Demand Forecasting – Scheduled Air Traffic
Outputs and Methodology Report

General Data

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Prepared by:	Tero Taskila
Reviewed by:	Shakeel Adam
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Executive Summary

Queenstown Airport is the main airport in the Queenstown Lakes District and is the primary domestic and international entry point to the lower South Island. The airport is the fourth busiest in the country, accommodating in excess of 1.95 million passengers for the 12-month period ending November 2017. The historic growth has been significant over the past ten years (2007-2017) and QAC needs to actively plan for the future growth and development of the airport.

To prepare the 2016 to 2045 traffic forecasts developed for Queenstown Airport (ZQN), market size was first calibrated using approximately 250,000 global Origin and Destination (O&D) city pairs. The market sizes were estimated using Aviado's proprietary market evaluation process and future country level growth rates published by IATA and Tourism New Zealand.

Aviado has re-optimised existing and new frequencies of the airline services to ZQN in order to determine the unconstrained growth potential. This optimisation was done by testing the flight timings during different times of the day. The flights were evaluated at 15 minutes, with a minimum allocated ground time for domestic flights of 30 minutes and a maximum ground time for 90 minutes. For international flights, a minimum ground time of 50 minutes was used with a maximum ground time of 120 minutes. This resulted in 420 different flight options for each flight.

Simulating the optimal capacity was done by adding capacity, frequencies and destinations until flights were not providing sufficient loads to the flight to/from ZQN or to other flights operated by the airlines considered. Thousands of simulations were performed for each destination with all meaningful carriers operating at both ends (either at ZQN or destination). A meaningful carrier is a carrier which has a network on the other end of the route capable of addressing the market demand to ZQN and appropriate aircraft to operate ZQN. This means, that Aviado did not model, for example, Chinese carriers operating from Sydney or Auckland.

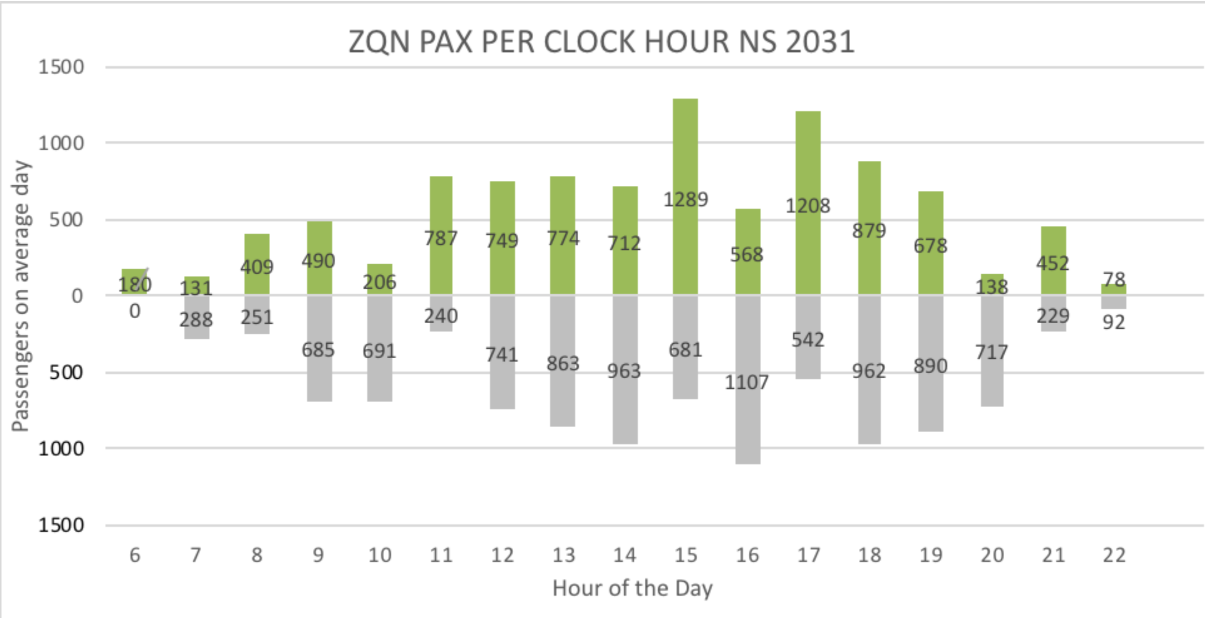
The model forecasts have been described for four snapshots in time: 2025, 2031, 2035 and 2045. During that time the annual movements in Queenstown grow from 25,389 to 55,309 and passenger numbers grow from 3,226,762 to 7,072,281.

Optimized Movement (Total)				
	2025	2031	2035	2045
Jan	2,267	3,716	4,207	5,040
Feb	2,041	3,345	3,786	4,536
Mar	2,154	3,530	3,997	4,788
Apr	1,976	3,239	3,681	4,439
May	1,819	2,981	3,401	4,131
Jun	1,680	2,753	3,154	3,858
Jul	2,746	4,500	4,916	5,456
Aug	2,746	4,500	4,916	5,456
Sep	1,925	3,155	3,589	4,337
Oct	1,833	3,004	3,379	3,999
Nov	1,935	3,172	3,570	4,230
Dec	2,267	3,716	4,207	5,040
Totals	**25,389**	**41,611**	**46,802**	**55,309**

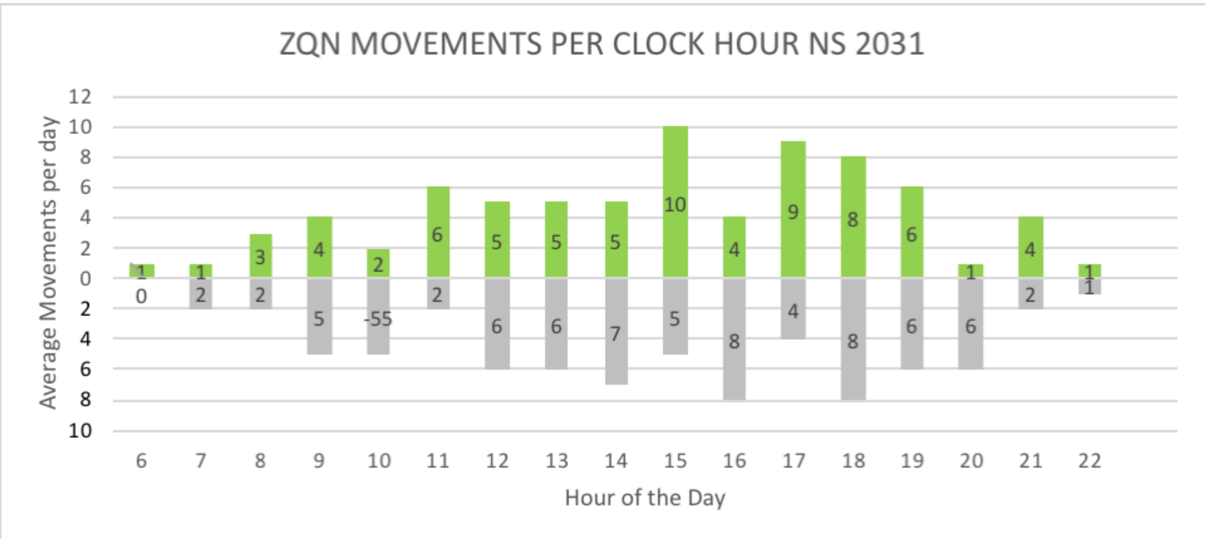
Optimized Passengers (Total)				
	2025	2031	2035	2045
Jan	287,007	455,406	542,775	646,244
Feb	258,306	409,865	488,497	581,619
Mar	272,657	432,635	515,636	613,932
Apr	224,563	356,323	425,528	509,239
May	232,048	368,201	446,299	526,213
Jun	224,563	356,323	425,528	509,239
Jul	371,880	590,078	659,879	729,656
Aug	371,880	590,078	659,879	729,656
Sep	224,563	356,323	425,528	509,239
Oct	232,048	368,201	446,299	526,213
Nov	240,240	381,198	462,054	544,789
Dec	287,007	455,406	542,775	646,244
Totals	**3,226,762**	**5,120,037**	**6,040,677**	**7,072,281**

The analysis of peak passenger arrivals and departures is based on the forecasted passenger numbers at 2031. It is Aviado's understanding that QAC has determined that this is the forecast that it wishes to develop its' infrastructure, and on which planning is currently being based on.

The peak hour for arrival passengers in 2031 Northern Summer (NZ winter) months is 15:00 to 16:00. During that time, the airport will have 1,289 arriving passengers on an average week day. The peak departure hour is forecast to be between 16:00 to 17:00. During that time, the airport will have 1,107 departing passengers on average week day. During the 15:00 to 16:00 timeframe, the airport has 1,971 passengers going through the terminal.



For the Northern Summer 2031 (NZ winter), the peak hour for total movement is from 18:00 to 19:00 (16 movements). The peak arrival hour is 15:00-16:00 (10 movements) and the peak departure hour is 16:00-17:00 (8 movements).



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Introduction

Queenstown Airport has experienced strong growth and demand and is forecast to expect continuation of this. Key leisure tourism markets around the world have experienced particularly strong growth and demand due to a number of industry trends:

- The continued expansion and new market entries of Low Cost Carriers (LCCs);
- Full Service Carriers (FSCs) seeking new leisure markets to increase aircraft utilization to compete with LCCs;
- Full Service Carriers seeking premium leisure markets to incentivize Frequent Flyer Program (FFP) redemptions for their most loyal customers; and,
- Continued demand growth from new segments of emerging / maturing affluent leisure travellers from China, Russia, Africa, India, and South America.

Queenstown Airport is the main airport in the Queenstown Lakes District and is the primary domestic and international entry point to the lower South Island. The airport is the fourth busiest in the country, accommodating in excess of 1.95 million passengers for the 12-month period ending November 2017. As a key leisure tourism market, Queenstown Airport (ZQN) has benefited from continued passenger growth and demand. While ZQN is unlikely to develop into a major airport hub, Queenstown is a strong destination market and providing efficient air transport infrastructure is critical to its growth.

Queenstown's connection to the rest of the world is largely limited to existing hub airports because it is unable to cater for wide body aircraft. Since ZQN is most significantly connected to Auckland, Sydney, Melbourne, Brisbane, and Christchurch it is subject to capacity constraints at those gateways as well as the demand profiles for those markets and their other connecting flows. Ongoing growth at ZQN will therefore rely at least in part on QAC's ability to ensure the right capacity is available at the right times and the formation of the optimal origin and destination (O&D) city pairs either through direct or connecting services.

The historic growth has been significant over the past ten years (2007-2017) and QAC needs to actively plan for the future growth and development of the airport. The purpose of this report is to describe the approach and the results of the traffic forecasting necessary to understand what future growth might look like to inform ongoing master planning and associated changes necessary to district planning documents.

Definitions

The forecasting of future air traffic demand has been completed using Aviado's proprietary market evaluation model. The following terms are used in this report to describe the outputs produced by this model:

- Origin and Destination (O&D): True origin and destination for a passenger journey i.e. the Origin is where the customer started their journey, while the Destination is their final destination, with the O&D city pair defining the journey. The O&D defines the end-points only, irrespective of connection points, if any.

- Itinerary: The travel itinerary of the customer, defining the Origin, the Destination and Connection Points. This can include up to three flight segments.

- Leg/Flight sector: One specific flight, one take-off and one landing.

- Segment: Flight segment which corresponds with the customer's flight ticket. This is typically one flight leg, but can in rare instances include two flight sectors. A two sector, single flight sector describes a flight where the aircraft performs a technical landing during the journey.

- Market Size: Total number of people forecast to want to fly between O&D points even if there is no service. In the modelling, market size is shown as average per week, which is typical for airline planning. The market size is constrained to the current average fare for the specific O&D.

