The concept of Aerotropolis applied to a medium-sized city and its airport. The case of Faro in the south of Portugal

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Abstract

Movements in Faro airport have been on a constant rise even exceeding the airport capacity. Faro city has grown in the same proportion. Both occurred in a pattern that can be applied to compare with the development of an Aerotropolis.

At least three steps must be taken to develop an effective Aerotropolis plan. First, the catchment area is determined based on the existing transportation network and 60-minute travel time from the airport. Second, several socioeconomic indicators within the catchment area are evaluated through different periods using GIS software. Third, catchment area and socioeconomic indicators for the Faro region are compared with layouts obtained from several examples of Aerotropolises in Europe.

The Aerotropolis model created by John Kasarda has been used in several regions across Europe. One key aspect of this model is determining whether the region evolved along with the airport throughout the years. Faro, its airport and surrounding areas, are not an exception. Thus, it is possible to identify Faro development patterns of growth useful for several stakeholders: administrative authorities, airport authorities, and territory planners.

Faro airport movements have been on a constant rise. Faro city has grown, probably, in the same proportion. Both growths can be compared with an Aerotropolis development. Identifying development patterns of growth will be useful for: those responsible for the distribution of services in the territory; those who oversee the airport operation and expansion; those who are responsible for combining the interests of all for the regional development.

Keywords

Aerotropolis; GIS; Catchment Area; Faro Airport

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I. Introduction

The continuous growth of air transport has been evident in recent decades, increasing at a fast pace and the forecast according to an EUROCONTROL study [1] is to continue to grow.
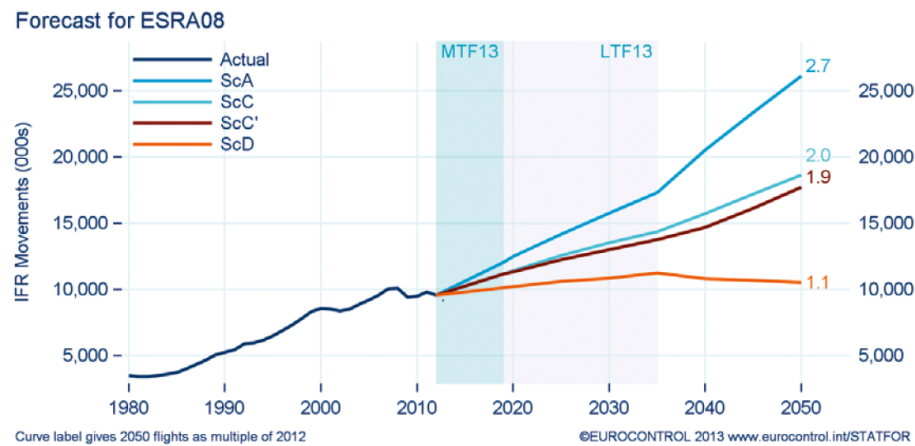

Figure 1 – Prediction of the number of aircraft movements until 2050
Source: [1]

Figure 1 sets the scenario for the future: in 2035 there will be approximately more 50% of flights than those currently exist, and the forecast for 2050 indicates that this number will double facing of current figures.

Air transport activity has a major impact over the global economy due to the number of jobs and revenue that directly or indirectly generates. In Portugal, air transport represents nearly €5.7 billion in GDP and 183 thousand jobs [2].

Airports have become essential to the global modern economy, as they represent high-speed access for freight, business and leisure travellers, but also contribute to social development and for better life quality [3].

In order to keep up with all this growth and evolution, a concept was developed by Dr. John Kasarda, called Aerotropolis. Over the years, the airport was made to serve the city, but as presented in Figure 1, the evolution of air transport has changed the scenario, which has boosted the idea of building cities around the airports. The main goal of an Aerotropolis is to facilitate activities related to air transportation, whether commercial or personal. This is why, in some cases, there is a need to create or adjust into an Aerotropolis.

This work is aimed at Faro International Airport, in the south of Portugal, where there is a pre-established Catchment Area, and from there, identify the counties inside the area, evaluate their socioeconomic indicators - using ArcGis software, assess how they influenced the region throughout chosen time periods, and try to implement an Aerotropolis planning to this airport following examples, such as Amsterdam or Paris Charles de Gaulle.

