Summary

Aircraft total route time consists out of two major components, being ground block time and air block time. The ground block time or the aircraft turnaround time involves all operations or services provided to the aircraft from the on-chock to the off-chock time. Chocks are rubber blocks which are placed in front of the wheels of the aircraft, to prevent the aircraft from moving during the turnaround process. The flight process is called the air block time or the aircraft flight time and in contrast to the ground block time it involves all process between the off-chock and the on-chock time. Besides the actual flight operation, the air block time also includes landing and takeoff procedures, the time spend on the taxi runway and the tugging or push-back operations performed by the ground handlers.

The main aircraft characteristics which are important in this research project are the seating capacities, the cruising speeds, the flying distances, the fuel consumption and the turnaround times. The amount of seats determines the number of aircraft required for transporting a certain amount of passengers, and therefore the number of turnarounds. The flying distances are important for route compatibility; they depend on the fuel tank size and specific fuel consumption. Fuel expenses are a large fraction of the operating costs. So although the increase of speed reduces the flight time, it influences the fuel consumption. Other important specifications are the maximum payload and the operating empty weight, which also affect the specific fuel consumption.

The logistic turn around operations that have to be performed at the airport, are prescribed by the manufacturer in standardized operating procedures (SOP) and can be divided into three main categories. First category are the passenger services, which entail boarding and deboarding, but also on-board services such as cabin services, catering services and entertainment services. Second category is the airplane servicing, this includes preparing for turnaround and departure, administrative requirements, crewing and refueling. Third category is the cargo and baggage handling, which enfold the positioning and removal of loading equipment, and the loading or unloading of freight or luggage. The activities that cannot be executed simultaneously, but sequentially are called the critical components of the SOP.

When comparing aircraft characteristics, it is best to use reference scenarios to calculate the appropriate values for range, passenger capacities and specific fuel consumption. The maximum range specified by the aircraft manufacturers is with minimum payload, while for the comparison the range with typical passenger capacities is must more interesting. If a passenger equivalent payload is used in the payload-range diagrams supplied by the manufacturers, then the typical fuel consumption and typical range can be determined. Other reference scenarios are empty operation for the maximum range, maximum payload for the minimum range, and a baseline scenario which uses maximum fuel capacity and maximum takeoff weight.

Aircraft total route time is influenced by disrupting events, especially when critical components in the SOP, such as aircraft refueling, are slowed down due to for instance late arrival of the fuel truck. Actual route times might differ also because of additional waiting times at the gate, mainly in high traffic conditions where the arrival rate of the aircraft almost equals the service rate of the airport. The average gate waiting time is included in the taxi times, while the average time spend in a landing waiting queue is incorporated in the airborne times. Aircraft flight time depends on distance and weather conditions, but is also influenced by tail wind so the flight direction is also important. The non-extreme weather delays account for almost two-third of the national aviation system delays, and are modeled as a markup on airborne time.

Aircraft route profitability can be calculated using the average revenue per passenger and estimating the operating costs based on the modeled fuel consumption and current jet fuel price. Aircraft fuel consumption can be computed using a model derived from the payload-range diagrams supplied by the aircraft manufacturers.

The total route time is predicted by either using expected delays or simulating the turnaround and flight time delays from the statistical distributions known in the literature and derived from the aircraft on-time statistics supplied by the US DOT. The airborne times are a function of distance, route direction and speed of the aircraft. Weather delays influence the airborne time, while the taxi times are airport specific averages. For the turnaround the critical path is used, the standard values are extracted from the SOP. The actual load factor is constrained by the aircraft's maximum payload capacity, while the aircraft route compatibility depends on maximum fuel capacity and maximum takeoff weight.

According to the generic fuel consumption model, the best aircraft in general is B737-400. The generic model is only a function of load (OEW + payload) and distance, therefore different fuel efficiencies per aircraft type can only be explained with differences in OEW. Aircraft with a low OEW per passenger (a high structural efficiency) perform better. Other characteristics such as aerodynamic efficiency and engine efficiency are captured in the parameter values, which in the formula do not change with aircraft type. Still the generic model does a great job and performs excellent. This is probably because engine efficiencies, aerodynamic efficiencies and aircraft cruising speeds all have the same magnitude and are related to each other depending on the aircraft design criteria. For instance the selection of engine type depends on the desired range (distance) and design weight (load) of the aircraft. So the engine efficiency can be related to those two variables. This is also the case for the aerodynamic efficiency, the resistance which will vary with the shape, which is designed for better range (distance) or higher payload (load).

Currently the total operating costs are only modeled using a cost factor and the fuel expenses. The model can be improved with the use of different cost factors for different aircraft types, and with the use of actual cost factors adjusted for the sharp increases in jet fuel prices nowadays. Introducing the value of time promotes faster flying aircraft and quicker turnarounds, while punishing for delay time.