- Demand: Total number of passengers attracted by the service (always unconstrained).

- On-board: Total number of passengers forecast to be sitting on a specific flight (constrained demand) based on the Revenue Management algorithm (passenger with highest value to operating airline chosen).

- Spill: The number of passengers not getting on-board their chosen travel option. When passengers are spilled, they are allowed by the model to choose another flight.

- Model / Typical Week: Due to the size of the world's transportation system, the model is constrained to model a typical schedule week. This means that instead of modelling passenger demand for each flight on each day for a full calendar year, representative snapshots of the schedule have instead been chosen jointly with the management team of Queenstown Airport. Those are called a typical schedule week for that season. This limitation allows the modelling to be more accurate on each day of the week. The schedules are designed and planned for two seasons in aviation. The seasons are the International Air Transport Association (IATA) Summer and IATA Winter. The summer seasons represent Northern Summer (NS) running from the last Sunday of March until the last Saturday of October (7 months). The Northern Winter (NW) season goes from the last Sunday of October until the last Saturday of March (5 months).

- Minimum Connection Time (MCT): Every commercial airport in the world has a minimum connection time (MCT). It is the amount of time, agreed in advance between the airlines and airport authorities, that is considered sufficient for a passenger to make a connection between an arriving flight and a departing flight on the same ticket. The airlines are obliged to take care of the customer who misses the connection where they have longer than the agreed MCT. If the customer misses a flight with a connection that does not meet the MCT, airlines do not have to, and generally will not, offer assistance.

- Connection Types: There are four different connection types a customer is expected to take, based on the attractiveness of the schedule.
  i. Online connection is the connection between two or more flights which are marketed and operated by the same airline.
  ii. Online connection with codeshare is the connection between two or more flights which are marketed as same airline, but operated by the two or more different airlines

  Marketing carrier is always the carrier which is shown on ticket. Operating carrier is the one flying the flight. In case of codeshare, marketing carrier and operating carrier are different.

  iii. Interline connection means, that both operating and marketing carriers are different in two or more flights.
  iv. Interline with alliance or special arrangement such as Special Prorate Agreement or Joint Venture means, that two or more operating and marketing carriers are different, but they have co-operation between each other on other service areas such as lounges etc. through the alliance to which they belong.

- Detour Factor: this is the amount of additional distance the customer is willing to fly between two destinations (compared to direct flight distance) in order to get to the destination. The detour is determined for each Origin-Destination pair and is dependent on the availability of competing services. If there is no non-stop service, the customer might be willing to travel longer distance to go through a hub to get to their destination. For example, the customer might be willing to travel from Melbourne via Sydney to Perth (detour factor 1.47), if no suitable non-stop flight is available.

- Passenger behaviour: Modelling term referring to how customers will choose, given certain product choices. The model uses Logit-based algorithms to calculate values for each schedule option available for the customer.

Global Aviation Trends

Looking back past ten years, it can be observed that global passenger traffic has grown significantly. Figure 1 shows that in fact, traffic has doubled from twenty years ago. The market has experienced a dip in traffic growth approximately every 10 years (eg. the Gulf War in the early 1990s, the September 11th terrorist attacks in 2001, and the Global Financial Crisis in 2009), however the market has always rebounded quickly.

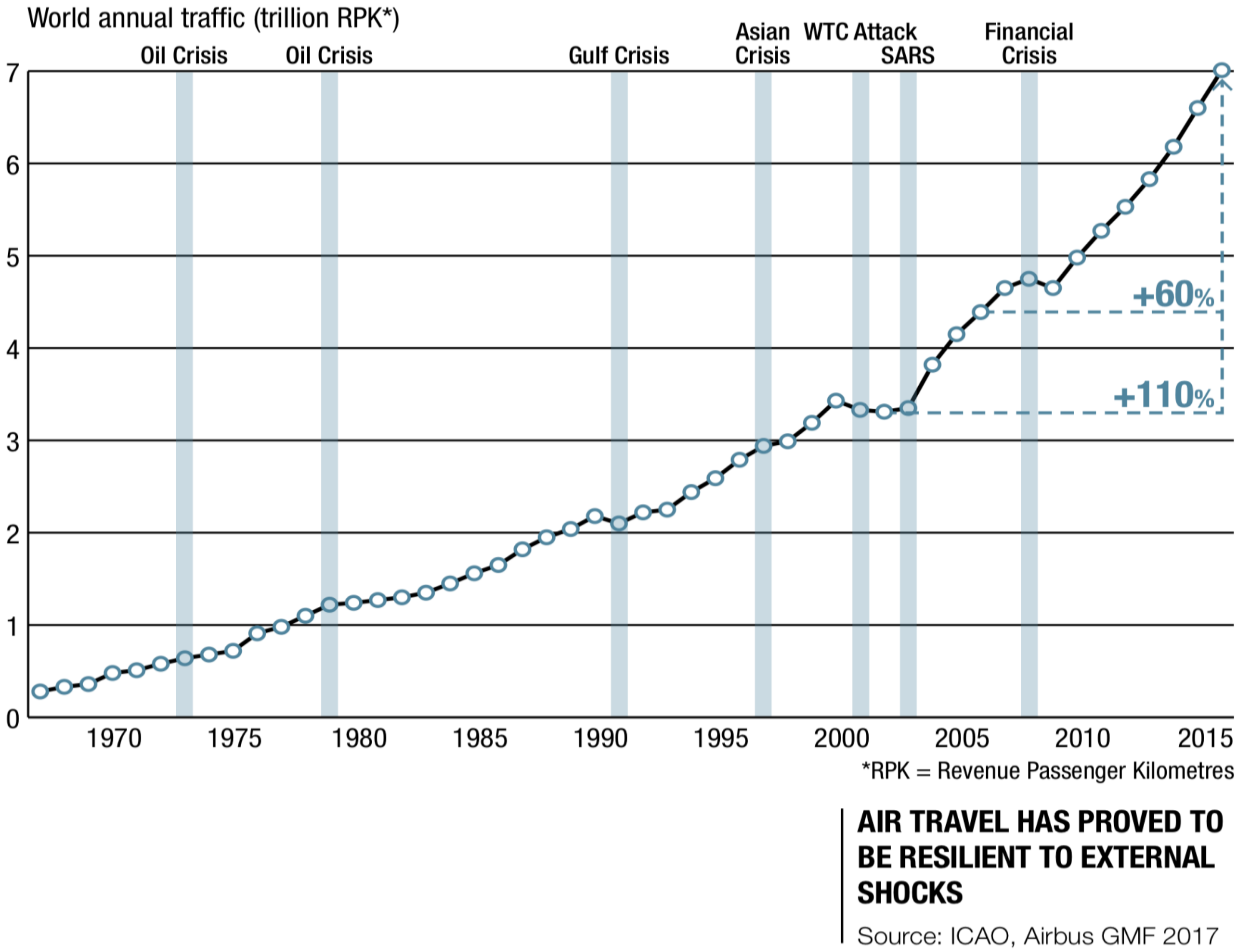

Figure 1: Historical market development - ICAO traffic report from Airbus Market Outlook 2017-2037

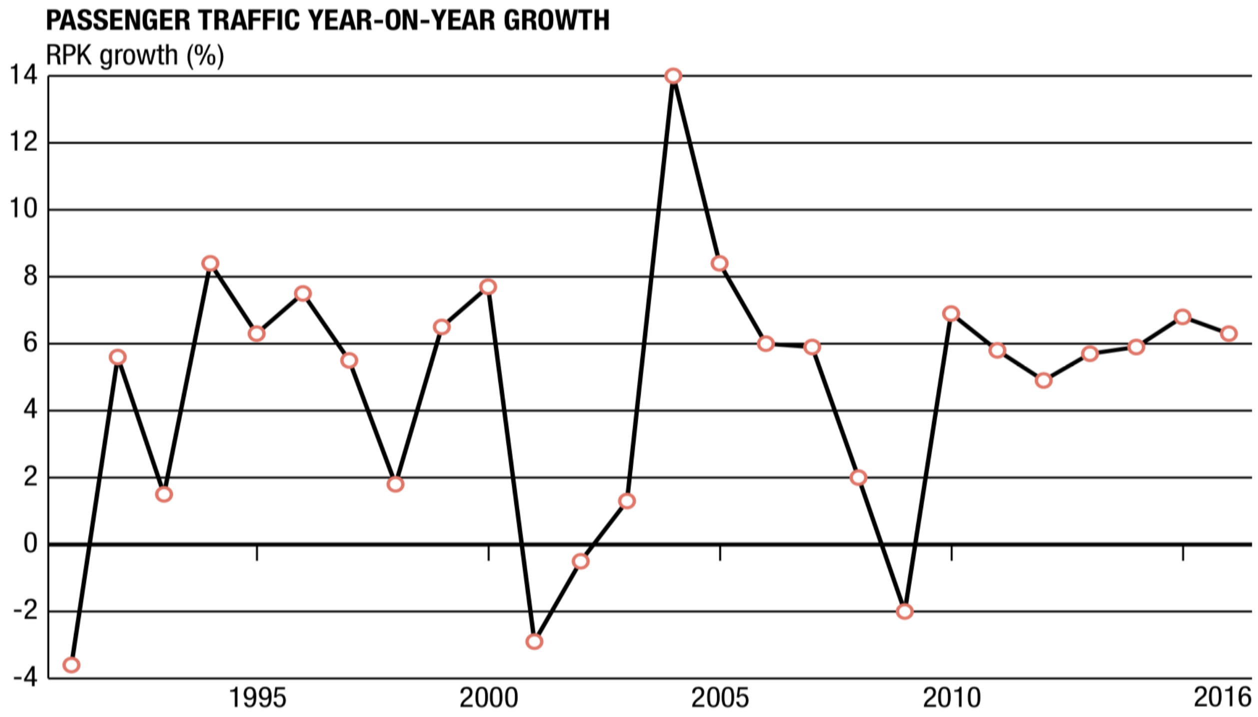

Figure 2: Historical Year on Year growth - ICAO traffic report from Airbus Market Outlook 2017-2037

The global aviation market grew 7.6% in 2017 (2017 vs. 2016) according to IATA. This was well above the 10-year average annual growth rate (2007 to 2017) of 5.5%. In fact, IATA (source IATA 20-year Forecast) has revised the 20-year average annual growth rate to 3.6% and estimates that the Global Aviation market will nearly double to 7.8 billion passengers by 2036.

The biggest driver of demand will be the Asia-Pacific region. The region will be the source of more than half the new passengers over the next two decades. More services, new aircraft technology and better airport infrastructure will drive this growth in the Asia-Pacific region and globally.

Aircraft manufacturers are more bullish on growth. Boeing's (Boeing Current Market Outlook 2017-2036) current estimates are that the global 20-year growth rate is 4.7%, with the Asia Pacific region even higher than that at 6.2%. They also forecast that the demand between Australia and New Zealand (and within Australia and New Zealand) is forecast to grow 3.9%.

Airbus's current estimates (Airbus Global Market Forecast 2017-2036) that global 20-year growth rate is 4.4% and Asia Pacific region is 5.6%. They also forecast that the demand between Australia and New Zealand (and within Australia and New Zealand) will grow 3.9%.

Queenstown Airport – Observed Aviation

Queenstown traffic has grown constantly during the past ten years. The small dip in 2009 was caused by the Global Financial Crisis, which also affected global aviation demand. The annual growth rates appear relatively high but represent a typical remote market which has been constrained by available airline capacity for a long time. The percentage growth is pronounced because of the small base. Notwithstanding this however, the absolute annual growth has been between 150,000 and 250,000 passengers in the last eight years. Figure 3 below, shows absolute and year on year (YoY) growth at Queenstown Airport for the past 10 years.

Figure 3: Queenstown Airport Traffic growth in past 10 years.

