FROST & SULLIVAN

INNOVATIONS IN AIRPORT SUSTAINABILITY, DIGITALIZATION & URBAN AIR MOBILITY

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Introduction

The COVID-19 pandemic has caused unprecedented levels of disruption for the aviation and travel industry ecosystems, with airports of all sizes and from all corners of the world being some of the heaviest impacted stakeholders. However, as the world moves from pandemic to endemic, signs of traffic recovery are encouraging and expected to continue. Despite the existing and potential future mutations of the COVID-19 virus, the world in general is on a much stronger footing on the path to recovery thanks to global vaccination efforts, which have allowed borders to re-open and for the international travel markets to return.

While the operational, financial and investment priorities of the ecosystem stakeholders, including airports, were naturally affected during the initial onset of the pandemic, key areas remain important for the future development and evolution of airports. While some airports had already made headway in their digitalization efforts before the pandemic, efforts by airports to continue their digitalization journey are expected to intensify. Digitalization is an inescapable reality that must be addressed by airports to ensure their continuing competitiveness in an ever-more competitive post-COVID marketplace.

Sustainability is another key area that is critical to not only airports and the travel industry but also the entire world. Airports are aware of the importance of sustainability and are at different levels of progress, with the majority of efforts concentrating on improving efficiency in terminal and airside operations with the ultimate aim of reducing greenhouse emissions.

Urban air mobility (UAM) is developing quickly and expected to become an important part of the future transport ecosystem. The ability to integrate this new mode of transport into existing operations, whether for passenger or freight, is important for airports.

However, airports cannot focus on these important areas alone. Like the recovery of travel, implementing digitalization initiatives, sustainability and UAM requires close coordination with countless industry stakeholders such as airlines, ground handlers, and authorities, among others.

Digitalization

Even before the onset of the pandemic, airports, like their counterparts within the travel ecosystem, were investing in new digitalization initiatives and programs at varying levels of implementation. The COVID-19 pandemic brought about a shift in the speed and scope of this change across the travel ecosystem.

Digital transformation is critical to support the recovery efforts of airports and other industry stakeholders. Increased use of mobile technologies and implementation of initiatives to enable contactless travel has been a priority for airports to rebuild passenger confidence.

Digitalization in all aspects of airport operations, including customer experience, operational optimization and revenue enhancement, is delivering measurable benefits. A recent Frost & Sullivan analysis established that the airport digitalization market is estimated to be worth US$ 8.5 billion by 2030.

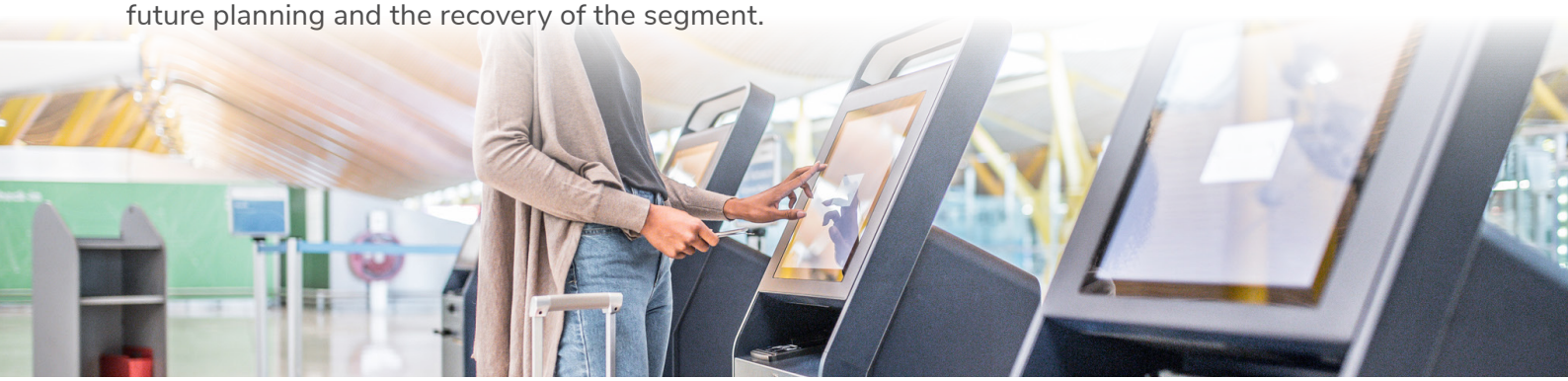
Digitalization in Airports

The importance of digitalization is clear in the airports segment. Optimized operational planning and management at strategic and tactical levels, enhanced passenger flow, and asset management through all stages of the airport journey were key areas of concentration before the pandemic.

