# AL AIN INTERNATIONAL AIRPORT

A look at designing a next generation airport terminal

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This thesis is presented to the Undergraduate Faculty of the Department of Architecture and Interior Design at The College of Engineering at Abu Dhabi University.

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# CONTENTS

# PART 1
## INTRODUCTION

# PROJECT IDENTIFICATION

## A NEXT GENERATION AIRPORT TERMINAL

The next generation of airport terminals will be the most technologically advanced and must be the most user-friendly terminals created. Automation and quick service will define which terminals are the best in the world. The main goal of airport design today is to reduce the distance between cars, buses, or trains on the outside of the terminal and an aircraft on the other side. The terminal must make it as easy and stress free as possible for passengers to get to their aircraft.

Several older terminals in the UAE were designed in times when passengers were far fewer and security requirements were less stringent. To comply with new security regulations and adapt to passengers' expectations, these airports have been retrofitted with security measures that are detrimental to the user experience. In addition, the use of retrofitted technology and automation is, by its nature, not as good as could be.

## FUTURE ISSUES AND SOLUTIONS

The main points of frustration faced by passengers:

1. Long and sometimes unfair queues
2. Congested and small spaces because of the increase in passengers
3. Airports can be confusing to navigate
4. A lack of clarity or transparency can cause passengers to become anxious
5. Slow security

## PROBLEMS, SOLUTIONS AND GOALS

### LACK OF A LINE OF SIGHT

Airports can lack transparency which can make the next step a mystery. A design goal of this project will be to give passengers a line of sight so that they can clearly see what the next step is.

### SPACES DO NOT ACCOUNT FOR QUEUING

Old airports that have had to take on capacities that they were not designed for have issues with queues lacking the space they require. This results in queues spilling into circulations spaces making the airport feel congested and busy. The solution is to design so that queues have their own spaces that are not directly shared with circulation space.

### DEPENDENCE ON SIGNAGE

The dependence on signage in airports is known to slow down passengers as they try to read signs instead of moving to their destination. To fix this problem, the dependence on signs must be reduced. In addition, any signs that are needed must be extremely clear and obvious. Finally, the design itself should be 'self-navigating'. In other words, it should make people automatically gravitate towards the place they need to go.

### SECURITY

Most airports were built in an era when security requirements were not as stringent as they are now. This means security is a frustrating and anxiety inducing experience for most people. One of the goals for this project will be to create a calm smooth experience while passing through security.

### BAGGAGE CAROUSELS

In many old airports, baggage carousels were retrofitted and placed in-between the columns of existing structure. This reduces their usability as people cannot used the space blocked by the columns. This project must take structure into consideration with any required elements placed appropriately to maximize the use of space.

Another issue with baggage is that recent advances in reducing the time it takes to get through security on arrival at an airport mean that bags are not ready for passengers at the carousel when they clear security. This is frustrating as the time saved has essentially been wasted.

### AUTOMATION

Automation is the future and must be integrated into any new airport. Automation will increase the efficiency of an airport. Will be further investigated as this semester progresses.

# AIRPORT ORIGINS

Where was the first airport built? In fact, what is even considered an airport? It is slightly disputed whether, back in the early 1900s, an airport should be classified as a building that only serves heavier than air aircraft (i.e. airplanes and helicopters) or if lighter than air aircraft (i.e. zeppelins and airships) should be included. Most agree that an airport is the former, a building that only serves heavier than air aircraft. With that established, what was the first airport?

## THE FIRST AIRPORT

There are two facilities that have made their name in aviation history. The first is Kitty Hawk, the place the first plane, the Wright Flyer flew, back in 1903. It is generally agreed that this place was not the first airport, even though the Wright Brothers had built a hanger there for testing. Kitty Hawk was not a dedicated airfield and was used for two years by the Wright brothers to build and test their invention. At the end of those two years they stopped building planes there as they grew wary that industry spies might try to sneak in and take their designs. Kitty Hawk was a very public place with a main road and tram passing close-by. The stakes were very high as they sold their first plane for $30,000 in 1909 (Pearman, 2004). So, the brothers moved The Wright Company, to Huffman Prairie, the world's first airport.

### HUFFMAN PRAIRIE

Huffman Prairie is located near the Wright Brothers hometown of Dayton Ohio. The

**Figure 1** The Wright Brothers with the Flyer II at Huffman Prairie

brothers began using the field in 1904 after getting permission from its owner, a banker Torrence Huffman. It is considered the first airport because it is where the Wright Brothers permanently established their company and built and testing their aircraft. In addition, the planes that flew there, flew long distances compared to the short hops made in other locations. In 1910, the brothers established the Wright Company School of Aviation and trained over a hundred passengers at this location.

The 34-hectare site had a public and private side clearly marked by flag poles at its boundary. Special equipment used to launch and hold aircraft was also placed at the boundaries of the site. The timber hangars used to house the aircraft can be traced back to 1904. In essence, Huffman prairie is considered the first airport because it served all the needs of is users, from building and testing to training and public flying on a permanent basis.

## PREVIOUS AND UNBUILT FACILITIES

It can be said that the story does not begin at Huffman Prairie. If lighter than air aircraft are considered, the idea of an airport can be traced back to the 18th century. In 1784, soon





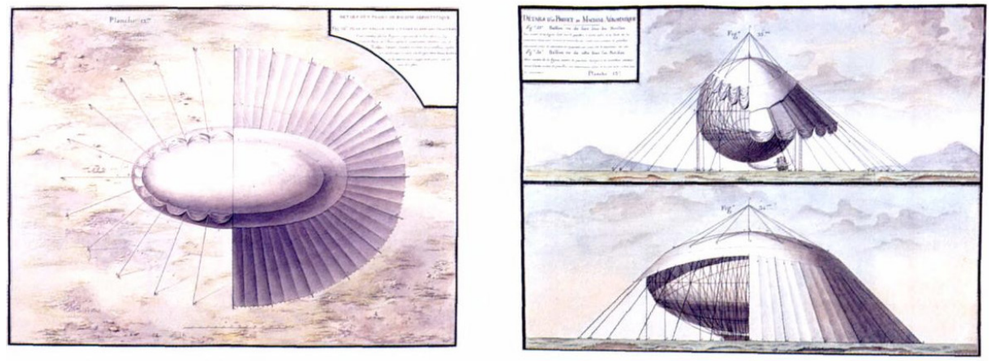


**Figure 2** (Above) Meusnier's sketches of his airship and hanger idea.

after the first balloon flight, French Engineer Jean-Baptiste-Marie Meusnier designed a propeller driven airship and a tent-like hangar to house it. He was never able to build either as he was killed in action in 1793. However, his designs were confirmed to work in 2002 when a scaled replica was built, tested, and found to work.

## AIRSHIP FACILITIES

### THE FIRST NAVIGABLE AIRSHIPS HANGAR

In the 19th century, several facilities were built for airship prototypes. In 1884, French engineers Charles Renard and Arthur Krebs built and piloted the world's first navigable airship. Part of their development was a steel lattice frame hangar built from modular components and glass left over from the 1878 Paris Expo. It can be said that Gustave Eiffel, who designed the Eiffel Tower, played a role in the first powered flights as he designed the modular components Charles and Arthur reused for their hangar.

### THE ZEPPELIN AND THE FIRST PASSENGER TERMINAL

In 1900 at the age of 62, Prussian soldier and aristocrat Ferdinand Graf von Zeppelin, flew five passengers several miles at a relatively high altitude in his first airship. Later in 1906

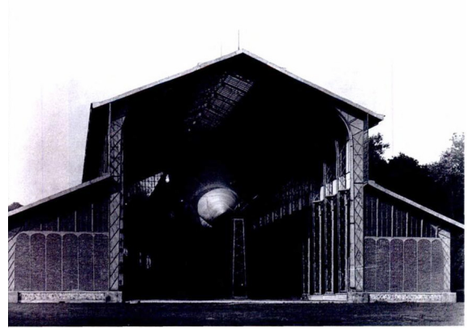


**Figure 3** The hangar used by Renard and Krebs with steel components designed by Eiffel.

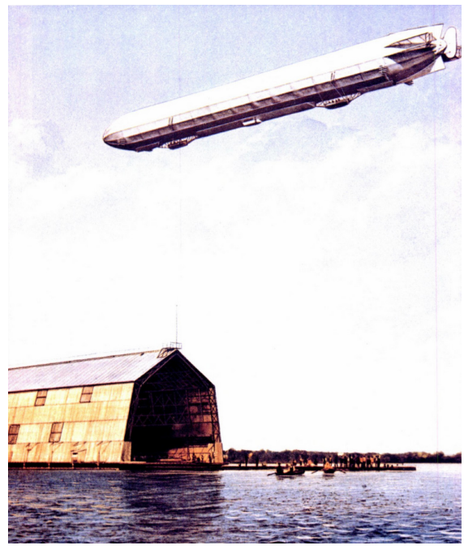


**Figure 4** Von Zeppelins airship above its hanger over the lake.

he achieved a 24-hour flight when back in the states the Wright brothers were struggling to achieve 40-minute flights. Von Zeppelins facility in Germany can therefor claim to be the world first passenger terminal. The terminal view from the terminal would have been quite a sight to behold. Passengers waiting would see their airship exit a hangar floating on a lake before making its way to them for boarding. It was favorable at the time and still is to build airports close to water. The reasons for doing so at the time were:

1. Air currents over water are more favorable
2. A crash over water had a higher chance of survival
3. Take offs and landings over water face fewer obstructions
4. Less noise for people on land
5. Harbors could be used by sea planes when an airport was not available
6. Airports could not be built on scarce land

When aviation was still in its infancy, airships challenged the airplane. The buildings built at the time were mainly to house, protect and maintain the extremely fragile planes. Remember at the time planes were made of materials like lightweight wood and canvas. They were nothing like the planes today which are buildings in their own right and can stay out in the elements for extended periods of time.

## THE SECOND WAVE OF AIRPORTS

Soon after word got out that man had achieved flight, it became common for these early flying machines to draw huge crowds especially if a competitive element was at play such as a time trial or race. Something needed to be done to accommodate and keep these spectators safe. A new model was introduced after the Huffman Prairie model of airport that kept people in mind in addition to the engineers and inventors in the Edwardian Air Show.

## THE EDWARDIAN AIRSHOW

The most important example of an Edwardian Airshow was the Reims Air Meet at a racetrack in August 1909 in France. This race is important historically because it took place just a month after the first international flight was made across the English Channel. The flight had put aviation in the public interest and so, approximately 500,000 people attended the airshow even though there were only 12 planes competing over the week. The airshow organizers were ahead of the curve and planned for all these people. In preparation, they converted the racetrack into a large aerodrome. They added amenities such as a 600-seat restaurant overlooking the airfield, a barber shop, post office, telegraph office and a grandstand for spectator. All these amenities, including the grandstands, were to become standard features of all early airports.

Airports conceived during this time of airshows were starting to show the characteristic L-shaped layout that became common at the time. One section was used by spectators while the aviators got their own section.

At the airshow were two key figures, David George Lloyd who would later become the prime minister of Britain and Former US president Theodore Roosevelt. Interestingly, as the leader of the country during the Great War, Lloyd George approved a massive expansion of military aviation. This paved the way for the British civil aviation industry. The same happened in France and Germany. The presence of President Roosevelt at the airshow had little effect in the US. Even though the US was the birthplace of the airplane, it lagged Europe for quite a while.





According to architectural historian Wolfgang Voigt (Pearman, 2004), all airshows held in France, Italy and Germany in that period followed the same configuration. A configuration derived from racing tracks like horse racing tracks seen today with their huge grandstands and pavilions able to intake a huge amount of people in very little time. Something that airports still do today, although for passengers in place of spectators.

## THE DELAG COMPANY MODEL

Another model for an airport was provided by a joint venture between Von Zeppelin and Hamburg-America Shipping Line. DELAG was the world's first airline, setting up bases near railway terminals where passengers could use the train to get to the airship that would take them further. The idea would not last because the huge size of Zeppelins meant their bases would need to move out of the cities they were meant to serve. However, the idea of connecting the passenger to the airport by train still survives to this day.

## GOING COMMERCIAL

Naturally during World War One airports were built all over Europe. The planes and airships had advanced significantly but the airfields used to support them had not changed much because they got the join done. However, after the war, the aircraft used in the war began to be converted for passenger and commercial use. All those fields, sports grounds, parade grounds and racetracks with their rundown buildings used during the war simply did not cut it for commercial passenger travel. These buildings had been designed for mechanics to work on planes and to store those planes. They sometimes included a clubhouse and sleeping accommodation for the mechanics.

Passengers needed to be accommodated in other ways than a mechanic or even the spectators from the days before the war. These people were fragile living cargo that tended to be wealthy, powerful, and articulate. These people were not the kind that would find an oil spill on their clothes or baggage amusing. They required a new kind of building that would accommodate them. Indeed, the airports built soon after the war were some amazing pieces of architecture.

After the war, Europe advanced the airport far more than America. Americans still were not convinced that giving up their freedoms of driving wherever and however they wanted was worth it over the, at the time, unreliable service of an airplane.

## COMMERCIAL BEGINNINGS IN EUROPE

In Paris, commercial airlines took over Le Bourget, a military airfield with buildings on one of its edges. Slowly, in the 1920s, these buildings began to be replaced with new classical buildings designed to accommodate passengers with functions separated amongst different buildings.

Wolfgang Voigt regards the Airport of Konigsberg, in the former Prussian capital, as the world first true passenger terminal. The terminal was built in 1922 by architect Hans Hopp who placed all passenger and administrative functions in a single rectangular multi story building located on the corner of an airfield. Placed to either side of the terminal were large hangars. At the time the facility was called an air station.

Konigsberg can be regarded as the prototype for Berlins Tempelhof. Before the war, Tempelhof was a venue for airshow and demonstration flights. It is regarded as the most im-

portant airport in aviation history. The airport kicked off operations in 1923 when Germany started to take commercial aviation more seriously than anyone in the world. Two terminals were built, the first Modernist style terminal by Paul and Klaus Engler was completed in 1929. The second was a neoclassical terminal build by Ernst Sagebiel in the late 1930s. The airport followed the pattern at the time, with hangar built first, then a control tower and finally a passenger building.

Designers soon discovered that two types of expansion needed to be considered during the design of an airport. The first is the expansion of the terminal to accommodate an increasing number of passengers and the second, less obvious expansion, was the increased size and number of airplanes operating from an airport.

By 1928, it is reported that in Germany alone there were 160 airlines in operation, flying more than 64,000km a day and 20,000 passengers a month (Pearman, 2004). Berlins Tempelhof and London's Croydon were the best in Europe at the time. Croydon initially processes passengers though a World War One aircraft hangar. By 1924, multiple British airlines had merged to become Imperial Airways, the precursor to today's British Airways. In 1928, Croydon opened its purpose built grand classical terminal.

**Figure 5** The second Berlin Tempelhof Terminal built by Sagebiel

### THE AIRBRIDGE

In the 1930s, as passenger numbers increased, it started to become impractical for passengers to simply walk onto the apron to their plane. Firstly, it posed a safety risk and secondly, the passengers, with all their wealth and power expected that they would be sheltered from the outside world to board their planes. Several solutions to this problem were devised. The first were simple shaded bridges that extended from the terminal to the aircraft. Then in 1930, a mechanically extendable canopy connected was design and tested by Boeing in California. London's Gatwick Airport to the idea and in 1936, opened a circular terminal with six 'gates' that led to telescopic tubes that extended to the aircraft. These tubes were complete with glass and moved on sliding rails. They allowed passengers to move to their aircraft from the terminal fully sheltered.

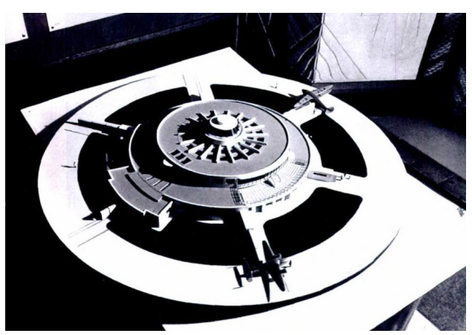


**Figure 6** An architectural model of Gatwick Airport with the first airbridges



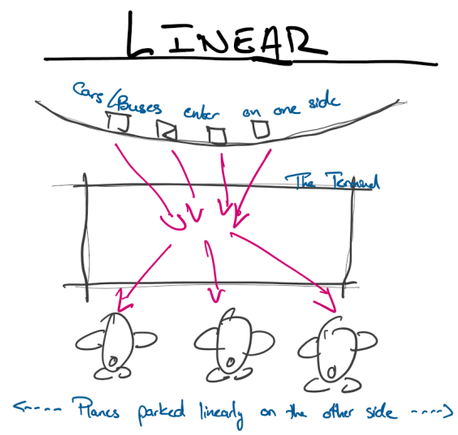


# AIRPORT CONFIGURATIONS

Over the past century, passenger buildings have gone through several evolutions and several types of passenger building have gained popularity. Discussed in this section are the history of the most popular types:

### OPEN APRON/LINEAR CONFIGURATIONS

Open aprons are the oldest type of terminal where aircraft park directly adjacent to the terminal. Passengers go through the terminal, walk onto the apron, and climb a set of stairs to their aircraft. However, as the demand for air travel grew, it became impractical to have so many passengers freely walking across the apron to their aircraft. This is where the linear terminal was introduced. This terminal is still quite popular with smaller regional airports like Sharjah International and Al Ain International. These airports have aircraft park facing the terminal building. Passengers board by taking jetways that connect the terminal to the aircraft.




These types of terminals are great for airports that only need small capacities of 1-6 gates and only accommodate medium sized aircraft (aircraft with a capacity of around 200 passengers).

### FINGER/PIER CONFIGURATIONS

As the demand for air travel grew even more in the 1950s, the pier or finger terminal found its place. Pier terminals use small narrow buildings connected to the main space where aircraft are parked on both sides. This design significantly increases the aircraft capacity of an airport but has several disadvantages as a result:

1. The distances passengers must travel can get extremely long.
2. As a result, building circulation volumes get quite large, making the terminal uncomfortable to use.
3. Finger terminals present passengers with many choices of circulation to take to get to their aircraft. If they make the wrong decision, they will have to backtrack to the beginning to get to another finger causing frustration and wasting time.
4. Aircraft must be about 75 meters away from the building to start their engines to not cause damage to the building. The nature of pier terminals mean aircraft must be pushed quite a bit further than linear terminals resulting in lost time and more delays.

5. In the 1950's when these terminals were built, aircraft held about 150-200 passengers. Today that number is about 300-400. This means larger aircraft that take more space resulting in longer walks for passengers.

6. The nature of the pier terminal means internal corners could not be used for meaningful things like parking aircraft. They were dead space.

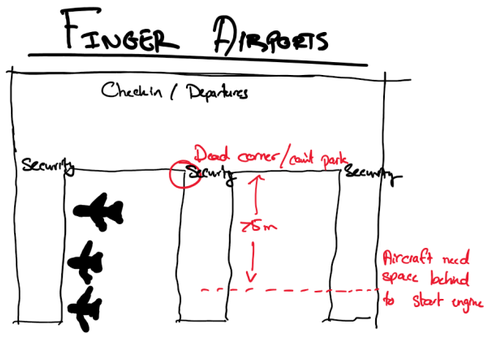



**Figure 8** The Finger/Pier Configuration

## SATELLITE CONFIGURATIONS

In the 1960's to address the issues faced by the pier terminal, the satellite terminal was developed. This type has a main building that houses the check-in, security, and amenity spaces. Then to get to their aircraft, passengers take a connection (some type of bridge or floating building) to a satellite building for boarding. This type has several advantages over the pier type:

1. The dead corners no longer exist.
2. The engine start issue is resolved
3. Increases versatility for taxiing to the runway. There is more than one route to get to the runway.
4. The multiple decision points presented to the passenger in the pier terminal are reduced to just one decision.

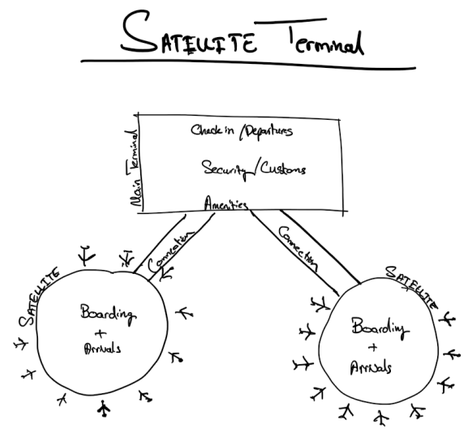



**Figure 7** The Satellite Configuration

## TRANSPORTER CONFIGURATIONS

In the 1960's, designers also introduced the transporter configuration to reduce the amount of maneuvering aircraft need to do to reduce operating costs for airlines. While the configuration successfully reduced maneuvering it introduced a new problem, passenger loading times. The configuration relied on specially designed vehicles to transport passengers from the terminal to their aircraft. These vehicles tended to be slow and unwieldy and significantly increased the time required to board and deboard and aircraft. As such the idea as mostly been abandoned after it was tried at airports like Washington Dulles and Jeddah King Abdul Aziz.

