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The Role of Freighter Aircraft in a Full-Service Network Airline Air Freight Services: The Case of Qantas Freight

Glenn Baxter[1]*, Panarat Srisaeng[1], Graham Wild[2]

[1]School of Tourism and Hospitality Management, Suan Dusit University, Hua Hin Prachaup Khiri Khan, Thailand
[2]School of Engineering, RMIT University, Melbourne, Victoria, Australia
***Corresponding author**: School of Tourism and Hospitality Management, Suan Dusit University, Hua Hin Prachaup Khiri Khan, Thailand. Email g_glennbax@dusit.ac.th

Abstract
The dedicated all-cargo aircraft market is vital to the global economy. Freighter aircraft now carry around 56 per cent of world air cargo traffic. Using an in-depth case study research design, this study examined the Qantas Freight Boeing B747-400 and B767-300 freighter aircraft route network design during the 2017/2018 Northern Winter Flight schedule period, which was in effect from the 29th October 2017 to March 24th, 2018. The qualitative data were examined by document analysis. The study found that Qantas Freight deploy their leased B747-400 freighter aircraft on a route network that originates in Sydney and incorporates key markets in Thailand and China with major markets in the United States. The Boeing B767-300 freighter aircraft operated 5 services per week on a Sydney/Auckland/Christchurch/Sydney routing as a well as a weekly Sydney/Hong Kong/Sydney service. The Boeing B747-400 freighter services could generate 114,755,020 available freight tonne kilometres (AFTKs) over the schedule period. The Boeing B767-300 freighter aircraft could generate 46,974,1440 AFTKs. The Qantas Freight route network and freighter fleet is underpinned by Australia's liberalized freighter aircraft policy, the "Open Skies" agreement between Australia and China – which permits the onward carriage of cargo traffic across the trans-Pacific – and the liberalized "open skies" agreement with New Zealand.

Keywords
air freight; air services agreement; airline route networks; case study; freighter aircraft; Qantas Freight

1. Introduction

The air transportation of goods/freight for commercial purposes plays a significant role in the global economy. Air freight is defined as "anything carried in an aircraft except for mail or luggage carried under a passenger ticket and baggage check but including baggage shipped under an airway bill or shipment record". [1] Passenger baggage is associated with the carriage of passengers and is included as part of the individual passenger's air fare. [2] Passenger baggage is therefore not a part of the air cargo service. In the world air

freight industry, air freight capacity is provided by combination passenger airlines, that is, airlines that carry passengers on the main deck and air cargo in their passenger aircraft lower lobe belly-holds and by dedicated all-cargo carriers as well as the integrators, for example, FedEx and United Parcel Service (UPS). [3] All-cargo services are operated by dedicated freighter aircraft with all the available capacity dedicated to air cargo transportation. The dedicated all-cargo market is vital to the aviation industry, and to the global economy. [4] A freighter aircraft is an aircraft that has been expressly designed or which has been converted to transport air cargo, express, and so forth, rather than passengers. [5] Boeing [6] estimates that currently around 56 per cent of global air cargo revenue ton kilometres (RTKs) is carried in dedicated freighter aircraft, and forecasts that this volume of traffic will more than double in the next 20 years.

In 1949-50, there was only a very small amount of Australia's international trade that was transported by the international air freight mode. During this infancy period of Australia's air freight industry, four airlines, British Commonwealth Airlines, Qantas Empire Airways Ltd, British Overseas Airways Corporation, and Tasman Empire Airways transported Australia's international air freight. The primary air freight destinations were in the South Pacific Islands, Hong Kong, London, Tokyo and Vancouver. [7] From these very humble beginnings, Australia's international air freight mode has now developed into an integral part of Australia's economy. Since the early 1990s, the Australian Government has increasingly embraced a more liberalized international air freight policy that has aimed to encourage the development of air freight as a market in its right and to ensure that air freight capacity is available to satisfy the opportunities for Australian firms in international markets. This policy was reaffirmed in the Australian Government's 2009 White Paper – Flight Path to the Future. [8] This liberalized air services policy has provided Qantas Freight, the air freight division of Qantas Airways, Australia's major flag carrier, with the opportunity to operate dedicated freighter services to key air freight markets using a fleet of two Boeing B747-400F and one Boeing B767-300F freighter aircraft.

The aim of this paper is to examine the Qantas Freight freighter aircraft route network architecture and to quantify the total available freight tonne kilometres (AFTKs) that these services produced during the 2017/2018 Northern Winter flight schedule period. The Northern Winter flight schedule period commenced on the 29th October 2017 and concluded on the 24th March 2018. A second aim is to quantify the flight stage lengths of the freighter services operated by Qantas Freight during the flight schedule period. A further aim is to examine the regulatory framework that underpins the ability of Qantas Freight to operate its desired Boeing B747-400 and Boeing B767-300 freighter aircraft services. A final aim of the paper is to examine the difference in the Qantas international passenger route network vis-à-vis the Qantas Freight freighter route networks.

The remainder of the paper is organized as follows. Section 2 sets the contextual setting of the study and presents a review of the extant literature on the research topic. The role of freighter aircraft in airline networks, the international aviation regulatory framework and the key operational characteristics of the Boeing B747-400F and the Boeing B767-300F are examined in this section. Section 3 describes the research method that underpinned the study. The case study is presented in Section 4. Section 5 presents the study's findings and conclusions.

2. Background

2.1 Air freight market liberalization

Air transport has had a long history of economic regulation. [9] Much of the recent focus in the global air transport industry has been on the liberalization of the passenger market, but the regulatory structure has also been applied to air freight activities. [10, 11] This is especially so in the case of combination carriers' belly-hold operations. The arrangement, in which passengers are carried on the aircraft's main deck, and cargo is carried below in the lower lobe "belly-hold" compartments, is referred to as a combination aircraft. [2]

International air transport operates within the framework of the 1944 Chicago Convention on International Civil Aviation and has been traditionally administered by a complex network of multilateral government air services agreements (ASA's) and International Air Transport Association (IATA) rules. The 1919 Paris Convention on the Regulation of Air Navigation established each state's complete and exclusive sovereignty over the airspace above its territory. [14, 15] The 1944 Chicago Convention on International Civil Aviation later reinforced this framework through codifying the rights and responsibilities of air service providers into a set of rules known as the Freedoms of the Air (Table 1) [16]. The 1944 Chicago Convention established multilateral agreements in some areas, mainly concerning an airline's right to overfly and make technical stops in a foreign country, but not in areas of commercial rights. Commercial air rights were left to bilateral air services agreements to be negotiated between individual countries. [17]

Following the 1946 Bermuda Agreement – between the United Kingdom and the United States – the Freedoms of the Air were operationalized globally in multiple reciprocal bilateral air services agreements between states (and supported by detailed Memoranda of Understanding). [16] In 1946, the very first bilateral air services agreement was signed between the United States and the United Kingdom and is known as Bermuda 1. The Bermuda 1 agreement set strict limitations regarding (1) ex post facto capacity, (2) designation of airlines, (3) air traffic rights in terms of which routes are to be served by the designated airlines, and (4) double approval of tariffs by both Governments. [18]

It is important to note that the International Civil Aviation Organization (ICAO) refers to all freedoms beyond the Fifth Freedom as "so-called" freedoms. The reason being that only

Table 1. The freedoms of the air [12, 13]

Freedom	Definition
1st	The right of the airline of State A to fly across the territory of State B without landing
2nd	The right of the airline of State A to land in the territory of State B for non-traffic purposes (that is, a technical stop)
3rd	The right of the airline of State A to put down passengers or freight originating in its home territory in the territory of State B
4th	The right of the airline of State A to take on, in the territory of State B, passengers or freight destined for State A
5th	The right of the airline of State A to operate beyond State B and to take on and put down passengers, cargo and mail travelling between State B and State C (that is, carriage of third country traffic, not originating or terminating in the home country of the airline
6th	The ability of the airline of State A to carry traffic between State B and State C via its home territory with nor requirement to include on such operation any point in the territory of the recipient State
7th	The right of airline of State A to transport traffic between State B and State C, with no requirement to operate via a point in its home territory (that is, the service need not connect to or be an extension of any service to/from the home State of the airline
8th	The right of the airline of State A to transport local domestic (often referred to as cabotage) traffic between two points in the territory of State B, on a service which originates or terminates in State A
9th	The right or privilege of transporting cabotage traffic of the granting State on a service performed entirely within the territory of the granting State

the first five freedoms have been officially recognized by way of international treaties arising from the Convention. [19]

Bilateral air services agreements (ASAs) are negotiated on the principle of reciprocity, and equal and fair exchange of air services traffic rights between countries very different in size and with airlines of varying sizes. Scheduled airline services and capacity between nations is therefore determined through a legal framework of bilateral negotiations of ASA's. [20] Bilateral ASA's vary in form, but in general, these agreements establish a country's market access (entitlement of capacity), airline designation, capacity (the level of flight frequencies, the authorized routings, and whether dedicated freight services would be permitted). These agreements can also determine tariffs, the types of aircraft that can be used, and what airports can be utilized by airlines for their services. [21] Bilateral air services agreements normally cover the carriage of both passengers and air freight by air, including both passenger and all-cargo flights. [11]

A critical issue arises once an air services agreement is agreed between two states: the designation of airlines. In addition to the nationality clause that defines the qualitative criteria an airline must fulfill to be designated, every ASA also generally contains a quantitative regulation on the total number of airlines that a country can designate. A country may be permitted to nominate just one airline (single designation) or several airlines (multiple designation). [12] For example, Australia has moved to a multiple designation policy. [22, 23]

Air traffic rights for the transportation of air freight and postal mail can be exercised both on passenger and all-cargo (freighter) flights. Those related to passenger services, which also carry air freight in the aircraft's lower deck belly holds, are dependent upon the carriage of passengers and the negotiations between the two governments is principally concerned with factors that are governed by the passenger market. [11] These air services agreements have been liberalized over the past 2 to 3 decades, particularly with the regard to the designation of the national carrier permitted to provide services, ranging from single to multiple airline designation. [11, 24]

The number of third and fourth freedom routes has also been liberalized, with the addition of some fifth freedom rights. Some airlines have also been able to expand their hub operations and the volume of traffic carried by combining two sets of third/fourth freedoms to carry sixth freedom traffic. Examples of this include Singapore Airlines, Etihad Airways and Emirates. Operating wide-body passenger aircraft they have been able to carry substantial amounts of air freight on these routes, primarily from Australasia to Europe. [11]

Air freight traffic rights are typically granted under the same Air Services Agreement (ASA) as passengers, and hence, have benefited from the gradual liberalization of air rights that was evident for passengers. [11]. Furthermore, in recent years, all-cargo services traffic rights have become increasingly liberalized. An intermediate traffic stop provides the airline with the possibility of earning additional revenue, which may often be the difference between the profit and loss on the overall freighter flight operation. [25] These agreements are often more liberal than their passenger counterparts,

as they provide less of a threat to national or flag carriers that are reliant upon passengers. [11]

