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Aviation industry

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ABSTRACT

The aforementioned paper is an attempt to understand the aviation industry in and address its most common problems. This is an industry which traditionally tends to operate on very thin margins. Considering the tremendous pressure that's been building on them in terms of growth in frequency of flights, a number of flyers and high fuel prices, it's important to sustain what's under their control, and their clientele qualifies as the most important element. Operational tools help to find the solution of most of the problems faced while running this industry.

Keywords: *Aviation Industry, airline*

1. INTRODUCTION OF AVIATION INDUSTRY

Aviation industry is the business sector that manufactures, maintains, and operates the aircrafts and the airports. When it comes to aviation, there is a broad range of responsibilities within. It comprises activities at the airport as well as in the aircraft. It involves ground duties that are required to perform before the flight takes off, the activities during the flight, and the activities after it lands. Aviation began in the 18th century with the development of the hot air balloon Some of the most significant advancements in aviation technology came with the controlled gliding flying of Otto Lilienthal in 1896; then a large step in significance came with the construction of the first powered airplane by the Wright brothers in the early 1900s. Since that time, aviation has been technologically revolutionised by the introduction of the jet which permitted a major form of transport throughout the world.

The spectacular rise in airline business over the past three decades has been accompanied by the extensively used research in operations and science management approach in all aspects of airline operations, which has become a highly competitive global transport network. All airlines invest heavily in modern aviation and hire highly competent and qualified personnel. An important priority for the administration of a profitable airline is obviously the efficient use of such valuable resources.

The research on operations has played a critical role in helping the airline industry and its infrastructure to maintain high growth rates and to move from an innovation that addressed the elite clientele to a mass services industry. It helps the industry to continuously become competitive on the market in order to meet the demands of complex customers. India is now the world's third largest domestic air transport market. The application of Operations Research in Airlines is essential with annual growth rates of 26.6%.

This paper deals with some of the well-known problems and their respective solution approaches and examines the current field research and highlights emerging areas of future importance. The paper covers operational research concepts that include certain theories that are applied in the aviation industry.

2. USAGE OF OPERATION RESEARCH

Operations research has been crucial in assisting the airline industry and its infrastructure in sustaining high growth rates and evolving from a novelty that catered to an elite clientele to a mass market sector. It helps the industry continually transform.

Itself to compete effectively within the marketplace to match complex consumer demands. The field of operations research has tremendously impacted the management of airlines. The exclusive air transport market is very competitive and to gain an advantage in this industry the airlines turned to various techniques of operations research. Contributions of Operations Research are in several areas like leg-based and network-based seat inventory management, air traffic control, etc. Its main areas of focus are fleet assignment and maintenance routing.

The average per cent of the time spent by operations researchers in them as of October 1970, are reported as follows:

Functional area	
1. Flight operations	15%
2. Maintenance and engineering	30%
3. Marketing	30%
4. Corporate planning	10%
5. Finance	5%
6. Other	10%

Category 1, "flight operations", includes the crew scheduling problem, on which virtually all the airlines in the survey were then working (and are known by the authors of this paper to be working now). "Maintenance and engineering", category 2, includes engine management, inventory supply and control, etc. The "marketing"* category includes flight and aircraft scheduling, reservations and booking, passenger operations, demand forecasting, customer service, and market research in general. "Corporate planning" includes economics, long range forecasting, operational planning and fleet planning. "Finance" relates to accounting applications, for the most part. Category 6 includes EDP and management information systems as well as administration.

3. LITERATURE REVIEW

Aviation industry, the business of transporting paying passengers and freight by air along regularly scheduled routes, typically by airplanes. It is an enormous industry with time and optimum application of resources being absolutely essential.

Problems in aviation industry in which OR tools have been used include, for eg- reducing the fleet operation's operational cost for a low-cost airline and OR tool used here the analytical hierarchy process and linear programming were used in this study to identify the best aircraft to fly and reduce daily operating costs. Aircraft crew scheduling problems due to quick response to demand of aircraft services so a Integer Programming for CASL is used in this study as a management decision support tool to solve difficult scheduling issues for more effective labor allocation. Better landing alignment or sequencing of the aircraft so that it can help to organize air traffic. It is done by applying Optimal Sequencing here.

