A Simulation Study on Boarding and Deplaning Utilizing Two-Doors for a Narrow Body Aircraft

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ABSTRACT

Boarding and deplaning processes are major and longest metrics for aircraft turnaround times. Currently, many studies have been conducted to develop more efficient strategies to reduce the boarding times. However, these studies, primarily focus on one-door boarding strategy for narrow body aircraft. Recent technological innovations provide the flexibility to add an extension to existing jet bridges making it possible to board and deplane through the front and rear doors of a narrow body aircraft. Motivated by this technological flexibility, the current study employs simulation approaches to examine, compare and contrast boarding and deplaning times utilizing one and two-door jet bridges. Different boarding and deplaning strategies are studied in this research. The results show significant time savings can be achieved for both boarding and deplaning for two-door jet bridges compared to current one-door practices.

KEYWORDS

Boarding, Deplaning, Simulation

1. INTRODUCTION AND BACKGROUND

Growing Air transportation industry has brought new opportunities for commercial airlines. As the number of passengers keeps increasing, airlines are trying to increase the frequency of their flights to accommodate the growing demand. However, airlines’ effort to improve the aircraft utilization is limited by the turnaround time particular at busy airports. In addition, turn-around cost varies from US$77 to US$250 per minute (Jahen & Neumann, 2015). Thus, it is critical to minimize the ground time for each aircraft so that airlines can achieve more profitability. Turn-around time consists of different components, including taxi-times, passenger/baggage deplaning, maintenance checks, catering, fueling, passenger/baggage boarding. Boarding and deplaning times are major turnaround time metrics. In recent years, several studies have been conducted to investigate more efficient boarding times. These studies examine various ways of grouping passengers into zones for boarding, which are extensively used by US carriers. The passengers then board the aircraft according to their zones. These studies attempt to assign passengers to boarding zones so that the interferences are minimized (Bazargan, 2007). These studies are focused on utilizing jet way boarding, which only allows passengers to board through one front door of the aircraft. Boarding through two doors has been rarely studied. Thus, the objective of this paper is to compare between one-door and two-door boarding/deplaning strategies using simulation approaches.

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Aircraft boarding can be defined as the process of passengers entering the main door of aircraft and occupying their seats. Boarding time refers to the time between the first passenger entering the main door and the last passenger occupying the seat. Passenger boarding is the major metric in turnaround times (Mas, et al., 2013). Airlines are looking for strategies that can reduce the boarding times. The challenge of boarding passengers is more prevalent for low-cost carriers as they need to have a high utilization of their aircraft. Van Landeghem and Beuselinck (2002) indicate that the turnaround times for a narrow body aircraft is 30-60 minutes. Many studies have been conducted to reduce these aircraft boarding times. These studies fall into two groups, quantitative and simulation approaches.

The quantitative approaches include Van Den Briel, et al. (2005) who proposed reverse pyramid boarding methods by utilizing a non-linear optimization model. Bazargan (2007) proposed a new linear programming method to solve for the most efficient boarding strategies by minimizing seat and aisle interferences. The new efficient boarding strategy allows passengers traveling together to board in the same group while reducing the boarding times. A similar study from Zhao, et al., (2007) also illustrated a model to reduce the interference in boarding process. Other recent quantitative studies on boarding strategies through the single front door jet way include Tang, et al. (2011) incorporating passengers’ motions and Wu, et al. (2012) considering personal passenger properties to further explain the boarding strategies. Yigunlu, et al. (2014) discuss how late-arriving passengers affect boarding times. Soolaki, et al. (2012) and Kuo (2015) offer integer programming models and meta-heuristics to solve their models.

The studies on wide body boarding strategies are very limited. Perhaps one reason can be the fact that the turnaround times for large and wide body aircraft are not as tight as narrow body aircraft. Bazargan (2011) proposed a zoning system for a wide body aircraft.

Because of the stochastic nature of boarding process, simulation modeling has been very popular for evaluating strategies on boarding times. Another advantage of these approaches is that with recent software advances and modeling, they enable the users to optimize their processes within their simulation environments. Marelli, et al. (1998) used simulation modeling to study the boarding process and times for a B 757 aircraft. Van Landeghem and Beuselinck (2002), Ferrari and Nagel (2005), Li, Mehta and Wise (2007), Bazargan (2007), and Yuan et al., (2007) are among the early researchers who adopted simulation modeling for boarding processes.

Jahen and Neumann (2015) provide a comprehensive review of literature on aircraft boarding strategies. As indicated before, these studies primarily consider boarding and deplaning passengers on a narrow-body aircraft through a single jet bridge leading to the front door.

Currently there are many claims and counter claims that the strategies offered by one or certain quantitative or simulation studies outperform other strategies in terms of speed of passengers boarding. However, to generate more revenue, many US carriers started charging for checked bags. Accordingly, passengers started bringing multiple bags onboard which defeats the expected benefits from these strategies.

In this paper, we are motivated by recent innovations in adding extensions to current narrow-body jet bridges enabling the passengers to board from both front and rear doors of the aircraft. These innovations provide the flexibility to the airlines to board and deplane the passengers through two doors. It is therefore of interest to study such a system where the passengers can board and deplane utilizing two doors and compare and contrast key metrics with current one door strategies. To the best of our knowledge, we are not aware other studies of narrow body aircraft boarding, utilizing two doors.

This paper is organized as follows. Section 2 introduces the simulation model and the logic. Section 3 provides the simulation results for two-door boarding and deplaning process and comparison with one door strategies. Finally, section 4 concludes this study.
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