INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

IJARIIT

ISSN: 2454-132X
Impact Factor: 6.078
(Volume 7, Issue 5 - V7I5-1247)
Available online at: https://www.ijariit.com

Use of Operations Research in Aviation-Scheduling of Aircraft and Crew

Varun Oza
varunoza52@gmail.com
Svkm'S Narsee Monjee Institute of Management Studies, Bengaluru, Karnataka

Anusha Bisht
anusha.bisht423@nmims.edu.in
Svkm'S Narsee Monjee Institute of Management Studies, Bengaluru, Karnataka

Anushka Khurana
anushka.khurana030@nmims.edu.in
SVKM's Narsee Monjee Institute of Management Studies, Bengaluru, Karnataka

Gouri Malhotra
gouri.malhotra378@nmims.edu.in
SVKM's Narsee Monjee Institute of Management Studies, Bengaluru, Karnataka

Madhav Acharya
madhav.acharya633@nmims.edu.in
SVKM's Narsee Monjee Institute of Management Studies, Bengaluru, Karnataka

Khushi Ahuja
khushi.ahuja771@nmims.edu.in
SVKM's Narsee Monjee Institute of Management Studies, Bengaluru, Karnataka

ABSTRACT

In these testing times of the pandemic, the aviation industry has suffered huge losses and the key is to optimize the cost by mathematical and technological advancements. Operations research helps optimizing fleet and crew to maximize efficiency, reduce costs and reduce delays. This paper deals with how integer linear programming and simulations help to solve the problem.

Keywords— *Operations Research, Aviation, Fleet Scheduling, Crew Rostering, Linear Programming*

1. INTRODUCTION

Studies show that optimized schedules can improve OTP by 3%, which can save millions of dollars.The Air transport industry has contributed essentially to the growth and development of communication, trade and tourism globally. Airlines face an uncertain environment, where timetables should be concluded and ready to move a long time ahead of their operation, while assumptions made with regards to contender plans and expected traffic while factoring in things like climate and environment events, strikes and other unpredictable events. the quality of a proposed plan relies upon the nature of the input data used to make it. Airlines begin producing revenues by using and flying their airplanes, and don't create any income while the airplanes are perched on the ground. Accordingly, a customary measurement utilized by commercial airlines to quantify the productivity of their tasks is plane turnaround time.

With the spotlight on-time performance, schedule dependability has turned into a critical need for airlines. Schedule reliability should be assessed with acceptable accuracy during the development process and it should be feasible to evaluate reliability close by schedule profitability. To satisfy both these double goals, present day solutions assemble simulations to estimate the schedule reliability. These models factor in block times, runway limit, staff and gates at various air terminals, airplane turnaround time, upkeep and carrier plan recuperation strategies. This implies the right crew is just in their respective place at the right time for their flight. Studies shows that by optimizing crew rotations, simulations can diminish the quantity of pilot and cabin duties needed for rotation and increase the overall utilization.

Scheduling is evolving with Cutting edge AI and AI algorithms which will keep on assuming an inexorably significant part in schedule forecasting. Modern scheduling depends on different departments inside airlines working and sharing data on developing, estimating, and distributing offers to clients.

Optimization models are more practical and yet more solvable. A lot bigger complex problems have been vanquished with a lot more shorter calculation time. Research identified with aircraft applications is significantly more dynamic, with numerous publications devoted to air transportation every year. This has prompted the fruitful advancement of decision support systems which save organizations a great many dollars. With the competition noticeable all-around transportation field expanding, customers expect variety in terms as far as more flights and handling of baggage, but then, a lower cost. The key is in the optimization.

The flight schedule is the focal component of a airline's planning process, aimed towards optimizing the deployment of the airline's resources to fulfil demands and maximize profits. The art of airline scheduling is tied in with knowing where, when and what to fly, yet aircrafts regularly battle to track down the most profitable schedule that is likewise operationally feasible.

Fleet assignment and crew scheduling are the most perplexing airline optimization problems. Aircraft routing and crew scheduling are normally considered after Fleet assignment.
Linear programming is a very efficient way to solve majority of the scheduling problems. It is an OR technique that uses an objective function that highlights the aim and the problem needed to be solved, it is then subjected to certain constraints which are like conditions to achieve the aim of the programme. Different approaches have been utilized so far to solve the previously mentioned sub-issues, like column generation, branch-and-price, and heuristic and meta-heuristic algorithms. In this paper, Flight scheduling is given and an integrated model is discussed for crew scheduling and fleet assignment problems.

2. LITERATURE REVIEW

The field of operations research hugely affects the administration of the management of today's air transportation. Driven by enormous demand from the board to acquire an upper hand on the lookout, aircrafts are turning to advanced optimization strategies to foster mission-critical decision support systems for the executives in the management and control of carrier activities. The product offered via carriers is represented by flights that convey carry passengers or cargo from various origins to designated destinations. As a rule, the attractiveness of the item is decided by the practicality, accuracy, functionality, quality, and price of the service.

