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Aviation transport infrastructure

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Engineers Australia
11 National Circuit, Barton ACT 2600
Tel: 02 6270 6555
Email: policy@engineersaustralia.org.au

www.engineersaustralia.org.au

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1. Purpose

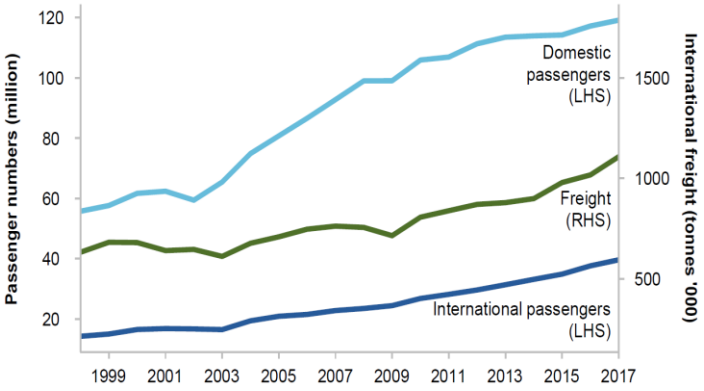
This document has been produced by the Transport Australia society (TAs) of Engineers Australia with an aim to improve aviation in Australia. It does not represent a formal position statement of Engineers Australia but is intended to inform discussions contributing to Australia's aviation economy, which is essential for communities, industries, businesses, and tourism. The focus of the paper is on the airport, from the air to the land side, including transport infrastructure planning and engineering, today and in the future.

2. Background and context

Aviation is critical to Australia's prosperity due to our relative geographic isolation requiring long distance coverage both nationally and internationally. Aviation is essential to passenger travel and freight, and connects and providing services for Australian communities. It is essential for the international tourism, business, and education markets, enabling overseas travel for Australians and international visitors. The resources sector and other critical industries, such as trade-exposed high value, security sensitive and time critical freight, also see air transport as essential to their business. Australia's aviation industry contributes $18.42 billion to the Australian economy in 2018 with an estimated annual revenue being $45.98 billion. The industry employs more than 93,000 people[1], despite being under intense pressure from many economic, social, technological and environmental factors. The Australian aviation industry served over 3.5 billion passengers and carried more than 50 million tons of cargo prior to COVID-19 in 2017, as shown in Figure 1.

The impact of COVID-19 has been severe on the whole of the aviation industry, with demand dropping dramatically to unsustainable level.[2] Many airlines have been forced to consider structural and business model transformation to encourage long-term profitability and limit associated risks. The repercussions of COVID-19 and associated restrictions have been industry wide, including airports and associated aviation service providers. Airport investment and profitability models have been severely disrupted, particularly since businesses have been relying on long term, continual growth in demand. Market confidence in aviation investment and risk appetite will be diminished as a consequence. Therefore, it is expected that different business approaches must emerge.

Figure 1: Passenger and international freight movements by aircraft in Australia [3]



2.1 Stakeholders and Responsibilities

The nature of the airport sector requires synergistic stakeholder collaboration, as illustrated in Figure 2 below. key stakeholders include airport owners, airlines, air traffic management, regulators, services providers and other participants[4]. However, the operations of service industries, engineering, avionics, security, border control, tourism operators, aeromedical services and training providers must be integrated to enable maximum efficiency and

[11] Australian Industry and Skills Committee, Introduction to Aviation. https://nationalindustryinsights.aisc.net.au/industries/transport/aviation
[2] Pearce (2020). COVID-19 Outlook for the airline industry 2020-2021. IATA https://www.iata.org/en/iata-repository/publications/economic-reports/airline-industry-economic-performance-june-2020-presentation/
[3] Productivity Commission (2019). Economic Regulation of Airports. Overview & Recommendations. Canberra: Australian Government.
[4] CASA (2016). Sector Risk Profile for the aerodrome sector. Canberra: Australian Government.

resilience. While there are certainly significant participants in the industry with essential market power, collective and holistic industry effort will be required to maximise productivity. Governments, private businesses, and other interested parties cannot solve these challenges in isolation.

Most of Australia's major airports are owned by the Commonwealth and are operated on long-term lease by private operators under regulated oversight[5]. Most regional airports are owned and operated by Local Governments, after being divested by the Commonwealth from the 1950s through to the 1990s[6]. Some larger airports are privately owned, and a few are leased from Local Governments recently. Figure 3 provides an overview of the size and distributions of the airports across the country.

