Development challenges facing general aviation airports: A case study of Archerfield Airport, Queensland, Australia

Abstract

In the last 30 years, many major airports around the world have embraced the concept of an 'airport city' through the development of both aviation and non-aviation related businesses and a localised planning policy response in support of these endeavours. In the Australian neo-liberal planning environment, there has been little federal policy direction and muted investment by the aviation community. This paper examines the case of Archerfield Airport in Brisbane, Australia, and identifies issues that may impede its growth and evolution towards an integrated and sustainable economic hub. These issues include zoning, airspace usage patterns, and the friction between social utility, historical preservation and commercial imperatives. Such issues likely represent endemic challenges nationally, requiring more affirmative planning action by stakeholders seeking to replicate international successes.

Key words: Aviation Policy, Archerfield Airport, General Aviation, Planning

1. Introduction

There are over 2000 airports and airfields in Australia, about 155 of which receive regular public transport (RPT) services (BITRE, 2017). Major capital airports have been leased to private operators under the Airports Act 1996. The vast majority of regional airports are owned and operated by state movements and local councils. Much of the existing research studying Australian airports focuses on the major airports in capital cities (e.g., Jiang and Zhang, 2015) or regional airports receiving RPT services (e.g., Zhang et al., 2017; Zhu et al., 2019). The group of federally leased secondary and metro airports are largely ignored. This group of airports include Archerfield in Queensland, Jandakot in Western Australia, Moorabbin and Essendon in Victoria, Bankstown in New South Wales and a host of others. These airports mainly cater for various general aviation (GA) activities

In the last 30 years, notable major airports around the world have embraced the concept of an 'airport city' through the development of both aviation and non-aviation related businesses (e.g., Appold and Kasarda, 2012; see Zhang and Czerny, 2012, and D'Alfonso and Bracaglia, 2017, for recent literature surveys). However, little research has discussed if this experience is replicable for a city's secondary airport. This paper considers several particular issues confronting Archerfield Airport, one of Australia's key capital city secondary airports privatised in the 1990s. It seeks to build on studies of other Australian ports, including the thriving Essendon precinct (Freestone and Wiesel, 2014) as a contribution to the understanding of how contemporary stakeholders globally might proceed to identify and address local barriers to growth and development for underperforming aviation assets.

Freestone, Williams and Bowden (2006, p.491) have correctly identified that 'in the global "space of flows", airports are critical nodes and have latterly assumed major economic significance extending beyond core aviation functions.' This is certainly the case for major commercial ports handling domestic and international passenger and freight logistics. But it is also reflected in the categorisation of the aged Archerfield airport in Brisbane's west as a key strategic asset for south-east Queensland (BCC, 2011). This major secondary airport is experiencing operating and modernisation challenges not dissimilar to many increasingly urbanised landscapes around the world.

Like many second-tier airports that cater for non-airline-centric GA activity, the story of Archerfield has not specifically been the subject of intense scholarly or political scrutiny since its privatisation. Mills (1995) highlighted in the early days of the privatisation debate that the Australian aviation industry was remarkably self-interested, demanding of taxpayer support, and fractious. That this characterisation still has merit is borne out by a recent federal government report that stated, 'there are currently no robust economic datasets compiled for the GA sector, restricting analysis of the impact of the various cost pressures facing GA or the contribution GA makes to the economy' (BITRE, 2017).

Contemporary economic and geographical theory holds that the airport, as a construct, is a nexus of networks, alliances, markets and infrastructure that supports commercial endeavour (e.g., Walker and Stevens, 2008; Morrison, 2009; Kidokoro, Lin and Zhang, 2016; D'Alfonso, Jiang and Wan, 2017). Yun (2015) holds that the speed to market implied by air transport support is the single most relevant factor in determining the competitiveness of a specific operating location in an increasingly globalised marketplace.

While Walker and Stevens (2008) suggest that there is very little empirical research into this changing role of the modern airport, the presence of the 'airport city' concept in contemporary literature is widespread. Arthur (2018) provides evidence of its global application, exploring the evolution of Ghana's Accra airport. His work notes that, while still emergent in Africa, the paradigm is tending to act as an accelerant for economic growth. Taiwan has experienced measurable growth attributable to the development of the airport city as a 'planning objective' (Wang, Chou and Yeo, 2011), rather than a simple physical manifestation. Nevertheless, the 'aerotropolis' (Kasarda, 2005) projects a significant geographical presence in an increasingly urbanised environment, and design firms worldwide vie for the opportunity to develop signature projects (Asia Today International, 2012).

Chandu (2017, p.373) suggests that such airport precincts are now ubiquitous, resulting from factors as diverse as privatisation, airline deregulation and 'revenue pressures to make airports economically self-sufficient'. Wang, Chou and Yeo (2013) have contributed a set of criteria for evaluating the service quality of individual locales, allowing a graduated scaling for the success and sustainability of different facilities across the globe.

Interestingly Kimelberg and Nicoll (2012) have found that the specific appeal of airports for firms is not clearly understood. They reason that there are prestige metrics at play, enhancing the perception of an airport located business as well connected, highly mobile, and on-the-

move. Appold and Kasarda (2013, p.1243) have opined that airports serve as 'functional urban anchors and as symbolic points of orientation' as traditional cities grow to subsume airports surrounds. Their efforts to correlate economic activity by reference to post code level data in the United States have generated three as-yet unresearched hypotheses which suggest that there is still some way to go in determining an absolute relationship between airport city functioning and general economic performance.

Many studies have examined the regulation and privatisation of the Australian airports as well as the associated challenges (e.g., Forsyth, 2002, 2008; Freestone and Baker, 2010; Donehue and Baker, 2012; Lohmann and Trischler, 2017; Zhang et al, 2017). Freestone and Wiesel (2014) have noted that today's Australian capital city airports are increasingly typified by land uses that 'conspicuously juxtapose' traditional aviation activities with non-aeronautical enterprises. This progressive clustering of disparate interests can either be seen as a contact zone for the development of new economic synergies (AAC, 2017), or a battle ground for those who believe that it is the vanguard of GA's demise (AACCI, 2011). Freestone and Wiesel (2014) documented the journey of Melbourne's Essendon airport as it evolved into Essendon Fields. These authors examined the conflict and progressive resolution of an underperforming aerodrome into a vibrant metropolitan airport and retail destination. Is the experience of creating such an economic hub transposable? This paper seeks to consider the trajectory of Brisbane's equivalent airport, Archerfield, and its unique issues from an economic and public utility perspective. This implies that we look at the issues facing the Archerfield Airport not just from the perspective of the airport itself or a small number of stakeholders. Rather, we investigate the issues from the perspective of the whole general aviation sector. At the same time, the airport and the surrounding facilities bear the nature of a public utility and thus the interests of the general public and the role of the government are also considered.