Forecasting Methodology

LiftPlan is a web-based application regarded by aviation experts as one of the most powerful forecasting tools in the industry. Aviado uses LiftPlan, in association with its own proprietary models to undertake forecasting within the aviation sector. Figure 4 below provides an overview of the forecasting methodology. The circles within the arch demonstrate the function, and boxes demonstrate output. The market data sources used in building the model are:

- MarketIS (Market Information System) from IATA
- MIDT (Market Information Data Tapes) from third party software providers

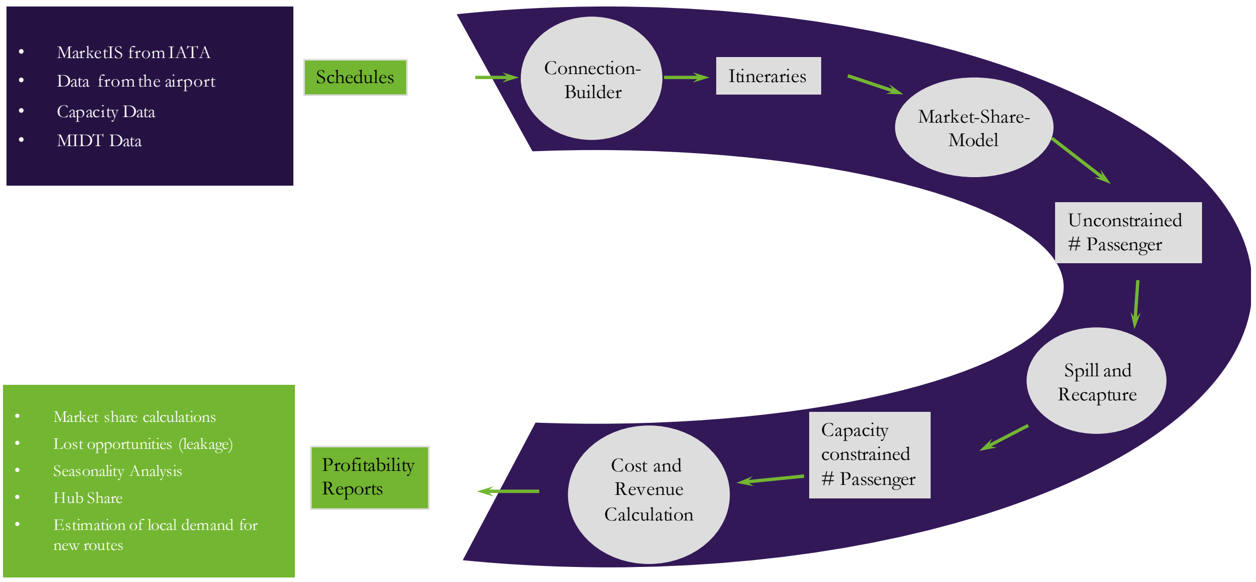

Figure 4: Overview of the forecasting methodology.

Aviado has used the above methodology to prepare forecasts for a number of airline carriers and airports around the world. Examples of Aviado's recent work are described in further detail in Appendix 1.

Overview of Forecasting Methodology

To prepare the 2016 to 2045 traffic forecasts developed for ZQN, market size was first calibrated using approximately 250,000 global Origin and Destination (O&D) city pairs. The market sizes were estimated using Aviado's proprietary market evaluation process and future country level growth rates published by IATA and Tourism New Zealand.

The achievable market share and passenger numbers were forecast using proprietary software for passenger behaviour modelling. The software is currently used by some of the world's leading airlines and airports. The model works by building logical O&D itineraries based on the worldwide published airline schedules and airport Minimum Connection Times. Itineraries are built for every true O&D in the market size database, resulting in approximately 5.5 million itineraries. Using a proprietary calibration process, viable itineraries are then identified.

As several itineraries are built for each O&D in the typical week modelled, the quality of each itinerary is measured by a market share model. The market share model uses passenger behaviour algorithms to determine which itinerary the customer is likely to choose, based on 12 different choice attributes including, amongst others, airline preference, departure/arrival time preference, connection station preferences, and price. Business rules that may apply to the passenger choice attributes are calibrated through a proprietary convergence calibration process which simulates historical performance, and thus forecasts future behaviour. Market share is attributed to each itinerary, then the market size is applied to the share resulting in an unconstrained demand volume by itinerary.

Since in many cases unconstrained demand exceeds capacity, a linked spill and recapture algorithm is used to redistribute passengers to itineraries with available capacity. Business rules for the spill and recapture algorithm are again calibrated using a proprietary calibration process. This results in a forecast of passengers by flight, for all airlines in the worldwide network.

One of the limiting factors for ZQN's growth is access to the world beyond the hubs which currently serve it. Aviado unconstrained the key hubs (Auckland, Sydney, Melbourne, Brisbane, and Christchurch) to the rest of the world. For routes with ZQN as the origin or destination, schedule optimisation was done for each route and airline utilising only narrow body aircraft. If the demand exceeded the operated capacity, flights were first upgraded to larger narrow-bodied aircraft. Further growth was achieved through the addition of frequencies to satisfy demand. Only those new routes which are within the existing narrow body aircraft operating range (including the latest generation Boeing 737MAX and Airbus 320neo families) were considered. Frequencies to destinations were constrained using Boeing Commercial Aircraft's Passenger Convenience Curve frequency curve as a reference. Passenger Convenience Curve frequency curve is based on the studies made by the Boeing Company. They interviewed people about the preference and requirements for daily frequencies on different distances.

Some of the key steps shown in Figure 1 and described above are discussed in more detail in the following sections.

Identifying market size

Understanding market size and the potential underservice (i.e. the portion of the market size which wants to get to Queenstown but does not have service or the capacity to do so) is an important first step in the forecasting process.

To determine market size, observations are often taken from global booking data sources. Airlines and airports have access to two main global booking data sources, including:

1) IATA, who collects data from participating travel agents and airlines; and,
2) Market Information Data Tapes (MIDT), which is collected by third party software providers from different Global Distribution Systems (GDS).

While the above sources are generally considered the most comprehensive by market reach, they have significant shortfalls as they do not include bookings made outside IATA participating airlines and travel agents (such as low-cost or regional airlines), and they do not include bookings made directly with airlines (i.e. via the internet, call centres or corporate bookings). Moreover, with respect to determining market size, the data captures only a snapshot of the number of people who have travelled, rather than the number of people who would like to travel if there was a service available (i.e. the true market size). As such, the above market data sources significantly underestimate the true O&D market size.

The classification of some data captured by MIDT and IATA can also result in skewed O&D results if the connection time between flights exceeds eight hours. Under the MIDT and IATA systems, an eight hour stop over is considered a trip break and is assigned two separate O&D classifications. For example, a customer traveling from London to Queenstown may need to stay overnight in Auckland before flying on to Queenstown due to a lack of suitable connections. The MIDT and IATA data considers such passengers as stopping in Auckland, and will create two O&Ds, one from London to Auckland and the other from Auckland to Queenstown. While individual airlines have an ability to make adjustments and apply correction factors to "global" data sources to account for such circumstances, such information is not available to airports. For this reason, Aviado uses a proprietary technique to triangulate the missing or misrepresented information and to calculate true market size. Typically airlines calibrate 50 000 – 70 000 O&D pairs. For Queenstown Airport, this included the use of 250,000 O&D pairs. The reason for the significant difference is that airports need to make sure that all of the relevant markets and airlines are calibrated, whereas the airlines tend to consider only their own customers and destination network.

Calibration of the passenger choice model

Itineraries are travel products which have one or more flight legs with one or more carriers. In order to determine how a customer chooses a specific flight, an understanding of itineraries needs to be formed.

Using the complete worldwide schedule, logical O&D itineraries are built for every true origin and destination in the market size database. Itineraries are built in the connection builder module which is calibrated to account for parameters for each O&D market such as detour factors, minimum connection times set by airlines or airports (or both), attractiveness, competition profile, connection type and airport preferences (where a city or catchment has more than one airport).

Customers typically choose their itinerary (product) based on its attractiveness and availability. The quality of each itinerary is measured against 12 passenger choice parameters. These parameters are considered to be the most meaningful in evaluating passenger behaviour when forecasting future customer demand. Each parameter includes one or more sub-criteria. For example, carrier preference includes an airline's product, brand and frequent flyer attractiveness for the evaluated market.

Passenger preference model

- Carrier preference
- Carrier dominance at airport
- Departure / arrival time
- Competition
- Elapsed time
- Market Presence

- Station Preference
- Connect Station Preference
- Connection Type
- Jet vs Prop
- Price Attribute
- Return Market Attribute

These parameters are weighted using Aviado's proprietary algorithms to identify the attractiveness of each itinerary. Using Aviado's market share model, the true market size is allocated to itineraries based on the attractiveness score. This process results in an unconstrained demand being able to be calculated for each service.

Approach to spill behaviour

Sometimes demand exceeds capacity and the spill and recapture algorithm is used to redistribute passengers to itineraries with available capacity. The result is a forecast of on-board passengers by flight, for all airlines in the worldwide network. When unconstrained demand exceeds capacity, the excess unconstrained demand is spilled. Spill and recapture means that customers that do not get their preferred choice will look for another option. In this case, the algorithms allocate the passenger to next highest weighted itinerary (the itinerary which is closest to characteristics of the original preferred itinerary).

The spill and recapture window depends on the market characteristics (amount of services, distance travelled etc.). In addition, each route and flight has been optimized for the best network volume for the airline flying the flight. This means that in a capacity constrained environment, an airline is simulated to prefer individual passenger itineraries which produce the most Revenue Passenger Kilometres (RPKs) for that airline. The itinerary which "loses" the value battle to the most attractive itinerary will be spilled to a secondary choice. The optimal routing of a passenger may be via point A, but may be forecast to be via point B due to capacity constraints.

The benefit of the optimisation approach is that the process mimics more closely the approach airlines actually take in their decision making (as opposed to just adding services evenly throughout the day as has been the approach in traditional forecasting). This allows the forecast to be more accurate on the likely timing of flights and thus capacity distribution during the typical day. This in turn will lead to a better understanding of real peak hours.

Size of the model

The world's leading airlines typically calibrate 50,000 O&D markets when creating market size models. Typical calibration includes market size estimation and the setup of passenger behaviour modelling parameters. The approach to calibration might vary slightly depending on the modelling tools used by the airline.

The market models Aviado has built for QAC have been refined over eighteen months and have been calibrated using 250,000 O&Ds in the IATA Summer Schedule for 2015 (NS15) and 210,000 in IATA Winter Schedule for 2015/2016 (NW16). The reason for the large difference between the number of O&D markets is because airlines typically undertake modelling based on volumes. In order to forecast the true demand for an airport, and to forecast the potential destinations and optimal capacity as well as timing, it is necessary to have greater accuracy on an itinerary level, as well as volume per leg (the latter being the approach of most airlines).

Approach to evaluate true demand potential for existing and new flights

Aviado has re-optimised existing and new frequencies of the airline services to ZQN in order to determine the unconstrained growth potential. This optimisation was done by testing the flight timings during different times of the day. The flights were evaluated at 15 minutes, with a minimum allocated ground time for domestic flights of 30 minutes. For international flights, a minimum ground time of 50 minutes was used. This resulted in 420 different flight options for each flight.

Simulating the optimal capacity was done by adding capacity, frequencies and destinations until flights were not providing sufficient loads to the flight to/from ZQN or to other flights operated by the airlines considered. Thousands of simulations were performed for each destination with all meaningful carriers operating at both ends (either at ZQN or destination). A meaningful carrier is a carrier which has a network on the other end of the route capable of addressing the market demand to ZQN and appropriate aircraft to operate ZQN. This means, that we did not model, for example, Chinese carriers operating from Sydney or Auckland.