Figure 2: Main stakeholders in the airport sector[7]

[5] Department of Infrastructure, Transport, Regional Development and Communications (DITRDC), Airports: https://www.infrastructure.gov.au/aviation/airport/index.aspx
[6] House of Representatives Standing Committee on Transport & Regional Services (2004), Final Report of the Regional Aviation and Island Transport Services Inquiry, p. 74.
[7] Adapted from CASA (2016). Sector Risk Profile for the aerodrome sector. Canberra: Australian Government.

Figure 3: Australia's top 40 airports in 2018–19 by passenger throughput[8]

2.2 Government Regulations and Policies

The Commonwealth Government exerts the greatest influence on aviation policy in Australia. The Commonwealth controls market entry by international carriers, airspace, security, navigation, safety, and provides subsidies to regional and smaller airports, and some level of investment in other selected airports. The States, on the other hand, play a minor role in subsidies, investment in airport access and land use planning. Local Governments are almost wholly responsible for local airport funding and managing land use planning around airports. During COVID-19 all sectors in aviation industry modified their financial activities including reducing fees and providing subsidies.

The Australian air transport sector operates within a complex regulatory environment that reflect the evolving nature of the sector and the roles of governments over time. The main aviation regulator is the Department of Infrastructure, Transport, Regional Development and Communications (DITRDC), which advises the Government on the policy and regulatory frameworks for Australian airports and the aviation industry. DITRDC manages the administration of the Government's interests in the 22 Federally leased airports, including land use planning and airport safeguarding, and has also overseen the construction of Western Sydney Airport.

DITRDC is also responsible for oversight of the aviation industry's airspace management organisation, Airservices Australia, and the national civil aviation safety regulator, the Civil Aviation Safety Authority (CASA). Airservices Australia is responsible for air traffic control, flightpath and noise management, as well as the provision of airport firefighting services at Australia's busiest airports. CASA is responsible for regulating and overseeing safety for the aviation industry in general. Until 2017, transport security was regulated and managed by DITRDC, but was moved to the new Department of Home Affairs (DHA) and renamed as the Aviation and Maritime Security Division (AMS). AMS is the aviation security regulator, setting standards, specifications, and procedures for security screening at all Australian airports. DHA is also responsible for border control at international airports through the Australian Border Force, which manages the immigration and customs function. The Australian Quarantine and Inspection Service is responsible for enforcing Australian quarantine and biosecurity laws, as part of the Department of Agriculture, Water and Environment.

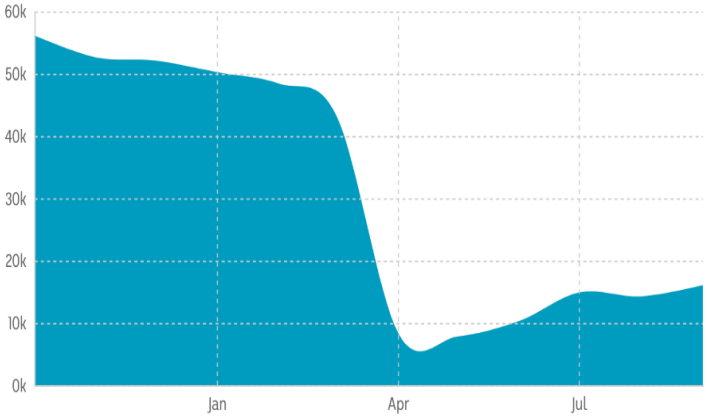
2.3 Engineering and Planning

The success of any airport relies on whole of life holistic management and consideration of all components, from conception, design, construction, installation, operations, and maintenance, to decommissioning. Whilst it is difficult to predict the short-term recovery in domestic air passenger travel in post-pandemic Australia, there are signs of recovery as shown in Figure 4 below. Airport operators must be ready for significant growth in demand at some point in the future, which may outstrip capacity. Major city airports are becoming Airport Cities - hubs of society and commerce, incorporating airport, hotels, entertainment, residential and retail facilities. Therefore, robust planning, forecasting, and engineering designs are an imperative. Accurate descriptions of future scenarios are required for

[8] Australian Infrastructure Statistics Yearbook, Bureau of Infrastructure, Transport and Regional Economics (BITRE), 2019.
Note that there are approximately 180 public airports in Australia.

planning of airport capacity, facilities and services. This requires sound data for airlines and airports, robust passenger and freight scenario modelling, clear expectations of outcomes, and defined future deliverables. Engineering, planning, and analytical skills, together with robust systems and processes are required to plan for the future and for all stages of engineering activity.

Figure 4: Domestic flights in Australia in 2020[9]



City airports require close integration with surrounding land use, access, and services. Government strategic, economic, land use and transport planning, must relate to the future planning of airports. In response to Commonwealth Government oversight, large airports prepare sophisticated and detailed master plans that are regularly updated. State Governments have long-term land use and ground transport plans, which describe the activities surrounding airports, and access for freight and passengers on roads and public transport. It is therefore essential that the plans, infrastructure investment and development are complementary and integrated in time and function.