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II. Methodology

The methodology that will be used in this work consists of studying in detail the State of the Art, specifically the literature mentioned in that chapter.
From there, a more practical approach is made with the use of software and analysis of the evolution that occurred in the airport Catchment Area.
Considering this basis and following the Aerotropolis concept, different layouts will be tested to assess the possibility of having one in this region.
In Figure 2, a flowchart details the methodology process, which is the foundation of this work.
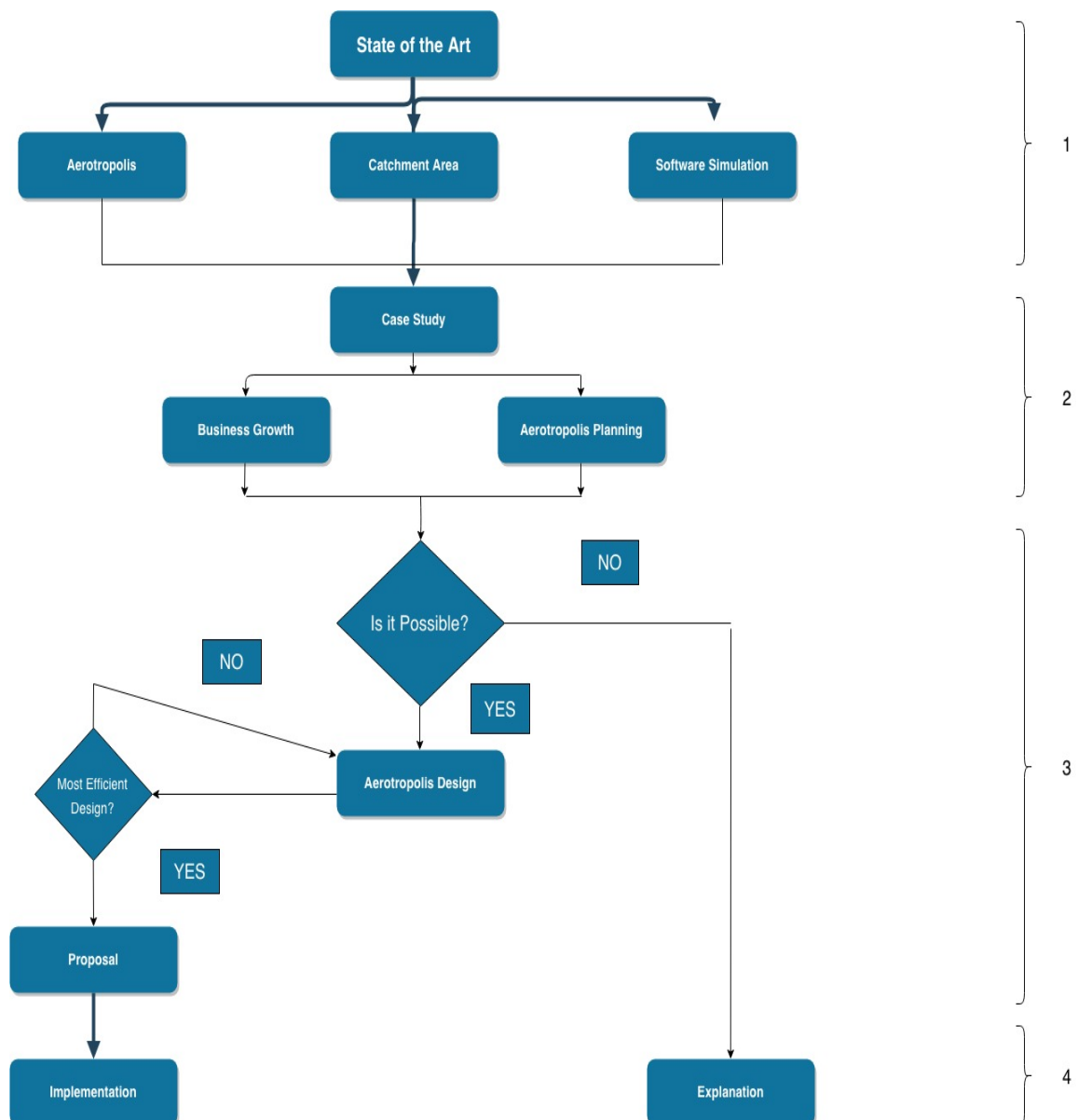

Figure 2 – Methodology Flowchart
Source: Own elaboration

As we can see from the flowchart, in Section 1, a further study of state of the art will be made to gather every information and understanding of the subject.