A proprietary route optimization algorithm was used to simulate and select the best time to operate each flight. Queenstown traffic is reliant on connections at nearby hubs such as Christchurch, Auckland, Sydney, Melbourne and Brisbane. Each of these airports has a different schedule profile in summer and in winter. This means that flights from ZQN to each destination might fluctuate between summer and winter schedules in order to get the best connectivity. It might also mean that the true O&D demand might use a different connecting hub in winter than they used in summer, because of the alignment of connecting schedules at the hubs.

Once flight timings were fixed, it was possible to estimate the true unconstrained demand to/from ZQN. In order to estimate peak opportunities, Aviado unconstrained the capacity in all hubs which have a connection to ZQN. The airlines were operating at 81.4% load factor (share of number of total seats available occupied by the travelling passengers) in 2017 (source: IATA). By increasing market sizes without any capacity increase, the model would not allocate seats to Queenstown passengers (as the flights are full) and therefore significantly underestimated the forecast market potential to the airport.

Aviado tested 20 new routes on top of the existing ones. This means that the top twenty unserved markets which are within reach of narrow body aircraft were evaluated for their performance. Several airlines for each route were considered. Only the routes which were assessed to be financially feasible to operate were added into the network. Three new destinations were added to the network during the evaluation.

Modelling Assumptions

Assumptions are an inherent part of any passenger forecasting model. When undertaking the passenger forecasting for ZQN, a series of assumptions were made with respect to:

- Market size growth;
- Demand simulation;
- Price elasticity;
- Price impact on market share;
- Spill constraints;
- Schedule, capacity and MCT;
- Model weeks;
- Hours and aircraft mix;
- Capacity constraints; and
- Frequencies and destinations.

The following sections provide a high-level overview of the key assumptions that underpin Aviado's passenger and aircraft traffic forecasting for Queenstown Airport for the period from 2016 to 2045.

Market size growth

It is a common assumption that the flown passenger numbers reflect proportionate the size of the markets the passenger originate from. This is not the case. In addition to flown passengers, there are always passengers who did not get the seats they wanted. In addition, there are passengers who were not offered an itinerary at all. When increasing capacity, airlines often see increases in flown passengers. This is falsely considered as stimulation of demand. In fact, the market sizes typically remain relatively constant, but increases in capacity allow the airlines to capture a higher portion of the market size.

Aviado's approach estimates the market sizes on O&D at a city level. This means, that the London market is considered as a market from the whole of London, not from individual airports such as London Heathrow, Gatwick or Stansted.

For this project, market size for 2016 was estimated using Aviado's proprietary market evaluation process. The market size was projected into the future using country level growth rates published by IATA and Tourism New Zealand. In cases where growth rates were not available, average growth rates for the specific geographical region were used.

At a network level, this process has a 3-4% error rate when compared to a 20-40% error rate for batch data that could be purchased on the market through providers such as [list or explain what these sources are].

Market size stimulation through improved service

In addition to market gap (difference between travelled passenger numbers and market size) explained in previously, markets can experience demand stimulation. Market size stimulation is typically a function of market conditions, the specific destination being modelled and the airline/airlines providing the service. Due to the variability of these factors, many of which QAC has limited control or influence over, a conservative approach was applied with no service stimulation applied to the forecasting undertaken for ZQN between the period 2016 to 2045.

Market size stimulation through price elasticity

Changing prices have an impact on market size. This is called price elasticity. When the price increases, market size tends to fall and when prices decrease, market sizes tend to increase.

As with the service-based stimulation, price stimulation/elasticity is dependent on the market conditions, schedule, route and airlines operating. For this forecasting report, market size was constrained to current average O&D fares from Sabre eMergo. Sabre is software company which collects market information from different global distribution systems.

Price elasticity was not built into the model. This means that the resulting forecast is conservative, for two reasons:

- As airlines provide better connectivity, lower average airfares tend to ensue which strengthens the demand for these flights. By excluding price elasticity, the model therefore conservatively forecasts demand; and,
- In many cases, and as is common in Oceania, low fare airlines grow routes with lead-in pricing. Such price point strategies lead to market size growth through price-led stimulation. The increase in market size growth from price-led stimulation is not included in the model.

Pricing impact to market share changes

Price does not always stimulate market size, but it can have an influence (shift) market share between carriers. For example, based on Aviado's previous work on price elasticity to airlines in Europe and United States estimates that an approx. 15 to 20% decrease in average price is required to shift market share from one full service carrier to another providing a similar offering (both in terms of schedule and service). By comparison, when a low-cost carrier enters the market, it is estimated that a 35 to 40% reduction is required in order to get a similar market share shift. The difference is largely explained by the different product proposition between low cost and full-service carriers and indicates that customers need a significant decrease in price to encourage them to shift to a less attractive product proposition.

Pricing impact is highly dependent on market conditions and an airline's product. In markets where full service carriers reduce their product, to get closer to low cost carriers, the impact on the price-product relationship is reduced and passengers make purchase decisions and thus shift market share based on price. For this forecasting report, such changes in relative pricing between airlines was not considered. Furthermore, the calibration of the passenger choice model reflects the attractiveness of different airline brands as they are now, not necessarily how they would be in the distant future.

Spill constraint

All flights in the model are programmed to spill at 90%. This means that once the passengers forecast on board any flight reaches 90% of the capacity for that specific flight on that specific day, the demand for that flight is spilled to another flight.

Schedule, Capacity and MCT

Flight capacity is based on the current flight schedules and aircraft types. The global schedule data assumes current aircraft configurations and Minimum Connection Times (MCT) defined by each of the global airports for each type of connection (online, interline, alliance, terminal change etc.). It also includes current daylight-saving time adjustments for each country.

For this report, schedules, capacity and minimum connection times have been obtained from the FlightGlobal Innovata April 2016 release. Air New Zealand's domestic schedule has been based on the data received from the carrier through announcements and information provided to QAC.

Model weeks used

A 2016 baseline for seasonality was modelled for five different seasons based on differing market characteristics (peak, shoulder and low season for each IATA schedule season). This identified specific characteristics of the overall market behaviour to enable a good understanding for future modelling.

The modelling was calibrated against the actual performance of the flights.

For 2025, 2031, 2035 and 2045 only the peak week for each IATA schedule season was modelled to determine the maximum design stress relevant for master planning.

Operating hours and aircraft utilisation patterns in Queenstown

Our modelling has assumed the retention of Queenstown Airport's current operating hours of 06:00 to 22:00. The route optimization algorithm was used to evaluate the optimal time of day for each flight at 15-minute intervals with a minimum ground time of 50 minutes for International flights and 30 minutes for domestic flights. Every flight was assumed to return to the original departure point, so no 'open jaws' or one-ways were allowed (i.e. a flight originating from Melbourne was forced to return to Melbourne and so on).

Open jaw sectors are sometimes used by airlines to increase asset utilisation. This means that the aircraft does not return to its original airport. For example, Air New Zealand could utilise an aircraft to fly from Auckland to Queenstown and then from Queenstown to Sydney (and from Sydney back to Auckland or Christchurch on following day). Each flight was therefore tested with 420 different timing combinations. Given the number of frequencies, the airlines might be able to build rotations differently and not be limited to the route optimization constraints we have imposed on our modelling. As such, load factors could be even higher than forecast and the modelling therefore could be considered conservative.

Capacity constraint

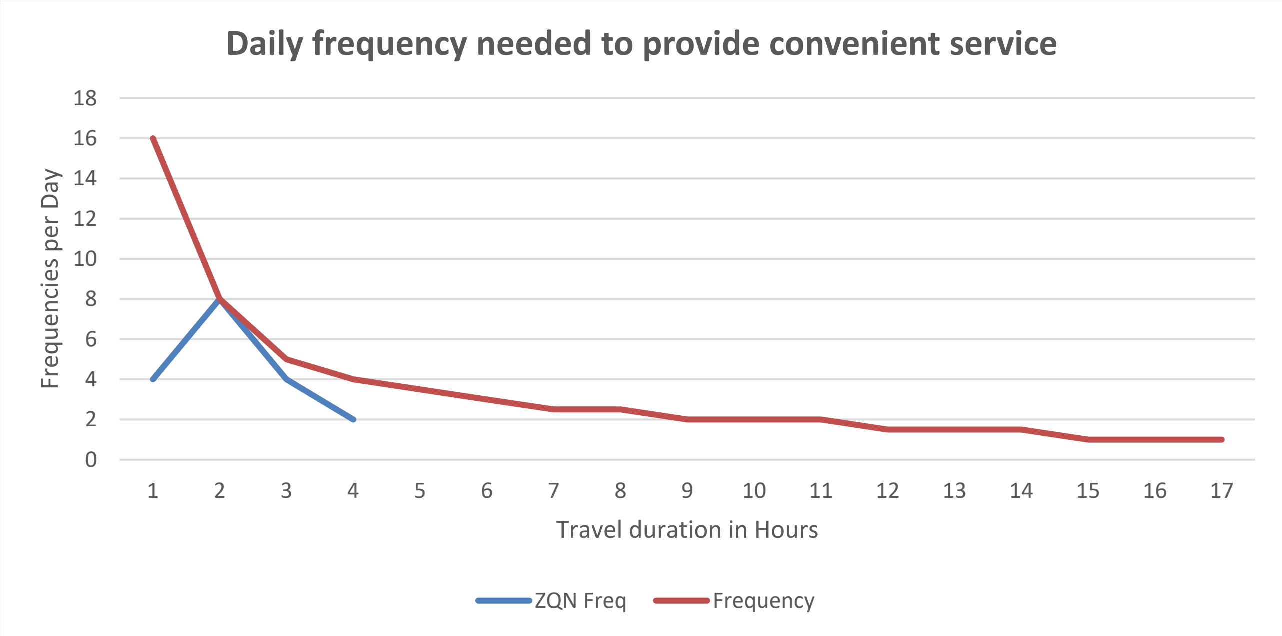

Figure 5: Boeing Commercial Aircraft's Passenger Convenience Curve

During the network planning process, airlines make decisions about whether to increase frequency and improve the product offered (i.e. more flight options) or to satisfy the demand with larger aircraft. The Boeing Company has developed a concept called Boeing Commercial Aircraft's Passenger Convenience Curve which identifies the maximum number of frequencies required to enhance passenger convenience for any itinerary length. As shown in Figure 5 (which is based on the Passenger Convenience Curve), additional frequencies do not necessarily improve passenger convenience. For example, if the flight duration is less than one hour, providing more than 16 flights per day to that destination has been shown to have little positive impact on passenger convenience. In such circumstances, increasing capacity through larger aircraft use rather than additional flights is therefore a more effective means for meeting demand and has reduced operating costs. This is not to say that more frequencies cannot be operated for other reasons such as hub alignment, aircraft availability or in Queenstown's case the length of the runway limited the size of aircraft able to be considered.

One of the limiting factors for ZQN's growth is access to the world beyond the existing global hubs such as Sydney, Auckland and Melbourne. Also, some of the major hubs such as Singapore, Los Angeles, Shanghai and Dubai will be constrained in future and limit the growth of ZQN, especially for the traffic originating from Europe and North America. Aviado did not consider new global destinations opened from neighbouring hubs. By limiting the growth to existing destinations flown from those hubs, the market model has been kept conservative.

New frequencies and destinations

In order to satisfy market demand, airlines can either increase aircraft size or frequency (or both in combination). Airline decisions are usually driven by economics. In some cases, it is cheaper to fly two frequencies with small aircraft than one frequency with a single large aircraft. In most cases, however, using larger aircraft will reduce the unit cost and therefore improve profitability.

Since the current airport terrain at ZQN does not feasibly allow a runway extension the study was restricted to narrow body aircraft only. For this reason, the only way to satisfy demand after the largest narrow-body aircraft capacity was reached, was to increase frequencies, even beyond the optimal Boeing Commercial Aircraft Passenger Convenience frequency.