A variation of the configuration still survives

**Figure 9** An architectural model of Gatwick Airport with the first airbridges





where passengers are taken to their aircraft by bus rather than the specialized transporters. The downside of the bus system is that it becomes difficult for handicapped passengers to board an aircraft because of the use of stairways.

# PART 2
## SITE ANALYSIS

## SITE SELECTION CRITERIA

Several sites were considered for this project. They included:

- Al Bateen Executive Airport
- Sharjah International Airport
- Abu Dhabi International Airport
- Al Ain International Airport
- Dubai international Airport
- Ras al Khaimah International Airport

To be chosen the site needed to fulfill the following criteria:

- NEED FOR DEVELOPMENT: Does the site/ airport in question have the need for new development?
- PLANS FOR THE FUTURE: Are there plans to build a new terminal or renovated the current terminal at the location?
- ACCESSIBILITY: Is the site easily accessible during COVID-19 restrictions?

Dubai and Abu Dhabi international Airports did not meet the criteria because they are relatively new facilities that have no need for development. Sharjah International did not meet the criteria because its management does not have plans to build a new terminal, instead opting to upgrade the current terminal. All airports outside the Emirate of Abu Dhabi would be difficult to get to because of the COVID 19 restrictions in Abu Dhabi. Al Bateen Executive airport was a good candidate but there are no plans for its development at the moment.

Al Ain International Airport was the only airport to fit all the criteria. According to the Al Ain Airport Master Plan of 2014, there are plans for the development of a new terminal next to the existing terminal. It is also easily accessible during COVID-19 and is need for an upgrade.





**Figure 10** Al Ain on the Global Scale

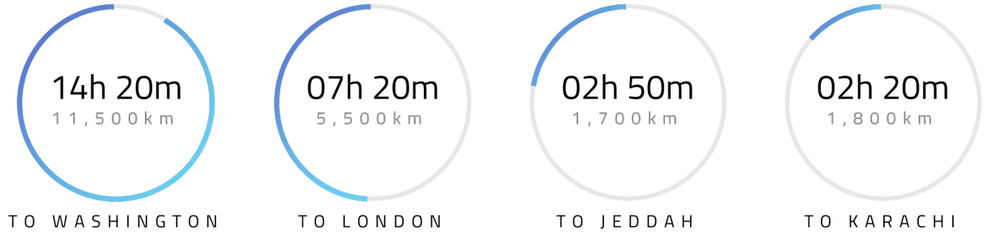



**Figure 11** Air Travel times from Al Ain

## GLOBAL SCALE MAP

On the global scale, Al Ain shares the geographic advantage its neighbors like Abu Dhabi, Dubai and Doha do by being at the center of many highly sought-after destinations.

Figure 10 and Figure 11 show the time required to travel to various highly visited places around the world. They show that the majority of people currently traveling from Al Ain (to Jeddah and the su-bcontinent) will be traveling for around three and three and a half hours.

Routes to farther locations such as London and Washington DC may be opened up once the airport has expanded and has the capacity to serve these locations.


**Figure 12** Al Ain's location in the UAE

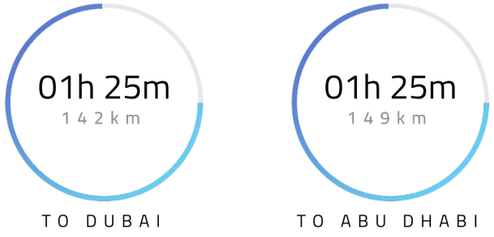



**Figure 13** Car Travel times from Al Ain

## UAE SCALE

Figure 12 shows Al Ain International Airport is located 149km from Abu Dhabi and 142km from Dubai. Both trips by car take roughly an hour and a half.

The city of Al Ain is located on the eastern side of the UAE. Dubai is to the northeast with Abu Dhabi is to the west.

The city is situated in-land and does not border the sea.

Figure 14 shows various landmarks around the city of Al Ain. Al Ain is known for being a quiet city which is reflected in the kinds of landmarks around the airport. They are mostly family and sports oreinted landmarks.

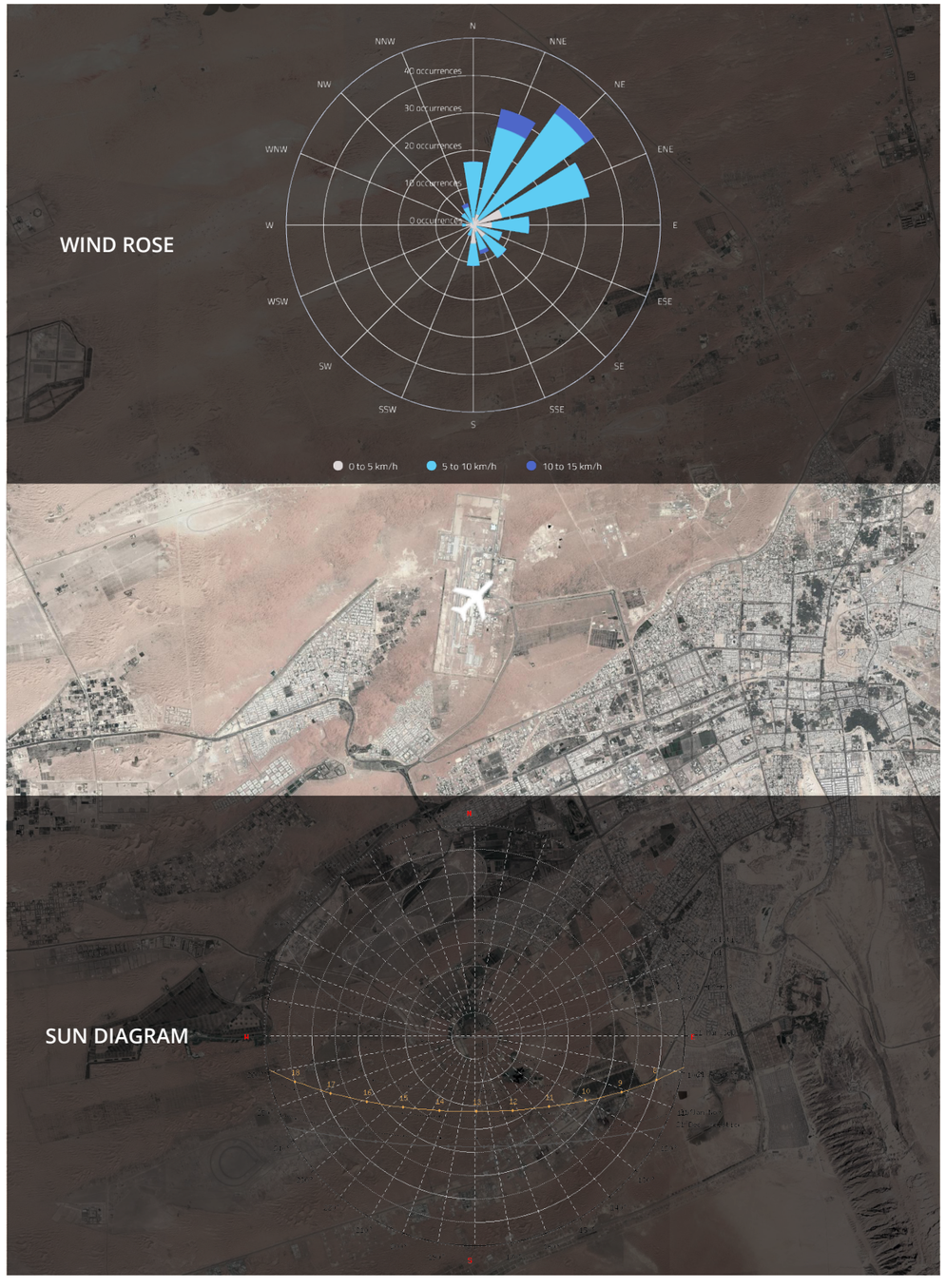





**Figure 14** Landmarks in Al Ain

## ENVIRONMENTAL INFORMATION

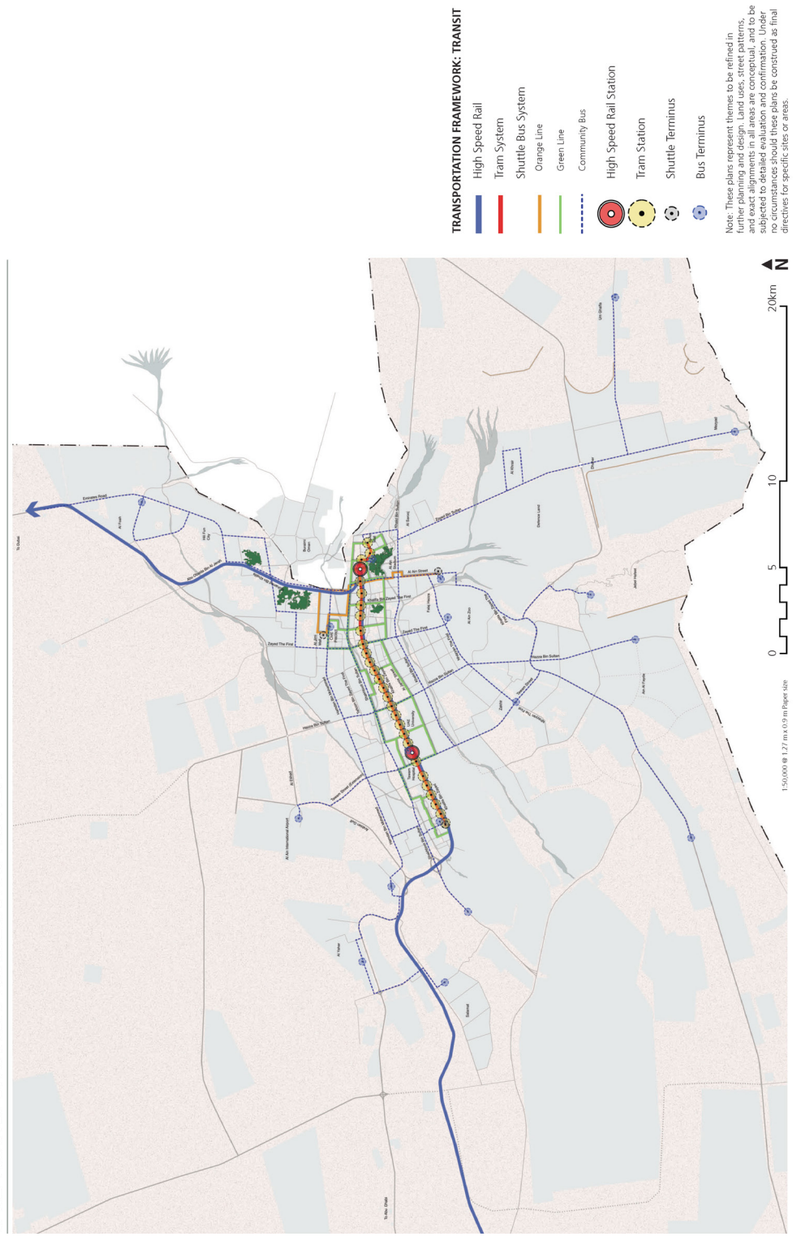
The sun diagram shows typical northern hemisphere sun behavior. The usual precautions and solutions will need to be applied to deal with solar radiation. The wind diagram shows a strong northeasterly wind, most likely the reason for the current orientation of the airports.






## 2030 PLAN

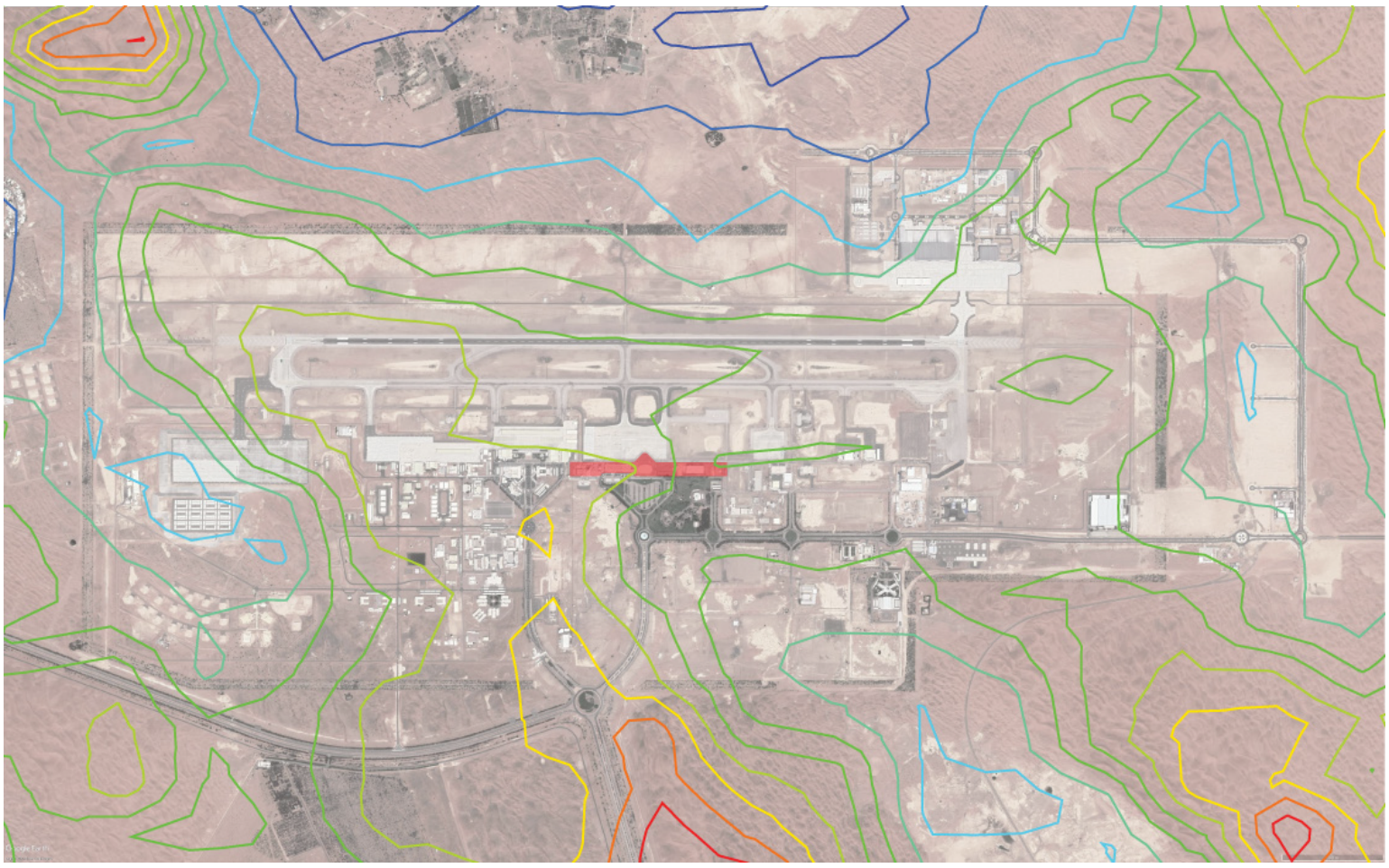
The Al Ain 2030 plan shows that only a community bus service is planned to serve Al Ain international. The metro is planned to connect to the airport. All road networks and land use will remain virtually the same as they are currently. There are no more airports planned in Al Ain.






4.4.2 TRANSPORTATION FRAMEWORK: TRANSIT

**Figure 15** Al Ain 2030 Transport Master Plan




## SITE CONTOURS

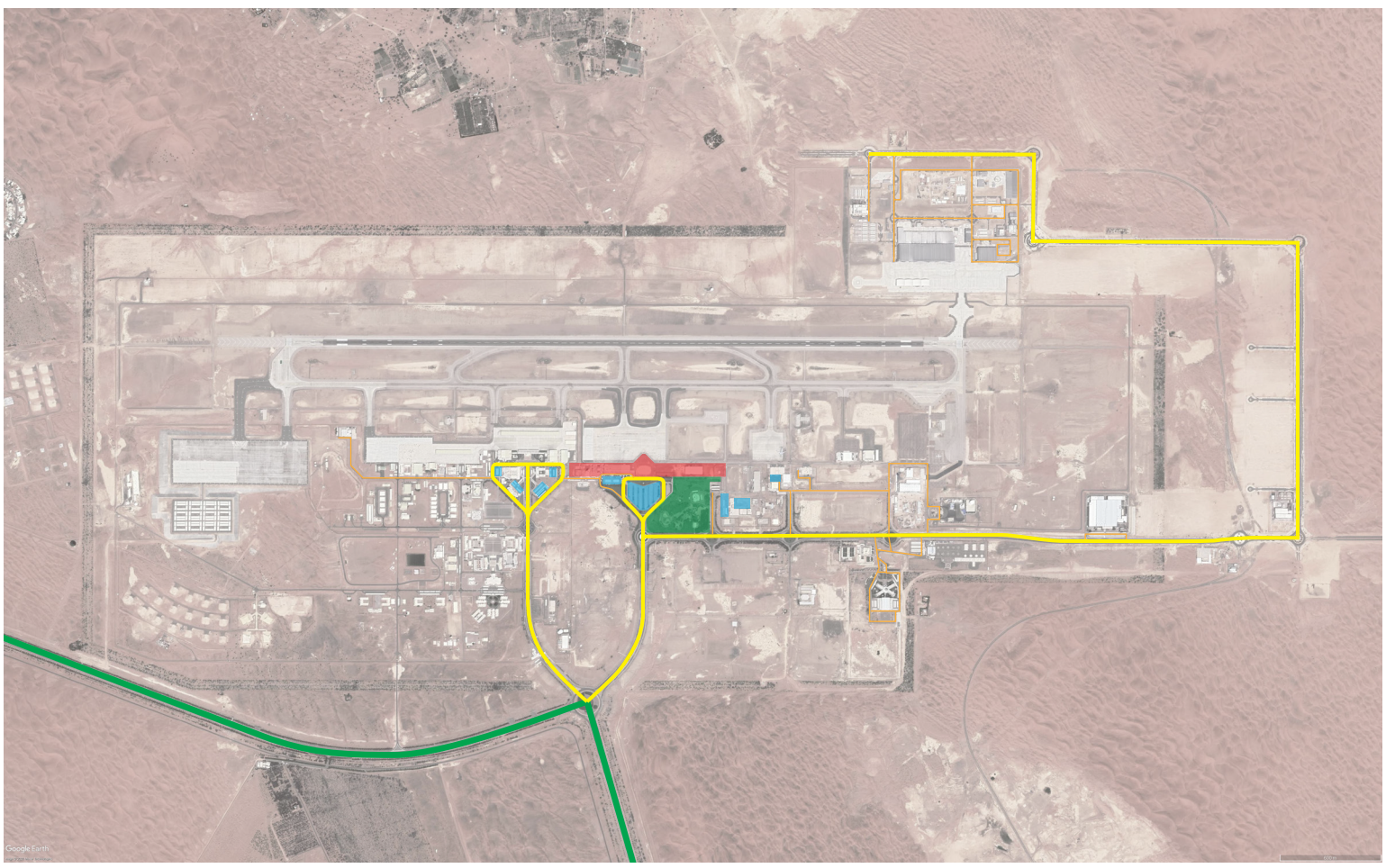
The site contours shown in Figure 16 are proof that the site is remarkably flat for the mountainous area that Al Ain is.

The 7x3km site is relatively flat with an altitude deviation within 25 meters.

**Figure 16** Al Ain International Airport Contours Map








## LANDSIDE ANALYSIS

Figure 17 shows the various roads that can be used to acces the airport, parks in the area and parking spots.

**Figure 17** Al Ain International Airport Access Map


**Figure 18** Buildings around Al Ain International Airport





## AIRSIDE ANALYSIS

The GCAA AIP Ground Movement chart in Figure 19 below shows the various taxi ways, aprons, and other facilities at the airport that will need to be considered in the design phase. The site, highlighted in red on Figure 18, measures 775x85 meters and has an area of 70,000m$^2$.

