Rating Framework to Evaluate Connection Flights at Tourist Airports

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ABSTRACT

Airport’s serving a tourist destination is an essential counterpart of the tourist demand supply chain, and their productivity is related to the region’s attractiveness and is enhanced by the air transport business. In this paper, the evaluation framework in order to prioritize the scheduled flights connecting two tourist airports is introduced, taking into consideration their available yield seats. By adopting a systemic approach, the arrivals from an airport that its connectivity is heavily depended on the departures of another airport are reviewed. The methodology approach, based on inventory control theory and the numerical example, promotes the use of the modeling formulation. The results would be essential for comparison and exercising to other similar cases.

KEYWORDS—Airport connectivity, flight attractiveness, connection flight rating, yield seats

INTRODUCTION

Air connectivity is a catalyst for economic growth, employment, trade and mobility in Europe, especially for south European countries. The concept of cohesion is more crucial when reflects on the notion of connectivity. Increasing connectivity enables local economies to grow by attracting foreign direct investments and creating new jobs. In addition enlarges the mobility of citizens in remote regions in Europe [1], [2].

The contribution of tourism and air transport to regional development stimulate the research interest [3], [4], providing evidence that the selection of the final tourist destination is related to air transport performance, transport infrastructures and supply chain management. For high demanded tourism destinations, the business sectors of air transport and tourism are interlinked. References [5] and [6] highlight the relationship between tourism and air transport and conclude that any changes in aviation efficiency are closely linked to tourism development.

Conventional wisdom in this paper is to develop an evaluation framework of the scheduled flights of two tourist airports. By adopting a systemic approach, the arrivals from an airport that its connectivity is heavily depended on the departures of another major airport are reviewed, based on their available seats. The methodology framework, based on inventory theory control and the numerical example, promotes the use of modeling formulation. The results would be useful for the management of airports and airlines, so that they can define their pricing policy, as well as for stakeholders and civil aviation authorities in order to reschedule flights in a more efficient way.

This analysis is a first step in a broader research on optimization of the flight program between two tourist airports, in order to improve their connectivity. The next stages of this research take into account other determinants, such as the load factor, the attractiveness of each flight depending on the destination etc.

II. AIR TRANSPORT, CONNECTIVITY AND TOURISM TRENDS

2.1 Air Transport and Connectivity trends

Aviation is a customer-focused economic sector. While there is no single definition of air connectivity, it can be viewed as the ability of a network to move passengers, cargo and mail involving the minimum of transit points, which makes the trip as short as possible with optimal user satisfaction at the minimum price possible. Improved air connectivity is at the heart of social and economic development [7]. Many States and governmental authorities place on the top of their agenda the contribution of air connectivity to economic development and they prioritize air transport infrastructure and aviation projects in their strategic development plans. [8] The European Commission has placed air connectivity at the core of its Aviation Strategy, which itself is part of its plan for growth, investment and jobs [1].
In 2017, overall average airport connectivity in Europe increased by +3.8%, reflecting significant airline capacity expansion. Most of the connectivity gains came from the EU market at 4.3%, where Cyprus, Latvia, Lithuania, Malta and Portugal achieved double-digit growth. Conversely, connectivity in the non-EU market grew at a much slower pace at +1.4% - mainly due to connectivity losses in Turkey (-6%) and Norway (-2%) as well as limited gains in Switzerland (+1%) [1]. Furthermore, according to ICAO’s long-term traffic forecasts, total passenger traffic of Europe is expected to grow by around 3.0% annually up to 2032 [8].

2.2 Air connectivity and Tourism development

Tourism plays an important role in the regional economic development, and in some cases, it significantly contributes to regional economic development, representing the main source of income [9]. Despite the high competition and the unstable economic environment, the destination in Mediterranean Region have undergone enormous growth in the tourist demand during the last decade, which in turn has significantly increased the demand for air travel, and placed under discussion the adequacy of the available infrastructures. [10], [6].

International tourist arrivals (overnight visitors) reached a total of 1,235 million in 2016. This was 46 million more than in 2015, or an increase of 3.9%. The global pace of growth was slightly more moderate than in 2015 (4.5%), but in line with UNWTO’s long-term forecast of 3.8% per year for the period 2010 to 2020 [11].

Europe welcomed 616 million international tourists in 2016, equivalent to half the word total, an increase of 13 million from 2015. This corresponds to 2% growth, reflecting mixed results across individual destinations with some reporting a remarkable performance whilst others recorded weaker results due to security concerns. Growth in South and Mediterranean Europe (+1%) was modest, despite sounds results in most countries, driven by Portugal (+13%), top destination Spain (+10%) and Croatia (+9%). Balkan destinations Serbia (+13%), Slovenia (+12%) and Albania (+8%), also enjoyed robust growth, as did island destinations Cyprus (+20%) and Malta (+10%). Greece reported a 5% increase in arrivals and Italy 3%. The sub-regional average was weighed down by the significant decline in arrivals faced by Turkey following various terrorist attacks and a failed coup [11].

