On Modeling of Logistic Overnight in Airlines

Santos, Felipe; Álvarez, Daniel
Universidad del Rosario
Bogotá, Colombia

Salazar, Fernando
Universidad del Rosario
Bogotá, Colombia

Abstract

The present work shows the results of a study that evaluated the overnight operation, using the modeling of air operations where simulation emerges as a tool, consistent with the objective of the organization to achieve better results. The old paradigms air transport issues have worn the new information systems and the need to compensate for supply capacity with demand. Some aviation sector organizations have felt the need to modify their strategic schemes. It is not enough to be part of the market and wait for the opportunities, now, which runs the changes and is innovative in their practices, achieves superior performance in the market. Because of these constant changes, organizations have had to adapt, as in the case of this particular airline, under higher demand stimulated and most comfortable travel plans and innovative, the operations involved in this value chain become more critical, since in the same chain, feels greater dependence and demand in the various logistics operations related to the provision of air service. When viewing this critical chain, there is a need to assess, innovate and improve the most important aspects in the operation.

Keywords
Logistics, services, modeling, airport sector, overnight operation

1. Introduction

The process of globalization and internationalization has led to significant development of air transport services, as the fastest way in the exchange of goods, services and movement of passengers. This mode of transport involves billions of dollars in the world market and has permitted the development of many populations as a consequence of an increased flow of goods and people in an agile way. Similarly, air travel has permitted the transfer of goods that previously could not be transported due to weather conditions or regulations inherent in many alternative modes of transport. In the last decade the sector has had a tendency towards growth; in 2013 the air transport grew by 5.3% headed by routes from the Middle East with a growth of 10.9%, followed by Latin America who reported a growth of 8.6%.[1]

Colombia has become one of the pioneers in the growth of air transport in Latin countries. With 15.8%, the country transported 28.6 million people in 2013, at the domestic level is perceived growth of 16.6% while the international segment was 14.2%. [2]

Given this situation, and taking into account that 47% [3] of mobilized passengers are from Bogota, organizations in this sector have been concerned with improving their multiple logistic processes: The influx of passengers, effectiveness airport operators, baggage handling, air traffic management etc. However, little has been improved on the overnight operation of aircraft in the country. The overnight can be defined as the time at which the aircraft returned to its base and spend a night in some kind of maintenance: corrective, preventive or predictive.

The administration of the Overnight directly influences the effectiveness of the air operation the next day, because it can compromise the performance of each planned itinerary (Flight sold). In addition little planning in the
organization of aircraft within the airport when they arrive, generate rework called repositionings, which are harmful for two reasons: first, generate down times in maintenance process and second, use scarce resources that are key in other areas of operation overnight. This critical process for the fulfillment of flights by airlines was investigated and the modeling of an Overnight airline of Colombia in Bogota airport was built.

As one of the most attractive service sector organizations, airlines have become the perfect example of a value-added system of complex character difficult to predict and projecting. The operation of the airline is understood and interpreted as an open complex dynamic system, which can be understood as "a method for promoting the learning of systems, creating simulation models that help to understand the dynamic complexity, to understand the sources of resistance to policies and design more effective strategies"[4].

A simulation is an abstraction of reality based on measurable models, focusing the study on the interactions and behavior of the system, which is translated into a measurable and structured language. Once the model is taken, the data used in reality become a feedback of information, which will be tested by experimentation to produce a result, decision making assertive character. This decision will affect the current reality restarting the cycle [5, 6, 7, 8].

2. The modeling in service provision

Many companies in the airline industry fail succeed or merge. Few advances have improved the level of service to the customer, benefit from technological boom, as has Southwest Airlines [9]: “It is the most profitable airline in USA. The organization has positioned itself as a company of low cost transportation on domestic routes. Its success is due to providing frequent and punctual flights that provide a high level of service, with a strategy of low-cost operations and an excellent relationship with its employees. These practices have broken paradigms of industrial rigid traditions and human resource policies [10].

To design and improve services there are numerous theories and tools, one of which is the modeling process, which was used in this research. When is evaluated the possibility of conducting a modeling in service organizations such as banks, hospitals, airports, hotels etc. are analyzed all the processes involved, which are subjected to assessment, prioritization and measurement of impact on service provision [11].

With the aim of find differentiating activities that increase the competitiveness of the airline in evaluation, the research team studied, researched and simulated operation overnight as one of the most critical processes in airline operation, because it directly influences the effectiveness of the air operation of the next day, it is possible to infer that if an aircraft does not comply in time its first flight of the day (6 am), is due to an unwanted situation overnight.