LEGEND

| SYMBOL | DESCRIPTION |
|---|---|
| Ⓗ | HELIPAD |
| | RWY HOLDING POSITION PATTERN-A |
| | ITHP WITHOUT STOP BAR |
| | ITHP WITH STOP BAR |
| | RUNWAY |
| | AIRSIDE SECURITY FENCE |
| | TAXIWAY & APRON |
| | CODE F ROUTING |
| | AIRSIDE SERVICE ROAD |
| | RUNWAY VISUAL RANGE (RVR) |
| | WINDSOCK |
| | TAXIWAY NO ENTRY |
| | SERVICE VEHICLE STOP MARKING |

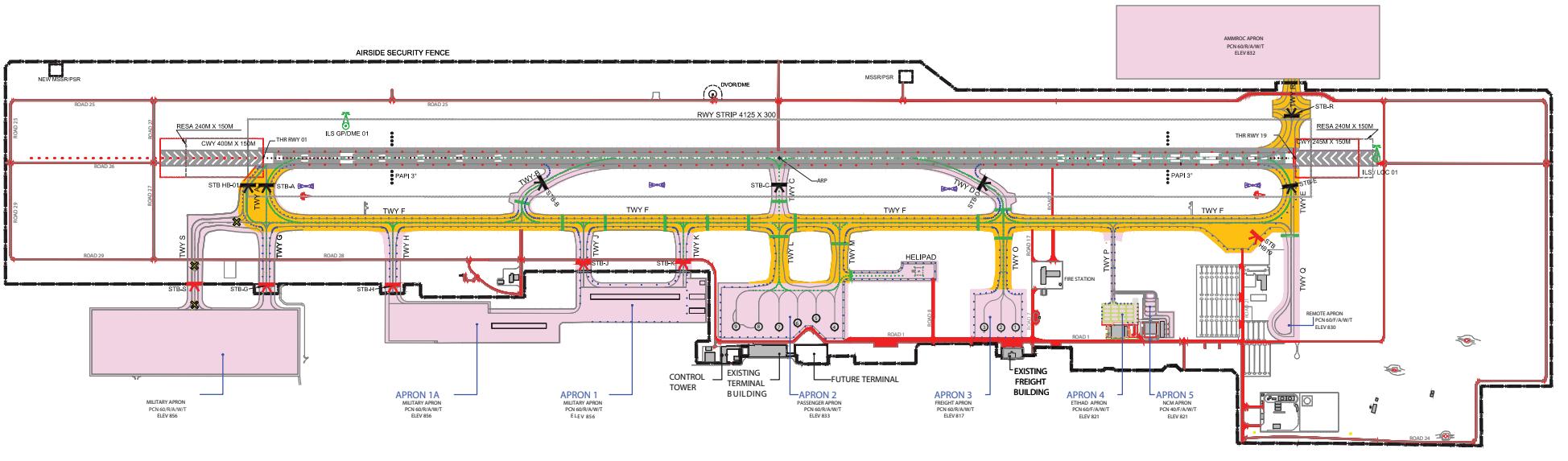



**Figure 19** GCAA AIP Ground Movement Chart

## SITE HISTORY

The images below show that since 2004 only one major development has taken place. In 2014 construction began on the AMMROC Apron and Facilities. These are used by the military for aircraft maintenance and development. Construction seems to have completed by 2015 with operations starting in before 2017. Other than this development the site remains unchanged.







## NATURAL LIFE

During a site visit, many kinds of vegetation were found and documented as shown below. In addition, a caravan of camels was seen nearby.

**ALOE VERA**

ALOE

**SMOOTH MESQUITE**

MESQUITE

**PAPER FLOWER**

BOUGAINVILLEA

**DATE PALM**

PHOENIX

**PERUVIAN TREE**

PEPPER TREE

**FOUNTAIN GRASS**

SANDBURS





## SITE IMAGES

Below are pictures of places around the site. All images point away from the site itself due to military restrictions on taking photos of the site itself. The pictures show an airplane sculpture, bus stop, police station, landscaped seating area, weather station, roundabouts decorated with poems, a villa near the airport, and Strata Aircraft Parts Factory.


## CONCLUSIONS

Three important conclusions important conclusion can be made from the site analysis. First the military presence in the are means special care needs to be taken to make sure government and military regulations are met. Second, the shape of the site may limit options for the configuration of the new terminal.

As the site is quite linear, a linear configuration may be the only choice. Finally, the orientation means that the airside faces directly west while the landside faces directly east. This means care will need to be taken to account for solar radiation.

# PART 3
## CASE STUDIES

# HAMAD INTERNATIONAL AIRPORT

## GENERAL INFORMATION

LOCATION: Doha, Qatar

ARCHITECT: HOK

OFFICIAL AREA: 600,000m$^2$

CALCULATED AREA: 593,263m$^2$

ANNUAL PASSENGERS: 50 million

GATES: 51 (41 Airbridge + 10 Remote)

COMPLETION: 2014

## REASONS FOR SELECTION

The project was selected to be the largest and newest airport studied for this report. The size and scale would help understand how the biggest and best airports are designed, what facilities they include and how they are layout. It is also located in the middle east and in a country with similar cultural values as Al Ain. In addition, it was ranked as one of the best airport terminals in the world by SKYTRAX (2020).

## DESIGN CONCEPT

The design of the terminal at Hamad international was to provide a highly efficient and inspirational travel experience that celebrates light, form, and materiality. The design, while contemporary, reflects the country's culture, heritage, and environment. A curved roof is meant to look like waves of the ocean nearby and the sand dunes present in a country like Qatar (HOK, 2014).

## PROGRAM ANALYSIS

This section analyzes the program and circulation of the airport. The flow is shown in Figure 20.

### DEPARTURES AND THE MAIN LEVEL

The departure hall is placed under that dramatic curved roof on level 2 which allows for a light to pass through and fill the area with diffused natural light. Once passed check-in, passengers proceed to security and immigration. After that passengers take an elevator or stairs down to the main transit level of the airport referred to as level 1 from now on.

Level 1 is host to all post security departure related functions of the airport. As such, passengers can move freely anywhere on the level. All passengers on the level at a duty-free area to entice them to shop a little before they board their plan. This is regardless of whether they are departing or transit passengers. Duty Free areas act as point where passengers must decide which concourse they need to go to. The north Duty-Free sends passengers to concourses A, B, and C. From the north Duty-Free area, premium passengers can access elevators and escalators to the various premium lounges located on level 3. Passengers who need to go to concourses D and E must pass through concourse C and the southern Duty-Free area. The Southern Duty-Free area is another decision point where passengers can choose between concourse D and E. At any time in these areas' passengers can back track to come back from where they came.

Once at the desired concourse passengers find their gate and must go through security before entering the secured gate waiting area. One in the waiting area, passengers may not leave to the rest of the airport. Once boarding begins passengers make their way to the airbridge just before which there is a final check to make sure everything is in order. The airbridge connects passengers to their plane.

### ARRIVALS AND TRANSIT PASSENGERS

Passengers arrive through the same airbridges that are used for departing passengers on level 1 or by bus on level 0 except they are routed to up to level 2, the arrivals level.

If arriving on concourses A, B or C, passengers make their way to the north part of the terminal where have the choice to either make their way to the arrivals area or to the transit areas. Arrivals passengers descend to level 0 for immigration and customs before making their way to baggage claim and finally the arrivals hall. Transit passengers branch off to the transit customs area on level 2 after which they descend to level 1 to the north duty free.





If arriving on concourses D or E, transit passengers can immediately access transit customs at the concourse on level 2 after which they descend to the southern duty free on level 1. Arrivals passengers must make their way to the northern part of the terminal where they join those arriving from the other concourses and make their way down to immigration on level 0 so on and so forth.

Arrivals passengers skip the duty free but even then, they pass by it and can see it through a glass wall while descending to immigration.

The large distance between the north and south of the airport is made shorted two Automatic People Movers. These move both departing and arriving passengers so that the two never meet by alternating the sides where passengers get on the APM.

### BAGGAGE HANDLING

Bags from check-in on level 1 are sent down to level 0 where they are processed and then sent to the correct gate to be loaded on to the aircraft. Arriving bags are unloaded from the aircraft and sent for processing on level 0. Bags belonging to passengers in transit are routed to the correct gate while bags belonging to arriving passengers are routed to baggage claim.

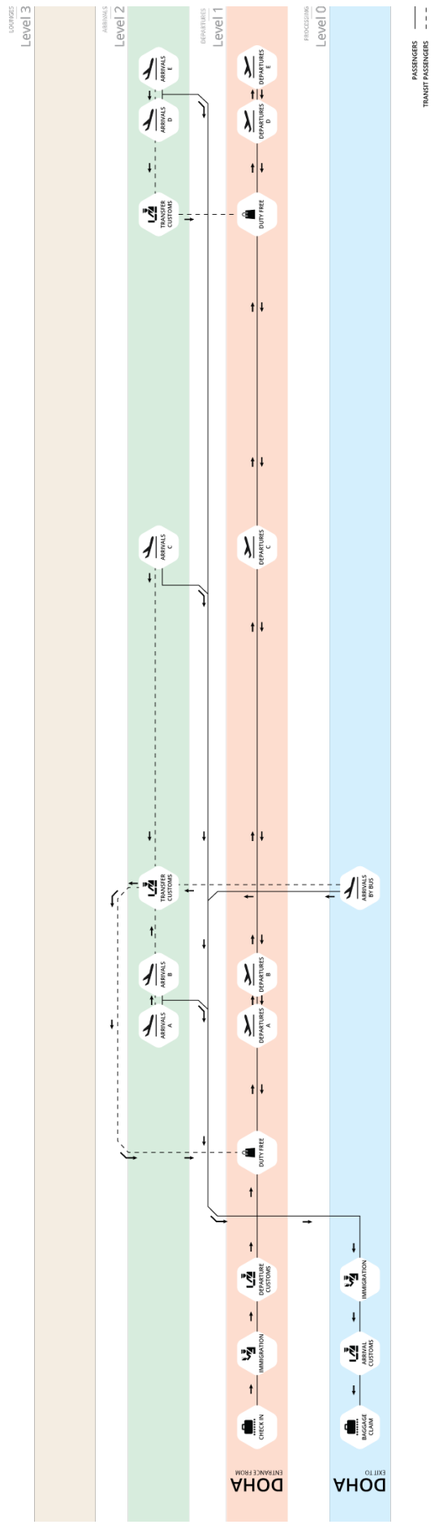



**Figure 20** Hamad International Program Flow Diagram

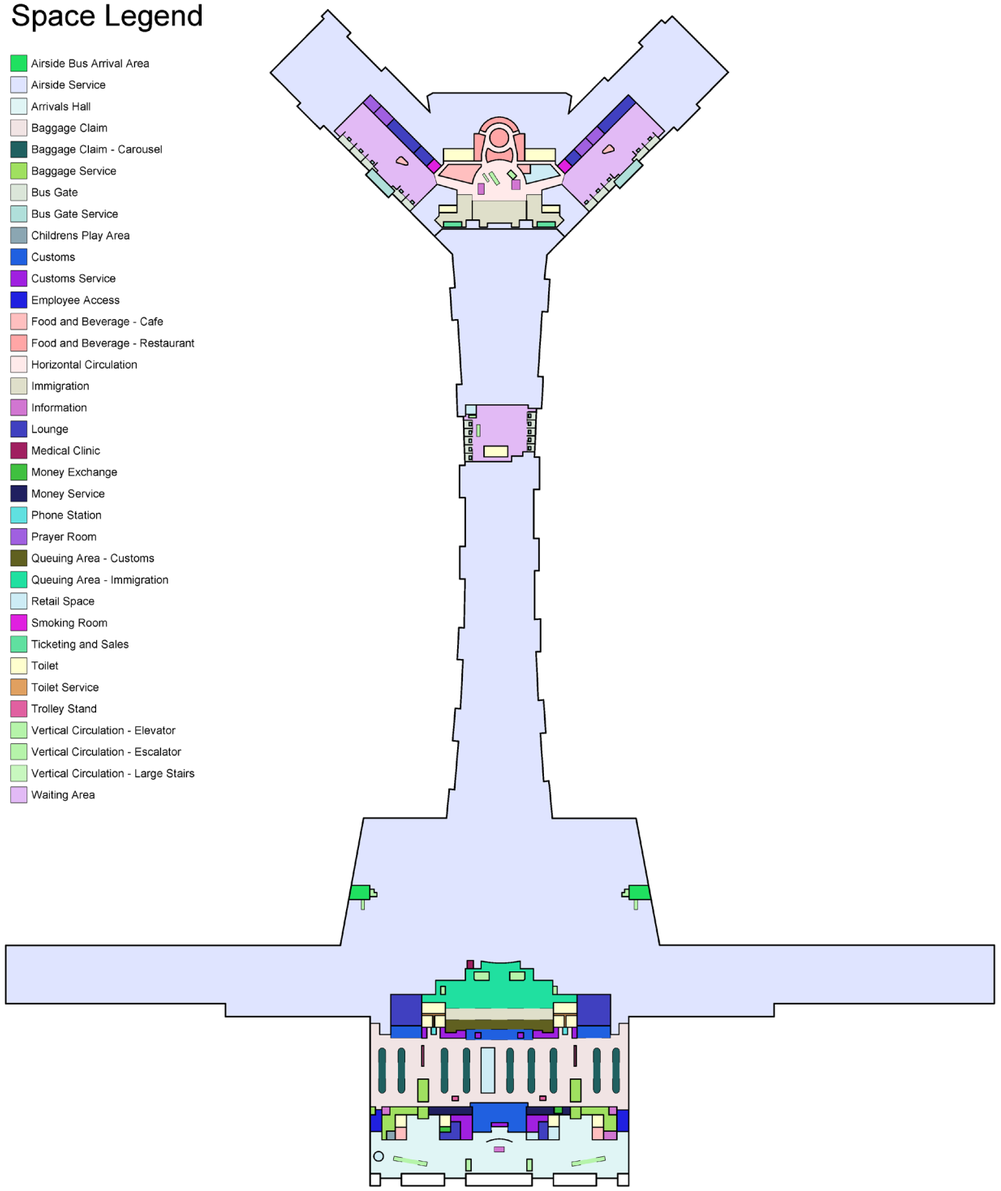



**Figure 21** Level 0 Floor Plan at Hamad International

## PLANS

This section details the program and looks at the plans generated for each level of the airport.

As shown in Figure 21, Level 0 houses the arŁ rivals hall, bus departure and arrival gates and most airside service areas (for baggage handling.





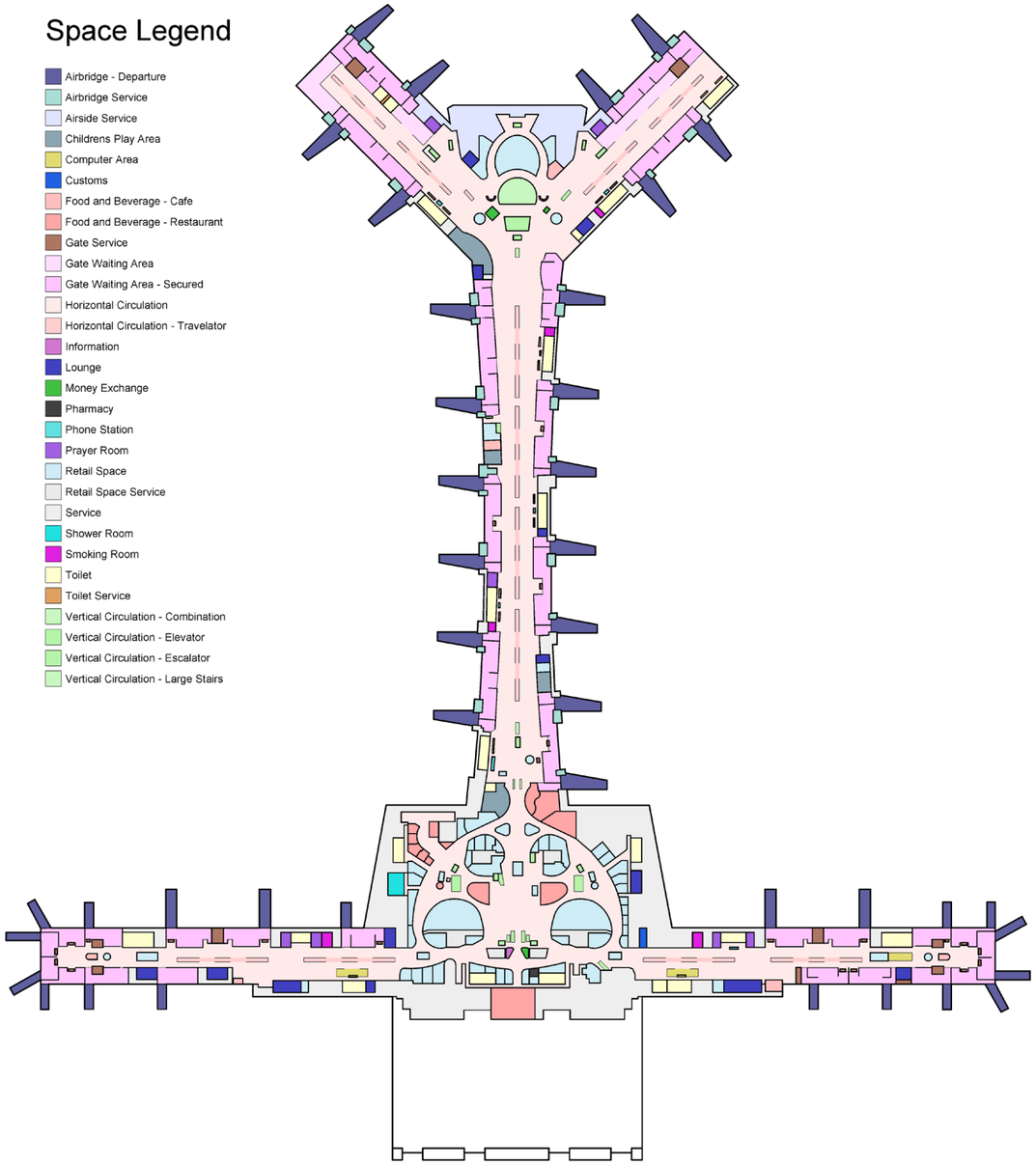



**Figure 22** Level 1 Floor Plan at Hamad International

Figure 22 shows that level 1 can be considered the main level of the airport. It houses all departure concourses, gates and airbridges as well as the duty-free areas.

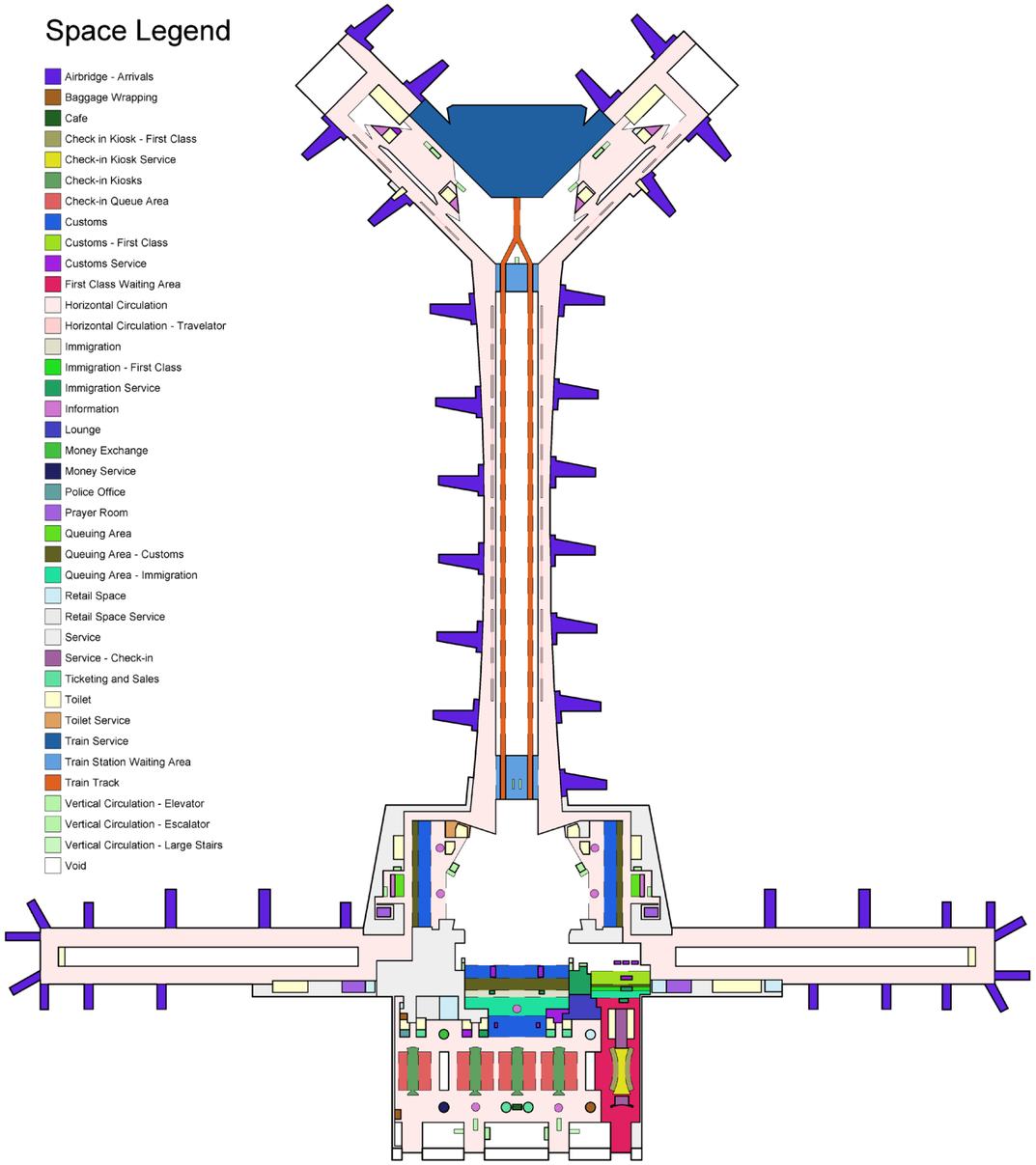



**Figure 23** Level 2 Floor Plan at Hamad International

Figure 23 shows Level 2. Arriving passengers are routed to this level. It houses transit customs and the departure hall. The airports APM run at this level too.





