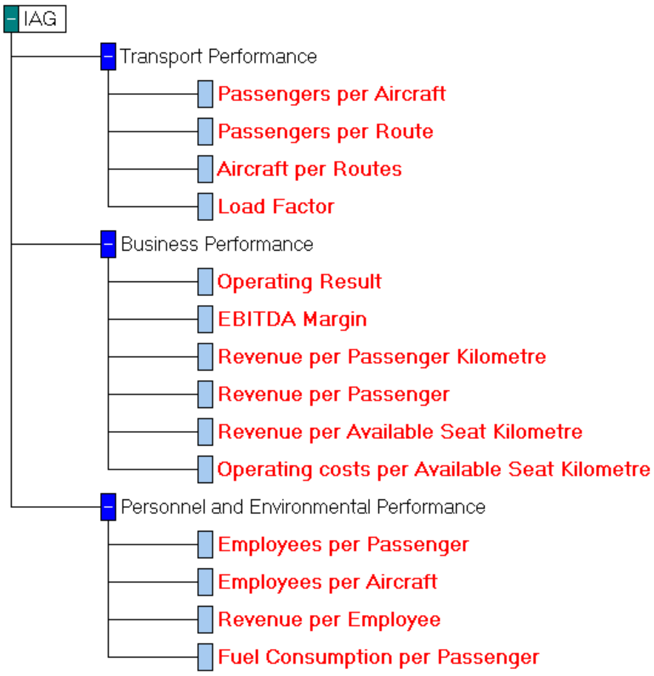


Figure 4. 8 - Decision Tree - IAG - Source: M-MACBETH

Through the quantitative documentary research performed to get data for the KPI defined for each KPA the results present at table 4.2 were obtained.

The data unveiled on table 4.2 comes from indicators exposed on carrier's annual reports. Several documents from 2007 to 2015 were accessed to get the most reliable results to conduct the study [36]-[45].

Table 4. 2 - Table of performances (IAG)

		2007	2008	2009	2010	2011	2012	2013	2014	2015
Transport performance	Passengers per Aircraft	164563	155635	150441	143750	148526	162018	155452	167756	179584
	Passengers per Routes	78817	74541	85897	94757	129218	136500	142251	160417	179924
	Aircrafts per Routes	0,48	0,48	0,57	0,66	0,87	0,84	0,92	0,96	1,00
	Load Factor	79%	78%	79%	79%	79%	80%	80%	80%	81%
Business performance	Operating result (income) (million €)	1406,4	309,4	-941,9	222,0	485,0	-23,0	770,0	1390,0	2335,0
	EBITDA Margin	18,50%	10,73%	3,62%	11,43%	11,43%	8,17%	12,09%	15,55%	18,82%
	Revenue per Passenger Kilometre RPK (million €)	168617	167474	162055	157323	168617	176102	186304	202562	222818
	Revenue per Passenger RP (€)	29,72	30,34	25,27	29,25	31,61	33,18	27,87	26,19	24,06
	Revenue per ASK RASK (€)	0,0835	0,0796	0,0652	0,0743	0,0766	0,0827	0,0810	0,0801	0,0839

	Operating costs per ASK CASK (€)	0,0769	0,0782	0,0698	0,0732	0,0744	0,0828	0,0777	0,0745	0,0753
Personnel	Employees per Passengers	1,08E-03	1,13E-03	1,12E-03	1,12E-03	1,10E-03	1,09E-03	8,97E-04	7,73E-04	4,21E-04
	Employees per Aircrafts	178,26	176,39	169,05	160,69	163,19	176,78	139,42	129,59	75,61
	Revenue per employee (€)	27437	26770	22486	26162	28770	30411	31079	33908	57145
	Fuel consumption per Passenger (tons)	1,04E-02	9,71E-03	1,08E-02	1,20E-02	1,19E-02	1,23E-02	9,93E-03	9,12E-03	8,13E-03

Based on the information on the Table of Performances for the selected timeframe, and with the weight for each KPI already defined, as stated on the section 3.4, M-MACBETH software attributed the efficiency scores for Case II (Figure 4.9), corresponding to the hierarchical model, as stated on chapter 3.4. For example, the sum of the weighs of the four indicators of the Transport Performance has a total of 0.33 – which is the weight of the KPA where they are enclosed.

It can be noticed that the first indicator of the TP KPA, Passengers per Aircraft, has a total weight on the model of 8.33%. We already know that the total weight of the TP KPA is 33%. Therefore, to know the weight of this KPI within the respective KPA it is necessary to divide its weight by the total weight of the KPA, resulting in a weight of 25%. Doing the same for the remaining KPI of the TP it is obtained a weight of 25% for the Passengers per Route KPI, 30% for the Load Factor KPI and finally 20% for the Aircraft per Route KPI. As it would be expected, the sum of these weights give a total of 100%.

Table of scores

Options	Overall	PAX/ACT	PAX/ROU	ACT/ROU	LF	INC	EBITDA	RPK	RP	RASK	CASK	EMP/PAX	EMP/ACT	REV/EMP	FC/PAX
[all upper]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
'15	83.86	100.00	100.00	100.00	100.00	100.00	100.00	100.00	0.00	100.24	49.42	100.19	0.01	100.00	100.00
'14	61.41	62.87	79.18	92.16	74.36	67.56	72.57	65.21	17.52	77.29	54.37	43.72	45.08	28.25	71.28
'13	47.77	24.49	59.78	84.32	66.67	46.27	47.43	37.28	34.50	82.73	33.85	28.08	53.28	21.25	50.84
'12	44.70	44.85	53.64	68.63	71.80	21.03	25.27	21.50	100.00	93.00	0.00	5.22	98.15	19.60	-0.11
'07	42.78	52.84	3.04	0.00	41.02	68.12	97.43	12.93	57.32	97.83	38.73	6.42	100.00	12.24	41.49
'11	38.60	10.00	45.87	74.51	41.02	36.49	43.43	12.93	80.63	56.16	55.56	4.01	81.13	15.54	6.91
'08	29.95	24.87	0.00	0.00	2.56	30.46	39.43	11.62	64.97	74.28	30.22	0.40	97.66	15.54	55.63
'10	27.44	0.00	14.39	33.33	38.46	27.46	43.43	0.00	51.52	42.27	65.95	1.61	77.99	14.04	4.50
'09	20.34	14.00	8.08	16.67	28.20	0.00	0.00	5.42	9.95	0.00	100.00	1.61	88.46	0.00	32.35
[all lower]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Weights :		0.0833	0.0833	0.0667	0.1000	0.0729	0.0608	0.0851	0.0729	0.0486	0.0486	0.0534	0.0641	0.0748	0.0855

Figure 4. 9 - Table of scores (IAG) - Source: M-MACBETH

The best results correspond to the most recent years as in the case I, however, in this case, it is much more evident since the years of 2015, 2014 and 2013 and 2012 appear in a sequenced way.

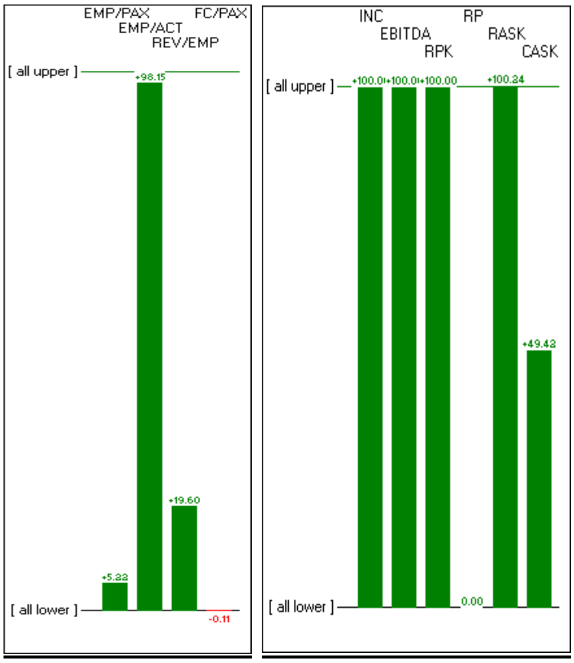


Figure 4. 10 – Value profile for Personnel and Environmental Performance KPA (2012) and for Business Performance KPA (2015) - Source: M-MACBETH

It is worth to mention that in some cases we've got negative values. For example, the score of "-0.11" obtained for Fuel Consumption per Passengers KPI for the year of 2012. This means a worse value than the neutral one, which was the inferior defined reference of intrinsic value. Also, we've got scores over 100.00 points – the case of the score of "100.24" obtained for Revenue per Available Seat Kilometre or "100.19" for Employees per Passenger KPI for the year of 2015. This means better values than the Good one, which was the superior defined reference of intrinsic value. These values are illustrated on the value profile graphs of Figure 4.10.

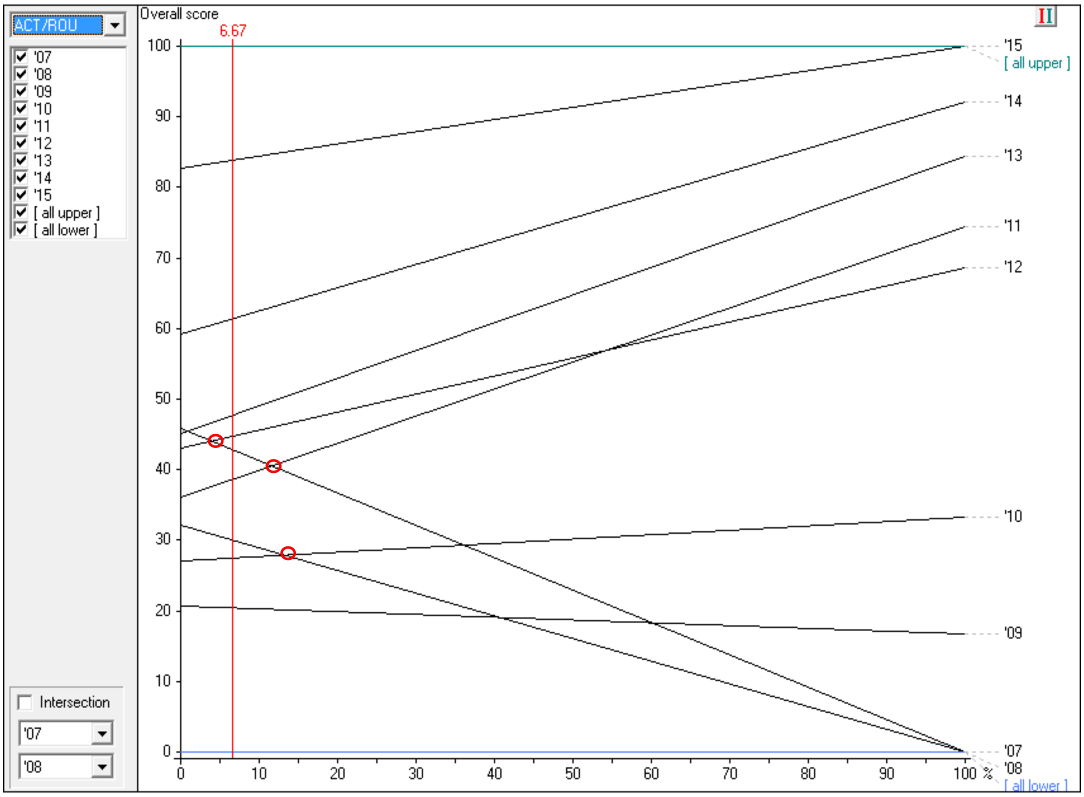


Figure 4. 11 - Sensitivity analysis on weight: Aircraft per Route - Source: M-MACBETH

Figure 4.11 allows performing a sensitivity analysis on the weight of the Aircraft per Route KPI, from Transport Performance KPA. The red line represents the actual weight (6.67%) assign to this indicator as explained in section 3.4 above. The first three years 2015, 2014 and 2013 would not register any difference if the assigned weight had changed. However, if the weight of this indicator was reduced by 2.67%, the score of 2008 would be better than that of 2012. On the other hand, if the weight of this indicator changed from 6.67% to a value above 13.00% the score of 2010 would be better than that of 2008. The same occurs for the years of 2011 and 2007.