2.2 Features of air freight services

The primary reason for liberalizing air freight services is that air freight has features that are quite distinct from air passenger services. Human air travelers prefer flying directly to their destination whenever possible. [26] Should a transfer be required, then passengers prefer the shortest possible waiting time at the hub airport. Passengers also prefer a comfortable and attractive airport environment to make their travel experience as productive and enjoyable as possible. [27] Air freight, being inanimate, have no such feelings and air freight shippers often have little preference regarding the routes that their consignment travels provided time windows are satisfied. Indeed, whether the consignment travels direct, or is routed through one or more hub airports, is of lesser consequence than for passengers. Nonetheless, the transportation of air freight is sensitive to other factors, such as whether a change of aircraft is required, whether aircraft containers or pallets are required to be broken down and rebuilt, and the cost of transshipment handling. [26]

In addition, patterns of international air freight traffic are clearly different from those of passenger transport. In general, passengers tend to travel to their destination, then return to their point of origin, thereby providing passenger airlines roughly even per-seat load factors across their network system. [25]

However, the air freight mode is an important part of the world merchandise trade regime [28], and so is highly directional. World air cargo traffic is concentrated on several key trade flows between regional centres of production and consumption. This concentration is especially pronounced in air freight than for airline passenger flows which are more diffuse in nature. [29] The most significant international air freight flows are in the northern hemisphere between North America, Europe, and Asia. The United States, the world's largest economy, has a large air cargo (both domestic and international markets) with trade to Asia, Europe and South America. In the Asia/Pacific region, the major markets are China (including Hong Kong), Japan, Korea, Singapore and Taiwan. Air-freighted exports from Asia comprise consumer electronic items, textiles and clothing that are destined to key "western" markets. [30]

Unlike passengers, air freight is normally just one-way [31]. This results in geographically unbalanced transportation patterns in terms of the structure and volume of the air freight shipped. [32] In addition, air freight flows are "unidirectional" in nature. [33, 34] This is because air freight tends to move from manufacturing to distribution centres or from production to the point of consumption. [27, 35] Moreover, in international import/export trade, in terms of air freight consignments shipped between two countries, the trade volume can vary substantially so that one of the destinations is more in demand than the other.[36] Thus, considerable imbalances in air freight flows on routes can occur, which rigid ASAs may be ill-equipped to deal with.[37] On major world air freight routes, it is quite common to find that the volumes of traffic shipped in the densest direction is almost double the volume of the return direction [24]. This is because the inbound/outbound imbalance is essentially influenced by import/export trade imbalances between countries/regions. [26]

Whilst combination airlines flights are confined to the requirements of passengers, freighters are routed and scheduled based on shipper requirements. [38, 39] Therefore, all-freight carriers sometimes design their route networks with "big-circle" or convoluted routes, whilst passenger airlines typically operate east to west or north and south along the same linear route linking two cities. [26] However, the 'directionality problem' in air freight flows can often make it difficult for freighter operators to fill their aircraft profitably across their international route networks. The opportunity to make an intermediate stop in a freighter network opens the possibility for the airline of earning additional revenue, which may often mean the difference between profit and loss on the overall routing. Hence, freighter aircraft operators require the aircraft routing and load-building flexibility provided by fifth, sixth and seventh-freedom rights in air services agreements (ASAs) [25].

2.3 Combination airline passenger and freighter airline aircraft route networks

Line-haul operators transport air cargo on an airport-to-airport basis and typically rely on international air freight forwarders to deal directly with shippers. Line haul operators embody both scheduled and unscheduled all-cargo undertakings transporting only cargo in dedicated freighter aircraft for example, dedicated all-cargo airlines provide relatively high reliability and have the capability to move large volumes of air cargoes over long distances. For the combination airlines, air cargo operations are primarily long-haul, with large volumes of cargo being interlined onto shorter haul feeder services. [40] Some combination airlines operate freighter aircraft as well their passenger services. [39, 41, 42]

Although not quite half of the world air cargo is still carried in the belly holds of passenger aircraft there are some inherent limitations with belly-hold air freight. [11, 43] On passenger flights, passengers and their baggage have a higher boarding priority than air freight [44]. If unfavorable wind conditions on a long-haul flight necessitate a reduction in the available payload, air freight is likely to bear the brunt of that payload reduction. Offloading of cargo is a major complaint of major shippers because it causes considerable problems with their supply chains. [43]

Furthermore, airline passenger services are timed for the convenience of passengers. For air cargo shippers, flights departing in the late evening and night tend to be the most compatible with their daily production schedules. [43] Accordingly, most all-cargo airlines schedule their services to operate to and from their hubs overnight to meet shippers'

requirements for overnight deliveries. [45] As shippers' expectations regarding the speed, reliability and timeliness of air transport has grown, so too has the attraction for the operations of dedicated freighter aircraft. The larger capacities of dedicated freighter aircraft are also an increasingly important advantage as major companies seek to ship large consignments, often at short notice. [43]

As freighter fleets have expanded, the ability of airlines to schedule higher frequencies services has further strengthened the attraction for freighter operations. Higher freighter frequencies are critical as they permit manufacturers to more tightly time larger consignments to fit in neatly meshed production networks. [43]

Airlines operating freighter aircraft often confront scheduling difficulties due to the directional imbalance in air cargo flows. Dedicated freighter aircraft may be fully laden when travelling eastbound from Asia to the United States, or westbound to Europe, but then fly back to Asia with much smaller cargo loads. Consequently, due to these demand/supply imbalances, airlines are required to construct special routing freighter aircraft patterns – for instance, clockwise circular routes around the Pacific or intensive hub-and-spoke operations. [26]

Inter-continental freighter routes are designed to link up the major centres of world trade. Such networks consist of long-haul flights to and from the airlines major hub airport, where long-haul shipments are often broken down and uplifted on subsequent flights to their final destinations. The major types of freighter aircraft operated on long-haul intercontinental routes are the Boeing B777-200LRF, B747-400F B747-8F and MD11 aircraft. Regional freighter routes are designed to link up the airline's major hub airport with important centres of regional trade. Air cargo is sourced from these markets and transported back to the airline's hub airport for loading onto to the airline's long-haul inter-continental services. [46]

3. Research Method

3.1 Research Approach

A qualitative research approach was used in this study. The study of the role of freighter aircraft in a full-service network carrier's (FSNC) air freight operations is still an emergent area of study. Thus, the most appropriate research method for such an emerging area is a qualitative method. [47] A case study approach was used in this study as this allows for the exploration of complex phenomena. [48, 49] Furthermore, a case study permits researchers to expand and build theories rather than perform statistical analysis to test a certain hypothesis. [50]

3.2 Document Collection

Qualitative data was also gathered from Qantas Airways, Qantas Freight and relevant Government web sites, air transport and airport industry-related magazines, and press articles. An exhaustive source of the air transport and cargo industry-related magazines – Air Transport World, Air Cargo World, Airline Business, Flight International, and Journal of Commerce was also conducted. These industry publications were accessed in the Proquest ABI/INFORM and EBSCO Information Sources databases. Table 2 shows the publications used in the study and the time-period for which the key word search was conducted. A search of the SCOPUS and Google Scholar databases was also undertaken. The key words used in the database searches were "Qantas Freight", "Qantas Freight freighter services", "Australia/China air services agreement", "Australia/New Zealand air services agreement". The website for Payload Asia, another key air freight industry publication, was also used in the study.

The study therefore used secondary data analysis to investigate the research problem. The three principles of data collection suggested by Yin [49] were followed in this study. These included the use of multiple sources of case evidence, the creation of a database on the subject, and the establishment of a chain of evidence.

3.3 Document Analysis

The empirical data collected for the case studies was examined using document analysis. Document analysis is often used in case studies and focuses on the information and data from formal documents and company records. [51, 52] According to Beaudry and Miller [53], qualitative document analysis "describes and interprets written materials that are produced by actors and are not solicited by the researcher". The documents collected for the study were examined according to four criteria: authenticity, credibility, representativeness and meaning. [54, 55, 56]

Prior to undertaking the formal analysis of the documents gathered in the study, the context in which the documents were created was determined and the authenticity of the documents was assessed. [57] Authenticity involves an assessment of the collected documents for their soundness and authorship. Scott and Marshall [55] note that 'soundness refers to whether the document is complete and whether it is an original and sound copy. Authorship relates to such issues as collective or institutional authorship. As previously noted, in this study the primary source of the case study documents was from the Qantas Freight 2017/2018 Northern Winter Flight Schedule, Qantas Airways and Qantas Freight websites, Qantas Airways press releases, and case study-related articles from the leading air transport and air cargo industry-related publications. Also, as previously noted, these publications included Air Cargo World, Air Transport World, Airline Business, Flight International, and Journal of Commerce. The documents gathered in the study were available in the public domain or from the Proquest/ABI Inform and EBSCO Host databases.

Authenticity addresses whether the document is original, are not of questionable origin, and that they have not been subsequently altered in any way. If a document has been found to be transformed, through textual editing, marginalia,

Table 2. Publication, time-period, and database sources used in the study

Publication	Time Period	Database
Air Cargo World	2004-2018	EBSCO Host
Air Transport World	2004-2018	Proquest ABI/INFORM
Airline Business	2004-2018	Proquest ABI/INFORM
Flight International	2004-2018	Proquest ABI/INFORM
Journal of Commerce	2004-2018	Proquest ABI/INFORM

or any other means, then the researcher is required to clearly identify those alterations. Once it has been determined by the researcher that the document is "genuine and of unquestionable origin," then the material can be considered "valid" as an artefact. [58] The documents gathered for the present study were all found to be genuine and there was no evidence of any changes being made to documents that were collected for the study.

Whilst any form of qualitative data may be original and genuine, that is, authentic, it is possible that the content may still be distorted in some manner. Thus, a second criterion in appraising materials is determining their credibility and identifying whether the document's information is both honest and accurate. [58] Hence, credibility refers to the extent to which a document is sincere and not distorted and is free from error and evasion. In assessing this criterion, it is necessary for the researcher to determine whether the document can be regarded as a credible, worthwhile piece of evidence and, also in some instances, whether it is accurate. [59] The documents gathered for the present study were all found to be free of error. The accuracy of all the gathered documents were checked to ensure that they were credible pieces of evidence, and thus, could be used in the study.

A third criterion, representativeness, refers to the "general problem of assessing the typicality or otherwise of the evidence" [59] collected for the study. A document's representativeness may become distorted over time. This is because with the passing of time the survival rate of certain materials becomes greater as the items may have been viewed as less valuable. Accordingly, the document(s) may have been stored away, rarely viewed following their point of origination, and hence, preserved. Furthermore, some important documents do not survive because their great significance caused them to become well used and worn. Consequently, they may be discarded while on the other hand less important documents survive because they attract so little use. [58] In this study, the Qantas Freight Northern Winter 2017/2018 flight schedule, Qantas Airways press releases and annual reports were available in the public domain. The news-items on Qantas Freight were stored in the Proquest ABI/INFORM or EBSCOhost databases, thus, the documents had been preserved. Consequently, the issue of a document being well used and worn did not arise in this study.