Contemporary scholastic endeavour encourages investigators to consider links to first nation peoples (Kirkness and Barnhardt, 1991), and so the next section provides the historical context of Archerfield as a realm of contact and conflict, as well as its current status. The methodology is briefly mentioned in section 3, followed by a discussion of a series of challenges that need to be resolved if Archerfield's highest and best use as an airport is to be fully realised. The last section details some interim conclusions.

2. Background - A short history of Archerfield

The traditional owners of the land known as Meanjin, on which Archerfield airport stands, are the Jagara (or alternatively Yuggera or Yagarabul) people. This indigenous group oversaw tribal lands that reached out from bayside Cleveland towards the west into the Brisbane Valley. The Maiwar, known today as the Brisbane River, watered the region; which until the arrival of white settlers, was well timbered although pocketed with swamps and boglands (Steele, 1972). The Jagara people enjoyed a high degree of mobility, as testified by the fact that many of the paths that connected Dreamtime sites became the foundations of road infrastructure for later white settlement (Petrie, 1904). These pathways also connected the Jagara with neighbouring tribes, like the Wakka to the west. Such connectivity facilitated trade and cultural exchange, along with diplomatic engagements like the triennial Bunya feast which reinforced familial connections across traditional borders (Queensland Museum, 2019).

By the 1850s, land to Brisbane's west had been opened to settlement, and publican Thomas Grenier purchased some 650 acres of lightly timbered prime grazing land for the handsome sum of £1,920. Within 10 years, the property had been divided into three farms shared by the Grenier family, including Franklin Grenier. Subsequently, the Beatty family acquired property from the family and ownership of the other properties changed hands into the early 1900s (Grenier, 2009). These family names live on in the form of the streets and roads that criss-cross the Archerfield precinct, or lie upon the headstones of these settlers in the God's Acre cemetery that is maintained within the airport boundary (FOGA, 2019).

When Qantas chief instructor Lester Brain landed his de Haviland Giant Moth aircraft on Franklin's Farm in 1927 to test its suitability as an airfield, he started a cycle of activity that gained rapid motion. After federal acquisition in 1929, gravel strips were created, and the aerodrome took on the name Archerfield (derived from an earlier property of the same name to the south-west). In the 1930s, Qantas moved from their Eagle Farm facility to the newly constituted airfield, and the property became the main airport in Brisbane (Prangley, 2013).

The Second World War saw a fortress mentality settle over Archerfield in defence of the Brisbane Line (Palazzo, 2006). The United States and the British authorities stationed both army air corps and naval forces at Archerfield, alongside Australian and other Allied troops. Hangars now occupied by Caterpillar and Hastings Deering to the east of the current airport

boundary testify to the scope of airfield operations during these critical days of war in the Pacific.

After World War Two ended, major air traffic once again moved to Eagle Farm where technology, political will and town planning coalesced to overcome the geological issues that had faced the waterlogged area. Archerfield came to be the home of light aviation and continued to play host to a variety of GA through to the heady days of the 1980s when the aerodrome facilitated approximately 320 000 movements a year under the auspices of the Federal Airports Corporation (AAC, 2019).

In 1998, Archerfield, along with some 20 other facilities around the nation, was privatised. The leasehold for the field passed to the Archerfield Airport Corporation Pty Ltd for the sum of USD$1.9m (Hooper, Cain and White, 2000). At this stage, Archerfield shared many of the same physical and performance characteristics that Freestone and Wiesel (2014) documented in their exploration of the Essendon experience.

Figure 1 - Archerfield Airport. Google Earth (2019)

Today's Archerfield, a little over 11km south west of the Brisbane CBD and some 25km from Brisbane International Airport, covers approximately 257 hectares of land (see Figure 1). It plays host to a much-reduced activity level of around 140,000 movements per annum (AAC, 2017) when compared to its pre-privatisation era. Nearby Ipswich Road and the South-East Freeway both provide convenient, although often heavily trafficked access to the city and the larger Brisbane airport through toll road and tunnel options. The facility is serviced by Brisbane City Council's bus routes, which have stops within walking distance of the airport entries proper. A Queensland Rail station, Coopers Plains, is the closest commuter rail link at 3 kms away; approximately a 38-minute walk.

The airport is divided into eight specific precincts under the Archerfield Airport Corporation (2017) masterplan. These precincts are located within five land use zones for planning purposes, including special purpose (airport), general industry, low impact industry, community facilities and conservation (AAC, 2017). Some 75 hectares of the site remains

available for development, presenting an attractive opportunity for value building in the second fastest growing GDP area in Brisbane after the Trade Coast zone (BCC, 2017).

The functional heart of the airport business is the 10/28 runway complex, consisting of twinned directional sealed runways running basically east-west. The 28R/10L is 1481 meters in length, sealed and rated PCN6 with pilot activated lighting. Its neighbour, 28L/10R is 1100 metres long, and only 18-metres wide through its mid sections. Twinned grass runways running 22/04 are also available for use, subject to prevailing winds and ground conditions.

The sealed 28R/10L major runway is currently subject to the major development works program, named the Airside Infrastructure Modernisation (AIM) Project, with some $17.5m to be spent in lengthening and strengthening the runway and associated taxiways and upgrading the lighting of the area to meet ICAO requirements and enhance operational safety (AAC, 2018; Muir, 2019). The airport managers purport that the upgrades will enhance the operational capability of existing airport users and encourage greater use of the infrastructure as an alternative for some users of the busy Brisbane airport (Gaynor, 2018).

3. Problem statement and methodology

Research analysing the efficiency of airport decision making in terms of inputs and outputs has been compiled over several years, using benchmarking tools like data envelopment analysis and other quantitative measures (Adler, Ülkü and Yazhemsky, 2013).

Experienced airport consultants have recognized several key qualitative metrics in managing risk for smaller airports. Included in these are such dimensions as operational management, stakeholder and community safety, future planning, and community expectation (Aviation Projects, 2020) alongside easier to measure functions like financial performance. Still others highlight the need for forward thinking airports to plan for speedy adaption to changing regulations and market conditions as part of their cyclical planning agendas (Chant, 2015).

The status quo at Archerfield is shared by a number of privatised airports in Australia in terms of the challenges represented in managing these planning dimensions, and many of the barriers to growth are experienced internationally where urbanisation and infrastructure tensions exhibit themselves (for substantive US and Indian examples, see Joiner, 2014 and Rana, 2017).

Yin (2009) suggests that a single case design is rational if the case is a representative or typical case from which the lessons learned are assumed to be informative about the experiences of the average situation. It is particularly useful and appropriate in exploratory research, or the early phase of a research program. The case study method is preferred when researchers have little or no control on the events or when there is little background. Given that there is little research into secondary airports mainly for GA activities and charter flight services, this research uses a typical case approach to examine the issues associated with Archerfield Airport, which will shed light on the operation of similar airports.