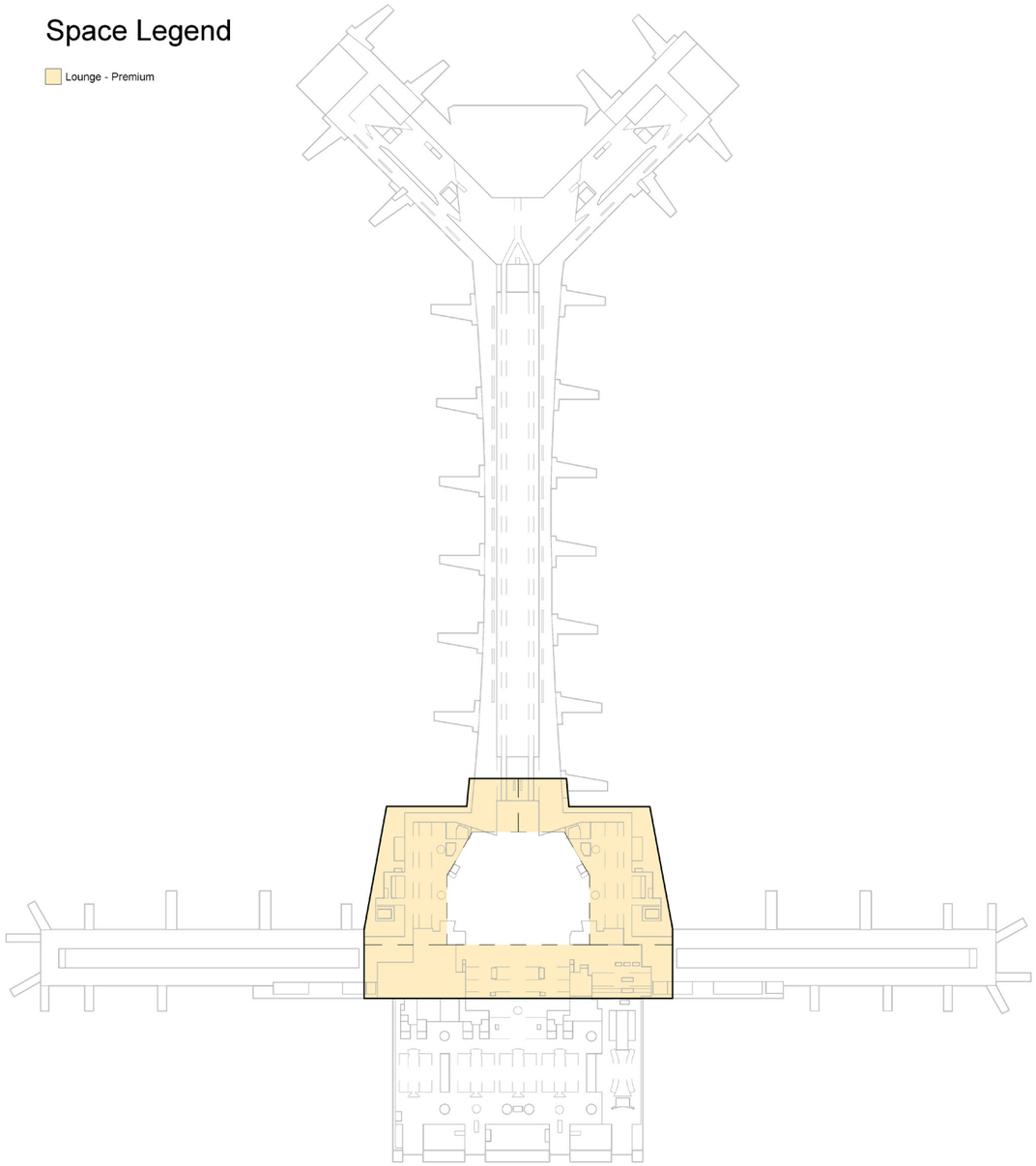



**Figure 24** Level 3 Floor Plan at Hamad International

Level 3 is housed under the highest point of the roof and, as can be seen in Figure 24, is home to 3 premium lounges accessible from the level 1 north duty free

## AREAS SUMMARY

The table below shows all information gathered by remaking the floor plans of the airport. This includes the sum of all the different types of spaces, the number of that type of space, averages, minimums, maxiumums and the derived totals per passenger and per gate.

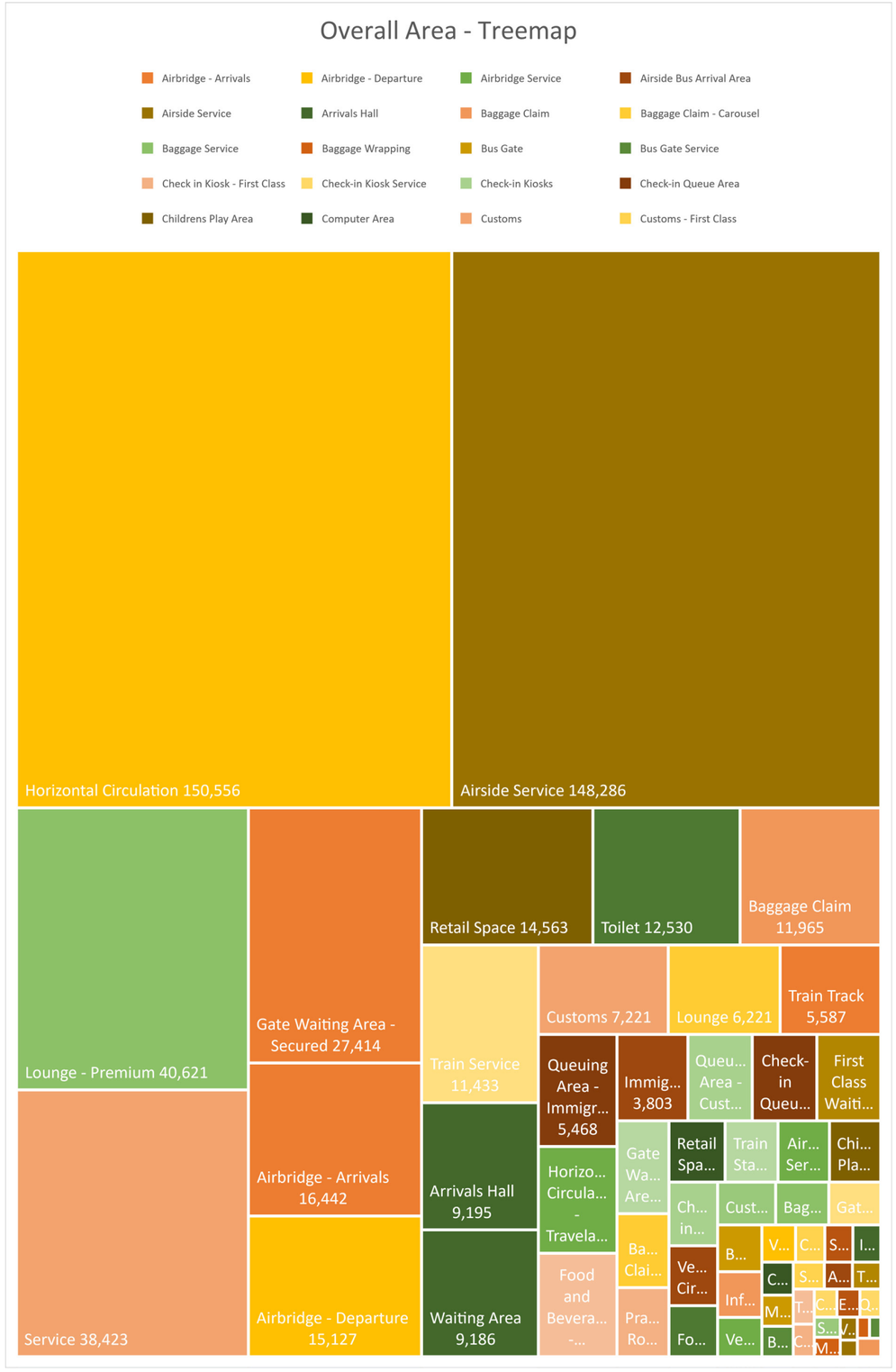
In the chart following, the areas are shown graphically as a Treemap, where the proporations of the areas is clearly visible. After that, the line plot shows the minumum, maximum and average for the most relevent spaces.

| Space | Sum of Area | Area Count | Average Area | Min Area | Max Area | Percent of Total | Per Peak Pass. Hr. | Per Gate |
|---|---|---|---|---|---|---|---|---|
| Airbridge - Arrivals | 16442 | 41 | 401 | 176 | 590 | 3% | 2.88 | 322.39 |
| Airbridge - Departure | 15127 | 41 | 369 | 176 | 525 | 3% | 2.65 | 296.61 |
| Airbridge Service | 1961 | 28 | 70 | 36 | 146 | 0% | 0.34 | 38.45 |
| Airside Bus Arrival Area | 473 | 2 | 237 | 230 | 243 | 0% | 0.08 | 9.27 |
| Airside Service | 148286 | 5 | 29657 | 2319 | 105704 | 25% | 25.98 | 2,907.57 |
| Arrivals Hall | 9195 | 1 | 9195 | 9195 | 9195 | 2% | 1.61 | 180.29 |
| Baggage Claim | 11965 | 1 | 11965 | 11965 | 11965 | 2% | 2.10 | 234.61 |
| Baggage Claim - Carousel | 2394 | 9 | 266 | 266 | 266 | 0% | 0.42 | 46.94 |
| Baggage Service | 1405 | 7 | 201 | 33 | 400 | 0% | 0.25 | 27.55 |
| Baggage Wrapping | 158 | 3 | 53 | 40 | 68 | 0% | 0.03 | 3.10 |
| Bus Gate | 1282 | 20 | 64 | 41 | 93 | 0% | 0.22 | 25.14 |
| Bus Gate Service | 594 | 22 | 27 | 6 | 240 | 0% | 0.10 | 11.65 |
| Check in Kiosk - First Class | 425 | 2 | 213 | 209 | 216 | 0% | 0.07 | 8.33 |
| Check-in Kiosk Service | 398 | 1 | 398 | 398 | 398 | 0% | 0.07 | 7.80 |
| Check-in Kiosks | 1924 | 4 | 481 | 481 | 481 | 0% | 0.34 | 37.73 |
| Check-in Queue Area | 3453 | 8 | 432 | 312 | 457 | 1% | 0.60 | 67.71 |
| Childrens Play Area | 1956 | 5 | 391 | 59 | 836 | 0% | 0.34 | 38.35 |
| Computer Area | 643 | 5 | 129 | 11 | 223 | 0% | 0.11 | 12.61 |
| Customs | 7221 | 9 | 802 | 125 | 1223 | 1% | 1.27 | 141.59 |
| Customs - First Class | 674 | 1 | 674 | 674 | 674 | 0% | 0.12 | 13.22 |
| Customs Service | 1533 | 20 | 77 | 11 | 302 | 0% | 0.27 | 30.06 |
| Employee Access | 397 | 2 | 199 | 188 | 209 | 0% | 0.07 | 7.78 |
| First Class Waiting Area | 3427 | 1 | 3427 | 3427 | 3427 | 1% | 0.60 | 67.20 |
| Food and Beverage - Cafe | 1545 | 13 | 119 | 42 | 447 | 0% | 0.27 | 30.29 |
| Food and Beverage - Restaurant | 5052 | 19 | 266 | 31 | 1272 | 1% | 0.89 | 99.06 |
| Gate Service | 1378 | 32 | 43 | 8 | 199 | 0% | 0.24 | 27.02 |
| Gate Waiting Area | 3000 | 3 | 1000 | 618 | 1212 | 1% | 0.53 | 58.82 |
| Gate Waiting Area - Secured | 27414 | 51 | 538 | 108 | 1402 | 5% | 4.80 | 537.53 |





| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Horizontal Circulation | 150556 | 7 | 21508 | 1598 | 71630 | 25% | 26.38 | 2,952.08 |
| Horizontal Circulation - Travelator | 5206 | 25 | 208 | 38 | 326 | 1% | 0.91 | 102.08 |
| Immigration | 3803 | 5 | 761 | 528 | 1060 | 1% | 0.67 | 74.57 |
| Immigration - First Class | 178 | 2 | 89 | 67 | 111 | 0% | 0.03 | 3.49 |
| Immigration Service | 646 | 6 | 108 | 14 | 491 | 0% | 0.11 | 12.67 |
| Information | 1249 | 22 | 57 | 13 | 93 | 0% | 0.22 | 24.49 |
| Lounge | 6221 | 22 | 283 | 65 | 891 | 1% | 1.09 | 121.98 |
| Lounge - Premium | 40621 | 3 | 13540 | 12712 | 15155 | 7% | 7.12 | 796.49 |
| Medical Clinic | 41 | 1 | 41 | 41 | 41 | 0% | 0.01 | 0.80 |
| Money Exchange | 313 | 6 | 52 | 19 | 90 | 0% | 0.05 | 6.14 |
| Money Service | 604 | 3 | 201 | 68 | 292 | 0% | 0.11 | 11.84 |
| Pharmacy | 66 | 1 | 66 | 66 | 66 | 0% | 0.01 | 1.29 |
| Phone Station | 148 | 9 | 16 | 5 | 33 | 0% | 0.03 | 2.90 |
| Police Office | 60 | 1 | 60 | 60 | 60 | 0% | 0.01 | 1.18 |
| Prayer Room | 2235 | 15 | 149 | 107 | 285 | 0% | 0.39 | 43.82 |
| Queuing Area | 362 | 2 | 181 | 181 | 181 | 0% | 0.06 | 7.10 |
| Queuing Area - Customs | 3455 | 5 | 691 | 135 | 1163 | 1% | 0.61 | 67.75 |
| Queuing Area - Immigration | 5468 | 3 | 1823 | 359 | 3651 | 1% | 0.96 | 107.22 |
| Retail Space | 14563 | 80 | 182 | 9 | 1371 | 2% | 2.55 | 285.55 |
| Retail Space Service | 2135 | 7 | 305 | 148 | 483 | 0% | 0.37 | 41.86 |
| Service | 38423 | 29 | 1325 | 11 | 6918 | 6% | 6.73 | 753.39 |
| Service - Check-in | 520 | 2 | 260 | 114 | 406 | 0% | 0.09 | 10.20 |
| Shower Room | 327 | 1 | 327 | 327 | 327 | 0% | 0.06 | 6.41 |
| Smoking Room | 650 | 7 | 93 | 51 | 139 | 0% | 0.11 | 12.75 |
| Ticketing and Sales | 472 | 7 | 67 | 60 | 78 | 0% | 0.08 | 9.25 |
| Toilet | 12530 | 64 | 196 | 13 | 550 | 2% | 2.20 | 245.69 |
| Toilet Service | 457 | 16 | 29 | 9 | 195 | 0% | 0.08 | 8.96 |
| Train Service | 11433 | 1 | 11433 | 11433 | 11433 | 2% | 2.00 | 224.18 |
| Train Station Waiting Area | 2015 | 6 | 336 | 117 | 839 | 0% | 0.35 | 39.51 |
| Train Track | 5587 | 1 | 5587 | 5587 | 5587 | 1% | 0.98 | 109.55 |
| Trolley Stand | 101 | 4 | 25 | 20 | 30 | 0% | 0.02 | 1.98 |
| Vertical Circulation - Combination | 781 | 1 | 781 | 781 | 781 | 0% | 0.14 | 15.31 |
| Vertical Circulation - Elevator | 1077 | 33 | 33 | 11 | 54 | 0% | 0.19 | 21.12 |
| Vertical Circulation - Escalator | 1809 | 31 | 58 | 14 | 304 | 0% | 0.32 | 35.47 |
| Vertical Circulation - Large Stairs | 243 | 8 | 30 | 17 | 39 | 0% | 0.04 | 4.76 |
| Waiting Area | 9186 | 3 | 3062 | 2299 | 3449 | 2% | 1.61 | 180.12 |
| Total | **593263** | **795** | | | | **100%** | | |


Overall Area - Treemap
Airbridge - Arrivals
Airbridge - Departure
Airbridge Service
Airside Bus Arrival Area
Airside Service
Arrivals Hall
Baggage Claim
Baggage Claim - Carousel
Baggage Service
Baggage Wrapping
Bus Gate
Bus Gate Service
Check in Kiosk - First Class
Check-in Kiosk Service
Check-in Kiosks
Check-in Queue Area
Childrens Play Area
Computer Area
Customs
Customs - First Class
Horizontal Circulation 150,556
Airside Service 148,286
Lounge - Premium 40,621
Gate Waiting Area - Secured 27,414
Retail Space 14,563
Toilet 12,530
Baggage Claim 11,965
Train Service 11,433
Customs 7,221
Lounge 6,221
Train Track 5,587
Queuing Area - Immigr... 5,468
Immig... 3,803
Queu... Area - Cust...
Check-in Queu...
First Class Waiti...
Airbridge - Arrivals 16,442
Arrivals Hall 9,195
Horizo... Circula... - Travela...
Gate Wa... Are...
Retail Spa...
Train Sta...
Air... Ser...
Chi... Pla...
Ch... in...
Cust...
Bag...
Gat...
Service 38,423
Airbridge - Departure 15,127
Waiting Area 9,186
Food and Bevera... -...
Ba... Clai...
Ve... Cir...
B...
V...
C...
S...
I...
Inf...
C...
S...
A...
T...
M...
T...
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Pra... Ro...
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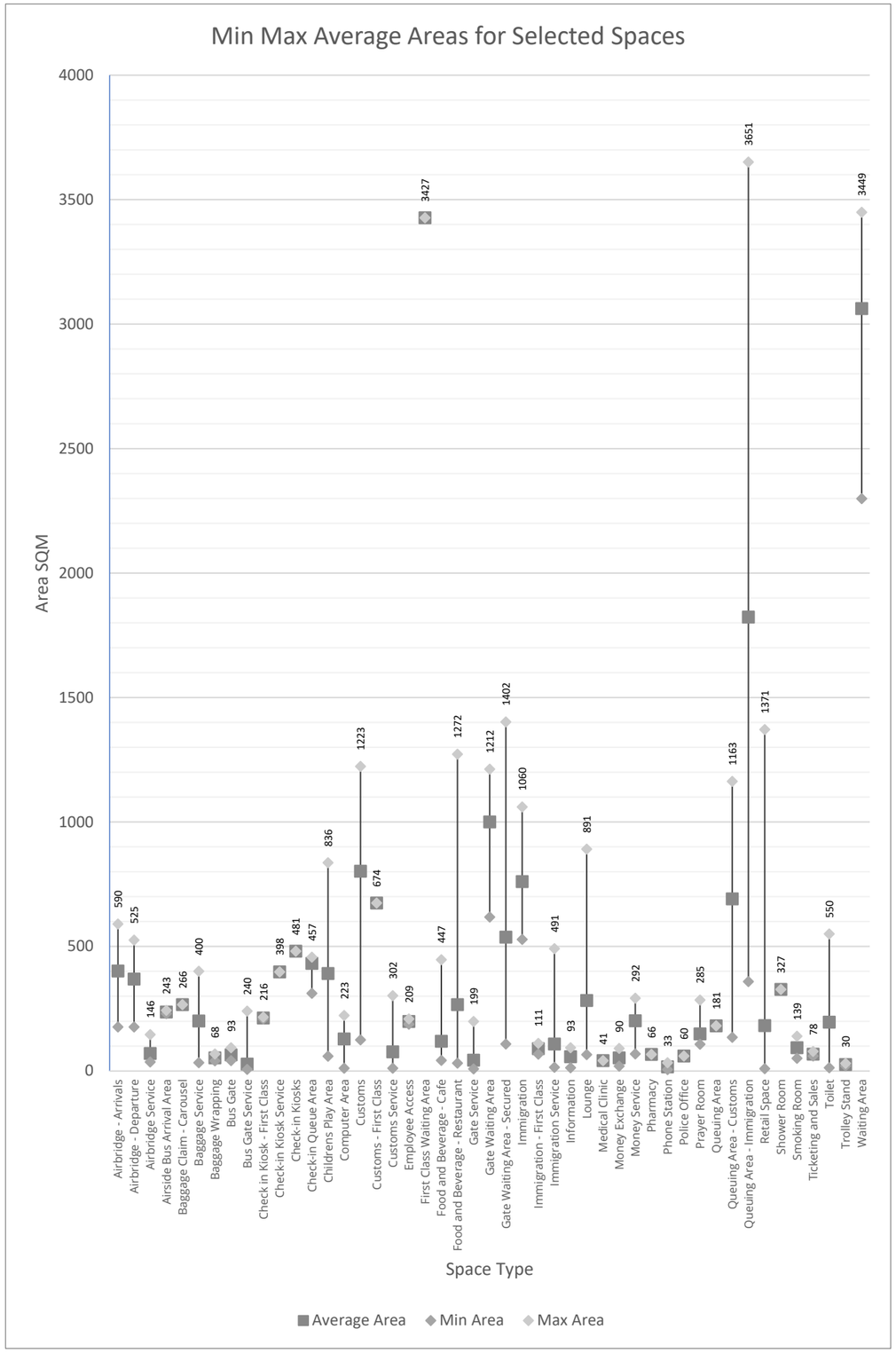
V...
M...