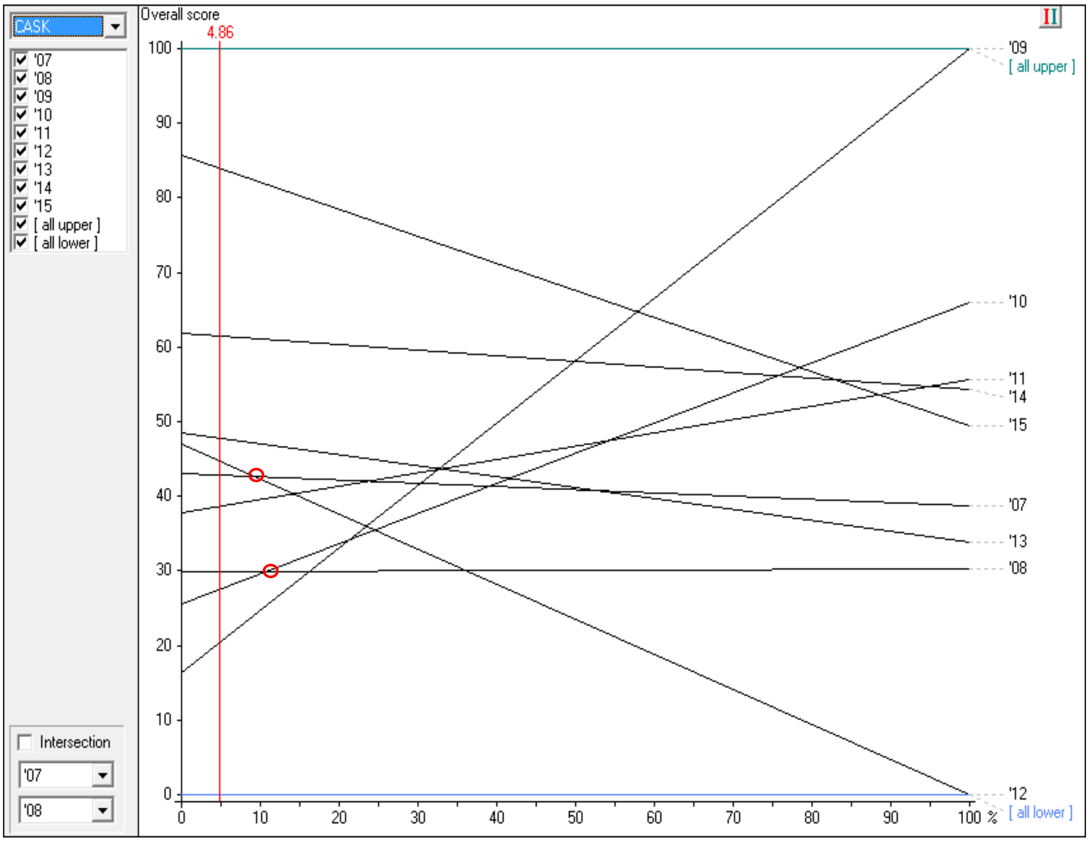


Figure 4. 12 - Sensitivity analysis on weight: Cost per Available Seat Kilometre - Source: M-MACBETH

Let's now perform the sensitivity analysis on the weight of the Cost per Available Seat Kilometre KPI (Figure 4.12), one of the two KPI which the specialists had given the weakest weight on Business Performance KPA. Remember that in Case I we already performed the sensitivity analysis for RASK KPI, the other one of the two KPI which the specialists had given the weakest weight.

It can be seen in this case that it only be necessary to increase 3.14% to the weight of this indicator to switch the position of 2008 and 2010 in the ranking (2008 would have a better score that 2010). Additionally, the score of 2007 would better than 2012 with this increase of weight.

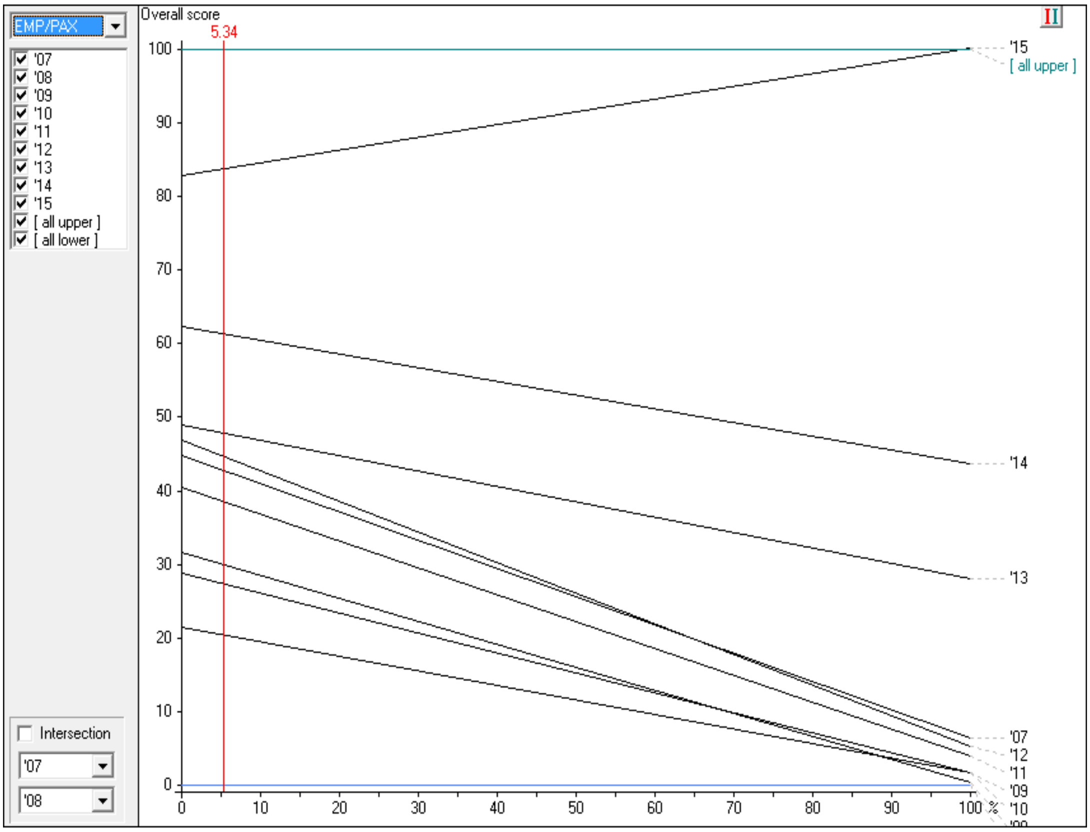


Figure 4. 13 - Sensitivity analysis on weight: Employees per Passenger - Source: M-MACBETH

Analysing Figure 4.13 regarding the sensitivity analysis on weight for Employees per Passenger KPI, from Personnel and Environmental Performance KPA, the results are very different from the other cases. In this case, there are no evident intersections in a range close to the weight vertical line. This means that even if the specialists had given a very different weight for this KPI, no differences would be noticed on the years' final score. This shows that the analysed KPI don't have a large sensitivity on the years ranking.

4.2.2.2. Conclusion

The best results correspond to the most recent years as in the case I, however, in this case, it is much more evident since the years of 2015, 2014, 2013 and 2012 come sequenced.

In some years, it was obtained a worse value than the neutral one. That is the case of the score of "-0.11" obtained for Fuel Consumption per Passengers KPI for the year of 2012.

In some years, it was obtained better values than the Good one. That is the case of the score of "100.24" obtained for Revenue per Employee or "100.19" for Employees per Passenger KPI for the year of 2014.

A sensitivity analysis has been performed, and if the weight of the Aircraft per Route KPI was reduced by 2.67%, the score of 2008 would be better than that of 2012. Additionally, the year of 2008 and

2007 would have a better score that 2010 and 2012, respectively, if the weight of the Cost per Available Seat Kilometre KPI had increased by 3.14%.

4.2.3. Case I Vs. Case II

On both cases, the best results correspond to the most recent years, however, this is much more evident in case II since the years of 2015, 2014 and 2013 and 2012 are sequenced while in Case I the best results correspond to the most recent years, with exception of the year of 2007, which was the second-best year for the company in terms of efficiency.

Ryanair's best results correspond to the most recent years, with exception of 2007, which was the second-best year for the company in terms of efficiency. This is explained mainly by the considerable number of passengers transported in 2007 and reduced size of the fleet, compared with the last years. In that year, traffic had grown by 20% taking a delivery of 30 new aircraft to operate the fleet. For example, in 2007 Ryanair's fleet was composed of 133 aircraft, 57% less than in 2015. Also, the number of routes in 2007 was 66% less than in 2015, so the ratios related to Passengers per Aircraft and Passengers per Route was very high for this year.

Formed by British Airways and Iberia in 2010, the IAG group has grown over the years and from 2015 The company encloses Aer Lingus, British Airways, Iberia and Vueling. There Is no doubt of why this airline group had the best results in the most recent years since it has grown and been composed of more carriers.

4.3. Peer-Benchmarking

In a globally competitive environment, the Peer-Benchmarking is a widely accepted means to analyse business performance against objectives and to evaluate achievements relative to peer performance. Thus, it is a way to compare performance across organisations with peers at a single point in time and through time [32].

On the previous chapter, the ten Airlines presented on the case study were analysed regarding its performance. It were obtained ten tables of scores that can be found in the Annexe D.

The sub-chapter aim comprises a performance analysis of the ten airlines presented on the case study, over a nine-year period. Perceiving the variations on the performance of each airline it was possible to understand its global variation within the airline market over this period.

A meeting with a set of specialists was promoted to assess weights for each airline in terms of their global efficiency perception. The specialists were assisted by an impartial facilitator who assisted the group to ensure and promote clear thoughts regarding airline's performances. The results of the meeting are shown on Figure 4.14.

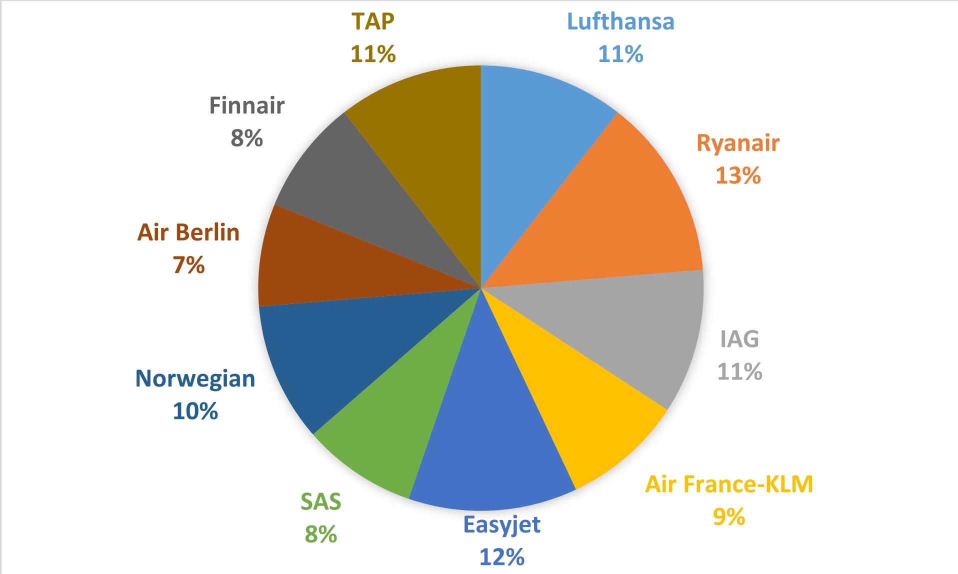


Figure 4. 14 – Weights assessed from meeting results - Source: Own Elaboration

With the biggest percentage comes the LCC Ryanair with a weight of 13.2% followed by EasyJet with a percentage of 12.3%. Tap Portugal, Lufthansa and International Airlines Group obtained the same percentage of 10.5%. Norwegian follows these three Airlines with a percentage of 10.1%. The Air France – KLM group obtained a percentage of 8.8% followed by Finnair and SAS, both with 8.3% of the global weight. The hybrid Airline Air Berlin obtained the smallest weight of 7.5%.

4.3.1.JAAPAI Outputs

The efficiency scores obtained on M-MACBETH after the self-benchmarking for the ten airlines comprised on the case-study were analysed trough the nine-year period defined.

The JAAPAI outputs for the Peer-Benchmarking consists on a pondered average of all carriers' scores, obtained from the self-benchmarking, for each year. This analysis allows a consistent understanding of the air transport performance over the years.

Through the weights obtained from the meeting composed by a set of specialists, pondered values were determined – referred as TOTAL ($\boldsymbol{T_i}$). This parameter measures the performance score, for each year, considering the group of carriers that represents the air transport market under analysis.

Assuming that:

- $\boldsymbol{W_i}$ is the weight obtained for each carrier;
- $\boldsymbol{S_i}$ is the score obtained for each carrier from the self-benchmarking.

$$\boldsymbol{T_i = W_i . S_{i+} W_j . S_j \pm \cdots + W_n . S_n}$$

Table 4. 3 - Table of Performances

Years	LH	FR	IAG	AK	U2	SK	DY	AB	AY	TP	TOTAL
2007	50,27	55,91	42,78	43,71	32,45	55,55	49,61	38,36	57,92	47,14	**47,25**
2008	43,95	36,21	29,95	42,97	26,3	39,65	31,37	50,45	47,93	40,24	**38,00**
2009	13,15	22,65	20,34	27,26	25,55	22,75	43,35	48,93	26,43	50,81	**29,50**
2010	47,05	29,76	27,44	45,64	30,48	32,56	30,04	46,2	35,79	44,96	**36,40**
2011	50,53	30,76	38,6	24,36	46,52	36,93	55,72	47,98	31,06	48,9	**41,29**
2012	64,15	36,6	44,7	58,3	53,86	27,13	56,31	56,89	57,44	56,44	**50,91**
2013	62,65	39,23	47,77	62,03	65,33	61,94	50,31	39,94	62,57	65,79	**55,60**
2014	65,73	42,6	61,41	44,23	48,71	57,52	56,59	56,17	50,88	54,67	**53,54**
2015	70,81	66,63	83,86	67,46	63,82	58,73	78,69	50,08	74,85	51,52	**67,03**
Weights	**0,10**	**0,13**	**0,11**	**0,09**	**0,12**	**0,08**	**0,10**	**0,07**	**0,08**	**0,11**	

On Figure 4.12 stands the evolution of efficiency scores obtained on M-MACBETH for each one of the ten carriers which are included on the case-study.