Only those new routes which are within existing narrow body aircraft operating range (including the latest generation Boeing 737MAX and Airbus 320neo families) were considered.

Queenstown Airport – Comparative analysis of 2016 actual and forecasts and seasonality trends

Typically, airlines and airports calibrate two work sets (one work set week per season). In order to determine whether that approach was valid for ZQN in this analysis, seasonality needed to be examined. As this section of the report shows, ZQN has high seasonality.

Historical seasonal trends

Historically, ZQN has shown strong seasonal passenger demand trends. Figure 6 demonstrates this seasonality for the years 2011 to 2017. This information was used to develop the seasonality characteristics for ZQN that were inputted into the forecasting models.

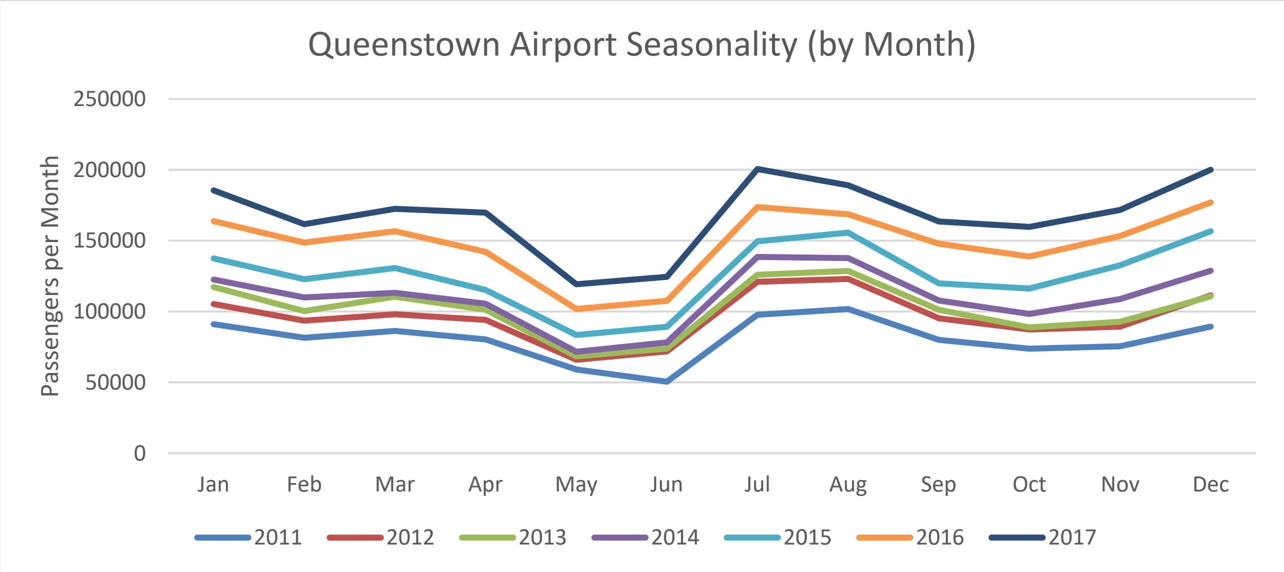

Figure 6: Monthly total passenger numbers at Queenstown Airport between January 2011 and December 2017.

It would be logical to conclude from the results shown in Figure 6 that because passenger demand is seasonal, aircraft traffic is also seasonal. Traffic seasonality is not however driven by genuine demand seasonality to ZQN however, but rather reflects airline capacity to the airport. Airlines tend to reduce capacity for various reasons. They schedule maintenance events to low-seasons and release aircraft capacity to destinations considered seasonal. It is worth noting that airports such as ZQN receive low-frequency operations from airlines. Cancelling even one frequency in those circumstances has a significant impact on demand. For example, if the normal operation is four flights a week (which is about the average for ZQN for Northern Summer season), cancelling one flight means a 25% drop in available capacity.

Aviado therefore modelled the impact of providing a consistent year-round schedule. One of the potential risks for airlines that have seasonal schedules (or frequent schedule changes) is the improper publishing of flights or filing the fares. The modelling was based on an assumption that all itineraries are properly published for sales (i.e. the potential forecast demand versus actual observed passengers).

Weekly passenger and aircraft traffic forecasts – NS (NZ Winter)

Figure 7a illustrates the forecast on-board passenger numbers on an average day for arriving and departing passengers at ZQN. When compared to actual 2016 traffic (Figure 7b), the modelling demonstrates that air traffic into ZQN could significantly grow based on current market sizes and route optimisation. For example, the peak clock hour in the optimized schedule is from 15:00 to 16:00. During that time, the optimized schedule has 1586 passengers moving through the terminal (708 passengers arriving, 878 departing). The actual passengers for the same time were 846 (273 departing, 573 arriving). If we compare the hour before (14:00-15:00), the passenger numbers for optimized schedule (809) and actual (751) are almost the same.

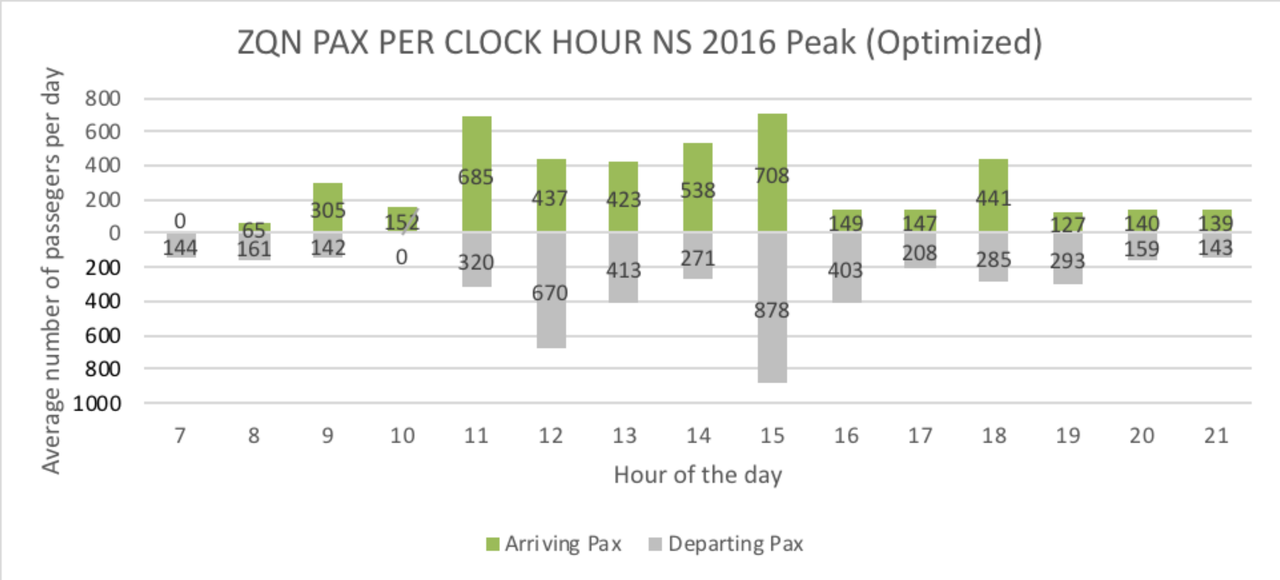

Figure 7a: Forecast passenger traffic for week commencing 1st August 2016. Average of July and August 2016 Demand. Based on optimization of capacity.

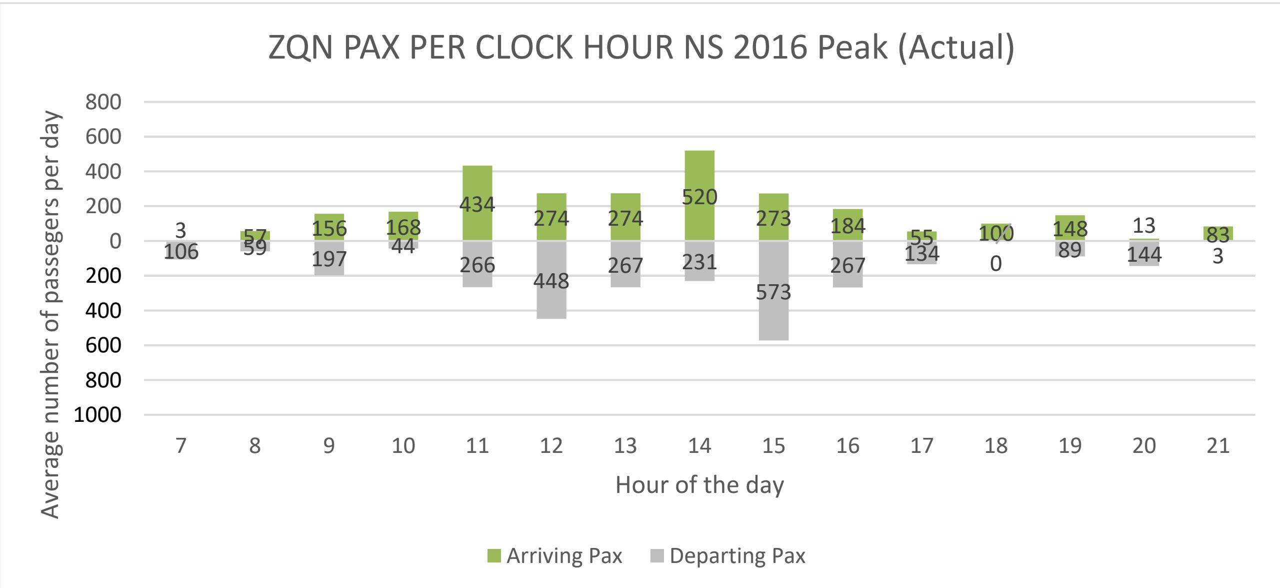

Figure 7b: Actual weekly passenger traffic for peak period (weeks 27-33) of NS 2016. Average passengers per week.

Figure 7c illustrates the number of flights arriving and departing ZQN on an optimised average day. Most of the added traffic arrives and departs in the afternoon, which is largely due to schedules at the hubs connecting into Queenstown. The airlines used in the modelling were the same as the ones flying to Queenstown already (to demonstrate the opportunity for passenger growth if current airlines were to fly with more consistent and optimised schedules).

The average operations per peak hour can be deceiving. Currently most of the flights to ZQN are operated with 4-5 frequencies per week (or an average of 0.6 flights per average day). In the optimized schedule most of the flights are daily (as demonstrated by having average close to full number). As with the passenger movements, the peak clock hour for the aircraft movements is from 15:00 to 16:00. During that time the optimized schedule has 12.7 movements (6.1 arriving and 6.6 departing flights). During the same period the actual schedule had 7 movements (2.4 arriving and 4.6 departing).

