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**The impact of terminal re-
organisation on belly-hold freight
operation chains at airports.**

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ABSTRACT: While it is widely acknowledged that airport re-organisation from destination to dedicated airline group terminals makes passenger travel more seamless, more efficient and also more profitable for both airlines and airports, there is little known about the impacts of such change on freight and in particular belly-hold cargo and luggage chains. Our analysis includes data from all airports in Australia and discusses cases from around the world but focuses primarily on the proposed re-organisation of Sydney Kingsford Smith airport. This paper reveals a significant relationship between international freight volumes, terminal organisation and aircraft type usage, indicating potential problems related to airport design and freight value chains at the airport. However, our interviews of relevant stakeholders don't support these findings and show, beside some drawbacks, a number of benefits for belly-hold freight operations that can result from airline group terminal organisation.

KEY WORDS: *Airport terminal organisation; air freight; belly-hold freight ground operations; supply chains.*

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1. Introduction

Reliable and cost efficient supply chains are paramount in air passenger and freight operations, as any disruption or delays have the potential to delude the key advantage of aviation that is fast and secure transport. As airlines suffer from structural low profitability, substantial competitive pressures and high volatility (in both demand and cost, particularly fuel cost), they are trying hard to constantly improve and streamline their products. One of the airlines' strategies is to work together with airports (e.g., Tang and Wang, 2013) in making the air travel experience ever more seamless (covering not only security, check-in and other services within the terminal but also customer experience beyond the terminal building such as ground access transport options; see for example, Ison et al., 2013) for all passengers but most importantly the high yielding business traveller market segment. The airports also recognise the benefits of providing passengers with a seamless and relaxed travel experience as this will not only enhance customer satisfaction but will also result in higher non-aeronautical revenues (food and beverages, duty free, specialty shops etc.; see for example, Graham, 2009). Particularly at large international hub airports, the importance of commercial (non-aeronautical) revenues has risen substantially over the last decade, with Frankfurt International, Singapore Changi and Incheon airport (ICN) all featuring a share of non-aeronautical revenues in total revenues of more than 60% (Lufthansa Consulting and Moody Report). London Heathrow (LHR) is another good example (overtook Dubai (DXB) as "World's Best Airport for Shopping") as it had the highest retail sales of any airport in the world (ahead of ICN) in 2012 with a net retail income of £6.21 per passenger (Davitt, 2013).

Interestingly, the two leading airports when measured in shopping experience (LHR and DXB) have both organised their terminals with respect to airline alliances. While London Heathrow's flagship airport terminal 5 is dedicated to British Airways (and now Iberia through IAG), Dubai's International airport terminal 3 is reserved for Emirates (and now Qantas). However, when airport terminals are organised by airline groups rather than destination (domestic versus international), efficiency and timing issues might arise for freight chains at the airport that are related to international freight carried in the belly-hold of passenger aircraft. As a result of passenger flows and processes for international and domestic flights being optimised by airline group terminal organisation, particularly for international freight additional distances or other constraints, might slow down freight processing and hence delay passenger flights where freight is carried in the belly-hold. Such problems are more likely to arise at large international hubs but can materialise at any airport that handles international freight transported in passenger aircraft.

In that sense it is interesting to study Sydney Kingsford Smith Airport (SYD) as it is the most important passenger and freight hub in Australia, with a large share of international belly-hold freight operations and most importantly with a management that is keen to change the airport terminal design from destination to airline group terminal organisation. We draw from data of all Australian airports to see whether a relationship between freight volumes, terminal organisation and freighter share in total aircraft movement exists. We also provide a case study of SYD airport that is enriched by both quantitative data and qualitative findings from interviews with senior management. In its essence this paper aims to contribute to the general discussion on the impact of passenger terminal organisation on belly-hold freight operations and more specifically to the consultation process around airport master planning.

The remainder of the paper is organised as follows: while section 2 provides some further background discussion section 3 introduces the methodology. This is followed by a discussion of the results in section 4 and a summary of our findings as well as key conclusions in section 5.

2. Setting the scene on potential impacts of passenger terminal organisation and air freight operations

The aeronautical part of airport infrastructure is used as an exchange area between aircraft, surface vehicles, cargo and passengers. Wells and Young (2004) argue that airport managers and airline companies are the two main actors that make airports work despite their different perspectives. We argue that a lot more players (such as ground handlers) and stakeholders (such as local businesses) are relevant to airport operations and that their objectives and utility functions can differ when it comes to finding an optimal mix between passenger and freight operations. Virgin Australia for example has extensive passenger operations at all Australian airports but has contracted out all freight operations to the Toll group (global logistics and freight forwarding player).