In case studies, six sources of evidence are mostly used: documentation, archival records, interviews, direct observations, participant observation and physical artefacts (Yin, 2009). Our case study considers a range of documents including archival records, newspaper and magazine articles, government and enterprise websites, industry reports, academic studies and so on. The results of our enquiry surveying the experience of flight training (fixed wing and helicopter) providers, transiting charter operators, embedded engineering and avionics contractors and aviation aligned service providers is discussed in the next section.

In focussing attention on Archerfield, this paper seeks to contribute to the relative vacuum of research into the trajectory of secondary airports as part of the contemporary urban planning discussion. It is noted that considerable investment has been made by the principals of Archerfield in the Transition Archerfield Logistics Estate to realise the highest and best use of land in the airport precinct. The Transition site is on the north western side of the airport and is promoted as allowing flexibility to provide solutions for both aeronautical and non-aeronautical business needs up to 80,000sqm (Transition, 2019). With intermodal rail access only 1.5km away, and the ability to operate 24/7 away from the more southerly residential zones, the estate is well placed to facilitate the operational needs of the South West Industrial Gateway Major Industrial Area (or SWIG MIA) (BCC, 2019). To date, this area remains largely untenanted by the sorts of businesses sought after in the design concept.

Where some sizeable new tenancies have been consummated, they have been primarily sourced from the public sector and corporate charities. Lifeflight, a major rescue service, has located its heavy helicopter maintenance facility at Archerfield, and the government funded Police Air Wing (PolAir) and Rescue 500 (Queensland Government Air Wing, or QGAir) helicopter bases are both found on the field after significant dollars were invested in their accommodation. For the most part, however, the eclectic mix of ageing buildings continues to

house businesses both aeronautical and non-aviation focused that have not typically been directly engaged by the airport in the facilitation of its re-emergence. While some progressive thinkers in the tenancy base are keen to grow their footprint, they are cognizant of several issues that limit their propensity to invest. This research will use Archerfield Airport as a case study to identify these issues and challenges facing the airport users, noting the fact that similar planning pressures appear to be an emerging theme around the world.

Kalakou and Macário (2013) developed airport business models based on Osterwalder and Pigneur's (2010) business model canvas concept, which includes nine interrelated components: customer segments, value proposition, channels, customer relationships, revenue streams, key resources, key activities, key partners and cost structure. The issues discussed in this paper are within the elements of the Kalakou and Macário (2013) model and in a more specific Australian GA context.

4. Contemporary challenges and the future

4.1 Zoning

When Archerfield aerodrome was created, it was set amongst farmland on the outskirts of the city where the tallest building until 1970 was Brisbane Town Hall at 95.7 metres nearly 12 kilometres away (Atfield, 2017). Today, the airport is encased in a light industrial planning zone and low-density residential areas characterised by affordable housing and post-war housing commission style properties. The three nautical mile operational zone of the airfield incorporates much more suburban space, where residential concerns for aircraft operating at the 1000-foot circuit height mark (including emergency services flights) are reflected in noise complaints of fifty-three separate suburbs through the Air Services reporting channel (Air Services, 2019b).

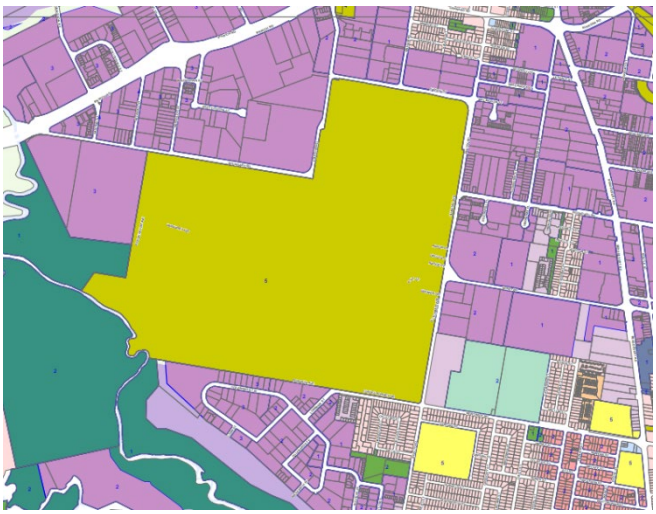

Figure 2 - Brisbane Zoning Map (BCC, 2019b)

The accompanying *Figure 2* graphically demonstrate two key issues previously identified by Baker and Freestone (2012, p.329), specifically 'the clashing of public and private values

with respect to the vision and role of airports, and the challenge of integrating intergovernmental planning responsibilities within a federal system.' Archerfield, as a federally owned but privately-operated airfield, remains subject to Commonwealth planning protocols under the auspices of the responsible Minister and the *Airports Act 1996* (Infrastructure, 2019). The surrounding infrastructure is owned by state and local government, and each of the three tiers reflect different planning priorities.

An instructive example of the planning tensions between the tiers was evidenced in the Archerfield Airport Community Consultation Group forum conducted on 21 February 2019 attended by one of the authors as part of the community outreach required in consultation for the major development works associated with the runway upgrades. The Local Councillor for the Moorooka Ward expressed frustration that federal departments namely Air Services Australia and the Civil Aviation Safety Authority (CASA), should be mandating the height of light poles and trees in the public safety area (PSA) at the end of the runways which is currently occupied by a community sporting club in a parkland. The ensuing discussion about public utility versus aviation safety highlighted the lack of communication and coordination about local area planning, flora and fauna management and economic value let alone any consensus on such recondite concepts as quality of life and free market activity.

The unfortunate incident involving the impact of a Beechcraft King Air turboprop aircraft at the Essendon Field's factory outlet shopping precinct in February 2017 was seized upon by many parties, both internal and external to aviation, to seek a redress of planning and development activity at Archerfield (Hamilton-Smith and Withey, 2017). However, such calls overlook that the airport is gazetted as a cornerstone piece of infrastructure for Brisbane which, in terms of its 50 year lease with 49 year option from the Commonwealth (AAT, 2015) must be retained as an airport. Furthermore, the capacity to maintain the facility mirrors the almost universal requirement for any airport to generate both aeronautical charges and revenue from commercial activities (Freathy and Connell, 1999).

The dilemma of how to ameliorate land-use conflicts, noise, residential concerns and commercial mandates is reflective of the Essendon Fields trajectory, and reflects documented international experiences (Lassen and Galland, 2014). As the population of Brisbane grows, and the drive for affordable housing and higher-density living both increase, it is clear that the socio-spatial and environmental challenges facing Archerfield will intensify. So too will

the associated challenge of balancing the on-airfield allocation of resources between commercial and aviation interests in the search for ongoing sustainability.