A final criterion—meaning—refers to the degree to which the evidence is clear and comprehensible to the researcher(s) [58, 59] and concerns the assessment of the actual documents gathered for the study. [59] The fourth criterion, meaning, is a most important matter and occurs at two levels. The first is the literal understanding of a document, by which is meant its physical readability, the language used and whether it can be read, as well as the date of the document. [59, 60]

The study's qualitative document analysis process was undertaken in six phases as presented in Table 3.

The documents gathered for the study covered the period 2004 to 2018, that is, the documents covered the period from the inception of the dedicated international freighter operations by Qantas Freight through to the present time of the study.

All the gathered documents were downloaded into a case study database. [49, 62] The documents collected for the study were all in English. Each document was carefully read and key themes, such as, "Qantas Freight", "Qantas freighter aircraft", "Qantas freighter services", "Australia/China air services agreement", "Australia/New Zealand air services agreement", and "airline freighter route network" were coded and recorded. This study followed the recommendation of van Schoor [63], to "avoid bias, documents of different sources were analyzed". Triangulation is used to add discipline to a study in both qualitative and quantitative research. One of the principal reasons for triangulation is the recognition that bias can be introduced if only one way of obtaining and interpreting data is used in the study. Triangulation is also used in qualitative research as a procedure to ensure stronger accuracy, employ cross-referencing, or demonstrate the verification of the data. This study used data triangulation with the documents being collected from various sources. This approach helped verify the themes that were detected in the documents gathered in the study. [62, 64]

4. Results

4.1 A Brief Overview of Qantas Freight

Qantas Freight is Australia's largest air freight services provider. Qantas Freight, the air freight division of Qantas Airways, markets the available freight capacity on Qantas and Jetstar Airways passenger aircraft. It also operates a fleet of 14 dedicated freighters. These aircraft are used to supplement the Qantas and Jetstar Airways belly-hold capacity on key domestic and international routes. [65]

In addition to being Australia's major air freight carrier, Qantas Freight is also Australia's largest airfreight cargo terminal operator. Qantas Freight operates a network of 22 air cargo terminals. These air cargo terminals provide ground

Table 3. The study's document analysis process [61]

Phase of the Study	Activity/Task Undertaken
Phase 1	This phase involved planning the types and required documentation and their availability.
Phase 2	The data collection involved gathering the documents and developing and implementing a scheme for the document management;
Phase 3	Documents were reviewed to assess their authenticity, credibility and to identify any potential bias
Phase 4	The content of the collected documents was interrogated, and the key themes and issues were identified
Phase 5	This phase involved the reflection and refinement to identify any difficulties associated with the documents, reviewing sources, as well as exploring the documents content
Phase 6	The analysis of the data was completed in this final phase of the study

handling to the Qantas Group and other client airlines. [65]. Figure 1 shows Qantas Freight's annual inbound and outbound enplaned air cargo tonnages for the period 2004 to 2016.

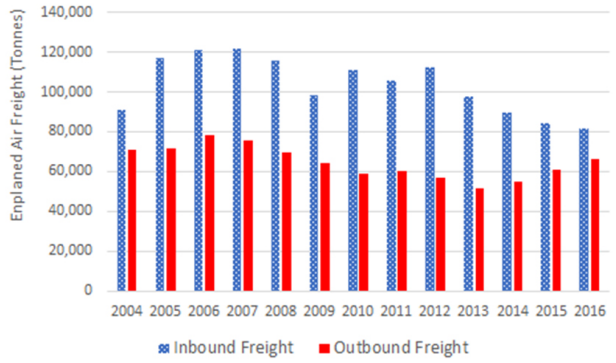

Figure 1. Qantas Freight annual inbound and outbound air freight tonnage: 2004-2016. Note: Data includes both Jetstar Airways and Qantas Airways. Source: data derived from [66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78]

Qantas Freight operates in all the international markets where the Qantas Group flies and, as previously noted, operates dedicated freighter aircraft through Asia to the Americas, and to New Zealand. In addition to the international freight services, Qantas Freight also serves over 80 domestic Australian destinations, utilizing Qantas Group passenger aircraft lower-deck belly hold capacity and the capacity provided by a fleet of dedicated freighters.

Qantas Freight's principal customers are firms seeking efficient and reliable domestic and international air freight transport and cargo and ground handling services. Qantas Freight's 'Q-GO' product range offers customers a comprehensive range of air freight services. These services include airport-to-airport air linehaul and ground handling services (including customs clearance), which are supported by related courier and road feeder trucking services. [65]

Qantas Freight have defined and implemented strategies to optimize their revenue and satisfy customer requirements. The Qantas Freight strategy aims to provide excellence in freight services, the leveraging of an integrated freight network and customer relationships, capitalize on air freight growth opportunities in the Asia/Pacific region and provide the lowest cost and best service through operational excellence. The Qantas Freight strategy also aims to leverage the company's position in China and to utilize favourable air services rights to optimize freight traffic, and to continually respond to the evolving air freight market dynamics, for instance, shifting manufacturing trends. [79]

Figure 2 shows the key milestones in the Qantas Freight Boeing B747-400F and B767-300F freighter aircraft acquisition and deployment. These are discussed in greater detail in the following sections of the case study.

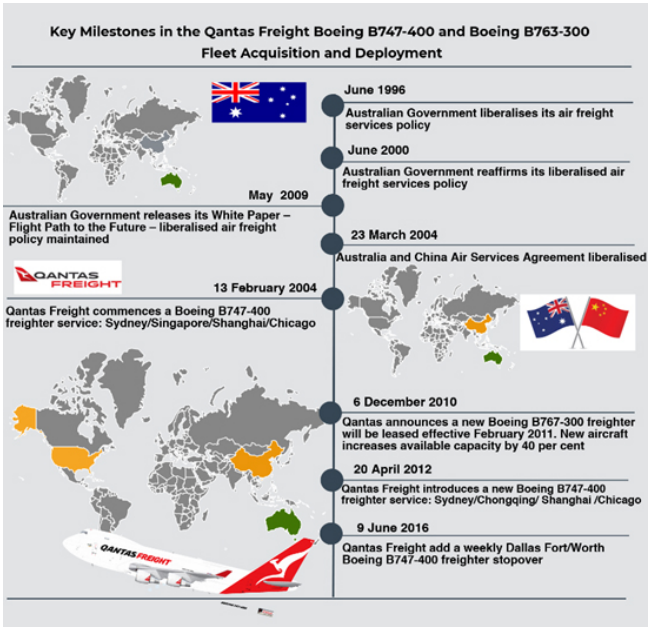

Figure 2. The key milestones in Qantas Freight Boeing B747-400F and B767-300F freighter aircraft acquisition and deployment

4.2 Australia's International Air Freight Policy

Prior to examining Qantas Freight's deployment of their Boeing B747-400 and B767-300 freighter aircraft and their freighter route network design, it is important to note Australia's international air freight policy, as this has a major impact on the route network design and Qantas Freight commercial operations. International trade in goods and services was significantly liberalized by Australia in the 1980s.[80] Commencing in the early 1990s, Australia moved further towards liberalized provisions, with the removal of restrictions on equity investments between international and domestic airlines, together with multiple designations, enabling more integration between these services. [81] Since the early 1990s, Australia has signed many free trade agreements (FTA) [82] and has ten currently in force with New Zealand, Singapore, Thailand, United States, Chile, Association of South East Asian Nations (ASEAN) (with New Zealand), Japan, Korea, Malaysia and China. [83] Currently, Australia generally favors an open free trade system. [80] At the time of the present study, Australia was engaged in nine FTA negotiations:

- Australia-Gulf Cooperation Council (GCC) FTA;
- Australia-India Comprehensive Economic Cooperation Agreement;
- Environmental Goods Negotiations;
- Indonesia-Australia Comprehensive Economic Partnership Agreement;
- Pacific Alliance Free Trade Agreement;
- Peru-Australia Free Trade Agreement;
- Regional Comprehensive Economic Partnership;
- Trade in Services Agreement; and
- Australia-Hong Kong Free Trade Agreement. [82]

Australia has air services agreements/arrangements with 101 countries/economies. Airlines operating international air services to and from Australia do so within capacity entitlements contained in air services arrangements. The air services arrangements ratified by Australia are usually comprised of a treaty level Air Services Agreement (ASA) supplemented by arrangements of less than treaty status between aeronautical authorities, such as Memorandums of Understanding (MOU) and/or exchanges of letters. It is an Australian Government policy to publish all treaty-level agreements. [84]

The role of Australia's Commonwealth Government in determining the economic regulation of Australia's international air freight industry is limited to negotiating dedicated air freight capacity in ASA's. The Australian Government negotiates through its bilateral ASA's whether dedicated freight services will be permitted and/or whether a conversion mechanism that authorizes airlines to exchange passenger rights for dedicated freight services can be applied. Essentially this is the limit of the Government's involvement in determining dedicated air freight capacity. Notwithstanding, the Government has indirect influence on the level of capacity through the passenger capacity ASA's, as the majority of Australia's international air freight is transported in the belly holds of scheduled passenger aircraft. [85]

The Australian Government has increasingly embraced a more liberalized air policy framework. In June 1996, the Australian Government implemented a liberalized air freight arrangements policy which aimed to encourage the development of air freight as a discrete market, rather than have it treated as a by-product arising from the supply of passenger services. [86]

In June 1999, the Australian Government further announced that international airlines would be granted unrestricted access (with no limits on capacity) to all airports except for Brisbane, Melbourne, Perth and Sydney – although dedicated freighter services would be allowed access to all airports. [82]

In 2000, the Government released its "International Air Services Policy Statement". The key areas of this policy statement included:

- The liberalization of air services arrangements;
- The liberalization of the ownership requirements of Australian airlines;
- The allocation of capacity available under Australian air services arrangements;
- Liberalizing international aviation multilaterally; and
- The development of air cargo as a discrete market, rather than have it treated as a by-product of passenger services. [86]

The key air freight related objective of this policy was to ensure that air freight capacity would be available to satisfy the opportunities for Australian exporters and importers in international markets. To achieve this objective, the Government defined and implemented three important strategies:

- Australia will continue to include "open skies" dedicated air freight arrangements in the country's air services arrangements where bilateral partners are willing.
- In all other cases, offer significant dedicated air freight capacity under each air services arrangement.
- Seek to negotiate a more liberal universal framework for dedicated air freight services in the World Trade Organization (WTO). [86]

In addition, the Australian Government has stated its intention to pursue multilateral liberalization of charter services in the WTO. [86] Since that announcement, the Government has negotiated ASA's that authorize designated airlines to determine the type of aircraft; frequencies, capacity and routing according to the market demand. [85]