The organisation between airlines and airports has changed considerably since deregulation, privatisation and the advent of low cost carriers (e.g., Francis et al., 2003) and have formed aviation markets across the world. It is likely that we will see further changes in the physical configuration and management of airports as both airports and airlines need to find ways to improve competitiveness, efficiency and profitability. Many authors (e.g., de Neufville et al., 2013) argue that the design of passenger terminals (with the two options being destination or airline group organisation) is fundamental to both airports' and airlines' success as their configuration considerably impacts upon passenger flows. De Neufville (1995) even argues that there is an optimum or preferred airport terminal configuration, primarily for transferring/connecting flights, but then again only for passenger operations.

Optimising passenger flows, particularly for connecting flights, has received much attention in the literature and practice of aeronautical airport re-organisation and management. Kuchinke and Sickmann (2005) for example show that the construction of terminal 2 at Munich airport (which is now dedicated to the Lufthansa group) increased efficiency of the airport on the passenger side. In another example Socorro and Betancor (2010) studied the (passenger) welfare effects (lack of competition, higher fares etc.) of the allocation of airlines to different terminals in the context of the re-organisation of Madrid airport.

However, there has been little mention of cargo operations that are often linked to passenger operations as at many airports (such as SYD airport) most air freight is carried in the belly hold of passenger aircraft.

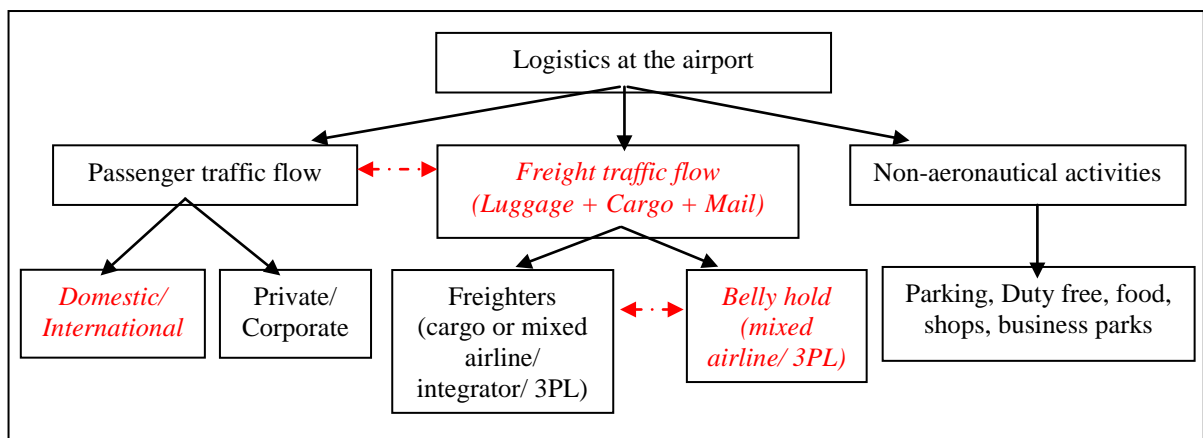


Figure 1: Different flows at the airport

Different to the previous literature, the focus of this paper is on the airport traffic flows directly related to air freight (luggage of passengers, mail and cargo) that is carried in the belly hold of passenger aircraft (domestic or international). We account for freighter aircraft (such as the Boeing 747F, which are usually operated by integrators and pure cargo airlines but also by some passenger/mixed airlines) to a lesser extent than belly-hold operation, as the aim of this paper is to show potential impacts of a change in passenger operations (passenger terminal organisation) to belly-hold freight chains at the airport. However, freighter operations can impact on this chain (as indicated in Figure 1), as some mixed airlines (such as Emirates) use belly-hold freight operations to support/feed large freighter operations.

3. Methodology

This paper aims to establish whether a re-configuration of passenger airport terminals from destination to airline group organisation can have impacts on freight, and in particular belly-hold freight chains at the airport. In a first step we analyse all airports in Australia to evaluate whether there is a trend between passenger airport terminal organisation and aircraft used to carry international freight (pure freighters versus belly-hold passenger aircraft). In a second step we carry out a case study analysis of Sydney (KSA) airport as it is currently the only airport globally that is proposing (in a consultation process with all stakeholders since early 2012) to change from destination to airline group based terminal organisation.