In this research, an optimized crew pairing set was considered as the input, and the crew was chosen to be assigned to each certain crew pairing. The fundamental goal of this section minimizes aircraft costs with certain considerations, for example, flight coverage, balance load of aircraft, and maintenance requirement. Crew scheduling includes assigning the crew to planned flight legs. It tends to be applied to both cockpit and cabin crew according to the scheduling requirements.

Crew scheduling incorporates two sub-issues: crew pairing and crew rostering problems. In crew pairing, a specific sequence of flight legs generates candidate pairings. In In crew rostering, each group is relegated to specific certain pairings according to the guidelines and regulations.

A mixed integer linear program (ILP) and simulation methods is presented for deterministically crew scheduling and fleet assignment. The strategy tends different schemes of managing the crew. Modifications for computational effectiveness are additionally introduced as re-planning certain limitations and defining additional inequalities for better bounds.

Solving the model would prompt better crew and aircraft routing scheduling, consequently determining that which pairing to choose and allocate to each crew. Further, solving the model specs the flights each airplane ought to do.

From a numerical view, while the objective of combinatorial advancement research is to discover and calculate an algorithm that guarantees an optimal solution in polynomial time with respect to the problem size, the principle interest by practice and by is to find a nearly optimal or at least good-quality solution in a reasonable measure of time. A genetic algorithm is utilized to tackle this issue.

In this section, each fleet type is assigned to a designed flight leg based on the available aircraft of that type with a specific sequence while optimizing some objective functions under different operational and technical limitations. Of note, the main focus of this section is put only on different fleet types, not any other specific aircrafts. In aircraft routing problems, the schedule and route of each aircraft are determined in detail, considering maintenance requirements.

In this paper, flight scheduling is given and an integrated model is presented for crew scheduling and fleet assignment problems. The present study contributes to proposing a novel Mathematical model for integrated fleet assignment and crew scheduling problems, considering closed routes for crew and fleets at the same time and applying a Vibration Damping Optimization (VDO) algorithm as the solution approach.

Airline scheduling is an important component of the airline industry since it allows the airline to produce more revenue while also providing more, better, and faster flights to their destinations. In the airline sector, airline scheduling comprises crew working hours and days, aircraft operating hours and days, forecasts, pricing, fleet planning, and finance. Airline scheduling entails both planning ahead of time and on the day of the flight. Airlines have a defined arrival and departure schedule for flights thanks to flight scheduling, which ensures passenger reliability because they can plan their vacations ahead of time.
Passengers who miss their flights on scheduled flights won't be unaffected because there are alternative airlines that go to the same destination and flights depart almost every hour.

3. ANALYSIS AND FINDINGS

Fleet scheduling in terms of time schedule is solved by integer linear programming whereas the problem of routes and routing can be done by simulations. The linear programming model has its objective function to minimize cost and time in turn increasing profits and efficiency. Each leg of the aircraft is first attached to the right aircraft carrier example Boeing 377 or an airbus 300.crew members flying on this model were subjected to such constraints as efficiency also depends on crew rostering and assignment of crew. Typically, a 3-day cycle is set and then rotation happens accordingly. Then a differentiation is made where there is no change in the flight and lag between two flights is minimum. Since crew rostering is kept minimum there is a chance of delay whilst switching aircrafts, aircraft companies reduce this cost by switching aircrafts in different legs. Certain constraints are kept in mind for the model

- Each crew group is identified, and the aircraft cannot fly indefinitely, its limited to a time constraint
- Each aircraft cycle and crew cycle are a closed loop, meaning they start and end at the same place
- Crew and scheduled maintenance are done at the same time

Mathematical model for this type of problem has objective function to minimize summation of crew cost subject to minimum number of crew members and cost of fleet assignment of the aircraft in that leg less the summation of deadhead flights(flights appearing more than once in a leg) in each leg for each flight .The constraints are each flight should be assigned to one aircraft carrier ,all flight crew should cover the leg with the flight and time lag between the flights on the leg is greater than maximum permitted time but being greater than max economic time. Flights taken from places other than origin will experience lags, flights with other than origin as base cannot be first flight and each ticket sold should be in sync with the capacity of the aircraft to maximize gain. The above process is than put through a vibration damping optimization algorithm which uses neighbourhood solution problems(alternate solutions, which include other factors as change in policies or weather delays) and gives an optimal solution giving flight leg assigned to the flight, crew assigned to the flight and crew assigned if there is a flight change which were the decision variables of the ILP.MATLAB and other softwares can use the VDO algorithm and derive an optimal solution showing flight hours carrier available and city code. It also isolates carrier available and flight time, and crew clusters assigned to each flight.

An airline's fleeting decision highly impacts its revenues, and thus, constitutes an essential component of its overall scheduling process. However, due to the large number of flights scheduled each day, and the dependency of the FAP on other airline processes, solving the FAP has always been a challenging task for the airlines. Studying dynamic fleeting mechanisms that update the initial fleeting solution as departures approach and more information on demand patterns is gathered, thus providing a more effective way to match the airline's supply with demand.