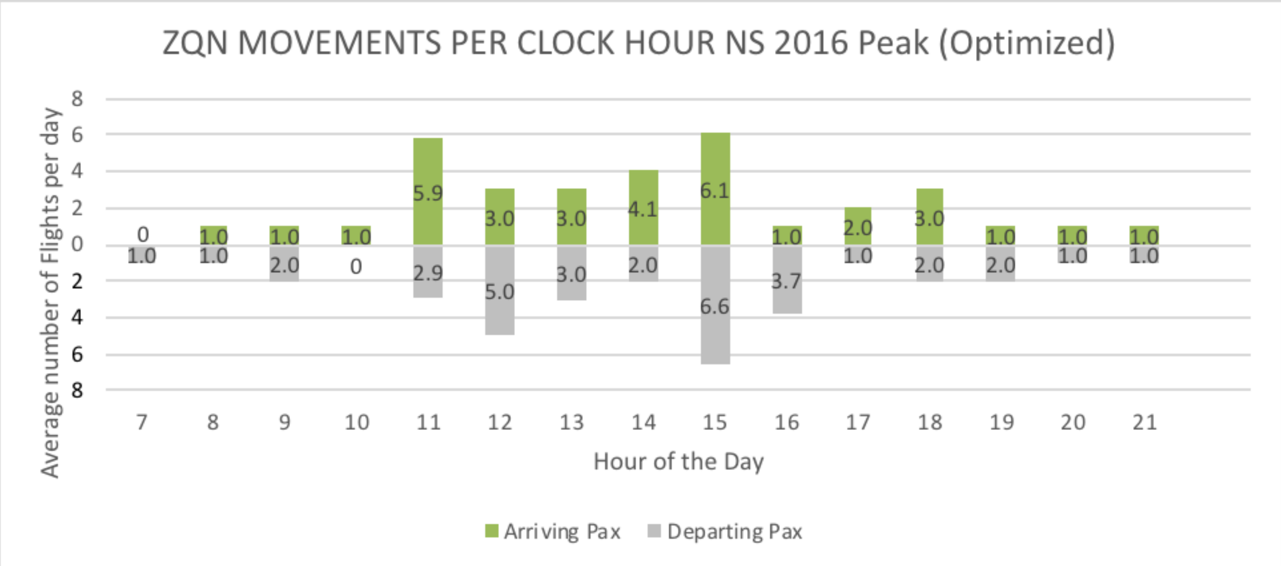

Figure 7c: number of flights for average day in forecast for week commencing 1st August 2016. Schedule modified to optimise demand.

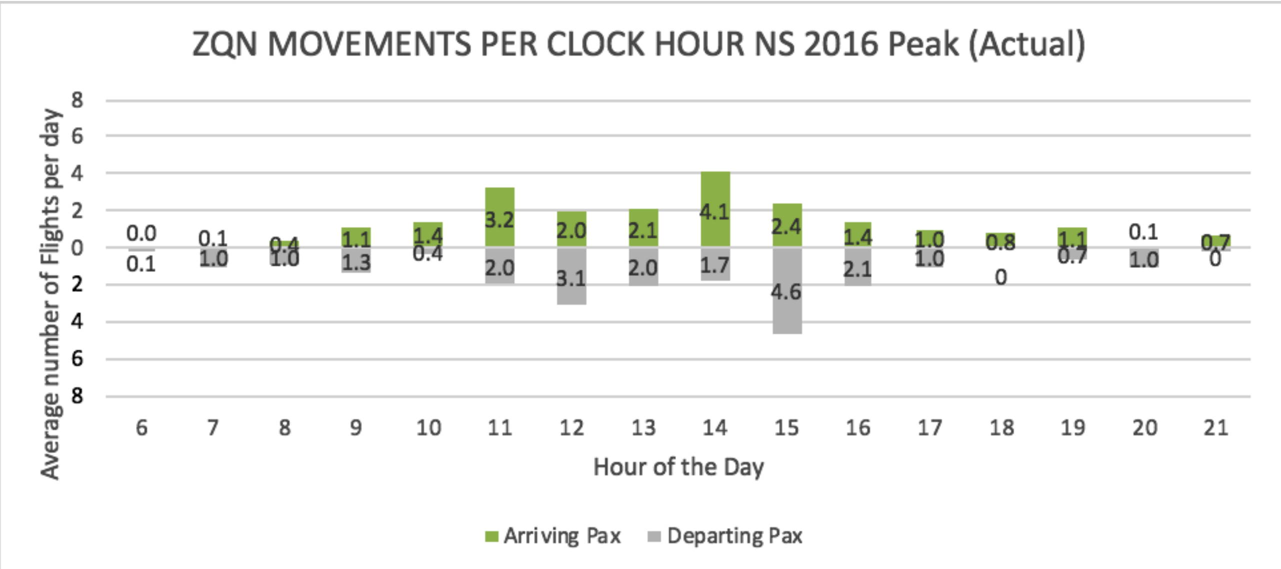

Figure 7d: Actual number of flights for average day Northern Summer 2016 peak period

Weekly passenger and aircraft traffic forecasts – NW (NZ Summer)

Figure 8a illustrates the forecast optimised on-board passenger numbers on an average day for arriving and departing passengers at ZQN during the NW (NZ summer - December and January). Like the NS (NZ winter) results, the modelling shows that potential passenger growth during 2016 could have been significantly greater than observed growth. During the NW peak (NZ summer peak) actual flown passengers (Figure 8b) are more evenly distributed during the day than in NS peak.

The 14:00-15:00 period is the peak clock hour in NW Optimized schedule by a small margin (total of 931 passengers – 542 arriving, 389 departing). The 15:00-16:00 period remains busy as well (923 passengers – 345 arriving, 578 departing).

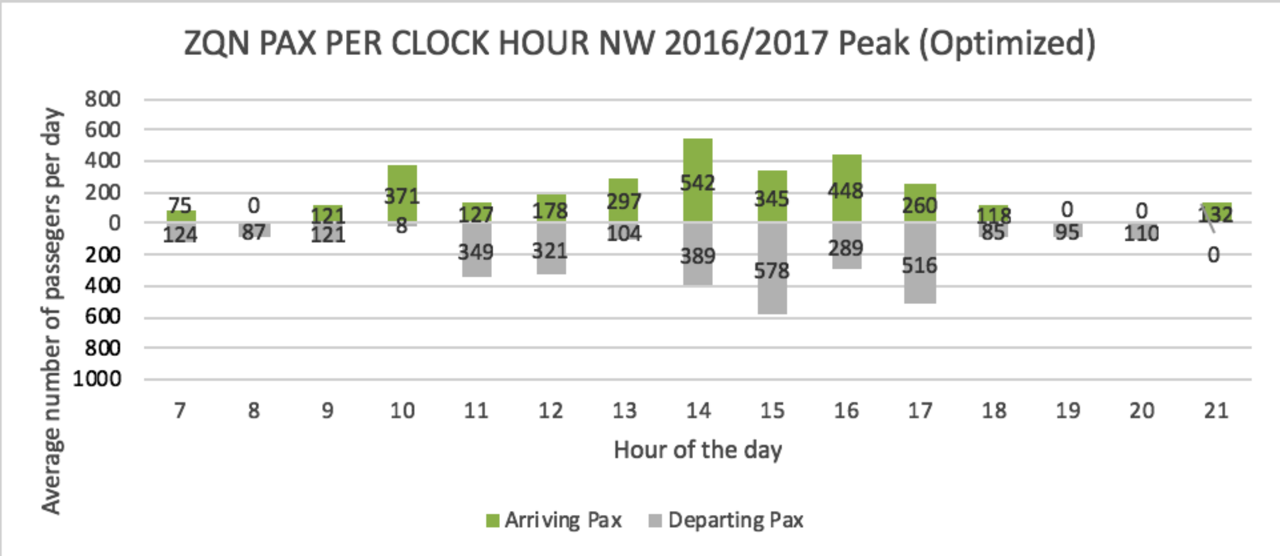

Figure 8a: Forecast passenger traffic for week commencing 9th January 2017. Average of December and January 2017 demand, total per week.

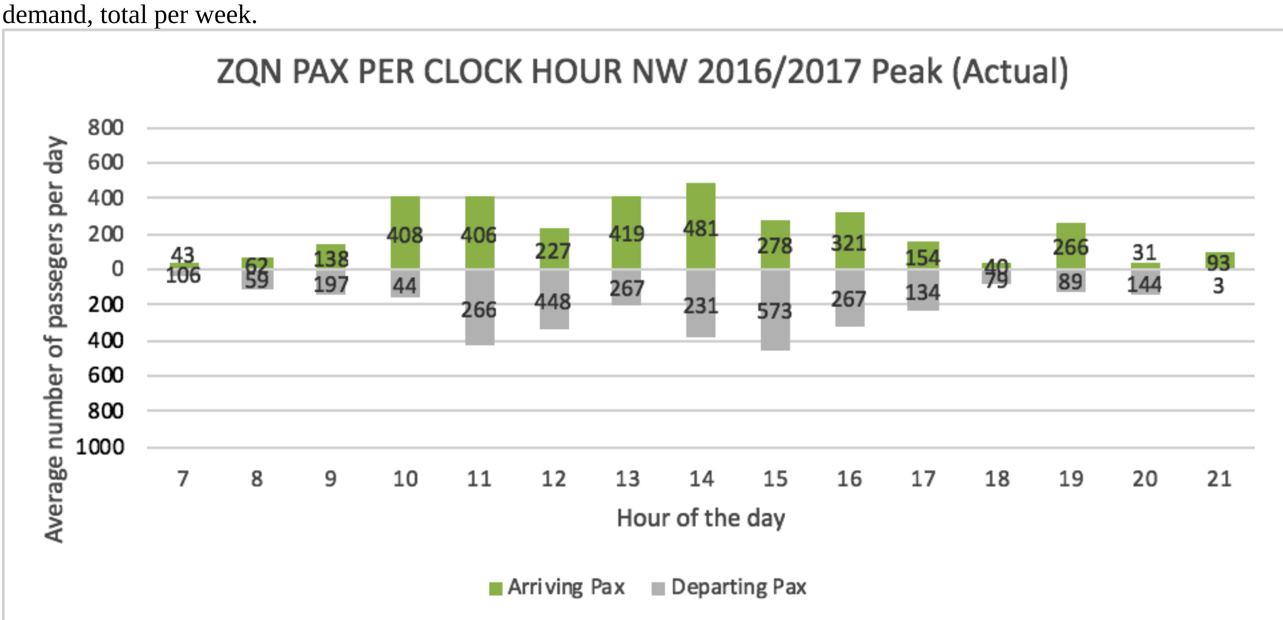

Figure 8b: Actual average weekly passenger traffic for weeks 51/2016-2/2017.

Figure 8c illustrates the number of flights arriving and departing ZQN on an average optimised day. Most of the added traffic arrives and departs in the afternoon which is largely due to schedules at the hubs connecting into ZQN. The airlines used in the modelling were again the same as the ones flying to Queenstown already (to demonstrate the opportunity for passenger increase if current airlines would fly with more consistent and optimised schedules). In the optimized schedule most of the flights are daily (as demonstrated by having average close to full passenger numbers). As with the passenger movements, the peak clock hour for the aircraft movements is from 14:00 to 15:00. During that time the optimized schedule has 8.5 movements (4.9 arriving and 3.6 departing flights). During the same period the actual schedule had 6.6 movements (3.8 arriving and 2.8 departing).

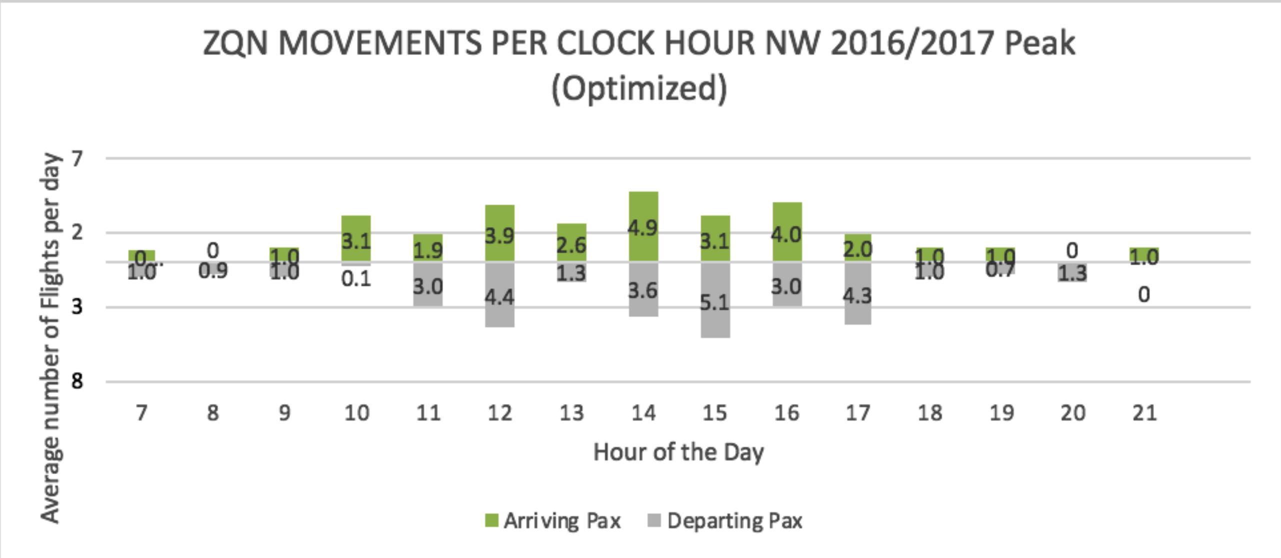

Figure 8c: Forecast aircraft movements for the week commencing 9th January 2017 modified to optimise demand. Average of December, January 2017 demand total per week.

