



Analysis of Serious Challenges Faced by the Aviation Industry

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Abstract. Nowadays, we encounter significant technological progress in several areas and branches of industry. The aviation industry is no exception. Improvements are constantly being made in the area of airlines' aircraft fleets and terminals are undergoing continuous development and modernization. As an example, we can cite the development of new, more modern and durable structural components and aircraft engines, which provide aircraft with better operational characteristics and contribute to more efficient use of aviation fuel. Control systems in aircraft cockpits are also undergoing a significant technological change. Over time, these are transitioning to fully computerized control without the need for significant intervention by the aircraft crew. The rapid introduction of new technologies due to the demand of the market also brings negative phenomena that can be the cause of air accidents. The aim of the article is to highlight the relevant challenges currently facing air traffic. The contribution is devoted to demographic factors that affect air transport, especially in economically developing regions of the world.

Keywords: digitalization · data collection · personalization

1 Introduction

Technologies in the digital space are an equally important area that not only airlines but also airport companies deal with. Their implementation or expansion can significantly facilitate the information of regular as well as occasional customers. It is not a problem to hear about situations where large global companies obtained information about customers or users of products, even though people were not informed about tracking in advance. The evidence that such activities also take place in aviation are, for example, pre-filled forms with your previous trip and personal data, which will significantly shorten your reservation time. The reality is that, even though such data collection can be undesirable, it is also beneficial for the functioning of the business and the facilitation of work.

Assurance of the safety and security of passengers, crew members, and the public is the number one priority of every airline worldwide. They maintain an unwavering

commitment to safety and security despite workforce challenges and all the issues facing the airline industry [1].

The various response actions, that were adopted by organizations to overcome mega disturbances, must be studied and further implemented [1]. Additionally, the practices from these experiences should be incorporated into a knowledge base that can be transferred to the corresponding enterprise via a feedback loop [2].

Keeping flights up to schedule is highly dependent on the weather. Due to seasonality, airlines have historically been able to anticipate some cancellations. For example, hurricane season in Florida leads to some flights being cancelled, and snowstorms in the Northeast of US can impede trips in the middle of winter. Such events can be planned for and airlines can prepare themselves to mitigate the costs. In the recent years, long term planning, however, has become nearly impossible because of the effects of climate change [3].

Digitalization is shaping all fields today as with any other significant economic event. Since the airline industry relies heavily on security and is highly competitive, it participates actively in digital innovation to improve customer experience and financial performance [4].

2 Challenge of Big Data Management

The collection of large amounts of data by airlines, otherwise known as “big data”, can take place in several ways and presents several benefits. In addition to faster and easier filling of reservation forms for passengers, there are other benefits, but from the airlines. One of the biggest advantages is the company’s ability to react in real time to the changing demands of the market, customers and to quickly adapt to incoming changes, their planning and implementation. Systematic adherence and application of knowledge and data to operations can bring a reduction in operating costs, an increase in market competitiveness for a company and value for shareholders [5].

“Big data” can affect various business areas of airlines, such as:

- Increasing the revenue of airlines
- Intelligent maintenance
- Cost reduction
- Customer satisfaction
- Digital transformation
- Performance values
- Risk management
- Control and verification
- Predicting usability [5]

A detailed examination of the data collected from websites allows airlines to better adapt to customers and understand their preferences. The analysis of received ticket reservations helps entities to modify the offered products and services designed directly according to the personal preferences of customers, which brings them an increased number of reservations in a given time interval. Based on the information obtained directly from customers, airlines adjust the offered destinations or adjust marketing

strategies for a specific market, which is reflected in different prices for identical products. From the point of view of passengers, the use of such data analysis results in more affordable prices [5].