In 2006, following a formal review of its international air services policy, the Government once again reaffirmed its commitment to developing Australia's international air freight market by seeking unlimited access for freighter aircraft from Australian markets to and beyond foreign markets.[87] Thus, the Australian Government negotiates ASA's with its key bilateral partners to ensure that dedicated air freight capacity is not used in ASA's at the expense of passenger capacity. [85] In 2009, the Australian Government's White Paper – Flight Path to the Future – reaffirmed the government's policy on liberalizing Australia's international air freight industry "recognising the benefits to the Australian economy of pursuing a liberal market for dedicated cargo services, the Government will continue to seek the removal of limits on all cargo capacity in our bilateral agreements and in multilateral forums". [8]

4.3 Qantas Freight Boeing B747-400 Freighter Aircraft Deployment and Route Network Design

As previously noted, an objective of Australia's international air freight policy has been to develop international air freight market by seeking unlimited access for freighter aircraft from Australian markets to and beyond foreign markets. Qantas Freight, the air freight division of Qantas Airways, Australia's major flag carrier has been able to take advantage of this policy. Following the conclusion of an "open skies" or liberalized agreement between Australia and China in 2004 [88], that allowed Australian airlines fifth freedom, or beyond rights from China, on the 13th February 2004 Qantas Freight introduced a twice weekly dedicated freighter service that operated on a Sydney/Singapore/Shanghai/Chicago routing before returning to Australia. On the 20th April 2012, Qantas Freight commenced a new weekly dedicated Boeing B747-400F freighter service (Flight number QF7583) direct from Sydney to Chongqing's Jiangbai International Airport. The aircraft continued to Chicago via Shanghai before returning to Sydney under flight number QF7552.89 This strategy has proved successful for Qantas who now carries around 5 per cent of the air freight traffic between China and the United States. [89]

Qantas Freight operated four weekly freighter routes linking Australia with China and the USA and returning to Sydney, Australia during the 2017/2018 Northern Winter flight schedule period. Qantas has wet-leased two Boeing B747-400 freighter aircraft from USA-based Atlas Air for use on trans-Pacific routes linking Australia with Asia and the United States. [90] On June 9, 2016, Qantas Freight added a new stop at Dallas Fort/Worth Airport. [91]

During the 2017/2018 northern winter flight schedule, Qantas Freight scheduled a Boeing B747-400 freighter aircraft each Monday on a Sydney to Chongqing, Pudong International Airport (Shanghai), Anchorage and Chicago's O'Hare International Airport flight routing (Figure 3). The outbound flight number from Sydney is QF7521 and the return flight from O'Hare International Airport, to Dallas Fort Worth, Los Angeles, and Honolulu to Sydney is QF7558 (Figure 3). [92]

Figure 3. Flight routing for the Qantas Freight QF7521 and 7558 Boeing 747-400 freighter services.

Legend: ANC=Anchorage, CKG=Chongqing, DFW=Dallas Fort/Worth, HNL=Honolulu, LAX=Los Angeles International Airport, ORD=O'Hare International Airport (Chicago), PVG=Pudong International Airport (Shanghai), SYD=Sydney

Table 4 shows the total available freight tonne kilometres (AFTKs) that could have been potentially generated on the QF7521 service. According to Qantas Freight (2018), the Boeing B747-400 freighter aircraft has an available payload of 110 tonnes. Due to the flight longer stage lengths, the largest source of AFTKs will be on the Sydney to Chongqing and Pudong International Airport to Anchorage sectors. The number of AFTKs on the Chongqing to Pudong International Airport are 161,040 AFTKs (Table 4); these are lowest AFTKs on this service due to the short flight stage-length. There will be a total of 503,910 AFTKs on the Anchorage to O'Hare International Airport sector. The total FTKs generated over these flight sectors is 2.358 million (Table 4).

Table 5 shows the total available freight tonne kilometres (AFTKs) that that could have been potentially generated on the QF7558 service. The most AFTKs on this service would be generated on the Honolulu to Sydney sector (896,940 AFTKs), due to the long stage length (Table 5). The US domestic legs, that is, between O'Hare International Airport and Dallas Fort/Worth have a quite short stage length, and thus, the AFTKs produced are quite low when compared to the Los Angeles to Honolulu (452,540 AFTKs) and the Honolulu to Sydney (896,940 AFTKs) sectors. The total AFTKs that could have been potentially produced on these services is 1.710 million AFTKs (Table 5). The AFTKs generated on the QF7558 are lower than for the QF7521 service, due to the shorter flight stage lengths on these services.

Following the return of the Boeing B747-400 freighter aircraft from the United States on Friday evening Sydney time (QF7558), the aircraft was scheduled to be unloaded and then subsequently reloaded in preparation for the QF7589 service departing on Saturday. During the 2017/2018 Northern Winter flight schedule [93], this service was scheduled to operate direct from Sydney to Shanghai's Pudong International Airport, then onwards to Anchorage before terminating at New York's John F. Kennedy International Airport (Figure 4). The return flight QF7554 operated on a John F. Kennedy International

Table 4. Available freight tonne kilometres (AFTKs) generated by flight segment on the QF7521 service

Flight Number	Sector	Distance (km)[6]	AFTKs
QF7521	SYD[5]/CKG[2]	8,462	930, 820
QF7521	CKG[2]/PVG[3]	1,464	161,040
QF7521	PVG[3]/ANC[1]	6,934	762,740
QF7521	ANC[1]/ORD[4]	4,581	503,910
Total		21,441	2,358,510

Legend: ANC=Anchorage Airport, 2 CKG=Chongqing Airport, 3 PVG=Pudong International Airport (Shanghai), 4 ORD=O'Hare International Airport (Chicago), 5 SYD=Sydney, 6 Source: flight distance. [94]

Table 5. Available freight tonne kilometres (AFTKs) generated by flight segment on the QF7558 service

Flight Number	Sector	Distance (km)[6]	AFTKs
QF7558	ORD[4]/DFW[1]	1,291	142,010
QF7558	DFW[1]/LAX[3]	1,988	218,680
QF7558	LAX/HNL[2]	4,114	452,540
QF7558	HNL[2]/SYD[5]	8,154	896,910
Total		15,547	1,710,170

Legend: 1 DFW=Dallas Fort/Worth Airport, 2 HNL-Honolulu, 3 LAX=Los Angeles International Airport, 4 ORD=O'Hare International Airport (Chicago), 5 SYD=Sydney, 6 Source: flight distance [94]

Airport (New York), O'Hare International Airport (Chicago), Honolulu, Sydney routing (Figure 4).

Figure 4. Flight routing for the Qantas Freight QF7589 and 7554 Boeing 747-400 freighter services.

Legend: ANC=Anchorage, HNL=Honolulu International Airport, JFK= John F. Kennedy International Airport (New York), ORD=O'Hare International Airport (Chicago), PVG=Pudong International Airport (Shanghai), SYD=Sydney

Table 6 shows the available AFTKs that that could have been potentially generated on the QF7589 services during the 2017/2018 Northern Winter flight schedule period. The Sydney to Pudong International Airport sector would generate the largest number of AFTKs (862,180 AFTKs), due to it being the long flight stage length. The Pudong International Airport to Anchorage flight sector is the second longest at 6,934km, and a total of 762,740 AFTKs could be generated (Table 6). This is followed by the Anchorage to John F. Kennedy International Airport sector, which could produce 599,390 AFTKs (Table 6). The total AFTKs for these services is 2.22 million (Table 5).

Table 7 shows the total available freight tonne kilometres (AFTKs) that that could have been potentially generated on the QF7554 service. The most AFTKs on this service would be generated on the Honolulu to Sydney sector (896,940 AFTKs), due to the long stage length of this sector (Table 7). The second largest source of AFTKs is on the O'Hare International Airport to Honolulu sector (751,190 AFTKs) (Table 6). The US domestic leg between New York's John F. Kennedy International Airport and O'Hare International Airport is quite short at 1,192km. The total AFTKs potentially produced over this sector is 131,120 AFTKs. The total AFTKs produced on these services is 1.779 million AFTKs (Table 7). The AFTKs generated on the QF7554 are lower than for the QF7589 service, due to the shorter flight stage lengths on this service.

As noted earlier, Qantas Freight leases two Boeing B747-400 freighter aircraft from Atlas Air. During the 2017/2018 Northern Winter flight schedule period the second Boeing B747-400 freight was deployed on two weekly rotations from Australia through Asia and across the Pacific to the USA. Qantas Flight Number 7581 was scheduled to operate each Monday on a Sydney, Bangkok, Pudong International Airport, Anchorage, John F. Kennedy Airport (New York) routing (Figure 5). The return flight QF7552 operates on a John F. Kennedy International Airport (New York), O'Hare International Airport (Chicago), Honolulu, Sydney routing (Figure 5).

Table 8 presents the available freight tonne kilometres (AFTKs) on the QF 7581 service for the 2017/2018 Northern Winter flight schedule period. The outbound sector from Sydney to Bangkok could have potentially generated 825,330 AFTKs. The distance between Bangkok and Pudong International is 2,894 kilometres, and thus, the total AFTKs produced on this leg of the flight could have been 318, 340 AFTKs. As

Table 6. Available freight tonne kilometres (AFTKs) generated by flight segment on the QF7589 service

Flight Number	Sector	Distance (km)[6]	AFTKs
QF7558	ORD[4]/DFW[1]	1,291	142,010
QF7558	DFW[1]/LAX[3]	1,988	218,680
QF7558	LAX/HNL[2]	4,114	452,540
QF7558	HNL[2]/SYD[5]	8,154	896,910
Total		15,547	1,710,170

Legend: 1 ANC=Anchorage, 2 PVG=Pudong International Airport (Shanghai), 3 JFK=John F. Kennedy International Airport, 4 SYD=Sydney, 5 Source: flight distance. [93]

Table 7. Available freight tonne kilometres (AFTKs) generated by flight segment on the QF7554 service

Flight Number	Sector	Distance (km)[6]	AFTKs
QF7558	ORD[4]/DFW[1]	1,291	142,010
QF7558	DFW[1]/LAX[3]	1,988	218,680
QF7558	LAX/HNL[2]	4,114	452,540
QF7558	HNL[2]/SYD[5]	8,154	896,910
Total		15,547	1,710,170

Legend: 1HNL=Honolulu International Airport, 2 JFK=John F. Kennedy International Airport, 3 ORD=O'Hare International Airport (Chicago), 4 SYD=Sydney, 5 Source: flight distance. [93]

Figure 5. Flight Routing for the Qantas Freight QF7581 and 7550 Boeing 747-400 Freighter Services.

Legend: ANC=Anchorage, BKK=Bangkok, HNL=Honolulu International Airport, JFK= John F. Kennedy International Airport (New York), ORD=O'Hare International Airport (Chicago), PVG=Pudong International Airport (Shanghai), SYD=Sydney.

previously noted, fifth freedom air services rights are the right of the airline of State A to operate beyond State B and to take on and put down cargo (and mail) travelling between State B and State C. [12, 13] Should Qantas Freight have decided to uplift air freight traffic between Bangkok and Pudong International Airport to the United States on the QF7581, then it would be exercising its fifth freedom rights from Thailand. The flight sectors between Pudong International Airport and Anchorage and Anchorage and New York's John F. Kennedy Airport will generate 762,740 and 599,390 AFTKs, respectively. Both sectors have quite long stage lengths, and hence, the AFTKs production reflects these distances. The total AFTKs that could have been potentially produced on each QF7581 service during the 2017/2018 Northern Winter Flight Schedule period was 2,505,800 AFTKs (Table 8).

