PASSENGERS' CHOICE BETWEEN COMPETING AIRPORTS

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Introduction

The origin departure airport choice problem is actual wherever more than one airport is aiming to accomodate air travel demand generated in the region observed. The closer those airports are and the more similar the services they offer the more significant will be the problem of airport choice.

The issue of airport choice is central to airport systems planning in multi-airport regions. The ability to model how air passengers choose which airport to use in a multi-airport region is an essential requirement in evaluating the consequences of any proposed action that could affect such choices. These actions can range from something as significant as constructing a new airport to such routine decisions as changing airport parking rates **[1]**.

While there is an average market share that any airport will attract, this is the result of individual choices that balance the relative accessibility of each airport and the air service available there. Without an explicit analysis of the factors affecting these choices, assumptions about airport market share are little better than guesswork **[2]**. A good understanding of the factors underlying a passenger's origin airport choice in multiple airport regions can enable airport management and airline carriers to attract passengers, upgrade airport facilities and equipment to meet projected air travel demands, and determine airport staffing needs. It can also aid Metropolitan Planning Organizations in forecasting travel demand in the urban region, and in planning transportation networks to/from airports **[3]**.

This paper[1] brings us closer to realization as to how far (in terms of its market share) a single airport can get while trying to improve or retain its position in the European or regional airport system[2]. As a case study, prediction of the effects of the potential air traffic supply attributes changes at Budapest, Belgrade and Nis airports on airport market shares in that region is attempted.

An airport demand allocation model is developed for this purpose. The model operates with traffic supply attributes (flight frequency, air fare and ground access time), its output being market shares of competing airports in a system considered.

Background

So far the problem of airport demand allocation has been considered almost exclusively in multi-airport systems serving American metropolises. In Europe, in contrast, this has not been the problem of principal interest, with the exception of the London airport system. The research undertaken, unlike most previous studies, attempts to establish a pattern of regional demand distribution in an airport system not serving one metropolis, but consisting of several airports "scattered" along the E-75 highway.

Usually, researchers model air traveler choices to understand passenger behavior and preference structures. These models used a wide range of functional forms and explanatory variables. However, there appears to be a growing agreement on the general form that these models should take, so that most of the previous studies used either the classical multinomial logit model or the nested logit model for analyzing airport choice.

These models assume that traveler choice is based on a combination of measurable attributes that include ground access characteristics, flight frequency, and air fare. More recent studies have generally included some measure of airport accessibility and flight frequency, although the different studies defined these measures in different ways. The extent to which air fare differences are included in the model varied between the studies. The results obtained indicate that increases in air fare or ground access costs decrease the attractiveness of an

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[1] The basis of the paper is the author's graduation thesis **[4]**.

[2] The fact that airports associated with different cities and jurisdictions can be part of the same multi-airport system needs to be stressed **[5]**.

airport, while increases in flight frequency increase its attractiveness.

A summary of the specific findings and model specifications of multiple airport systems studies involving demand allocation models is reviewed in references **[1]** and **[6]**.

Airport use is determined by interactions between passenger choices and airline decisions; so, ideally, both should be modeled together. Nothwithstanding, only two formal models have been identified in the literature that attempt to integrate the air passenger airport choice process with a prediction of the level of air service offered at each airport in a multiple airport system (Hansen, 1995; Pels et al., 1998) **[1]**. However, the procedure followed in this paper considers airline services exogenous and models air traveler behavior for a given set of airline services.

Proposed Airport Demand Allocation Model

A model was developed that attempts to predict the distribution of business travelers between competing airports in the multi-airport region considered. The basis of the model is an exponential formula which calculates the effects of choice attributes on the attractiveness of every single airport in the system. These choice attributes include daily-direct flight frequency (FF), air fare (AF), and ground access characteristics in terms of access time difference (ATD), meaning the difference in time needed to reach different airports offering flight to a desired destination.

There is evidence that the trip purpose influences the behavior of the air passengers (**[7]**-**[14]**); that is business and non-business travelers place different values on the attributes that influence their airport choices. Consistent with previous studies of airport choice, the results obtained from the Faculty of Transport and Traffic Engineering (FTTE) air passengers surveys (Belgrade, 2001, 2002, 2003; **[15]**-**[17]**) confirmed that business travelers have a higher time elasticity than non-business travelers, while non-business travelers are more cost-sensitive. This fact pointed that separate functional relationships should be developed for these two categories of travelers.