Under the term “intelligent maintenance”, we can imagine the analysis of data that is obtained directly from the aircraft during the flight itself using several modern technologies, sensors or chips. Like other technical industries, the aviation industry undergoes regular modernization. Just for comparison, the aircraft themselves have changed over the past decades not only in terms of design, but also in terms of technology. Nowadays, a lot of electronics and components are installed in aircraft, which provide airlines and engineers with a huge amount of valuable information and data. These are subsequently evaluated in a relatively short time by software that can inform the aircraft operator about technical problems, necessary maintenance, general repairs or, in the worst case, about the replacement of the aircraft. Proper identification, analysis and timely implementation of the necessary measures can reduce maintenance and repair budgets for airlines by up to 30–40% [6].

The reason why airlines currently invest considerable funds in data collection software is that unplanned maintenance causes considerable financial and operational problems for airlines. The most common problem in the occurrence and solution of unplanned maintenance is the subsequent financial compensation of affected passengers [6].

The care and maintenance of the aircraft fleet can be divided into active and reactive. Each form of maintenance has its own advantages and disadvantages. Reactive maintenance is performed additionally in the form of a reaction to a situation or problem that has already arisen. This may result in the aircraft being grounded for an extended period of time until the problem is resolved. Active maintenance is further divided into preventive and predictive. Preventive maintenance is generally defined by the aircraft manufacturer. We may encounter maintenance based on the number of hours flown, the number of landings performed or the age of use of individual components. The downside, but safety-wise, to this type of maintenance is that it is often done before significant wear and tear. Predictive maintenance is performed at the ideal time when specific conditions require it. Predictive maintenance provides airlines with a more convenient report on data obtained from sensors that monitor the technical condition of the aircraft. In most cases, these sensors are directly compatible with computers or other portable devices, so that technicians receive information in the form of notifications immediately and also with the possibility of viewing historical records [6] (Fig. 1).

The advantages of data collection are also reflected in the area of saving operating costs. According to available IATA data from 2019 [7], fuel costs accounted for up to 23.7% of total operating costs for airlines. Currently, with the help of software, airlines can calculate the amount of fuel consumed in real time and ensure its more efficient use. Artificial intelligence systems that work with built-in algorithms monitor the distance, flight level, weight of the aircraft or the surrounding weather during the flight. Based on the evaluation of these factors, the systems can inform the technical staff about the estimated amount of fuel for the next flight. The reduction of operating costs through these systems can also be achieved with passengers’ checked luggage. A significant part of the costs of airlines is used in the form of refunds for lost or damaged luggage of passengers. Delta Airlines currently operates a mobile application that can show the

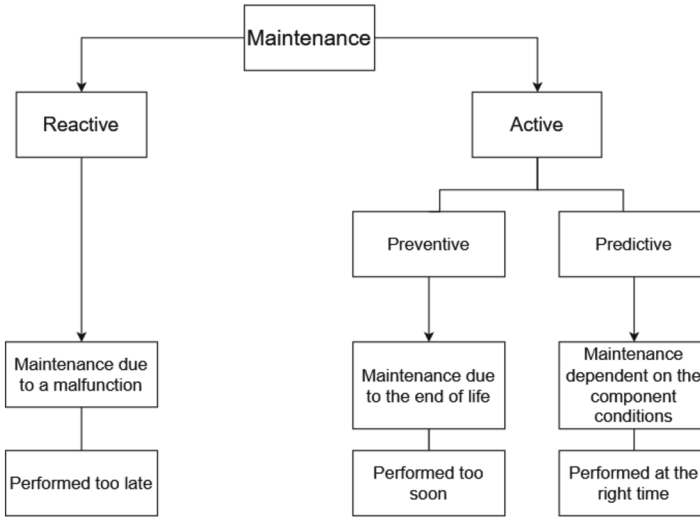


Fig. 1. The difference between preventive and predictive maintenance [6]

current location of luggage in real time and inform passengers about its status via their own smartphones. This app had a huge success immediately after its launch, as evidenced by more than 11 million downloads [5].

