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Demand for Air Travel

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***Abstract*—This article describes the demand elasticity of air transport and algorithm of demand modelling that is used as part of reservation system. The next section explains Quantitative Share Index that quantifies the market share for each carrier in the monitored market and Herfindahl Hirschman Index that quantifies the concentration of service providers in this market. The last chapter describes the choices of air travel itinerary.**

Keywords-demand; elasticity; modeling, choise of itinerary

I. INTRODUCTION

Few businesses have as many variables and challenges as airlines. In terms of service consumption, air transport is considered as intermediate product. Flights are usually taken to reach various objectives. That makes demand analysis and data collection very complex. Final destination contains numerous aspects, which needs to be in hand with related market properties.

II. ELASTICITY OF DEMAND

In aviation transport price and income elasticity are emphasized. In order to set right price of transport, there is need to know income and price elasticity of demand on chosen market and for various types of customers. Price elasticity PE (1) represents responsiveness of customers to change of price. Final elasticity, always represented by absolute value, can be elastic or inelastic. For results representation elasticity coefficient EDP can be used (2). In example with 2 categories of passengers only - business and tourists - result is logical: elastic demand (EDP > 1) is applicable for tourist travellers, inelastic demand (EDP < 1) to business customers. Particular elasticity values are shown in table 1. Income elasticity is related to economic situation of citizens in chosen country. This premise is especially applicable for air transportation. Higher salaries in rich countries results in higher demand in opposite of salary change in less developed countries where this fact will not have any influence. On the other hand, economic recession like crisis in 2008 always affect air transportation demand on global scale.

$$PE = \frac{\%\ change\ of\ demand\ \ volume}{\%\ change\ of\ price} \quad (1)$$

$$E_{DP} = \frac{Q_2 - Q_1}{(Q_2 + Q_1):2} : \frac{P_2 - P_1}{(P_2 + P_1)} \quad (2)$$

$$IE = \frac{\%\ change\ of\ demand}{\%\ change\ of\ income} \quad (3)$$

Elasticity differences are caused by following main factors:

- Market where carrier operates – this factor relates to income elasticity and willingness of passengers to travel by air transportation
- Importance of ticket price change in total cost of transportation – when increase is significant, demand becomes inelastic
- Granularity of demand – related to influence of demand to single carrier or air transport in general

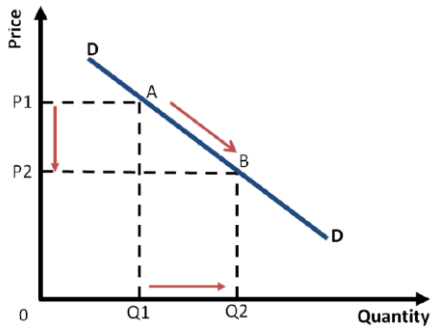

Figure 1. Demand curve [1]

Demand is also dependent on types of customers, types of travels, target destination, competitors, flight network, market behaviour and price and income elasticity in given market. Aim of demand estimation is to satisfy passenger's needs, create right sales strategy, maximize profits and offer optimal ticket price structure in reservation system. In order to estimate demand, we need to analyse above factors.

TABLE I. ELASTICITY VALUES [2]

	Market level		National level		International level	
	Short haul	*Long haul*	*Short haul*	*Long haul*	*Short haul*	*Long haul*
N. America	1,5	1,4	0,9	0,8	0,7	0,6
Europe	2,0	2,0	1,2	1,1	0,9	0,8
Asia	1,5	1,3	0,8	0,8	0,6	0,6
Africa	0,9	0,8	0,5	0,5	0,4	0,4
S. America	1,9	1,8	1,1	1,0	0,8	0,8
Trans-Atlantic	1,9	1,7	1,1	1,0	0,8	0,7
Trans-Pacific	0,9	0,8	0,5	0,5	0,4	0,4
Europe-Asia	1,4	1,3	0,8	0,7	0,6	0,5

$|E_{DP}| > 1, elastic\ demand$

III. DEMAND FORECASTING AND MODELING

The goal of demand modelling and forecasting is:

- Count of passengers on specific routes in selected flight network estimation
- Airline market share estimation
- Analysis of strategic and operational decisions impacts on demand
- Cost and income calculations

Estimation of passengers is related to reservation system data. Complex data about European flight schedules (Flight Schedule Data) can be retrieved from OAG database – Official Airline Guide - Absolut Aviation Advantage. Modelling process is using data about passengers' requests from multiple reservation systems and amount of passenger for each flight is being estimated. Every passenger is defined by two places and date of reservation. Reservation time is typically several months before departure date. Model also tracks available seats of selected line (Fig. 2) and represents interface between offer and demand.