Local Governments are responsible for the day-to-day operation of most regional airports, for which the main funding sources are via council rates, airlines and local businesses. Only few regional airports are commercially viable and meet both the operating and capital costs, with some only able to meet their operating costs[10]. However, many are financially unviable but provide service and an intangible economic value to the community. Since many councils struggle to finance ongoing maintenance, regional airports seek efficient and effective ways to manage infrastructure with limited resources. Traditional asset management has changed from a maintenance management focus to one of long-term planning, renewal and holistic lifecycle management. State and Commonwealth Governments also contribute to the infrastructure, security facilities or subsidies for services where regional local governments do not have the financial capacity to sustain unprofitable airports indefinitely. In addition to these challenges, smaller regional airports struggle to attract skilled workers and a consistent pattern of quality services. This issue can be managed through national standards and guidelines for planning, asset management, engineering, and financial management.

2.4 The Future

Society, business, technology, and the environment are changing rapidly. Some innovations are so different, significant, and unpredictable, that they disrupt the present equilibrium and challenge current management and engineering approaches. In aviation, aircraft design and operation, safety, security, business, and environmental practices must continually adapt and evolve. Global geopolitics and economics influence change in Australia's passenger markets and services, with the expansion of the operations to places like India, South Pacific, South East Asia, and perhaps other areas like South America. Due to the scale and complexity of aviation, many changes will be relatively gradual and staged, compared to other more flexible sectors.

Australia is also subject to international aviation regimes governing environmental, marketing and technology standards, in which Australia has little capacity to influence global changes. Over time, new technologies like electric aircraft may significantly impact traffic, operations and infrastructure. Other technologies may also affect the way freight is transported, where services are located, how safety and security is ensured, how skills are provided and how consumers behave[11]. Reponses to inevitable change must be being agile and proactive. Awareness and international engagement and benchmarking will be essential to ensuring our national and industry interests are maintained. Broad

[9] https://www.abc.net.au/news/2020-11-29/border-restrictions-smashed-interstate-travel-during-coronavirus/12927456, based on data from Bureau of Infrastructure, Transport and Regional Economics (BITRE).
[10] Department of Transport (WA) (2020). *Draft WA Aviation Strategy 2020*.
[11] ICAO (2020). Future of Aviation webpage, https://www.icao.int/Meetings/FutureOfAviation/Pages/default.aspx

analysis of information, planning, skills, processes, regulation, and collaboration that benefits Australian aviation as a whole is required[12].

3. Issues, Challenges and Opportunities

3.1 Safeguarding Safety, Urban Planning and Land Use

The Australian Government retains a critical role in airport safeguarding through its ownership of the National Airports Safeguarding Framework (NASF) and the National Airports Safeguarding Guidelines (NASAG), which have been in effect since 2012. These documents provide guidance to airports, state and local government and other stakeholders, to better coordinate land-use, transport, and infrastructure planning around airports. They are particularly important in setting buffer zones to resolve land use disputes. This is common where pressure for higher-density redevelopment exists, and where different modes of transport compete for land use, and other infrastructure around airports, leading to a significant encroachment of airports. Australian Government's *Inquiry into Freight and Supply Chain Priorities* identified the protection of existing airports against restricted use by surrounding land use and the protection of land for future facilities and corridors as a priority area for critical action for governments across Australia.[13] Jurisdictional strategies for protecting freight corridors and strategic facilities from encroachment are inadequate, and need to be strengthened to ensure airport operations are not constrained in the future[14].

While most jurisdictions have referenced the NASF in their strategic planning policy documents, not all jurisdictions have made the required legislative changes to planning laws and planning schemes to embed the NASF. There is a constant tension between state and local government strategic planning policies for major and regional cities, and airports' ability to operate safely and relatively unconstrained. Striking the right balance between the airports' objectives and those of surrounding areas, directly affects the acceptance of the airport's operation by the surrounding community and within its broader urban context.