The problem of Scheduling of Personnel and Cargo can also be resolved by a three phased model containing a seven day cycle was developed which helped to solve the problem through linear programming or through responsibility matrix (RAM). Next to solve the problem of reducing the wait time of queues a Queueing Theory was applied in information send prior and continuous reminders are provide. OR tool Game theory has been proved essential in the industry for avoiding airline overbooking. The aircraft grounding problem basically related to disruptions caused by aircraft groundings where aircraft are out of service due to unforeseen events. For example mechanical failure, or other unexpected scenarios. To solve this issue Tabu Search(TS) a metaheuristic search method was introduced. Route Selection Problem which is associated with determining which aircrafts will serve specific routes, as well as whether or not that route should be included in the airline's network. So Vogel's Approximation Method(VAM) , an iterative approach for determining a transportation problem's initial basic feasible solution (IBFS) utilizing penalties, was introduced. And to reduce the working hours and increase efficiency a critical path technique was used.

Classical approach and Heuristic algorithm was used to solve the problem of schedule development and evaluation. Problem Of knowing how much booking is appropriate and how to compensate for the problem of flight cancellation an Heuristic search method within assignment problem is used. A Simulation and approximate analytical method is used to Identify policies for the management of the cycle of rotables. different approaches were developed for solving the airline seat inventory control problem. The most important and widely used model – EMSR or expected marginal seat revenue model is being used. Origin-destination-(O-D) based fleet assignment approach is used to specify what size aircraft to assign to each flight. To reduce the cost-based overbooking of flights dynamic programming is used. Air Traffic Flow Management (ATFM) is brought into the picture, in order to anticipate and prevent overload and limit resulting delays and traffic control is maintained.

4. FINDING AND ANALYSIS

During the course of our research , we found that few problems in the airline industry were recurring in all of our summaries.However , each problem was solved by multiple ways using different OR Tools.Here are highlighted some problems that occured in 2 or more summaries:
Recurring problems:

Problem-Scheduling of Flights
The airline scheduling planning is a very complex matrix where every arrival time is a deliberate result of the scheduled flight times that are systematic.

Various OR tools used to solve this problem-*Geometric Algorithm, LP-Classical Approach*
Geometric Algorithm
Once the airlines are provided with the desired service frequency indifferent city pairs for every fleet type, an operational flight timetable is produced by the framework.The GA helps to seek a near-optimal schedule and the competition analysis model and the resource-tracking model gauge the competency of each proposed schedule.

Classical approach-Linear programming This Model which assigns aircraft types and frequencies to flights in such a way that the difference between revenue and direct cost is maximized.

Problem-scheduling of personnel
Selecting which crews to assign to each flight to minimize crew costs

Various OR Tools used to solve the problem-*Heuristic Method,Integer Programming ,Duty Matrix*

Heuristic method branch-and pricing-
Researchers have embedded heuristics within the branch-and-price optimization process. For example variable-fixing approach(1994) in which variables with fractional values close to one are sequentially fixed to one.

Integer Programming-
Integer Programming for CASL is used in this study as a management decision support tool to solve difficult scheduling issues for more effective labour allocation.

An ideal solution can be found for every scenario. With the proposed methodology, although there are some variables that cannot become a binary number, optimal solution is reached, considering the workload of each group is balanced and all the constraints are then respected rounding and computing time is acceptable.

Duty Matrix-
A three phased model was developed which helped to solve the problem through linear programming.

Phase (1) of the model was operational and optimized crews for given schedules.

Phases (2) and (3) were to assign crews individually and cover procedures for emergencies.

In separating aircraft rotation from crew assignments, suboptimization of the whole system is probable.

This model helped to save millions of dollars and the solution did allow for schedule differences by day through the week, for staff rotations shift to shift, or for off days.

Problem: Overbooking
Airlines sell tickets to more people than the plane can actually seat. They overbook assuming that some people will miss the flight/ simply not show up.

But when there are not enough no shows, airlines must find volunteers who would want to reschedule for a later flight.
Various OR tools used to solve the problem:
Game Theory,Dynamic Programming
Game theory-
It is designed to address situations in which the outcome of one's decision does not only depend on his or her own choice but also on the decisions made by others who are also involved in the interaction.