The segmentation of the passenger market based on passenger resident status was also attempted. The results of the survey did not confirm expectations that whether a passenger is a resident or a visitor of a multiple airport system would influence his behavior.

Similarly, there was not enough statistical support for market segmentation based on length of flying time to destination, although some of the previous studies (**[11]**, **[12]**, **[18]**) have found certain differences in passenger behavior regarding this factor.

When everything had been considered, a decision was made to develop a model to predict the distribution of business passengers between competing airports in a multiple airport region.

Model specification

The model proposed is based on an exponential formula which was formally composed of several independent results of previous research in airport choice. Two stages of the model can be identified. First, the indifference equation which relates the compensating frequency ratio variable to the access time difference variable is calculated. The airport choice model was then estimated, the former equation being incorporated into its structure.

Case Study: E-75 Highway Connected Airport System

The proposed airport demand allocation model was applied to the regional airport system formed by three airports: Belgrade “Aerodrom Beograd” airport, Budapest “Ferihegy” airport, and Nis “Konstantin Veliki” airport (Figure 1).

These airports are interconnected by the E-75 highway, which enables using of highway travel time to the airport as the only (but good enough **[13]**, **[14]**) ground access representative included.

Why these three specific airports? While it is intuitive that Belgrade and Nis airports do compete to attract the passenger demand generated in Serbia, it may seem doubtful whether Budapest Airport could be considered the part of this same regional airport system. The results obtained in a 2001 FTTE survey **[16]** spoke in favor of our assumption. These results indicated that Budapest airport attracted almost 10 percent of all the international departures generated in Serbia. This is by no means an irrelevant percentage, therefore it was found justifiable to include Budapest Airport to the multiple airport system considered.

Figure 1. E-75 Highway Connected Airport System

Stage 1 Specification

There are three basic assumptions of the first stage of the model:

- A 100 % improvements in flight frequency (FF) is worth about 15 % of fare for business travelers **[9]**. This is the data form that the proposed model necessarily requires. Since no such data were obtainable from the FTTE air passengers surveys[3], it was assumed that business travelers originating from Serbia place approximately equal values on airport choice attributes as do Dutch business travelers. Implementation of such a thesis implicates that the relationship between flight frequency and airport attractiveness is logarithmic, that is, as FF increases its marginal impact on airport attractiveness decreases. This is consistent with several previous studies of airport choice **[11]**, **[19]**.
- A one hour difference in travel time is worth 20-40 % of fare for the business traveler, with the highest value for the shorter trip segments **[9]**.
- Every ensuing hour that the business traveler spend to access the airport is worth the same as the previous one, that is, the relationship between the air fare (AF) and access time difference (ATD) is linear.

Based on these assumptions the functional relationship between the frequency ratio (FR) and the ATD was established. It shows the way that the greater FF to a desired destination offered at one of the competing airports compensates for the longer access time needed to reach that particular airport. This relationship has proved to be exponential **[4]**. The 20 % of ATD to AF parity being assumed, the functional form of the relationship would be:

$$\mathbf{FR_k = 1.1025*e^{0.7392*ATD}} \qquad (1)$$

where the FR_k is the compensating frequency ratio, which means the frequency ratio which would compensate longer access time. This means that if:

- airport A offers FF_A daily direct flights to a destination D, and
- airport B offers FF_B direct flights to this same destination, and
- the potential traveler is to travel longer for ATD hours to airport A comparing to his access time if he choses airport B,

then, in order to become equally attractive for this traveler as (closer to him) airport B, airport A should offer FF_B*FR_k daily flights to the traveler's desired destination. In other words, after this correction (if this would be the case), the traveler would equally often (i.e., with equal probabilities) choose each of these airports.

Inversely, for a given FR ($=FF_A/FF_B$) for these two airports, an ATD which designates the equal-attractiveness point (EAP) of these airports can be calculated. Even proportions of passengers residing in this way denoted places will be attracted to each of the two airports. This is calculated using the following formula:

$$\mathbf{ATD = 1.3529*\ln FR - 0.132\ [hours]} \qquad (2)$$

An illustration of the stage 1 implementation is presented below.

Stage 1 Application Example

Assume, for example, that a trip to Munich is considered, and that Belgrade and Budapest airports are possible origin departure airports for this flight. The E-75 highway section between Budapest and

[3] It should be noted that the survey questionnaires were created for different kind of research purposes.

Belgrade is assumed to be the common catchment area of these airports. Budapest airport offers seven flights to Munich on a daily basis, while from Belgrade airport there are two such flights. Hence, FR equals 3.5.