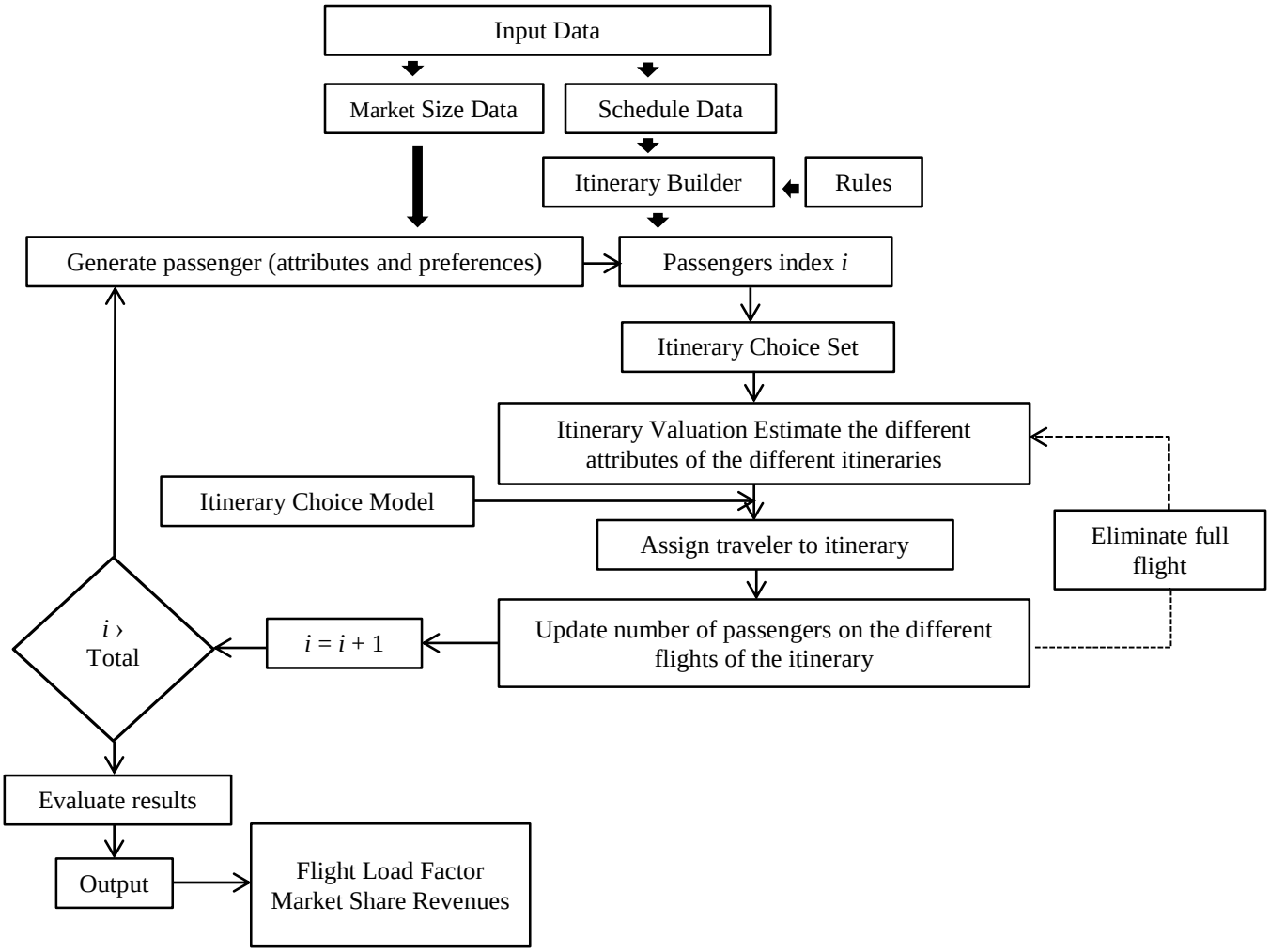

Figure 2. Modeling framework

For modelling of market share of each airline we can use Herfindahl – Hirschman Index, also known as QSI Index - Quantitative Share Index. QSI value represent ratio of passengers which use particular airline on given market. QSI is calculated for each airline *i* on market *j* (4).

$$QSI_i^j = \frac{N_i^j}{\sum_{i \in I} N_i^j} \quad (4)$$

N_i^j count of passengers transported by airline *i* on market *j*
I count of airline operating on market *j*

$$0\ \% \leq QSI_{ji} \leq 100\ \%$$

Density of providers is defined by Herfindahl – Hirschman Index (HHI). HHI considers all airlines on given market (5). Value range is between 0 and 1.

$$HHI^j = \sum_{i \in j} (QSI_i^j)^2 \quad (5)$$

IV. Air Travel Itinerary Choice

Traveller which needs transport from point A to point B has multiple choices how to reach his destination. Each choice has its own characteristics. Most relevant factors include price, transfers, departure and arrival time or total flight distance. It is important for airlines to know, how much each factor influence passenger when choosing travel itinerary.

Itinerary choice modelling is based on previous data – what was chosen from variety of offers in the past. Based on retrieved data we can predict model situation „what if".

Besides itinerary characteristics we must consider socio-economic characteristics of passenger, such as income, age, gender or loyalty program membership. Income influence price sensitivity, age and gender influences choice of number of transfers, departure and arrival times. Loyalty program motivates passenger to choose one of the programmes itinerary.

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For mathematical modelling is necessary to set variables: passenger *i*, departure airport *D*, arrival airport *A*, set of itineraries *J* joining airports *D* and *I*. Each itinerary $j \in J$ has different characteristics. Respondent *i* evaluate available itineraries prior to choice of the most attractive one. Confident determination of exact choice does not exist, however, we can evaluate price and schedule time attractiveness. For example based on customer type we can predict who will pick cheapest flight in early morning hours with long transfer time, and what type of customer will choose more expensive itinerary: direct flight with comfortable departure and arrival time.