Airlines use concepts from game theory to make better choices about how to approach bumping passengers off a flight in order to avoid future incidents.

Dynamic Programming-
This approach represents a static formulation of the overbooking problem, in that the dynamics of passenger bookings, cancellations, and no-shows are not explicitly accounted for in determining an overbooking level.

Analytical Capacity and Delay Models.
The capacity of a runway as the expected number of movements (landings and takeoffs) that can be performed per unit of time typically one hour.

Multirunway analytical capacity models also provide good approximate estimates of true capacity in cases involving three or more active runways.

Fleet assignment
According to equipment capabilities and availability, operational expenses, and prospective revenue streams, the fleet assignment problem (FAP) involves allocating different aircraft types—each with a varied capacity—to the scheduled flights. An airline's fleeting decision has a significant impact on its income and is therefore a crucial part of the whole scheduling process.

The airlines have traditionally found it difficult to resolve the FAP because of the numerous flights that are scheduled each day and the FAP's dependence on other airline operations.

Fleet assignment methods based on origin-destination (O-D) was used as the OR tool to tackle the issue. These methods see passenger costs, demand, spill, and recapture as itinerary-specific rather than flight-leg-specific. Thus, research on fleet assignment issues has not only benefited the economy but also produced cutting-edge methods for handling generic linear programming. To guarantee that there are enough aircraft of each type present at maintenance stations on a regular basis, the modified fleet assignment model includes pseudo maintenance constraints.

Queuing problems
Delay in Processing Time, according to the results of the primary survey conducted, respondents selected "waiting time in qu at various airpart checkpoints" as the number one problem which they face during their flying experience

Why do problems arise with regard to waiting in lines?
A "queueing problem" as it is so called, arises when a service counter has to service numerous customers, who arrive in a particular order (or even at random). The customers have to wait for their turn as in most cases, the performance of the service takes more time than the arrival rate of the customers. Queueing Theory is a technique in Operations Research used to help devise solutions to this problem.

We will be focusing on two important areas where passengers at airports must wait in line: at immigration and at the preliminary check-in.

5. LIMITATION

Problem with schedule development with LPP
For small networks, the results' non-integer character and lack of demand function realism might be acceptable; in big and interconnected networks, however, they usually cause problems. Since there is no assurance that non-integer solutions rounded to the nearest (small) integers are even remotely close to the best options, a rounding technique is far from straightforward given the need to preserve aircraft continuity at stations. Of fact, if integer linear programming approaches were employed, these issues could be avoided. Still, the demand function's shortcomings remain. For marketplaces with competition, the assumption of fixed demand is not simply wildly implausible.

Fleet assignment solved using assignment models
Even though the majority of airlines operate on distinct schedules on weekends, many fleet assignment models assume that the flight schedules repeat daily. Despite the fact that historical evidence indicates that day-to-day changes in demand exist, most fleeting models presuppose that flight leg demand is known and does not fluctuate by day of the week. Fleet assignment models normally assume that flight timings and ground times are deterministic; however, delays due to traffic on the ground and in the air, weather, and new security procedures result in significant variances in flight and ground durations. The majority of fleet assignment models make the assumption that it is possible to calculate the number of spilt passengers and the

expenses related to those spills at the level of a flight leg. In actuality, demand for passengers, spill, and the money connected to each passenger are itinerary specific, not flight-leg specific. As a result, it is possible to estimate leg-specific spill costs only approximately.

6. CONCLUSION

The aviation industry has seen tremendous growth over the past 50 years with one of its major contributors being operational research. The aviation industry has seen tremendous growth over the past 50 years with one major contributor being operations research. Advances in paradigms and problems have been fueled by issues and complications that are grappled with in practice, and in many cases have led to insights of a general nature and to significant methodological advances in operations research in general. Airlines, airports and ATM service providers at this point consist of OR models coupled with algorithms that are spread throughout the sector. Given the numerous obstacles it currently faces, we can assume a permanent central role for OR in the air transport industry. . Therefore, if the aviation industry is to continue at the same rate of growth as in recent decades, a scientific approach is necessary.

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