If average highway speed of 80 kmph is assumed, plus a 30-minute border-crossing-formalities stopping, then from the equation (2) the ATD value of 1.56 hours (94 minutes) is obtained. This, in fact, means that the equal-attractiveness point in this particular case is placed approximately in Backa Topola. Therefore, the 94 minutes longer access time to Budapest airport is compensated by the 3.5 times greater flight frequency this airport offers.

To find out the pattern of alteration of airport attractiveness with respect to ATD alteration in the system considered seemed to be a logical extension of the research undertaken. In order to establish the relationship between the airport attractiveness (in terms of market share attracted) and ATD, for a given set of airline services, the stage 2 of the model has to be introduced.

Stage 2 Specification

In this stage of the model the passengers' share that each of competing airports is to attract is calculated, based on traffic supply attributes in a system considered. To ease the procedure to be understood it will be presented sequentially.

Input variables in a procedure developed are:

- daily-direct flight frequencies (FF) to a selected destination that each of competing airports in a system considered is offering,
- access time difference (ATD), as already explained, and
- "S"-curve[4] **a** parameter, which is to be estimated.

The procedure proposed operates as follows:

1. ATD variable given, the compensating frequency ratio (FR_k) is calculated, equation (1);
2. To get a corrected flight frequency (FF_k) of a more distant (from the trip origin) airport, the computed FR_k value is to be multiplied by the flight frequency value (FF_c) the closer airport offers, that is:

$$\mathbf{FF_k = FR_k * FF_C} \qquad (3)$$

If the "distant" airport would offer FF_k daily direct flights to a destination considered, then it would become equally attractive to a potential traveler (from the place of origin denoted by ATD) as the "close" airport.

3. Based on FF_k and FF_D (true "distant" airport flight frequency), the local relative frequency (LRF_D) of a "distant" airport is calculated using the following formula:

$$\mathbf{LRF_D = FF_D / FF_k} \qquad (4)$$

On the other hand, local relative frequency of the "close" airport equals one ($LRF_C = 1$). It should be noted that $LRF_D < 1$.

4. The next step in a procedure is to compute the relative frequency (RF) - each airport's share of the total system supply, based on local relative frequencies previously calculated. The functional form of this relationship is:

$$\mathbf{RF_D = LRF_D / (LRF_D + LRF_C)}, \qquad (5)$$

while

$$\mathbf{RF_C = 1 - RF_D} \qquad (6)$$

5. Following the Renard theory **[2]** that a superior frequency gives an even more superior market share (consistent with de Neufville's "S"-curve related observation), each airport's passengers' share attracted (PS) is calculated. The mathematical formula expressing this relationship is:

$$\mathbf{PS_D = (RF_D)^a / [(RF_D)^a + (1 - RF_D)^a]} \qquad (7)$$

for a "distant" airport's passengers' share, and analogously for the other airport. The **a** parameter is to be estimated, the range of its values being between 1 and 2 **[21]**.

Up to this moment, the presented procedure calculated passengers' share attracted considering only one trip origin zone (because ATD value is fixed). To establish the pattern of PS variable alteration in the whole common catchment area of competing airports the ATD variable has to be varied. Therefore, FF attributes for both airports being given, as well as the **a** parameter, the

$$\mathbf{PS = f\,(\,ATD\,)} \qquad (8)$$

relationship is to be established. It reflects the probability-of-choosing-particular-origin-departure-airport alteration with respect to airport accesibility alteration.

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[4] The relationship between frequency of service and its attractiveness is generally represented by S-shaped curves **[20]**.

Stage 2 Application Example

Let the same example as in stage 1 application be assumed, that is: trip to Munich desired, Belgrade and Budapest airport considered as possible departure airports. Assume, for example, that trip origin zone is Novi Sad. This town is 90 km away from Belgrade, and 310 km away from Budapest. Therefore, estimated ATD equals 3.25 hours. Budapest airport, as formerly, offers seven flights to Munich per day, while Belgrade airport offers two such flights.

The **a** parameter value of 1.5 being assumed, the consequent output of the procedure would be:

$\mathbf{PS_{BUD} = 13.3\ \%}$,

$\mathbf{PS_{BEG} = 86.7\ \%}$

which means that under these assumptions 13.3 % of all the business passengers residing in Novi Sad would choose Budapest "Ferihegy" as their departure airport when traveling to Munich, the rest opting for Belgrade Airport.

Figure 2 provides the market shares of both Budapest and Belgrade airports in this particular case (trip to Munich) when different trip origin zones are considered.

