Airlines Data Analytics for Aviation Industry

LITERATURE SURVEY :

1. Aviation Capacity Analysis

The main objective of airline capacity analysis aims to analyse the capacity of the airline facilities for aircrafts arrivals and departures. The following leading papers addressed the airline capacity analysis problems (Barnhart et al., 2012; Dalmau and Prats, 2017; Derigs and Illing, 2013; Flores-Fillol, 2010; Kim, 2016; Lapp and Cohn, 2012; Lonzius and Lange, 2017). Dalmau and Prats (2017) investigated an optimal control problem for evaluating the effects of continuous descent operations with arrival time windows. Lonzius and Lange (2017) studied an econometric model to analyst the real-world impact of two robust scheduling methods, i.e., hub connectivity and swap opportunities. Kim (2016) applied a probabilistic simulation method to analyze the impacts of changing flight demands and throughput performance on airport delays in the recession. Derigs and Illing (2013) introduced a model-based evaluation of network configuration and optimization at cargo airlines in different European emissions trading schemes. Lapp and Cohn (2012) presented a new metric maintenance reachability model which measures the capacities and robustness of a planned set of lines-of-flights. Barnhart et al. (2012) concluded research trends and opportunities in the area of managing air transportation demand and capacity; then described a strategic approach for the better management of demand and available capacity in terms of specifying, allocating, and utilizing capacity in air transportation.

2. Air Traffic Flow Management

The main target of Air Traffic Flow Management (ATFM) is to maintain the traffic flow of en route airspace and reduce the ground holding cost (Bertsimas et al., 2014; Bertsimas and Gupta, 2016; Ivanov et al., 2017; Kim and Hansen, 2015; Koepke et al., 2008; Lulli and Odoni, 2007; Zhang et al., 2017). Ivanov et al. (2017) proposed a two-level mixed-integer optimization model to solve en-route demand-capacity imbalance problem, reduce the ATFM delay and improve airport slot adherence. Zhang et al. (2017) developed the MIP models and a two-stage hybrid algorithm to solve the hub location and plane assignment problems for the air-cargo delivery service. Bertsimas and Gupta (2016) proposed a two-stage approach for that incorporates fairness and collaboration in air traffic flow management. Kim and Hansen (2015) presented a game theoretic model of a sequential capacity allocation process in a congestible transportation system and investigated the principles at work in how airlines will time their requests for en-route resources under capacity shortfalls and uncertain conditions. Bertsimas et al. (2014) introduced a binary optimization framework for modelling dynamic resource allocation problems.

3. Tail Assignment with Aircraft Maintenance Routing

Most papers on Tail Assignment and Aircraft Maintenance Routing aim to determine how to assign the airplanes to flight legs and route the aircrafts to minimise the total flight operating and maintenance cost (Ben Ahmed et al., 2017; Faust et al., 2017; Grönkvist, 2006; Khaled et al., 2018; Liang et al., 2015; Maher et al., 2014; Marla et al., 2018; Quan et al., 2007; Reményi and Staudacher, 2014). Marla et al. (2018) discussed different classes of robust aircraft routing models from a data-driven perspective. Khaled et al. (2018) developed a compact mathematical formulation model to solve the airplanes' tail assignment problem (i.e., assigning the airplanes to flight legs) with the objective of minimizing the total flight operating and maintenance cost. Ben Ahmed et al. (2017) introduce a hybrid optimization-simulation aircraft scheduling methodology, methodology, in which a mixed-integer nonlinear programming model is developed for optimize aircraft maintenance routing and a Monte-Carlo-based procedure is used for sequentially adjusting the flight departure times. Faust, Gönsch and Klein (2017) developed a new integrated scheduling problem to optimize the choice of flights and aircraft maintenance routing based on the real-world data provided from an airline information technology provider called Lufthansa Systems. Liang et al. (2015) solved two closely related airline planning problems, i.e., the robust weekly aircraft maintenance routing problem and the tail assignment problem, in order to minimize the total expected propagated delay of the aircraft routes.