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In Section 2 there is the case study, where the study of the business growth in the Catchment Area is conducted, and in parallel, the study of planning and development of such model, which is key to accomplish the main objective.

Section 3 is where the findings of the research will allow whether it is possible to transform the designated airport into an Aerotropolis. If that option turns out to be positive, then we design a possible model for the airport and improve it until it is the most efficient it can be.

Section 4 is about the proposal; creating one from the most efficient solution and after that, try to implement that proposal if possible with the local authorities.

However, if we have a negative outcome in Section 3, and therefore determine it is not possible to adapt to an Aerotropolis, an explanation about what will be the objective of the paper.

III. Aerotropolis and Airport City

Aerotropolis is a concept dated 1939 by Nicholas DeSantis, a commercial artist from New York. This plan took 5 years of studying and consists on a skyscraper 200-stories high capped by an airplane field eight city blocks long and three blocks wide [4].

Throughout the years, Aerotropolis was used in different ways, like as H. Mckinley Conley in the 1970s and later by Dr. John Kasarda. Traditionally airports have been located 15 to 30 kilometres away from their corresponding city, mainly for air transport purposes, and they lack high relevance to the economy in their neighborhood areas [5]. Facing these facts, a new urban form is emerging "The Aerotropolis" as more and more aviation-oriented are being drawn to airport areas. Transportation corridors are radiating from the Aerotropolis extending up to 30 kilometres outward from the major airports [6]. An Aerotropolis is considered a metropolitan subregion whose infrastructure, land use and economy are centered on airport.

The emergence of and evolution of airport cities in recent years is a response to four basic factors [8]:

1. Airports need to create new non-aeronautical revenues;
2. The commercial sector's search for accessible land;
3. The increased passengers and cargo flow, generated by gateway airports;
4. Airports serving as a catalyst for landside business development.

The key value of Aerotropolis is that it offers businesses rapid connectivity on a massive scale. Inside the Aerotropolis study, there are various factors to consider like planning, layout and the industry.

Planning is vital into the Aerotropolis plan; it is the key to achieve its goals. An effective Aerotropolis master plan must also be both an economic plan and a strategic one, that articulates the drivers of and barriers to Aerotropolis development, as well as provide data-based assessments of commercial real estate demand for various functions and sites. Five planning requirements are focused upon [9]:

1. Local and regional market demand for air commerce;
2. Sufficiency and efficiency of air and ground connectivity;
3. Incorporating customers and stakeholders wants and needs;
4. The management of commercial real estate development;
5. Attracting investors and investment.

To validate this concept, Dr. John Kasarda created a layout schematic to represent a dynamic model, that although no Aerotropolis will look like this, most will adopt similar features. There are some key points to look for in an Aerotropolis model, which combined with Figure 3 representation of the model, help us picture the main goal [10]:

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1. Dedicated airport expressway links (aero lanes) and airport express trains (aero trains) should efficiently connect airports to major regional business and residential concentrations;
2. Special truck-only lanes should be added to airport expressways, as should improve interchanges to reduce congestion;
3. Time-cost accessibility between key nodes should be the primary Aerotropolis planning metric rather than distance;
4. Businesses should be steered to locate in proximity to the airport based on their frequency of use, further reducing traffic while improving time-cost access;
5. Airport area goods-processing activities (manufacturing, warehousing, trucking) should be spatially segregated from white-collar service facilities and airport passenger flows;
6. Noise and emission-sensitive commercial and residential developments should be sited outside high-intensity flight paths;
7. Cluster rather than strip development should be encouraged along airport transportation corridors with sufficient green space between clusters;
8. Form-based codes should establish general design standards for airport area buildings, walkways, travel lanes, landscaping and public space;
9. Placemaking and way finding enhanced by thematic architectural features, public art and iconic structures should make Aerotroplis developments interpretable, navigable and welcoming;
10. Mixed-use residential/commercial communities housing airport area workers and frequent air travellers should be developed with easy commutes and designed to human scale providing local services, urban amenities and sense of neighborhood.
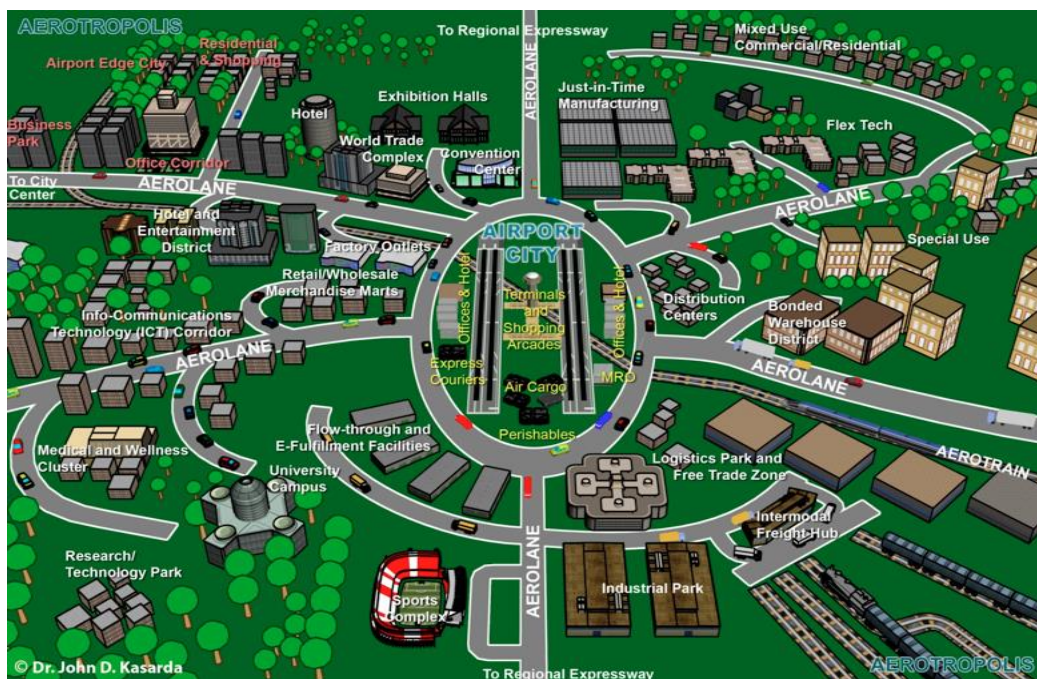

Figure 3 – Aerotropolis Schematic
Source: [10]

This industry has increased heavily, and it is safe to say that the employment scale and business mix of the Aerotropolis are far greater than many realize. A research conducted by Dr. Stephen Appold and Dr. John Kasarda on employment around the 25 busiest passenger airports within the U.S., found that: 3.1 million jobs as of 2009 were located within a 2.5-mile radius of these airports (2.8% of total U.S. employment); over 7.5 million jobs within a five-mile distance (6.8% of all U.S. employees); and 19 million jobs (17.2% of the U.S. total) within 10 miles [11]. In the European case, and looking more specifically for two examples: in the Paris Charles de Gaulle airport this

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adaptation led to the creation of 248 000 jobs, representing 6.1% of the salaried jobs in the Paris Region [12]; in Amsterdam the number of jobs created is 65 000 [13].

IV. Case Study

This work is aimed at the development of a proposal that can prove the viability and adaptability of an Aerotropolis in Faro. To reach such proposal, several steps must be taken to accomplish a credible conclusion. The first step is to take into consideration the Catchment Area, obtained in a previous work [14], to identify the counties that are within the area. The counties identified (20) are the following:

- Albufeira;
- Alcoutim;
- Aljezur;
- Aljustrel;
- Almodôvar;
- Castro Marim;
- Castro Verde;
- Faro;
- Lagos;
- Lagoa;
- Loulé;
- Mértola;
- Monchique;
- Olhão;
- Ourique;
- Portimão;
- São Brás de Alportel;
- Silves;
- Tavira;
- Vila Real de Santo António.

We set the temporal scenarios to evaluate the socioeconomic indicators presented in Table 1 of the twenty counties and analyze their evolution throughout the years.