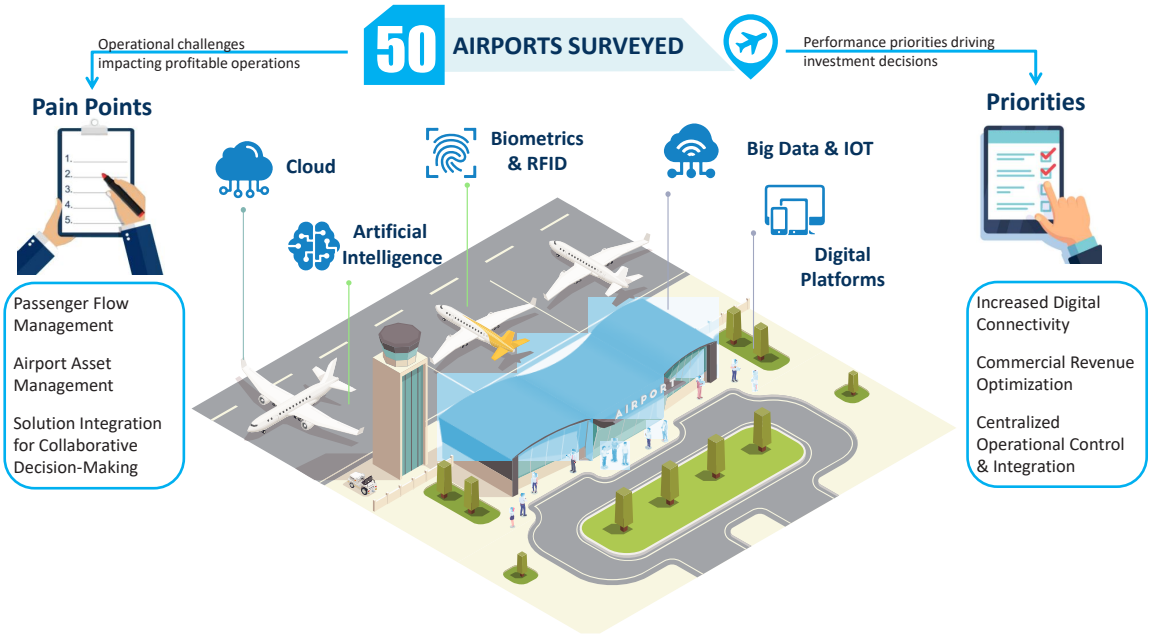
A recent, pre-pandemic Frost & Sullivan analysis covering over 50 airports of different sizes worldwide highlighted that passenger flow management, integrated solutions for collaborative decision-making and airport asset management were the main pain points for the majority of the airports surveyed. Airports also indicated that increased digital connectivity, commercial revenue optimization, and centralized operational control and integration were key priorities.

While the pandemic led to a never-before-seen drop in the passenger levels of a vast majority of airports around the world, the recovery in air and passenger traffic is underway. Therefore, the operational challenges that existed before the pandemic for airports will resurface as passenger recovery continues, and airports will once again need to plan for future growth.

Furthermore, the stringent health and safety requirements brought on by the pandemic, which necessitated the wider implementation of initiatives such as touchless travel and increased use of mobile technologies, have further highlighted the growing importance of digitalization at airports for future planning and the recovery of the segment.



DIGITALIZATION - AIRPORTS



Source: Frost & Sullivan

Digitalization initiatives applicable at each part of the passenger's journey through the airport create multiple benefits for the airport. They include reducing costs through airport operations optimization and passenger processing, revenue enhancement through the development of ancillary revenue strategies, and helping the airport achieve its sustainability targets for greenhouse emissions and noise levels.