4. Airline Recovery and Rescheduling

Most studies on Airline Recovery and Rescheduling aim to handle unexpected disruptions (e.g., storms, frog or haze) and prevent them from operating in routine to reduce the delay propagation (Aktürk et al., 2014; Arıkan et al., 2017; Atkinson et al., 2016; Burke et al., 2010; Cadarso and de Celis, 2017; Clausen et al., 2010; Eggenberg et al., 2010; Kohl et al., 2007; Maher, 2015; Manley and Sherry, 2010; Mukherjee and Hansen, 2007; Rosenberger et al., 2003; Takeichi, 2017; Thengvall et al., 2003; Zhang et al., 2016). Takeichi (2017) developed a nominal flight time optimization method to minimize the delay accumulation of the whole traffic stream. Zhang et al. (2016) investigated an integrated airline service recovery problem in which the aircraft and passenger schedule recovery problems are simultaneously considered, with the objective of minimizing aircraft recovery and operating costs, passenger itinerary delay cost, and passenger itinerary cancellation cost. To solve this complicated problem, a three-stage sequential math-heuristic approach is developed to solve the flight schedules and aircraft rotations in the first stage. Then, a flight rescheduling problem and passenger schedule recovery problems are iteratively solved in the next two stages. Atkinson et al. (2016) investigated how three common practices (i.e., flexibility to swap aircraft, flexibility to reassign gates, and scheduled aircraft downtime) to mitigate the effect of unanticipated disruptions on airlines' profits. It is found that "the per-dollar return from expenditure on gates, or more effective management of existing gate capacity, is three times larger than the per-dollar returns from other inputs". Akturk et al. (2014) proposed an airline recovery optimization model to achieve good balance between fuel consumption and cruise speed due to flight rescheduling situations.

5. Airline Revenue Management

The Airline Revenue Management problem aims to fill each flight with the maximum possible revenue to maximize the total profit (Abdelghany et al., 2017; Bollapragada et al., 2007; Czerny et al., 2017;Yan et al. 2019; Ge et al., 2010). Abdelghany et al. (2017) developed a flight timetabling modelling framework to maximize the airline's revenue by satisfying the constraints of the airline's resources (e.g. aircraft and crew) as well as passenger demand shift due to the network-level competition. Czerny et al. (2017) compared the optimal mix of per-passenger and per-flight based airport charges from the carriers' and the social viewpoints when carrier markets are oligopolistic. The proposed method is able to reduce the airport aeronautical charges which are traditionally aircraft-weight related and to increase the share of aeronautical airport revenues derived from passenger related charges. Ge et al. (2010) proposed an overbooking model to handle the optimal transferring quantity among flights with different departure times and the overbooking limit of each flight. Bollapragada et al. (2007) developed an integer programming model to minimize the total portfolio cost of long-term service agreements for the maintenance of capital-intensive equipment.

6. Aircraft Scheduling Problems

Aircraft Scheduling Problems (ASPs) aims to aims to determine the accurate timing information (timetable/schedule) of each aircraft on the airport terminal resources (e.g., taxiways, air segments, runways) in such that any potential conflicts between aircraft are resolved at a microscopic level. In practice, however, air traffic control operations and related issues are still scheduled by human controllers, who construct feasible aircraft schedules in the airport terminal control area based on their previous experience, in tuition and straightforward scheduling rules without using performance indicators. A detailed description and the literature review on the ASPs can be found in the recent publications (D'Ariano et al., 2015; Samà et al., 2017, 2014, 2013). The theoretic footstone of the ASPs methodology is actually based on the extensions of job shop scheduling models (D'Ariano et al., 2015; Liu et al., 2018; Liu and Kozan, 2017, 2016, 2011, 2009; Masoud et al. 2016b, 2013, 2015; Samà et al., 2017). In terms of this main idea, we will report a detailed literature review in another journal paper which is being under preparation.