The modeling of aircraft for evaluation in the provision of services has become a tendency tool, practice in the presentation of scenarios and situations in the development of the logistics activity with the aim that the operations involved can be optimized and can be analyzed with additional topics such as [12]:

- Diagram of travel and infrastructure adequacy.
- Evaluation of Through-put in the study process.
- Raise, monitor and improve the operations involved.
- Design work programs in line with demand.
- Reduction in waiting times.
- Analysis and management of complexity in the system.
- Improve the quality and level of service.
- Engineering service.
- Capacity Analysis.

The simulation can be described as an instrument, through a computer is close to imitate dynamics of a real model interpreted with logic and mathematics, aiming at the knowledge of its reaction to deliberate events. This knowledge is beneficial to build action plans that lead to improved productivity in the processes of any logistics system.
3. The model elaboration

As was mentioned in the preceding paragraph, the study focused on the operation overnight. Although this process starts at 9 p.m. and ends at 6 a.m. all flights, repositioning and movements were simulated over a period of 3 days with 57 aircraft, in order to identify inefficiencies, rework and waste that can cause delays in enlistment of flights.

This model was simulated in Pro-Model Software version 8.6, undoubtedly, was complex the construction, because each aircraft was simulated in separate file. The simulator lets you create each aircraft operation in an autonomous way for the purpose that in a new file every different aircraft itineraries are merge, which helped in the simulation of several flights at the same time. To design the simulation model used the following constructors:

**Lay-out.** The lay-out is the work area on which the simulation is performed. In this model, the plane of the airport was designed on a scale of 1: 6,000 cm (Figure 1).

![Figure 1: Airport Layout](image-url)
Locations. Those sites where entities (Planes) are served or are temporarily stationed [13]. This locations are found through traceability chart that identified the places (site parking and local and international destiny) where all aircraft were moved in every hour (Figure 2).

In the tracking chart can be seen parking locations and national and international destinations aircraft with acronyms that defined the model locations, (Figure 3):

Figure 2: Traceability chart

Figure 3: Acronyms of destiny and parking locations
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**Entities.** These are the elements that move within the model. The simulation model used 57 scale aircraft with plates (L451AJ) distributed in 8 fleets: Boeing-757, B-767, Airbus A-319, A-320, A-330, MD-83, Fokker-50, and F-100 (Figure 4). Each aircraft features its flow and graphical rotation. Likewise, each aircraft has a standard speed taxiing and complementary its acceleration and deceleration on the track way.

<table>
<thead>
<tr>
<th>A320</th>
<th>Focker 100</th>
<th>Focker 50</th>
<th>B757</th>
<th>B767</th>
<th>MD83</th>
<th>A319</th>
<th>A330</th>
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Figure 4: Fleets used in the simulation

**Path Networks.** Consist of nodes and path segments which connect nodes to other nodes [13]. Define the routes by aircraft will move. An overview diagram displays the flow path of each aircraft within the airport considering operation, movement and relocation of the aircraft. In the figure 5 you can see the flow path of a Boing 757 identified with the plate EV-CES for 4 days.

Figure 5: Overview diagram
Processing. This part of the simulation defines the routing of entities through the system and the operations that take place at each location they enter [13]. Each aircraft has its process above its path network. As mentioned at the beginning, each fleet was simulated individually (8 fleets, 8 files). In the process (Figure 6), each aircraft identified with its registration is configured according to traceability, their times outside the airport and their service times.

![Processing of 330 Airbus fleet.](Image)

Arrivals. An arrival record is defined by specifying this information: Number of entities, Frequency, time of the first arrival and total occurrences of the arrival. Each aircraft fleet was built in separate file. Each file contains the simulation of all aircraft that constitute the fleet. To distinguish the simulation of each aircraft, arrival for each aircraft was built, ie, if the 330 Airbus fleet has 5 aircraft, the simulation must be 5 arrivals.

Independently of the construction, the structure and parameters of Promodel, the first thing to consider when the model is built, is the immersion of the researchers in the real situation: being present in the movements within the airport, be present in the operations of Overnight and perceive the details that make up the reality and dynamics of the system.

According with the traceability of Airline under study, it was possible build a time interval with all aircraft to simulate. From 00 pm on Sunday March 21, 2010 until 24 pm Wednesday March 24 all aircraft movements involved as shown in the following tracking were analyzed.

To simulate the entire system, each itinerary for each aircraft according to traceability was programmed, example:

The A-319 with registration N432AV began its movement in the F5 position, at 6 pm on Sunday is repositioned in the F2 position and at 11 pm the same day flew to CLO (Cali). At 13 pm the same day back to El Dorado and the aircraft was parked in position F2, and so on (Figure 7).