During the 2017/2018 Northern Winter flight schedule period, the weekly QF7550 could have been potentially been able to produce a total of 1.77 million AFTKs (Table 9). The return flight to Sydney from New York's John F. Kennedy Airport includes two long stage lengths, that is, the O'Hare International Airport to Honolulu and the Honolulu to Sydney sectors. These two sectors could have potentially produced 751,190 and 896,940 AFTKs, respectively. Due to the short stage length between John F. Kennedy Airport and O'Hare International Airports, the number of AFTKs (131,120 AFTKs) is much lower than for the two other sectors, due to the shorter flight stage length (Table 9).

During the 2017/2018 Northern Winter flight schedule period, Qantas Freight deployed its second leased Boeing B747-400 freighter on a Sydney, Chongqing, Pudong International Airport, Anchorage, O'Hare International Airport routing. The return flight includes a stopover in Auckland, New Zealand as part of the routing: O'Hare International Airport, Los Angeles, Honolulu, Auckland, Sydney (Figure 6).

The longest stage length on the QF7557 service is between Sydney and Chongqing, and consequently, this sector could have potentially produced the highest number of AFTKs (930,820 AFTKs). The flight stage lengths between Pudong International Airport and Anchorage and Anchorage and O'Hare International Airport are also quite long, and the AFTKs generated on these two sectors are 762,740 AFTKs and 503,910 AFTKs, respectively (Table 10). The smallest number of AFTKs on the weekly QF7557 service was on the short domestic leg in China between Chongqing and Pudong International Airports. Due to the short stage length distance of 1,464km, a total of 161,040 AFTKs could have been potentially generated over this sector. During the 2017/2018

Table 8. Available freight tonne kilometres (AFTKs) generated by flight segment on the QF7581 service

Flight Number	Sector	Distance (km)[6]	AFTKs
QF7581	SYD[5]/BKK[2]	7,503	825,330
QF7581	BKK[2]/PVG[4]	2,894	318,340
QF7581	PVG[4]/ANC[1]	6,934	762,740
QF7581	ANC[1]/JFK[3]	5,449	599,390
Total		22,780	2,505,800

Legend: 1ANC=Anchorage, 2BKK= Bangkok, 3JFK=John F. Kennedy International Airport, 4PVG=Pudong International Airport (Shanghai), 5SYD=Sydney, 6Source: flight distance. [93]

Table 9. Available freight tonne kilometres (AFTKs) generated by flight segment on the QF7550 service

Flight Number	Sector	Distance (km)[5]	AFTKs
QF7554	JFK[2]/ORD[3]	1,192	131,120
QF7554	ORD/HNL[1]	6,830	751,190
QF7554	HNL/SYD[4]	8,154	896,940
Total		16,176	1,779,250

Legend: 1 HNL=Honolulu International Airport, 2 JFK=John F. Kennedy International Airport, 3 ORD=O'Hare International Airport (Chicago), 4 SYD=Sydney, 5 Source: flight distance. [93]

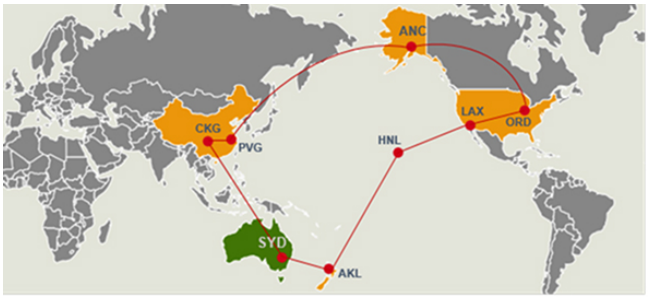

Figure 6. Flight routing for the Qantas Freight QF7557 and 7552 Boeing 747-400 freighter Services

Legend: AKL-Auckland, ANC=Anchorage, CKG= Chongqing, HNL=Honolulu International Airport, ORD=O'Hare International Airport, PVG=Pudong International Airport (Shanghai), SYD=Sydney.

Northern Winter flight schedule period, the total AFTKs generated on the weekly QF7557 service would have been 2.35 million AFTKs (Table 10).

During the 2017/2018 Northern Winter flights schedule period, Qantas Freight included a stop-over in Auckland on the return leg of the QF7552 flight to Sydney. This provided Qantas Freight with the ability to source Auckland destined cargo traffic in the United States and carry it to New Zealand, should it have decided to do so. In such a case, Qantas Freight would be using fifth freedom rights. The longest stage length on the QF7552 service was between Honolulu and Auckland (7,063km) (Table 11). The total AFTKs potentially produced over this sector is the highest at 776,930AFTKs. This is followed in significance by the Los Angeles to Honolulu sector with 452,540 AFTKs. The domestic service between O'Hare International Airport and Los Angeles offers 308,770 AFTKs. The Auckland to Sydney service has quite a short stage length of 2,165 kilometres. Due to the short stage length, a total of 238, 040 AFTKs could have been generated over this sector (Table 11).

4.4 Qantas Freight Boeing B767-300 Freighter Aircraft Deployment and Route Network Design

4.4.1 Qantas Freight Boeing B767-300 Trans-Tasman Freighter Network

On December 6, 2010, Qantas Airways announced that it would be increasing its Trans-Tasman by 40 per cent through the lease and deployment of a Boeing B767-300F freighter aircraft on the route. The aircraft will be operated for Qantas Freight by Express Freighters Australia (EFA). Express Freighters Australia (EFA) are the Qantas Group's freighter management company. EFA holds its own Air Operators Certificate and the group's freighter aircraft on behalf of Qantas Freight. The new Boeing B763-300F freighter aircraft entered service in February 2011. 95 During the 2017/2018 Northern Winter flight schedule period, Qantas Freight were operating the aircraft in the Trans-Tasman and Sydney to Hong Kong air cargo markets (Figure 7).

Before examining the deployment of the Qantas Freight Boeing B767-300 freighter aircraft in the Trans-Tasman market and quantifying the AFTKs that these services could have produced, it is important to note the regulatory framework covering this market, as this affects the route network design and the services provided by the actors competing in this market. Air services between Australia and New Zealand were initially regulated by an air services agreement (ASA) signed in 1961 [22, 94], and the subsequent Memoranda of Understanding (MOU). The arrangements were originally very restrictive. Air New Zealand and Qantas Airways were the only two designated airlines and the governments of both countries had to

Table 10. Available freight tonne kilometres (AFTKs) generated by flight segment on the QF7557 service

Flight Number	Sector	Distance (km)[6]	AFTKs
QF7557	SYD[5]/CKG[2]	8,462	930, 820
QF7557	CKG[2]/PVG[3]	1,464	161,040
QF7557	PVG[3]/ANC[1]	6,934	762,740
QF7557	ANC[1]/ORD[4]	4,581	503,910
Total		21,441	2,358,510

Legend: 1 ANC=Anchorage, 2 CKG= Chongqing, 3 PVG=Pudong International Airport (Shanghai), 4 ORD=O'Hare International Airport (Chicago), 5 SYD=Sydney, 6 Source: flight distance. [93]

Table 11. Available freight tonne kilometres (AFTKs) generated by flight segment on the QF7552 service

Flight Number	Sector	Distance (km)[6]	AFTKs
QF7552	ORD[4]/LAX[3]	2,807	308,770
QF7552	LAX[3]/HNL[2]	4,114	452,540
QF7552	HNL[2]/AKL[1]	7,063	776,930
QF7552	AKL[1]/SYD[5]	2,164	238,040
Total		16,148	1,776,280

Legend: 1 AKL=Auckland, 2 HNL=Honolulu, 3 LAX= Los Angeles International Airport, 4 ORD=O'Hare International Airport (Chicago), 5 SYD=Sydney, 6 Source: flight distance. [93]

agree on air fares, flight frequencies and capacity. Some of these restrictive features were relaxed during the 1980s. [95] Since the Australia–New Zealand Closer Economic Relations Trade Agreement (known as the CER Agreement) entered effect in 1983, the Australian and New Zealand economies have become increasingly integrated. In 1988, when the CER Trade in Services Protocol was concluded, however, Australia chose to exclude international and domestic air services from its application; the only air services exclusion by New Zealand was international airlines flying cabotage. Consequently, liberalization of air services across the Tasman continued to be dealt with by a bilateral air services agreement and related understandings (for example, the 1989 understanding agreed to multiple designation for freight with no capacity constraint). [96]

In 1992, Australia and New Zealand concluded a Memorandum of Understanding (MOU). This agreement lifted capacity restrictions across the Tasman Sea, introduced multiple designation and a double disapproval tariff regime. [81, 96] The ratification of the MOU opened the Trans-Tasman air travel market to Australasian airlines other than Air New Zealand and Qantas and provided a phased introduction (with a limit up to 12 Boeing 747s per week) of an all-points exchange so that by November 1st, 1994, all Australasian airlines could operate to, from or between and designated international airport in either country. [97] The MOU also contained a commitment by both States to consult on the subsequent full exchange of beyond rights and cabotage rights, the ownership and control of designated airlines, and the possibility of forming a joint bloc for negotiating international traffic rights. [81] Airlines were permitted to set their own air fares and flight frequencies. [98] In addition, by November 1, 1994, there was multiple designation for passenger and air cargo services with no limit on the number of cities that an airline(s) could serve. The joint air services agreement was due to take effect on November 1, 1984. In October 1994, Australia withdrew its commitment. [95, 96, 99]

In 1996, Australia and New Zealand ratified the "Single Aviation Market" (SAM) arrangements, which was incorporated into the CER Protocol. The arrangements permitted a "SAM carrier" to operate without restrictions trans-Tasman and domestic services in either State. Unlimited beyond rights were excluded from the agreement, and which were subsequently governed by the bilateral air services (ASA) agreements and the 1992 MOU. In 2000, Australia and New Zealand ratified an "open skies" agreement, which was officially signed in 2002. [96] This agreement liberalized air traffic between the two States and opened the Trans-Tasman market to other airlines from other countries, thus raising the connectivity of both countries with foreign markets [100]. Effective from November 2006, any airline with 50 per cent or more Australian and/or New Zealand ownership was permitted to operate services freely between the two countries or within them, subject only to border restrictions.

During the 2017/2018 Northern Winter Flight Schedule period, Qantas Freight deployed their leased Boeing B767-300 freighter aircraft on five Sydney/Auckland/Christchurch/Sydney services per week (Figure 7). The five Boeing B767-300 freighter services per week from Sydney to Auckland could have potentially generated 606,200 AFTKs. The return flights from Christchurch (QF7524/QF7528) could have potentially produced 596,400 AFTKs (Table 12). The very short sector between Auckland and Christchurch (745km) could have potentially generated 208,600 AFTKs (Table 12). On a weekly basis, these services could have potentially produced a com-

Figure 7. Flight routing for the Qantas Freight Boeing B767-300 freighter services

Legend: AKL=Auckland, CHC=Christchurch, HKG=Hong Kong, SYD=Sydney.

bined total of 1.41 million AFTKs, during the 2017/2018 Northern Winter flight schedule period (Table 12).