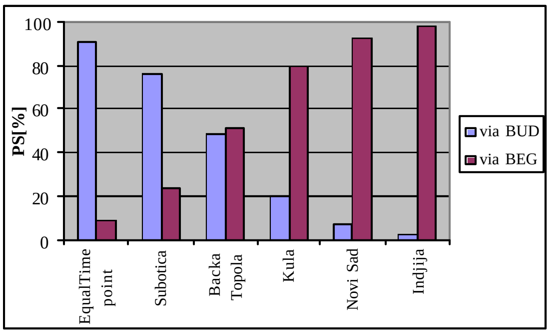

Figure 2. Airport Choice of Business Travelers, Munich Trip

Data Used

Air passenger characteristics were obtained from the 2001, 2002 and 2003 Faculty of Transport and Traffic Engineering air passenger surveys conducted at Belgrade Airport and the 2001 FTTE survey of Serbia originating air passengers departing from Budapest Airport.

Flight frequency data were gathered from the official flight schedule publications and/or internet sights of airports considered.

Highway travel times were collected from the Automobile and Motorcycle Association of Serbia (AMSS) statistical yearbook.

Description of Different Scenarios Considered

This section compares predicted airport choice probabilities for current levels of airline services in a system considered with those under several different scenarios representing incrementally increasing number of daily-direct flights offered from different airports forming the system. The scenarios created reflect the expected expansion of the Serbian air travel market, based on short- and long term forecasted acceleration of economic development and GDP growth.

After the base case airport choice probabilities for the different destinations were estimated, it seemed reasonable to try to predict the effects of potential changes of the airport choice determinants, in terms of redistribution of passengers among the available facilities. Through an iterative procedure it was established that the **a** value range between 1.3 and 1.4 provided the best fit of modeled to observed passenger distribution. Therefore, a fixed value of **a** = 1.35 was adopted.

In the base case (BC), Belgrade versus Budapest Airport passenger distribution was modeled. For that purpose, flights to nine destinations were considered, namely: Munich, Frankfurt, London, Paris, Amsterdam, Milano, Zurich, Vienna, and Moscow. To each of these destinations there was at least one flight per day from both Belgrade and Budapest airports.

For the next scenario (SC1), the additional flight to each of these destinations from Belgrade Airport is assumed, Budapest Airport flight frequencies remaining unchanged. Then (SC2), both Budapest and Belgrade airports are assumed to offer one additional daily flight to each of destinations considered. Finally (SC3), the impact of Nis Airport joining the competition is given consideration. In order to predict the passenger distribution between Nis and Belgrade airports, the assumption was made that Nis Airport offers one flight per day to Zurich, Belgrade's FF remaining unchanged (two flights per day).

Airport Choice Probabilities

Figure 3 illustrates the predicted airport choice probabilities under three different scenarios, when a flight to Munich is considered. It shows the extent to which an increase in Belgrade Airport flight frequency increases its attractiveness. This effect reaches almost 14 % (under SC1) of market share, the increase being fully expressed in the section of ATD values between 0.5 and 2 hours, that is, from Kula (120 km north of Belgrade) to a Serbia-Hungary border. Under the SC2 scenario Belgrade Airport would increase its market share for 2-9 %, this value varying with respect to ATD.