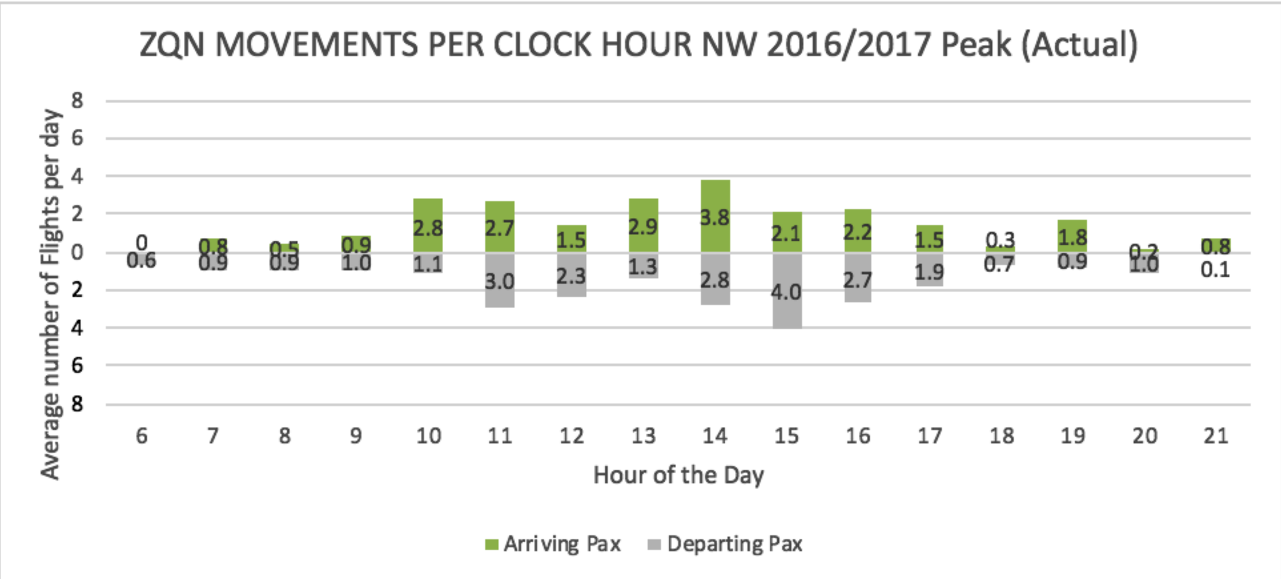

Figure 8d: Actual average aircraft movements for the weeks 51/2016-2/2017.

Summary

Overall, the modelling has shown that demand currently outstrips capacity in ZQN and that through schedule optimisation and consistency, passenger numbers at ZQN could significantly grow under the current market environment.

Using the seasonal characteristics identified in this section, passenger and aircraft traffic forecasts were undertaken for 2025, 2031, 2035 and 2045.

Forecast Results

The model forecasts have been described for four snapshots in time: 2025, 2031, 2035 and 2045. For the purposes of describing the modelled results, the following section is structured as follows:

- Passenger Forecasts:
  - Domestic passenger forecasts;
  - International passenger forecasts;
  - Overall passenger forecasts;
  - Peak hourly passenger forecast 2031.

- Forecast Aircraft Movements:
  - Domestic aircraft movements;
  - International aircraft movements;
  - Overall aircraft movements; and,
  - Peak hourly aircraft movements 2031.

Passenger Forecasts

Domestic Passenger Forecast Results

Figure 9 shows the development of domestic passenger growth by month and by forecast year. Significant and continuous growth is forecast until 2035, after which the passenger growth slows but remains in a positive trajectory. This slowing reflects that by 2045, most aircraft would have been up-gauged to the largest possible narrow-body aircraft available.

By December 2035, peak domestic NW (NZ summer) passenger numbers (January and December) are forecast to exceed NS (NZ winter) passenger numbers by approximately 5,000 passengers.

Optimized Passengers (Domestic)				
	2025	**2031**	**2035**	**2045**
Jan	195,451	235,208	343,741	394,302
Feb	175,906	211,687	309,367	354,872
Mar	185,678	223,448	326,554	374,587
Apr	121,264	184,034	217,019	259,712
May	125,306	190,169	227,613	268,369
Jun	121,264	184,034	217,019	259,712
Jul	201,730	304,764	338,640	379,989
Aug	201,730	304,764	338,640	379,989
Sep	121,264	184,034	217,019	259,712
Oct	125,306	190,169	227,613	268,369
Nov	163,363	196,881	281,853	332,321
Dec	195,451	235,208	343,741	394,302
Totals	**1,933,712**	**2,644,400**	**3,388,819**	**3,926,236**

Figure 9 – Forecast Domestic Passengers by Month per Forecast Year.

International Passenger Forecast Results

Figure 10 shows the development of international growth by month and by forecast year. Forecast trends in international passenger numbers follow a similar pattern to domestic passenger growth (above), with the most significant growth occurring through until 2031 when the benefits derived from aircraft up gauging are expected to have reached capacity. It is also anticipated that by this time, capturing destinations within the flight distance capabilities of narrow body aircraft will become more challenging.

Unlike the domestic passenger trends however, international passenger numbers continue to peak during the NS (NZ winter) months.

Optimized Passengers (International)				
	2025	**2031**	**2035**	**2045**
Jan	66,017	91,556	220,197	251,941
Feb	59,415	82,401	198,178	226,747
Mar	62,716	86,978	209,188	239,344
Apr	64,940	103,299	172,289	249,527
May	51,111	106,742	178,032	257,845
Jun	64,940	103,299	172,289	249,527
Jul	121,219	170,150	285,314	349,667
Aug	121,219	170,150	285,314	349,667
Sep	64,940	103,299	172,289	249,527
Oct	67,105	106,742	178,032	257,845
Nov	56,766	76,877	184,317	212,468
Dec	66,017	91,556	220,197	251,941
Totals	**866,405**	**1,293,050**	**2,475,637**	**3,146,045**

Figure 10 – Forecast International Passengers by Month per Forecast Year.

Overall passenger forecast results

Figure 11 and 12 shows the overall total forecast traffic by month and by forecast year. For the reasons previously described with respect to Figure 9 and 10, growth continues steadily until approximately 2035, after which growth rates dampen, but remain in a general upward trajectory.

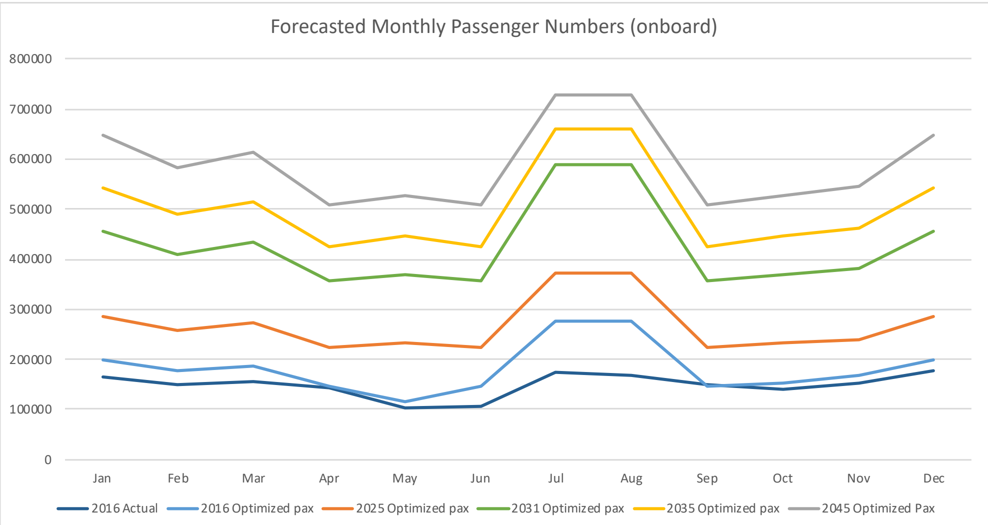

Figure 11 – Overall forecast monthly passenger numbers by forecast year.

Optimized Passengers (Total)				
	2025	2031	2035	2045
Jan	287,007	455,406	542,775	646,244
Feb	258,306	409,865	488,497	581,619
Mar	272,657	432,635	515,636	613,932
Apr	224,563	356,323	425,528	509,239
May	232,048	368,201	446,299	526,213
Jun	224,563	356,323	425,528	509,239
Jul	371,880	590,078	659,879	729,656
Aug	371,880	590,078	659,879	729,656
Sep	224,563	356,323	425,528	509,239
Oct	232,048	368,201	446,299	526,213
Nov	240,240	381,198	462,054	544,789
Dec	287,007	455,406	542,775	646,244
Totals	**3,226,762**	**5,120,037**	**6,040,677**	**7,072,281**

Figure 12 –Total forecast monthly passenger numbers by forecast year.

Peak Passenger Arrivals and Departures (busiest months of the year)

The analysis of peak passenger arrivals and departures is based on the forecasted passenger numbers at 2031. It is Aviado's understanding that QAC has determined that this is the forecast that it wishes to develop its' infrastructure, and on which planning is currently being based on.

The peak hour for arrival passengers in 2031 NS (NZ winter) months (Figure 13) is 15:00 to 16:00. During that time, the airport will have 1,289 arriving passengers on an average week day. The peak departure hour is forecast to be between 16:00 to 17:00. During that time, the airport will have 1,107 departing passengers on average week day. During the 15:00 to 16:00 timeframe, the airport has 1,971 passengers going through the terminal.