Theory of discrete choice provides possibility of measurable outputs. We define function U_{ij} which measures attractiveness of itinerary *j* for traveller *i*. U_{ij} represents individual score of each itinerary. Higher score makes itinerary more feasible.

$$U_{ij} = V_{ij} + \varepsilon_i$$

V_{ij} – Measurable part of utility function
ε_i – Random part of utility function

Measurable part of utility function represents itinerary characteristics, passenger and route. Random component represents errors or unexplained choice of passenger caused by various factors, which influence on alternative choices. Choice of more expensive itinerary from same itineraries is considered as error as well. Why traveller decided to pick more expensive option is caused by unknown factor which we cannot identify. Discrete model works with indexes for each itinerary based on its attractiveness, and utility function into probability function institution.

V. Conclusion

For demand quantification in air transport we can use several tools. It is good to know demand elasticity in relation to different types of passengers. Demand elasticity is represented by change of demand volume in relation with ticket price change or with population income change. For modelling and demand estimation we use data from reservation systems. Outputs from model frame are Flight Load Factor, Market Share and Revenues. Quantitative Share Index value represent ratio of passengers which use particular airline on given market. Density of providers is defined by Herfindahl – Hirschman Index. Choice from multiple itineraries can be simulated with utility function of discrete choice theory. Output of the model is probability of choice of particular itinerary.

Demand quantification is an important and one of the first steps factor for airlines business and new routes planning. Others are market potential, competition, operating strategy, pricing strategy, financial summary and funding requirement, sales and distribution. The process involves constant learning and adaptation.

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