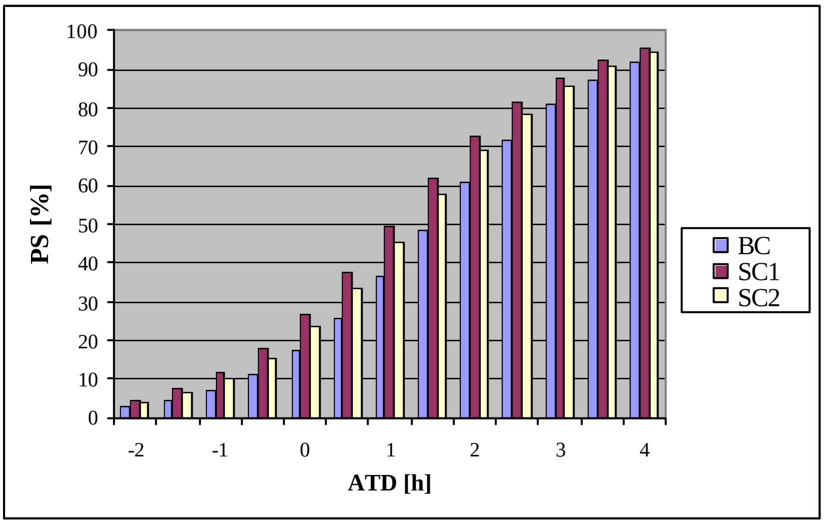

Figure 3. Belgrade Airport Passengers' Share, Munich Trip

Figure 4 presents base case Belgrade Airport attractiveness (compared to Budapest Airport) in terms of passengers' share attracted, for nine selected destinations (for Frankfurt, London, and Paris the frequency ratio equals 6, so one curve-"FRA" represents these three destinations). It can be seen that Budapest Airport is a far superior competitor (except for Vienna and Moscow flights) as long as it is less than a one hour more distant option for an air traveler than Belgrade Airport (i.e., as long as ATD is less than 1h).

Figures 5 and 6 show how the Belgrade Airport passengers share would change for the different scenarios considered, as provided by the model developed. The results indicate that the impact of additional flight offered would be the greatest in the sections approximately equally distant from both airports or closer to Belgrade.