DIGITALIZATION BENEFITS: OPERATIONAL KPI

	Key Operational KPIs	Key Technologies	Benefits of Digitalization
1	Baggage Tracking/Reconciliation	RFID	Lower cases of misplacing passenger luggage 25% ↓
2	Passenger Screening Time (Check-in/Security)	Data Analytics	Reduction in security screening wait times 30% ↓; Reduction in passenger check-in time 42% ↓
3	Passenger Screening Time (Boarding)	Data Analytics & Biometrics	Improve speed of passenger boarding at terminal gates 30% ↑
4	Parking Availability & Vehicle Queuing Time	Autonomous Robots for Car Towing	Increase in-car parking capacity with no additional space requirement 50%
5	Non-aeronautical (Retail) Revenue Per Passenger	Passenger Counting, Tracking & IoT	A 10-minute reduction in security queues can potentially improve retail revenue by up to 30% 30% ↑
6	Greenhouse Gas Emissions (GHG) Levels	Robotics, Electric Vehicles	Reduction in CO2 and other noxious emissions 85% ↓; Reduction in noise pollution 60% ↓
7	Digital Readiness Score	5G Connectivity	Achieve 100% 5G coverage, which was at 98% for 4G 100% ↑
8	Number of Security Incidents	Nanotechnology Sensors	Accurate detection of illegal substances compared to ion spectrometry devices 80% improved ↑

Airport Operations
Sustainability
Passenger Processing
Ancillary Revenue

Source: Frost & Sullivan

For example, Dubai Airports implemented several initiatives as part of its digitalization strategy. An example is the simulation and optimization of each aircraft stand every five minutes to enhance its operations via increased asset utilization and improve its customer experience. Another example is baggage management, where the airport operator applies predictive maintenance capabilities and flow management technology to the baggage system to increase reliability and attain maximum throughput with the highest possible baggage connection rates.

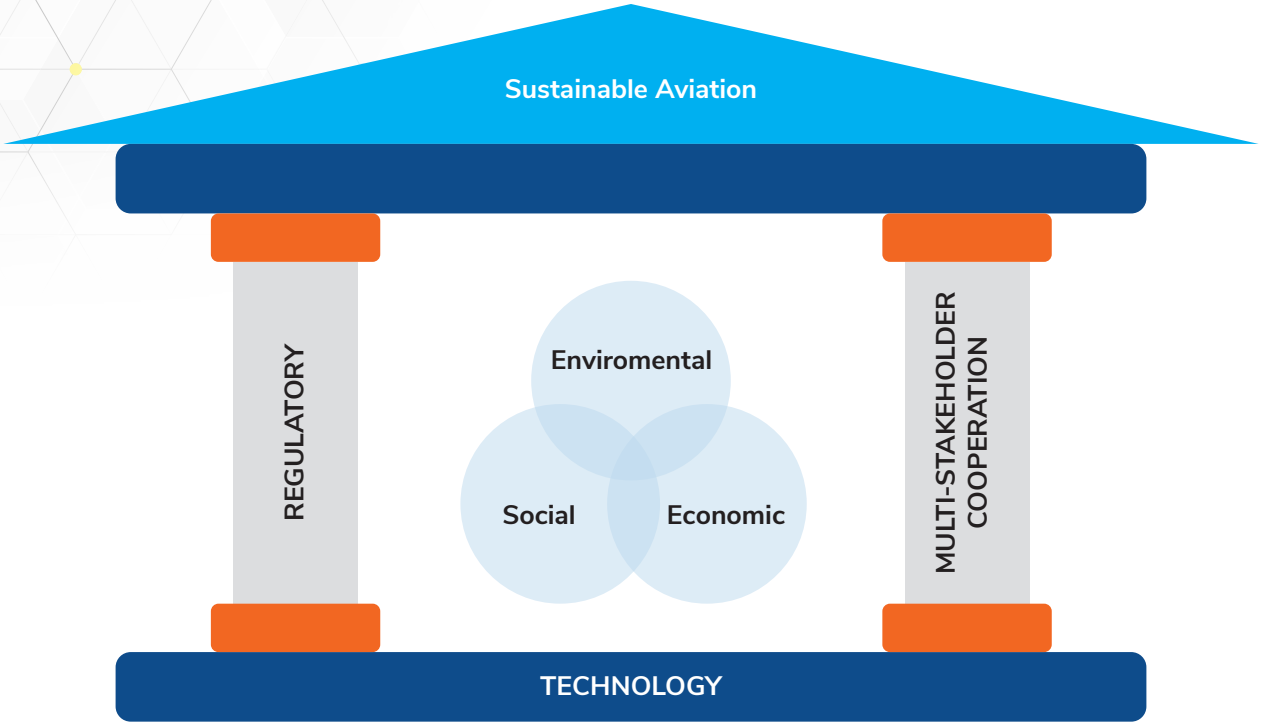
In general, airports now accept that investment in physical infrastructure has its own limitations compared to investing in technology and process automation, which is leading the high adoption rate of digitalization. Furthermore, a majority of tier 1 and tier 2 airports accept the benefits that digitalization brings in terms of passenger experience and incremental revenue. Therefore, investments in digitalization initiatives are expected to increase within the total IT expenditure for airports.