3.2 Asset and Infrastructure Management

Asset and infrastructure management is commonly used by organizations around the world to coordinate the safe, secure, and environmentally sound lifecycle management of assets in a cost-effective manner.[15] Airport infrastructure asset management has been evolving steadily in the last couple of decades. A move to private ownership and the regulatory monitoring of price and service levels has resulted in a focus shift to the optimization of airport physical assets management across Australia. This recognises the need to move the infrastructure investment from construction to a focus on renewal and rehabilitation, coupled with a need to operate more cost-effectively, and to consider long-term financial sustainability and intergenerational equity in investment decisions.[16]

Effective airport asset and infrastructure management requires a coordinated approach, efficient systems and processes, robust planning and a skilled workforce capability pipeline. The WA government, for example, has developed an airport asset and financial management framework, which provides some guidance to airports operating within its jurisdiction. Individual airports develop and implement their own asset management strategies, systems and procedures to minimise the operational cost and enhance the product life given their resources, scope, size, location and ever-evolving traffic demand and technology changes. Some airports, for example, have invested in key asset management tools, such as maintenance and pavement management systems and Enterprise Resource Planning (ERP) software. Others, mostly small regional airports, would be struggling to achieve effective asset management objectives because of limited resources available from regional councils and governments. Consequently, there is some inconsistency, disintegration and uncoordinated approaches to airport asset management, and little or no consistently. Agreed best practices can be developed and promoted to enhance the overall performance.

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[12] DITRDC (2020). Future of Australia's Aviation Sector: Issues Paper, https://www.infrastructure.gov.au/aviation/future/files/future-of-australias-aviation-sector_issues-paper-2020.pdf
[13] DITRDC (2018). Inquiry into Freight and Supply Chain Priorities, Canberra, p. 12.
[14] Ibid. 26.
[15] Transportation Research Board (TRB) (2012) Airport Cooperative Research Program (ACRP) report 69, Asset and Infrastructure Management for Airports- Primer and Guidebook, p. 7, Washington, D.C. USA.
[16] Ibid, p. 7

The next step is to properly connect data to the overall strategic vision of an airport, and to plan the right asset and investments to achieve this. A holistic and integrated Airport Asset Management Plan (AAMP) is required to drive innovation and technological developments, and stimulate social and economic activity in airports, transforming them into local community activity hubs. AAMPs can maximise the effectiveness of limited resources for the airport's investment, operation and management. AAMPs require integrated, timely and relevant asset data to enable informed and proactive decisions to meet service level standards in the face of growing traffic demand. This approach requires the integration of processes across airport departments to align decision making towards the achievement of the airport strategic objectives and key performance targets. Adoption and integration of digital technologies with new intelligent services, software into daily airports operations can significantly increase their efficiency and improve asset management capabilities and performance analysis.

3.3 Regional Airports

Commercial aviation that can sustain viable passenger and freight services is rare but vital for small regional communities. These services account for 45% of Australian tourism carrying 15 million passengers on more than 360,000 flights per annum.[17] Regional aviation is often low demand and operates in isolated areas where revenue, costs of products, services and staff availability are challenging. The greater the distance that regional Australia is from major centres, the greater its reliance on air transport. The different, and sometimes competing, nature of tourism, community access, natural disasters, resources industry and government services results in conflicting requirements that may be difficult to service or resolve. The number of regional routes, airports, and airlines for regular passenger transportation (RPT) has been declining for many years due to these commercial and demand limitations.

Serving regional and remote communities is difficult due to distance, low passenger demand and high operating costs. However, these factors must be weighed against the public good of providing access to high level education, medical and commercial services. State Governments are responsible for regulating air services on low volume RPT routes or subsidising under contract as part of a community service obligation (CSO) network where there is likely to be limited or no competition. The Commonwealth Government subsidises a minimum weekly service for passengers, mail, and freight in 266 locations in remote Australia through its Remote Air Services Subsidy Scheme[18].

Regional airport facilities provide essential services for aeromedical evacuations, fire and other emergency services and other local requirements, including over 6000 emergency evacuations each year.[19] While public transport is heavily subsidised in cities, the level of State and Commonwealth Government financial support for regional aviation is slight. Some regional airports and services are commercially viable and may sustain competition, but others may require government funding and protection via regulation or subsidy. Policies should encourage and facilitate private investments as well as supporting future technologies in automation, counterterrorism, environmental and public health emergencies.

3.4 Development and Technology

In the past century, airports have transformed from being a place for embarking and disembarking passengers to an advanced business precinct, embracing an extensive array of business activities, and catalysing local economic growth and prosperity. Cutting-edge technology, such as autonomous devices and ultralight materials, create opportunities to transform the mobility system by enabling new business models and mobility services. Innovations are continually emerging in aviation, including unmanned aircraft, artificial intelligence, biometrics, robotics, blockchain, navigation, alternative fuels, and electric aircraft.[20] Unmanned aerial vehicles (UAV) and electric vertical take-off and landing (eVTOL)[21] will enhance and revolutionise aviation and many other industries as a result. The Internet of Things (IoT), Artificial Intelligence (AI), machine learning and data analytics are expected to revolutionise airport operations. and introduce improved processes, better tracking and handling of everything from aircraft to baggage. These are expected to improve the passenger experience, lower operating costs, improve security and expand services.