Min Max Average Areas for Selected Spaces
Area SQM
4000
3500
3000
2500
2000
1500
1000
500
0
Space Type
Average Area
Min Area
Max Area
Airbridge - Arrivals
Airbridge - Departure
Airbridge Service
Airside Bus Arrival Area
Baggage Claim - Carousel
Baggage Service
Baggage Wrapping
Bus Gate
Bus Gate Service
Check in Kiosk - First Class
Check-in Kiosk Service
Check-in Kiosks
Check-in Queue Area
Childrens Play Area
Computer Area
Customs
Customs - First Class
Customs Service
Employee Access
First Class Waiting Area
Food and Beverage - Cafe
Food and Beverage - Restaurant
Gate Service
Gate Waiting Area
Gate Waiting Area - Secured
Immigration
Immigration - First Class
Immigration Service
Information
Lounge
Medical Clinic
Money Exchange
Money Service
Pharmacy
Phone Station
Police Office
Prayer Room
Queuing Area
Queuing Area - Customs
Queuing Area - Immigration
Retail Space
Shower Room
Smoking Room
Ticketing and Sales
Toilet
Trolley Stand
Waiting Area
590
525
146
243
266
400
68
93
240
216
398
481
457
836
223
1223
674
302
209
447
1272
199
1212
1402
1060
111
491
93
891
41
90
292
66
33
60
285
181
1163
1371
327
139
78
550
30

## CONCLUSIONS

Hamad international is an excellent example of a modern and efficient airport. Its does well to solve the main goals of reducing walking distances and aircraft maneuvering using conventional approaches to airport design. There is nothing particularly ground breaking about the program of the airport, it is an evolution of airport design that adds more spaces for passenger comfort rather than a whole new approach.



HAMAD INTERNATIONAL

# CHANGI INTERNATIONAL TERMINAL 3

## GENERAL INFORMATION

LOCATION: Singapore

ARCHITECT: CPG Architects + SOM

OFFICIAL AREA: 380,000m$^2$

CALCULATED AREA: 384,521m$^2$

ANNUAL PASSENGERS: 22 million

GATES: 43 (28 Airbridge + 15 Remote)

COMPLETION: 2008

## REASONS FOR SELECTION

Singapore's Changi International airport is well known to be one of the world's best airports It has ranked been ranked the best airport by SKYTRAX for the past 8 years (SKYTRAX, 2020). In addition, Terminal 3 has been ranked the best terminal as well. The reason for selection was to understand how the airports design has helped it maintain its number one ranking. How is it that since its opening no airport has been able to surpass it in terms of user experience?

## DESIGN CONCEPT

The idea behind the design of Changi Terminal 3 was to create an airport that would leave a lasting impression on its users (Technistone, A.S., 2009). It was designed to reflect the 21st century airports economic influence and become a civic center for the city and region. In fact, many of the facilities at the airport are designed for people who are not traveling to come visit, use, and go back home from.

## PROGRAM ANALYSIS

This section analyzes the program and circulation of the airport. The flow is shown in Figure 25.

### THE LANDSIDE

At Changi, the departure hall is placed in the main level of the airport or Level 2. Departing passengers enter a massive space with a beautiful roof that diffuses and evenly lights the space. Check-in kiosks are placed in rows through the hall. From the hall, visitors have the option to go up to level 3, a shopping and restaurant area. Further visitors can go up to level 4 where an observation deck looks over Changi's runways and aprons providing views of aircraft on take-off and landing.

On the far side of the departure hall is living green wall which extends down to the baggage claim area below. The void creates a place where all functions of the airport can be viewed from one central location.

### THE AIRSIDE - DEPARTURES

Once past security and immigration passengers enter the airside of level 2 and are placed in the middle of the duty-free area. To either side are concourses A and B. From the duty-free area passengers can access the airside of level 3 which continues the duty free and adds lounges and passenger experiences like a koi pond and butterfly garden. The concourse is lined with trees to bring in some of Singapore's nature, an idea that was recently expanded on with the introduction of Changi's Jewel building.

Once past the duty free and restaurants, the experience is like Hamad international where passengers find their gate by choosing the correct concourse. Before entering the secured gate waiting area passengers go through a security check. Once in the waiting area, passengers may not leave to the rest of the airport. Gate waiting areas have amenities like cafes and toilets. Once boarding begins passengers make their way to the airbridge just before which there is a final check to make sure everything is in order. The airbridge connects passengers to their plane.

### ARRIVALS AND TRANSIT PASSENGERS

Arriving passengers enter through the same airbridges that are used for departures. However, unlike Hamad International where there is a strict separation of arriving and departing passengers, Changi places all arriving passengers in the same area as departing passengers directly upon exit from the airbridge.

The direct exit off the airbridge to the main area means transit passengers do not have to go through a security check to change planes. There are no transit customs at Changi. If the connecting flight departs from the same terminal passengers must simply walk from their arriving gate to their departure gate. If the connecting flight as at a different terminal, passengers must walk to one of 2 'Sky Train' stops depending on the terminal desired. The train then connect passengers to the required terminal where they can board their next flight.

Arriving passengers make their way through the concourse at which they arrived towards the duty-free area and descend to level 1 for immigration, customs, baggage claim and finally the arrivals hall.

### BAGGAGE HANDLING

Bags from check in on level 2 are sent down to level 1 where they are processed and make their way to the correct gate to be loaded onto the aircraft. Arriving bags are unloaded from the aircraft and sent for processing on level 1. Bags belonging to passengers in transit are routed to the correct gate or terminal while bags belonging to arriving passengers are routed to baggage claim.

### OTHER AREAS

Changi has 3 basement levels which mainly consist of parking space. Level B1 is an office level with space for airport and airline offices. Level B2 connects to the city's metro system and filled with shops catering to Singaporean people. As stated earlier, one of the ideas of the airport was to create a civic place where Singaporean people can come to socialize.

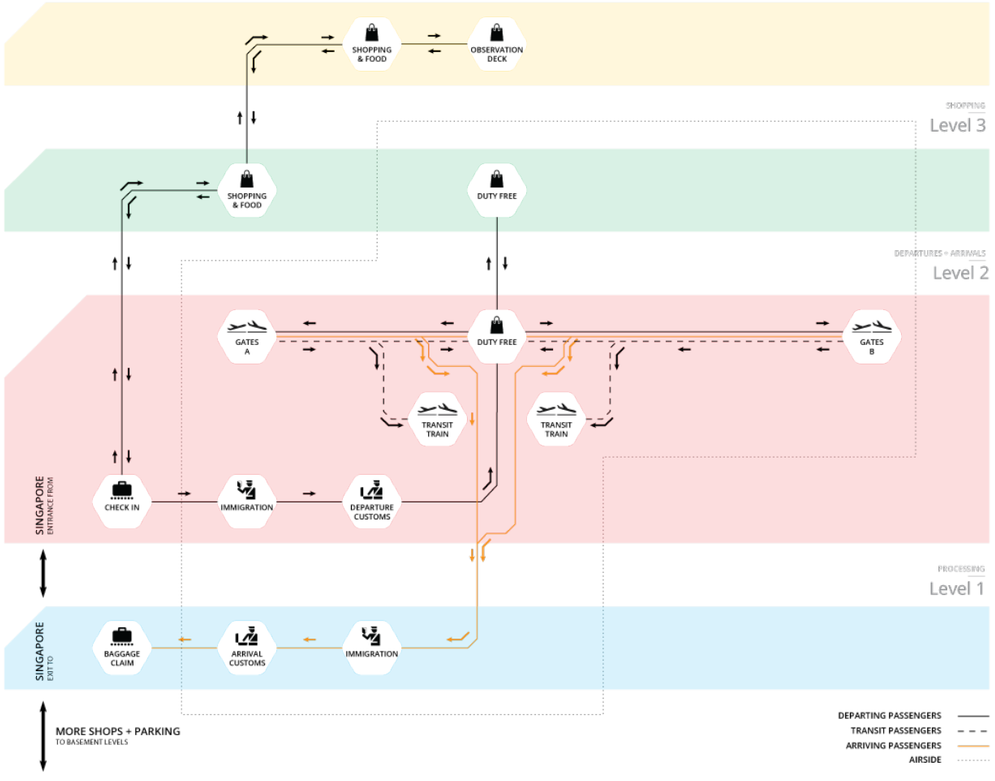



**Figure 25** Changi International Terminal 3 Program Flow Diagram

## PLANS

This section details the program and looks at the plans generated for each level of the airport.

Level 1 (Figure 26) includes mainly arrival funca tions such as immigration, customs, baggage claim and the arrivals hall.

Level 2 (Figure 27) is the main airside level of the airport with concourses A and B, gates, and duty free. Level 2 is also home to the departure's hall.

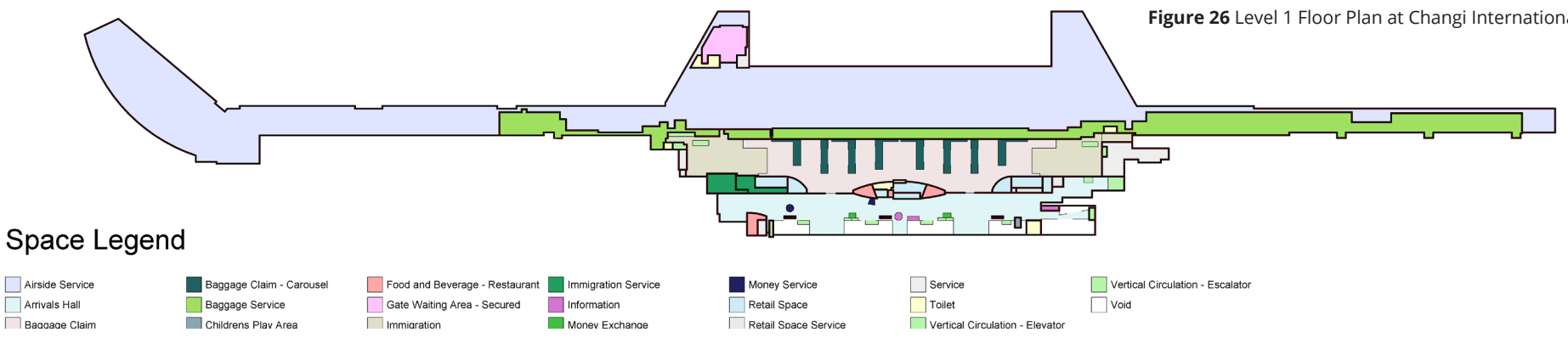



**Figure 26** Level 1 Floor Plan at Changi International Terminal 3

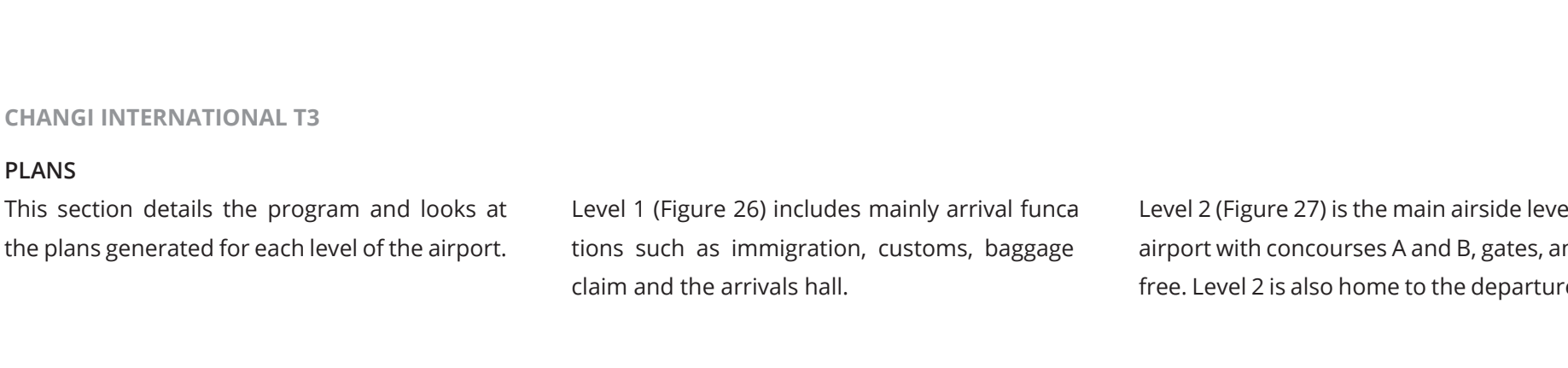



**Figure 27** Level 2 Floor Plan at Changi International Terminal 3





Level 3 (Figure 28) is exclusively a shopping and restraint area. It is divided into two sections, one accessible from the airside, the other from the landside

Level 4 (Figure 29) is the observation level. It is only accessible from the landside.

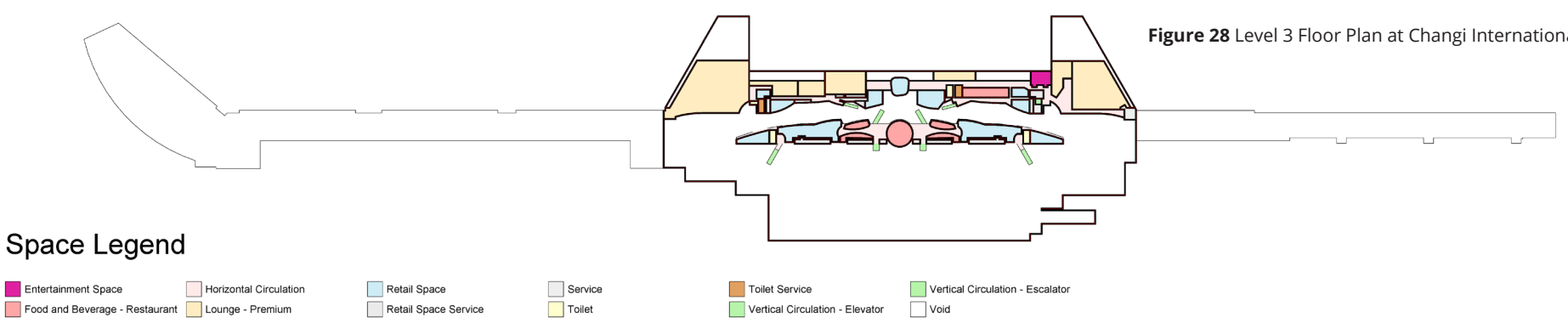



**Figure 28** Level 3 Floor Plan at Changi International Terminal 3

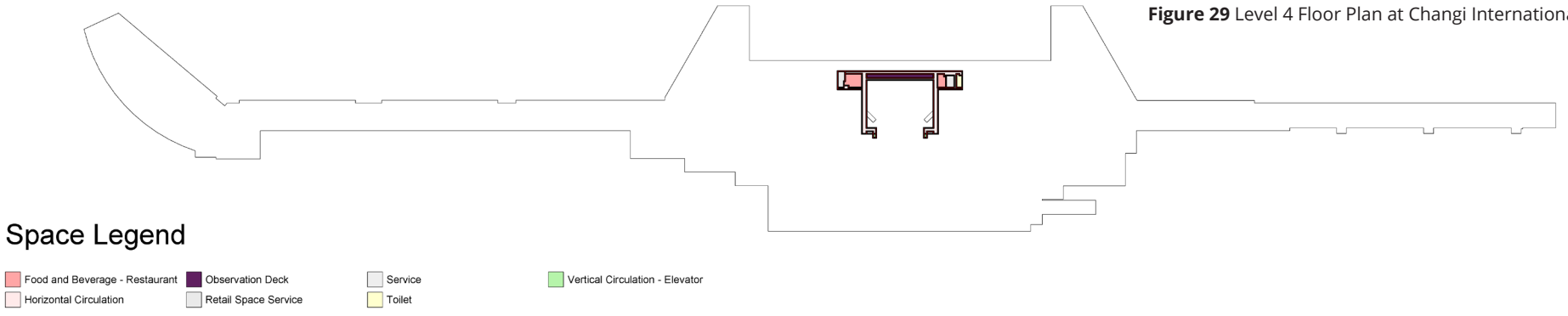



**Figure 29** Level 4 Floor Plan at Changi International Terminal 3

Basement Level 1 (Figure 30) is mainly an office level. It is also the first level of underground parking.

Basement Level 2 (Figure 31) is another shopping level for landside users and houses more parking.

**Figure 30** Basement Level 1 Floor Plan at Changi International Terminal 3

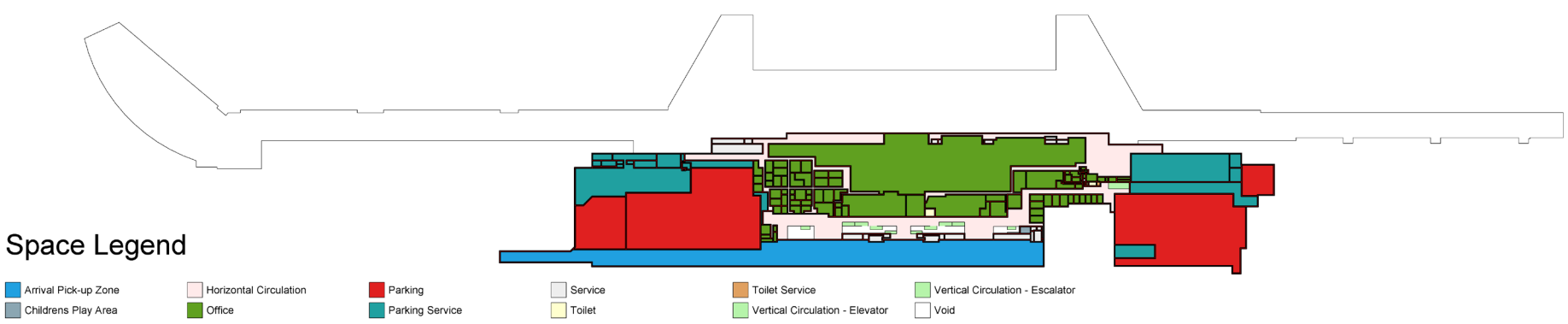
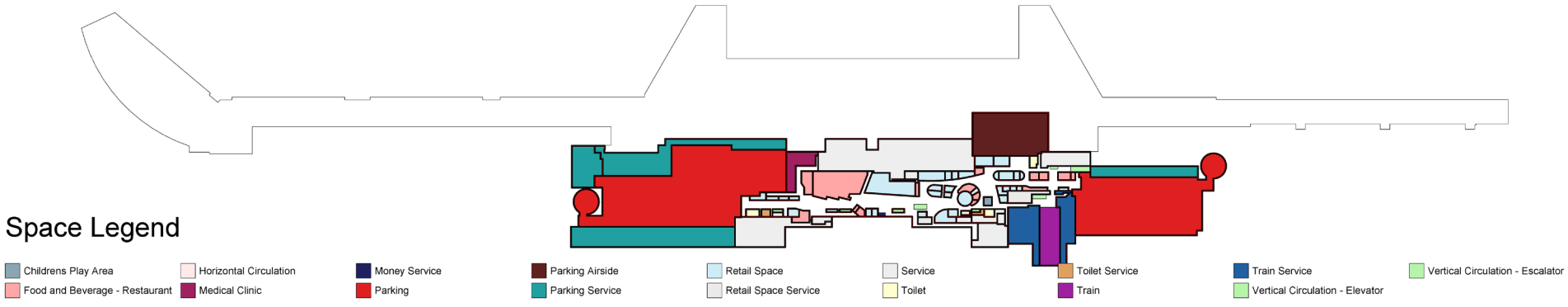



**Figure 31** Basement Level 2 Floor Plan at Changi International Terminal 3

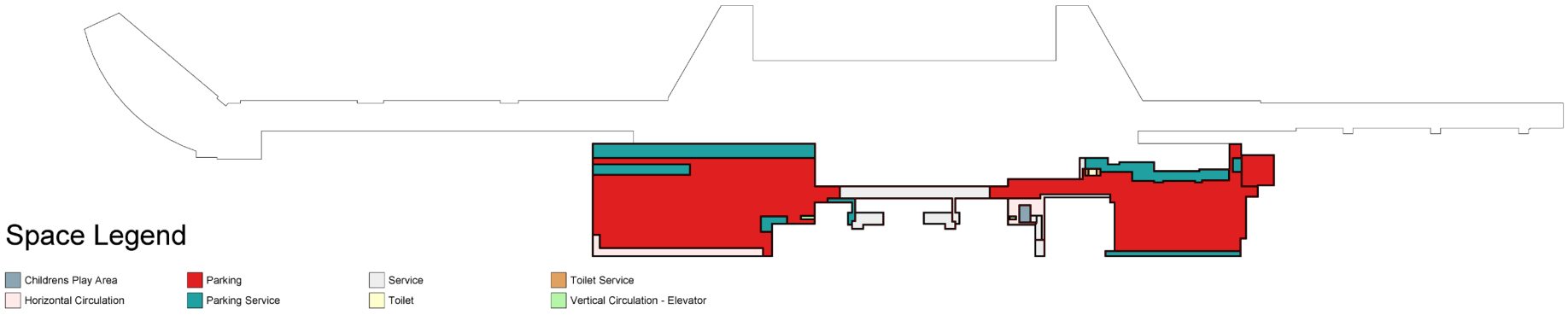







BASEMENT LEVEL 3 (Figure 32) has more parking and mainly consists of mechanical services.

