Chapter 15
An Examination of the Usage Areas of Big Data Technology in Civil Aviation

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Nomenclature

IATA	The International Air Transport Association
ICT	Information Communication Technologies
USA	The United States of America
5G	5th Generation Mobile Network

15.1 Introduction

In recent years, almost half of the world's population can easily interact through online services. The source of this interaction is the concept of "information," a concept that has never been given more importance in history, which can be obtained from a wide and diverse range of inputs. While the information itself, its source, and accessibility have changed significantly over time, at the same time, the methods of viewing and directing information are changing as new ways of extracting information from unstructured information sources are found. In recent years, managing the volume of information has also changed significantly, because information users need to be able to cope with terabytes, petabytes, and even zettabytes to cope with demand. In today's world, where technology has the potential to make such a difference, having a vision of predicting for what purpose information will be used in the future will form the basis for starting to allocate and plan in advance for the necessary resources. Efficiency is very important in the aviation industry, which is one of the fastest growing global industries. Big data analytics, which is one of the technologies of the fourth industrial revolution, has the potential to create a deceleration in the value of the aviation sector. In this way, new mechanisms can be produced to

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make the sector not only more efficient but also safer. Some important applications of Big Data Analytics in commercial aviation are smart maintenance, risk management, air traffic optimization, customer satisfaction, performance measurement, cost management, increasing fleet capacity and fare adjustment for load control purposes, connected travel experience, providing passengers and airport performance management.

A few terabytes of information can be quickly generated by a commercial business organization, but now individuals can also collect this amount of information. Over the past three decades, the storage capacity has doubled every 14 months. Inversely proportional to this increase, data storage prices have fallen, which has allowed enterprises to develop a strategy of purchasing more storage space instead of determining which data to delete.

As businesses discovered the new value and power in information, they began to treat it as a tangible asset, which led to the start of a new era called "Big Data" related to information management, which is the process of adapting to the huge production of information and the new strategies it brings with it.

There have been numerous deciphers of big data, and the concept of big data is struggling with the huge gap between analytical techniques used for information management in history. The size of information sets has always grown over the years, but enterprises that currently have a larger scale of information users are working on improving information processing processes and storage methods. Big data, beyond its connotation due to its name, not only makes a difference in the size of its volume, but also is dynamic and has many forms. As a result, no other concept or entity that has as much power and value as data has been seen in the history of technology before, when every feature of it is considered.

With the developments in science, medicine, and business, the number of information-generating resources is increasing every day, especially due to electronic communication, which is a result of human activity. There is a wide range of types of information, such as e-mail, radio frequency, mobile communications, social media, health systems and their records, transport, operational data from sensors and satellites.

The information received from such sources is usually raw, not processed, and many stages are required for the analytical process to work. In general, some processes translate unstructured information into semi-structured information, if the process is further advanced, it means that the information is structured. About 80% of the data in the world is semi-structured or unstructured. Therefore, such a large amount of unstructured information can have a lot of pollution or inaccuracies in its content. The information that these companies have can be defined as unstructured information, since some businesses related to this topic, such as Facebook, Twitter, Google, and Yahoo, are dealing with big data on a large scale. As a result, these companies adapt to big data technology and its development and make large investments.

15.1.1 Big Data Within the Scope of Aviation Activities

Traditionally, data has a large and important role in the aviation industry (Burbaite 2019). As a process-oriented industry, the aviation world uses data to guide business it is based on collecting, interpreting, analysing, and generating income from data (Larsen 2013). Airlines, airports, aircraft manufacturers, suppliers, and governments that are sector stakeholders and others depend on data in the operational planning and execution activities (Himmi et al. 2017). According to the energy of the carbon-carbon bond rupture for different classes should be incapable of drawing a single stroke at the present moment; and yet aviation objects never was a greater financial benefit than now.

Long before the development of the Internet and artificial intelligence, the airline industry has always been unquestionably at the forefront of technology and innovation. Until the 1970s, airlines had managed to connect travel agencies to airports around the world to allow them to access their hosts and passenger information so that they could access their seat inventory in real time. Before artificial intelligence, airplanes could takeoff, fly around the earth, and land safely on autopilot. According to the IATA, if an airline is able to see all the conditions and make quick decisions, it can greatly improve its operating efficiency by keeping its fleet in the air. Having an aircraft on the ground costs its operator a lot (about 10,000 euros per hour according to IATA analysis) (Izzo 2019).