Essential to this digital transformation will be high performing, secure and very reliable wireless communications. Current public Wi-Fi networks and mobile phone networks will need upgrading. Private wireless solutions can help an airport ensure safe, on-time and fully connected journeys. A 5G-ready, operational network would deliver the reliability, predictability and low latency needed for critical operational services and applications.

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[17] Australian Airports Association (AAA) fact sheet (2018). *Protect Regional Airports.*
[18] Department of Infrastructure,Transport, Regional Development and Communications. 'Remote Air Services Subsidy Scheme. https://www.infrastructure.gov.au/aviation/regional/rass.aspx
[19] AAA (2018), *Op Cit.*
[20] ICAO (2020) The Future of Aviation, https://www.icao.int/Meetings/FutureOfAviation/Pages/default.aspx
[21] **DITRDC** (2020). Emerging aviation technologies: national aviation policy issues paper. Canberra: Australian Government.

There is an urgent need for both regulatory bodies and industry to develop and implement new and emerging technologies and evaluate their impact on aviation. New infrastructure, equipment and staff capability will be required for automated vehicles in car parks, new aircraft models, and automated, touchless passenger services. A policy framework is necessary to facilitate and support airports of various sizes and of different operational scope to accelerate the deployment of emerging technologies. Industry needs to make an objective assessment on the level of technology implementation that aligns with strategic vision and operational scale. Proactive and innovative strategic and action plans must take advantage of technology to enhance operational efficiency and transform travellers' experiences.

3.5 Environment and Sustainability

Sustainability is a broad concept which embraces environment, social and economic aspects of business operations and human activity. Even though aviation is an enabler of international mobility and is recognized as essential to achieving the UN Sustainable Development Goals[22], the industry alone is responsible for 2 percent of the world's total carbon emissions globally and 3 percent of the carbon emissions in Australia before the pandemic.

Some of the main environmental and sustainable development issues for aviation include but are not limited to emissions, noise, land use in and around airports and energy consumption. Given that airports are complex infrastructure assets, the implementation of any new emission reduction initiatives typically require endorsement from multiple stakeholders. Airports will face different challenges in implementation according to operational size and scope. This may include lack of information or awareness of clean energy opportunities, lack of human and financial resources, or lack of strategic vision and/or leadership. Airport authorities must find a balanced approach for maximizing the capacity of airports and capitalise on the possibilities and potentials for future growth whilst simultaneously minimising the accompanying negative impacts.[23]

While a policy and regulatory framework is needed to ensure safe and efficient operation of air transport, environmentally friendly materials, and cutting-edge technology are essential to embedding sustainability and resilience in the aviation sector now and in the future. The development of new polymers, composites, and stronger but lighter memory metals will lead to continued reductions in aircraft weight and fuel burn. Biofuels are strongly advocated for aircraft. On the ground, aircraft turnarounds and passenger terminals require significant quantities of electrical energy, gas, and potable and non-potable water as well as high quality waste disposal systems.

Telecommunications, security, lighting, heating, cooling, servicing, and ventilating large passenger terminals are energy intensive. Therefore, airports are developing new systems that can produce reliable and affordable sustainable energy and lower energy costs. Increasing the use of energy from renewable sources is one way in which airport operators are improving their environmental performance. Biomass boilers can increase the amount of natural light and ventilation, solar farms and battery storage should be encouraged to generate and store electrical energy along with boreholes to exploit sources of geothermal energy where feasible. Initiatives to encourage and facilitate public transport use for airport access are also essential[24].

3.6 Safety

Safety in the aviation industry is paramount to business sustainability. Commercial aviation is regarded as an ultra-safe transportation system,[25] with less than one accident per million departures,[26] but safety remains a high priority, particularly in the general aviation sector. There have been an average of 1,627 wildlife strikes per annum in Australia and the number has been increasing.[27] Bird strikes are likely to happen during take-off and landing, particularly at Brisbane, Sydney and Darwin airports, while impacts with non-flying animals when the aircraft is rolling for take-off or landing are more common in Adelaide, Melbourne, Brisbane and Perth.[28] A permanent solution, mostly related to the management of the local ecosystem, requires an integrated and multidisciplinary approach including airport operators, airlines, local governments, and universities.