In addition to the private benefit from the collected information, airlines also take care to improve the travel experience of their customers. To increase passenger comfort and provide better services and products, airlines cooperate with external technology companies that provide them with tailor-made platforms and technologies. Such services include e.g. mobile applications containing virtual assistants who provide the passenger with basic information about the products offered, regarding flights, the current situation at the airport or help in filling out reservations. According to the annual report of the International Society for Aviation Telecommunications (SITA) from 2021 [8], several airlines are planning to engage in the field of artificial intelligence technologies to the extent that they will introduce technologies that facilitate the use of customer services. As an example, we can cite the cooperation of United Airlines with Amazon, which is developing its virtual bot Alexa. Miami International Airport already uses an application that provides passengers with a wide range of information about their flights [9].

Airlines also feel the benefits resulting from data collection in the area of operational performance measurement. While in the past airlines did not deal with operational indicators in such detail, today they devote considerable time and attention to this activity. Of course, constantly evolving software working with different analysis methods has the greatest impact on this. As stated by the website [5], “airlines usually operate in a globally competitive environment and therefore require fast and accurate measurement of business performance”. Obtaining accurate and useful operational or financial information is a difficult activity in the aviation industry, as their variability differs not only in the method of data collection, the type of software used, but also in the different preferences of several airlines. The impact on different operating performance measures

may be due to, for example, different business strategy, size and type of operating fleet or economic environment. Operational performance measures can be expressed in the form of physical or financial indicators. Natural operational indicators include distance flown, block hours, profitability point of aircraft capacity utilization, offered passenger kilometers, average seat capacity utilization and others. Financial operating indicators include the following indicators: total profit/loss of the company, operating profit/loss of the company, total revenues, operating costs, number of employees in the company or the number of aircraft that the company has. All these indicators inform airlines about the areas in which they achieve the highest goals or, on the contrary, where it is necessary to reevaluate the business strategy. Automating data collection gives airlines the opportunity to intervene in a timely and effective manner and minimize adverse impacts on the business [5].

Air transport is statistically one of the safest forms of transport, but even this does not guarantee a carefree way of doing business for airlines. The reason is the situations when air accidents and conflicts occur. The cause of an air accident may not only be the technical problems of the aircraft, but also the failure of the human factor in critical situations or overwork. In order to avoid such situations or to minimize their occurrence, airlines are currently focusing on developing and implementing models, simulators or choosing a risk management strategy. From this point of view, the analysis of the obtained data makes it easier for them, for example, to plan flight schedules for specific crews. Constantly flying through different time zones, long work shifts or unexpected changes in planning can negatively affect human health and concentration when performing work. Boeing's American business Jeppesen recently began integrating bio-mathematical fatigue models into operations to predict the level of exhaustion of crew members at specific times and reduce the risk of accidents resulting from human failure [5].

The aviation industry is currently facing massive development in the technical, economic and social spheres. From the point of view of constant adaptation to new regulations, directives or trends, it is important to apply knowledge and solutions in practice at the right time. The simplest method by which airlines can improve their offered services is to work on the personalization of products tailored to customers. The result can be an increase in potential and regular passengers.

By the term product personalization, we can understand the adaptation of offered services and products with regard to customer interest. Nowadays, people prefer variety and originality of purchased products and are looking for options and opportunities to differentiate themselves from others. The times when a uniform portfolio of products and services was on offer are on the wane and products of different price levels and features are coming to the fore. Airlines and entities operating in the field of aviation are currently able to meet customers and offer them various packages that customers can combine according to their own wishes [10].

Low-cost airlines, which began to appear on the aviation market to a large extent at the beginning of the 21st century, had a significant impact on the change in the way products and services are offered. The business model of low-cost airlines is aimed at reducing operating costs, which results in cutting down the offered product to the core and paying customers extra for additional services.

By additional services, we can understand any services that are available to the customer during different stages of the journey. Globally, we can divide them into services before the flight, services during the flight, i.e. on board the aircraft, and services available after arrival at the destination [10].

An additional service before the flight, for which the customer can pay, is, for example, an increase in the weight limit on the checked-in luggage, speeding up the security process directly at the airport or enabling priority boarding. A popular service, mostly among business travelers, is the provision of transportation from the hotel directly to the airport by airline. At the airport, customers will encounter additional services such as access to the business lounge, where drinks, meals and daily newspapers are available [11].