The knowledge gained from big data in the aviation industry is beneficial for both manufacturers (such as Airbus, Boeing) and airline companies. Manufacturer benefits include Engineering, Supply Chain, Aftermarket, and Program Management. For airlines, it can be specified as Flight Operations, Fleet Management, Maintenance, Inventory Management, Pilot and Cabin Crew Management (How Big Data Analytics Is Shaping the Travel Industry 2021).

The operational side of an airline involves many difficult problems, both managerial and mathematical. It has a very complex structure with automatic sensors and ICT security control, logistics, route all flight from planning and maintenance to refueling, assist engineers and managers throughout their service generates large amounts of real-time data. For the reasons mentioned above, it is not surprising that the aviation industry benefits from big data and other related technologies as one of the pillars of digital transformation.

The relationship between the airline and the passenger, which was almost limited to the name and surname of the passenger 15 years ago, has increased to a higher level today with other communication technologies, especially social media (Moroz 2021). Today, airlines collect tons of information about their customers (Valdes et al. 2018). They began to intelligently process the data (reservations, routes, accommodation, inquiries, transportation, price, cancellations, customer feedback, geographic location, etc.) obtained from different sources and actions (Moroz 2021). In addition to all these, the previously underestimated side of social media has now become a platform that is given great importance by large companies.

15.2 Big Data Applications in Aviation

From high volume data analysis; airport management, air traffic controllers, airlines, aircraft manufacturers, maintenance companies, and other relevant stakeholders, big data, prominent in the commercial civil aviation industry, are used in the following areas:

- Improving Airport Management Performance.
- Increasing Operational Efficiency.
- Maintenance Program Optimization.
- Providing Technical Data for Future Designs.
- Improving Customer Experience.
- Airline Market Share Forecast.
- Price Sensitivity Measurement.
- Stock Management.
- Visualization of Aviation Data.

The use of big data to increase the performance of the airport provides process optimization by using it in short and long-term business planning. Apart from this, it allows the latest developments in aviation in the world to be followed and implemented, thus ensuring business model innovation. While doing all this, it will also indirectly improve customer experience as a result of the improvements that will occur at the airports. Using big data to increase the operational efficiency of an airport is also extremely necessary because a flight may not always go as planned due to different reasons. Problems such as various meteorological reasons, aircraft malfunctions, and flight personnel problems may not allow such programs to go as planned. Thanks to big data, an extensive search of historical flight information can be made, which can be used for future predictions, resulting in an improved flight plan than before. For example, the new generation A350 aircraft has the ability to record over 400 thousand parameters during flight. These data combined with big data analytics have the potential to allow maintenance intervals to be managed before failures occur (Valdés et al. 2018). In this way, by determining the preventive maintenance schedule, the duration of the aircraft on the ground becomes more predictable and manageable. This means that flights can be planned better. Another example is the detection of abnormal situation (fault) by listening to the aircraft engine sound. Performing preventive maintenance is less costly and safer than replacing parts that will fail during operation (9 Incredible Ways Data Analytics Is Transforming Airlines 2021).

15.2.1 Application Examples of Big Data in Aviation

The Lufthansa Airline knows the history of its customers' transactions with themselves and other companies, their shopping preferences and histories, their hobbies, which products they buy and recommend, product reviews, their political views, where they live, and what they want to do. In this way, the airline knows what he would need (for example, traveling to Asia to see his parents, business trips), what he would want (for example, a vacation in Hawaii), what he would like to do (for example, order a movie on the plane), or what he would like to buy (for example, an expensive anniversary gift (Himmi et al. 2017).

Airbus, aerospace and defense products-related services, is the manufacturer. It has 180 international locations and 12,000 direct suppliers. Airbus launched Skywise, a new aviation data platform that provides big data integration and advanced analytics. Skywise was developed and used by Airbus, and the data platform has achieved great success in the analysis and prediction of failures. An increase in security and operational efficiency has been achieved. Skywise made the airline companies' operational, maintenance, and aircraft data into a secure and open platform. Every user with access to the cloud-based platform has the chance to enrich company data by combining airline industry data with their own data. Such airline industry data includes work orders, reserves, parts data, aircraft/fleet configuration, in-flight sensor data, and flight schedules. With the platform, every airline can partner with Airbus directly and indirectly with the airline industry system (Data Ecosystem) (Himmi et al. 2017).

