

A Strategic Outlook on Future-Ready Aviation and the Need for Industry Change

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Despite these substantial investments, airports continue to face mounting challenges. Space constraints, evolving sustainability goals, and complex regulatory requirements threaten the efficiency and scalability of aviation infrastructure. According to the International Air Transport Association (IATA), global air travel is projected to double by 2040, necessitating significant infrastructure expansion and operational advancements (IATA, 2023).

As the aviation industry undergoes rapid transformation, airport operators must not only address immediate capacity demands but also anticipate future trends and complexities. The sector's ability to adapt quickly to emerging technologies, evolving sustainability mandates, and shifting passenger expectations will be crucial in determining its resilience and success in an increasingly competitive global landscape.

Christopher Shugg, Executive Director, Aviation and Aerospace (Acting) at Surbana Jurong (SJ), provides invaluable insights about how industry leaders can navigate these challenges and embrace opportunities to build future-ready airports. His perspectives highlight the broader trends shaping the aviation industry, providing context on how airports can remain agile, resilient, and efficient.

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Emerging trends shaping the aviation industry

Globally, airports are contending with a combination of universal challenges and region-specific obstacles that are influencing the future of aviation. The COVID-19 pandemic caused significant disruption in airport development, creating a backlog in projects that many airports are still working to resolve. As aviation rebounds, revenge travel, the surge of trips taken as restrictions lifted, has played a pivotal role in recovery, with international tourism almost back to pre-pandemic levels.

According to the latest World Tourism Barometer by UN Tourism, 1.1 billion tourists travelled internationally in the first nine months of 2024, reaching 98% recovered of pre-pandemic levels. However this rapid resurgence has highlighted the infrastructure limitations, many airports face, exacerbating the need for modernised designed, digital delivery technologies and sustainable practices to accommodate growing passenger numbers and new operational demands (UN Tourism, 2025). There are seven key trends that have emerged and are driving change in the aviation built environment:

1. Digital Delivery in Engineering Design

The adoption of digital delivery in engineering design is transforming how airports are planned, built, and managed, acting as a single source of truth. A survey conducted by SITA in 2024 revealed that 47% of airports cited business intelligence as their top area of technology investment. Technologies such as digital twin modelling, powered by Building Information Modelling (BIM) and 3D ground modelling, have revolutionised asset management by providing accurate and dynamic representations of physical assets. These models enable better planning, monitoring, and decision-making across all stages of a project.

Drone-based data capture and interpretation further enhance efficiency by providing high-resolution imagery and topographical data that can be rapidly analysed for site surveys and progress tracking. At airports like Singapore's Changi and the new Istanbul Airport, digital tools are being used to simulate construction processes, optimising design and construction timelines while improving safety and efficiency.

Organisations such as SMM, a member of the SJ Group, are already utilising IoT to manage systems and facilities effectively. Expanding the application of IoT and AI will further enhance airport maintenance and operations, ensuring that airports are equipped to meet the challenges of the future with resilience and innovation.



2. Machine Learning and AI

Artificial intelligence (AI) and machine learning are increasingly integral to airport management, contributing to predictive maintenance, operational efficiency, and improved passenger flows. One of the key application of AI in airports is cybersecurity, where 52% of airports are implementing AI-driven solutions – more than any other areas (SITA, 2024).

Changi Airport recently trialled the Automated Prohibited Items Detection System (AIPIDS) to improve security screening. Traditionally, security officers rely on X-ray machines to manually detect prohibited items in tens of thousands of carry-on bags daily, making security screening one of the most labour-intensive airport operations. AIPIDS uses AI and ML-based algorithms to automatically highlight security risks in both 2D and 3D X-ray images, significantly reducing the time required for manual analysis and minimising human error. Early trials of the system in Changi Terminal 3 have demonstrated high detection rates, and as the technology matures, it is expected to increase security clearance speeds by up to 50% while allowing manpower resources to be optimised (Cheung, 2023).

Beyond security, AI is being deployed for predictive maintenance, helping airports reduce equipment downtime and extend asset lifespans. Changi Airport's AI-driven predictive systems anticipates maintenance needs before failure occur, reducing equipment downtime and enhancing safety. Furthermore, AI-driven flight optimisation and scheduling software is enabling airports to maximise runway capacity and reduce delays, contributing to more efficient air traffic management. AI-powered security screening, automated check-ins, and biometric boarding systems are now reducing passenger processing times enhancing both safety and efficiency while improving the overall traveller experience. SJ SMM has been involved in predictive maintenance processes at the Changi Airport and developed technology and systems to support the optimal management of the facilities.