Modeling lasted 96 hours. In this range the following variables were assessed:

- Time in service: Aircraft which have left the airport to meet itinerary.
- Aircraft position: Airplane is in parking at the airport.
- Replenishment aircraft: Aircraft which have positioned more than once at the airport.
This model is an approximation to the reality of airport logistics, so that, taken into account the scale of size, time taxing, takeoff speed, routes, maintenance times, distances etc. However, some elements were excluded due to their complexity to simulate the air traffic as other companies, assistance services in land, climate, wind direction, etc.

4. Analysis of modeling

When starting the simulation, the respective settings on the daily behavior of aircraft were made, because each income per unit time has a different distribution, also taxing and departure. One of the peculiarities of the models is based on their approach to reality, ie, modeling represents one of the millions of events that can occur in behavior of the aircraft at the airport, for that reason, is smoothed the sample with traceable information of aircraft.

The model analysis was carried out for periods of time, and consequently its description in every situation. The model is executed in finite form, but for the case study were assessed four days: the model starts at midnight on Sunday March 21, 2010 and ends on Wednesday 24th at midnight (96 hr. in operation).

As mentioned in the previous paragraph, three variables were evaluated in the simulation: Time in service, aircraft in position and replenishment aircraft. Under these parameters the model was evaluated, obtaining the following statistics (Figure 8):
For a competitive airline is important to use their assets, ie their aircraft, however, is not so easy to keep in operation the majority of the fleet this because maintenance time, the sale of flights, the weather and other restrictions contained in the operation. However, we do not mean with this that the operation overnight and daily operation of aircraft do not have opportunity for improvement.

While aircraft are in service, productivity will increase. When aircraft are in position, are receiving some type of maintenance required, or simply are not programs in operation. Finally, when aircraft are moved on land more than once, more resources are used to rework that could have been avoided with better planning in the overnight operation and the operation of the day.

With a sample of 57 aircraft studied in a 96-hour interval is inferred that all fleets have 16% (871 hr) of rework, represented in the relocation of aircraft on the ground. This time is mainly constituted by the relocation of the Fokker 50 with 20% (190 hr) and Focker 100 with 31% (439 hr). As for aircraft parking position, 25% (1,374 hr) of the planes is in stand-be, this flag is represented mainly by the Airbus 320 with 27% (362 hr), the Airbus 330 with 26% (123 hr), the B757 with 26% (98 hr), the Fokker 50 with 26% (250 hr.) and the Fokker 100 with 25% (360 hr). According to the above, it can be said that a sample of 5,453 hours in 57 aircraft available, the 59% (3,208 hr) is in service and the remaining 41% (2,245 hr) is stopped. Of all the stops fleets, higher index are represented by the B757 (38 %), the Fokker 100 (56 %) and the Fokker 50 (46%).

Given the above data, it can be summarized that the fleets of F-50 and F-100 are the most represented in the overnight repositioning, thus, generate more downtime front cost incurred in their rework. On the contrary, the rest of the fleets are productive, because they generate a high percentage of operation.

5. Conclusions

With adequate and elaborate short term planning it is possible reduce downtime related to the repositioning of fleets by up to 20% focally in land displacements of Fokker-100 and Fokker-50.

As an added value of this research, was designed for the airline, a visualization and planning tool for the operation overnight, that will help the chief-base to make more effective his decisions, also this tool will be in the intranet of the airline, such a way that any driver, fleet manager or maintenance manager can consult by internet, so that any resources can monitor, assess or controlling operation and the state of the aircraft as to maintenance and location from anywhere in real time (Figure 9).

This wizard can be described as a planner fleet positioning for overnight operation, which allows the user to graphically locate the aircraft within the plane of the El Dorado International Airport. Each aircraft has a single sheet of record keeping in which is possible to write all the basic information to determine the status of an aircraft, its corrective, preventive or predictive maintenance at a given time. This information is relevant to making more effective and efficient decisions that contribute to the fulfillment of the itinerary of the company.

Likewise is possible see a report in real time, which provides an overview of airplanes that stay overnight on a given day and indicates the proximity to your departure time by a color code.

The wizard successfully installed, with the possibility of its implementation in other air bases in the country, which will require more time to perform all tests and adjustments of the case.

It remains a portfolio of research projects related to the following topics: Management Tools within the hangars, Optimization Traffic Operations aircraft, optimization of fueling operations, optimizing the flow of goods and luggage inside the terminal, optimizing the assignment of personnel to specific jobs, among others.

The development of maintenance on aircraft fleet, presents an academic challenge, in the sense, to understand complex systems that do not allow linear analysis, but that constitute the understanding of complex systems.
Figure 9. Planning board for the organization of Aircraft Operations Overnight

References