**Figure 32** Basement Level 1 Floor Plan at Changi International Terminal 3



## AREAS SUMMARY

The table below shows all information gathered by remaking the floor plans of the airport. This includes the sum of all the different types of spaces, the number of that type of space, averages, minimums, maxiumums and the derived totals per passenger and per gate.

In the chart following, the areas are shown graphically as a Treemap, where the proporations of the areas is clearly visible. After that, the line plot shows the minumum, maximum and average for the most relevent spaces.

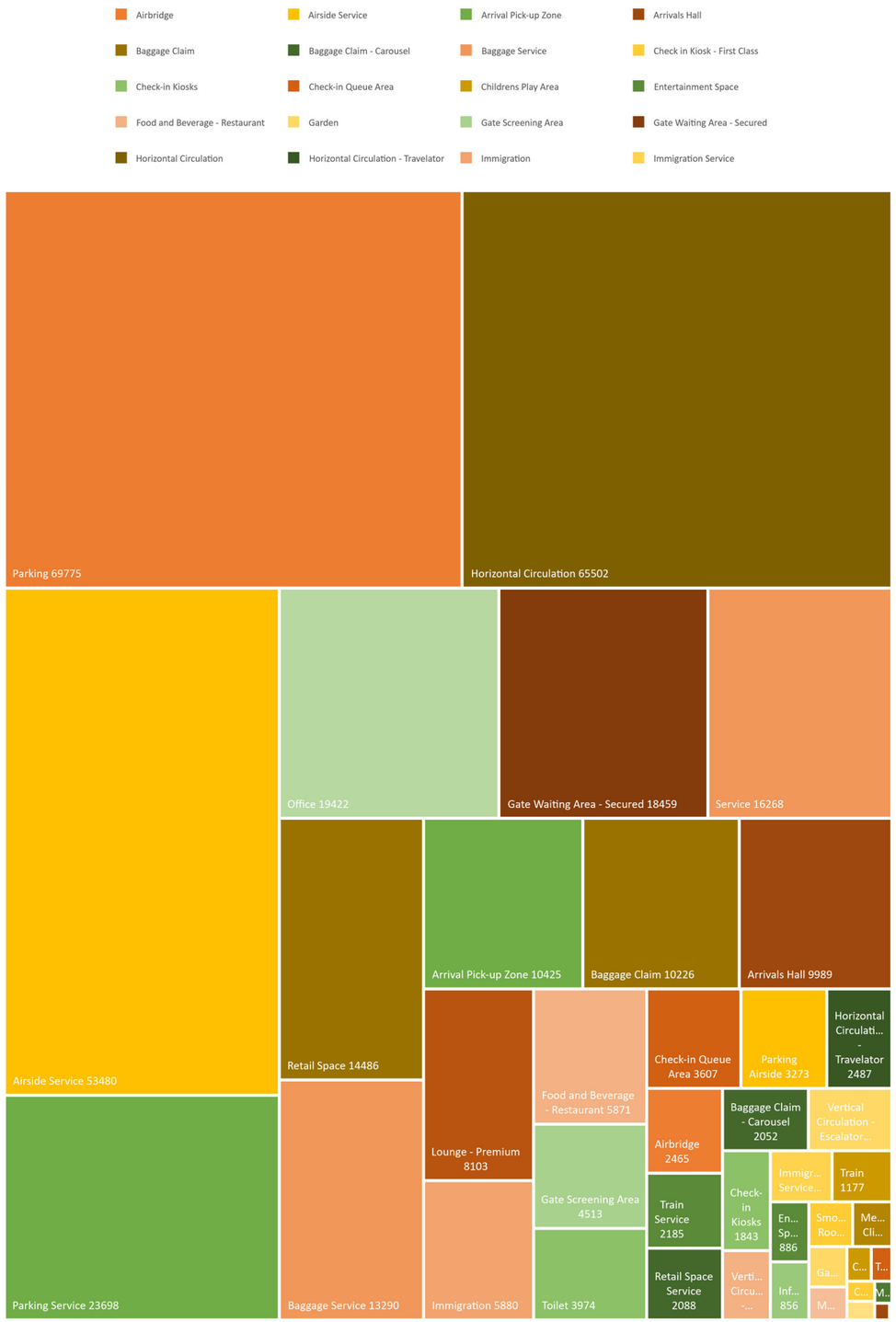
| Space | Total Area | Area Count | Average Area | Min Area | Max Area | Percent of total | Per Peak Pass. Hr. | Per Gate |
|---|---|---|---|---|---|---|---|---|
| Airbridge | 2465 | 28 | 88 | 20 | 208 | 1% | 0.98 | 57.33 |
| Airside Service | 53480 | 1 | 53480 | 53480 | 53480 | 14% | 21.29 | 1243.72 |
| Arrival Pick-up Zone | 10425 | 1 | 10425 | 10425 | 10425 | 3% | 4.15 | 242.44 |
| Arrivals Hall | 9989 | 1 | 9989 | 9989 | 9989 | 3% | 3.98 | 232.30 |
| Baggage Claim | 10226 | 1 | 10226 | 10226 | 10226 | 3% | 4.07 | 237.81 |
| Baggage Claim - Carousel | 2052 | 8 | 257 | 242 | 281 | 1% | 0.82 | 47.72 |
| Baggage Service | 13290 | 3 | 4430 | 373 | 10613 | 3% | 5.29 | 309.07 |
| Check in Kiosk - First Class | 214 | 1 | 214 | 214 | 214 | 0% | 0.09 | 4.98 |
| Check-in Kiosks | 1843 | 11 | 168 | 164 | 203 | 0% | 0.73 | 42.86 |
| Check-in Queue Area | 3607 | 11 | 328 | 318 | 427 | 1% | 1.44 | 83.88 |
| Childrens Play Area | 324 | 4 | 81 | 45 | 160 | 0% | 0.13 | 7.53 |
| Entertainment Space | 886 | 6 | 148 | 45 | 269 | 0% | 0.35 | 20.60 |
| Food and Beverage - Restaurant | 5871 | 46 | 128 | 10 | 1304 | 2% | 2.34 | 136.53 |
| Garden | 591 | 1 | 591 | 591 | 591 | 0% | 0.24 | 13.74 |
| Gate Screening Area | 4513 | 15 | 301 | 94 | 719 | 1% | 1.80 | 104.95 |
| Gate Waiting Area - Secured | 18459 | 18 | 1026 | 436 | 3091 | 5% | 7.35 | 429.28 |
| Horizontal Circulation | 65502 | 11 | 5955 | 685 | 42070 | 17% | 26.08 | 1523.30 |
| Horizontal Circulation - Travelator | 2487 | 11 | 226 | 174 | 249 | 1% | 0.99 | 57.84 |
| Immigration | 5880 | 4 | 1470 | 241 | 2711 | 2% | 2.34 | 136.74 |
| Immigration Service | 1211 | 4 | 303 | 73 | 554 | 0% | 0.48 | 28.16 |
| Information | 856 | 8 | 107 | 33 | 306 | 0% | 0.34 | 19.91 |
| Lounge - Premium | 8103 | 8 | 1013 | 115 | 3402 | 2% | 3.23 | 188.44 |
| Medical Clinic | 671 | 2 | 336 | 39 | 632 | 0% | 0.27 | 15.60 |
| Money Exchange | 145 | 4 | 36 | 32 | 41 | 0% | 0.06 | 3.37 |
| Money Service | 480 | 6 | 80 | 26 | 234 | 0% | 0.19 | 11.16 |





| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Observation Deck | 198 | 1 | 198 | 198 | 198 | 0% | 0.08 | 4.60 |
| Office | 19422 | 88 | 221 | 1 | 11275 | 5% | 7.73 | 451.67 |
| Parking | 69775 | 9 | 7753 | 909 | 17052 | 18% | 27.78 | 1622.67 |
| Parking Airside | 3273 | 1 | 3273 | 3273 | 3273 | 1% | 1.30 | 76.12 |
| Parking Service | 23698 | 31 | 764 | 1 | 3319 | 6% | 9.44 | 551.12 |
| Prayer Room | 96 | 1 | 96 | 96 | 96 | 0% | 0.04 | 2.23 |
| Retail Space | 14486 | 130 | 111 | 1 | 785 | 4% | 5.77 | 336.88 |
| Retail Space Service | 2088 | 23 | 91 | 7 | 324 | 1% | 0.83 | 48.56 |
| Service | 16268 | 58 | 280 | 2 | 4948 | 4% | 6.48 | 378.33 |
| Smoking Room | 751 | 4 | 188 | 96 | 299 | 0% | 0.30 | 17.47 |
| Ticketing and Sales | 15 | 1 | 15 | 15 | 15 | 0% | 0.01 | 0.35 |
| Toilet | 3974 | 30 | 132 | 25 | 485 | 1% | 1.58 | 92.42 |
| Toilet Service | 272 | 8 | 34 | 5 | 70 | 0% | 0.11 | 6.33 |
| Train | 1177 | 1 | 1177 | 1177 | 1177 | 0% | 0.47 | 27.37 |
| Train Service | 2185 | 2 | 1093 | 897 | 1288 | 1% | 0.87 | 50.81 |
| Vertical Circulation - Elevator | 1276 | 35 | 36 | 6 | 73 | 0% | 0.51 | 29.67 |
| Vertical Circulation - Escalator | 1997 | 32 | 62 | 16 | 201 | 1% | 0.80 | 46.44 |
| Total | **384521** | **669** | | | | **94815** | | |

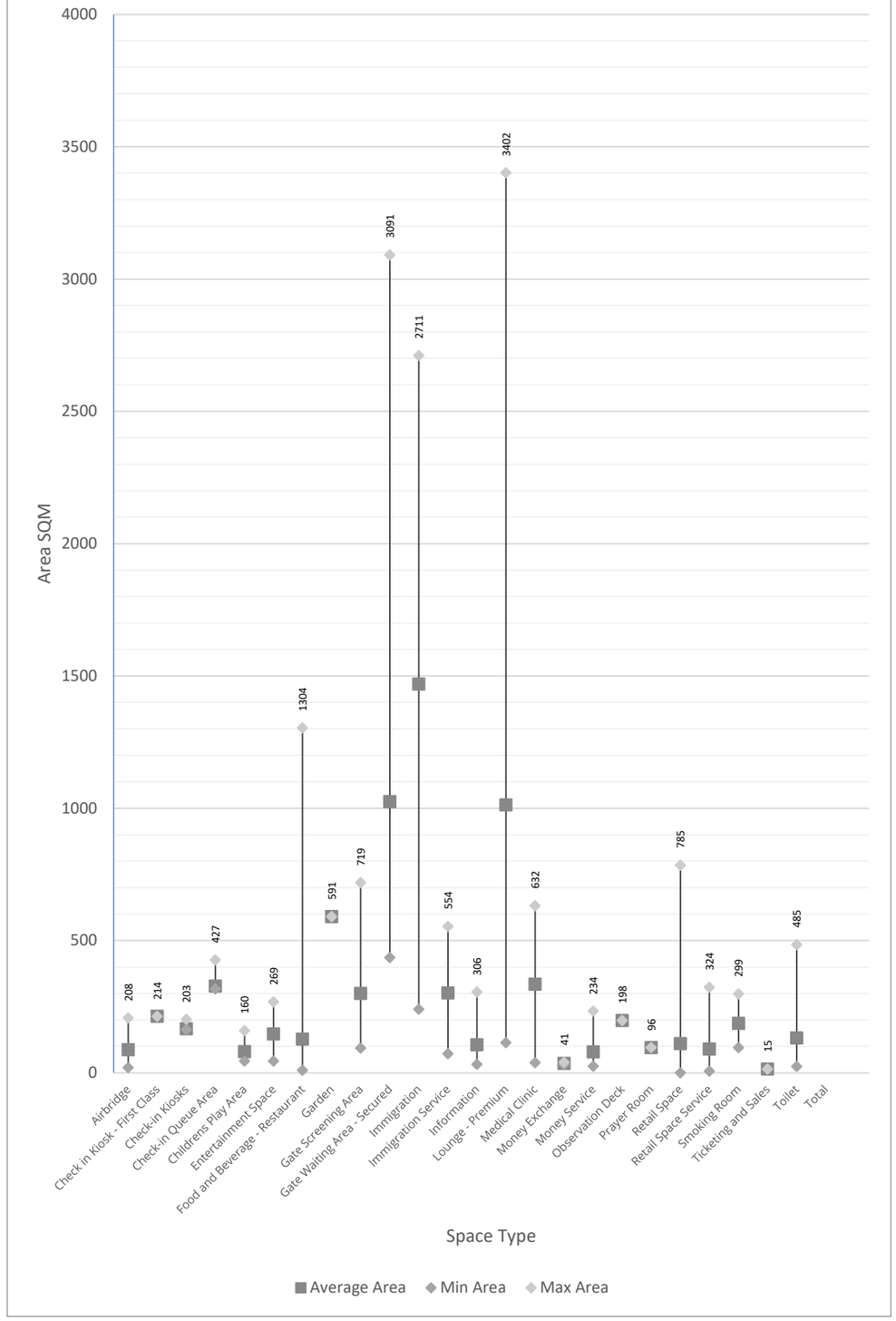
## Overall Area - Treemap








## Min Max Average Areas for Selected Spaces



CHANGI INTERNATIONAL T3

## CONCLUSIONS

Changi international deviates in its flow from Hamad international most likely due to government regulations. The airport serves all passengers on one level. The difference with Changi is that it has been designed for both travelers and non-travelers. Its does this by adding spaces that only people who are not traveling or are in a rush to get one plane to use. Spaces like a mall that is not duty free, additional restaurants and an observation deck.


# HANEDA INTERNATIONAL TERMINAL 3

## GENERAL INFORMATION

LOCATION: Tokyo, Japan

ARCHITECT: Waro Kishi + K. Associates/Architects

OFFICIAL AREA: 224,148m$^2$

CALCULATED AREA: 249,200m$^2$

ANNUAL PASSENGERS: 16 million

GATES: 28 (20 Airbridge + 8 Remote)

COMPLETION: 2010

## REASONS FOR SELECTION

Tokyo's Haneda International Terminal 3 is the smallest terminal studied and for good reason. It provides balance to the study. The previous airports studied are measurably larger and since the project is smaller in nature it was necessary to study a smaller airport. In the search for a smaller airport, Haneda fit the bill not only because of its size but also because it has been ranked very highly and has an interesting take on the movement of users throughout the building.

## DESIGN CONCEPT

Haneda's Terminal 3 was designed to give visitors, be it tourists, or businesspeople a good first impression of Japan (Jun Mitsui & Associates Inc. Architects, 2010). The designers understood the importance of an international terminal and designed it to be the face of Japanese culture by being convenient to move around, giving attention to the architectural design and art placed at the airport. The designers recognized that it may be difficult to show visitors the culture of japan as it seems similar to that of neighboring countries like Korea and China, so they placed special emphasis on the things that make Japanese culture unique.

The design of the departure lobby reflects the cirrus clouds of the Japanese autumn sky. The geometric structure holding the roof up represent the outline of a town in Japan. The roof diffuses light which shines down on the departure halls cobalt floor. The terminal was designed to show long distance travelers the bliss and sensitivity of Japan

## PROGRAM ANALYSIS

This section analyzes the program and circulation of the airport. The flow is shown in Figure 33.

### DEPARTURES

The departures hall is directly below the cloud inspired roof mentioned in the concept. It is on level 3 of the terminal. Departing passengers enter the airport from Tokyo to a beautifully lit, cobalt floored departures hall. From there they make their way to check-in or past check in up to the food and shopping area on level 4. This area is design to slowly change from modern to traditional Japan as you walk through it. Past that visitors can ascend further up to level

After check-in, passengers make their way to immigration and customs after which they end up on the airside. The first thing on the airside is the duty free. The duty free is also a decision point where passengers must choose between going to concourse A or concourses B, C and D. A little past duty free towards concourse B is a way up to the one of the lounges at the airport. Another lounge is just past that. The bus gates are located below concourse B. Passengers needing to go to concourse D must walk through concourse B and C.

Once at the desired concourse, passengers find their gate and descend to the waiting area. The area is not secured so passengers can leave if they wish. Once boarding begins passengers make their way to the airbridge just before which there is a final check to make sure everything is in order. The airbridge connects passengers to their plane.

### ARRIVALS AND TRANSIT PASSENGERS

Passengers arrive through the same airbridges that are used for departing passengers on level 3 or by bus on level 1 except they are routed to level 2, the arrivals level.

All arriving passengers must make their way to the main section of the airport. Once at the main section, transit passengers branch off to a separate transit check-in and customs area. Once through transit customs, transit passengers are routed up to level 3, the departures level where they meet other departing passengers.

Arrivals passengers make their way to immigration and arrivals customs. Once through customs, they make their way to baggage claim and finally the arrivals hall.

If transferring to another domestic flight in another terminal, passengers must arrange transport to the other terminal.

Unlike at other airports and perhaps due to its smaller size, Haneda Terminal 3 does not incorporate any sort of Automatic People Mover system. Passengers must walk wherever they need to go.

### BAGGAGE HANDLING

Bags from check-in on level 1 are sent down to level 0 where they are processed and then sent to the correct gate to be loaded on to the aircraft. Arriving bags are unloaded from the aircraft and sent for processing on level 0. Bags belonging to passengers in transit are routed to the correct gate while bags belonging to arriving passengers are routed to baggage claim.

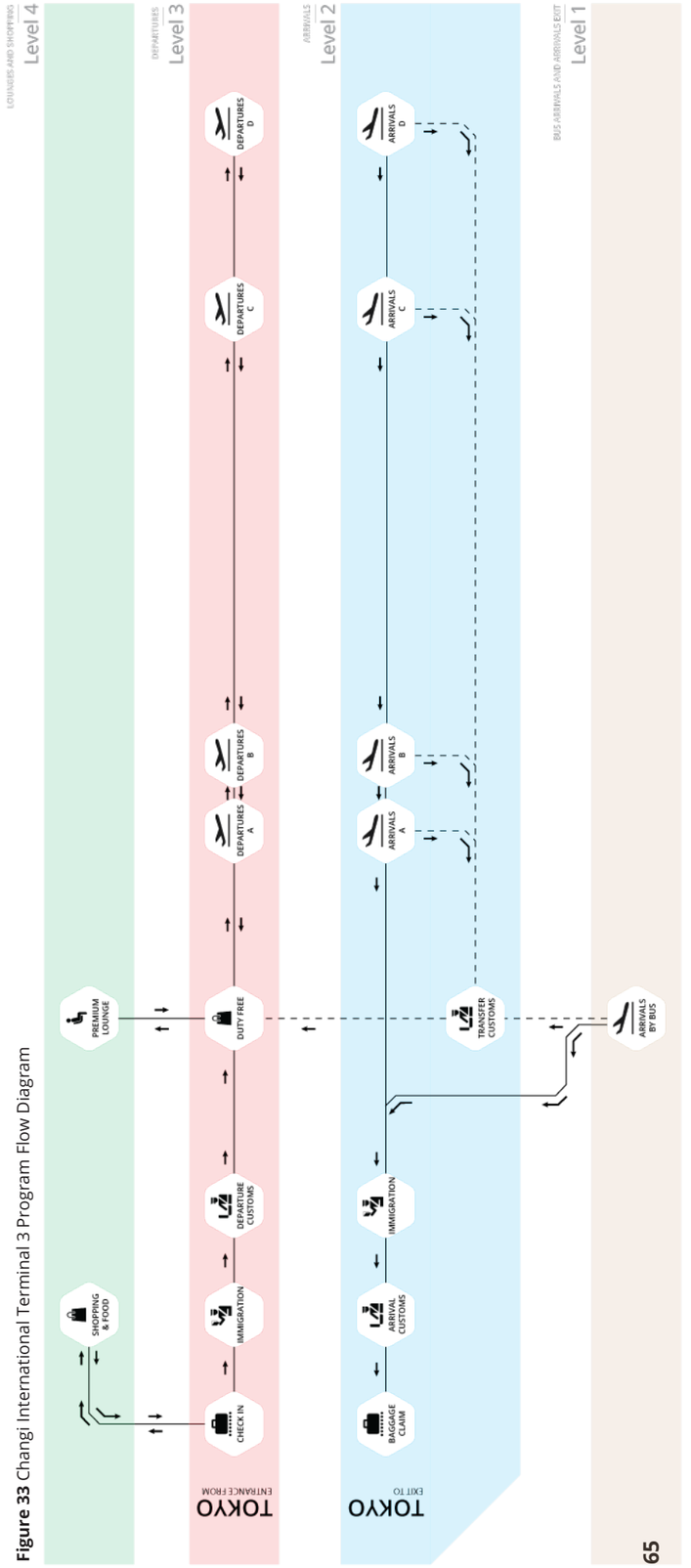



**Figure 33** Changi International Terminal 3 Program Flow Diagram

## PLANS

This section details the program and looks at the plans generated for each level of the airport.

Level 1 (Figure 34) has a few services for arrivs ing passengers and the bus arrival and departure gates.

Level 2 (Figure 35) is the arrivals level, with all arrivals converging on arrival and transfer services. It also has gate waiting areas in concourse C.