Table 1 – Socioeconomic Indicators
Source: [14]

INDICATOR	DISCRIPTION
Population Density	Population density is expressed by the ratio between the population and the surface area. It is usually expressed in inhabitants per square kilometer
Education Level	It is a ratio between the inhabitants with higher education level by the total number of inhabitants
Household Income	Average income per capita by month (in euros)
Economically Active Population	It is the fraction of a population that is either employed or actively seeking employment. Is measured by the ratio between the economically active populations by the number of inhabitants
Employment Level	Is measured by the ratio between the numbers of employees by economically active population
Companies Density	It is the number of companies by square kilometer
Sectorial Structure of Employment	Is the number of employed people by the total of companies from the sectors (industrial, real estate and housing)
Business Volume	Is measured as a GDP (Gross Domestic Product) density
Health	It is the number of doctors by square kilometer
Tourist Attractions	Tourist Attractions are measured by the number of attractions by square kilometer. Includes museums, golf camps, zoos, botanic gardens...
Hotel Establishments	It is the number of hotels; apart hotel; guesthouses; motels; hostels; tourist villages
Accommodation Capacity	Is measured as the number of beds available in hotel establishments
Occupation Rate	Is measured as the ration between the number of beds occupied in hotel establishments, by the number of beds offered

One of the concerns is the accuracy of the study and with that in mind, six time periods were chosen: 2001, 2011, 2016, 2001-2011, 2001-2016, and 2011-2016. 2001 and 2011 were Census years, therefore all the data is available; while 2016 is the year where the data can be obtained directly or indirectly, with accurate results. The study has not an incidence previous to the year 2001 because the airport only began to be relevant to the region in the early 2000's, mainly because of the impact of increasing LCC movements (Figure 4).
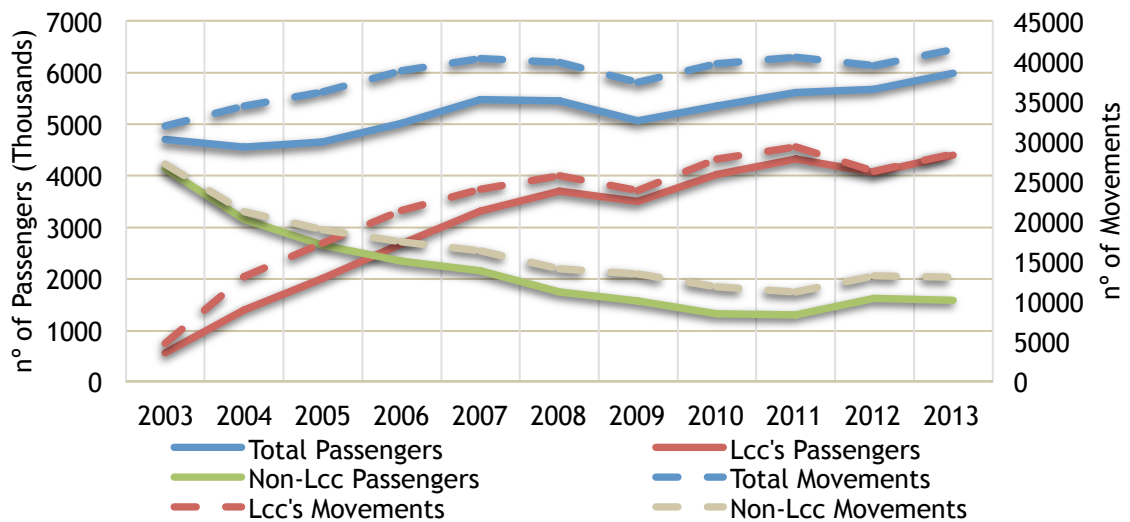
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Figure 4 – Faro airport movements and passengers evolution distributed by type of airline.
Source: [15]

The last step is to analyze the layout evolution throughout the years, observing if it adopted a more Aerotropolis-like model, along with the increasing number of movements and passengers. The LCC's growth transformed this airport, once seen only as a checkpoint to reach Portugal, into nowadays one of critical importance to serve whole its Catchment Area. One important observation to do is if the airport does serve the region adequately and has the main characteristics that make it an Aerotropolis, or if it at least can adapt into one is the objective.