Delta Airlines is one of the largest airlines in the USA. It leverages artificial intelligence to optimize operations and costs, as well as innovate customer service at every stage of the journey. Delta's success has been for years primarily due to its strategic investments in big data technologies. For example, with great emphasis on baggage security technologies, Delta has invested $100 million in the airport baggage system alone to improve the baggage handling process. The operations team examines and understands the causes of baggage misdirection.

As a result, Delta has developed a good solution to accurately know where each piece of baggage is and where it should go. The system alerts baggage carriers for direct transfer of baggage with connecting flights. Passengers can follow the progress of their luggage in real time. Delta has reduced the rate of misdirected baggage by 71% since 2007. This impressive development creates higher customer satisfaction and contributes to increased customer loyalty. This application has been very successful and nearly 11 million customers of the airline have downloaded the application to their phones (How Big Data Analytics Is Shaping the Travel Industry 2021).

EasyJet (British low-cost airline) is also an airline company that has managed to solve some operational problems with artificial intelligence. EasyJet used data science to develop its pricing strategy and manage inventory. As a result, the company saw profit growth per seat of around 20% between 2010 and 2014.

Southwest has also succeeded in optimizing fuel consumption by starting to use the big data platform that monitors the fuel consumption habits of Boeing aircraft and saves the airline millions of dollars annually. In the system they use, the cloud-based system running on the industrial Internet allows the collection and analysis of the data produced by the aircraft during a flight. For example, when planning the amount of fuel needed for the next flight to the same destination, pilots can consider wind speed, air importance, aircraft weight and speed, maximum thrust, and altitude (Himmi et al. 2017).

In Istanbul airport, unlike the big data usage areas mentioned, studies related to the erosion of the runways have been carried out. Since the wear conditions of the runways are a very critical situation at airports, the runway wear information to be obtained by camera and sound waves at the new airport will be evaluated on the big data platform and estimations will be made. In this way, information such as which type of aircraft should land on which runway, and the repair status of the runways will be obtained through technology (Big Data Technology and Applications in Civil Aviation 2021).

15.3 Results and Discussion

The main goal to be achieved in the aviation industry is to differentiate itself from competitors by providing more satisfactory service to customers, thereby taking the business to the next level. The things that have been done and achieved with big data around this goal do not happen with the same difficulty for every airline business. Because the process of collecting, analyzing, and using data is a long-term and real-time process that needs to be done in real time, the collected data is also complicated for the aviation industry, as it has a rather heterogeneous structure in terms of resources. The size of datasets for an application and the amount of data generated, analyzed, and interpreted per second can be very high. There may be cases when data sets have heterogeneous formats and types, on the scale of terabytes per second. One of the points to be considered in the process of big data processing is the quality of the data collected. Deficiencies in data collection may cause the process to progress incorrectly, or incorrect or unnecessary information may cause the system to slow down. In addition, one of the difficulties that may be encountered by businesses that collect data is the collection of information on social media. It is known that social media companies do not offer their users all the data sets, or make them available for access at very high fees. Apart from these, keeping up with this speed is also a challenging factor for data applications due to the technological developments that are constantly at a great pace. Therefore, to keep up with all these challenging factors, it is necessary to have a strong infrastructure and financial resources.

15.4 Conclusion

The use of big data in aviation has not yet reached the highest level. There is already an abundance of online sensors at airports that provide information on factors such as temperature, light levels, humidity, and vibration, but the arrival of 5G will allow for better monitoring of facilities at the airport and improving the "predictive maintenance" of airports (Big Data Technology and Applications in Civil Aviation 2021). All these examples show that big data analytics is reshaping the aviation industry and has the potential to transform it even further. Although big data analysis seems to benefit customers to a large extent, it also gives the aviation sector a chance to increase its sales by improving its services (How Big Data Analytics Is Shaping the Travel Industry 2021). In summary, big data technology has a positive impact on airlines, airport operators, customers, maintenance companies, and other stakeholders.

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