4.2 Historic Preservation

Getting the balance right between progress and preservation is often a difficult task. Archerfield Airport principal, Gavin Bird, is quoted as saying

> Archerfield is a significant place in the history of international aviation. It is a significant place also in the soul of our nation through its multifaceted role during World War II. Above all it remains the heart of our community (AAC, 2017).

The capacity to preserve elements of the past is complicated when a sense of place is defined by activities rather than any particular piece of infrastructure fabric as an artefact of culture (Kaufman, 2009). The airport's masterplan (AAC, 2017) specifically notes that 'there is no evidence of archaeological sites or features that require specific management at this time.' However, given the emotional attachment that many aviators have with the precinct, they are sensitive to preserving the heritage of the aerodrome for future generations.

Arguably, there are three buildings that feature significantly in the photographic record of Archerfield. Its art deco styled terminal building was erected in 1941, and originally housed the control tower atop its roof. Hangars 4 and 5 are often pictured bedecked in their original Qantas signage (see Figure 3). Several other empty buildings of yesteryear are dotted about, and of course there are remnants of the settler history on the property. Some of these presented themselves as recently as 2015 when a sinkhole opened at the end of one of the grassed runways revealing a 19th century windmill from one of the original Grenier family homesteads (Lim, 2015).

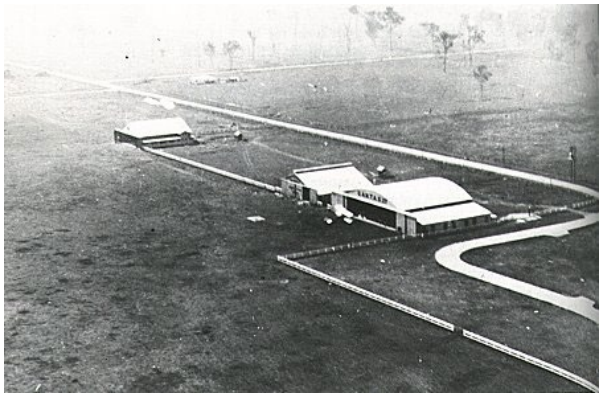

Figure 3 Hangar 4 (centre) in 1931 (Ozatwar, 2020)

Figure 4 - Hangar 4 Challenged to suit modern aircraft requirements

While the aforementioned premises call to mind the heady days of activity and associated nostalgia, it is not possible to discount the issues of functionality for the 21st century business. Enhanced need for electrical and data services, increased compliance requirements under workplace safety legislation, the security demands of the Office of Transport Safety, paying customers expectations and comfort, larger aircraft handling requirements, general accessibility and freedom of movement are all competing demands on the ageing fabric of a facility which proactively bills itself as Brisbane's Metropolitan Airport (see Figure 4).

That preserving space and place is possible was evidenced by Essendon Fields approach to the refurbishment of the Area Approach Control Centre and its rebirthing of its Beaufort Building into appealing contemporary office space (Essendon Fields, 2019). Archerfield, however, demonstrates a paralysis of purpose in the execution of its vision. It has, with perhaps the exception of Boeing subsidiary Aviall, failed to attract the sort of aviation aligned corporatized support that could act as catalyst group for the attraction of business interests to the airport proper. The will to attract new investment and enhance the visual appeal of the property has not been widely promoted, nor have incentives been publicly offered to private interests to participate in the renewal. A kind of preservation by default is in evidence, which does not telegraph the progressive emergence of an airport city-style mentality where the leaseholder is the primary driver of value creation on the property (Schaafsma, 2010).

4.3 Affordable Rent

The aviation industry tends to be highly capital intensive and operates on very modest margins (Jorge-Calderon, 2013). This axiom holds true across the GA sector. The sorts of

activity volumes and or profits that enable the larger multi-nationals to afford modern, purpose-built facilities are not typically enjoyed by the approximately 820 air operator certificate holders across the country, many of whom are small family businesses.

This perpetuates a lack of demand for the renewal of ageing infrastructure at many airports, with Archerfield being a case in point. Thus, of the 72 hangars on the airport, the vast majority bear the hallmarks of advanced age or are no longer fit for purpose. The airport's wartime legacy endures with hangars designed for tailwheel aircraft and lacking the tail clearance to accommodate or service larger tricycle gear aircraft. As a case in point, the ubiquitous workhorse of Queensland, the Beechcraft King Air, can only be accommodated in one hangar anywhere along the eastern Qantas Ave frontage of the airport.

From a development perspective, the Archerfield Airport Corporation and its parent company have a desire to design and build new infrastructure rather than encourage external capital placement from tenants. In doing so, they are seeking to earn revenue from the ground rent and a return on their investment, an appropriate strategy for a for-profit family business. In a recent offering by the Corporation (L. Bird, personal communication, February 21, 2019), a facility with a gross lettable area in the order of 1840 square meters costing $960 psm to build commands approximately $250,000 per annum plus GST and outgoings. These sorts of figures are not out of keeping with current commercial expectations in industrial developments in the Brisbane market (BMT, 2019).

Unfortunately, aircraft do not necessarily earn revenue directly proportional to their size (Wei and Hansen, 2003). A larger lettable area is required to protect an expensive charterable aircraft from the elements, but the leased space is not a function of what the aircraft earns. As a result, many operators are forced to house their aircraft out in the open, on limited hardstand or on the grassed areas which makes wet weather operations hazardous. In the catastrophic Brisbane storm of 2014 (Donoughue, 2014), many operators experienced the complete destruction or long-term grounding of their aircraft with repairs and loss of income proving significant. Insurance claims managers estimate that across three major storms to affect the airfield between November 2015 and 2015, some 400 aircraft were damaged with settlement costs in the order of AUD$9m (D. Tait, personal communication, 28 March 2019).

The 2017 BITRE General Aviation Study (p.31) reported that, of the sample collected, GA businesses factored 8% of their expenses as 'rent including airport lease costs'. Using the above example of a meaningful hangar of 1840 sqm capable of housing a fleet of 10 mixed

size machines, a business would be carrying an expense budget in the order of $3.125m; well above the gross turnover of most operators on the airfield. Realistically, rent consumes a much higher proportion of expenses even for those in post war accommodations, let alone anything more contemporary.

The costs of maintaining a fleet where the average age of aircraft is approaching forty years (CASA, 2017), along with the cost of regulatory compliance in operating and piloting them, leave few dollars for expenditure on rents for new developments with price tags reflective of industrial estates where the same structural pricing limitations do not apply. Add to this the costs of finance for the airframes which are often not scaled to their utilisation, and the confidence of operators to push their operational presence in facilities they will never own is considerably diluted. Overcoming the disproportionate cost-to-income ratio for tenants will remain a significant impediment to discretionary airside development and does tend to support the need for a genuine ramp up in non-aviation incomes to provide cross-subsidy capacity if the overall precinct is to experience renewal.