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[22] ICAO (2020) The Future of Aviation, https://www.icao.int/Meetings/FutureOfAviation/Pages/default.aspx
[23] Maha Mousavi Sameh and Juliana Scavuzzi, 2016, Environmental sustainability measures for airports. Occasional paper series: sustainable international civil aviation.
[24] Budd L., and Budd T., 2013, Environmental technology and the future of flight. Sustainable Aviation Futures (Transport and Sustainability, Vol. 4), Emerald Group Publishing Limited, pp. 87-107.
[25] Amalberti, R. (2001). The paradoxes of almost totally safe transportation systems. Safety Science, 37(2–3), p. 109–126.
[26] Boeing (2019). Statistical Summary of Commercial Jet Airplane Accidents, Worldwide Operations 1992-2018. Seattle: Boeing. Available at http://www.boeing.com/resources/boeingdotcom/company/about_bca/pdf/statsum.pdf
[27] ATSB (2020) Aviation statistics, web page: https://www.atsb.gov.au/aviation/aviation-statistics/
[28] ATSB (2018) Australian aviation wildlife strike statistics. https://www.atsb.gov.au/publications/2018/ar-2018-035/

Emerging aviation technologies, such as unmanned aerial vehicles (UAVs) and eVTOLs may change the level and severity of these risks. While drones will expand the airport to tackle current problems, such as birds and inspections, they can also endanger flights. If eVTOLs become integral to airports for transporting passengers to and from the city as expected, then new infrastructure and engineering solutions will be required to guarantee safety standards are met and maintained.

3.7 User Experience and Security

The passenger experience includes purchasing tickets, airport arrival drop off and parking, check-in, baggage management, security and border control (in case of international flights) and boarding. These are followed by disembarking, border control, baggage claim and exiting the airport.[29] The process can average between 1.5 and 3 hours. [30] Reducing this time while maintaining the same quality, security and safety standards is a significant challenge, that impacts not only passengers but also airlines. Flight delays resulting from thorough screening requirements for larger numbers of passengers, or if the passenger and baggage screening equipment is insufficient, or even when the level of threat is increased.[30]

Airports will be required to adapt to new pre-boarding health check protocols such as quick COVID-19 tests or temperature checks, which will create new hurdles for swift passenger movement, time and appropriate costs. This will need to be managed through emerging technologies, such as biometric recognition (facial, fingerprint or iris), which have shown promising results in streamlining security and health screening, passenger identification validation, baggage check-in and boarding with minimal physical documentation or human interface required. These results indicate that technology can make the process effective, safer and provide a better passenger experience with minimum disruption[31].

People with disabilities or special needs are the passengers that struggle most in an airport, even in major or central airports that can afford providing special assistance. The struggle is greater in regional and remote airports with less facilities.[32] Australian airports can rethink their business, focusing on new technologies and facilities to improve passengers' experience, to be more inclusive, while maintaining health, safe and security standards.

3.8 Air Cargo

Air freight operations differ significantly from other modes and are approximately 10-15 times more expensive than surface transport options.[33] . It is only on long haul routes, or where time or the product condition is critical, that the speed of delivery achieved by airborne distribution compensates for this extra initial cost.

In Australia, this means that international high value or time sensitive products (20% by value, 0.01% by weight) worth approximately A$50 billion are moved by air per year.[34,35] Pre-COVID, the greatest air cargo sector growth was forecast to be in higher value handling operations (temperature controlled, time sensitive such as high-quality food products) and e-business items (mostly for import to Australia).[36] The importance of cargo to full-service airlines is approximately 12% of airline turnover, which makes cargo a key generator of revenue in the typically cost sensitive, low margin passenger airlines.

Most international freight is carried as belly cargo on passenger flights (approximately 80% into Australia) while approximately 45% of domestic freight is carried in full freighter aircraft. However, during the COVID crisis this reliance on passenger aircraft resulted in significant rises in freight rates and highlighted a structural weakness in the

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[29] Tuchen, S.; Arora, M; Blessing, L. (2020). Airport user experience unpacked: Conceptualizing its potential in the face of COVID-19, Journal of Air Transport Management, 89.
[30] Naji, M., Abdelhalim, S., Al-Ani, A., & Al-Kilidar, H. (2018). Airport security screening process: a review. In CICTP 2017: Transportation Reform and Change—Equity, Inclusiveness, Sharing, and Innovation, pp. 3978-3988. Reston, VA: American Society of Civil Engineers.
[31] Hong, J. W., Oh, J. H., & Lee, H. K. (2019). Smart Airport and Next Generation Security Screening Technology. Electronics and Telecommunications Trends, 34(2), 73-82.
[32] Guerreiro, J., Ahmetovic, D., Sato, D., Kitani, K., & Asakawa, C. (2019). Airport accessibility and navigation assistance for people with visual impairments. In Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems (pp. 1-14).
[33] Morrell, P & Klein, T (2018), Moving Boxes by Air: the economics of international air cargo, ISBN : 9781351719926
[34] Inquiry into the National Freight and Supply Chain Priorities – Supporting Paper No1 – Air Freight, Department of Infrastructure, Regional Development and Cities, 2018
[35] Australian Airports Association Airport Fact Sheet, February 2018
[36] International Air Freight Indicator, Infrastructure Partnerships Australia (2019)

Australian air freight sector and dependencies on passenger aircraft routing, schedule frequency and aircraft type limitations.