Sustainability

The growing impact of climate change is the single biggest challenge facing the world. The question is no longer whether climate change is a reality but how the world can make concrete changes to the way it functions to safeguard future generations.

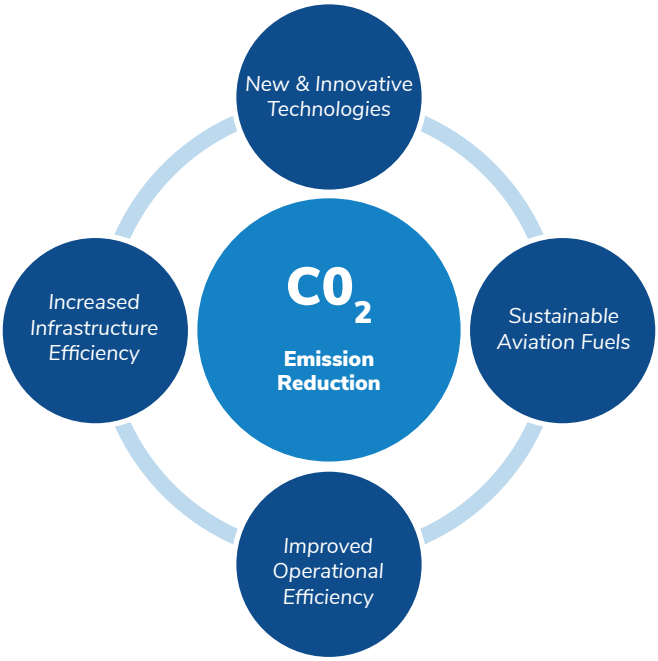
Aviation has been a central focus of the efforts to deal with climate change. Aviation accounts for between 2.5% to 3% of global CO2 emissions. However, it is expected that the contribution of aviation will likely increase in the future with increased demand for air travel. The impact of the COVID-19 pandemic has resulted in a significant yet temporary reduction of the aviation industry's impact on climate change, with drastically reduced flights due to global travel restrictions. The Global Carbon Project estimated a reduction of up to 60% based on the peak of the pandemic in 2020. However, as the industry recovers, the same pressures on the aviation industry to address climate change will return.

Sustainable aviation, in its general form, is an ecosystem that allows an efficient and environmentally friendly operating environment based on innovative new technologies. Specifically, the ecosystem needs to have three important elements—environment, economy and social—at its core. These elements must be based on a concrete foundation comprised of innovative new technologies, regulatory implications and multi-stakeholder cooperation. Airports are an integral part of this ecosystem.



Source: Frost & Sullivan

The end goal of reduced emissions will be based on the capabilities and cooperation of the stakeholders in the industry. Specifically, the reduction in CO2 emissions will be made possible at the operational level and will be dependent on the four core elements of innovative technologies, sustainable aviation fuels (SAF), improved operational efficiencies and improved infrastructure efficiencies. This involves a coordinated approach between manufacturers, solution providers, operators, users and relevant authorities to assure successful implementation of the next generation of operation.



Source: Frost & Sullivan

Current Examples of Sustainability Efforts

Different aviation industry stakeholders have undertaken significant initiatives to minimize their carbon footprint. Airlines are working on initiatives to optimize their operations to reduce on-board weight, optimize fuel usage, reduce greenhouse emissions and increase usage of eco-friendly materials in the air and on the ground. Airports are also concentrating their efforts on optimizing energy usage while improving their greenhouse emissions and noise levels.