4.4 Commercial Imperatives

In an attempt to more fully realise the forecast of up to 260,000 aircraft movements per year by 2037, the Archerfield Airport Corporation has sought to encourage the re-establishment of regular passenger transport services at the airport. The current masterplan (AAC, 2017, p.66) points to a handling capacity of 400-500,000 passengers per annum across some 9000 movements in aircraft equivalent to Dash 9 – Q400 or Embraer 170 capacity. Passenger throughput charges, aeronautical and landing fees and revenues earned from terminal business activities would add further stimulus to the Archerfield Airport Corporation's (AAC) cash flows. Such supplements are a natural expression of the airport city paradigm, if executed in a way that encourages consumer engagement at the airport rather than a simple drop and run regional airport experience.

Freight handling is also considered a prime driver of activity, if such could be integrated with the Transition logistics park. Formerly, experienced operators like Jetcraft operated Metroliners and Cessna C441 aircraft from Archerfield. Unfortunately, low margins and a structural change within the air freight industry served to force them out of business in early 2008, and there has not since been a credible logistics handling presence on the field. With the increasing cost of operations at Brisbane airport, and the restriction on movements there,

there is surely an opportunity to address the vacuum in freight handling services from Archerfield. New aircraft like the Cessna C408 Sky Courier due to launch in 2020, for which FedEx is a launch customer in the US, would be well placed to operate from Archerfield in the overnight inter-city express air freight business.

Aeromedical activity features in the basket of opportunities for Archerfield to evolve into an airport city with a fully integrated offering. With the secondary QEII hospital approximately four kilometres away, and the Princess Alexandra and Mater hospitals both having helicopter retrieval facilities and major trunk road access, it would seem natural to have Royal Flying Doctors Service (RFDS) and Angel Flight activities provisioned for. However, recent overtures to the RFDS faltered on commercial and operational grounds, and CASA's tightening of volunteer medical support aviation requirements is likely to have a limiting effect on this activity (Cripps, 2019).

Flight training has provided the backbone of movement activity at Archerfield for some time. When the oldest aero club in the southern hemisphere, the Royal Queensland Aero Club, floundered financially in 2016, the airport lost significant momentum with tertiary institutions and international student training. A similar experience was felt in 2009 with the failure of Flight Training Australia. Since these failures, Basair Aviation College and Flight One have grown to be the principal providers of flight training on the field, with several other smaller operators also present in the GA and recreational aviation spheres. Many operators in the industry have developed a reliance on the Vocational Education and Training (VET) Student Loan (VSL) funding model orchestrated by the federal Department of Education Skills and Employment (DESE) and the Australian Skills Quality Authority (ASQA), and sudden changes in funding models (as was experienced in 2017) can test their financial resilience, particularly where there is little depth to their source of revenue. The high cost of operating to a CASA regimen in an Air Services Australia-managed control tower environment compared to the low cost self-regulated Recreational Aviation Australia (RAAus) operations and cheaper non-towered council operated airports will continue to be an impediment to attracting larger cohorts of both domestic and international students; the latter being an under-explored market for the Archerfield precinct even before the impact of COVID-19 in 2020.

4.4 Airspace

Airports operate in a three-dimensional framework. While the intensity of zoning previously addressed can be addressed in two dimensions, it is important to recognize that the airspace above and surrounding an airfield is equally contested. This is manifestly in evidence in the case of Archerfield Airport.

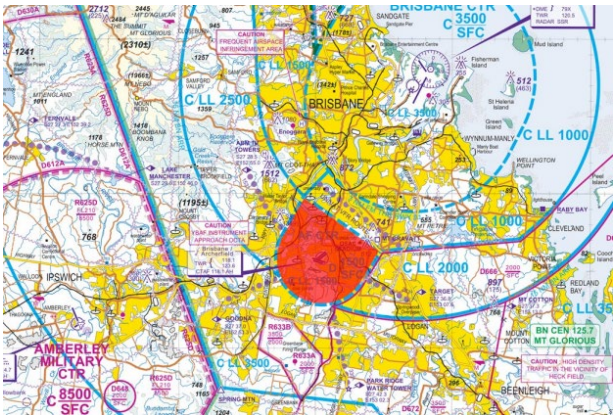

Figure 5 - Archerfield control zone (Air Services Australia, 2019a)

The airspace controlled by Air Services Australia staff at Archerfield is relatively small and is juxtaposed between Brisbane Class C airspace and military control zones and restricted areas, including Amberley airbase and the Greenbank Training Area managed by the Department of Defence (Air Services Australia, 2019a). Further to the south, the Gold Coast airport represents another concentration of active airspace.

Two recent demands on airspace availability have been the growth in Amberley as a RAAF superbase, accommodating the operations of Super Hornets and C17 heavy-lift aircraft, and Brisbane Airport's AUD$1.3b second runway development.

The creation of 'Little Amberley' and 'Big Amberley' has meant that the Defence Force has the capacity to massively increase the size of its military control zone with as little as 30 minutes notice. The implication of this for commercial operations into and from Archerfield is not insignificant. Western departure procedures are altered and navigation exercises to the west can be materially curtailed, impacting student bookings and planned activities for flight training organisations, with potential loss of revenue. Inbound flights can be redirected adding increased track miles and adding costs to the operator which erode any margins earned on fixed price charter activities (C.Dudman, personal communication, March 28, 2019). There is then an impact on customer satisfaction levels for the GA passenger, who may have chosen to travel in a chartered capacity because of time critical engagements elsewhere. Oftentimes such occurrences cannot be planned for as the military control zone will become active during flights already in progress, and without previous promulgation by published notices to airmen (NOTAM).

Currently, Archerfield sits directly under the instrument approach for Brisbane's runway 01R (right), and the departures for 19L (left). The airspace separation between aircraft is only 1000 feet. Brisbane currently provides a gateway for a little over 23 million passengers each

year, and this is set to increase significantly with the second runway generating an additional AUD$5b in economic benefit from 2020 (Brisbane Airport Corporation, 2019). As the flight paths to support the new dual runway operation come on stream, it is expected that increased holding requirements may be experienced by aircraft operating under the Instrument Flight Rules (IFR) looking to avail of the Archerfield runway 10L (left) Area Navigation (RNAV) satellite assisted arrival. Naturally, the cost and time delays associated with this will be borne by aircraft operators, and there may well be an increase in noise complaints from the broader community in the holding areas. The follow-on issues to flight trainers who will have even less access to instrument approaches will include escalated training costs for students who must travel further afield to access the necessary navigation aids.