Moreover, in 2016, slightly over half of all overnight visitors travelled to their destination by air (55%), while the remainder travelled by surface transport (45%) - whether by road (39%), rail (2%) or water (4%). The trend over time has been for air transport to grow at a somewhat faster pace than surface transport, thus the share of air transport is gradually increasing [11].

III. METHODOLOGY CONCEPT

The research question deals with the prioritization of inbound flights, based on their available yield seats, from a tourist region (Airport A) compared with the accessibility to available seats of outbound flights from a busiest hub airport (Hub Airport B). The optimization framework based on a hub and a spoke air transport network, ultimately examines the possible optimum allocation of connections, based on the availability of yield seats of each flight, between tourist airport A and a hub tourist airport B for improving the connectivity to tourist market of airport A.

IV. MODELLING FORMULATION

The modeling formulation based on the inventory control theory, whereby an optimization structure based on the availability of the yield seats of each flight is developed, and the existing schedule services are evaluated over time.
The assumptions adopted regarding the operation characteristics of connection flights at airports A and B are:

- Lower connection time is 60 min for scheduled carriers;
- Only international flights from Airport B are taken into consideration;
- Seat availability in connecting flights;
- Additional cost or special offers for transfer passengers;
- All connectivity destinations attract demand;
- The flight of which the variable $F_{C_i}^d$ takes the maximum value, receives the highest value of the scale which is 5.00;
- Each flight for which the variable $F_{C_i}^d$ is less than the maximum value will take a value from 0.00 to 5.00;
- As a typical aircraft type, the A320 of Aegean Airlines is considered to have 174 seats;
- For the LCCs, respectively, 186 seats are considered.

Based on the above assumptions, the solution of this prioritization problem is addressed with the aid of the following objective function, depending on the above 2 cases:

- If $d_i > 60$, then
  \[ F_{C_i}^d = \frac{\sum t_i^{(i+1)}ASF_{j,B}}{ASF_{i,A}} \]  
  (1)

- If $d_i \leq 60$, then
  \[ F_{C_i}^d = \frac{\sum t_i^{(i+1)}ASF_{j,B}}{ASF_{i,A} + ASF_{j,B}} \]  
  (2)

Where: $ASF_{j,B} =$ number of available yield seats of each departure j from airport B for each flight i that arrive from airport A in a specific day; $t_i =$ the minimum connection time for each flight i; $ASF_{i,A} =$ number of available yield seats of each flight i arrives from airport A over the same day; $d_i =$ time between two consecutive arrivals from airport A.

Min and Max values for factor $F_{C_i}^d$ are defined as following:

- If $\sum t_i^{(i+1)} ASF_{j,B} = ASF_{i,A}$ then:
  \[ \text{min}F_{C_i}^d = 1 \]  
  (3)

- If $\sum t_i^{(i+1)} ASF_{j,B} > ASF_{i,A}$ then:
  \[ \text{max}F_{C_i}^d = \frac{\sum ASF_{j,B,i}}{ASF_{A,t}} \]  
  (4)

Where: $ASF_{j,B,i} =$ Available yield seats of departures j from airport B for the longest time t between two consecutive arrivals from airport A; $ASF_{A,t} =$ number of available yield seats of the flight that arrives from airport A for the same time t.

In order to solve the prioritization problem, a scale from 0 to 5 is adopted. The max $F_{C_i}^d$ is considered to be equal with the value 5, then for each flight i that arrives form airport A, $\mu_i$ is calculated as:

\[ \mu_i = \frac{F_{C_i}^d}{\text{Max}F_{C_i}^d} \mu_i \in [0.0, 5.0] \]  
(5)

The values for the variable $\mu_i$, in the scale from 0 to 5 for each flight i that arrives from airport A, depend on the value of the variable $F_{C_i}^d$ and the corresponding assessment and prioritization of each flight, and are placed into four different zones as presented in Table I.

<table>
<thead>
<tr>
<th>Intervals of $\mu_i$</th>
<th>Depiction of the zones based on the value of the variable $\mu_i$</th>
</tr>
</thead>
<tbody>
<tr>
<td>(3.5, 5.0]</td>
<td>High connectivity zone</td>
</tr>
<tr>
<td>[2.5, 3.5]</td>
<td>Good connectivity zone</td>
</tr>
<tr>
<td>[1.0, 2.5)</td>
<td>Moderate connectivity zone</td>
</tr>
<tr>
<td>(0.0, 1.0]</td>
<td>Poor connectivity zone</td>
</tr>
</tbody>
</table>
V. CASE STUDY

Mediterranean region is one of the most attractive tourism destinations in the world, accounting for approximately more than a third of ITA [1]. For decades, the Mediterranean destinations have provided, along with other attractions, the traditional sun, sand and sea product, essentially for the North European markets. The northern part of Mediterranean tourism market is much more mature, although, recently a widespread development in the south part is occurred [13]. Greece and Cyprus are among the top Mediterranean tourism destinations. The busiest airports of each island are of vital importance with a strategic position. In this section, analysis on air connectivity features between Athens International Airport (the main hub airport in Greece) and Larnaca International Airport (the busiest airport in Cyprus) is given in order to highlight the optimum air connectivity allocation between the two airports.