Alcoholic and non-alcoholic drinks, fast food and other snacks are available on board the aircraft. When traveling longer distances, passengers will appreciate the option to get pillows, blankets or headphones to privately enjoy multimedia content via the built-in screens in the seats. The availability of a WiFi connection is gradually becoming a matter of course [11].

After arriving at the destination airport, passengers can use services such as priority processing of travel documents, transfer from the airport by means of public transport, tracking of lost luggage using mobile devices or services of other business entities that cooperate with airports [11].

All the above examples of additional services are defined on the so-called ad-hoc basis, which means that they are bound to a given purpose. Individual airlines define these services based on their own business model, which differentiates them from their competitors. The aim of these aforementioned services is to expand the basic offer and provide passengers with greater comfort [11].

According to [12], additional services can be provided in two ways: in the form of “unbundling” or in the form of “added value”. We can define unbundling as a puzzle of separately available services, which are already defined when booking and purchasing a ticket with a predetermined price. The customer’s task is to assemble the final product according to their choice. In general, these are services that used to be part of the ticket and the customer paid for them, even if they did not actually use them [13].

The second form is the so-called “commission-linked products”. Passengers encounter these services mainly after arriving at their final destination. This includes car rentals from the airport, hotel room reservations in partner hotels, various forms of travel insurance, currency exchange or the purchase of tickets for cultural events. The sale of such services by airlines means additional income for them from the provision of third-party services in the form of commissions [14].

Airlines have prepared for their regular and loyal customers various advantages resulting from frequent travel with their airline. One of them is the introduction of the so-called “partner programs”. The purpose of these programs is to enable the customer to collect loyalty points, which can be used to apply discounts on new tickets up to 100% over time. These programs are mainly aimed at business travelers who travel around the world. While it may seem like it cannot be profitable for airlines, the opposite is true. Such loyalty points can also be purchased by other competing airlines or commercial companies, which subsequently provide them to their own customers. As an example,

we can cite the cooperation of an airline with a food retail chain. By purchasing a ticket from an airline, the customer receives loyalty points of the grocery store chain, which can be used for the next purchase in its stores [11].

In today's era of technological boom, airlines use various information technologies for more detailed personalization of their products, through which they can collect a large amount of data and information about their regular and first customers. As an example, we can cite pre-prepared partially filled forms on the airlines' websites, which, in addition to collecting and storing passenger data from their previous flights, can speed up the reservation process for the passengers themselves. How it can look in real operation is shown in the following table [10] (Table 1).

Table 1. Customization of the product to the customer's needs

| STANDARD PACKAGE OF SERVICES | PERSONALIZED SERVICE PACKAGE |
|--|---|
| The customer visits the website, chooses a date and completes the flight reservation | Websites detect repeat customers and offer them a pre-filled form, speeding up the process |
| The customer's flight is delayed - he will get the information on the airport information board | The customer will receive a personal SMS with an apology and further instructions |
| A frequent customer repeatedly orders the same whiskey but must inform the flight attendants of their preferences before each flight | When boarding the aircraft, the flight attendants greet the passenger by name and inform him that his drink is ready to be served |

3 Challenge of B737 MAX Aircraft Grounding

The grounding of Boeing 737 MAX aircraft resulted in another challenge that has to be overcome by the aviation industry. The largest producers of commercial jet aircraft in the world include the French company Airbus, based in Toulouse, and the American company Boeing, based in Chicago. While they competed for the world market leadership in terms of the number of units sold, the year 2018 brought two aircraft crashes, which over time led to the suspension of Boeing 737 MAX machines.

The Boeing 737 MAX aircraft are among the latest models mainly of the Boeing company, which started their operations in January 2016. They are twin-engine narrow-body aircraft that are produced in four variants - MAX 7, MAX 8, MAX 9 and MAX 10. The differences between them are in size, seat capacity or maximum range [15].