- Each city gets a unique code assigned to it and a respective flight assigned to it by a respective cluster of crew.
- Each flight route generates a time interval to optimize cost and giving stay time and maintenance time.
- VDO model can be used for a large pool of data and optimize it efficiently.
- Relaxing the boundaries between the successive stages of aircraft and crew schedule planning, so that schedule design, fleet assignment, aircraft maintenance routing, and crew scheduling might eventually be performed in an integrated way, rather than solved sequentially as interrelated, but distinct subproblems.
- Developing fast decision support tools that increase the safety and efficiency of air transport operations by taking advantage of the massive, real-time data flows in an increasingly "info-centric" aviation infrastructure.

4. LIMITATIONS

Airline scheduling is described by various complexities, including an organization of flights, distinctive airplane types, restricted quantities of entryways, aviation authority limitations, ecological guidelines, severe wellbeing necessities, a heap of group work runs and muddled instalment structures, and cutthroat, unique conditions in which traveller requests are uncertain and evaluating procedures are intricate. This, layered with the aircraft business' endemic issues of low productivity, quarrelsome work issues, and obsolete and deficient foundation, presents overwhelming difficulties that have interesting tasks analysts for somewhere around 50 years, and have given a prolific ground to the turn of events and utilization of models and calculations.

- Because of financial contemplations in creating the plans and timetables, every one of the assets is firmly coupled and used to the degree of the carriers' information. A very little leeway is passed on to move and to react to changes.
- The condition carriers are working in, is unique and questionable. Many causes might prompt disturbance of a unique arrangement, coming about in possibility taking care of or unpredictable tasks. The significant causes are severe climate, airplane mechanical issues, team affliction, and fuel deficiencies. The shortfall of plentiful freedom in the timetable makes the assimilation of disturbance a troublesome assignment.

5. CONCLUSION

Operation research has been one of the principal contributors of the tremendous development that the air transport area has experienced during the beyond 50 years. The current study planned to propose a numerical model for tackling the integrated fleet assignment and crew scheduling issues. . Proposing solution techniques that include additional considerations into the traditional fleeting models, such as considering itinerary-based demand forecasts and the recapture effect, as well as investigating the effectiveness of alternative approaches such as randomized search procedures. Created pairings were considered as the information for this issue dependent on the integer programming model of the airline crew planning. In the proposed model, closed routes for crew and fleet were all the while thought of.

Certain constraints are kept in mind for the model like each crew group is identified, and the aircraft cannot fly indefinitely, its limited to a time constraint, each aircraft cycle and crew cycle are a closed loop, meaning they start and end at the same place and Crew and scheduled maintenance are done at the same time. Also, the model considered two back-to-back flight legs and some different attributes, for example, delay, least allowed delay, and greatest economic time. To address this model, a novel Vibration Damping Optimization (VDO) calculation was utilized and the got results were contrasted and Particle Swarm Optimization (PSO) and ideal arrangements.

The VDO uses neighbourhood solution problems (alternate solutions, which include other factors as change in policies or weather delays) and gives an optimal solution giving flight leg assigned to the flight. It also isolates carrier available and flight time. The target capacity of this model was to limit the all-out cost (i.e., armada and team costs). Overall, To inspect the exhibition of the

VDO calculation, huge scope issues were created and the presentation of VDO was contrasted and that of PSO dependent on the produced test issues. By and large, 6.71% better solution in a more limited time frame than PSO.The problem of fleet assignment and rostering of crew was optimally solved by an integer linear programme which resulted in less delays, better efficiency, and higher profits.

6. RECOMMENDATIONS

- The above model constraints limit the scope of flight source. It does not account for a flight if it starts midway through the leg. A parallel model done with Taguchi analysis can be used and corelation and regression analysis can be performed to get a better idea on efficiency.
- Lot of delays can also occur due to Air traffic control's permission to land and take off. A design analysis of the carriers from various routes can be co related and analysed or a programme can be written which integrates airport and fleet scheduling data to increase the efficiency and to reduce scope of error
- Simulations with pilots can be done to give an accurate idea on the applicability and to test the model, every problem in the simulation will just lead to updating the linear programming saving the firm a lot of money.

7. REFERENCES

[1] Operations research in management of airlines-Maximilian M Estchaimer
[2] A mathematical model for an integrated airline fleet assignment and crew scheduling problem solved by vibration damping optimization A. Rashidi Komijana;———————————————— , R. Tavakkoli-Moghaddamb, and S.-A. Dalilc
[3] blog.satair.com/six-cost-cutting-strategies-for-airlines
[4] inmarsat.com/en/insights/aviation/2018/the-skys-the-limit-2-the-future-of-airline-operational-cost-savings-revealed.html
[5] University of British Columbia-Applications of operations research in the airline industry, Arthur Alexander
[6] Business Applications of Operations Research Bodhibrata Nag
[7] SOLVING REAL-LIFE TRANSPORTATION SCHEDULING PROBLEMS By JIAN LIU
[8] Integrated Airline Operations: Schedule Design, Fleet Assignment, Aircraft Routing, and Crew Scheduling Ki-Hwan Bae
[9] Airline Scheduling: Accomplishments, Opportunities and Challenges | SpringerLink
[10] Applications of Linear Programming Dr. Antonio A. Trani Associate Professor of Civil Engineering Virginia Tech Analysis of Air Transportation Systems Falls Church, Virginia