In terms of the first part of our analysis, we analyse all Australian airports that have at least one passenger by a commercial airline company and by using the records of the Australian Bureau of Infrastructure, Transport and Regional Economics (BITRE) of traffic and aircraft data. We have chosen that sample because of data availability and also because it provides the basis for the second part of our analysis. Out of our panel of 101 Australian airports over the period of 2001 to 2012, we have selected those which have a least one tonne of international air freight, as the focus of this paper is on freight chains (and particularly on belly-hold freight of connecting flights). By applying that filter we reduce the number of relevant airports to eight, namely Sydney Airport, Melbourne Airport (Tullamarine), Brisbane Airport, Perth Airport, Adelaide Airport, Darwin Airport, Cairns Airport and the Gold Coast Airport. By applying a linear regression model to our airport panel, we aim to show whether international freight volumes and passenger airport terminal organisation have an impact on the share of pure freighters in total aircraft movements (freighter plus belly-hold passenger aircraft) at the relevant airport. Economic theory that still holds today would suggest that the greater the international freight volume/ demand, the higher the share of freighters in total aircraft movements, as the increased capacity and advanced technology of cargo aircraft reduce the direct unit cost of air cargo operations (Kim, 1966). However, despite its complexities (Morrell, 2011), many mixed airlines and also freight forwarders around the world use the belly hold of passenger aircraft for carrying freight, particularly in Australia (as we found in our 2001-2012 panel data). Our hypothesis is that these complexities are amplified by an airline group passenger terminal organisation, which should be reflected in a higher share of freighters in total aircraft movements.

In the second part of our analysis we evaluate the potential impact of the proposed passenger terminal reorganisation (proposed in December 2011 and still under consultation in May 2013) on belly-hold freight chains at Sydney (KSA) airport. In doing so we analyse descriptive data and more importantly use in-depth interviews to establish a) key (belly-hold) freight chains at Sydney airport and b) whether the proposed reorganisation will have any impact on those freight chains from the perspective of the involved stakeholders.

We have undertaken twelve structured interviews with senior managers (either in a general manager, commercial manager, freight manager or business development manager role) of key players involved in the belly-hold freight chain at Sydney airport (the firms interviewed were Sydney Airport Corporation, Qantas, Virgin Australia, Jetstar, DHL, Toll Dnata Airport Services, Australian Air Express, Menzies Aviation). A few players who we contacted stated that they are not involved in freight at Sydney airport and others replied saying that they would

not be allowed to comment on the impacts of the proposed terminal changes on their freight activities at Sydney airport. Although our sample does not include all players at Sydney airport, we are confident that we cover the most important players directly involved in international (i.e. transshipment) belly-hold freight operations.

4. Results

In this section we first present the results of the regression models applied to our sample of Australian airports. Building on this we then discuss the findings of our Sydney airport case study.

4.1 Results of the regressions analysis of our Australian airport sample

As shown in Figure 2, there appears to be a significant relationship between international freight volumes and the share of freighters in total international aircraft movements (ATM). This is confirmed by our regression results of our panel data of 8 Australian airports from 2001 to 2013. Our results suggest not only a very significant ($t=12.48$) positive impact of international freight volumes on the share of freighters on ATM but more importantly also an even very more significant ($t=14.38$) impact of passenger terminal organisation by destination on the share of freighters on ATM with a model fit of $R^2=0.82$. If we take out the airport configuration dummy variable and only consider airports that have a passenger terminal organisation by destination (such as Sydney airport), we get a model fit of $R^2=0.97$ and a significance of $t=34.9$ for the impact of international freight volume on relative freighter aircraft usage. Similar to our regression results, also the trends shown in Figure 2 strongly suggest that there is indeed a relationship between international freight volumes and freighter share in total ATM (which would appear to be strongest for Sydney airport) and also between terminal organisation and freighter share in total ATM.