Boeing 737 MAX aircraft differ from their predecessors with a new design of wings that are curved at their ends in the shape of >. The leading edge of the wing is covered with a coating of special materials that contribute to a natural laminar air flow. The developers also worked on the efficient use of fuel and engine performance, thereby achieving an increase in the maximum possible range by 19%. The very construction of the aircraft engines also underwent a change, on which the production materials

were changed. In the cockpit, the latest model of display panels with larger displays are prepared for the pilots, which make it easier for the crew to search for the necessary data [15, 16].

The MCAS - Maneuvering Characteristics Augmentation System was a revolutionary technological system that was supposed to contribute to ensuring higher safety on flights. It is a computer-controlled aircraft stability system. This software helps the crew evaluate information from available sensors and prevents the so-called stopping the aircraft due to a steep climb. Sensors located in the nose of the aircraft's fuselage acquire data on the pitch angle. If this climb is too steep, the system can correct this angle by using the horizontal stabilizers in the rear of the fuselage and pushing the nose of the aircraft down. The risk may arise in the case of recording erroneous data from the aircraft sensor when the MCAS system applies its stabilization processes even at moments when the aircraft maintains a stable rate of climb. The disadvantage of this system can also be the fact that the data recorded through the built-in sensors are received continuously and this leads to the repeated switching on of the MCAS system. The solution in this case is a complete manual shutdown of the system by crew members. This cause could also be linked to two tragic crashes of Boeing 737 MAX aircraft [15, 16].

The first aircraft crash of a Boeing 737 MAX 8 aircraft, which belonged to the Lion Air airline took place in October 2018. It provided air connections between the cities of Jakarta and Pangkal Pinang in Indonesia. The aircraft fell into the Java Sea 13 min after takeoff. All 189 passengers on board, including the crew, did not survive the crash [16].

The second aircraft crash of the same type of Boeing 737 MAX 8 aircraft occurred in March 2019. Ethiopian National Airlines was operating a flight from the capital of Ethiopia, Addis Ababa, to the metropolis of Kenya - Nairobi. This aircraft crashed just 6 min after takeoff. There were 149 passengers and 8 crew members on board who did not survive the accident. The causes of both accidents are under investigation [16].

As a result of these accidents, the aviation authorities focused on the measures that need to be put into operation so that similar accidents do not happen again. This resulted in the immediate grounding of all Boeing 737 MAX aircraft until further notice. Several countries and airlines around the world have started applying these measures [17].

After the given decisions of the aviation authorities, the airlines had to immediately deal with the situation and look for solutions for the next few months to ensure further operation. As is generally known, the vast majority of airlines use one type of aircraft from a specific manufacturer when operating aviation activities, due to easier maintenance or repairs. Among the airlines with the most aircraft types at the time of the grounding order were Southwest Airlines (34 aircraft), Air Canada, American Airlines and China Southern (24 aircraft each), and Norwegian Air (18 aircraft) [17].

Immediately after its introduction, the Boeing 737 MAX became the fastest-selling aircraft type in Boeing's history, with approximately 5,000 units ordered from more than 100 companies worldwide [15].

According to Boeing's statistics, which are published on their website, 4,932 of 737 MAX aircraft were ordered by December 2019. However, only 387 aircraft were delivered [18].

Their biggest competitor, Airbus, could use the unpleasant situation on the aviation market to their advantage. Around the same time, it introduced a new class of twin-engine narrow-body aircraft called the A320neo Family. This "family" includes the A319neo, A320neo, A321neo aircraft. Since 2014, Airbus has received orders for 4,766 aircraft, while by the end of 2019, 1,186 aircraft were delivered to customers [19].

The following graphs illustrate the mutual comparison of the number of received orders and delivered pieces.