With the growth of south-east Queensland, and the planned increase in federal aviation infrastructure utilisation in the Brisbane catchment, the protection of airspace will certainly be a priority for the Archerfield management to engage with if it is to preserve its utility as a viable transport hub for GA.

4.5 Social Utility

When all of the above is taken into consideration, there remains the hard to fathom quantum of social utility. What is the inherent value of having an active airport city precinct in the community? Does that value, if measurable, warrant support from community coffers to offset the cost of the evolution? Mills (1995, p.81) commented that, in the case of supporting privatised airfields, 'it is much more difficult to find a political rationalisation for subsidy, especially since the beneficiaries of such subsidy are not among the poorest sections of society.' While this does not necessarily hold true for many operators who appear to compete in a very tight margin environment simply to provide a living, or for GA pilots who are among the lowest paid professionals in the market, there is some merit in understanding that there are significantly competing social priorities in contemporary Australia.

With a lack of coordinated development planning across government tiers, and the inability for policy makers to access robust economic data on the GA sector, there does not exist a platform to leverage an integrative value proposition of appeal to the broader population (Baker and Freestone, 2014; Dooms, 2010). The message that airports are generators of economic value and investment catalysts (Conventz and Thierstein, 2014) is not being broadcast effectively in the Archerfield journey. The often-contentious results to date of ad

hoc interactions between stakeholders tends to bear out Winn's (2001) research that more focus on case-based communication and demonstration of co-dependence is needed to improve stakeholder management and buy-in.

5. Conclusion

Without doubt, Archerfield airport is experiencing the ripples of stones cast within the wider GA pond. Australian GA is grappling with maintaining an ageing aircraft fleet, a high cost of operations, currency pressures which drive up the cost of new aircraft acquisition, a very active (some would say over-active) regulator in CASA (Morgan, 2019) with performance challenges of its own (Professionals Australia, 2019; Hatch, 2019), a sluggish economy, three-tiers of government, a small population and relatively unsophisticated corporate culture within the fraternity. These issues, in the comparatively small south-east Queensland aviation community, are serving to constrain Archerfield's growth.

Albeit a Master Plan is widely promulgated and opportunities to connect and explore are available, there remain divergent but equally intransigent world views held by parts of the airport management, many of its tenants and the local community about the direction of the precinct and its importance to the domestic and local economy. While such fractures exist, it is hard to envision that the beneficial synergies of a cohesive economic hub can be achieved, including airport renewal, the promotion of new technologies, growth in the education sector, improvement in industrial job prospects and the attainment of safer skies for all. All this means that early privatised adopters of the airport city concept and progressive planning policy, like Essendon Fields, will have stolen a long march on their Queensland counterpart.

The relevance of the Archerfield experience to national and international planning bodies is clear. An expectation that an extant secondary airport will remain of commercial relevance and economic value is misplaced if it is underpinned by a lack of buy-in from the local constituency, poor communication of vision and purpose, over-zealous regulation, and lack of political will. Time invested in integrating secondary airports into a multi-modal transport system and community value proposition that recognizes employment, mobility and economic momentum would do much to reinvigorate GA both domestically and internationally. Finally, it should be pointed out that this case study does not intend to present a silver bullet to solve all the issues discussed above, but rather to categorise the extant issues facing the GA industry that policy makers are as yet unaware of. Part of the contribution is to

start a national discussion about the state of national infrastructure so that emergent themes can be dealt with effectively in the national interest.

References

Adler, N., Ülkü, T., & Yazhemskya, E. (2013). Small regional airport sustainability: Lessons from benchmarking. *Journal of Air Transport Management, 33*, 22-31.

Administrative Appeals Tribunal (AAT). (2015). *Archerfield Airport Chamber of Commerce Inc and Minister for Infrastructure and Regional Development [2015] AATA 489 (8 July 2015)*. Retrieved 28 March, 2019, from http://www6.austlii.edu.au/cgi-bin/viewdoc/au/cases/cth/AATA/2015/489.html

Airport city gets planting (2018). Retrieved 25 March, 2019, from https://search-proquest-com.dbgw.lis.curtin.edu.au/docview/2098703742/fulltextPDF/BECE8E0FE0E8419APQ/1?accountid=10382

Air Services Australia. (2019a). *Tips for flying at Archerfield* [Factsheet]. Retrieved from http://www.airservicesaustralia.com/wp-content/uploads/16-106FAC_Tips-for-flying-at-Archerfield_WEB.pdf

Air Services Australia. (2019b). *Complaints.* Retrieved 29 March, 2019, from http://aircraftnoiseinfo.bksv.com/archerfield/complaints/

Appold, S.J., & Kasarda, J.D. (2013). The airport city phenomenon: Evidence from large US airports. *Urban Studies, 50*(6), 1239-1259.

Archerfield Airport Corporation (AAC). (2017). *Master Plan 2017-2037*. Retrieved 7 March, 2019, from http://archerfieldairport.com.au/Downloads/Masterplan2017/MP_2017-37_HighRez.pdf

Archerfield Airport Corporation (AAC). (2018). *Airside infrastructure improvements planned for Archerfield Airport* [Press Release]. Retrieved from http://www.archerfieldairport.com.au/index.php?option=com_content&view=article&id=553:media-release-preliminary-draft-major-development-plan-2&catid=59&Itemid=189

Archerfield Airport Corporation (AAC). (2019). *Overview*. Retrieved 7 March, 2019, from http://archerfieldairport.com.au/index.php?option=com_content&view=article&id=112&Itemid=81

Archerfield Airport Chamber of Commerce Inc. (2011). *2011 Airport Plan a Grab for Industrial Land* [Media Release]. Retrieved from https://www.aacci.org.au/index.php/media-releases/70-2011-airport-plan-a-grab-for-industrial-land

Arthur, I.K. (2018). Exploring the development prospects of Accra Airport City, Ghana. *Area Development and Policy. 3*(2), 258-273.

Asia Today International. (2012). Woods Bagot wins China Southern airport city project [online]. *Asia Today International, 30* (4), 14. Retrieved 25 March, 2019, from https://search-informit-com-au.dbgw.lis.curtin.edu.au/documentSummary;dn=678770119198720;res=IELBUS

Atfield, C. (2017). Tracking Brisbane's tallest buildings through the years. *Brisbane Times.* Retrieved 28 March, 2019, from https://www.brisbanetimes.com.au/national/queensland/tracking-brisbanes-tallest-buildings-through-the-years-20170313-gux7ko.html

Australian Airports Association (2018). Connecting Australia: The economic and social contribution of Australia's airports. Access Economics. Deloitte.