Athens International Airport (ATH) in 2017 recorded an all-time high performance, with 21.7 million passengers (surpassing previous year traffic by 1.7 million (+8.6%). This outcome was mainly driven by the strong growth of the international market (+1.5 million or +12%), whereas the domestic market presented a slow rise of 2.4% due to capacity reduction in the winter periods [14].

Larnaca International Airport (LCA) in 2017 accommodated 7.7 Mio total numbers of passengers, with 65 airlines having operated to 110 destinations in 40 countries; thus, it is assumed that Athens International Airport serves as a hub airport, where Larnaca Airport serves as a spoke [15].

Observations on data analytics on the specific window sample highlight that there is daily direct flight from Larnaca Airport to Athens International Airport. The carriers serving the direct connection between Larnaca and Athens are: Aegean Airlines, Cobalt and Blue Air, while the connection between Pafos and Athens is served only by Cobalt.

There is finally a high diversification in fares. The lowest fare from Larnaca Airport for one way route to Athens is 65€, offered by Blue Air and the highest fare is 170€, offered by Aegean Airlines.

The specific time window adopted is the second week of July 2017 (period 12-7-2017 to 19-7-2017). The next step is to analyze how passengers may use this hub-and-spoke network. In order to optimize how this hub and spoke network may be used, a specific time window, thus a specific day (Thursday 13th July) was selected to illustrate the results.

VI. CASE STUDY RESULTS

The key results of the prioritization of flights arriving from Larnaca, based on their available seats, compared with the accessibility to available yield seats of the connecting scheduled international flights from Athens, are depicted in Table II.
TABLE II
Prioritization of flights arriving from Larnaca to Athens based on the value of variable $\mu_i$
(Thursday, 13th July, 2017)

<table>
<thead>
<tr>
<th>Flight Details</th>
<th>Number of Yield Seats</th>
<th>Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Flight (AF_i)</strong></td>
<td><strong>Arrival time at ATH</strong></td>
<td><strong>Flight number</strong></td>
</tr>
<tr>
<td>AF_1</td>
<td>6:55</td>
<td>A3 901</td>
</tr>
<tr>
<td>AF_2</td>
<td>8:30</td>
<td>CO 712</td>
</tr>
<tr>
<td>AF_3</td>
<td>9:20</td>
<td>OB 5161</td>
</tr>
<tr>
<td>AF_4</td>
<td>9:50</td>
<td>A3 911</td>
</tr>
<tr>
<td>AF_5</td>
<td>13:00</td>
<td>A3 903</td>
</tr>
<tr>
<td>AF_6</td>
<td>14:45</td>
<td>OB 5261</td>
</tr>
<tr>
<td>AF_7</td>
<td>15:35</td>
<td>CO 716</td>
</tr>
<tr>
<td>AF_8</td>
<td>17:30</td>
<td>A3 905</td>
</tr>
<tr>
<td>AF_9</td>
<td>20:00</td>
<td>OB 5361</td>
</tr>
<tr>
<td>AF_10</td>
<td>22:45</td>
<td>A3 909</td>
</tr>
<tr>
<td><strong>max</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

As depicted in TABLE II, the higher value of the variable $FC_i$ results for flight AF_4. Therefore, for this flight, the variable $\mu_i$ will receive its maximum value which is equal to 5.00.

The prioritized flights are placed graphically in the different zones defined in TABLE I. The graphic depiction for the reference day is given in Fig. 3.

*Classification of the results based on the connectivity zones, (July 13th, 2017)*

![Graphic depiction of the classification in different zones (July 13th, 2017)]

According to the above results, the key messages could be summarized as:
- Most flights are low in rank and they are placed in the low and very low (unacceptable) connected zone;
- Especially during afternoon and evening hours (flights AF_6 to AF_10), there is a significant lack of connectivity, based on the available seats, between the two airports;
- The last flight at a late hour does not improve the connectivity and the only reasonable reason for its operation is to serve the business traffic between Cyprus and Greece;

The recommendations to air carriers, for the best allocation of arrival time for this air corridor, in order to increase connectivity, between Larnaca International Airport and Athens International Airport could be summarized as:
- Afternoon and evening hours are highly competitive time windows for air carriers to provide additional services;
- The yield pricing should be connected with the value $\mu_i$ and the connectivity zones resulting from it.
VII. CONCLUSION

Tourism and regional socioeconomic development is based on the optimization of air connectivity between hub and spoke airports serving tourist destinations. Airports serving tourism destinations develop hub and spoke networks to provide optimum connectivity between popular origins and destinations. In this research paper, an overview of the existing air connectivity between the two countries and specifically between Athens International Airport as the main airport in Greece and Larnaca International Airport as the main airport in Cyprus is analyzed. In portraying the air transport sector in these countries, this research assesses possible concerns in relation to current and potential future air connectivity gaps between the two main hub airports. The assessment concept and methodology provided is an essential tool for the management of airports and airlines, as well as for planners, analysts and researchers. The application results are essential for comparisons with other destinations and provide key messages regarding the importance of air connectivity in remote tourist destinations especially in the Mediterranean region.

REFERENCES