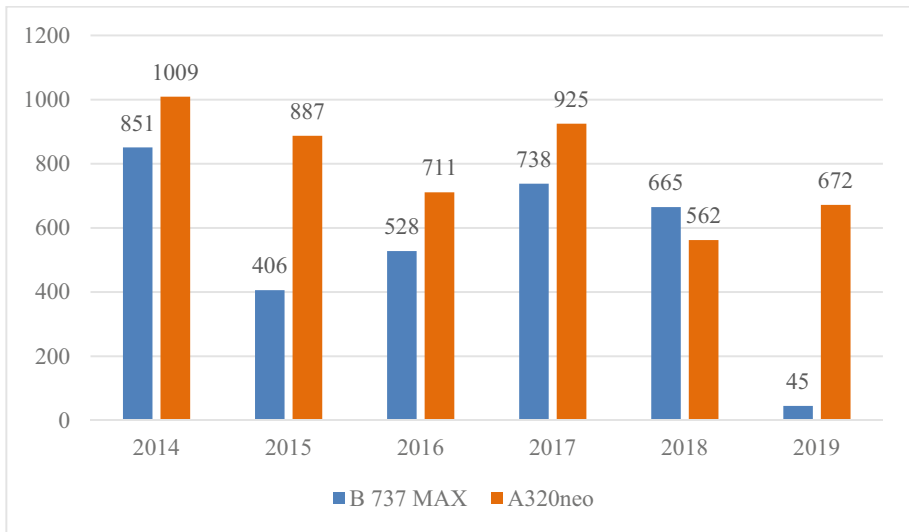


Fig. 2. Comparison of the number of received orders B 737 MAX vs. A320neo [18, 19]

As can be seen from Figs. 2 and 3, the competition between the two largest aircraft manufacturers moved in an almost identical range until the moment when two aircraft crashes occurred. After them, due to security measures, the airlines decided to suspend or cancel their orders, which resulted in a significant drop. While in 2014 Boeing received more than 800 orders, in 2019 there were only 45 of them. The situation became significantly more complicated for Boeing at the end of 2019, when the Federal Aviation Administration (FAA) announced that the lifting of restrictions would not take place before 2020. Thus, as of January 2020, Boeing stopped the production of new aircraft. In the same period, Airbus increased the number of its orders by more than 100, to more than 550 [16, 18].

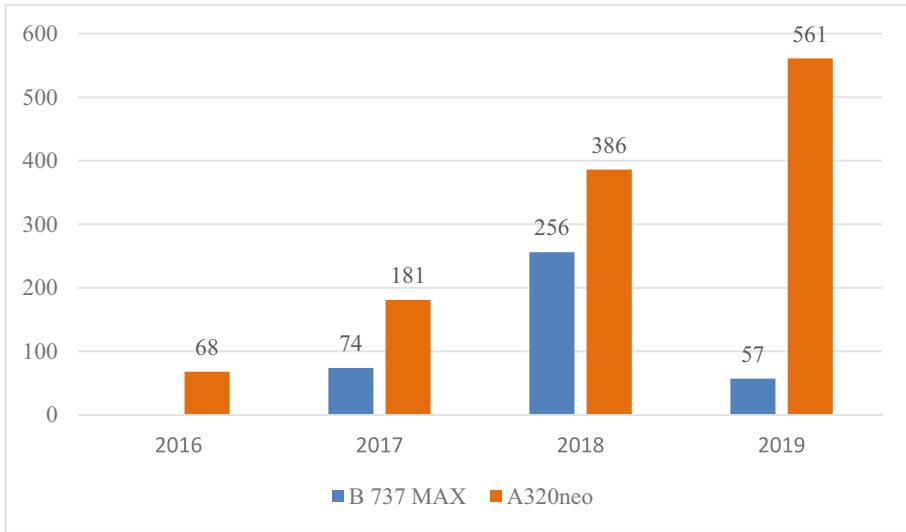


Fig. 3. Comparison of the number of delivered B 737 MAX aircraft vs. A330neo [18, 19]

According to an August 2019 article published by Forbes magazine, the economic loss of revenue in the airline industry due to the grounding of B737 MAX aircraft is estimated at 4.1 billion US dollars. The British company OAG, which specializes in obtaining and evaluating travel schedules and travel data, has published a list of five airlines that will experience the greatest economic losses. These airlines are China Southern (370 million), Air Canada (300 million), Southwest Airlines (290 million), Turkish Airlines (270 million) and American Airlines (220 million) [20].