Positive Impact Ranking

1

Increased Use of Electric Handling Equipment

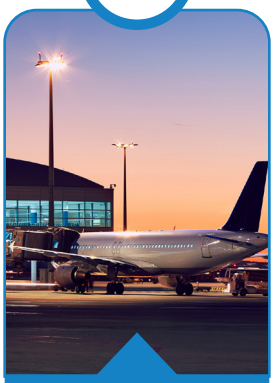
Increased adoption of electric ground equipment to handle aircraft operations, decreasing the effects of carbon emissions

2

Efficient Airside Operations

Improved usage of resource planning tools to optimize the resources required for airside operations

3



Efficient Terminal Operations

New terminal designs as well as improvements to existing infrastructure to reduce energy usage and waste generation

4

Automated Transportation

Automated & electric transporters at landside (car parking) and airside (terminal to aircraft) to reduce emissions and noise

5

Reducing Noise Pollution

Increased limitations on inefficient aircraft with higher fuel burns, emissions and noise levels

For example, in Dubai Airport (DXB), the airport operator monitors thousands of energy-consuming devices to optimize its energy usage and reduce its carbon footprint. The operator achieves optimization in its energy usage and benefits from reduced costs. Many airports around the world such as Chicago O'Hare, Zurich, Stockholm Arlanda and Singapore Changi, amongst many others, are also addressing sustainability through a wide range of initiatives, such as waste and water management, usage of solar, geothermal and wind energy, and usage of green vehicles.

While airports worldwide are working to become cleaner and more sustainable, other initiatives are taking place to help airports and the wider aviation industry in their sustainability efforts.

A key example is the Airport Carbon Accreditation program from Airports Council International (ACI), which has more than 350 accredited airports around the world; nearly 100 of those airports are expected to achieve net-zero carbon emissions by 2030.

Another example is the European Commission's approval of a new initiative—hOListic Green Airport (OLGA)—to help mitigate the environmental impact of the aviation sector. The initiative consists of multiple stakeholders from the aviation ecosystem working on developing innovative, sustainable solutions that will not only reduce airside and landside emissions at airports but will also cover other important environmental considerations such as waste management, air quality and biodiversity. Stakeholders for this initiative are Paris Charles De Gaulle, Milan Malpensa, Zagreb and Cluj airports.

Urban Air Mobility (UAM)

UAM is a fast-developing mode of transport that is expected to be an integral and important part of the future transport ecosystem, including intra and intercity travel. Consequently, the integration of the UAM segment to existing airport operations will also be critical.

A comprehensive study carried out by Frost & Sullivan in 2021 revealed interesting and valuable insights into the future of this segment. This study used customer and consumer surveys in several cities to understand the perceptions of industry stakeholders (B2B) and customers (B2C) on the usage of UAM as a mode of transportation for passengers and freight. The study further assessed the perceived UAM operational readiness of more than 100 cities around the world to highlight those most likely to offer UAM capability and provided the global market revenue forecast until 2040. In addition to the customer and consumer surveys, the study covered 60 parameters assessing a city's transportation and mobility profile, UAS and aerospace expertise, and level of digitization to measure that city's readiness for air taxis. The highlights of this study include:

Location – The top 10 cities that are most likely to offer UAM services

- Dubai, London, Los Angeles, San Francisco, Sao Paolo, Singapore, Paris, Rio De Janeiro, Vancouver and Dallas

Perception – Consumer's willingness to use UAM services

- A majority of respondents (53%) would prefer to have a human pilot operating the air taxi.
- Over 60% of respondents declared that travel time is the main determining factor when choosing what mode of transport they use to travel to work.
- The main reason for the unwillingness to use air taxis is the perception that trips would be too expensive. This was followed by the next most popular concern of aircraft safety.
- Across the 12 cities surveyed, potential customers would be willing to pay between:
    - $17 and $50 for shared air taxi trips (carpool-style approach)
    - $50 and $110 for personal air taxi trips (Uber-style approach)

Willingness – The openness of consumers to using UAM services

- Nearly half of all consumer/customer survey respondents declared that they would definitely or probably use air taxis as a transportation option in the future. In addition, the age group over 50 was the least likely to use, meaning that the overall percentage of potential customers willing to fly in air taxis should steadily increase with time.
- From a stakeholder perspective, the most impactful technology affecting the progress of developing and implementing air taxi platforms is battery energy density limitations.
- A majority of stakeholders were positive about the potential for air taxis in the future, but most conceded that they believed the market for delivering cargo with unmanned (and eventually, autonomous) aircraft platforms would materialize before the market for moving passengers.