V. Results

At this stage, the Catchment Area evaluation must be made in order to determine the counties that have benefitted the most from the closeness to the airport. Using the socioeconomic indicators to evaluate the six different time periods (2001, 2011, 2016, 2001-2011, 2001-2016, and 2011-2016), and while it is impossible to present all the data here, Figure 5 shows the Population Density in the year 2001 to illustrate the study, the following conclusions can be drawn:

- In the year 2001, Mértola ranked bottom three in all but one indicator and did not make the top three in any indicator. Alcoutim ranked bottom three in 10 of the 13 indicators. Faro and Albufeira ranked top three in 7 of the 13 indicators. In this year, one can say that Faro and Albufeira benefitted from their relatively close location to the airport, while Mértola and Alcoutim, being close to the end of the Catchment Area, felt the least advantages of being within this Area;

- The results for the year 2011 shows that Alcoutim ranked bottom three in 10 of the 13 indicators and top three in one of them, while Ourique ranks bottom three in 9 of the 13 indicators and none in the top three. Ourique belongs to a Competition Zone between Faro and Lisbon, therefore is located at the end of both Catchment Areas, while Alcoutim is within only one Catchment Area, but also at the end of it. Faro and Portimão, however, rank top three in 9 of the 13 indicators. Faro is closer to the airport, and that is whit it ranks so high, while Portimão is easily accessible by highways, shows good values for Health, Companies Density and Accommodation Capacity, making it one of the counties affected positively by the development of the airport;

- In the year 2016, Ourique had the lowest numbers in 9 of the 13 indicators, while Albufeira ranked top three in 11 of the 13 indicators. Albufeira took advantage of the rise in the movements in the airport in the latest years to reach these values;

- The evolution between 2001 and 2011 happened somewhat evenly. Ourique ranked bottom

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three in 6 indicators, which is less than half, while Portimão ranked top three in 7. Thus, this occurred due to the development of the accessibility to each county and the growth of the airport in these years;

- In the fifteen years interval between 2001-2016, one county came on top in terms of evolution, Albufeira. It ranked top three in 9 indicators, and it is a visible indication that Albufeira followed the airport's improvement in this period, taking advantage of the easy accessibility. On the other hand, São Brás de Alportel ranked bottom three in 6 of the 13 indicators and zero in the top three. Being a small county and not very reachable, the ageing population contributed to the low scores in this period;

- Finally, in the evolution from 2011 to 2016 does not exist a big disparity between the county's evolution, as almost every single one ranked bottom and top three in the 13 indicators. Albufeira ranked top three in 6 indicators, the most by any county, therefore maintaining the status as one of the most influenced by the airport evolution.