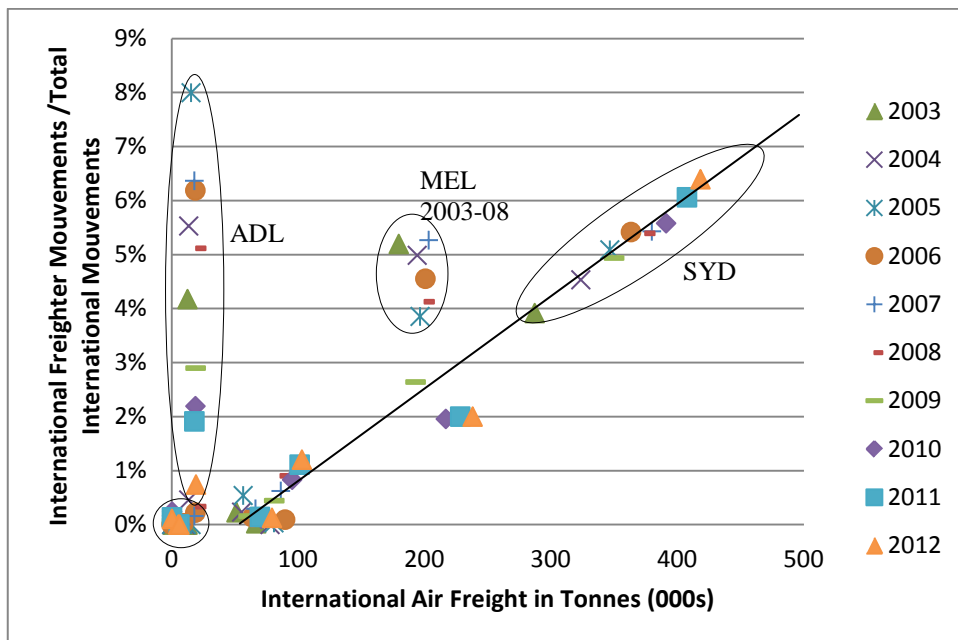


Figure 2: Freight volume vs percentage of freighters at key Australian airports 2003-2012

Figure 2, also reveals that there appear to be four groups of observations. The first group is nicely aligned to the correlation between freight volume and relative freighter usage and Sydney airport fits that model (the straight line) best. The second group consists of airports with very little international freight. More interestingly are groups 3 and 4. Group 3 shows the annual observations for Adelaide airport which has had a passenger terminal organisation by destination throughout the analysed period (2003-2012). It is very obvious that the share of freighters in total ATM at this airport is relatively higher compared to the other airports (although declining lately). Group 4 entails only Melbourne airport observations and only for the period of 2003 to 2008. At this point it is worth noting that Melbourne airport has changed its passenger terminal organisation from destination to airline group in late 2007. The Melbourne airport observations for 2009-2012 show a relatively much lower usage of freighters. Combined with the Adelaide observations and the regressions results discussed above, there seems to be sufficient evidence to suggest that airport terminal organisation can have an impact on the use of aircraft for international air cargo. Given that Sydney airport is in a consultation process with its stakeholders and customers since 2012 with respect to its proposal to reconfigure its passenger terminals from destination to airline group based organisation, it is worth asking whether once that modification has been implemented the choice of aircraft for international air cargo will change too.

A possible explanation for that could be that although passenger flows being much optimised once airline group terminal organisation is implemented, the luggage, cargo and mail processes (which not only take time but also require the freight to be moved across the airport) still need the same amount of time as with the terminal organisation by destination. Such processes include for example for a transshipment on a connecting flight at least the following steps: unload aircraft – ramp transport – break down ULDs – incoming checks and administration – sort goods and documents – outgoing checks and administration – build ULDs – ramp transport and security checks – load aircraft. Perhaps because of that timing/synchronisation of passenger and belly-hold freight issue the use of belly holds becomes less cost efficient (given the ever increasing pressure to reduce turnaround times following the low cost carrier approach) and hence freighters more attractive. However, this is only a theoretical consideration and the following case study aims to find evidence from the managers involved in the strategic planning and daily operations of belly-hold air freight at Sydney airport.

