

Scheduling Aircraft Ground Handling Operations Under Uncertainty Using Critical Path Analysis and Monte Carlo Simulation: Survey and Research Directions

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ABSTRACT

Aircraft ground handling is an integral part of airline operations. Although ground handling operations usually are straightforward, it could be very complicated in certain situations, such as troubling cargo loading and unloading incidents, weather conditions or improper use of equipment and breakdowns. Ground handlers need to orchestrate a number of activities within a confined area around airplane in a short period of time. Punctuality is important for airlines and resulting increased efficiencies. In this article, scheduling aircraft ground handling operations with uncertain durations using the critical path analysis and Monte Carlo simulation is considered with the aim of improving aircraft ground services during the turnaround. Having an accurate estimate of aircraft turnaround time considering its type and load, the recourses would be assigned to the ground operations more efficiently. A case study of a long-range wide-body twin-engine jet aircraft is discussed in detail. The results indicate that the proposed method gives improved scheduling relative to the routines observed at a hub airport.

KEYWORDS

Aircraft Ground Handling, Airport, Critical Path Analysis, Monte Carlo Simulation, Scheduling, Uncertainty

INTRODUCTION

Aircraft ground handling represents a crucial process among airport activities as it affects directly airline performance also passengers' service quality perception. Ground handling addresses a number of operations requirements of an aircraft between the time it arrives at a terminal gate of an airport and the time it departs on its next flight. Ground handlers need to orchestrate a number of activities, such as baggage handling, cabin servicing, catering, aircraft fueling, maintenance and so on. Indeed, safety, accuracy, and speed are important in ground handling operations for a minimum turnaround and resulting increased efficiencies. Due to the practical importance of the subject many books and articles have been published on its various aspects (Atkin, 2013; Bazargan, 2016). The 32nd International Air Transport Association (IATA) Ground Handling Conference took place in Madrid, Spain (IGHC, 2019). However, the majority of the research focused on the classical airport airside optimisation problems, such as gate assignment (Dijk et al., 2018; Chao et al., 2019), aircraft ground movement (Stergianos et al., 2016; Brownlee et al., 2018), and runway sequencing (Guépet et al., 2017; Solak et al., 2018). In this paper, scheduling aircraft ground handling operations with uncertain durations using the critical path analysis and Monte Carlo simulation is considered with the aim of improving aircraft ground services during the turnaround in general, and equipment availability, and the crew

DOI: 10.4018/IJBSA.2020010103

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assignment in particular. A case study of a hub airport on a long-range wide-body twin-engine jet aircraft is discussed in detail.

There has been considerable research devoted to aircraft ground operations. Kuster and Jannach (2006) conducted a research in collaboration with Deutsche Lufthansa AG on handling airport ground processes based on the resource-constrained project scheduling for real-time decision support in the disruption management of the aircraft turnaround. Abdelghany et al. (2006) developed an activity selection algorithm for assigning the baggage of departing flights to available piers in the baggage-handling facility of a major US air-carrier hub. Bazargan (2007) proposed a particular mixed integer linear programming model for minimising the passenger interferences in boarding on a single-aisle aircraft considering various strategies and accommodating neighboring passengers boarding together. Nugroho et al. (2012) applied Lean solutions approach to the aircraft ground handling at PT Garuda Indonesia for categorising the ground handling operations into value-added activity, avoidable non-value-added activity, and unavoidable non-value added activity which resulted some suggestions for performance improvement. Burghouwt et al. (2014) investigated the impact of European Parliament amended airport ground handling regulation for competition on the ground handling market, at Amsterdam Schiphol Airport, and concluded that an open market will result lower ground handling costs for airlines but unlikely any serious market failure for the airports. Gok (2014) proposed a mixed integer linear programming model minimising the turnaround of a short- to medium-range, narrow-body with bulk cargo holds, twin-engine jet aircraft of a Turkish low-cost airline, and discussed the critical path in certain scenarios. Fitouri-Trabelsi et al. (2015) proposed a hierarchical approach for Palma de Mallorca Airport ground handling resources management considering both on time and delayed inbound and outbound flights. Kabongo et al. (2016) developed a forward multi-agent planning approach to airport ground handling management under a unified framework. Kierzkowski and Kisiel (2017) simulated the aircraft ground handling operations at Wrocław Airport on a category B aircraft according to International Civil Aviation Organization (ICAO) in order to evaluate the operational performance. Schmidt (2017) provides an introduction to aircraft ground operations focusing on the aircraft turnaround and passenger processes, including current challenges for airline operators, airport capacity constraints, and schedule disruptions. Studic et al. (2017) considered a systemic hybrid approach to safety risk management of ground handling operations based on a combination of functional resonance analysis, grounded theory, template analysis and goals-means task analysis. Frey et al. (2017) developed a hybrid metaheuristic based on a combination of reedy randomized adaptive search procedures with a guided local search and path-relinking, for scheduling inbound baggage handling at the baggage carousels of Munich's Franz Josef Strauss Airport. Malandri et al. (2018) considered a detailed discrete event model of inbound baggage handling at a large regional Italian airport in order to identify bottlenecks, critical operations, and study alternative scenarios in different situations for dynamic allocation of resources and personnel. Senvar and Akburak (2019) analysed improvements for the non-value adding processes in airline ground handling operations using lean six sigma methodology. Zeng et al. (2019) developed a branch-and-price approach to a hierarchical skills formulation for airport ground staff, based on the classical tour scheduling problem, minimising workforce mix that satisfies a target coverage rate with respect to a given demand profile, thereby staff with higher level skills is permitted to cover demands of lower levels. Tabares and Mora-Camino (2019) investigated the challenges of an automated aircraft ground handling operations, such as docking of ground support equipment to aircraft, and autonomous vehicles moving around the aircraft.

This paper consists of two main parts, the first part focuses on description of scheduling aircraft ground handling operations, and the second part demonstrates experimental results of the proposed critical path analysis and Monte Carlo simulation. The concluding remarks contain some suggestions for further research.

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