Also, it is represented a TOTAL line which is the JAAPAI output for the Peer-Benchmarking and consists of a pondered value of carriers' scores for each year.

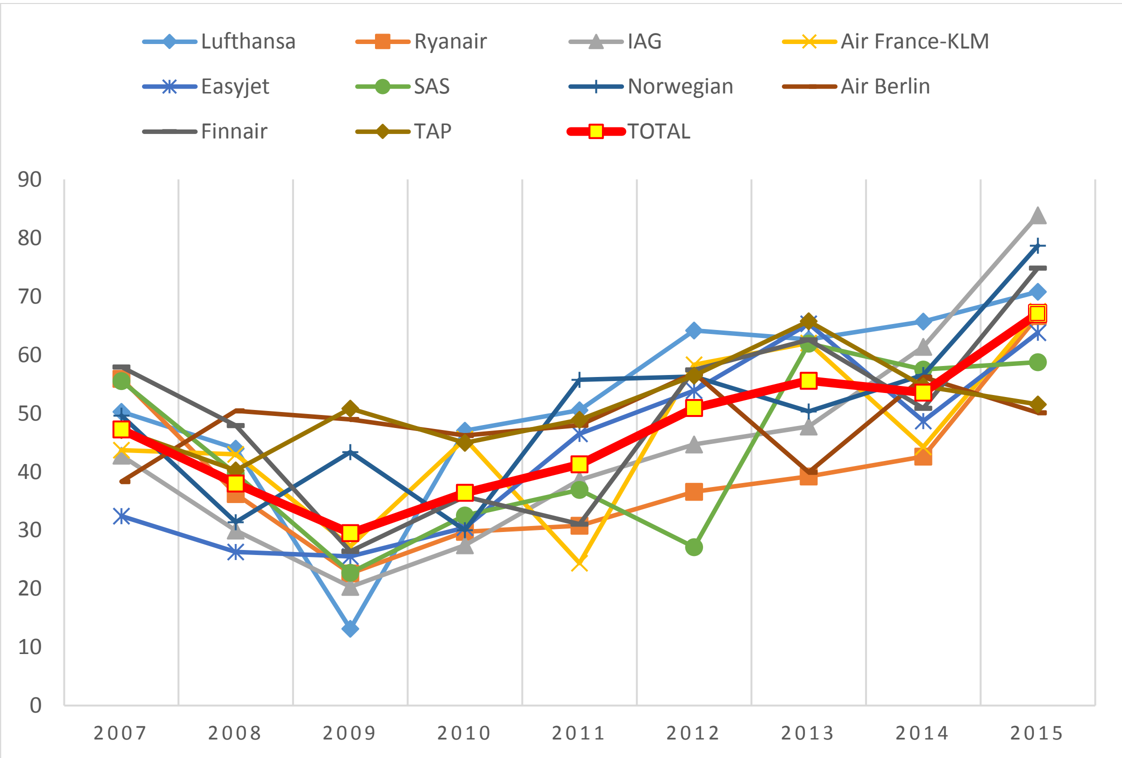


Figure 4. 15 - Performance Evolution - Source: Own Elaboration

Figure 4.15 depicts that the global efficiency of all the carriers has been rising. Between 2008 and 2010 it was registered the worse results of efficiency for almost all the carriers analysed. This can be explained for the crisis on airline market that was experienced in the mentioned years, as stated on page 10 of IATA 2010 Annual Report: "*Early 2009 marked the low point for international air travel markets. From the early-2008 peak to the early-2009 trough, premium travel fell 25%. Economy travel fell 9%, the decline softened by a shift to cheaper seats*" [46].

The year of 2010 seems to be the turning point for the efficiency trend. It can be noticed that after 2010 the scores have been rising until the end of the nine-year period, except for 2014.

4.3.2. Conclusion

The outputs of this analysis can be very interesting regarding the global efficiency of the airlines. It was verified that almost all carriers had a fall in their efficiency scores during the Air Transport Market crisis.

However, since 2010 until the end of the study, it was noticed that the total efficiency of the Air Transport Market had not only recovered but also has been rising to the highest levels of efficiency.

It was also found that during the years corresponding to the Air Transport Market crisis while the major LC as Lufthansa or AF-KLM had the worse scores, the LCC like Easyjet or Ryanair had maintained their trend line.

4.4. Conclusion

Regarding the Self-Benchmarking, on both cases, the best results correspond to the most recent years, however, this is much more evident in case II since the years of 2015, 2014, 2013 and 2012 come sequenced while in Case I the best results correspond to the most recent years, with exception of 2007, which was the second-best year for the company – Ryanair, in terms of efficiency.

In some years, it was obtained a worse value than the neutral one. Is the case of the score of "-7.87" obtained for Employees per Passengers KPI for the years of 2010, 2011, 2013 and 2014 on the case I and the score of "-0.11" obtained for Fuel Consumption per Passengers KPI for the year of 2012 in Case II.

In some years, it was obtained better values than the Good one. That Is the case of the score of "100.24" for Revenue per Employee KPI or "100.05" for Revenue per Available Seat Kilometre KPI for the year of 2007 in Case I and the case of the score of "100.24" obtained for Revenue per Employee or "100.19" for Employees per Passenger KPI for the year of 2014 in Case II.

Resulting from the sensitivity analysis on Case I, it was found that the years of 2010 and 2008 would have a better score than 2011 and 2012 respectively if the weight of Aircraft per Route KPI had increased 1.44%. it was also found that the year of 2008 would have a better score than 2012 if the weight of Revenue per Available Seat Kilometre KPI had increased 1.24%. Finally, it was also found that the year of 2007 would have a better score than 2015 if the weight of Employees per Passenger KPI had increased 1.56%. If this had happened, the year of 2007 would have been the best year in terms of efficiency. On Case II it was found that if the weight of the Aircraft per Route KPI was reduced by 2.67%, the score of 2008 would be better than that of 2012. Additionally, the year of 2008 and 2007 would have a better score that 2010 and 2012, respectively, if the weight of the Cost per Available Seat Kilometre KPI had increased by 3.14%.

Concerning the Peer-benchmarking, the outputs of this analysis were very interesting regarding the global efficiency of the Air Transport Market. It was verified that almost all carriers had a fall in their efficiency scores during the Air Transport Market crisis, which took place between 2008 and 2010. The year of 2010 was the turning point of the crisis and it was verified that since 2010 until the end of the study, the total efficiency of the Air Transport Market had not only recovered but also has been rising to the highest levels of efficiency.

Chapter 5

Conclusion

This chapter consists of the conclusion of the dissertation. It is composed by three sub-chapters: dissertation synthesis, concluding remarks and prospect of future work.

5.1 Dissertation Synthesis

The objective of this study was to assess carriers' efficiency, simulating different scenarios with more than one KPA. LC and LCC was tested in this model. Also, it was studied cases of Equity Partnerships, such as IAG or AF-KLM.

LCC have completely transformed people's leisure and travel habits, opened direct services between European Union city pairs that were not available through the LC, forcing airlines and tour operators to change their business models, popularised regional airports by taking advantage of otherwise underutilised airports and changed the dynamics of the industry. In the last years and reinforced by the strong presence of LCC, passengers have been switching from LC to LCC. LC are now reconsidering their strategies to modify the restrictions imposed on their tickets.

Some other factors, such as fuel prices, airport taxes and increased competition on the Aviation market are leading to the conception of hybrid airline business models that combines the best features of the LCC and LC. The key point on the uniformitarian of the global airline ticket model is that ticket prices will be increasing with the service increase on board.

This hybrid airline business model has been widely accepted and it combines cost savings methodology which is a characteristic of the LCC base model, with service, flexibility, and en-route structure of LC business model.

The emergence of this model does not imply the disappearance of the already established business models of traditional and LCC and LC from the market. Nevertheless, LCC are expected to continue the dominant carrier in a point-to-point network model, even though there are some cases long-haul flights, also based on the hybrid air transport model, which is introducing further competitiveness to the already weakened LC group.

The performed survey was answered by thirty-four aviation specialists, which was essential part of the model, contributing to the faithfulness of the results.

From the survey analysis, the strongest KPA was the Business performance followed by Transport Performance and personnel and Environmental Performance. These results caused no surprise since the economic factor plays a big part on the Airline Management Industry since the Air Transport market deregulation.

The strongest Transport Performance KPI was the Load Factor and the weakest is the Aircraft per Route. This also, is no surprise result as the Load Factor is the main indicator of general Airline Performance Analysis.

On the business performance, the EBITDA is the strongest KPI. Despite the fact of the main indicator in this field was expected to be the operating result, since we are evaluating carriers established in different countries and with different state taxes, the EBITDA can give a much more impartial impression.

On Personnel and Environmental performance, the strongest KPI was the Fuel Consumption per Passenger. This caused also no surprise since fuel costs are one of the main carrier's concerns nowadays regarding the operational expenses.

After the Self-Benchmarking study, the best results corresponded to the most recent years in both cases, however, this was more evident in case II for the years 2015, 2014, 2013 and 2012 come sequenced, while in Case I the best results correspond to the most recent years, with exception of 2007, which was the second-best year for the company in terms of efficiency.

In some years, it was obtained a worse value than the neutral one, such as negative scores to Employees per Passengers KPI for the years of 2010, 2011, 2013 and 2014 on the case I, revealing the LCC policy of less employees to large indexes of aircraft utilization.

In some years, it was obtained better values than the Good one, such as scores over 100 to Revenue per Employee KPI and Revenue per Available Seat Kilometre KPI for the year of 2007 in Case I, and for Revenue per Employee or Employees per Passenger KPI for the year of 2014 in Case II. It should be mentioned that these values are only related with the revenues and not with the operational margin/profit.

From the sensitivity analysis, it was found on Case I that the years of 2010 and 2008 would have a better score than 2011 and 2012 respectively if the weight of Aircraft per Route KPI had increased 1.44%. it was also found that the year of 2008 would have a better score than 2012 if the weight of Revenue per Available Seat Kilometre KPI had increased 1.24%. Also, it was found that the year of 2007 would have a better score than 2015 if the weight of Employees per Passenger KPI had increased 1.56%. If this had happened, the year of 2007 would have been the best year in terms of efficiency.

On Case II it was found that if the weight of the Aircraft per Route KPI was reduced by 2.67%, the score of 2008 would be better than that of 2012. Additionally, the year of 2008 and 2007 would have a better score that 2010 and 2012, respectively, if the weight of the Cost per Available Seat Kilometre KPI had increased by 3.14%. Thus, no major changes would be registered with this weight changes in

Case II. This unveils that Case I is more sensitive to chances as it would be necessary shorter variations of the KPI weight to produce several changes on the obtained results.

Concerning the Peer-benchmarking, the outputs of this analysis were very interesting regarding the difference of performance for each company within the air transport market. The results revealed that almost all carriers had a drop in their efficiency scores during the air transport market crisis, which took place between 2008 and 2010. The year of 2010 was the turning point of the crisis and it was verified that since 2010 until the end of the study, efficiency of all carriers analysed had not only recovered but also has been rising to the highest levels of efficiency.

It was also found that during the years corresponding to the air transport market crisis while the major LC as Lufthansa or AF-KLM had the worse scores, the LCC like Easyjet or Ryanair had maintained their growing trend line.

5.2 Concluding Remarks

Performance of the Low Cost and Legacy Carriers changes depending on the area upon which they are compared: LCC have higher efficiencies based on Transport Performance KPA while LC have higher performance efficiencies based on Business Performance KPA. LCCs low prices results in lower revenue per passenger, which necessarily does not mean to have a lower income margin because the cost per passenger is lower too. Still, LCC need higher flow of passengers as well as greater offer than the LC to obtain better results.

The aviation market is forcing carriers to jump to a hybrid airline business model that combines the best features of the LCC and LC models. The key point on the standardization of the global airline ticket model is that ticket prices will be increasing with the service increase on board. This hybrid airline business model has been widely accepted and combines cost savings methodology which is a characteristic of the LCC base model, with service, flexibility, and en-route structure of LC business model.