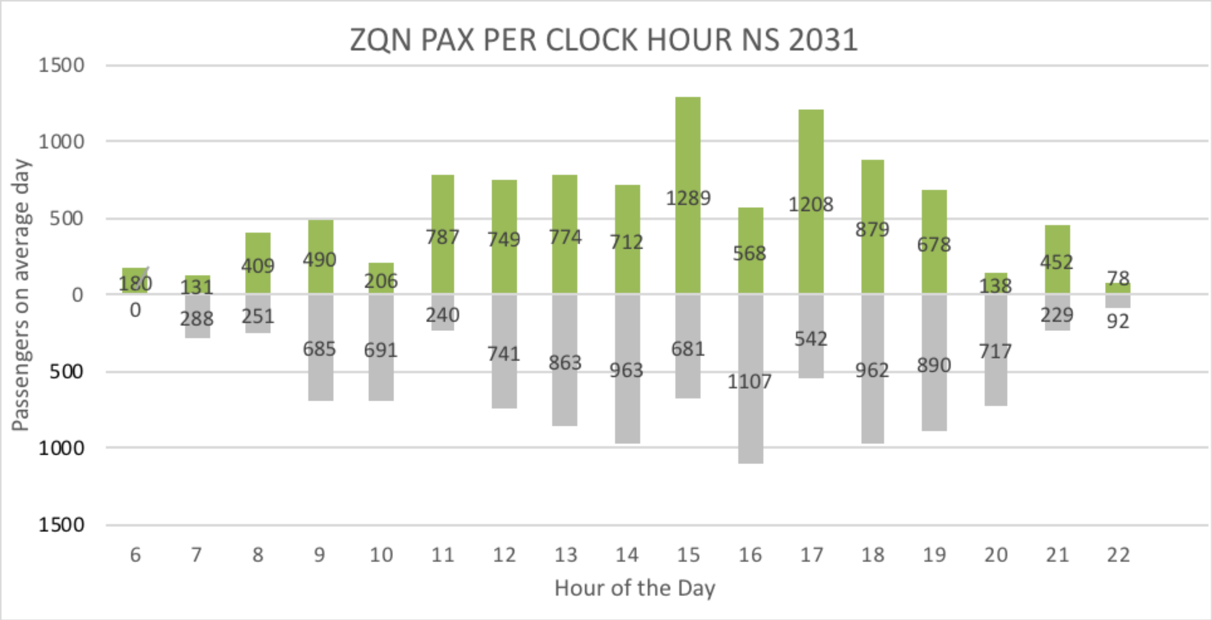

Figure 13 – Arrival (green) and departing (gray) passengers per clock hour during the 2031 NS (NZ winter) months (July, August).

In 2016, the peak hour departing passengers were forecasted to be 878 and in 2031 this number would be 1,107, (26% growth) and arrival passengers have increased 22% in same operating hour (864 arrival passengers in 2031 vs 708 passengers in 2016).

Forecast aircraft movements

Domestic Aircraft Movements

Figure 14 shows the forecast domestic aircraft movements (arrivals + departures) by month and by forecast year. Aircraft traffic generally follows the same trend as passenger forecasts, with significant growth forecast until 2035, after which the growth of operations slows due to most aircraft being up gauged to the largest possible narrow-body aircraft available. Growth beyond this is what is left to increase frequencies to the maximum level of the Boeing's Passenger Convenience Curve (discussed above).

Like the domestic passenger forecast trends, the NS (NZ winter) months (July, August) continue to provide peak domestic aircraft traffic until approximately 2031, after which domestic aircraft traffic becomes more pronounced during December.

Optimized Movement (Domestic)				
	2025	**2031**	**2035**	**2045**
Jan	1,461	1,883	2,577	2,799
Feb	1,315	1,695	2,320	2,519
Mar	1,388	1,789	2,449	2,659
Apr	1,219	1,641	2,150	2,334
May	1,070	1,510	1,887	2,049
Jun	940	1,395	1,657	1,799
Jul	1,382	2,280	2,418	2,728
Aug	1,382	2,280	2,418	2,728
Sep	1,173	1,599	2,069	2,247
Oct	1,269	1,522	2,238	2,431
Nov	1,330	1,607	2,346	2,548
Dec	1,461	1,883	2,577	2,799
Totals	**15,391**	**21,083**	**27,107**	**29,640**

Figure 14 – Domestic Aircraft Movements by Month (arrivals + departures)

International Aircraft Movements

Figure 15 shows the forecast international operating movements (arrivals + departures) by month and by forecast year. As can be seen, the significant growth of traffic comes in the earlier periods (up until 2031) after which the growth in operations slows down. The timings for arrivals are largely dependent on the timings of operations at the international hubs. Domestic operations can be distributed more evenly throughout the day, for example to spread the load on infrastructure.

Optimized Movement (International)				
	2025	2031	2035	2045
Jan	806	1,833	1,630	2,241
Feb	725	1,650	1,467	2,017
Mar	766	1,742	1,548	2,129
Apr	757	1,598	1,531	2,105
May	749	1,471	1,514	2,082
Jun	740	1,358	1,497	2,058
Jul	1,364	2,220	2,498	2,728
Aug	1,364	2,220	2,498	2,728
Sep	752	1,556	1,520	2,091
Oct	564	1,482	1,140	1,568
Nov	605	1,565	1,224	1,682
Dec	806	1,833	1,630	2,241
Totals	**9,998**	**20,528**	**19,696**	**25,669**

Figure 15 – International Aircraft Movements by Month (arrivals + departures)

Overall Aircraft Movement Forecasts 2016 to 2045

Figure 16 shows the overall forecast growth in operating movements (arrivals + departures) by month and by forecast year. As can be seen, the significant growth occurs until 2035, after which the growth of operations slows down.

Optimized Movement (Total)				
	2025	**2031**	**2035**	**2045**
Jan	2,267	3,716	4,207	5,040
Feb	2,041	3,345	3,786	4,536
Mar	2,154	3,530	3,997	4,788
Apr	1,976	3,239	3,681	4,439
May	1,819	2,981	3,401	4,131
Jun	1,680	2,753	3,154	3,858
Jul	2,746	4,500	4,916	5,456
Aug	2,746	4,500	4,916	5,456
Sep	1,925	3,155	3,589	4,337
Oct	1,833	3,004	3,379	3,999
Nov	1,935	3,172	3,570	4,230
Dec	2,267	3,716	4,207	5,040
Totals	**25,389**	**41,611**	**46,802**	**55,309**

Figure 16 – Forecast total aircraft movements by Month (arrivals + departures)

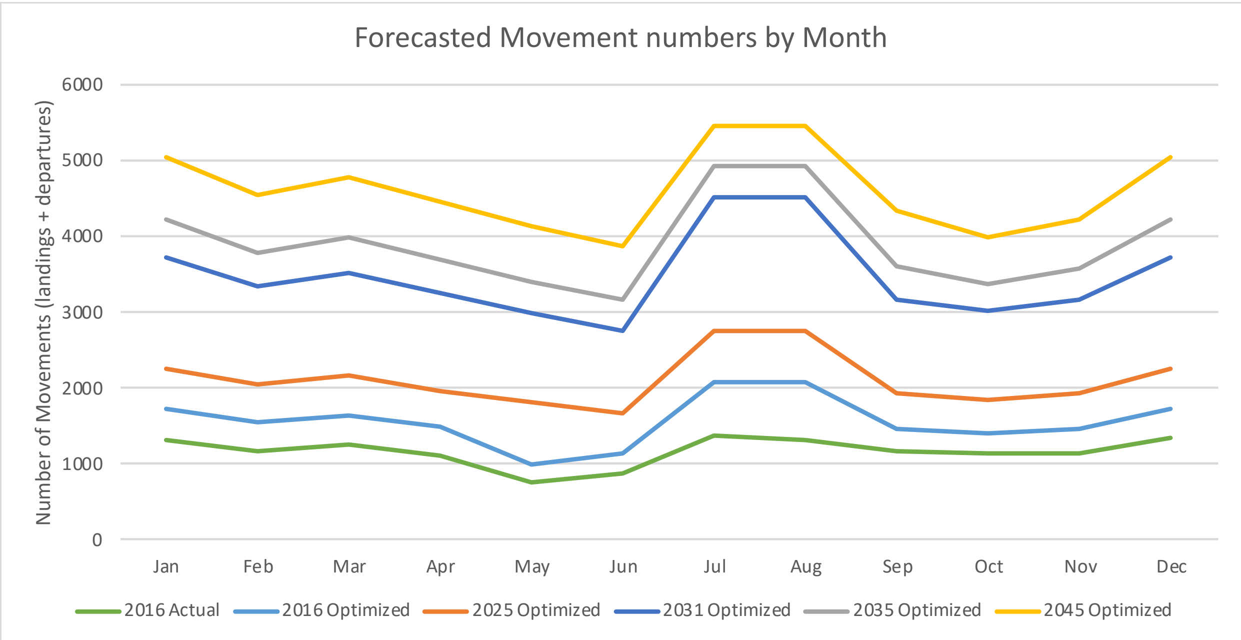

Figure 17 – Forecast aircraft movements by Month (2016 to 2045).

Forecast Peak Hourly Aircraft Operations

Figure 9 shows the aircraft operations distribution throughout the day for the NS (NZ winter) months of 2031. For the NS (NZ winter), the peak hour for total movement is from 18:00 to 19:00 (16 movements). The peak arrival hour is 15:00-16:00 (10 movements) and the peak departure hour is 16:00-17:00 (8 movements).

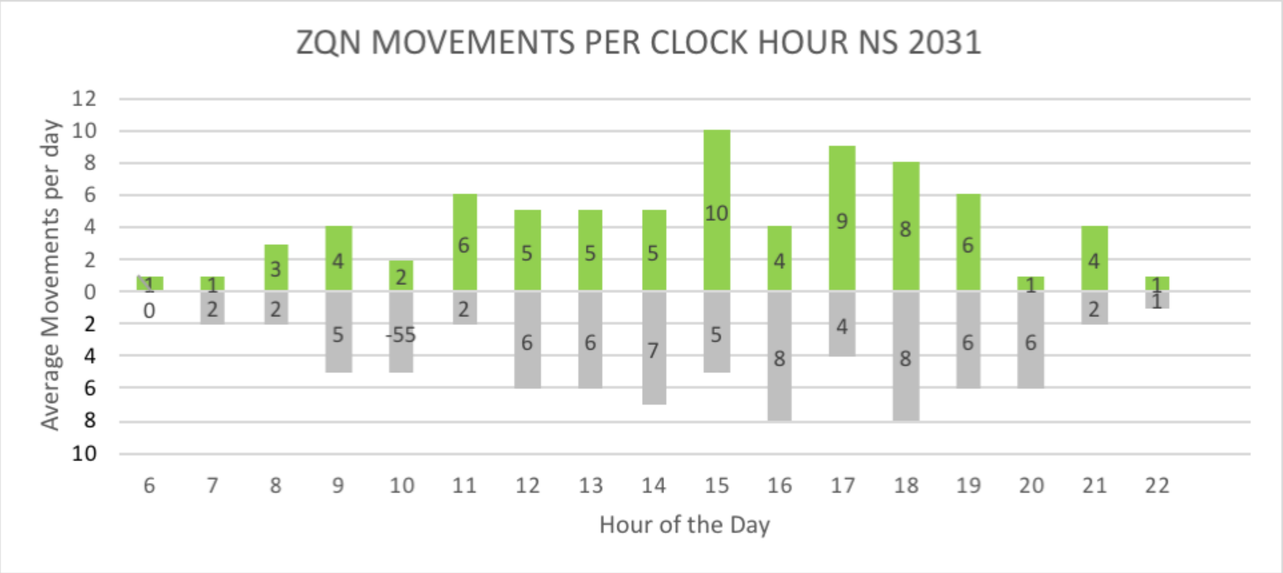

Figure 9– Arrival (Green) and Departure (grey) movements for NS (NZ winter) of 2031.

Appendix 1

Aviado Partners is an aviation management consulting firm providing trusted advice to corporates, government and institutional stakeholders. AVIADO Partners and Associates have extensive experience working for and with airlines, airports, train operators and other travel industry companies.

Aviado has worked in the region with Auckland Airport, Air New Zealand, Qantas Airlines and Cairns Airport in the region. All the work in the region have included significant market modelling and forecasting.

The modelling and forecasting has been used for:

- Network restructuring of the airlines
- Fleet Planning
- Capacity planning for the airports
- Route development (forecasting of route results for new and existing airlines)
- Market and tourism development

Aviado has also worked for major airports and airlines in Asia, Middle East, Canada, United States and Europe. In those regions and countries, the modelling and forecasting has been used for:

- Network restructuring of the airlines (aiming for optimizing profits)
- Fleet Planning
- Master Planning of the airport (Terminal sizing, apron and runway planning)
- Capacity planning for the airports
- Route development (forecasting of route results for new and existing airlines)
- Market and tourism development
- Decisions on approval of mergers and acquisitions.

Aviado's modelling accuracy has been validated by all above clients and their partners and target customers.