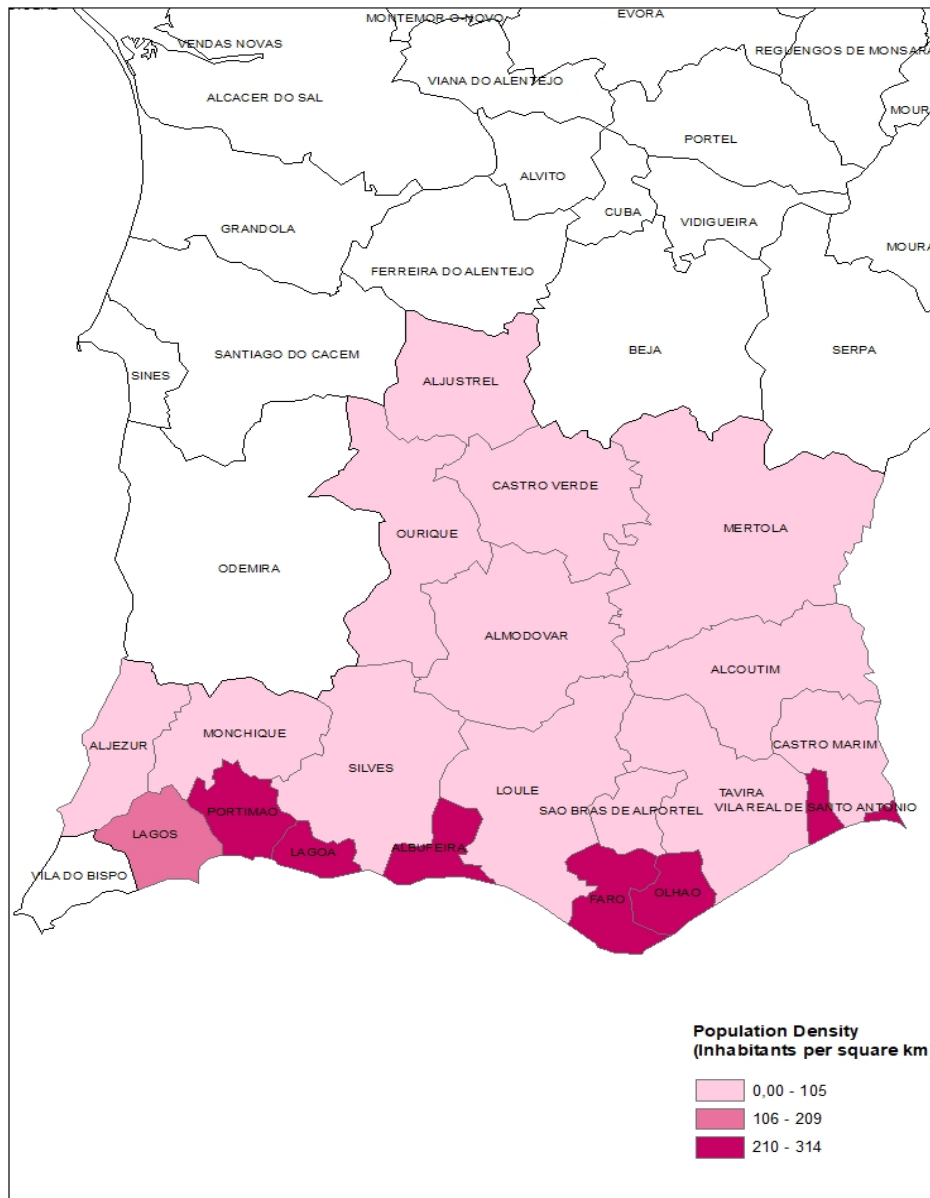
Figure 5 – Population Density (2001)

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The layout of Faro International Airport remained very similar over the years; Figure 6 presents an overlap of the layout in 2016 over the 2011. Comparing with Amsterdam or Paris Charles-de-Gaulle, the current layout lacks housing in the proximity, multimodal connections and a clearer district to where the idea must grow and develop.

Figure 6 – Faro Airport 2016 over 2011
Source: Adapted from Google Earth

In Table 2, a better illustration of the assessment of the urban form of Aerotropolis currently in place is presented.

Table 2 – Assessing the urban form of Aerotropolis
Source: Adapted from [16]

Building Block	Centres	Districts	Preserves	Corridors	Assessment
Zuidas, Aalsmeer, Amsterdam (Schiphol)	Town Centres with mixed land-use, offices, retail, hotels	Amsterdam Airport Area (AAA) Zuidas (business district), Aalsmeer ("global floral hub") airport city district	Built on a drained lake; agriculture/ Greenbelt; World's "green floral hub".	Multimodal, roads, trains, rail, Aalsmeer shuttle, Zuidas	District with regional centers; housing in proximity; district is in a regional city with multimodal mobility
Charles de Gaulle, Roissy, Paris	Mixed land-use with offices, hotels, sporting cultures	Roissy-en-France, Charles de Gaulle	Built around an area with floor space ranging from several thousands of km^2	Multimodal, roads, rail, rivers, boat, maritime	High density, potential housing in proximity; a regional city with multimodal mobility
Faro	Mixed land-use with hotels, offices	Faro, Algarve and Baixo Alentejo	Partially covered by the sea; cannot be expanded	Roads, buses connecting to the Algarve region, Lisbon and Seville	Regional city, lacking housing in proximity, a business district with some multimodal mobility

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Analyzing the Table 2, it stands out how well thought out Paris and Amsterdam are, while Faro lacks some infrastructures. Faro has two restraints: it cannot be expanded, and it is only a medium-sized city. However, Faro needs improvement on its infrastructure to support movements as the airport, currently exceeds its capacity, surpassing the six million passengers a year. It is crucial to establish a business district strong enough to attract important stakeholders and create housing in the proximity to become an efficient Aerotropolis, within the Catchment Area.