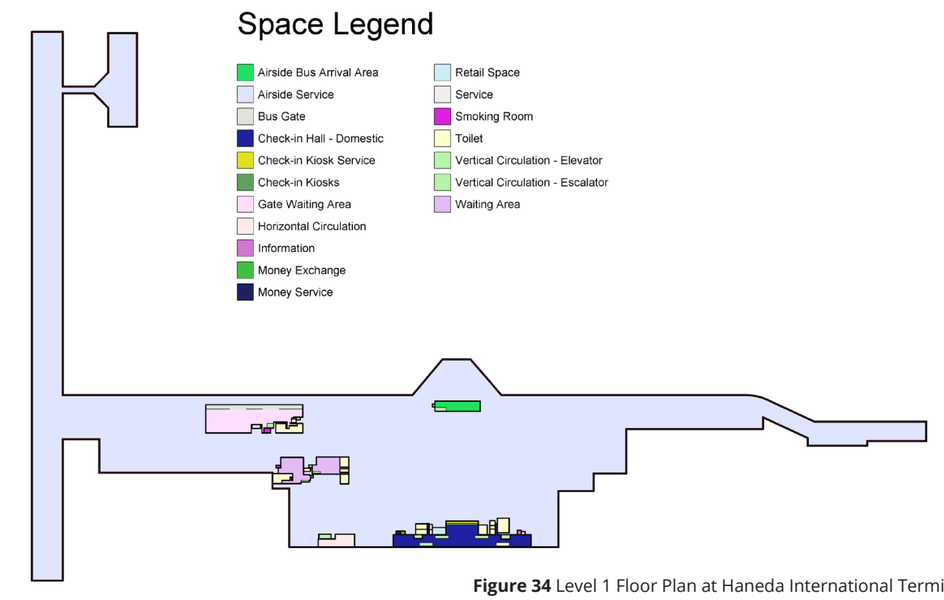



**Figure 34** Level 1 Floor Plan at Haneda International Terminal 3

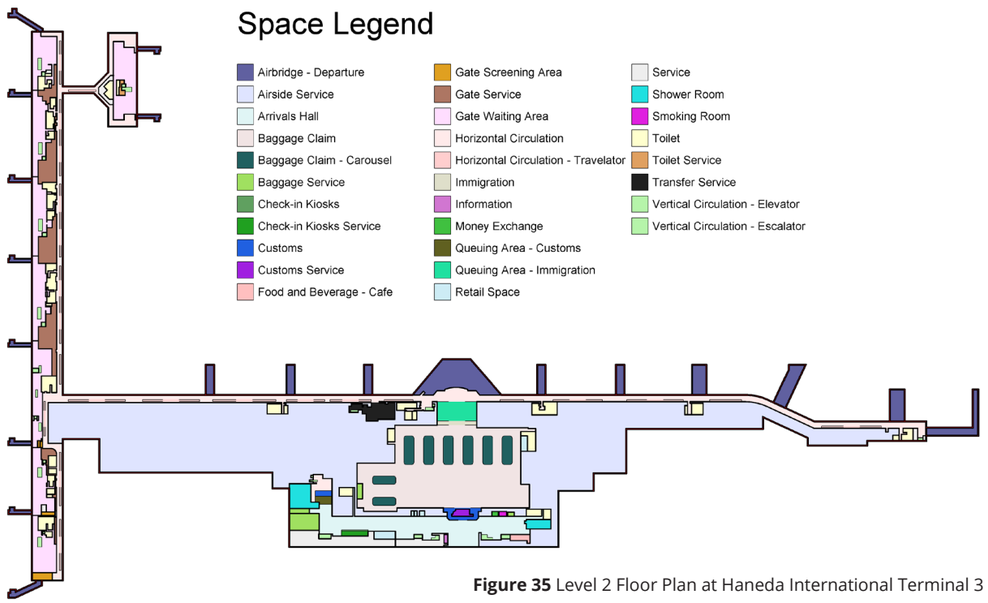



**Figure 35** Level 2 Floor Plan at Haneda International Terminal 3





Level 3 (Figure 36) is the departures level with the departure's hall, duty free, immigration and concourses to gates.

Level 4 (Figure 37) is divided into a shopping and food area in the landside and lounges on the airside.

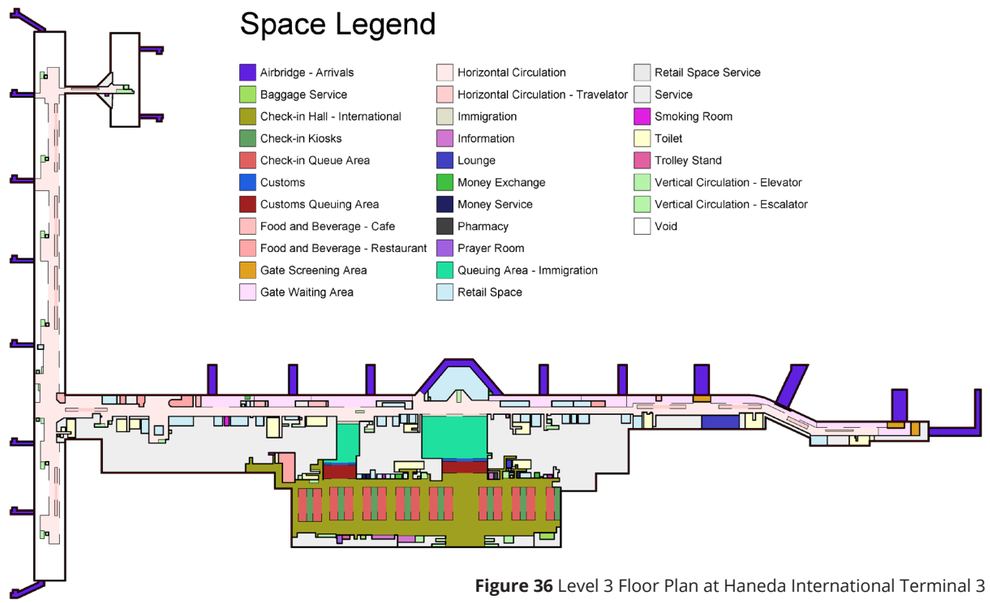



**Figure 36** Level 3 Floor Plan at Haneda International Terminal 3

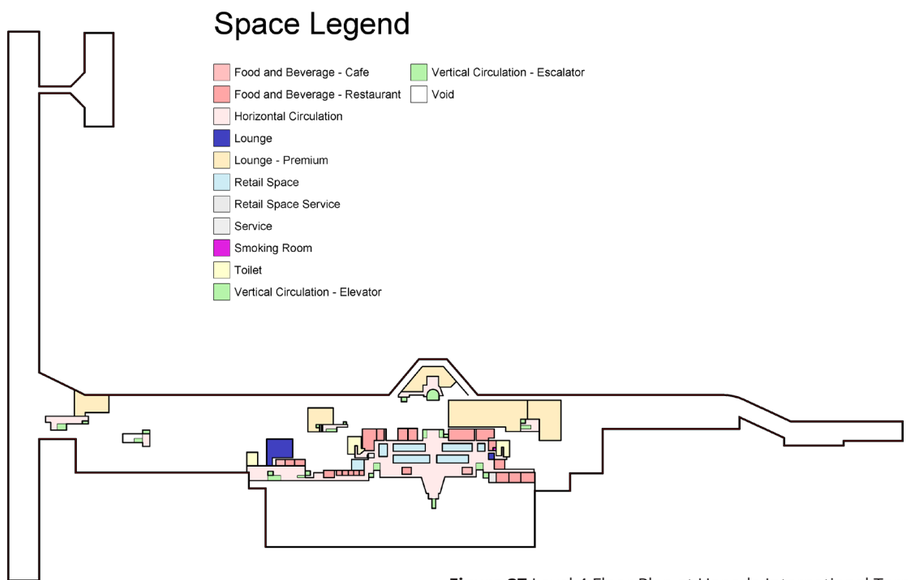



**Figure 37** Level 4 Floor Plan at Haneda International Terminal 3

Level 5 (Figure 38) is home to the terminal's observation deck from the landside and lounges from the airside.

Level 6 (Figure 39) is only accessible from the airside and continues one of the lounges on level 5

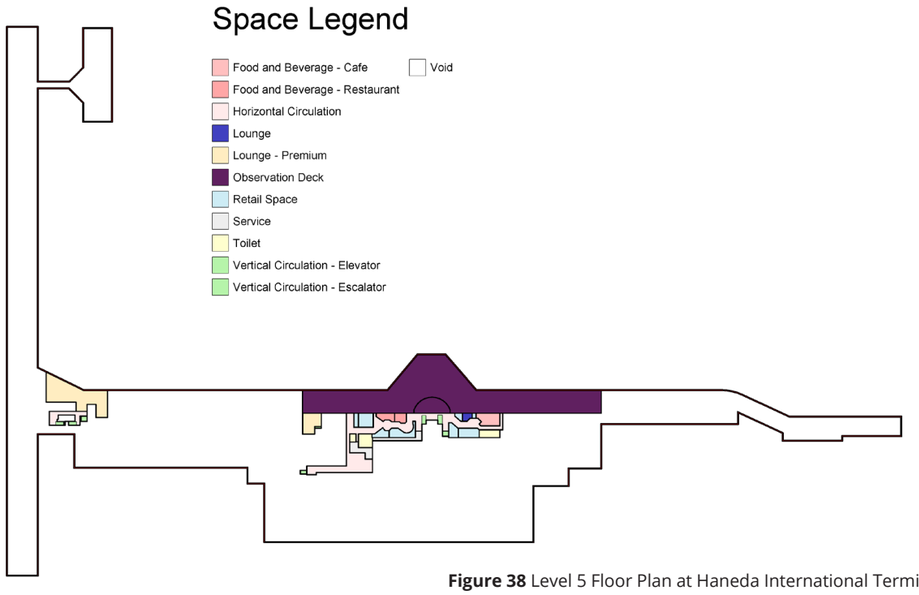



**Figure 38** Level 5 Floor Plan at Haneda International Terminal 3

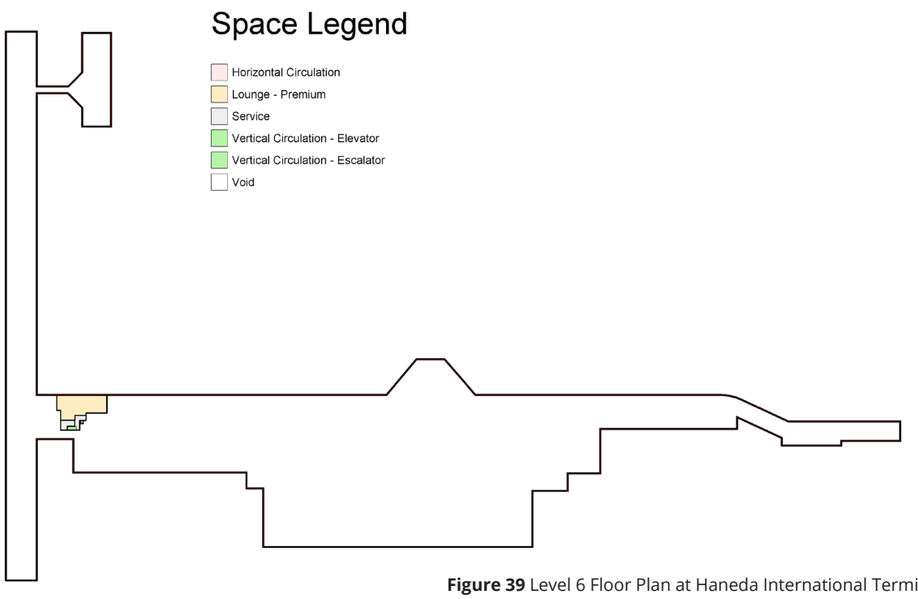



**Figure 39** Level 6 Floor Plan at Haneda International Terminal 3





## AREAS SUMMARY

The table below shows all information gathered by remaking the floor plans of the airport. This includes the sum of all the different types of spaces, the number of that type of space, averages, minimums, maxiumums and the derived totals per passenger and per gate.

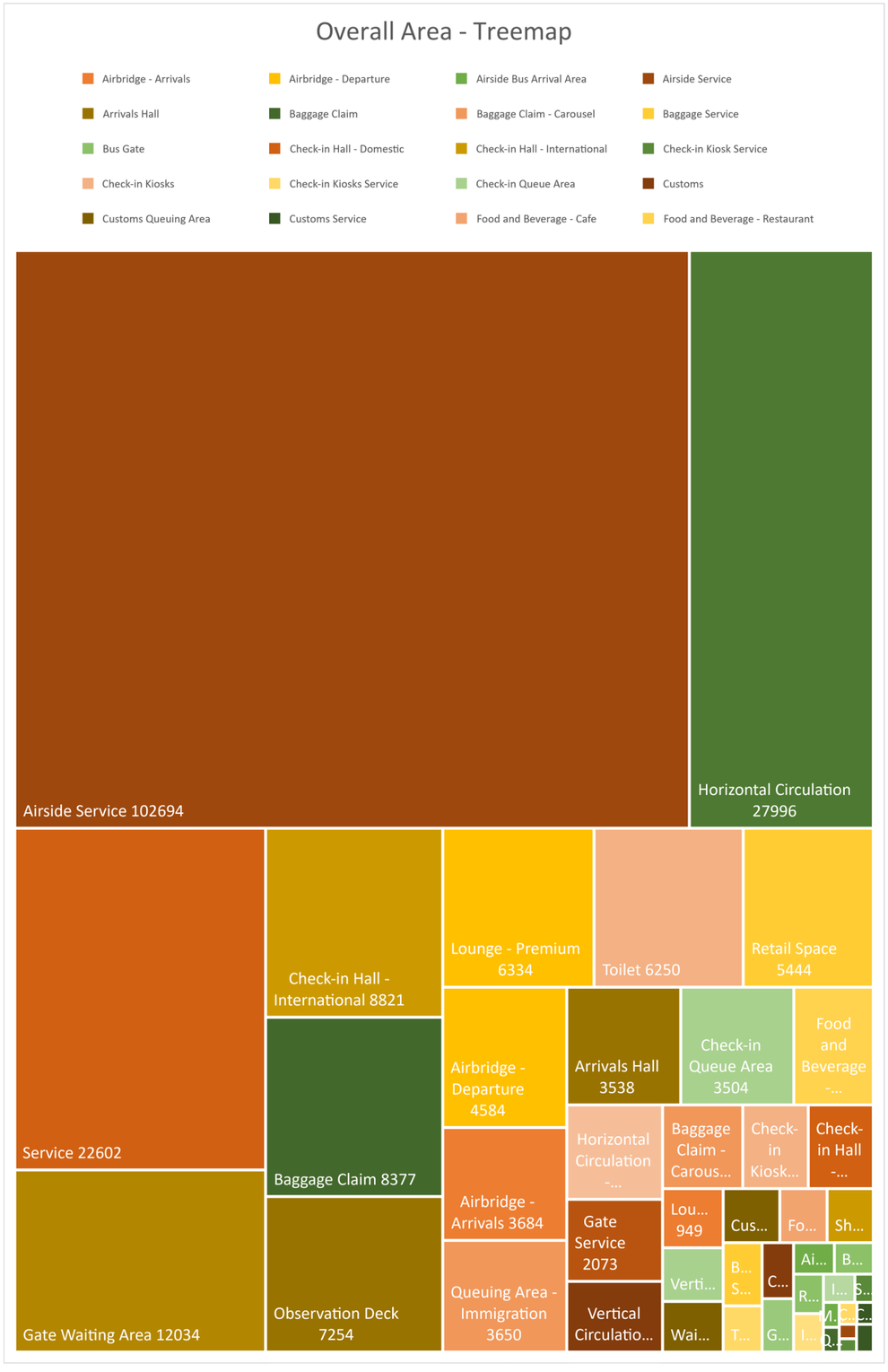
In the chart following, the areas are shown graphically as a Treemap, where the proporations of the areas is clearly visible. After that, the line plot shows the minumum, maximum and average for the most relevent spaces.

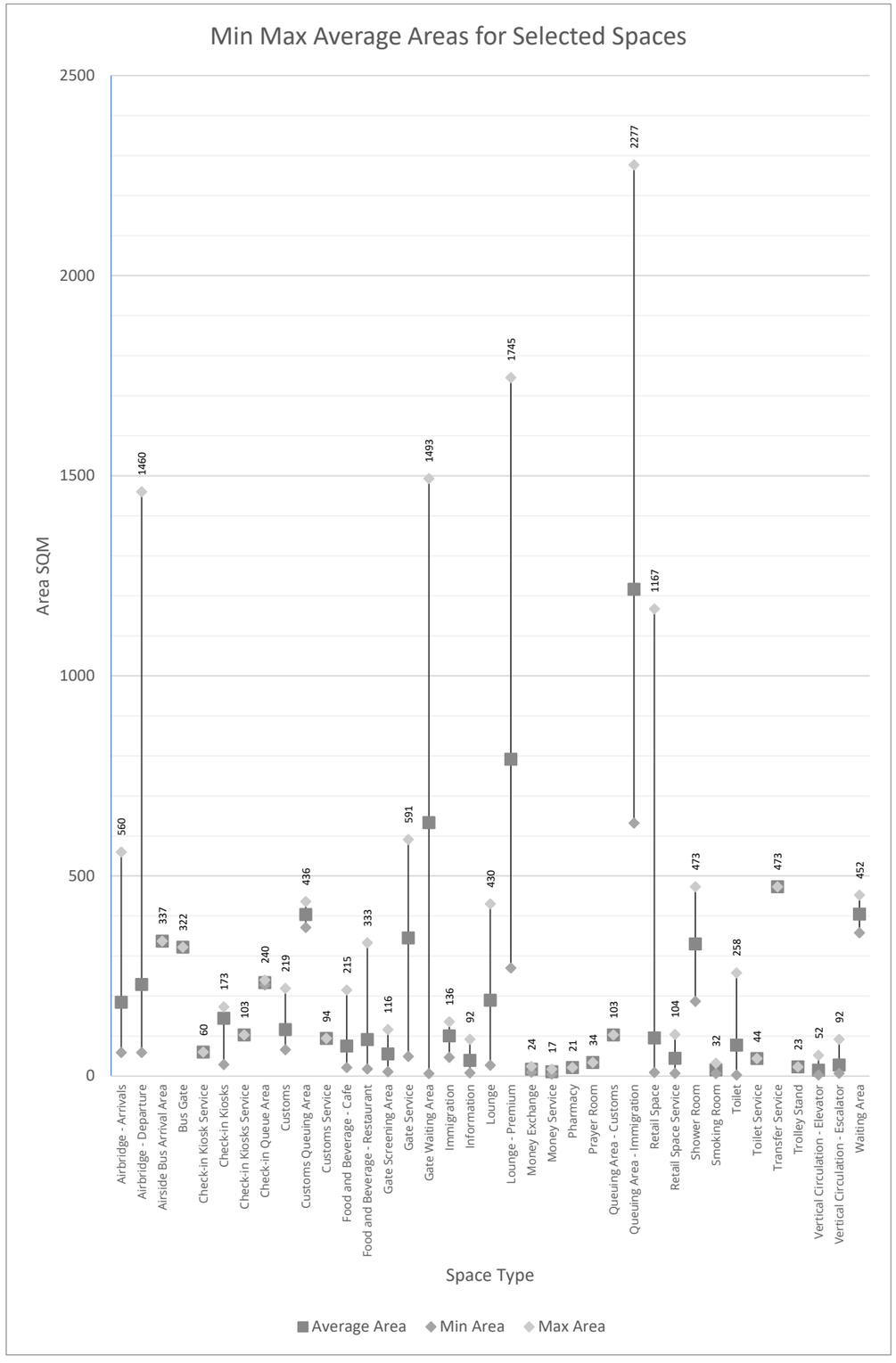
| Space | Sum of Area | Area Count | Average Area | Min Area | Max Area | Percent of Total | Per Peak Pass. Hr. | Per Gate |
|---|---|---|---|---|---|---|---|---|
| Airbridge - Arrivals | 3684 | 20 | 184 | 59 | 560 | 1% | 2.02 | 131.57 |
| Airbridge - Departure | 4584 | 20 | 229 | 59 | 1460 | 2% | 2.51 | 163.71 |
| Airside Bus Arrival Area | 337 | 1 | 337 | 337 | 337 | 0% | 0.18 | 12.04 |
| Airside Service | 102694 | 3 | 34231 | 13370 | 69674 | 41% | 56.22 | 3,667.64 |
| Arrivals Hall | 3538 | 1 | 3538 | 3538 | 3538 | 1% | 1.94 | 126.36 |
| Baggage Claim | 8377 | 1 | 8377 | 8377 | 8377 | 3% | 4.59 | 299.18 |
| Baggage Claim - Carousel | 1768 | 8 | 221 | 158 | 242 | 1% | 0.97 | 63.14 |
| Baggage Service | 649 | 6 | 108 | 15 | 403 | 0% | 0.36 | 23.18 |
| Bus Gate | 322 | 1 | 322 | 322 | 322 | 0% | 0.18 | 11.50 |
| Check-in Hall - Domestic | 1435 | 1 | 1435 | 1435 | 1435 | 1% | 0.79 | 51.25 |
| Check-in Hall - International | 8821 | 1 | 8821 | 8821 | 8821 | 4% | 4.83 | 315.04 |
| Check-in Kiosk Service | 60 | 1 | 60 | 60 | 60 | 0% | 0.03 | 2.14 |
| Check-in Kiosks | 1444 | 10 | 144 | 29 | 173 | 1% | 0.79 | 51.57 |
| Check-in Kiosks Service | 103 | 1 | 103 | 103 | 103 | 0% | 0.06 | 3.68 |
| Check-in Queue Area | 3504 | 15 | 234 | 228 | 240 | 1% | 1.92 | 125.14 |
| Customs | 465 | 4 | 116 | 66 | 219 | 0% | 0.25 | 16.61 |
| Customs Queuing Area | 807 | 2 | 404 | 371 | 436 | 0% | 0.44 | 28.82 |
| Customs Service | 94 | 1 | 94 | 94 | 94 | 0% | 0.05 | 3.36 |
| Food and Beverage - Cafe | 675 | 9 | 75 | 21 | 215 | 0% | 0.37 | 24.11 |
| Food and Beverage - Restaurant | 2466 | 27 | 91 | 18 | 333 | 1% | 1.35 | 88.07 |
| Gate Screening Area | 444 | 8 | 56 | 11 | 116 | 0% | 0.24 | 15.86 |
| Gate Service | 2073 | 6 | 346 | 49 | 591 | 1% | 1.13 | 74.04 |
| Gate Waiting Area | 12034 | 19 | 633 | 6 | 1493 | 5% | 6.59 | 429.79 |
| Horizontal Circulation | 27996 | 13 | 2154 | 71 | 13326 | 11% | 15.33 | 999.86 |
| Horizontal Circulation - Travelator | 2384 | 30 | 79 | 32 | 155 | 1% | 1.31 | 85.14 |
| Immigration | 302 | 3 | 101 | 47 | 136 | 0% | 0.17 | 10.79 |
| Information | 234 | 6 | 39 | 8 | 92 | 0% | 0.13 | 8.36 |
| Lounge | 949 | 5 | 190 | 27 | 430 | 0% | 0.52 | 33.89 |
| Lounge - Premium | 6334 | 8 | 792 | 270 | 1745 | 3% | 3.47 | 226.21 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Money Exchange | 104 | 6 | 17 | 10 | 24 | 0% | 0.06 | 3.71 |
| Money Service | 66 | 6 | 11 | 5 | 17 | 0% | 0.04 | 2.36 |
| Observation Deck | 7254 | 1 | 7254 | 7254 | 7254 | 3% | 3.97 | 259.07 |
| Pharmacy | 21 | 1 | 21 | 21 | 21 | 0% | 0.01 | 0.75 |
| Prayer Room | 34 | 1 | 34 | 34 | 34 | 0% | 0.02 | 1.21 |
| Queuing Area - Customs | 103 | 1 | 103 | 103 | 103 | 0% | 0.06 | 3.68 |
| Queuing Area - Immigration | 3650 | 3 | 1217 | 632 | 2277 | 1% | 2.00 | 130.36 |
| Retail Space | 5444 | 57 | 96 | 9 | 1167 | 2% | 2.98 | 194.43 |
| Retail Space Service | 310 | 7 | 44 | 7 | 104 | 0% | 0.17 | 11.07 |
| Service | 22602 | 37 | 611 | 1 | 8717 | 9% | 12.37 | 807.21 |
| Shower Room | 660 | 2 | 330 | 187 | 473 | 0% | 0.36 | 23.57 |
| Smoking Room | 137 | 9 | 15 | 6 | 32 | 0% | 0.08 | 4.89 |
| Toilet | 6250 | 81 | 77 | 3 | 258 | 3% | 3.42 | 223.21 |
| Toilet Service | 44 | 1 | 44 | 44 | 44 | 0% | 0.02 | 1.57 |
| Transfer Service | 473 | 1 | 473 | 473 | 473 | 0% | 0.26 | 16.89 |
| Trolley Stand | 23 | 1 | 23 | 23 | 23 | 0% | 0.01 | 0.82 |
| Vertical Circulation - Elevator | 855 | 58 | 15 | 3 | 52 | 0% | 0.47 | 30.54 |
| Vertical Circulation - Escalator | 1783 | 65 | 27 | 7 | 92 | 1% | 0.98 | 63.68 |
| Waiting Area | 810 | 2 | 405 | 358 | 452 | 0% | 0.44 | 28.93 |
| Total | 249200 | 571 | | | | 100% | | |