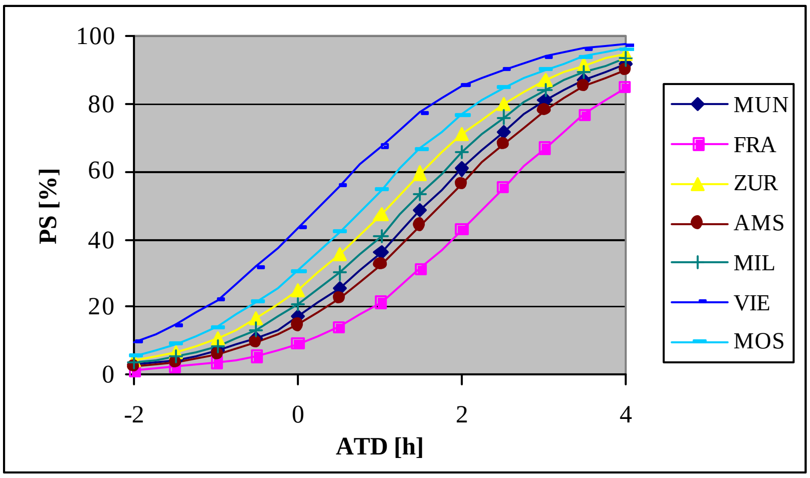

Figure 4. Base Case Belgrade Airport Market Shares

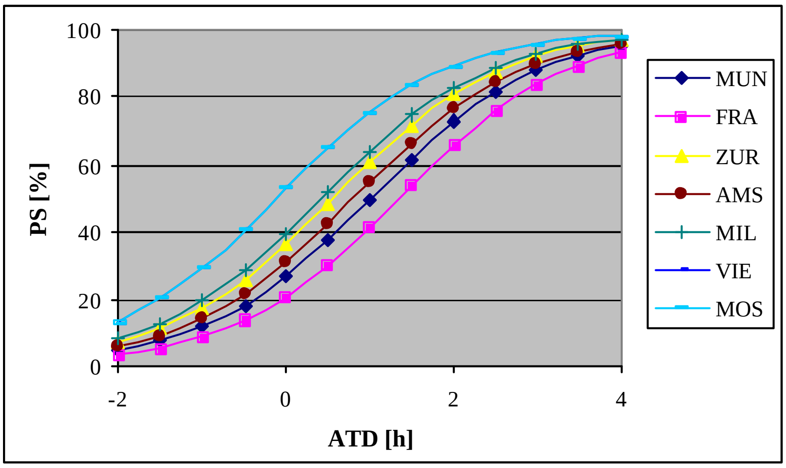

Figure 5. Belgrade Airport Market Shares, SC1 scenario

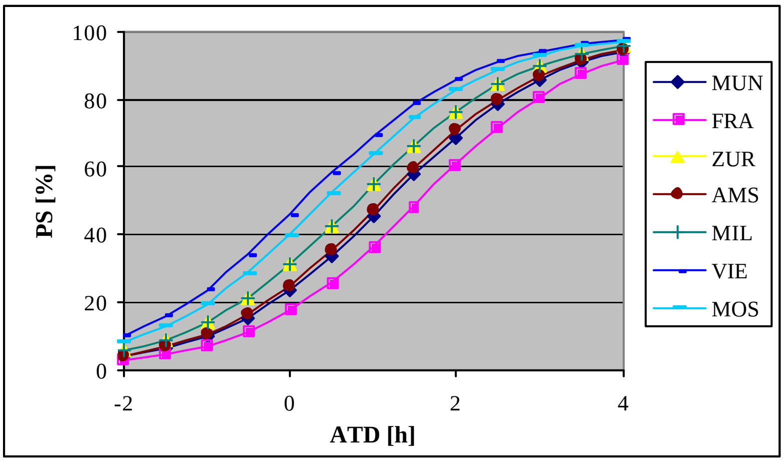

Figure 6. Belgrade Airport Market Shares, SC2 scenario

Predicted growth of passengers share reaches a peak of almost 23 % in some sections. Naturally, more modest Belgrade Airport market growth is obtained under the SC2 scenario, yet still by no means negligible. Another fact to be noted from the figures is that the higher the proportion of Belgrade to Budapest airport offered flights is, the closer to Belgrade the geographical point of peak effect of additional flight will gravitate (that is, the higher the related ATD will be).

Figure 7 provides the Nis Airport market share under the SC3 scenario. It suggests that this airport would become as attractive as Belgrade Airport at an ATD = 0.8 h point, that is, at a 90 km distance from Nis. Whether this is enough to justify a daily flight introduction is a matter of detailed regional demand analysis.

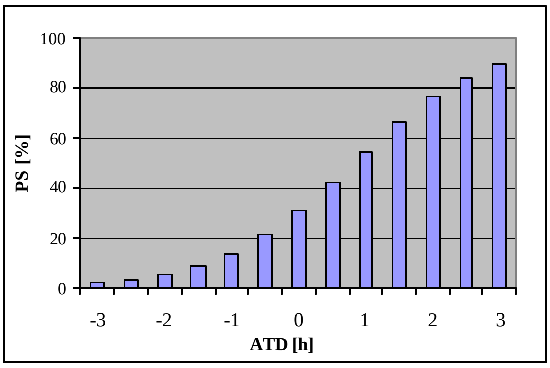

Figure 7. Nis Airport Market Share, SC3 scenario

Conclusions

The results are effort to quantify expectations that improvements to airline services offered at Belgrade Airport and Nis Airport would strengthen their positions in a regional airport system considered. The increase in Belgrade Airport market share would be significant, relative to Budapest Airport as the dominant airport in the area. Its success in attracting greater share of passengers would be more obvious in sections closer to Belgrade or equally distant from both airports. The Budapest Airport response to Belgrade's increased frequency being assumed (SC2), would still leave Belgrade Airport with a market share surplus of peak 7.5 % to 18 % (except for the Vienna flight) relative to the base case considered. When the impact of recently re-opened Nis Airport on demand distribution is considered, the situation is not that clear. Little can be said for sure without a detailed regional air travel demand analysis in this case. Anyway, this airport would, under the SC3 scenario, attract a significant share of Zurich business travelers within a distance of 100 km from Nis.

The form of the model developed enables sensitivity analysis, i.e. the possibility of evaluating the consequences of any proposed action (concerning flight frequency or ground access time) that could affect passengers' choice of airport. Except for the FF changes effects evaluation, which has been illustrated, the model could also be used to predict effects of ATD changes, which could come from ground access improvements or aggravations, simplified or complicated boundary-crossing procedures, etc.

The calibrated causal relationship also allows the estimation of the effect on passenger demand allocation of a new-constructed airport joining the competition, provided its flight schedule is assumed. Or, as illustrated, it could aid in making a decision "what to offer" (in terms of destination choice and distribution of take-off times) or "where to locate" a new airport in order to maximize its market share attracted.

Provided a geographical demand generation pattern is established, the model presented could assist airline managers in matching the aircraft capacity to demand attracted, that is, to maximize the passenger load factor achieved.

Given that the different multiple airport systems have different characteristics, the type of study presented here should be performed on a case-specific basis to establish whether possible changes of airport choice determinants have significant effects on the airport market shares.

A limitation of this study is the absence of genuine data representing authentic preferences of business travelers originating from Serbia. To establish an empirical justification for further applications, the undertaking of a survey to collect such data will be necessary.

More work has to be done concerning credible calibration of the "S"-curve **a** parameter. It reflects the sensitivity of business travelers to the travel time, therefore its value need not necessarily be the same for all the destinations nor for all the origin trip zones considered. In this way specific behavior of air travelers from different origin zones would be taken into account.

Also, getting quantitative perceptive scales from qualitative survey data (**[22]**, **[23]**) would undoubtedly improve the model's ability to predict airport demand allocation in the airport system considered. Integration of such a methodology into the model presented is an interesting problem for further research.

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Biography

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