Study on multi-objective optimization for the allocation of transit aircraft to gateway considering satellite hall*

Extended Abstract†

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ABSTRACT

The [1] Aircraft-Gateway Allocation Problem (AGAP) has long been a key research issue in the field of management and operations. When a satellite hall is expanded, the passengers' transit process and time will increase. This paper re-models and optimizes AGAP. From the perspectives of airports, passengers and airlines, the objective of minimizing overall transit tension is added to the traditional optimization goals of maximizing the number of flights allocated to appropriate gates and minimizing the average passengers transit time. A non-dominated genetic algorithm (NSGA-III) is used to solve the new multi-objective AGAP model. Finally, using the modified case data of Pudong Airport in China Eastern Airlines, the models and methods are analyzed. Firstly, the feasibility of the model and method is verified. Secondly, by comparing with the effect of NSGA-II algorithm, the NSGA- III is proved better in obtaining a more ideal Pareto frontier in solving three target optimization problems.

CCS CONCEPTS

• **Applied computing ~ Transportation** • Applied computing ~ Multi-criterion optimization and decision-making

KEYWORDS

Transit aircraft, gateway, allocation, satellite hall, transit tension, NSGA-III

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[1]It is a datatype.

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1 INTRODUCTION

In airport management operations, the aircraft gate assignment problem (AGAP) is one of the most important daily operations. AGAP's goal is to allocate each aircraft (flight) to an available gate, while maximizing the efficiency of the airport. If it is not properly coordinated or handled, it may cause mild delays or even safety incidents, which may trigger the domino effect. Affect the overall operation of the airport. Therefore, AGAP has always been a key research issue in the field of management and operations.

With the rapid development of the travel industry and other transshipment services, passengers needing to transit in the airport continue to increase, resulting in continuous increase of requirement for existing infrastructure and ground resources, especially for parking spaces, running systems, security inspection channels, and vehicle protection. The shortage of key resources seriously restricts the operational efficiency of airports. In order to solve the congestion problem caused by the increase of passenger flow, many airports add satellite halls based on original terminals to ease the pressure. However, satellite halls make the number of transit between flight connection increases, because some passengers need to re-board in gates different to arriving gates. This prolongs passengers' transit time, leading to the increase of operation pressures. Therefore, in the new context of extending satellite halls, it is necessary to re-study AGAP in consideration of passenger transit time and transit pressure.

For AGPA problems, Obata [1] proposed that AGAP is an NP-hard problem. Many researchers have proposed different heuristics and meta-heuristics to solve aircraft-boarding assignment problems. In theory, heuristic algorithms can be used to find the optimal solution, but heuristics tend to fall into local optimal solutions. However, meta heuristics or "modern heuristics" introduce system rules to avoid local optima or have the ability to jump out of local optimal solutions. Among them, Drexl and Nikulin [2] set the parking space allocation problem as a multi-objective programming problem and solve the problem by using a simulated annealing algorithm. Hu and Paolo [3] propose a hybrid genetic algorithm that abstracts the aircraft queue relative to parking spaces into points in parameter space, and then establish a corresponding ripple diffusion model. Genç et al [4] use a random neighborhood search method to solve the problem of airport parking space assignment, and maximize the utilization efficiency of each parking space. Marinelli et al. [5] propose a heuristic algorithm based on bee colony optimization, which mainly considers two main objectives: minimizing the total walking distance of passengers and minimizing the utilization rate of remote boarding gate. A common feature of these metaheuristics is the use of mechanisms to avoid local optima.

This paper studies AGAP considering satellite halls. Considering that transit passengers may need to transfer between terminals and satellite halls and handle relevant procedures, thereby increasing the passenger transit time and the stop time of transit aircrafts, the paper tries to maximize the number of appropriate gates and minimize the average transit time while considering the overall transit tensions.. In addition, the NSGA-III algorithm, which performs well in multi-objective optimization problems, is used to solve the problem. In addition, the flight data generated by China Eastern airlines on January 20, 2018 in pudong airport is analyzed to verify the feasibility and effectiveness of the proposed model and algorithm.

The result shows that the effect of the NSGA-III algorithm is significantly better than NSGA-II. In addition, the Pareto solution obtained by NSGA-III is more focused, and its Pareto frontier is more concentrated, while the Pareto solutions obtained by NSGAII algorithm is more divergent with the Pareto frontier more even and smooth. Second, by increasing the objective of minimizing overall transit tension, the passenger delays and flight delays caused can be reduced to some extent. It shows that the proposed AGAP model considering satellite hall has certain practical significance. At the same time, the superiority of NSGAIII algorithm in solving the AGAP problem of three targets is verified. In the next step, more objectives can be included to study how to construct the AGAP model with more detail, and to study whether the NSGA-III algorithm can effectively solve the AGAP optimization model with more than three targets.

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