Aviation Projects. (2020). *Small aerodrome management framework*. Retrieved from http://www.aviationprojects.com.au/our-projects-view/small-aerodrome-management-framework-38

Brisbane City Council (BCC). (2011). *Brisbane City Council Submission to Productivity Commission regarding economic regulation of airport services.* Retrieved 29 March, 2019, from https://www.pc.gov.au/inquiries/completed/airport-regulation/submissions/sub042.pdf

Brisbane City Council (BCC). (2017). *Brisbane Industrial Strategy.* Retrieved from https://www.brisbane.qld.gov.au/sites/default/files/20171102-brisbane-industrial-strategy.pdf

Brisbane City Council (BCC). (2019). Brisbane Industrial Strategy. Retrieved from https://www.brisbane.qld.gov.au/sites/default/files/20190211-brisbane-industrial-strategy-2019-2.pdf

Brisbane City Council (BCC). (2019b). *Brisbane City Planning Scheme Zoning Map*. Retrieved 28 March, 2019, from http://docs.brisbane.qld.gov.au/City%20Plan/v14_00_20190215/MAPS/Zoning%20maps/zm001-43.pdf

BMT Quantity Surveyors. (2019). *Average costs of construction in Australia.* Retrieved 26 March, 2019, from https://www.bmtqs.com.au/construction-cost-table

Bureau of Infrastructure, Transport and Regional Economics (BITRE). (2017b). *General aviation study.* Retrieved from https://bitre.gov.au/publications/2017/cr_001.aspx

Chandu, A. (2017). The world's first purpose-built airport city: Melbourne Airport, Tullamarine. *Planning Perspectives, 32*(3), 373-400.

Chant, D. (2015). Planning small and medium-sized airports for flexibility and future growth. *Journal of Airport Management, 9*(3), 223-233.

Civil Aviation Safety Authority (CASA). (2017). *Project MS 12/29 - Ageing Aircraft Management Plan.* Retrieved 28 March, 2019, from https://www.casa.gov.au/standard-page/project-ms-1229-ageing-aircraft-management-plan

Conventz, S., & Thierstein, A. (2014). *Airports, cities and regions.* New York: Routledge

Cripps, S. (2019). CASA responds to concerns of potential loss of Angel Flight. *Queensland Country Life,* 1 February 2019. Retrieved 29 March, 2019, from

https://www.queenslandcountrylife.com.au/story/5882346/casa-responds-this-is-not-about-flying-friends-or-relatives/

D'Alfonso, T., & Bracaglia, V. (2017). Two-sidedness and welfare neutrality in airport concessions. In: J. Peoples, J. Bitzan (eds.), *The Economics of Airport Operations*, Vol. 6, pp. 49-68, Emerald Publishing Limited.

D'Alfonso, T., Bracaglia, V., & Wan, Y. (2017). Airport cities and multiproduct pricing. *Journal of Transport Economics and Policy, 51*, 290-312.

Department of Infrastructure, Regional Development and Cities (Infrastructure). (2019). *Airport planning and regulation.* Retrieved 28 March, 2019, from https://infrastructure.gov.au/aviation/airport/planning/index.aspx

Donehue, P., & Baker, D. (2012). Remote, rural, and regional airports in Australia. *Transport Policy*, *24*, 232-239.

Donoughue, P. (2014). Brisbane storm: Photos show full scale of destructive cell system. *ABC News.* Retrieved 28 March, 2019 from https://www.abc.net.au/news/2014-11-27/photos-show-full-scale-of-destructive-brisbane-storm/5923606

Dooms, M. (2010). *Crafting the integrative value proposition for large scale transport infrastructure hubs: A stakeholder management approach.* Brussels: ASP

Essendon Fields. (2019). *History.* Retrieved 28 March, 2019, from https://ef.com.au/community/about/history/

Forsyth, P. (2002). Privatisation and regulation of Australian and New Zealand airports. *Journal of Air Transport Management, 8*(1), 19-28.

Forsyth, P. (2008). Airport policy in Australia and New Zealand: privatisation, light-handed regulation and performance. In: C. Winston, G. de Rus (eds.), *Aviation Infrastructure Performance: A Study in Comparative Political Economy*, Washington DC: Brookings Institution Press.

Freathy, P. & O'Connell, F. (1999) Planning for profit: The commercialisation of European airports. *Long Range Planning, 32*(6)*,* 587–597.

Freestone, R., & Baker, D. (2010). Challenges in land use planning around Australian airports. *Journal of Air Transport Management*, *16*(5), 264-271.

Freestone, R., Williams, P., & Bowden, A. (2006). Fly buy cities: Some planning aspects of airport privatisation in Australia. *Urban Policy and Research, 24*(4), 491-508.

Freestone, R., & Wiesel, I. (2014). The making of an Australian 'airport city'. *Geographical Research, 52*(3), 280-295.

Friends of God's Acre. (n.d). Retrieved 7 March, 2019, from http://www.foga.org.au/

Gaynor, C. (2018). $17.5 million upgrades for Archerfield Airport. *Infrastructure,* 6 December, 2018. Retrieved from https://infrastructuremagazine.com.au/2018/12/06/17-5-million-upgrades-for-archerfield-airport/

Google Earth. (2019). Retrieved 1 April, 2019, from https://earth.google.com/web/@-27.57740877,153.02581356,17.05369054a,6446.65234504d,35y,65.48259752h,60.01498727t,0r

Grenier, B. (2009). Thomas Grenier (1808-1877) - pioneer, publican, storekeeper, landowner, alderman and farmer. *Queensland History Journal, 20*(11), 652-661.

Hamilton-Smith, L., & Withey, A. (2017). Calls for Archerfield Airport safety check after Melbourne tragedy. *Shanghai Daily* [Online], 22 February, 2017. Retrieved from https://archive.shine.cn/AustraliaPlus/Calls-for-Archerfield-Airport-safety-check-after-Melbourne-tragedy/shdaily.shtml

Hatch, P. (2019). Aviation safety inspectors claim staff shortage amid CASA restructure. *Sydney Morning Herald* [Online], 9 December, 2019. Retrieved from https://www.smh.com.au/business/workplace/aviation-safety-inspectors-claim-staff-shortage-amid-casa-restructure-20191203-p53gg0.html

Hooper, P., Cain, R. & White, S. (2000). The privatisation of Australia's airports. *Transportation Research, Part E* 36, 181–204.

Jiang, H., & Zhang, Y. (2016). An assessment of passenger experience at Melbourne Airport. *Journal of Air Transport Management*, 54, 88-92.

Joiner, S. (2014). *The day they shut down Meigs Field*. Air and Space. Retrieved 28 August, 2020, from https://tinyurl.com/y3sds7v2

Jorge-Calderon, D. (2013). *Aviation investment. Economic appraisal for airports, air traffic management, airlines and aeronautics.* London: Routledge

Kaeys, S. (2006). *Stories of the suburbs: The origins of Richlands 'Servicetown' / Inala area on Brisbane's western fringe*. Paper presented to The Pacific in Australia; Australia in the Pacific Conference, Brisbane, Qld. Retrieved 7 March, 2019, from https://eprints.qut.edu.au/4995/1/4995.pdf

Kalakou, S., & Macário, R. (2013). An innovative framework for the study and structure of airport business models. Case Studies on Transport Policy, 1(1-2), 2-17.