4.4.2 Qantas Freight Boeing B767-300 Hong Kong Route Network Design

Under the terms of the air services agreement (ASA) ratified between the Australian and Hong Kong governments only one all-cargo services between Sydney, Melbourne, Brisbane and Perth and Hong Kong is permitted per week. [84] During the 2017/2018 Northern Winter flight schedule period, Qantas Freight scheduled a once weekly Boeing B767-300 freighter service from Sydney to Hong Kong and return. The QF7531 service from Sydney to Hong Kong could have potentially generated 412,832 AFTKs, whilst the return flight (QF7532) from Hong Kong to Sydney could have produced the same amount of AFTKs (412,832 AFTKs). The total weekly available freight tonne kilometres (AFTKs) that potentially could have been produced on these services was 825,664 AFTKs (Table 13).

4.5 Qantas Freight Freighter Fleet Available Freight Tonne Kilometres (AFTKs) Production in the 2017/2018 Northern Winter Flight Schedule Period

Figure 8 presents the distribution of the available total weekly available freight tonne kilometres (AFTKs) for the four Boeing B747-400 freighter services that operated from Australia to Asia, China, Trans-Pacific, the USA and return during the 2017/2018 Northern Winter flight schedule period. The figure also shows the percentage of AFTKs by flight sector. The largest number of AFTKs that could have been potentially produced by the Qantas Freight Boeing B747-400 freighter fleet during this flight schedule period are on the Pudong International Airport to Anchorage sector 64,070,160 AFTKs (19 per cent of the total AFTKs produced). The total available AFTKs on the Honolulu to Sydney leg is 56,507,220 AFTKs (16.7 per cent of the total FTKs produced). The third busiest route, as measured by AFTKs, is the Sydney to Chongqing sector, where the total AFTKs amount to 39,094,440 AFTKs (11.5 percent of the total AFTKs performed). The lowest numbers of AFTKs are on the O'Hare International Airport to Dallas Fort/Worth (1.3 per cent of the total AFTKs performed), Dallas Fort/Worth to Los Angeles (1.3 per cent of the total AFTKs performed) and the Auckland to Sydney (1.4 per cent of the total AFTKs performed) sectors (Figure 8).

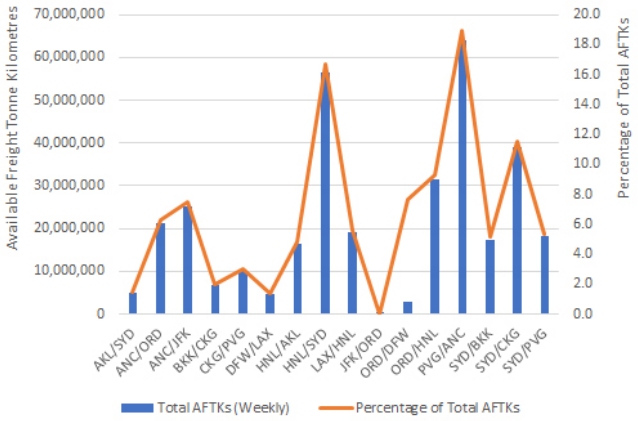

Figure 8. The distribution of the Boeing B747-400 freighter aircraft available freight tonne kilometres (AFTKs) and the percentage of total weekly AFTKs by flight sector during the 2017/2018 northern winter flight schedule period

Figure 9 shows that on the Boeing B767-300 freighter aircraft deployment on the Trans-Tasman that the Sydney to Auckland sector could have potentially generated slightly more AFTKs than for the Christchurch to Sydney sector. This is because of the slightly longer stage length of the Sydney to Auckland segment. Due to the short stage distance between Auckland and Christchurch, the total potential AFTKs would have been 208,600 AFTKs (14.7 per cent of the total AFTKs performed) versus 606,200 AFTKs (43 per cent of the total AFTKs performed) and 596,400 AFTKs (42.3 per cent of the total AFTKs performed) for the Sydney to Auckland and Christchurch to Sydney sectors. Figure 9 also presents the total weekly AFTKs that could have potentially been produced on the Qantas Freight Trans-Tasman and the Sydney, Hong Kong, Sydney Boeing B767-300 freighter aircraft services. The largest share of the Qantas Freight Boeing B767-300 freighter fleet AFTKs during the 2017/2018 Northern Winter

Table 12. Available freight tonne kilometres (AFTKs) generated by flight segment on the Qantas Freight Boeing B767-300 Trans-Tasman freighter services

Flight	Sector	Frequency4	Distance (km)[5]	Km/week	AFTKs
QF7523	SYD[3]/AKL[1]	M,Tu, W, Th	2,165	8,660	484,960
QF7524	AKL/CHC[2]	Tu, W, Th, F	745	2,980	166,880
QF7524	CHC/SYD	Tu, W, Th, F	2,130	8,520	477,120
QF7527	SYD/AKL	Sa	2,165	2,165	121,240
QF7528	AKL/CHC	Su	745	745	41,720
QF7528	CHC/SYD	Su	2,130	2,130	119,280
Total			16,790	25,200	1,411,200

Legend: 1AKL=Auckland, 2 CHC=Christchurch, 3 SYD=Sydney, 4 Frequencies, M=Monday, Tu=Tuesday, W=Wednesday, Th=Thursday, F=Friday, Sa=Saturday, Su=Sunday, 5 Source: flight distance [93]

Table 13. Available freight tonne kilometres (AFTKs) generated by flight segment on the Qantas Freight Boeing B767-300 Sydney/Hong Kong/ Sydney freighter services

Flight Number	Sector	Frequency3	Distance (km)[4]	AFTKs
QF7531	SYD[2]/HKG[1]	Su	7,372	412,832
QF7532	HKG[1]/SYD[2]	Su	7,372	412,832
Total			14,744	825,664

Legend: 1HKG=Hong Kong, 2 SYD=Sydney, 3 Frequencies, Su=Sunday, 4 Source: flight distance. [93]

flight schedule period could have been produced on the Trans-Tasman services (29,635,200 AFTKs) (63 per cent of the total AFTKs produced). The weekly Boeing B767-300 freighter service from Sydney to Hong Kong and return could generate 17,338,944 AFTKs (37 per cent of the total weekly AFTKs produced).

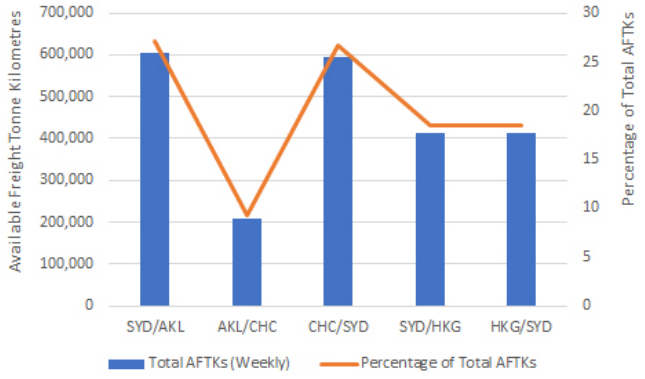

Figure 9. The distribution of the Boeing B767-300 freighter aircraft available freight tonne kilometres (AFTKs) and the percentage of total weekly AFTKs by flight sector during the 2017/2018 northern winter flight schedule period

4.6 Qantas Freight Freighter Fleet Flight Stage Lengths During the 2017/2018 Northern Winter Flight Schedule Period

According to Wensveen [5], the "overall flight stage length is the average distance covered per aircraft hop in revenue service, from takeoff to landing, including both passenger/cargo and all-cargo aircraft". In the global airline industry, there are various categories of flight stage lengths. 57 Length of haul or transportation of freight is divided into short-haul (up to 1,500km), medium haul (1,500 to 3,500km), and long haul (more than 3,500km). [101]

The Atlas Air freighter fleet includes the Boeing B747-400F and the Boeing B747-400ERF aircraft models. The maximum range of the Atlas Air Boeing B747-400 freighter aircraft is 7,170 kilometres. [102] The maximum range of the Boeing B747-400ERF freighter aircraft is 9, 220 kilometres for the General Electric CF6-80C2-B5F powered aircraft and 9,230 kilometres for the Pratt and Whitney PW4062 powered aircraft. [103]

Figure 10 presents the flight stage lengths for the city pairs that were served by the Qantas Freight Boeing 747 freighter services during the 2017/2018 Northern winter flight schedule period. As can be observed in Figure 10, Qantas freight operate their freighter aircraft on several short-haul routes in the USA – Dallas Fort Worth to Los Angeles (1,099km), John F. Kennedy Airport (New York) to Chicago's O'Hare International Airport (1,192km) and from O'Hare International Airport to Dallas Fort Worth Airport (1,291kms). The Chongqing to Shanghai Pudong International Airport at 1,464 kilometres, and thus, falls into the short haul category.

Qantas Freight operates three medium haul flight stage length sectors. The weekly Boeing B747-400 freighter service on the Auckland to Sydney sector has a flight stage length of 2,165 kilometres. The O'Hare International Airport to Los Angeles International Airport sector has a flight stage length of 2,807 kilometres. The Boeing B747-400 freighter service from Bangkok to Shanghai (Pudong International Airport) has a flight stage length of 2,894 kilometres, and thus, these services fall into the medium haul category (Figure 11).

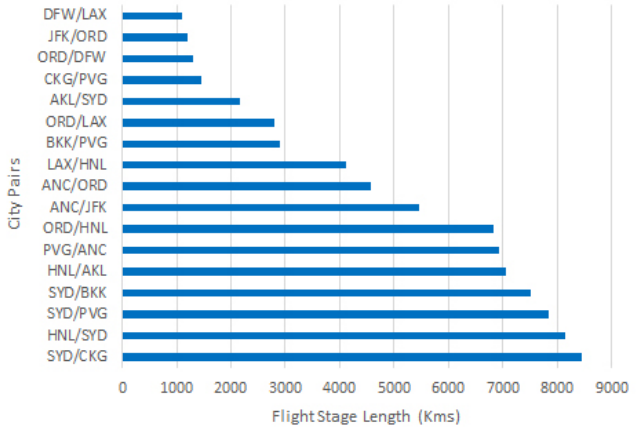

Figure 10. Qantas Freight Boeing B747-400 freighter flight stage lengths

Legend: AKL=Auckland, ANC=Anchorage, BKK=Bangkok, CKG-Chongqing, DFW=Dallas Fort/Worth, HNL=Honolulu, JFK=John. F. Kennedy Airport (New York), LAX-Los Angeles International Airport, ORD=O'Hare International Airport (Chicago), PVG=Pudong International Airport (Shanghai), SYD=Sydney

As can be observed in Figure 10, Qantas Freight operated their fleet of Boeing B747-400 freighter aircraft in the 2017/2018 Northern Winter flight schedule on 10 long-haul sectors. The flight stage lengths between Los Angeles and Honolulu, from Anchorage to O'Hare International Airport, are 4,114 and 4,581 kilometres, respectively. The Anchorage to John F Kennedy Airport in New York has a flight stage length of 5,449 kilometres. The non-stop service from Chicago's O'Hare International to Honolulu International Airport is 6,830 kilometres in length. The Pudong International Airport (Shanghai) to Anchorage, Alaska service is slightly longer at 6.934 kilometres. The non-stop flight distance from Pudong International Airport to O'Hare International Airport and to John F Kennedy International Airport are 11,358 and 11, 897 kilometres, respectively, and are thus, greater than the range offered by the Boeing B747-400F or Boeing B747-400ERF. Thus, the en-route stop in Anchorage, Alaska enables Qantas Freight to optimize the air freight uplift on these two sectors as the Boeing B747-400F or Boeing B747-400ERF offers a meaningful payload on these sectors.