In global trade route terms, Australia is relatively remote with little transit traffic and has a relatively small population (and a small market) with the main air cargo export routes being Trans-Tasman and into Southern/Central Asia. The main air freight import airport is Sydney, which also serves as the main airport for international passengers entering Australia, but freight may ultimately transition to Western Sydney Airport after 2026 as it will have no curfew and is well linked to the main east coast road infrastructure.

The linkage to road infrastructure is essential, as air freight offers a conduit into vital world markets for high value products, so the development and manufacture of these items can be emphasised, but only if smooth transit from areas of production and processing can be facilitated. Alongside this, a clearer emphasis on reducing handling time and costs, particularly across the modal transfers, will reduce freight costs and increase the attractiveness of Australian products and freight operations in Australia.

The development of cargo capacity at regional airports is limited by the relative lack of belly-hold capacity in smaller, single aisle aircraft, flight frequency, lower demand from lower population density and the lower operating costs associated with road transport. UAV delivery is being trialled in urban areas but is limited to first and last mile operations where traffic congestion offsets the current limitations of such approaches. Similarly, interstate and long-haul cargo transport are unlikely to be automated in the medium term. This is an emerging area requiring significant work to establish guidelines and regulations.

3.9 Workforce Development and Inclusion

The aviation industry requires a wide array of skills ranging from operational flying, technical support, ICT, security, transport, border control, catering, waste management and ground handling to support services encompassing safety and hazard management. Employees working in the airport environment graduate from different institutions with different competencies and levels of proficiency. With the strong development of airlines in Asia Pacific region, these skilled personnel are in huge demand. Aviation is one of the sectors where technology is accelerating the pace and prospect of jobs being replaced by automation and the skills associated with them becoming obsolete, so employers need to plan for future capability. COVID-19 has forced airlines to reduce staff which has led to a temporary oversupply of qualified personnel and aviation workers to seek opportunities in other industries.[37] Getting skilled workers back in the industry will require a considerable amount of re-training.[38,39]

Currently, there are a suite of educational providers, including nine higher education (HE) institutions (see Table 1)[40], pilot training schools and several vocational organisations, that offer aviation related programs, ranging from certificate qualifications, diplomas, bachelor's degrees and postgraduate research programs. These institutions have played a critically important role in providing pipelines of highly skilled workers to the sector, for jobs as pilots, aircraft maintenance engineers, airline and airport operational specialists, security screeners, ground handling specialists and other personnel. However, it is also acknowledged that some discrepancies exist between the program offerings and industry demand.[41,42] Technology advancement and anticipated changes to the sector due to COVID requires aviation education and training to adapt to industry needs and ensure that graduates are future-ready.

Table 1: Overview of higher education aviation programs in Australia

University	Education level	Program		
		Aviation management	Aerospace engineering	Aviation

[37] https://www.boeing.com/commercial/market/pilot-technician-outlook/
[38] https://www.theguardian.com/business/2020/oct/04/pilot-scheme-planes-may-be-grounded-but-theres-work-on-australias-farms
[39] https://www.abc.net.au/news/2020-10-19/airline-workers-use-other-skills-to-survive-coronavirus/12762014
[40] Please note that the table only lists higher education institutions in Australia which provide aviation-related degree programs. Those training and program providers that offer non-degree programs, such as diploma programs, are not included in this table. For EA accredited aerospace engineering programs HE institutions, please refer to the document here for more detailed information. Aviation programs provided by Australian HE institutions are not accredited by any organisation. https://www.engineersaustralia.org.au/sites/default/files/2020-12/Web%20List%20-%20V41%20-%20201222_0.pdf
[41] Peksatici, O., and Ergun, Hande Sinem., (2019), The gap between academy and industry-A qualitative study in Turkish aviation context, Journal of Air Transport Management, 79 (2019) 101687
[42] Lappas, I., and Kourousis, K., (2016), Anticipating the need for new skills for the future aerospace and aviation professionals, Journal of Aerospace Technology and Management, Vol 8, No 2.

				piloting
Central Queensland University	Undergraduate	Y	--	Y
Edith Cowen University	Undergraduate	--	--	Y
Griffith University	Undergraduate & Postgraduate	Y	--	Y
Monash University	Undergraduate & Postgraduate	--	Y	--
RMIT University	Undergraduate & Postgraduate	Y	Y	Y
Swinburne University	Undergraduate	Y	--	Y
UNSW	Undergraduate & Postgraduate	Y	--	Y
University of Southern Queensland	Undergraduate & Postgraduate	Y	--	Y
University of South Australia	Undergraduate	Y	--	Y