According to the OAG airlines have lost approximately 41 million passenger seats because of grounding of B737 MAX aircraft. When calculating the seats, they were based on the chosen methodology, which expresses the difference between the planned capacity of individual airlines and the currently available capacity. A total of 387 aircraft operating for 43 different airlines were grounded [20] (Table 2).

In a public statement, Boeing apologized to all affected companies and passengers for the complications caused in air transport. The company expressed that safety is a priority and therefore they are working toward new updated software that would be certified and could ensure the return of 737 MAX aircraft back to service [20].

Airlines that experienced the greatest losses due to the grounding of aircraft confirmed that they had extensive conversations with Boeing regarding the damages caused and their refunds, but Boeing has not yet provided concrete solutions [20].

Table 2. The number of seats lost due to the grounding of the B737 MAX by individual airlines [20].

| | |
|--------------------|-----------|
| China Southern | 3 653 816 |
| Air Canada | 3 268 291 |
| Southwest Airlines | 2 962 400 |
| Turkish Airlines | 2 706 367 |
| American Airlines | 2 186 292 |
| Norwegian Air | 2 178 036 |
| Fly Dubai | 2 136 420 |
| SpiceJet | 2 002 266 |
| LOT | 1 968 600 |
| Jet Airways | 1 578 180 |

Assistance to airlines in the given situation, whether financial or material, was provided by aircraft rental companies, which enabled airlines to reduce the amount of monthly flat-rate fees, or granted them exemptions from paying rental fees for a fixed period. According to some sources, even Boeing was supposed to participate in their introduction [17].

In addition to airlines, these problems also affected pilots and other carrier employees, who lost compensation for scheduled flights during the given period. American Airlines said that it will transfer the money received from Boeing in the form of compensation (up to \$30 million) to the accounts of its employees [17].

However, according to experts from the field of air transport, this situation also brought positive effects, namely the reduction of the offered capacity of airlines. There has been a talk for a long time about a situation where the offered capacity of aircraft on the market was greater than the demand for air transport itself. This phenomenon was mostly reflected in airlines operating in North America, where it brought them higher revenues. However, the question remains how long this advantage will continue and whether it will change with the reintroduction of the B737 MAX aircraft into service [17].

The reintroduction of 737 MAX aircraft will not solve the situation immediately. The number of narrow-body aircraft in service will not be sufficient, although as Boeing reports, it currently has 400 manufactured aircraft ready to be shipped to customers. However, their delivery may take more than 6 months under optimal conditions. Experts agree on a duration of around three years [17].

Another challenge that either the aircraft manufacturer Boeing or the airlines themselves will have to face is to restore confidence in their aircraft among passengers and the general public. American Airlines, Southwest Airlines and United Airlines say they will conduct dozens of practice technical flights to assure passengers of their safety before returning their aircraft to service [17].

4 Conclusion

The benefit of new modern technological equipment is currently in great demand. It is no secret that when we give the customer a choice, his choice will be a newer and more modern model. And that is even in the case when the changes are minimal and often unimportant for a specific purpose. For this reason, but also for others, airlines approach the renovation of their aircraft fleets, which include more modern control systems, more economical aircraft engines or more aerodynamic construction materials. It is the rush to invent something newer and more modern that costs manufacturers, and subsequently airlines, considerable financial resources.

As a solution that could reduce unexpected operational problems, we consider slowing down the application of technological innovations and the introduction of more extensive safety tests, which would be carried out under specific laboratory conditions, thereby minimizing some errors that could otherwise have catastrophic consequences for the safety of passengers.

A similar situation is also taking place in the digital space, where companies apply new tools to their systems that help them get to know the passengers' requirements more closely, which the customers themselves often have no idea about. We see the application of support tools designed to improve commercial activities positively, but great attention must be paid to the security and degree of protection of the collected data. In general, this is the personal data of specific individuals, which in the wrong hands could cause serious problems for specific individuals. Therefore, it is advisable for airlines or airport companies to work closely with security companies and experts in the field of IT security when applying digital tools.

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