The weekly service on the Honolulu to Auckland sector has a flight stage length of 7,063 kilometres. The flight stage lengths on the services from Sydney to Bangkok and Sydney to Pudong International Airport are 7,503 and 7, 838 kilometres in length, and thus, fall into the long-haul category. The two longest Boeing B747 freighter services operated by Qantas Freight during the 2017/2018 Northern Winter flight schedule were the Honolulu to Sydney and Sydney to Chongqing services at 8,154 and 8,462 kilometres, respectively (Figure 10).

Figure 11 shows the city pair flight stage lengths of the Qantas Freight Boeing B767-300 freighter aircraft during the 2017/2018 Northern Winter flight schedule. As can be seen in Figure 12, the Boeing B767-300 freighter services are operated on a mix of short, medium and long-haul sectors. The shortest flight stage length is between Auckland and Christchurch, New Zealand's two largest air freight markets, at just 745 kilometres. The Sydney to Auckland and Christchurch to Sydney services are 2,130 kilometres and 2,165 kilometres in length, respectively, and hence, fall into the medium range category. The weekly Boeing B767-300 freighter service from Sydney to Hong Kong and return is 7,372 kilometres in length and is therefore categorized as a long-haul service (Figure 11).

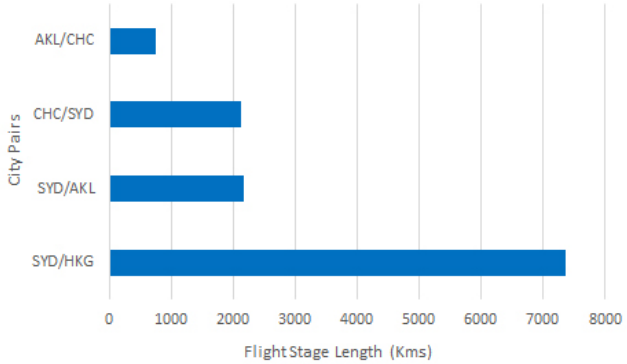

Figure 11. Qantas Freight Boeing B767-300 freighter flight stage lengths

Legend: AKL=Auckland, CHC=Christchurch, HKG=Hong Kong, SYD=Sydney

Figure 12 shows the relationship between flight stage length and the AFTKs produced by the Qantas Freight Boeing B747-400 freighter aircraft. As can be seen in the figure, the longer the flight stage length the greater the number of AFTKs produced. Conversely, the shorter the flight stage length, the small the number of AFTKs. As previously noted, the greatest number of AFTKs are produced on the Qantas Freight service from Sydney to Chongqing (the longest flight sector), whilst the smallest number of AFTKs are produced on the Dallas Fort Worth to Los Angeles sector (Figure 12).

Figure 13 shows the relationship between flight stage length and the AFTKs produced by the Qantas Freight Boeing B767-300 freighter aircraft. The long-haul services over the Sydney/Hong Kong/Sydney flight routing produce the greatest number of AFTKs as these are the longest sectors operated by this aircraft type. The smallest number of AFTKs are on the relatively short Auckland to Christchurch sector (Figure 13).

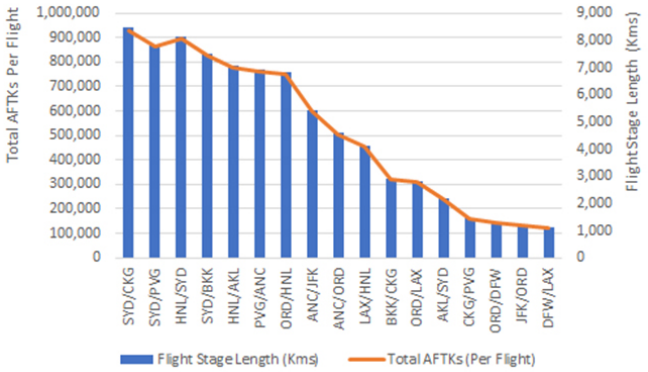

Figure 12. The relationship between flight stage length and AFTKs produced on the Qantas Freight Boeing B747-400 freighter services

Legend: AKL=Auckland, ANC=Anchorage, BKK=Bangkok, CHC=Christchurch, CKG=Chongqing, DFW=Dallas Fort Worth, HKG=Hong Kong, HNL=Honolulu International Airport, JFK=John F. Kennedy International Airport (New York), LAX=Los Angeles International Airport, ORD=O'Hare International Airport, PVG=Pudong International Airport (Shanghai), SYD=Sydney

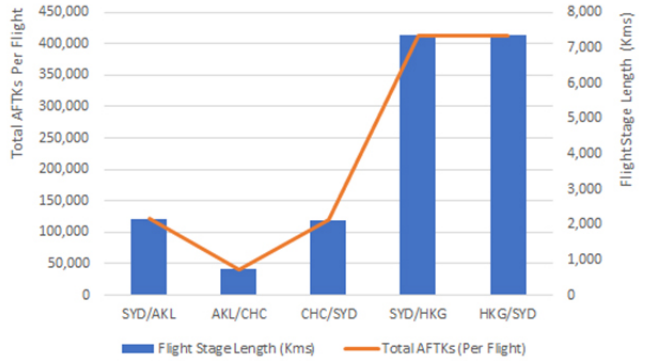

Figure 13. The relationship between flight stage length and AFTKs produced on the Qantas Freight Boeing B767-300 freighter services

4.7 A Comparison of the Qantas Airways International Passenger and Qantas Freight Boeing B747-400 and Boeing B767-300 Freighter Route Network Designs

An airlines network design is the most important attribute of its product offering [104] as it is the primary driver for generating an airline's revenues and costs. Network design is also a source of competitive strength or weakness for an airline. [105] In addition to its route network, a further principal benefit to an airline from operating freighter aircraft is that these services can be scheduled and attuned to the requirements of its customers. [106] Figure 13 presents the Qantas Freight Boeing B747-400 and Boeing B767-300 freighter aircraft route network. The route network has been very carefully designed to satisfy shippers' air freight requirements. Qantas Freight has been able to use the Australia/China "open skies" liberalized air service agreement (ASA) to operate a dedicated freighter route network that connects China with the major United States air cargo markets of O'Hare International Airport, John F. Kennedy International Airport, Dallas Fort/Worth and Los Angeles International Airport. This strategy has proven most successful for Qantas Freight, who have captured around 5 per cent share of the air-freight market between China and the US - the world's two biggest economies.[89] In addition, Qantas Freight has been able to take advantage of fifth freedom rights on its service linking Los Angeles with Sydney via Honolulu and Auckland – these rights give the carrier the ability to carry US-origin cargo destined for New Zealand, should it decide to do so. Airlines operating freighter aircraft have the option of an enroute technical stop, though this can result in additional costs. [107] Anchorage often serves as a midway point on trans-pacific services. [11] As can be observed in Figure 14, all the Qantas Freight Boeing B747-400 freighter services from China to the United States make a stop in Anchorage, Alaska.

Figure 14. Qantas Freight Boeing B747-400 and Boeing B767-300 freighter aircraft route network: 2017/2018 northern winter flight schedule period

Legend: AKL=Auckland, ANC=Anchorage, BKK=Bangkok, CHC=Christchurch, CKG-Chongqing, DFW=Dallas Fort/Worth, HKG=Hong Kong, HNL=Honolulu, JFK=John. F. Kennedy Airport (New York), LAX-Los Angeles International Airport, ORD=O'Hare International Airport (Chicago), PVG=Pudong International Airport (Shanghai), SYD=Sydney

Figure 15 shows the Qantas international passenger and freighter route networks. As can be seen in the figure, the Qantas international passenger route is very dense in nature and links key Australian gateway cities with cities in the Asia, Europe, Middle East, South Africa, South Pacific, and the United States. In contrast, as noted in the case study, the Qantas freighter network is very concentrated focusing on important global air cargo markets: Thailand, China, Hong Kong, New Zealand the USA. Also, a further difference between the Qantas international passenger network and the Qantas Freighter network, is that Qantas Freight serves Chicago in the United States and Chongqing in China. At the time of the study, Qantas Airways did not operate passenger services

to either of these cities. In addition, it can be observed in Figure 15, that the Qantas freighter services supplement the air cargo capacity offered on the Qantas international passenger services in the Auckland and Christchurch to Sydney, Dallas Fort Worth to Sydney, Sydney/Hong Kong/Sydney, and the Los Angeles and Honolulu to Sydney city pairs or origin-and-destination markets (O & Ds).

It is important to note that combination airlines passenger flights, particularly those operated by wide-bodied aircraft, such as the Airbus A380-800, A350-900XWB or the Boeing B777-300ER and 787-8/-9 aircraft, can now offer a significant air freight payload for the transportation of air freight shipments. [107] For a large full-service network carrier (FSNC), like Qantas Airways, these aircraft have the advantage of frequent services to many destinations. [11, 24] There are, however, two principal disadvantages with combination airlines: the timing of the flights is geared around passenger requirements, although on long-haul intercontinental flights they may also suit freight shippers. Second, as noted earlier, the lower deck belly holds on passenger aircraft are restricted in the size of the freight consignments that can be carried and may not be able to accommodate larger shipments, whether due to space availability or the size of the aircraft door. [11] Also, some passenger destinations are not major air freight markets, and therefore, will not attract much air freight. [11, 108] A further problem with the air freight product based only on the use of lower deck passenger service belly hold capacity is that it often fails to take into consideration air freight shippers' requirement for dedicated air freight space. [108] Air freight generally peaks strongly at night, following production during the working day, and at the end of the working week. [39] There is also often a very pronounced lull in demand for air freight space on Sundays and Mondays. Some combination airlines belly hold capacity will be provided at times of the day or week when there are relatively small volumes of air freight being shipped. At other times, though, there may be a critical shortage of air freight capacity, this is especially so on a Friday evening. [108] In contrast, airlines operating dedicated freighter aircraft enjoy some important advantages: flight schedules can be optimized to meet shipper requirements, freighter aircraft offer greater payload and air freight space, distinct types of dangerous goods and large dimensional cargoes can be carried on freighter aircraft, and freighter services offer reliability and predictability. [109] The Qantas freighter network has been customized to satisfy air freight shippers requirements with the flights timed to optimize air cargo traffic flows. The Qantas freighter services also enable Qantas Freight to carry large, dimensional freight that may be too large to be carried in the lower-lobe passenger aircraft belly-holds of the Qantas Airways passenger services.