However, it should be noticed that the appearance of this model does not imply the disappearance of the already established business models of traditional and LCC and LC from the market.

From the benchmarking studies, it was revealed that between 2008 and 2010 it was registered the worse results of efficiency for almost all the carriers analysed. This can be explained for the crisis on airline market that was experienced in the mentioned years. However, the year of 2010 was the turning point of the air transport market crisis and it was verified that since 2010 until the end of the study - 2015, the total efficiency of the market had not only recovered but also has been rising to the highest levels of efficiency. This study ends in 2015 since it is demanding that data is present on annual reports available in a public basis to work with the realistic carriers' performance. However, it is known that the air transport market continues rising in an exponential way through the years and it is expected to continue growing on the future years.

Finally, it would be valuable that in the future the performed survey was sent to a wider range of air transport experts to obtain more robust weights thus to mitigate the subjectivity of the assignment of weights.

5.3 Prospects for Future Work

As stated previously on this chapter, the goal of this dissertation was to assess Carriers' efficiency, simulating different scenarios with more than one KPA.

LC and LCC was tested in this model. Also, it was studied cases of Equity Partnerships, such as IAG or AF-KLM. However, it would be interesting in the future to follow the same model to assess the level of efficiency of different Alliances, since they are different organisations sharing resources to pursue a strategy and due to its commercial based relationship where a joint product is marketed under a single commercial name; results obtained using a Multi Criteria Decision Making (MCDA) tool could be very promising.

Since the increased competition on the aviation market are leading to the conception of hybrid airline business models that combines the best features of the LCC and LC, it would be very interesting to perform the same study within a group of carriers which follows this type of hybrid model, as it has been widely accepted as the future of the global airline model.

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Annexe A- MACBETH

Let X $(with\ \#X\ =\ n\ \geq\ 2)$ be a finite set of elements: choice options, alternatives or performance levels that an individual or a group, J, wants to compare in terms of their relative attractiveness

Ordinal value scales (defined on X) are quantitative representations of preferences which reflect numerically, the order of attractiveness of the elements of X for J. The construction of an ordinal value scale is a straightforward process, assuming that J is able to rank the elements of X by order of attractiveness, either directly or through pairwise comparisons of the elements to determine their relative attractiveness. Adapted from [47].

Once the ranking is defined, it is needed to assign a real number $v(x)$ to each element x of X, in such a way that:

1- $v(x)\ =\ v(y)$ if and only if J judges the elements x and y to be equally attractive.
2- $v(x)\ >\ v(y)$ if and only if J judges x to be more attractive than y.

A value difference scale (defined on X) is a quantitative representation of preferences, used to reflect the order of attractiveness of the elements of X for J and the differences of their relative attractiveness Adapted from [27].

J is asked to provide preferential information about two elements of X at a time, firstly by giving a judgement as to their relative attractiveness (ordinal judgement).Then, if the two elements are not believed to be equally attractive, by expressing a qualitative judgement about the difference of attractiveness between the most attractive of the two elements and the other. Besides, seven semantic categories of difference of attractiveness: “no difference”, “very weak”, “weak”, “moderate”, “strong”, “very strong” or “extreme”, are offered to J as possible answers to ease the judgemental process. By pairwise comparing the elements of X a matrix of qualitative judgements is filled in, with either only a few pairs of elements, or with all of them (in which case $n\ \cdot\ (n\ -\ 1)/\ 2$ comparisons would be made by J) Adapted from .

Assuming that:

- J is a specialist.
- X $(with\ \#X\ =\ n\ \geq\ 2)$ is a finite set of elements (alternatives, choice options, courses of action) that J wants to compare in terms of their relative attractiveness (desirability or value).
- $\Delta att(x,y)$ is the “difference of attractiveness between x and y for J”, where x and y are elements of X such that x is more attractive than y for J.
- φ is an empty set.
- R is the set of real numbers.

- $R_+^* = \{x \in R \mid x \geq 1\}$.
- N is the set of non-negative integer numbers.
- $N_{s,t} = \{s, s+1, \ldots, t\} = \{x \in N \mid s \leq x \leq t\}$ where $s, t \in N, and\ s < t$.

Types of preferential information

Type 1 Information

Let x and y be two different elements of X. Type 1 information refers to preferential information obtained from J through the following procedure:

- A first question is asked to J: Is one of the two elements more attractive than the other?
- J 's response can be: "Yes", "No", or "I don't know".
- If the response is "Yes", a second question is asked: Which of the two elements is the most attractive?

The responses to this procedure for several pairs of elements of X enable the construction of three binary relations on X:

- $P = \{(x,y) \in X \times X : x\ is\ more\ attractive\ than\ y\}$
- $I = \{(x,y) \in X \times X :$
  $x\ is\ not\ more\ attractive\ than\ y\ and\ y\ is\ not\ more\ attractive\ than\ x, or\ x = y\}$
- $\tau = \{(x,y) \in X \times X : x\ and\ y\ are\ not\ comparable\ in\ terms\ of\ their\ attractiveness\}$

Type 1 information about X is a structure $\{P, I, \tau\}$ where P, I and τ are disjoint relations on X. Adapted from [27], [48], [49].

Type 1+2 information

Suppose that type 1 information $\{P, I, \tau\}$ about X is available. The following procedure should be done:

- The following question is asked, for all $(x,y) \in P$: How do you judge the difference of attractiveness between x and y?
- J 's response would be provided in the form "d_S" (where $d_1, d_2, \ldots, d_Q$ ($Q \in N \setminus \{0,1\}$) are semantic categories of difference of attractiveness defined so that if $i < j$, the difference of attractiveness "d_i" is weaker than the difference of attractiveness "d_j") or in the more general form (possibility of hesitation) "d_S to d_t", with $s \leq t$ (the response "I don't know" is adjusted to the response "d_1 to d_Q").

When $Q = 6$ and $d_1 =$ very weak, $d_2 =$ weak, $d_3 =$ moderate, $d_4 =$ strong, $d_5 =$ very strong and $d_6 =$ extreme, this procedure is the mode of interaction used in the MACBETH.

Type 1+2 information about X is a structure $\{P, I, \tau, P^e\}$ where $\{P, I, \tau\}$ is type 1 information about X and P^e is an asymmetric relation on P, the meaning of which is "$(x, y)\ P^e\ (z, w)\ when\ \Delta att(x, y) > \Delta att(z, w)$". Adapted from [27], [48], [49].

Numerical representation of the preferential information

Type 1 scale Suppose

Let's suppose that type 1 information $\{P, I, \tau\}$ about X is available. A type 1 scale on X relative to $\{P, I\}$ is a function $\mu : X \to R$ satisfying:

Condition 1: $\forall x, y \in X, [xPy \Rightarrow \mu(x) > \mu(y)]\ and\ [xIy \Rightarrow \mu(x) = \mu(y)]$.

Let $Sc_1(X, P, I) = \{\mu : X \to R \mid \mu$ is a type 1 scale on X relative to $\{P, I\}\}$. When X, P and I are well determined, $Sc_1(X, P, I)$ will be noted Sc_1.

When $\tau = \varphi$ and $Sc_1(X, P, I) \neq \varphi$, each element of $Sc_1(X, P, I)$ is an ordinal scale on X. Adapted from [27], [48], [49].

Type 1+2 scale

Let's suppose type 1+2 information $\{P, I, P^e\}$about X is available. A type 1+2 scale on X relative to $\{P, I, \tau, P^e\}$ is a function $\mu : X \to R$ satisfying condition 1 and:

Condition 2: $\forall x, y, z, w \in X, [(x, y)P^e(z, w) \Rightarrow \mu(x) - \mu(y) > \mu(z) - \mu(w)]$.

$Sc_{1+2}(X, P, I, P^e) = \{\mu: X \to R \mid \mu$ is a type 1+2 scale on X relative to $\{P, I, P^e\}\}$. When X, P, I and Pe are well determined, $Sc_{1+2}(X, P, I, P^e)$ will be noted Sc_{1+2}. Adapted from [27], [48], [49].

Consistency and Inconsistency

Type 1 information $\{P, I, \tau\}$ about X is consistent when $Sc_1(X, P, I) \neq \varphi$ and inconsistent when $Sc_1(X, P, I) = \varphi$.

Type 1+2 information $\{P, I, \tau, P^e\}$ about X is consistent when $Sc_{1+2}(X, P, I, P^e) \neq \varphi$ and inconsistent when $Sc_{1+2}(X, P, I, P^e) = \varphi$.

When $Sc_{1+2}(X, P, I, P^e) = \varphi$ one of these two options can arise:

- $Sc_1(X, P, I) = \varphi$: in this case, the message "no ranking" will appear in M-MACBETH; it occurs because J declares, in regards to elements x, y and z of X, that $[xIy, yIz\ and\ xPz]$ or $[xPy, yPz\ and\ zPx]$.

- $Sc_1(X, P, I) \neq \varphi$: in this case, the message "inconsistent judgement" will appear in M-MACBETH.

Although this is the only difference between the types of inconsistency introduced in M- MACBETH, it should be mentioned that one could further distinguish two subtypes of inconsistency when $Sc_{1+2}(X,P,I,P^e) = \varphi$ and $Sc_1(X,P,I) \neq \varphi$:

- Sub-type a): inconsistency arises when there is a conflict between type 1 information and P^e that makes simultaneously satisfaction of conditions 1 and 2 impossible. Adapted from [27].

- Sub-type b): inconsistency arises when there is no conflict between type 1 information and P^e but at least one conflict exists inside P^e that makes satisfying condition 2 impossible. Adapted from [27].

<u>**Consistency test for preferential information**</u>

<u>Testing procedures</u>

Let's assume that $X = \{a_1, a_2, \dots, a_n\}$. During the questioning process with J, each time that a new judgement is obtained, the consistency of all the responses already provided is tested. The consistency test begins with a pre-test that detects the presence of cycles within the relation P and, if no such cycle exists, making a permutation of the elements of X in such a way that, in the matrix of judgements, the cells P or C_{ij} will be located above the main diagonal. Adapted from [49].

When there is no cycle in P, the consistency of type 1 information $\{P, I, \tau\}$ is tested as follows:

- If $\tau \neq \varphi$, a linear program named LP-test1 is used.

- If $= \varphi$, a method named DIR-test1 is used, which has the φ advantage of being easily associated with a very simple visualization of an eventual ranking within the matrix of judgements. Adapted from [27], [48], [49].

When $\{P, I, \tau\}$ is consistent, the consistency of type 1+2 information $\{P, I, \tau, P_e\}$ is tested with the help of a linear program named LPσ-test1+2. Adapted from [27], [48], [49].

<u>Pre-test of the preferential information</u>

The algorithm PRETEST detects cycles within P and sorts the elements of X by making permutations of the elements.

PRETEST:

1 $s \leftarrow n$;

2 among $a_1, a_2, \dots, a_s$ find a_i which is not preferred over any other:

if a_i exists, go to 3;

if not, return FALSE ($Sc1 = \varphi$); finish.

3 permute a_i and a_s;

4 $s \leftarrow s - 1$;

if $s = 1$, return TRUE; finish.

If not, go to 2. Adapted from [27].

Consistency test for type 1 information

Let's suppose that PRETEST detectes no cycle within P and that the elements of X were renumbered as: $\forall i,j \in N_{1,n}1\ [i > j \Rightarrow a_i(notP)a_j]$.

Let's make the consistency test for incomplete type 1 information,onsidering the linear program LP-test1 with variables $X_1, X_2, \ldots, X_n$:

$min\ X_1$

subject to

$X_i - X_j \geq d_{min} \quad \forall(a_i, a_j) \in P$

$X_i - X_j = 0 \qquad \forall(a_i, a_j) \in I\ with\ i \neq j$

$X_i \geq 0 \ \ \forall i \in N1, n$

Where d_{min} is a positive constant, and the variables $X_1, X_2, \ldots, X_n$ represent the numbers $\mu(a_i), \mu(a_j), \ldots, \mu(a_n)$ that should satisfy condition 1 so that μ is a type 1 scale.

The objective function $min\ X_1$ of LP-test1 is random. $Sc1 \neq \varphi \Leftrightarrow$ LP- test1 is possible.

Let's now make the consistency test for complete type 1 information. When $\tau = \varphi$ and the elements of X have been renumbered (after the application of PRETEST), another simple test (DIR-test1) allows one to verify if $P \cup I$ is a complete preorder on X.

Proposition: $if\ [\forall i,j \in N_{1,n}\ with\ i < j, (a_i, a_j) \in P \cup I\ ]$ then $P \cup I$ is a complete preorder on X if and only if $\forall i,j \in N1, n$ with $i < j$: $\left[a_i P a_j \Rightarrow \begin{Bmatrix} \forall s \leq i\ \forall\ t \geq j\ a_s\ Pa_t \\ \exists s : i \leq s \leq j-1, a_s\ Pa_{s+1} \end{Bmatrix}\right]$. Adapted from [27], [48], [49].