As AI technology continues to evolve, its role in airport operations will expand further, shaping the future of smarter, safer, and more efficient air travel.





3. Sustainability and 'Green' Airport Design

The global aviation industry is increasingly embracing net-zero airports, prioritising sustainability in both design and operations. As of March 2023, 395 airports across 79 countries have achieved accreditation through the Airport Carbon Accreditation program, reflecting a 30% growth in participation. Notably, 89 of these airports have reached advanced levels of carbon management, underscoring the global airport community's commitment to full decarbonisation in alignment with international climate goals (Airports Council International, 2023).

Airports are now integrating renewable energy sources, carbon-neutral materials, and circular waste management systems, setting new standards for eco-friendly infrastructure. According to the SITA 2024 Air Transport IT Insights report, building energy efficiency has become the top priority for 86% of airports, a significant increase from 53% in 2023. Similarly, 77% of airlines now focus on flight optimisation software, reflecting a 16 percentage point rise.

Examples include Oslo Airport's green terminal, which utilises timber construction and efficient systems to achieve an 85% reduction in emissions. At Changi Airport, super low-energy buildings significantly reduce energy consumption, while Amsterdam's Schiphol Airport is focusing on circular economy principles, aiming to use 100% recyclable building materials by 2050.

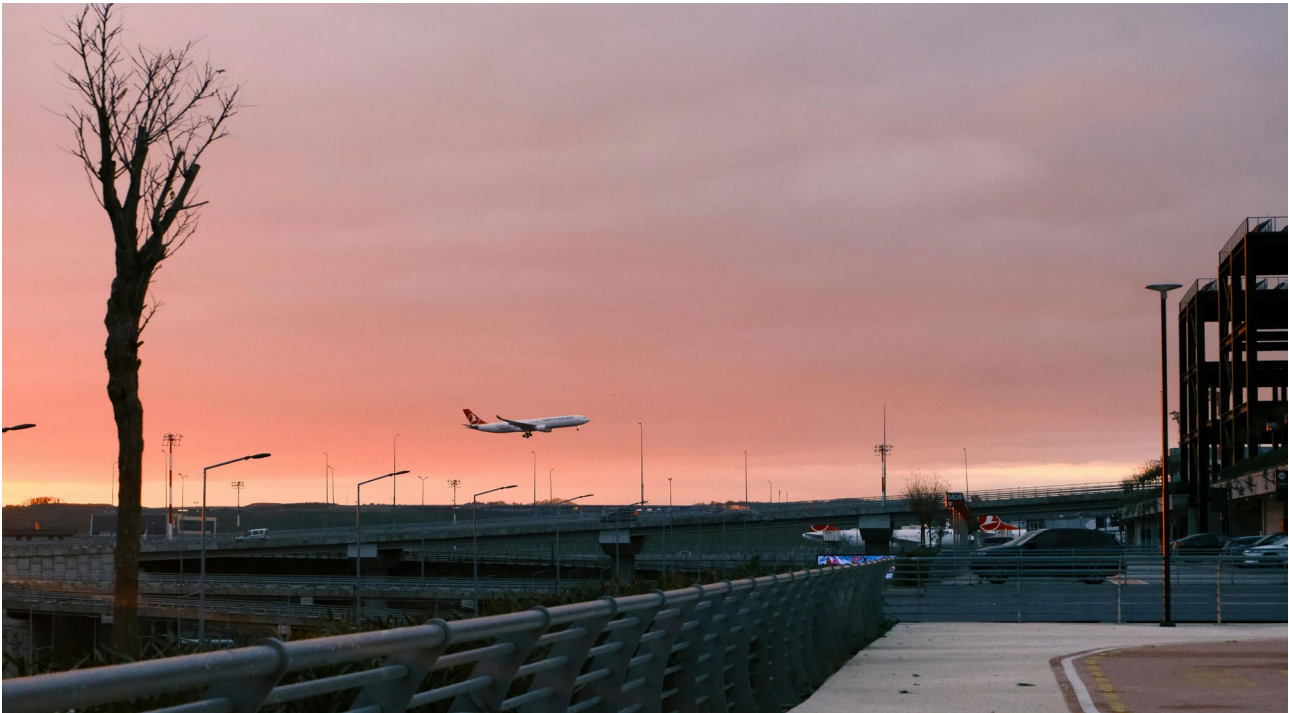
Ground transportation systems are also evolving, with airports adopting zero-emission electric and hydrogen-powered vehicles, contributing to lower carbon footprints. Beyond transportation, airports in the United States, such as San Diego International are implementing advanced stormwater management systems to mitigate environmental impacts and preserve local ecosystems.