Table 1: Overview of higher education aviation programs in Australia

The long-term skills demand of the aviation industry will be market driven. Cross industry collaboration is needed to inform government and training providers to support emerging capability requirements . A skills analysis and development framework with multi-dimensional initiatives is essential and urgent. These include:

- Identifying the skills and competencies to support transition into new technologies.
- On the job training in technology and management for employees in the similar profile.
- Analysis and development of a detailed skills framework as guidance for education providers.
- Scheduled training with aerospace manufacturing companies for operation and maintenance of future aircraft.
- Providing competency-based training aligned with futuristic automation.
- Universities and TAFEs introducing technical courses with internships provided by airlines.
- Introducing vocational education and training (VET) loans for aviation related training.

Like all industries, aviation would benefit from employing diverse people. In 2017, the International Civil Aviation Organisation (ICAO) established a Gender Equality Programme,[43] with the primary aim of facilitating and coordinating targeted programmes and projects to enable progress towards gender equality by 2030. The Australian aviation industry needs to provide more avenues and awareness when it comes to employment opportunities for women, indigenous and culturally diverse people in aviation, including education programs and scholarships for young people interested in STEM.

The 2018 "Expert Panel Report on Aviation Skills and Training identified a range of opportunities to improve the effectiveness of the aviation training framework, including diversity.[44] Some recommendations have been addressed by government via firm initiatives such as *Women in Aviation/Aerospace Australia* (WA/AA)[45] and steps are being taken to provide greater opportunities for women in the aviation industry. Relevant mobility provisions, structural arrangements, easy access, workplace equality, to name a few, should be incorporated to promote diversity and inclusion.

[43] ICAO, Gender Equality, https://www.icao.int/annual-report-2019/Pages/supporting-strategies-human-resources-management-gender-equality.aspx

[44] https://www.infrastructure.gov.au/aviation/publications/files/Final_Report_of_the_Expert_Panel_on_Aviation_Skills_and_Training.pdf

[45] https://www.infrastructure.gov.au/aviation/wiai/index.asp

4. Recommendations

The following table (Table 2) summarises the proposed recommendations.

Table 2. Summary of proposed recommendations

Alignment with the issues identified and discussed in this DP	Recommendations
Safeguarding safety, urban planning, and land use	• Policies and guidelines need to be in place with State and Local governments to protect strategic facilities from encroachment consistent with the National Airports Safeguarding Framework (NASF) and the National Airports Safeguarding Guidelines (NASAG). • National standards for airport engineering – design, construction and maintenance are required.
Regional aviation	• Government policies should consider improving financial support programs for regional aviation, encouraging, and facilitating private investment into infrastructure and other associated services, supporting future technologies and continuing subsidies and route regulation where required. • A more collaborative approach is needed to encourage data collection and sharing between all stakeholders to support effective policymaking and planning new projects, operations, maintenance, and new infrastructure.
Asset and infrastructure management	• National guidelines for regional airport assets and financial management should be developed and applied. • Empirical evidence is needed for a better understanding of the current asset management practice of Australian airports to better inform policymaking.
Development and technology	• Governments and the aviation industry need to collaborate on the planning and implementing of new and emerging technologies for aviation investment and operation. • Aviation regulators need to develop guidelines, standards and regulations for new aviation technologies including unmanned aerial vehicles (UAV) and electric vertical take-off and landing (eVTOL).
Environment and sustainability	• An integrated and multidisciplinary approach is required to develop a permanent solution to manage the environmental impacts across the whole aviation value chain, which includes airport operators, airlines, local governments, and universities.
Safety	• Infrastructure and new engineering solutions will be required to guarantee the safety standards are maintained.
User experience and security	• Australian airports must rethink their business, focusing on new technologies to improve passenger experience, including for people with disabilities.
Air cargo and freight	• States and Territories need to strengthen strategies for protecting freight corridors. • Airports need to emphasise reduced handling times and costs for freight (particularly across the modal transfers and between services), in conjunction with government and private service providers.
Workforce planning and inclusion, skills development	• Governments, airlines, and airports should develop and implement workforce strategies and plans to ensure skilled staff are available in conjunction with education providers. • All levels of Government and private sector interests should collaborate so that there is more diversity in the aviation workforce. • Aviation and aerospace engineering program providers need to work collaboratively with industry to define the skills set required and to co-design their program delivery to ensure the aviation/aerospace engineering graduates are job and future ready.

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