The principal differences between the Qantas Airways international passenger route network and the Qantas Freight are summarized in Table 14.

5. Conclusion

This paper has examined, for the first time, the Qantas Freight 2017/2018 Northern Winter flight schedule freighter route network. Despite the increasing trend in the operation of freighter aircraft in the global air freight industry, there has been very limited research undertaken on such initiatives. Thus, this study adds some valuable insights to the literature. The study was underpinned by a case study research framework that followed the recommendations of Yin (2017). Qantas is a full-service network carrier (FSNC) that has strategically deployed a fleet of two Boeing B747-400 and one Boeing B767-300 freighter aircraft in key air cargo markets. The aircraft are leased and operated on its behalf by Express Freighters Australia, a subsidiary of the Qantas Group, The Boeing B747-400 fleet is deployed on several different routes that link Australia with Asia/China and across the trans-Pacific to the United States.

- Route 1: Sydney/Chongqing/Pudong International Airport (Shanghai)/Anchorage/O'Hare International Airport (Chicago)/ Dallas Fort Worth/Los Angeles/Honolulu/Sydney
- Route 2: Sydney/ Pudong International Airport (Shanghai)/Anchorage/John F Kennedy International Airport (New York)/ O'Hare International Airport/Honolulu/Sydney
- Route 3: Sydney/Bangkok/ Pudong International Airport/ Anchorage/O'Hare International Airport/ Honolulu/Sydney
- Route 4: Sydney/Chongqing/Pudong International Airport /Anchorage/O'Hare International Airport/Honolulu/Auckland/Syd

The Boeing B767-300 freighter aircraft operated five services per week on a Sydney/Auckland/ Christchurch/Sydney routing as a weekly Sydney/Hong Kong/Sydney service. During the 2017/2018 Northern Winter Flight Schedule period (from 29 October 2017 to 24 March 2018), the Boeing B747-400 services could have potentially generated 114,755,020 AFTKs. The Pudong to Anchorage sector could have generated the most AFTKs (64, 070,160 AFTKs). This represents 19 per cent of the AFTKs performed by the Boeing B747-400 freighter aircraft during the 2017/2018 Northern Winter flight schedule period. The Boeing B767-300 freighter services could have potentially produced 46,974,144 AFTKs during 2017/2018 Northern Winter flight schedule period. The Trans-Tasman services could have accounted for 63 per cent of these AFTKs, with the balance being produced on the weekly Sydney/Hong Kong/Sydney services. The case study revealed that there are distinct differences in the Qantas Airways international passenger and the Qantas Freighter route networks. The Qantas Airways international passenger route has been carefully designed to link key Australian gateway cities with destinations located throughout Asia, the Middle East, South Africa, South Pacific, United States and London in the United Kingdom. In contrast, the Qantas Freighter route network has been designed to serve key air freight markets

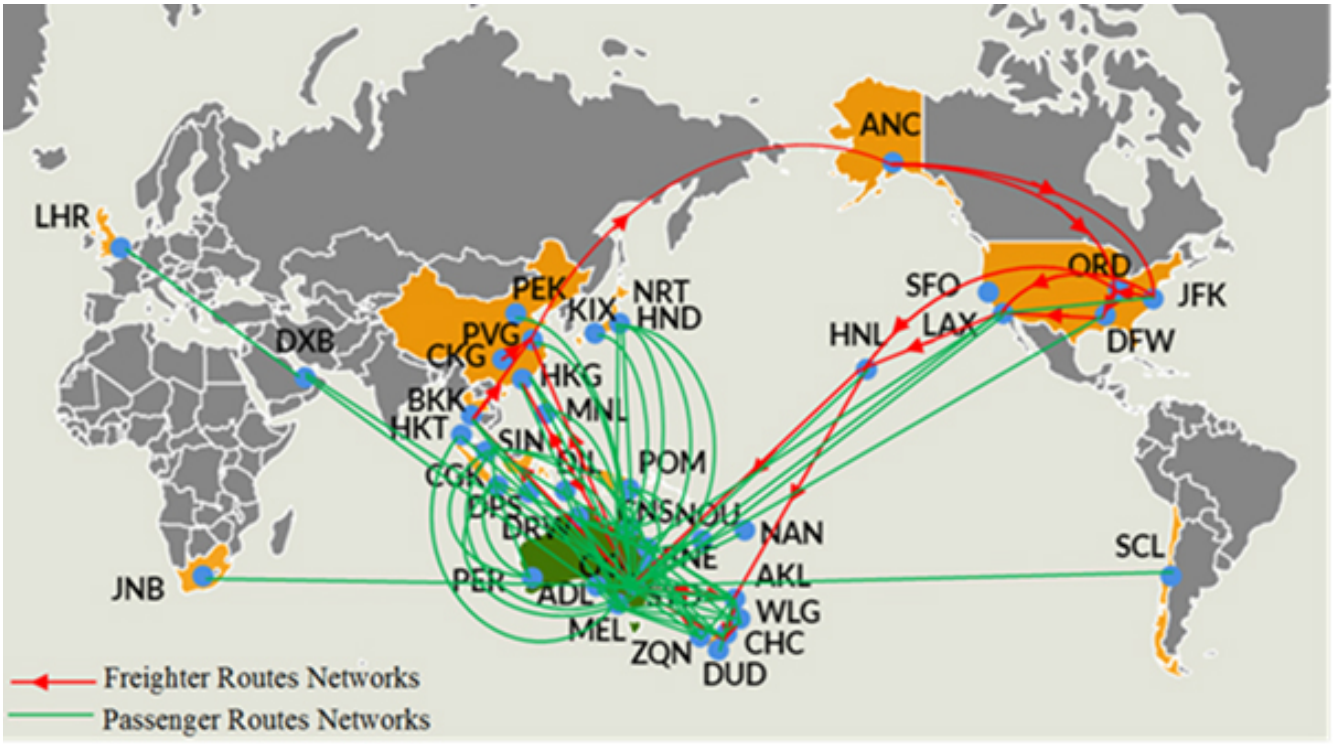

Figure 15. Qantas International passenger and dedicated freighter route networks: 2017/2018 northern winter flight schedule period

Legend: ADL = Adelaide Airport, ANC=Anchorage, AKL = Auckland Airport, BKK=Bangkok, BNE = Brisbane Airport, CHC = Christchurch International Airport, CKG = Chongqing Jiangbei International Airport, CGK = Soekarno–Hatta International Airport (Jakarta), CNS = Cairns Airport, DFW = Dallas/Fort Worth International Airport, DIL = Presidente Nicolau Lobato International Airport (Díli, Timor-Leste), DPS = Ngurah Rai International Airport (Denpasar), DRW = Darwin International Airport, DXB = Dubai International Airport, DUD = Dunedin Airport, HKG=Hong Kong, HND = Haneda Airport, HNL = Daniel K. Inouye International Airport (Honolulu), HKT = Phuket International Airport, JFK = John. F. Kennedy Airport (New York), JNB = O. R. Tambo International Airport (Johannesburg), KIX = Kansai International Airport, LAX-Los Angeles International Airport, LHR = Heathrow Airport, MEL = Melbourne Airport, MNL = Ninoy Aquino International Airport, NAN = Nadi International Airport (Fiji), NOU = La Tontouta International Airport (New Caledonia), NRT = Narita Airport, OOL = Gold Coast Airport, ORD=O'Hare International Airport (Chicago), PEK = Beijing Capital International Airport, POM = Jacksons International Airport (Papua New Guinea), PVG = Shanghai Pudong International Airport, SCL = Santiago International Airport, SFO = San Francisco International Airport, SIN = Singapore Changi Airport, SYD=Sydney, WLG = Wellington International Airport, ZQN = Queenstown Airport

in Australia, China, New Zealand and the USA. The Qantas Freight freighter network serves several cities that are not serviced by the Qantas Airways passenger services. These cities are Chongqing in China and Chicago in the USA. Importantly, the Qantas Freight freighter networks supplement the Qantas Airways passenger services from Auckland and Christchurch to Sydney, Dallas Fort Worth to Sydney, Sydney/Hong Kong/Sydney passenger services and the passenger services from Los Angeles and Honolulu to Sydney. The Qantas Freight freighter services are routed and scheduled to optimize air freight shippers' requirements. These services also enable the carriage of over-sized and certain types of dangerous goods that could not be carried on passenger services. The regulatory framework has played a key role in underpinning the Qantas Freight Boeing B747-400 and Boeing B767-300 freighter network. Australia has a fully liberalized freighter aircraft aviation policy. Australia and China have also ratified an 'open skies' or liberalized air services agreement (ASA), which enables Australian-based airlines to carry air freight from China across the trans-Pacific to the United States of America. Qantas Freight has also been able to take advantage of liberal air service arrangements that permit it to carry air freight traffic between the United States and Auckland, New Zealand. Australia and New Zealand also have an "open skies" air services agreement, which grants airlines based in either country, with full access to the Trans-Tasman aviation market. In conclusion, the study has shown that the Qantas Freight freighter network and services act as an important revenue stream for the Qantas Group and form a key part of the carrier's overall route network. A limitation of

Table 14. Key differences between the Qantas Airways international passenger route network and the Qantas Freight freighter route network

	Qantas Airways	Qantas Freight
Route network market segments	Global route network focusing on key premium and leisure air travel markets	Concentrated: focusing on key trade lanes
Route network design	Hub-and-spoke1. For example, Sydney is a key hub linking domestic and international services	Point-to-point linking key air freight markets
Aircraft fleet	Heterogenous – Airbus A330, Airbus A380, Boeing B737, Boeing 747-400	Boeing B767-300 and Boeing B747-400 dedicated freighter aircraft
Traffic directionality	Typically, round trip	Typically, uni-directional
Air freight capacity	Lower lobe belly-hold on the Qantas Airways passenger services	Main deck and lower deck on the Boeing B747-400 and Boeing B767-300 freighter aircraft

Note: Qantas Airways operates an Airbus A380 passenger service from Sydney to Dallas Fort/Worth (and return) on a hub-to-hub basis linking the Qantas passenger hub in Sydney with its fellow oneworld alliance partner American Airlines key hub at Dallas Fort/Worth Airport.

the current study was that the actual freight tonne kilometres (FTKs) or enplaned tonnages carried on the Qantas Freight freighter services was not available in the public domain at the time of the study. Thus, it was not possible to quantify the actual volumes of air cargo traffic transported on these services. The available freight tonne kilometer (AFTKs) provides an indicative idea of the available payload protentional on a flight sector. Should the actual FTK data become available then a future study could investigate the traffic flows and quantify the actual load factors of dedicated freighter services operated on the various Qantas Freight freighter aircraft routes.

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