4.2 Sydney airport case of proposed terminal reorganisation

In December 2011 Sydney Airport Corporation Limited (SACL) announced a new proposal (as a complement of the 2009 master plan) and its intention to commence stakeholder consultation on its “New Vision” that, if implemented (by 2019), would see a fundamental reconfiguration of the passenger terminals at Sydney Airport. As of May 2013 this consultation is on-going (as part of the consultation for the Sydney Airport Master plan 2033) and the terminals are still organised by destination. The International Terminal Precinct (T1) is used only by airlines offering international flights, whereas, the Domestic Terminal Precinct (T2 and T3) welcomes all airlines which operate domestically within Australia. As a result, passengers connecting in Sydney from a domestic to an international flight and vice versa are forced to change terminal and hence to transfer from one side of the airport to the other, which reportedly creates frustrations. This transit involves the need to either take a bus through the Qantas/Virgin airside transfer system or to use public transport and rail networks. A key advantage of the proposed new terminal configuration is seen in that it would significantly reduce the necessity for passengers to transit across the airport (although not eliminate it all together). Under the proposed reconfiguration terminals would no longer be organised by destination but by airlines groups/alliances. Qantas, Jetstar and Oneworld carriers would then be allocated in the current domestic terminal, while Virgin Australia and Star Alliance carriers would be operating out of the current international precinct (it is worth noting that the announced configuration of airlines by carrier was at the time of the New Vision announcement and has been slightly modified since then as explained further below). According to the management of Sydney airport, all terminals in the Master Plan will cater to international / domestic and regional traffic allowing airlines to

transfer traffic more easily than the current setup. In addition each terminal will have freight facilities located in close proximity.

While such an alliance-based configuration of the terminals will improve passenger flows, it is important to also consider freight operations and particularly the luggage of transfer passengers and belly-hold cargo/mail that also want to make international/domestic connections. With Qantas, Jetstar, Virgin Australia and their partners operating more than 80 per cent of the aircraft movements (as of June 2012), it is apparent that any terminal modification involving those airlines would considerably affect the entire operations of the airport. Given that Sydney airport is Australia's gateway (according to Sydney airport it operates 42 per cent of all international arrivals to Australia, has handled 37 million passengers in 2012, hosted close to 40 airlines flying to a network of 100 destinations and is also a significant freight hub with 550,000 tonnes lifted in 2012) and that the predicted strong passenger growth for the Sydney region (Department of Infrastructure and Transport, 2012) will lead to even more crowded (potentially constraint) and complex airport operations (Forsyth, 2013), it becomes evident that getting the terminal organisation right is not only important for the airport but also for the competitiveness and development of the entire region. The importance of belly-hold freight activity becomes even more important when considering that most freight at Sydney airport is carried in the belly hold of passenger aircraft, as shown in Figure 3. While the freight volume of carried in freighters is considerable, in terms of aircraft movements belly-hold operations strongly dominate Sydney airport's freight operations. With ever increasing sizes of aircraft flying into Sydney (according to its CEO, Sydney airport is already the world's sixth busiest A380 airport with further growth expected), it is evident that the increased belly-hold capacity will offer even more opportunities for airlines to carry freight that way.