Consistency test for type 1+2 information

To test the consistency of type 1+2 information, the efficient linear program LP-test1+2 is used, which includes "thresholds conditions" equivalent to conditions 1 and 2. LP-test1+2 is based on the following procedure:

Let $\mu : X \rightarrow R$. μ satisfies conditions 1 and 2 if and only if there exist Q "thresholds" $0 < \sigma_1 < \sigma_2 < \ldots < \sigma_Q$ that satisfy these conditions:

$-\forall (x, y) \in I, \mu(x) = \mu(y)$

$-\forall i, j \in N1, Q \; with \; i \leq j, \forall (x, y) \in C_{ij}, \sigma_i < \mu(x) - \mu(y)$

$-\forall i, j \in N1, Q - 1 \; with \; i \leq j, \forall (x, y) \in C_{ij} < \mu(x) - \mu(y) < \sigma_j + 1$

Program LP-test1+2 has variables $X_1(= \mu(a_1)), \ldots, X_n(= \mu(a_n)), \sigma_1, \ldots, \sigma_Q$:

$min \; X_1$

subject to

$X_p - X_r = 0$	$\forall (a_p, a_r) \in I \; with \; p < r$
$\sigma_j + d_{min} \leq X_p - X_r$	$\forall i, j \in N_{1,Q} \; with \; i \leq j, \forall (a_p, a_r) \in C_{ij}$
$X_p - X_r \leq \sigma_j + 1 - d_{min}$	$\forall i, j \in N_{1,Q} - 1 \; with \; i \leq j, \forall (a_p, a_r) \in C_{ij}$
$d_{min} \leq \sigma_1 \; \sigma_i - 1 + d_{min} \leq \sigma_i$	$\forall i \in N_{2,Q}$
$X_i \geq 0$	$\forall i \in N_{1,n}$
$\sigma_i \geq 0$	$\forall i \in N_{1,Q}$

Taking into account the previous assumption, $Sc_{1+2} \neq \varphi$ if and only if the linear program LP-test1+2 which is based on the previous conditions is feasible. Adapted from [27], [48], [49].

Annexe B - Specialists Survey and Results

Ranking KPA:

RANK	*Very Weak (1)*	*Weak (2)*	*Moderate (3)*	*Strong (4)*	*Very Strong (5)*	*Extreme (6)*	*AVG*	*RESULT*
Transport Performance	0	2	2	8	16	6	4,6	Strong-Very Strong
Business Performance	0	0	4	11	9	10	4,7	Strong-Very Strong
Personnel and Environmental Performance	0	2	6	16	6	4	4,11	Strong-Very Strong

Transport Performance:

RANK	*Very Weak (1)*	*Weak (2)*	*Moderate (3)*	*Strong (4)*	*Very Strong (5)*	*Extreme (6)*	*AVG*	*RESULT*
Please rank the following indicators in order of relevance: [Passengers per Aircraft]	0	0	2	11	5	4	4,5	Strong-Very Strong
Please rank the following indicators in order of relevance: [Passengers per Route]	0	1	2	8	7	4	4,5	Strong-Very Strong
Please rank the following indicators in order of relevance: [Aircraft per Route]	1	0	7	9	3	2	3,9	Moderate-Strong
Please rank the following indicators in order of relevance: [Load Factor]	0	0	2	6	7	7	4,9	Strong-Very Strong

Passengers per Aircraft									
RANK	*No Difference*	*Very Weak*	*Weak*	*Moderate*	*Strong*	*Very Strong*	*Extreme*	*AVG*	*RESULT*
Passengers per Aircraft variation [AD - Question 1]	0	1	0	4	6	8	3	4,3	strong
Passengers per Aircraft variation [AC - Question 2]	0	0	1	6	9	6	0	3,9	Moderate-Strong
Passengers per Aircraft variation [BD - Question 3]	0	0	3	7	9	3	0	3,5	Moderate-Strong
Passengers per Aircraft variation [AB - Question 4]	0	0	2	12	5	1	2	3,5	Moderate
Passengers per Aircraft variation [BC - Question 5]	0	2	6	7	3	4	0	3,0	Moderate
Passengers per Aircraft variation [CD - Question 6]	0	3	6	6	5	2	0	2,9	Weak-Moderate

Passengers per Route									
RANK	*No Differen ce*	*Very Weak*	*Weak*	*Moderat e*	*Strong*	*Very Strong*	*Extreme*	*AVG*	*RESULT*
Passengers per Route variation [AD - Question 1]	0	2	1	6	6	4	3	3,8	Moderat e-Strong
Passengers per Route variation [AC - Question 2]	0	0	3	8	7	3	1	3,6	Moderat e-Strong
Passengers per Route variation [BD - Question 3]	0	0	3	8	7	4	0	3,5	Moderat e-Strong
Passengers per Route variation [AB - Question 4]	0	1	6	6	4	4	1	3,3	Moderat e
Passengers per Route variation [BC - Question 5]	0	3	5	4	6	3	1	3,2	Moderat e
Passengers per Route variation [CD - Question 6]	2	1	7	3	5	3	1	3,0	Weak-Moderat e

Aircraft per Route									
RANK	*No Differen ce*	*Very Weak*	*Weak*	*Moderat e*	*Strong*	*Very Strong*	*Extreme*	*AVG.*	*RESULT*
Aircraft per Route variation [AD - Question 1]	0	1	2	3	9	6	1	3,9	Moderat e-Strong
Aircraft per Route variation [AC - Question 2]	0	1	3	7	8	3	0	3,4	Moderat e
Aircraft per Route variation [BD - Question 3]	0	1	4	9	7	1	0	3,1	Moderat e
Aircraft per Route variation [AB - Question 4]	0	3	5	7	5	1	1	3,0	Weak-Moderat e
Aircraft per Route variation [BC - Question 5]	0	4	7	4	4	2	1	2,8	Weak-Moderat e
Aircraft per Route variation [CD - Question 6]	2	3	7	5	4	1	0	2,40	Weak

Load Factor									
RANK	*No Difference*	*Very Weak*	*Weak*	*Moderate*	*Strong*	*Very Strong*	*Extreme*	*AVG*	*RESULT*
Load Factor variation [AD - Question 1]	0	1	2	3	4	3	9	4,5	Strong
Load Factor variation [AC - Question 2]	0	1	2	8	4	7	0	3,636364	Moderate-Strong
Load Factor variation [BD - Question 3]	0	0	3	8	5	5	1	3,681818	Moderate-Strong
Load Factor variation [AB - Question 4]	0	2	3	3	9	4	1	3,590909	Moderate-Strong
Load Factor variation [BC - Question 5]	1	2	3	3	9	4	0	3,318182	Moderate
Load Factor variation [CD - Question 6]	1	2	3	6	7	2	1	3,181818	Moderate

Business Performance:

RANKING INDICATORS								
RANK	*Very Weak (1)*	*Weak (2)*	*Moderate (3)*	*Strong (4)*	*Very Strong (5)*	*Extreme (6)*	*AVG*	*RESULT*
Please rank the following indicators in order of relevance: [Operating Result]	0	1	0	1	2	1	4,4	Strong
Please rank the following indicators in order of relevance: [EBITDA Margin]	1	0	1	0	2	1	4	Strong
Please rank the following indicators in order of relevance: [RPK - Revenue per Passenger Kilometer]	0	0	0	2	2	1	4,8	Strong-Very Strong
Please rank the following indicators in order of relevance: [RP - Revenue per Passanger]	0	0	1	1	3	0	4,4	Strong
Please rank the following indicators in order of relevance: [RASK - Revenue per Available Seat Kilometres]	1	0	1	2	1	0	3,4	Moderate
Please rank the following indicators in order of relevance: [CASK - Costs per Available Seat Kilometres]	0	2	1	1	0	1	3,4	Moderate

Operating Result									
RANK	*No Difference*	*Very Weak*	*Weak*	*Moderate*	*Strong*	*Very Strong*	*Extreme*	*AVG*	*RESULT*
Operating Result variation [AD - Question 1]	0	1	0	0	0	3	1	4,4	Strong
Operating Result variation [AC - Question 2]	0	0	1	0	3	1	0	3,8	Moderate-Strong
Operating Result variation [BD - Question 3]	0	0	0	3	1	1	0	3,6	Moderate-Strong
Operating Result variation [AB - Question 4]	0	0	1	1	2	0	1	3,8	Moderate-Strong
Operating Result variation [BC - Question 5]	0	1	1	1	0	2	0	3,2	Moderate
Operating Result variation [CD - Question 6]	1	1	0	1	2	0	0	2,4	Weak

EBITDA Margin									
RANK	*No Difference*	*Very Weak*	*Weak*	*Moderate*	*Strong*	*Very Strong*	*Extreme*	*AVG*	*RESULT*
EBITDA Margin variation [AD - Question 1]	0	1	0	0	3	0	1	3,8	Moderate-Strong
EBITDA Margin variation [AC - Question 2]	0	0	1	2	0	2	0	3,6	Moderate-Strong
EBITDA Margin variation [BD - Question 3]	0	0	1	2	1	1	0	3,4	Moderate

EBITDA Margin variation [AB - Question 4]	0	1	0	2	1	0	1	3,4	Moderate
EBITDA Margin variation [BC - Question 5]	1	0	2	0	1	1	0	2,6	Weak-Moderate
EBITDA Margin variation [CD - Question 6]	1	1	1	0	1	1	0	2,4	Weak

RPK variation									
RANK	*No Difference*	*Very Weak*	*Weak*	*Moderate*	*Strong*	*Very Strong*	*Extreme*	*AVG*	*RESULT*
RPK variation [AD - Question 1]	0	1	0	0	1	2	1	4,2	Strong
RPK variation [AC - Question 2]	0	0	1	1	2	1	0	3,6	Moderate-Strong
RPK variation [BD - Question 3]	0	0	1	2	1	1	0	3,4	Moderate
RPK variation [AB - Question 4]	0	1	1	0	2	0	1	3,4	Moderate
RPK variation [BC - Question 5]	1	1	0	0	1	2	0	3	Moderate
RPK variation [CD - Question 6]	2	0	0	0	2	1	0	2,6	Weak-Moderate

RP variation									
RANK	*No Difference*	*Very Weak*	*Weak*	*Moderate*	*Strong*	*Very Strong*	*Extreme*	*AVG*	*RESULT*
RP variation [AD - Question 1]	0	1	0	0	0	3	1	4,4	Strong
RP variation [AC - Question 2]	0	0	1	0	2	2	0	4	Strong
RP variation [BD - Question 3]	0	0	0	2	3	0	0	3,6	Moderate-Strong
RP variation [AB - Question 4]	0	0	1	2	1	0	1	3,6	Moderate-Strong
RP variation [BC - Question 5]	0	1	1	1	1	1	0	3	Moderate
RP variation [CD - Question 6]	1	1	0	1	2	0	0	2,4	Weak

RASK variation									
RANK	*No Difference*	*Very Weak*	*Weak*	*Moderate*	*Strong*	*Very Strong*	*Extreme*	*AVG*	*RESULT*
RASK variation [AD - Question 1]	0	1	0	0	1	2	1	4,2	Strong
RASK variation [AC - Question 2]	0	0	1	0	3	1	0	3,8	Moderate-Strong

RASK variation [BD - Question 3]	0	0	0	2	3	0	0	3,6	Moderate-Strong
RASK variation [AB - Question 4]	0	0	1	2	0	1	1	3,8	Moderate-Strong
RASK variation [BC - Question 5]	0	1	1	1	1	1	0	3	Moderate
RASK variation [CD - Question 6]	1	1	0	1	2	0	0	2,4	Weak

CASK variation									
RANK	*No Difference*	*Very Weak*	*Weak*	*Moderate*	*Strong*	*Very Strong*	*Extreme*	*AVG*	*RESULT*
CASK variation [AD - Question 1]	0	1	1	0	1	1	1	3,6	Moderate-Strong
CASK variation [AC - Question 2]	0	0	2	0	1	2	0	3,6	Moderate-Strong
CASK variation [BD - Question 3]	0	1	0	1	2	1	0	3,4	Moderate
CASK variation [AB - Question 4]	0	1	0	2	0	1	1	3,6	Moderate-Strong
CASK variation [BC - Question 5]	1	0	1	1	1	1	0	2,8	Weak-Moderate
CASK variation [CD - Question 6]	1	1	0	1	2	0	0	2,4	Weak

Personnel and Environmental Performance:

RANKING INDICATORS								
RANK	*Very Weak (1)*	*Weak (2)*	*Moderate (3)*	*Strong (4)*	*Very Strong (5)*	*Extreme (6)*	*AVG*	*RESULT*
Please rank the following indicators in order of relevance: [Number of Employees per Passenger]	0	2	1	3	1	0	3,4	Moderate-Strong
Please rank the following indicators in order of relevance: [Number of Employees per Aircraft]	0	2	0	3	2	0	3,7	Moderate-Strong
Please rank the following indicators in order of relevance: [Revenue per Employee]	0	2	0	2	2	1	4,0	Strong
Please rank the following indicators in order of relevance: [Fuel Consumption per Passenger]	0	0	3	1	2	1	4,1	Strong-Very Strong