4. Airports as Community Spaces

The 2020 COVID-19 pandemic served as a wake-up call to rethink the traditional airport model, which prioritised airside retail, duty-free shopping, and minimal landside facilities, catering mainly to captive travellers. Today, airports are transforming into vibrant community spaces that enhance the passenger experience and foster public engagement. Facilities like Jewel at Changi Airport showcase how biophilic design principles, wellness-focused spaces, and green infrastructure can create more inviting environments. By incorporating natural elements such as greenery, open sunlight, and relaxation areas, airports are not only improving comfort for travellers but also attracting local residents to enjoy their amenities.

Beyond improving passenger experiences, airports are evolving into destinations themselves, offering shopping malls, entertainment venues, cultural exhibits, and recreational spaces. This shift is redefining airports as economic and social hubs, where smart city principles, digital services, and energy-efficient infrastructure support sustainable urban development. These innovations position airports as more than just transit points—they become multi-use environments that drive community interaction, long-term economic growth, and a stronger connection between cities and their aviation infrastructure.





5. Integrated Multi-Modal Transportation

Airports are increasingly becoming integrated transport hubs, connecting seamlessly with regional and urban transportation networks. Los Angeles International Airport (LAX) is introducing an Automated People Mover (APM) to enhance connections with local transit systems, easing road congestion and reducing emissions.

A key example of large-scale intermodal integration is the 2028 Los Angeles Olympics, which is driving a coordinated transport strategy across rail, metro, roads, and airports to ensure seamless movement of athletes, spectators and airport passengers. The LAX/Metro Transit Center Station, opening in 2025, marks a major milestone as it will provide direct rail access to the airport for the first time. Additionally, the LAX People Mover, set to launch in 2026, will further enhance connectivity between the transit centre and airport terminals. These projects are part of LA Metro's "Twenty-Eight by '28" initiative, which includes key rail extensions, pedestrian-friendly infrastructure, and improved public transit systems to reduce the city's reliance on cars and prepare for the Olympic Games (Reinisch, 2025).

By investing in multimodal solutions that seamlessly integrate airports with urban centres, Los Angeles is demonstrating how large-scale events can accelerate meaningful transport infrastructure improvements that extend well beyond the immediate needs of the Games.

The exploration of eVTOL air taxis is another transformative innovation reshaping airport intermodality. According to McKinsey's experts, industry projections suggest that eVTOL services will become a \$7 billion industry by 2035 (Heineke et al, 2021). These developments reinforce the role of airports as key nodes in sustainable, multimodal transport networks.

6. Seamless Baggage Handling Systems

Despite the growth in the number of passengers, baggage mishandling is improving—recent research from IT firm SITA shows that in 2023, the number of mishandled bags dropped from 7.6 to 6.9 per thousand passengers (SITA, 2024). This progress is driven by technology, including intelligent baggage tracking, autonomous robotics, and AI-driven analytics.

At Hong Kong International Airport, an automated, driverless baggage handling system has helped reduced waiting times and improved luggage tracking by processing over 15,000 bags per hour. In addition, the integration of radio frequency identification (RFID) technology allows passengers and airport staff to monitor the baggage in real time, minimising the the risk of lost baggage, providing accurate location updates from check in to arrival, and offering customer peace of mind. Given the example of Delta Airline, by incorporating over 600 RFID readers across 64 airports, they were able to substantially increased the baggage handling performance. (Allan, 2024).

In addition, automated bag drop systems have become a common solution for baggage handling, allowing passengers to check in their bags independently—significantly reducing wait times, minimising human errors, and cutting costs. According to a public survey by Statista in 2016, the self-bag drop services is expected to increase terminal capacity by 60 percent and reducing operational cost by 40% (Statista Research Department, 2016). Together, these innovations provide passengers a seamless experience from check in to arrival.