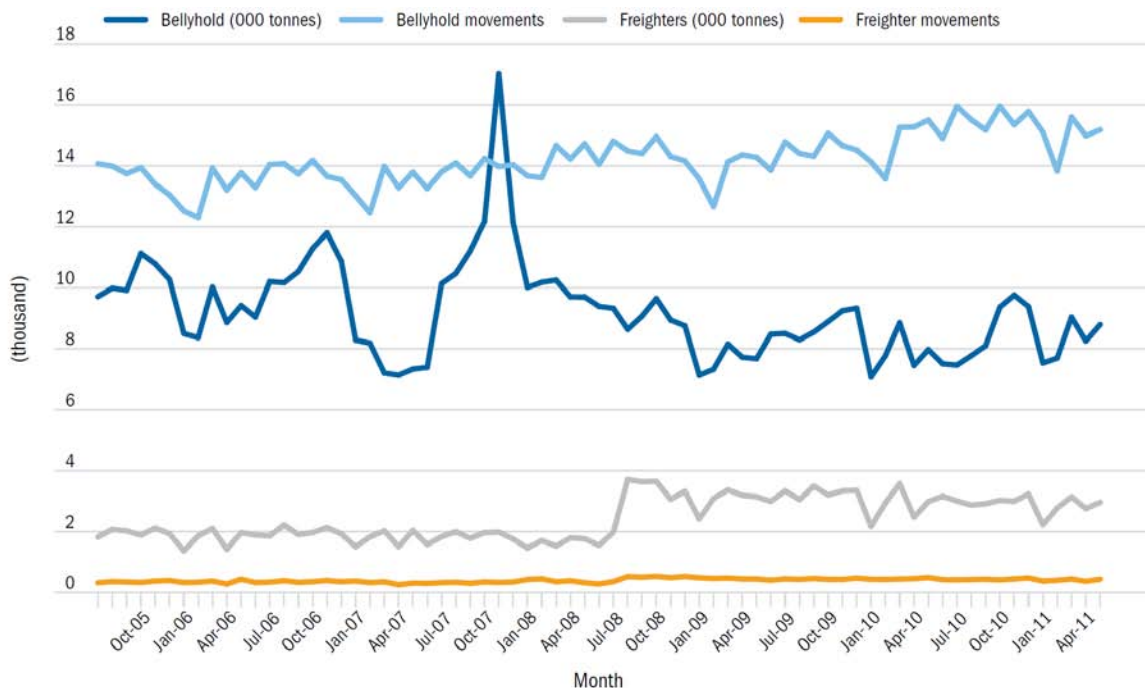
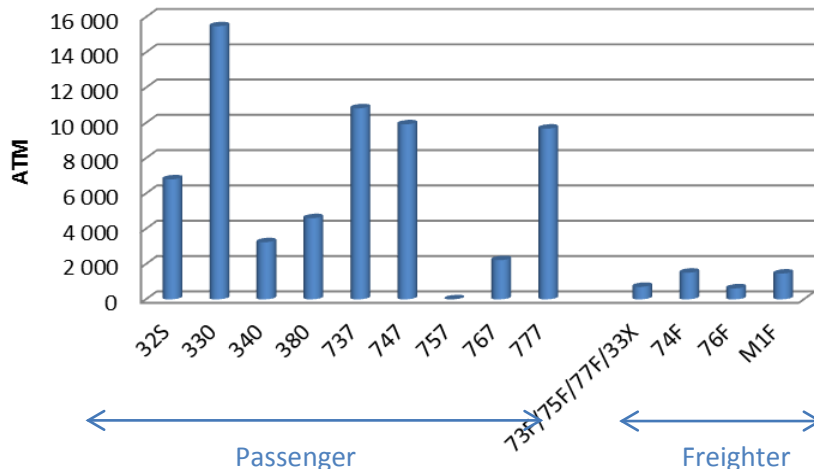


Figure 3: Freight carried in freighters or in passenger aircraft belly hold at Sydney airport

Note: Peak for freight in cargo hold was due to an incidental spike in commercial opportunity. Source: BITRE.

The data shown in Figure 4 confirms that it is indeed passenger aircraft and their belly holds that dominate aircraft movements at Sydney airport.



Source: BITRE.

Figure 4: Aircraft movements by aircraft type at Sydney (KSA) airport in 2012

The evidence gathered through our interviews with senior managers shows generally a strong support for the terminal reconfiguration proposal not only for passenger but also for freight operations, as most interviewees agree that the 2009 master plan had a lack of importance placed on freight. Interestingly, both Jetstar and Virgin Australia outsource their freight operations to Qantas and Toll respectively, but they still depend on those actors as any delay in belly-hold freight operations (outsourced or not) will have impacts on their passenger on time performance and cost structures. The support for the proposal may also be a result of it including further improvements such as new dedicated freight facilities, a new general engineering complex, as well as additional gates. All of our interviewees did not confirm our proposition that in the case of passengers transferring within one alliance/terminal (much faster than under the current system), the belly-hold operation would slow down the process and hence incentivise airlines to use more freighters for their freight operations. Particularly for luggage it would appear to be the opposite, meaning that under an alliance-based terminal organisation, similar to the passengers, their bags also would be transferred much faster and efficiently (and even in the current system the transfer of bags takes only around 15 minutes, which is different to cargo that needs additional security checks for example for explosives, not to mention life stock which is also relevant to the Sydney airport context). Interestingly, mail does not appear to be a concern to neither airlines nor the airport, as its share in total freight volume is diminishing.

When confronting the interviewees with our regression results (see section 4.1), most of them confirmed the possibility that transits issues at Adelaide and Melbourne could have been drivers of freight aircraft choice. However, during the interviews some further explanation of the relationship between international freight activity and use of freighters emerged. A number of interviewees suggested that the lack of belly-hold capacity to certain airports means more dedicated freighter capacity to deliver freight volumes that are demanded to/from that city. This would hold true for Adelaide which has had limited (but now increasing) international services, and to some extent also for Melbourne through 2003-2008 before they saw significant growth in international passenger services. In other words, where there is belly-hold capacity to meet freighter demand, freighters are not required. Where demand on a city pair outstrips the capacity for belly-hold freight then dedicated freighters are operated.