According to the results of the socioeconomic indicators, there are counties, that could operate as a business hub: Faro, Albufeira and Portimão ranked high in indicators such as Companies Density, Business Volume and Population Density. Faro city is closest to the airport and seems to be the most viable option, while Loulé being close and recording good results on most indicators could be an alternative too.

The next in creating an Aerotropolis plan is to ensure there are accessibilities that efficiently serve the area. Right now, Faro airport only offers roads and buses routes to the city Centre, Seville, Lisbon and some parts along the Algarve region. Geographically covered by the sea and close to Africa, the creation of a port infrastructure would contribute to an ideal Aerotropolis planning in this city, because it would create new ways of cargo and passenger routes to Northern Africa, something that would boost the economy in this area. Faro airport also lacks a train connection, something that most Aerotropolis offer; however, there is a train station within seven kilometres that connect Faro to everywhere within the Catchment Area and most important cities in the country. Figure 9 presents a possible planning schematic to adapt Faro into an Aerotropolis.
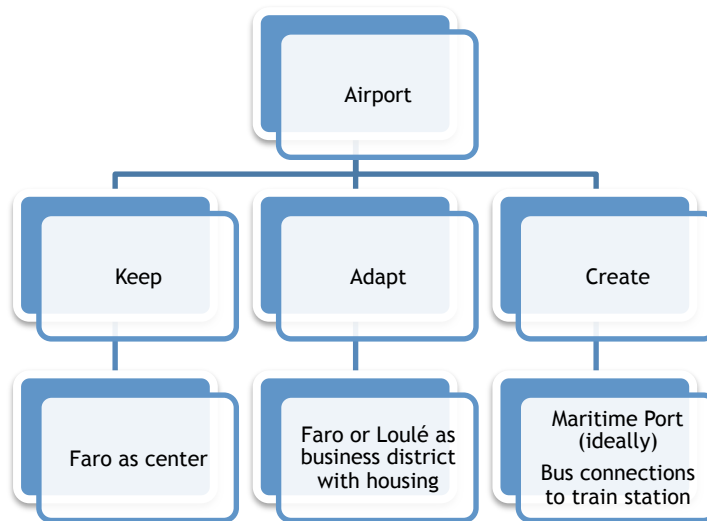

Figure 7 – Faro Aerotropolis Schematic
Source: Own elaboration

The assessment concludes that Faro can be adapted into a medium-sized Aerotropolis, like (unless the scale, of course) the mega-Aerotropolis of Paris and Amsterdam. The airport and region show much potential to be an attractive site, not just for tourism, but also for companies.

VI. Conclusions

The main object of this work is to determine the possibility and consequent viability of an adaptation of Faro airport into an Aerotropolis-like model, using a GIS conventional approach and evaluation of the Catchment Area.

This work has three specific objectives: use the socioeconomic indicators to evaluate the Catchment Area based on data from public and other sources, compare the results of the indicators in three temporal scenarios (2001, 2011 and 2016); with layout examples of operational Aerotropolis

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combined with the gathered data, reach a general assessment on the possibility and viability of the Aerotropolis adaptation in this region.

These goals were achieved; however, more time would allow a broader and extensive discussion of the results; also, it could be included older data of the Catchment Area to make a deeper analysis to the area and create more correlations between the more temporal scenarios and the evolution of different businesses. In terms of evaluation of the Catchment Area, the limitations to get actual data were determinant for choosing the temporal scenarios.

Gathering the socioeconomic indicators data was very time consuming, especially in 2016, because there was no census in that year and they had to be achieved in alternative sources. Some of the indicators also had to be calculated using secondary indicators to provide more accurate results.

Despite some difficulties and missteps, this work was rewarding in how it brings a new perspective, a modern one, to an ever-evolving region.

Future developments in this area must be focused on the following items:

- To research a new model to integrate all the information about airport performance with the Catchment Area component;
- To research the best indicators that can describe the characterisation of the region;
- To geo-refer all the data with GIS software;
- To extend the transportation network to other modes of transport, as water and rail transport;
- To study the possibility and viability of an Aerotropolis both in Lisbon and Oporto, considering that both cities are of a higher dimension and importance to the country;
- To perform a study regarding the impact of using Beja as a commercial airport, helping Lisbon and Faro to relief the override of the movements limit.
- Perform an environmental and health impact study concerning this work, to find out the risks for people living close to the airport.

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