Number of Employees per Passenger Variation									
RANK	*No Difference*	*Very Weak*	*Weak*	*Moderate*	*Strong*	*Very Strong*	*Extreme*	*AVG*	*RESULT*
Number of Employees per Passenger Variation [AD - Question 1]	0	1	2	1	1	1	1	3,3	Moderate

Number of Employees per Passenger Variation [AC - Question 2]	0	0	2	2	2	1	0	3,3	Moderate
Number of Employees per Passenger Variation [BD - Question 3]	0	2	1	2	2	0	0	2,6	Weak-Moderate
Number of Employees per Passenger Variation [AB - Question 4]	0	2	1	1	2	0	1	3,0	Moderate
Number of Employees per Passenger Variation [BC - Question 5]	2	1	0	2	1	1	0	2,3	Weak
Number of Employees per Passenger Variation [CD - Question 6]	1	0	1	3	2	0	0	2,7	Weak-Moderate

Revenue per Employee variation									
RANK	*No Difference*	*Very Weak*	*Weak*	*Moderate*	*Strong*	*Very Strong*	*Extreme*	*AVG*	*RESULT*
Revenue per Employee variation [AD - Question 1]	0	1	0	2	2	2	0	3,6	Moderate-Strong
Revenue per Employee variation [AC - Question 2]	0	0	3	3	0	1	0	2,9	Weak-Moderate
Revenue per Employee variation [BD - Question 3]	0	0	3	2	1	1	0	3,0	Moderate
Revenue per Employee variation [AB - Question 4]	0	0	2	1	2	1	1	3,7	Moderate-Strong
Revenue per Employee variation [BC - Question 5]	1	2	1	2	0	1	0	2,1	Weak
Revenue per Employee variation [CD - Question 6]	0	1	3	1	1	1	0	2,7	Weak-Moderate

Fuel Consumed per Passenger variation									
RANK	*No Difference*	*Very Weak*	*Weak*	*Moderate*	*Strong*	*Very Strong*	*Extreme*	*AVG*	*RESULT*
Fuel Consumed per Passenger variation [AD - Question 1]	0	1	2	0	1	1	2	3,7	Moderate-Strong
Fuel Consumed per Passenger variation [AC - Question 2]	0	0	2	2	0	3	0	3,6	Moderate-Strong
Fuel Consumed per Passenger variation [BD - Question 3]	0	0	1	2	2	2	0	3,7	Moderate-Strong
Fuel Consumed per Passenger variation [AB - Question 4]	0	0	0	2	2	2	1	4,3	Strong
Fuel Consumed per Passenger variation [BC - Question 5]	1	0	1	3	0	2	0	3,0	Moderate
Fuel Consumed per Passenger variation [CD - Question 6]	0	1	0	1	3	2	0	3,7	Moderate-Strong

Annexe C – Tables of Performances

Air France – KLM:

Table of performances

Options	PAX/ACT	PAX/ROU	ACT/ROU	LF	INC	EBITDA	RPK	RP	RASK	CASK	EMP/PAX	EMP/ACT	REV/EMP	FC/PAX
'07	129145.87	153091.67	1.19	81.4	1200	4.8	199510	31.44	0.088	0.08347	0.0015	193.97	20929.79	0.11688
'08	123220.76	144951.55	1.18	80.8	399	15	207227	32.97	0.0962	0.09465	0.00148	182.67	22240.66	0.11673
'09	119882.45	152555.33	1.27	79.7	-1324	10.5	209060	28.25	0.0802	0.08521	0.00146	174.5	19408.12	0.10774
'10	119048.82	144907.79	1.22	81.7	28	7.3	203114	39.96	0.0938	0.09368	0.0015	178.33	22005.51	0.12068
'11	127792.58	149177.2	1.17	82.7	-353	5.3	117170	33.47	0.0957	0.09708	0.00141	179.79	23788.67	0.1181
'12	137078.53	159259.26	1.18	83.1	-336	5.5	223034	32.87	0.0949	0.07617	0.00135	181.73	24430.04	0.11571
'13	132638.08	154039.84	1.16	83.8	130	7.3	228313	33	0.0937	0.0732	0.0013	172.5	25375.61	0.11322
'14	135639.23	122547.47	0.9	84.7	296	6.4	229347	32.17	0.092	0.0909	0.00128	173.87	25093.43	0.11304
'15	168164.79	140312.5	0.83	85.1	816	9.4	235715	29.06	0.0943	0.09131	0.00104	174.72	27974.28	0.09746

Air Berlin:

Table of performances

Options	PAX/ACT	PAX/ROU	ACT/ROU	LF	INC	EBITDA	RPK	RP	RASK	CASK	EMP/PAX	EMP/ACT	REV/EMP	FC/PAX
'07	227419.35	104444.44	0.46	77.3	21	14.9	46070	8.99	0.0427	0.04236	0.0003	67.42	30340.91	0.00476
'08	228800	113492.06	0.5	78.6	-75	14	44310	11.89	0.0602	0.06154	0.00029	66.49	40918.06	0.00451
'09	198773.01	120895.53	0.61	77.5	-9.5	15.5	43911	10	0.0572	0.05736	0.00026	50.79	39143.51	0.00384
'10	206508.88	107055.21	0.52	76.5	-97.2	16.6	45244	10.67	0.0633	0.065	0.00026	52.66	41838.2	0.00367
'11	207648.29	108951.26	0.52	78.2	-420.4	10.1	52140	11.98	0.068	0.07477	0.00026	53.61	46387.58	0.00407
'12	215138.68	95823.26	0.45	79.8	6.8	17.1	48720	12.93	0.0714	0.07127	0.00028	59.9	46442.27	0.00391
'13	225256.19	32210.14	0.41	84.9	-232.83	10.4	48570	13.15	0.0724	0.0765	0.00028	53.61	46567.1	0.004
'14	212860.42	107878.24	0.51	83.5	-296.57	8.4	49270	13.12	0.0705	0.0755	0.00027	56.64	49291.47	0.00403
'15	197707.6	109598.78	0.55	84.2	-307.22	8.8	47010	13.49	0.0731	0.0786	0.00029	57.97	46023.23	0.00403

easyJet:

Table of performances

Options	PAX/ACT	PAX/ROU	ACT/ROU	LF	INC	EBITDA	RPK	RP	RASK	CASK	EMP/PAX	EMP/ACT	REV/EMP	FC/PAX
'07	271532.85	128719.72	0.47	83.7	222.73	16.7	43118.58	5.6	0.0479	0.04278	0.00015	40.09	37936.69	0.03432
'08	264848.48	115000	0.43	84.1	143.43	10.5	55612.42	6.31	0.0495	0.04691	0.00015	38.64	43224.3	0.02761
'09	249723.76	107109	0.43	85.5	51.31	8.4	58966.19	6.88	0.0535	0.05258	0.00014	35.79	48005.83	0.0258
'10	262365.59	95874.26	0.37	87	264.69	12.1	65452.17	7.1	0.0551	0.06229	0.00014	37.03	50341.24	0.02311
'11	276649.75	99634.37	0.36	87.3	298.48	11.2	71538.17	8.92	0.0701	0.06581	0.00014	39.21	62922.18	0.02074
'12	272897.2	96528.93	0.35	88.7	446.31	11.4	91833.82	9.29	0.0752	0.06899	0.00014	38.35	66123.44	0.01955
'13	280184.33	96050.55	0.34	89.3	672.98	13.8	95136.78	9.86	0.0808	0.0717	0.00014	38.45	71855.28	0.01627
'14	286725.66	96000	0.33	90.6	677.52	18.2	85.4887	8.15	0.0664	0.05786	0.00015	42.69	54710.75	0.01691
'15	284647.3	93333.33	0.33	91.5	802.29	20.1	90513.33	7.97	0.0652	0.0556	0.00015	41.93	54082.09	0.01579

Finnair:

Table of performances

Options	PAX/ACT	PAX/ROU	ACT/ROU	LF	INC	EBITDA	RPK	RP	RASK	CASK	EMP/PAX	EMP/ACT	REV/EMP	FC/PAX
'07	141806.45	64647.06	0.46	75.2	142	7.6	17923	20.91	0.0684	0.0631	0.00095	134.27	22078.08	0.07609
'08	129218.75	59927.54	0.46	75.5	-58	-2.7	21896	27.28	0.0775	0.07952	0.00099	127.47	27653.84	0.08357
'09	109308.82	53092.86	0.49	75.9	-115	-6.8	19934	24.73	0.07	0.07437	0.00118	129.1	20933.33	0.09585
'10	113317.46	50992.86	0.45	76.5	-13	-1.6	19222	28.34	0.0805	0.08103	0.00106	120.13	26720.97	0.09874
'11	123276.92	55645.83	0.45	73.3	-55.5	1.3	21498	24.59	0.0671	0.06904	0.00093	114.88	26389.45	0.09989
'12	127159.42	59283.78	0.47	77.6	44.9	0.7	23563	27.91	0.0806	0.07917	0.00076	96.16	36910.32	0.08949
'13	132414.29	63486.3	0.48	79.5	8.8	0.3	24776	24.51	0.0729	0.07262	0.00063	82.9	39150.44	0.08004
'14	143731.34	48150	0.34	80.2	-43.5	-4.6	24772	22.51	0.0702	0.07159	0.00052	74.34	43519.37	0.07633
'15	142972.22	65987.18	0.46	80.4	23.7	4.9	25592	22.58	0.073	0.07225	0.00047	66.9	48245.8	0.07371

IAG:

Table of performances

Options	PAX/ACT	PAX/ROU	ACT/ROU	LF	INC	EBITDA	RPK	RP	RASK	CASK	EMP/PAX	EMP/ACT	REV/EMP	FC/PAX
'07	164563.19	78817.11	0.48	79.1	1406.44	18.5	168617	29.72	0.0835	0.07691	0.00108	178.26	27437.35	0.01036
'08	155634.62	74540.79	0.48	77.6	309.38	10.7	167474	30.34	0.0796	0.0782	0.00113	176.39	28770.08	0.00971
'09	150440.68	85896.77	0.57	78.6	-941.92	3.6	162055	25.27	0.0652	0.06979	0.00112	169.05	22485.88	0.01078
'10	143750	94756.55	0.66	79	221.97	11.4	157323	29.25	0.0743	0.07323	0.00112	160.69	28161.98	0.01205
'11	148525.86	129217.5	0.87	79.1	485	11.4	168617	31.61	0.0766	0.07436	0.0011	163.19	28770.4	0.01194
'12	162017.8	136500	0.84	80.3	-23	8.2	176102	33.18	0.0827	0.08277	0.00109	176.78	30410.92	0.01226
'13	155452.44	142250.53	0.92	80.1	770	12.1	186304	27.87	0.081	0.07765	0.0009	139.42	31078.9	0.00993
'14	167755.99	160416.67	0.96	80.4	1390	15.6	202562	26.19	0.0801	0.07454	0.00077	129.59	33908.28	0.00912
'15	179584.12	179924.24	1	81.4	2335	18.8	222818	24.06	0.0839	0.07529	0.00042	75.61	57145	0.00813

Lufthansa:

Table of performances

Options	PAX/ACT	PAX/ROU	ACT/ROU	LF	INC	EBITDA	RPK	RP	RASK	CASK	EMP/PAX	EMP/ACT	REV/EMP	FC/PAX
'07	122612	152670	1.245	79.8	1378	13.48	135011	35.64	0.1326	0.1147	0.0016	196.45	22246.7	0.1078
'08	134542	145661	1.0826	78.9	1280	9.45	154156	35.24	0.1271	0.1151	0.00153	206.34	22975.69	0.1088
'09	107064	96625	0.9025	77.9	130	8.25	162286	28.83	0.107	0.0982	0.00145	155.47	19838.85	0.0994
'10	130563	154500	1.1833	79.6	1020	11.52	186452	28.54	0.1129	0.0999	0.00126	164.88	22601.78	0.0913
'11	144540	204472	1.4146	77.6	820	8.86	200376	28.56	0.1113	0.1014	0.00118	171.1	24129.19	0.0897
'12	165231	207200	1.254	78.8	839	10.85	204775	29.09	0.1158	0.1033	0.00114	188.78	25458.74	0.0857
'13	168156	190863	1.135	79.8	697	8.89	209652	28.71	0.083	0.092	0.00112	188.77	25574.46	0.0838
'14	172354	195568	1.1347	80.1	954	6.63	214641	28.31	0.08	0.088	0.00112	193.45	25225.05	0.0833
'15	179465	181278	1.0101	80.4	323	10.59	220436.31	29.77	0.0776	0.0781	0.00111	199.27	26811.87	0.0832

Norwegian:

Table of performances

Options	PAX/ACT	PAX/ROU	ACT/ROU	LF	INC	EBITDA	RPK	RP	RASK	CASK	EMP/PAX	EMP/ACT	REV/EMP	FC/PAX
'07	215625	60526.32	0.28	80.1	14.72	4.9	6059	6.73	0.0614	0.05946	0.00021	44.28	32764.28	0.03029
'08	227500	53529.41	0.24	78.7	-37.13	-3.3	9074	7.52	0.0593	0.06254	0.00018	39.9	42856.55	0.03297
'09	234782.61	52427.18	0.22	78.2	62.84	9.9	10602	7.43	0.0592	0.0546	0.00016	36.61	47682.26	0.03201
'10	228070.18	52208.84	0.23	77.4	23.07	4.6	13774	7.27	0.0531	0.05176	0.00016	37.49	44201.18	0.0383
'11	253225.81	57933.58	0.23	79.3	45.7	6.7	17421	7.37	0.0527	0.05061	0.00016	39.27	47517.42	0.03171
'12	260294.12	57467.53	0.22	78.5	44.38	6.1	20353	7.68	0.0545	0.05279	0.00016	42.5	48882.15	0.03218
'13	243529.41	52941.18	0.22	78.3	106.56	9.6	26881	8.27	0.0499	0.04677	0.00017	41.26	48805.94	0.03551
'14	252631.58	59701.49	0.24	80.9	-155.01	-3.4	37615	8.94	0.0462	0.04952	0.00018	46.05	49066.77	0.04089
'15	260606.06	57718.12	0.22	77	38.23	6.6	42284	9.58	0.0504	0.04962	0.00018	46.22	53996.27	0.01935

Ryanair:

Table of performances

Options	PAX/ACT	PAX/ROU	ACT/ROU	LF	INC	EBITDA	RPK	RP	RASK	CASK	EMP/PAX	EMP/ACT	REV/EMP	FC/PAX
'07	394726.84	95454.55	0.242	82	471.75	19.5	51457.36	4.26	0.04339	0.03424	8E-5	30.01	56048.48	0.02261
'08	312269.94	67776.3	0.217	82	537.08	16.2	55434.39	5.33	0.0408	0.03272	0.0001	32.28	51573.96	0.02903
'09	323756.91	69349.11	0.214	81	92.63	-6.1	63076.49	5.02	0.03882	0.0376	0.00012	35.19	46191.95	0.02849
'10	286637.93	70744.68	0.247	82	402.1	11.4	72149.29	4.49	0.03473	0.03006	0.00012	30.31	42492.89	0.02539
'11	265073.53	55461.54	0.209	83	488.2	11.6	85690.34	5.03	0.0356	0.03081	0.00011	29.64	45014.26	0.02367
'12	257823.13	50533.33	0.196	82	683.2	14.4	94262.38	5.79	0.03835	0.03239	0.00011	28.63	52339.06	0.02275
'13	260000	49562.5	0.191	82	718.2	13.3	96323.75	6.16	0.04168	0.03555	0.00012	29.96	53452.99	0.02198
'14	275084.18	51062.5	0.186	83	658.6	11.7	103732.87	6.17	0.04018	0.03492	0.00012	31.99	53015.47	0.02155
'15	294155.84	56625	0.193	88.2	1042.9	17.4	113162.48	6.24	0.0441	0.03596	0.00011	31.12	58981.85	0.01965

SAS:

Table of performances

Options	PAX/ACT	PAX/ROU	ACT/ROU	LF	INC	EBITDA	RPK	RP	RASK	CASK	EMP/PAX	EMP/ACT	REV/EMP	FC/PAX
'07	147292.93	255824.56	1.74	74.5	272.57	2.1	3368.44	17.67	0.1159	0.10981	0.00056	83.07	31322.52	0.05955
'08	160220.99	145000	0.91	72.3	101.52	-1.8	3369.96	18.56	0.1176	0.11541	0.00056	89.98	33054.56	0.06035
'09	156784.88	134835	0.86	72.7	-133.49	-7.6	2955.35	16.96	0.1145	0.11787	0.00054	83.94	31677.42	0.06292
'10	184326.53	106677.17	0.58	75.6	25.05	-7.5	2992.61	15.43	0.1076	0.10699	0.00051	93.35	30472.78	0.05966
'11	167572.25	113242.19	0.68	74.9	307.4	-3.9	3122.64	14.55	0.103	0.09546	0.00046	77.91	31282.76	0.05622
'12	166128.21	95279.41	0.57	76.7	97.24	-3.5	2820.64	14.14	0.1014	0.09873	0.00058	95.53	24586.48	0.06083
'13	218964.03	109877.26	0.5	75	371.34	3.9	3406.01	14.11	0.0962	0.08792	0.00046	101.63	30402.81	0.04565
'14	213101.45	106166.06	0.5	76.9	160.47	-2.4	3534.61	13.16	0.0857	0.08214	0.00042	89.34	31387.79	0.04543
'15	184868.42	107662.84	0.58	76.3	292.94	3.6	3439.61	14.37	0.0912	0.08454	0.0004	74.26	35765.37	0.04802

TAP Portugal:

Table of performances

Options	PAX/ACT	PAX/ROU	ACT/ROU	LF	INC	EBITDA	RPK	RP	RASK	CASK	EMP/PAX	EMP/ACT	REV/EMP	FC/PAX
'07	134482.76	42391.3	0.32	71	79.31	13	19135	24.62	0.0712	0.06822	0.00139	186.66	17735.08	0.10122
'08	124285.71	51176.47	0.41	67	-61.73	2.1	21908	27.59	0.0734	0.07526	0.00159	197.53	17235.34	0.11017
'09	116666.67	50000	0.43	69	52.18	12.7	21076	26.18	0.0714	0.06974	0.00159	186.07	16414.12	0.08694
'10	128169.01	52298.85	0.41	74	-421	3.4	23944	25.84	0.0732	0.08625	0.00144	184.69	17928.77	0.08524
'11	138028.17	34628.98	0.25	76	-18.1	6.4	25970	25.29	0.0728	0.07332	0.00126	174.58	19995.16	0.09439
'12	143661.97	26020.41	0.18	77	40.8	7.8	27226	26.3	0.0757	0.07451	0.00123	176.14	21448.9	0.09359
'13	150704.23	27020.2	0.18	81.1	44.1	8.1	28152	25.91	0.0782	0.07698	0.0012	180.11	21683.61	0.08972
'14	148051.95	32022.47	0.22	70.6	2.6	6.4	30119	24.61	0.075	0.07497	0.00116	171.34	21266.58	0.08939
'15	146753.25	25111.11	0.17	80.3	-105.7	5.3	32197.21	23.61	0.0676	0.07024	0.00116	170.16	20361.01	0.09213

Annexe D – Tables of Scores

Air France – KLM:

Table of scores

Options	Overall	PAX/ACT	PAX/ROU	ACT/ROU	LF	INC	EBITDA	RPK	RP	RASK	CASK	EMP/PAX	EMP/ACT	REV/EMP	FC/PAX
'07	43.71	15.42	81.10	80.95	31.48	100.00	-0.34	0.00	56.25	42.45	100.00	0.36	100.00	15.23	14.73
'08	42.97	6.37	56.16	78.57	20.37	64.30	100.00	15.99	89.22	99.93	15.33	4.06	40.62	28.34	15.31
'09	27.26	1.27	79.46	100.00	0.00	0.00	47.67	19.78	0.00	0.19	83.57	7.76	8.02	0.00	50.16
'10	45.64	0.00	56.02	88.10	37.03	47.76	20.67	7.47	239.87	83.11	21.44	0.36	23.30	25.99	0.00
'11	24.36	13.35	69.10	76.19	55.56	30.78	3.87	-170.57	100.00	96.43	0.00	17.02	29.13	43.83	10.00
'12	58.30	28.80	100.00	78.57	62.97	31.54	5.55	60.60	87.07	90.82	168.92	28.13	36.87	50.25	19.27
'13	62.03	20.75	84.01	73.81	75.93	52.31	20.67	77.00	89.87	82.41	196.95	37.39	0.04	60.99	28.92
'14	44.23	25.50	0.00	14.58	92.59	59.71	13.11	80.21	71.98	70.49	38.95	41.09	5.51	56.89	29.62
'15	67.46	100.00	41.94	0.00	100.00	82.88	38.38	100.00	11.64	86.61	36.37	99.72	8.90	100.00	100.01
[all upper]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
[all lower]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Weights :		0.0833	0.0833	0.0667	0.1000	0.0729	0.0608	0.0851	0.0729	0.0486	0.0486	0.0534	0.0641	0.0748	0.0855

Air Berlin:

Table of scores

Options	Overall	PAX/ACT	PAX/ROU	ACT/ROU	LF	INC	EBITDA	RPK	RP	RASK	CASK	EMP/PAX	EMP/ACT	REV/EMP	FC/PAX
'07	38.36	95.00	35.48	27.78	10.67	100.00	71.25	19.68	0.00	0.00	100.00	0.00	100.00	0.00	0.00
'08	50.45	100.00	70.96	47.62	28.00	73.90	60.00	3.64	60.00	52.10	40.35	14.29	92.82	47.84	20.27
'09	48.93	2.57	100.00	100.00	13.33	91.71	78.75	0.00	16.83	40.97	50.23	100.00	0.00	39.81	81.11
'10	46.20	21.23	45.72	57.14	0.00	67.87	92.50	12.15	29.50	63.61	32.16	100.00	9.66	52.00	100.00
'11	47.98	23.98	53.16	57.14	22.66	0.00	15.18	100.00	62.25	81.06	9.06	100.00	14.57	80.30	56.67
'12	56.89	50.57	9.45	22.22	43.59	96.14	98.75	53.24	86.00	93.69	17.34	28.57	47.00	80.67	73.33
'13	38.94	87.18	-156.87	0.00	108.97	38.24	17.86	51.19	91.50	97.40	4.97	28.57	14.57	81.52	63.33
'14	56.17	42.33	48.95	52.38	91.03	25.25	0.00	60.76	90.75	90.35	7.33	57.14	30.22	100.00	60.00
'15	50.08	0.00	55.70	71.43	100.00	23.08	3.57	29.87	100.00	100.00	0.00	14.29	37.06	77.82	60.00
[all upper]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
[all lower]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Weights :		0.0833	0.0833	0.0667	0.1000	0.0729	0.0608	0.0851	0.0729	0.0486	0.0486	0.0534	0.0641	0.0748	0.0855

easyJet:

Table of scores

Options	Overall	PAX/ACT	PAX/ROU	ACT/ROU	LF	INC	EBITDA	RPK	RP	RASK	CASK	EMP/PAX	EMP/ACT	REV/EMP	FC/PAX
'07	32.45	53.81	100.00	100.00	0.00	17.12	62.79	0.00	0.00	0.02	100.00	-7.18	53.41	0.00	-0.01
'08	26.30	33.48	56.38	66.67	5.13	9.20	15.17	18.01	12.50	3.67	81.64	-7.18	35.40	13.36	32.58
'09	25.55	0.00	31.29	66.67	23.07	0.00	-0.29	22.85	22.54	12.80	56.67	71.26	0.00	25.44	41.38
'10	30.48	25.94	5.39	22.22	42.31	21.31	26.95	35.80	27.11	16.45	27.89	71.26	15.40	31.35	54.44
'11	46.52	69.37	13.35	16.67	46.15	24.68	20.32	48.96	75.18	63.49	17.46	71.26	42.48	66.14	67.94
'12	53.86	57.96	6.77	11.11	64.11	46.67	21.80	92.86	84.95	80.94	8.03	71.26	31.80	78.27	75.65
'13	65.33	80.11	5.76	5.56	71.80	80.63	39.50	100.00	100.00	100.10	0.00	71.26	33.04	100.00	96.89
'14	48.71	100.00	5.65	0.00	88.46	81.31	79.40	-62.04	54.84	50.83	41.02	-7.18	100.00	42.39	92.75
'15	63.82	93.68	0.00	0.00	100.00	100.00	100.44	90.00	50.09	46.73	47.72	-7.18	85.84	40.80	100.00
[all upper]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
[all lower]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Weights :		0.0833	0.0833	0.0667	0.1000	0.0729	0.0608	0.0851	0.0729	0.0486	0.0486	0.0534	0.0641	0.0748	0.0855

Finnair:

Table of scores

Options	Overall	PAX/ACT	PAX/ROU	ACT/ROU	LF	INC	EBITDA	RPK	RP	RASK	CASK	EMP/PAX	EMP/ACT	REV/EMP	FC/PAX
'07	57.92	93.71	91.55	80.00	27.53	100.00	100.00	0.00	0.00	7.22	100.00	28.57	100.00	3.58	89.10
'08	47.93	52.57	61.78	80.00	31.88	16.64	24.40	45.78	83.97	74.17	7.23	23.60	87.02	21.08	56.12
'09	26.43	0.00	20.78	100.00	37.50	0.00	0.00	19.67	45.41	16.11	31.87	0.00	90.13	-0.01	13.90
'10	35.79	8.73	11.95	73.34	45.83	32.15	30.95	12.70	100.00	99.17	0.00	14.91	73.00	18.15	3.96
'11	31.06	33.15	34.78	73.34	0.00	17.37	48.21	39.94	43.30	0.00	57.43	30.95	62.98	17.11	0.00
'12	57.44	45.84	57.72	86.67	61.11	57.50	44.64	70.24	93.50	100.00	8.90	51.19	37.21	50.13	35.77
'13	62.57	63.01	84.23	93.33	87.50	41.69	42.26	88.03	42.09	35.83	40.23	71.43	20.34	57.18	71.00
'14	50.88	100.00	0.00	0.00	97.22	20.87	13.09	87.97	16.19	17.22	45.15	91.07	9.46	77.75	88.00
'15	74.85	97.52	100.00	80.00	100.00	48.22	75.89	100.00	16.90	36.67	42.00	100.00	0.00	100.00	100.00
[all upper]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
[all lower]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Weights :		0.0833	0.0833	0.0667	0.1000	0.0729	0.0608	0.0851	0.0729	0.0486	0.0486	0.0534	0.0641	0.0748	0.0855

IAG:

Table of scores

Options	Overall	PAX/ACT	PAX/ROU	ACT/ROU	LF	INC	EBITDA	RPK	RP	RASK	CASK	EMP/PAX	EMP/ACT	REV/EMP	FC/PAX
'07	42.78	52.84	3.04	0.00	41.02	68.12	97.43	12.93	57.32	97.83	38.73	6.42	100.00	12.24	41.49
'08	29.95	24.87	0.00	0.00	2.56	30.46	39.43	11.62	64.97	74.28	30.22	0.40	97.66	15.54	55.63
'09	20.34	14.00	8.08	16.67	28.20	0.00	0.00	5.42	9.95	0.00	100.00	1.61	88.46	0.00	32.35
'10	27.44	0.00	14.39	33.33	38.46	27.46	43.43	0.00	51.52	42.27	65.95	1.61	77.99	14.04	4.50
'11	38.60	10.00	45.87	74.51	41.02	36.49	43.43	12.93	80.63	56.16	55.56	4.01	81.13	15.54	6.91
'12	44.70	44.85	53.64	68.63	71.80	21.03	25.27	21.50	100.00	93.00	0.00	5.22	98.15	19.60	-0.11
'13	47.77	24.49	59.78	84.32	66.67	46.27	47.43	37.28	34.50	82.73	33.85	28.08	53.28	21.25	50.84
'14	61.41	62.87	79.18	92.16	74.36	67.56	72.57	65.21	17.52	77.29	54.37	43.72	45.08	28.25	71.28
'15	83.86	100.00	100.00	100.00	100.00	100.00	100.00	100.00	0.00	100.24	49.42	100.19	0.01	100.00	100.00
[all upper]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
[all lower]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Weights :		0.0833	0.0833	0.0667	0.1000	0.0729	0.0608	0.0851	0.0729	0.0486	0.0486	0.0534	0.0641	0.0748	0.0855

Lufthansa:

Table of scores

Options	Overall	PAX/ACT	PAX/ROU	ACT/ROU	LF	INC	EBITDA	RPK	RP	RASK	CASK	EMP/PAX	EMP/ACT	REV/EMP	FC/PAX
'07	50.27	16.11	44.52	66.88	78.50	100.00	100.00	0.00	99.94	100.05	0.93	0.35	74.95	29.60	3.65
'08	43.95	30.20	37.39	35.17	46.24	91.17	35.21	16.81	93.80	88.79	0.01	12.54	100.00	38.56	0.14
'09	13.15	0.00	0.00	0.00	10.39	0.00	20.21	23.95	5.29	47.66	39.17	26.48	-0.17	0.00	33.13
'10	47.05	24.34	46.38	54.83	71.33	67.73	63.16	55.24	2.32	59.73	35.23	60.80	15.72	33.96	62.07
'11	50.53	45.73	97.22	100.00	-0.36	49.70	27.82	73.58	2.53	56.46	31.76	81.71	26.22	52.74	69.55
'12	64.15	77.88	100.00	68.64	42.65	51.41	52.75	79.38	7.95	65.67	27.35	92.16	56.06	75.05	88.26
'13	62.65	82.43	83.38	45.40	78.50	38.61	28.20	85.80	4.06	7.37	53.54	97.39	56.05	77.18	97.15
'14	65.73	88.95	88.17	45.34	89.25	61.78	0.00	92.37	-0.03	3.27	65.65	97.39	67.35	70.74	99.49
'15	70.81	100.00	73.63	21.01	100.00	11.60	49.50	100.00	14.91	0.00	100.07	100.00	82.09	100.00	99.96
[all upper]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
[all lower]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Weights :		0.0833	0.0833	0.0667	0.1000	0.0729	0.0608	0.0851	0.0729	0.0486	0.0486	0.0534	0.0641	0.0748	0.0855

Norwegian:

Table of scores

Options	Overall	PAX/ACT	PAX/ROU	ACT/ROU	LF	INC	EBITDA	RPK	RP	RASK	CASK	EMP/PAX	EMP/ACT	REV/EMP	FC/PAX
'07	49.61	0.00	100.00	100.00	79.49	60.50	53.97	0.00	0.00	100.00	16.78	0.00	74.02	0.00	100.00
'08	31.37	19.80	11.91	33.33	43.59	38.20	0.66	6.24	20.79	84.56	0.05	42.86	29.28	40.74	69.63
'09	43.35	35.41	1.97	0.00	30.77	81.20	100.00	9.41	18.42	83.82	43.18	100.00	0.00	61.76	80.51
'10	30.05	20.75	0.00	16.67	10.26	64.09	52.06	15.97	14.21	38.97	59.34	100.00	7.83	46.17	21.95
'11	55.72	81.54	64.93	16.67	58.98	73.82	69.52	23.52	16.84	36.03	68.71	100.00	23.67	60.76	83.91
'12	56.31	99.22	58.63	0.00	38.46	73.26	63.81	31.89	25.00	49.26	53.01	100.00	52.50	69.03	78.58
'13	50.31	57.29	6.60	0.00	33.33	100.00	97.14	52.16	48.29	18.50	100.00	57.14	41.43	68.57	45.64
'14	56.59	80.06	88.84	33.33	100.00	0.00	0.00	85.50	74.74	0.00	77.59	42.86	97.72	70.15	0.00
'15	78.69	100.00	62.02	0.00	0.00	70.61	68.57	100.00	100.00	21.00	76.78	42.86	100.00	100.00	223.97
[all upper]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
[all lower]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Weights :		0.0833	0.0833	0.0667	0.1000	0.0729	0.0608	0.0851	0.0729	0.0486	0.0486	0.0534	0.0641	0.0748	0.0855

Ryanair:

Table of scores

Options	Overall	PAX/ACT	PAX/ROU	ACT/ROU	LF	INC	EBITDA	RPK	RP	RASK	CASK	EMP/PAX	EMP/ACT	REV/EMP	FC/PAX
'07	55.91	99.99	100.00	92.16	13.89	32.38	100.00	0.00	0.00	91.52	38.16	87.29	19.05	77.24	62.17
'08	36.21	32.24	32.15	51.31	13.89	40.12	83.55	4.83	48.30	60.40	55.45	34.66	48.26	47.15	0.00
'09	22.65	41.68	36.00	46.40	0.00	0.00	0.00	14.12	30.68	36.61	-0.04	-7.87	100.00	19.12	5.19
'10	29.76	15.78	39.43	100.33	13.89	24.43	59.63	25.23	8.71	-0.02	99.97	-7.87	22.91	0.00	34.98
'11	30.76	3.97	9.64	38.23	27.78	34.33	60.63	49.91	31.25	6.95	87.18	13.39	14.29	13.03	51.47
'12	36.60	0.00	1.59	16.99	13.89	57.42	74.58	65.54	74.43	30.97	60.23	13.39	1.29	51.15	60.38
'13	39.23	1.19	0.00	8.82	13.89	61.56	69.10	69.30	95.45	70.98	23.27	-7.87	18.40	56.97	70.22
'14	42.60	9.46	2.45	0.65	27.78	54.50	61.13	82.81	96.02	52.95	30.43	-7.87	44.53	54.68	75.72
'15	66.63	19.90	11.54	12.09	100.00	100.00	89.53	100.00	100.00	100.05	18.60	13.39	33.33	100.24	100.00
[all upper]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
[all lower]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Weights :		0.0833	0.0833	0.0667	0.1000	0.0729	0.0608	0.0851	0.0729	0.0486	0.0486	0.0534	0.0641	0.0748	0.0855

SAS:

Table of scores

Options	Overall	PAX/ACT	PAX/ROU	ACT/ROU	LF	INC	EBITDA	RPK	RP	RASK	CASK	EMP/PAX	EMP/ACT	REV/EMP	FC/PAX
'07	55.55	0.00	100.00	100.00	46.67	77.99	79.70	73.82	81.46	93.99	19.33	9.52	27.57	51.65	17.34
'08	39.65	13.53	23.23	33.33	0.00	39.87	42.86	74.06	100.00	100.00	5.90	9.52	49.21	68.82	13.22
'09	22.75	9.93	18.48	29.27	8.33	0.00	0.00	14.15	66.67	89.03	0.00	19.05	30.29	54.37	0.00
'10	32.56	45.63	5.32	6.50	71.11	23.55	0.73	18.06	34.79	64.62	26.10	33.33	61.09	45.13	16.78
'11	36.93	21.22	8.39	14.63	55.56	85.75	27.10	35.09	19.31	48.35	53.76	57.14	11.42	51.34	34.48
'12	27.13	19.71	0.00	5.69	95.56	38.92	30.07	0.00	13.61	42.69	45.91	0.00	71.33	0.00	10.75
'13	61.94	100.00	6.82	0.00	57.78	100.00	100.00	79.74	13.19	24.53	79.20	57.14	100.00	44.59	98.49
'14	57.52	90.80	5.09	0.00	100.00	53.01	38.34	100.00	0.00	0.00	100.00	85.71	47.21	52.15	100.00
'15	58.73	46.48	5.79	6.50	86.67	82.53	96.62	85.03	16.81	12.85	91.36	100.00	0.00	100.00	82.23
[all upper]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
[all lower]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Weights :		0.0833	0.0667	0.0833	0.1000	0.0729	0.0608	0.0851	0.0729	0.0486	0.0486	0.0534	0.0641	0.0748	0.0855

TAP Portugal:

Table of scores

Options	Overall	PAX/ACT	PAX/ROU	ACT/ROU	LF	INC	EBITDA	RPK	RP	RASK	CASK	EMP/PAX	EMP/ACT	REV/EMP	FC/PAX
'07	47.14	46.39	59.00	59.26	28.37	100.00	100.00	0.00	19.13	25.00	100.00	38.77	51.70	21.49	32.31
'08	40.24	16.79	95.36	92.59	0.00	68.29	0.00	15.92	100.00	48.57	52.24	0.00	100.00	13.36	0.00
'09	50.81	0.00	90.49	100.00	14.18	93.90	96.43	11.14	60.24	27.14	89.16	0.00	49.85	0.00	91.82
'10	44.96	25.52	100.00	92.59	49.65	0.00	10.04	28.92	50.66	46.43	0.00	28.57	45.53	24.64	100.00
'11	48.90	58.10	26.88	33.33	63.83	78.10	33.33	46.37	35.15	42.14	63.63	69.39	13.86	58.80	56.97
'12	56.44	76.72	2.51	4.17	70.92	91.34	44.44	57.18	63.63	73.21	55.81	78.57	18.75	94.27	59.86
'13	65.79	100.00	5.27	4.17	100.00	92.08	46.82	65.16	52.63	100.00	44.07	87.75	31.20	100.00	78.44
'14	54.67	91.23	19.07	20.83	25.53	82.75	33.33	82.10	18.94	65.71	53.62	100.00	3.70	89.82	80.02
'15	51.52	86.94	0.00	0.00	94.33	58.40	24.71	100.00	0.00	0.00	85.59	100.00	0.00	67.73	66.84
[all upper]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
[all lower]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Weights :		0.0833	0.0833	0.0667	0.1000	0.0729	0.0729	0.0851	0.0608	0.0486	0.0486	0.0534	0.0641	0.0748	0.0855

Annexe E- Scientific Production

Articles produced as a result of this dissertation:

1. M. Miranda, M. E. Baltazar, and J. Silva, "Airlines Performance and Efficiency evaluation using a MCDA Methodology . The case for Low Cost Carriers vs Legacy Carriers," *ICEUBI2015 - International Conference on Engineering, 2-4 December, Covilhã (Portugal), 2015* .

2. M. Miranda, M. E. Baltazar, and J. Silva, "Airlines Performance and Efficiency evaluation using a MCDA Methodology . The case for Low Cost Carriers vs Legacy Carriers," *Open Engineering, 389-396, 2016*