Kaufman, N. (2009). *Place, race and story. Essays on the past and future of historic preservation.* New York: Routledge

Kasarda, J.D. (2005). Gateway airports, speed and the rise of the aerotropolis. In D.V. Gibson, M.V. Heitor, A. Ibarra-Yunez (Eds.), *Learning and Knowledge for the Network Society* (98-103). West Lafayette: Perdue University.

Kidokoro, Y., Lin, M.-H., & Zhang, A. (2016). A general equilibrium analysis of airport pricing, capacity and regulation. *Journal of Urban Economics, 96*, 142-155.

Kimelberg, S.M., & Nicoll, L.A. (2012). Business location decisions in the medical device industry: Evidence from Massachusetts. *Economic Development Quarterly, 26*(1), 34-49.

Kirkness, V.J., & Barnhardt, R. (abcd). First nations and higher education: The four R's – respect, relevance, reciprocity, responsibility. *Journal of American Indian Education 30*(3), 1-15.

Lassen, C., & Galland, D. (2014). The dark side of aeromobilities: Unplanned airport planning in Mexico City. *International Planning Studies, 19*(2), 132-153.

Lim, N. (2015). Airport field staff inspecting sinkhole at Archerfield Airport make historic find at the Brisbane site. *Courier Mail* [Online], 13 March 2015. Retrieved from https://www.couriermail.com.au/questnews/southeast/airport-field-staff-inspecting-sinkhole-at-archerfield-airport-make-historic-find-at-the-brisbane-site/news-story/63ad25ee7f5813a0943e1bbf2b2468b6.

Lohmann, G., & Trischler, J. (2017). Licence to build, licence to charge? Market power, pricing and the financing of airport infrastructure development in Australia. *Transport Policy*, *59*, 28-37.

Mills, G. (1995). Airport users don't pay enough—and now here's privatisation. *Economic Papers, 14*(1): 73–84.

Morgan, B. (2019). Australian senate debates Bill to amend Civil Aviation Act. *AOPA Australia.* Retrieved from https://aopa.com.au/australian-senate-debates-bill-to-amend-civil-aviation-act/

Morrison, W.G. (2009). Real estate, factory outlets and bricks: a note on non-aeronautical activities at commercial airports. *Journal of Air Transport Management, 15*(3), 112-115.

Muir, K. (2019). Archerfield airport upgrade will support Brisbane Airport. *Courier Mail* [Online], 9 January 2019. Retrieved from https://www.couriermail.com.au/questnews/southeast/archerfield-airport-upgrade-will-support-brisbane-airport/news-story/052ac6a8d71510fa60eba2ed55fb481c

Osterwalder, A., & Pigneur, Y. (2010). Business model generation: a handbook for visionaries, game changers, and challengers. John Wiley & Sons, USA..

Ozatwar. (2020). *Hangar no. 4 at Archerfield airfield used during WWII.* Retrieved from https://www.ozatwar.com/hang04.htm

Palazzo, A. (2006). Projecting power: the development of Queensland as a base for war. Journal of the Royal Historical Society of Queensland, 19(6), 878-891. Retrieved from https://search-informit-com-au.ezproxy.usq.edu.au/fullText;dn=200606514;res=IELAPA

Petrie, C. (1904). *Tom Petrie's reminiscences of early Queensland.* Brisbane: Watson, Ferguson & Co.

Prangley, D.N.W. (2013). The Eagle Farm agricultural establishment. *Queensland History Journal, 21*(12), 839-846.

Professionals Australia. (2019). *CASA in Crisis*. Retrieved from https://members.professionalsaustralia.org.au/PA/documents/CASA_in_crisis.pdf

Queensland Museum. (2019). *Bunya Mountains Gathering*. Retrieved March 7, 2019, from https://www.qm.qld.gov.au/find+out+about/aboriginal+and+torres+strait+islander+cultures/gatherings/bunya+mountains+gathering#.XIB2Higzbic

Rana, S. (2017). *Challenges and opportunities for small and emerging airports in the 21st century.* Submission for ACI Asia-Pacific Young Executive of the Year 2017. http://www.aci-asiapac.aero/services/main/20/upload/service/20/self/YE201711_BOM.pdf

Schaafsma, M. (2010). From airport city to airport corridor. In U. Knippenberger (Ed.) *Airports in Cities and Regions: Research and Practise* (173-179). New York: Routledge

Steele, J.G. (1972). *The explorers of Moreton Bay district, 1770-1830.* Brisbane: UQ Press.

Transition. (2019). *Transition.* Retrieved 25 March, 2019, from http://www.transitionestate.com.au/

Walker, A.R., & Stevens, N.J. (2008). Airport city developments in Australia: land use classification and analyses. In *10th TRAIL Congress and Knowledge Market, 14-15 October 2008*, Rotterdam, The Netherlands. Retrieved 25 March, 2019, from https://eprints.qut.edu.au/17641/

Wang, Y., Chou, C., & Yeo, G. (2013). Criteria for evaluating aerotropolis service quality. *The Asian Journal of Shipping and Logistics, 2*(3), 395-414.

Wei, W., & Hansen, M. (2003). Cost economics of aircraft size. *Journal of Transport Economics and Policy, 37*(2), 279-296.

Winn, M.I. (2001). Building stakeholder theory with a decision modelling methodology. *Business & Society, 40*(2), 133-166.

Wong, W.H., Zhang, A., Cheung, T.K.Y., & Chu, J. (2019). Examination of low-cost carriers' development at secondary airports using a comprehensive world airport classification. *Journal of Air Transport Management, 78*, 96-105.

Yin, R.K. (2009). *Case study research: design and methods.* Thousand Oaks: Sage Publications

Yun, J. (2015). A new city prototype? Songdo international city as an airport city. *Journal of Asian Architecture and Building Engineering, 9*, 549-556.

Zhang, A., Czerny, A.I. (2012). Airports and airlines economics and policy: An interpretive review of recent research. *Economics of Transportation, 1*, 15-34.

Zhang, Y., Wang, K., & Fu, X. (2017). Air transport services in regional Australia: Demand pattern, frequency choice and airport entry. *Transportation Research Part A: Policy and Practice*, *103*, 472-489.

Zhu, Z., Zhang, A., Zhang, Y., Huang, Z., & Xu, S. (2019). Measuring air connectivity between China and Australia. *Journal of Transport Geography*, 74, 359-370.