Solution – What is required to serve the future UAM market?

- In addition to freight-only UAM equipment, a mixed fleet of air taxis, with two-passenger and four-passenger options, would fulfil most of the demand.
- A majority of respondents would prefer a network of small vertiports placed throughout a city instead of having one large centrally located vertiport.

Overall, the serviceable addressable market (SAM) across intercity and intracity journey types is estimated to generate US$ 2.7 trillion in OEM and operations services revenues by 2040. Furthermore, again by 2040, cumulative consumer demand will translate into an estimated need for 2.5 million air taxi platform units across the various vehicle capacity types (one, two and four passengers). While London has topped the ranking of cities assessed to be the most attractive to host UAM operations, Dubai is expected to become the first city globally to host commercial UAM operations by 2025.

With the growing importance of UAM services within the transport infrastructure of cities globally, integrating this segment with the airport is critical. This must be part of any airport's master plan, especially regarding future operational and infrastructure planning. At a high level, these can be divided into two main areas:

Airspace Integration & Coordination

- Whether manned or autonomous, enhanced and collaborative initiatives need to be implemented to ensure the safe and efficient integration of UAM services with the airspace of the airport, keeping in mind the air navigation and communication requirements that will need to be met. Furthermore, UAM operations will need to be independent and not affect the existing runway and flight operations of aircraft and helicopters using the airport.

Airport Infrastructure

- UAM operational areas within the airport parameters, whether airside or landside, will need to ensure sufficient provision for charging and maintenance facilities, including positioning these areas close to relevant airport passenger and cargo facilities. Similar to airline or freight aircraft operations, supporting logistical infrastructure will need to be planned regarding the movement of passengers and freight to and from the UAM operational site.

There is substantial and growing activity to develop and establish UAM services through multi-stakeholder collaboration initiatives. While OEMs such as Boeing and Embraer or existing transport solution providers such as UBER are investing in developing solutions within the UAM ecosystem, airports have also been active in UAM service delivery through their facilities.

For example, Fraport AG, a leading airport management company, and Volocopter GmbH, an aircraft manufacturer specializing in the design of electric multi-rotor helicopters in the form of air taxis, aim to develop airport infrastructure and passenger processes for air taxi services. This will allow Fraport's flagship airport of Frankfurt Main to connect with the urban transport infrastructure of the Frankfurt/Rhine-Main region.

Another example of an airport making strides to offer UAM services is the French airport operator ADP Airports, which has partnered with Skyports to build Europe's first test vertiport in France to launch commercial UAM services in time for the Paris Olympics in 2024.

CONCLUSION

The COVID-19 pandemic dealt a crippling blow to the wider aviation and travel community, and airports were one of the worst impacted stakeholders. However, recovery is underway and expected to continue. Equally as important, airports are an integral part of the wider aviation ecosystem and a key stakeholder.

Digitalization is a key area of investment and development for airports as the world moves from pandemic to endemic but also as a core part of their future operations. While increased usage of digital technologies is helping airports recover their traffic levels, they are also a prerequisite for future operations and growth.

With climate change, sustainability is a real, clear and present challenge for all stakeholders of the aviation ecosystem, including airports. Sustainability will be a core area for airports regarding future operations and growth plans, along with optimizing current operations and processes to reduce the airport's carbon footprint.

UAM is expected to be an increasingly important part of the local urban transport ecosystem, directly impacting airports in the coming years. While numerous airports and industry partners have already begun addressing future commercial UAM services and what they mean for airport operations, the planning and integration of UAM services with an airport's existing operations and future growth plans will be important to help airports offer the best services for their catchment areas.

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