According to our interviewees, the reconfiguration of passenger terminals would have one key benefit, that is, that it would give Sydney airport the opportunity to streamline freight chains, to improve freight visibility and touch points (e.g. from ramp to carousel) and to overhaul freight facilities in general. For example, currently all roads at the airport are behind the aircraft, which leads to interference of aircraft and ground vehicles and hence inefficiencies. In terms of facilities, the airlines hope to get more space (particularly for sorting and storage), a larger number of counters, more carousels, air bridges and gates as they not only expect more but also larger aircraft to use Sydney airport in the future (which may not be at capacity in terms of runways by 2019 but is reportedly already today at peak times close to capacity at certain freight facilities, such as bag rooms). In that sense it was seen as more important that the proposal also includes a reserved airside transfer corridor and a bypass freight area at the airport boundary (which will primarily be used for freighter operators such as DHL and FedEx, but is also important for the overall freight operations that are forecasted to double by 2033 from the currently 550.000 tonnes per year).

According to all interviewees the success of the proposal will not so much depend on destination versus alliance-based terminal organisation, but on the location of the gates, and the proximity of the freight facilities (i.e. the cargo terminal) to suppliers and intermodal touch points. In that respect, all interviewed players see positive aspects in the proposal but particularly, the airlines are cautious with regards to some details (as they compete for the best locations and gates) and highlight that the proposal is still just a notion at this stage. Indeed, Sydney airport appears to be still open in regards to the details of the proposed reconfiguration. During the interview period it emerged for example that the proposal has been (in consultation with the airlines) slightly modified. The plan is still to overcome the divide between the domestic and international terminals, making it easier for passengers to catch connecting flights. However, according to Sydney airport management, the 2014 Master Plan will now no longer specify the location of any airlines. Whilst the New Vision initially announced an alliance-based approach the airport management now recognises that the competitive landscape amongst airlines is very dynamic. Since the announcement of the “New Vision” Virgin Australia entered into many of its significant airline partnerships, and also the Qantas / Emirates alliance, changed operation patterns at the airport. According to the 2013 preliminary draft version of the Sydney Airport Master Plan 2033 (SACL, 2013) all terminals will cater to international / domestic and regional traffic allowing airlines to transfer traffic more easily than the current setup. In addition each terminal will have freight facilities located in close proximity. While the consultation has resulted in this minor change, it has not resulted in any major concern with regard to belly-hold transfer operations. If the reconfiguration is going ahead as planned it will remain to be seen whether the impact on freighter/belly-hold international freight operations will be a similar one to that of Melbourne after they reconfigured their terminals in 2007. Interestingly, none of our interviewees saw such a development likely to occur at Sydney airport, at least not as a direct result of the proposed reorganisation. One of the key constraints to freight operations at Sydney airport is the night curfew (mentioned by all interviewees), which may present a further hurdle for operating pure freighter operations at a commercially viable level (in addition to the unidirectional international freight chains that Sydney airport faces).

5. Conclusions

This paper set out to analyse potential impacts of passenger terminal organisation (destination versus alliance-based) on international/domestic belly-hold freight operations. Such analysis is timely as major hubs, such as Dubai T3, London Heathrow T5 or Munich T2 have changed their terminal organisation towards the alliance-based approach and others, such as Sydney are in the process of following suit. The benefits of the alliance-based terminal configuration are obvious for the case of passenger operations (i.e. much enhanced passenger flows for flight connections) and well discussed in the literature.

In contrast, we discuss for the first time that an alliance-based approach can have detrimental impacts on international belly-hold operations. That view is initially supported by our regression analysis, as the regression results suggest that airports in Australia who have followed the alliance-based approach, have a larger share of freighter aircraft in total aircraft movements compared to those that organise their passenger terminals by destination.

However, our findings from analysing the Sydney airport case and its proposed terminal reconfiguration provide no evidence that an alliance-based passenger terminal organisation is indeed inferior to the destination organisation approach when considering international (connecting) belly-hold operations. Our interview results suggest rather the opposite but also highlight that successful freight operations depend on many other factors too and that airlines worry most about being potentially in an unfair advantage compared to their competitors in terms of having access to the most customer friendly and efficient passenger and freight airport facilities. In future research we aim to further investigate the discussed intramodal and also intermodal airport freight chains.

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