7. Modular and Flexible Airport Design with VDC and CMES

Airports are increasingly adopting modular and flexible design principles to accommodate evolving travel demands while optimising construction efficiency and cost-effectiveness. Advanced modular construction techniques, such as Construction Methodology and Erection Sequencing (CMES), enable the prefabrication of terminal sections and infrastructure, minimising disruptions to ongoing operations while allowing for rapid expansion to meet future passenger growth. Additionally, Virtual Design and Construction (VDC) methodologies have played a pivotal role in modern airport development, integrating Building Information Modelling (BIM), 3D simulations, and real-time collaborative workflows. This digital framework enhances project coordination and minimises design conflicts, ensuring smoother execution. For instance, at Istanbul New Airport, the integration of BIM facilitated an end-to-end digital workflow, enhancing project coordination, reducing delays, and enabling the efficient assembly of pre-manufactured components (Koseoglu et al., 2019).

Adaptive terminal layouts are increasingly recognised as essential to future-proofing airport infrastructure. Changi Airport Terminal 5 is being reconceptualised as a series of smaller “neighbourhoods” that can function independently, allowing for operational flexibility in response to fluctuating passenger demand or potential public health crises. This modular approach ensures that certain sections of the terminal can be isolated if needed, such as for health screenings or quarantine in the event of another pandemic, without affecting the entire facility (Catherine, C.A., 2022).

Balancing global insights with local execution

Global trends are setting the stage for innovation, regional contexts often dictate execution strategies. Airports in politically unstable regions, for example, may face investment hurdles that are less prevalent in more stable markets. Local regulations, funding constraints, and geopolitical factors can significantly impact the feasibility and pace of infrastructure projects. In such environments, a tailored approach that aligns global best practices with local realities becomes critical to success.

Similarly, space constraints in urban airports require creative design solutions and longer-term planning. The ongoing expansion challenges at Heathrow Airport exemplify how regulatory, environmental, and community considerations can complicate infrastructure projects. The use of modular construction techniques and adaptive design principles can help airports maximise available space and enhance operational flexibility.

Moreover, climate resilience is becoming a crucial consideration. Rising sea levels, extreme weather events, and evolving regulatory environments necessitate airports to build adaptable and robust infrastructures. The implementation of advanced stormwater management systems, green roofing technologies, and flood-resistant infrastructure is not just a proactive measure but a necessity. Airports like Kansai International in Japan, which built flood defences after Typhoon Jebi, demonstrate the importance of integrating climate resilience into airport design.

To support sustainable ground transportation, airports are increasingly investing in electric vehicle (EV) infrastructure, promoting public transit connectivity, and implementing bike-friendly amenities. Airports in Scandinavia, for instance, are leading the charge with initiatives to enhance public transport links, reduce single-car journeys, and promote sustainable travel choices among passengers and staff.

SJ Group's expertise in driving the future of global airports

While broader industry trends shape the future of aviation, SJ Group's tailored solutions often provide the competitive edge. At SJ, the approach involves combining global expertise with local insights to deliver practical, innovative solutions. Having completed projects in over 40 countries, including iconic developments at Changi and King Abdulaziz International Airport, SJ has demonstrated a consistent ability to adapt and thrive in diverse market conditions.

By offering integrated end-to-end solutions—from master planning to facilities management—SJ helps airports enhance efficiency, build sustainability into their operations, and improve passenger experiences. Each project is approached with a bespoke strategy that considers regional needs while leveraging lessons learned from SJ's global portfolio.

A Vision for the Future of Aviation

Looking ahead, future is envisioned where airports are not only hubs of transportation but also pillars of community engagement and sustainability. Projects like Changi Airport Terminal 5 and the King Abdulaziz International Airport development are not just construction achievements; they represent a broader shift towards innovation, resilience, and excellence in the aviation industry.

The next decade will likely see airports embrace smart technologies, modular construction, and green initiatives more deeply. As the industry grapples with evolving demands, leaders like SJ will play a critical role in setting new benchmarks and demonstrating how thoughtful design, advanced technology, and strategic foresight can transform the passenger journey and the broader aviation ecosystem.

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Real impact,
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