**CONCLUSIONS**

Haneda International Terminal 3 is more similar in program and circulation to Hamad International. The separation of arriving and departing passengers is inverted but the same idea is applied. In addition, despite being the smallest, it also manages to include the non-traveler spaces in its program. The airport includes restaurants, café's, shopping, and an observation deck in virtually the same way as Changi International.

# CASES COMPARISON

This chapter will look at the different spaces at each of the terminals studied and compare them. It also includes figures that show various data that was derived from the analysis which can be used to aid in the design process.

## DEPARTURES

The check in halls at all three airports are very similar in their placement in the building and the places they connect to. All three have the hall located directly under the highest point under the roof. This is done to give the best impression to departing passengers. It creates a huge open and free flowing space. Changi and Haneda provide facilities to non-passengers too through the check-in hall. At both airports, the check-in hall leads to a series of escalators and elevators that can take visitors up to space for shopping, restaurants, and observation decks. Hamad does not offer this sort of facility to people who are not traveling. All three connect directly to immigration on the same level as the check-in hall.

All airports studied have immigration as they all serve international flights. Each airport handles departing passengers the same in terms of flow to immigration and customs. Once through check-in, passengers move through to immigration which is a highly secure area with strict movement and flow of passengers.

Once past immigration, Haneda and Changi place passengers at the duty-free area on the same level. At Hamad passengers enter a huge triple height open space which leads down to the main departures area and directly to the duty-free area. From the duty-free area, all users can access retail area, restaurants, and cafes. All airports also connect the duty free to the premium lounges located on a higher level. Most importantly, passengers move through the duty-free area to get to their required concourse and gate.

Both Hamad and Changi have the concept of secured gates which are gates that passengers can access only once they go though a final security check. Once through this check and inside the secured gate area, passengers can not exit until they board their aircraft. Haneda does not have secured gates, instead using open waiting areas in front of the airbridge where passengers can wait till boarding begins. The secure system is preferred by airlines as it means faster boarding times and quicker turn arounds which help their bottom line. Passengers tend not to like the idea of being locked in a room that they can't exit.

## ARRIVALS

Arriving passengers and transit passengers are handled similarly at Hamad and Haneda. At both airports, passengers are routed from the airbridge to a level with the sole function of handling these passengers. This level connects either to immigration for arrivals or to a transfer area where passengers go through customs and security checks before being routed back to the main departures level. Both airports keep arriving and departing passengers separated. Changi takes a different approach. Passengers arriving at Changi are routed from the airbridge to the same level as departing passengers. Those transferring do not have to go though any customs to get to their next flight. They simply walk off one plane and onto another.

This difference in the handling of arrivals passengers likely stems from government regulations. Some regulations will require that all arriving passengers go through customs like at Hamad and Haneda. This is the reason they separate departing and arriving passengers onto two separate levels. Singapore on the other hand does not require these checks, meaning all types of passengers can be handled on the same level. Regulations in the UAE will require a similar approach to Hamad and Haneda (see "GCAA Regulations" on page 83).

All three airports place the baggage claim and arrivals hall on the level below the check-in hall level. This is done to keep the airside service, which handles baggage as close as possible to both the airside and the arrivals hall, ensuring the smallest distance for passengers from aircraft to exit. A potential downside of this however is that the ceiling on these levels can be restrictive and does not have the same wow factor as the check-in halls above. The creative use of voids, gardening, and open spaces at Changi international does a good job making up for this restriction.

**Figure 40** Overall Minimums, Averages, and Maximums derived from all studied airports

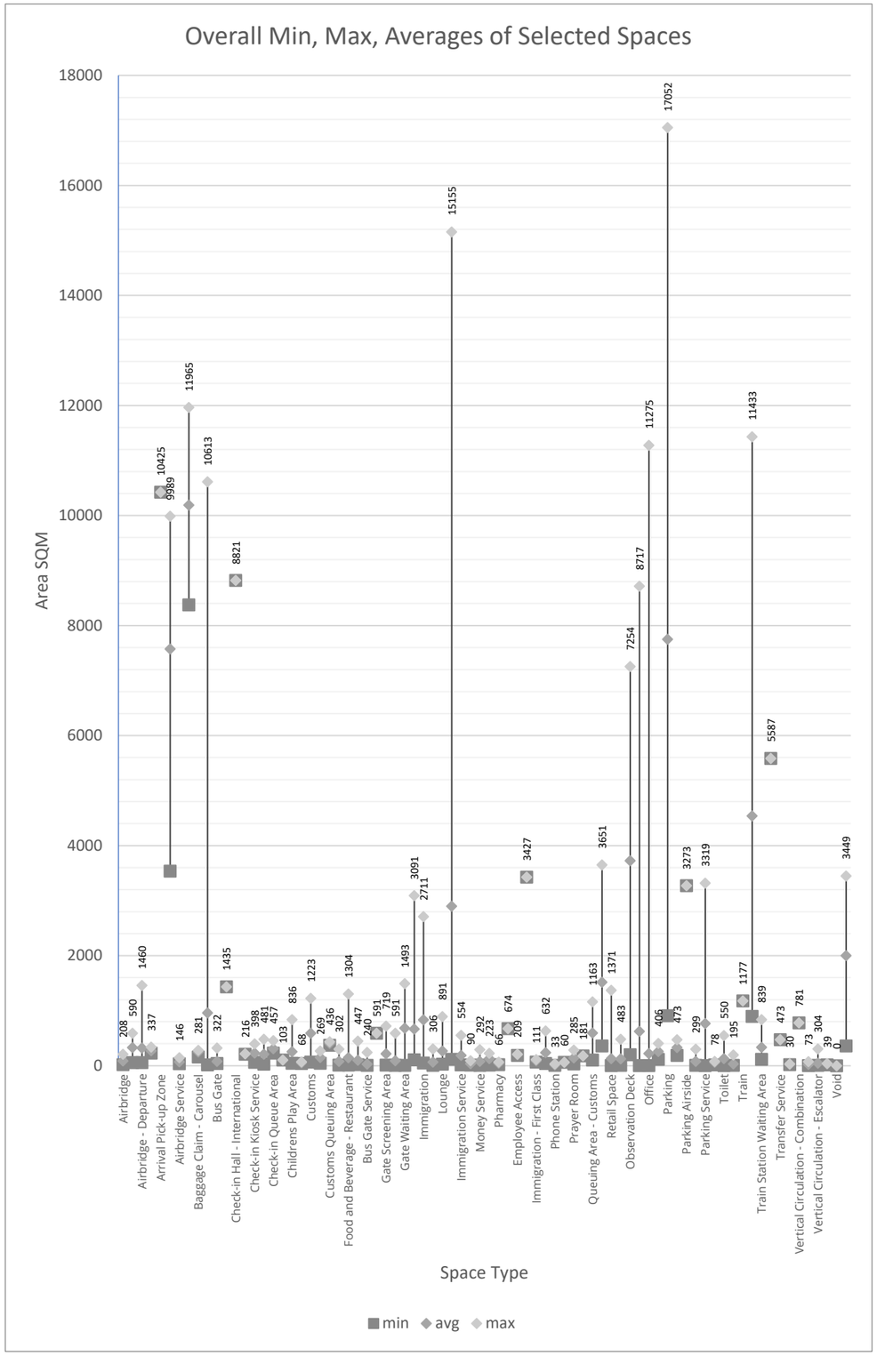


| Space | Min | Avg | Max |
|---|---|---|---|
| Airbridge | 20 | 88 | 208 |
| Airbridge - Arrivals | 59 | 330 | 590 |
| Airbridge - Departure | 59 | 323 | 1460 |
| Airside Service | 2319 | 33829 | 105704 |
| Airside Bus Arrival Area | 230 | 270 | 337 |
| Arrival Pick-up Zone | 10425 | 10425 | 10425 |
| Arrivals Hall | 3538 | 7574 | 9989 |
| Airbridge Service | 36 | 70 | 146 |
| Baggage Claim | 8377 | 10189 | 11965 |
| Baggage Claim - Carousel | 158 | 249 | 281 |
| Baggage Service | 15 | 959 | 10613 |
| Bus Gate | 41 | 76 | 322 |
| Check-in Hall - Domestic | 1435 | 1435 | 1435 |
| Check-in Hall - International | 8821 | 8821 | 8821 |
| Check in Kiosk - First Class | 209 | 213 | 216 |
| Check-in Kiosk Service | 60 | 229 | 398 |
| Check-in Kiosks | 29 | 208 | 481 |
| Check-in Queue Area | 228 | 311 | 457 |
| Check-in Kiosks Service | 103 | 103 | 103 |
| Childrens Play Area | 45 | 253 | 836 |
| Baggage Wrapping | 40 | 53 | 68 |
| Customs | 66 | 591 | 1223 |
| Entertainment Space | 45 | 148 | 269 |
| Customs Queuing Area | 371 | 404 | 436 |
| Customs Service | 11 | 77 | 302 |
| Food and Beverage - Restaurant | 10 | 146 | 1304 |
| Food and Beverage - Cafe | 21 | 101 | 447 |
| Bus Gate Service | 6 | 27 | 240 |
| Garden | 591 | 591 | 591 |
| Gate Screening Area | 11 | 216 | 719 |
| Gate Service | 8 | 91 | 591 |
| Gate Waiting Area | 6 | 683 | 1493 |
| Gate Waiting Area - Secured | 108 | 665 | 3091 |
| Horizontal Circulation | 71 | 7873 | 71630 |
| Horizontal Circulation - Travelator | 32 | 153 | 326 |
| Immigration | 47 | 832 | 2711 |
| Information | 8 | 65 | 306 |
| Lounge | 27 | 266 | 891 |
| Lounge - Premium | 115 | 2898 | 15155 |
| Immigration Service | 14 | 186 | 554 |
| Money Exchange | 10 | 35 | 90 |
| Money Service | 5 | 77 | 292 |
| Computer Area | 11 | 129 | 223 |
| Pharmacy | 21 | 44 | 66 |
| Customs - First Class | 674 | 674 | 674 |
| Employee Access | 188 | 199 | 209 |
| First Class Waiting Area | 3427 | 3427 | 3427 |
| Immigration - First Class | 67 | 89 | 111 |
| Medical Clinic | 39 | 237 | 632 |
| Phone Station | 5 | 16 | 33 |
| Police Office | 60 | 60 | 60 |
| Prayer Room | 34 | 139 | 285 |
| Queuing Area | 181 | 181 | 181 |
| Queuing Area - Customs | 103 | 593 | 1163 |

| | | | |
|---|---|---|---|
| Queuing Area - Immigration | 359 | 1520 | 3651 |
| Retail Space | 1 | 129 | 1371 |
| Retail Space Service | 7 | 123 | 483 |
| Observation Deck | 198 | 3726 | 7254 |
| Service | 1 | 623 | 8717 |
| Office | 1 | 221 | 11275 |
| Service - Check-in | 114 | 260 | 406 |
| Parking | 909 | 7753 | 17052 |
| Shower Room | 187 | 329 | 473 |
| Parking Airside | 3273 | 3273 | 3273 |
| Smoking Room | 6 | 77 | 299 |
| Parking Service | 1 | 764 | 3319 |
| Ticketing and Sales | 15 | 61 | 78 |
| Toilet | 3 | 130 | 550 |
| Toilet Service | 5 | 31 | 195 |
| Train | 1177 | 1177 | 1177 |
| Train Service | 897 | 4539 | 11433 |
| Train Station Waiting Area | 117 | 336 | 839 |
| Train Track | 5587 | 5587 | 5587 |
| Transfer Service | 473 | 473 | 473 |
| Trolley Stand | 20 | 25 | 30 |
| Vertical Circulation - Combination | 781 | 781 | 781 |
| Vertical Circulation - Elevator | 3 | 25 | 73 |
| Vertical Circulation - Escalator | 7 | 44 | 304 |
| Vertical Circulation - Large Stairs | 17 | 30 | 39 |
| Waiting Area | 358 | 1999 | 3449 |







# PART 4
## GENERIC DATA

# STAKEHOLDERS, CONSIDERATIONS, AND REGULATIONS

A critical airport design issue is the layout of passenger buildings[1] . Poor choices by designers in the past have hurt the success of airports and the communities which they serve. Ill thought-out design can not only cause difficulties for passengers and airlines, but it can also impact an airports competitiveness, reducing traffic to the airport and hurt the economy of the region it serves. Therefore, airport planners and designers have a responsibility to make the correct and informed choices. They need to choose the correct configuration for the region and consider the operational and economic impacts of their choices.

This section will look at the different possible shapes passenger buildings can take and try to understand which design is preferable in different circumstances. It will consider the wide variety of users and functions a passenger building needs to serve. In addition, it will look at UAE regulations that come into play in the design of a terminal.

## STAKEHOLDERS AND PASSENGERS OVERVIEW

Passenger buildings serve the needs of many different types of users/stakeholders:

1. Arriving and departing passengers through check-in and baggage processing.
2. Transit passengers by quickly and efficiently connecting them between flight.
3. Departing and arriving aircraft.
4. Airlines that operate the aircraft.
5. Owners who provide the means to build.
6. A retail experience that helps finance the airport.

Airport service operators such as security and customs agencies.

Each function must be performed efficiently and profitably for the concerned stakeholder.

## BASIC CONFIGURATIONS OVERVIEW

As discussed briefly in a previous section, five basic configurations for passenger buildings are most common. These are:

1. Linear configuration
2. Finger/pier configuration
3. Satellite configuration
4. Midfield (Linear or X-shaped) configuration
5. Transporter configuration

Each configuration has its advantages and disadvantages depending on the type and amount of traffic. Many passenger buildings nowadays are either designed or have evolved to be hybrids of the different basic configurations to reduce the downsides of the basic configurations and use their strengths. Therefore, nowadays, hybrid configurations are most desirable.

Three factors most greatly affect which configuration or combination of configurations should be used for a specific project (Neufville, 2013):

1. **Overall Traffic Level:** A configuration that works for a small airport may not work for a larger airport.
2. **Traffic Seasonality:** Airports that are used only a few months a year will have higher costs per passenger – something that will need to be considered during design.
3. **Transit Traffic:** the percentage of transit passengers should affect the design.

The best configuration depends on the stakeholders. As the stakeholders can vary or change significantly over time, the desirability for one configuration over another can also vary significantly over time. This means that the long-term use of a facility depends on the flexibility of the of the configuration chosen during the initial design of the airport.

Hybrid designs are generally preferable because they can serve all the different types of traffic and stakeholders while also providing the opportunity to expand if the future calls for it. In practice, airport operators will need to build new specialized facilities as time progresses meaning any single basic configuration will eventually turn into a hybrid solution no matter what the original plans were.

This reality that most airport need hybrid configurations is against current norms when it comes to airport proposals. Proposals for new airports usually show basic single configurations. These produce beautiful renders but usually end up falling apart when put in practice as they are unlikely to provide the best service to the wide variety of users. Then to remedy these issues, the operators and owners must resort to building other facilities turning the airport into a hybrid configuration. Therefore, would not it be better to simple start with a hybrid configuration?

## DESIGN CONSIDERATIONS

It is standard practice for architectural programs for passenger buildings to focus mainly on the estimated number of passengers and aircraft that will use the building. The problem is that these totals fail to account for a variety of things such as types of traffic and the needs of the various stakeholders. They also fail to consider the possibility that traffic, and the needs of the stakeholders may change over the life of the building. Basically, the architect and the owner should consider the future needs of the airport and the long-term risks to the airport and choose a configuration that best suits the future evolution of the airport.

### GENERAL CONSIDERATIONS

Airport passenger buildings serve not just passengers but also airlines, owners, retailers, and operators to name a few. This may seem obvious, but it is important because typically during design work, designers do not include the stakeholders in the design process in the beginning stages of design. Most of the time, space is let aside for the needs of the stakeholders based on general standards. This leads to spaces that are suboptimal for their intended purpose.

### PASSENGERS

The following are the main categories of pas-

1 'Passenger buildings' are buildings that serve both passengers and airlines. 'Terminals' is a more common but misleading terminology that implies that these buildings only serve arriving passengers. Usually these buildings are thought of as 'gateways' to the regions. This line of thinking incorrectly implies that they only serve arriving and departing passengers. The usage of 'terminals' and 'gateways' to label these buildings neglects one of the most important functions of an airport which is facilitating passengers transferring between flights, users who are not arriving nor departing. These passengers may account for much of the traffic passing through an airport. For example, 63% of passengers who used Dubai International Airport in 2018 were transit passengers (Arabian Business, 2019).

sengers that use airports:

1. **Domestic Passengers:** Passengers who will not go through customs
2. **International Passengers:** Passengers who will go through customs
3. **Transit Passengers:** Passengers who will board a connecting flight
4. **Business Passengers:** Passengers who are used to travelling and often travel with limited baggage. They expect facilities such as luxury lounges
5. **Tourists:** Passenger who often have families and lots of baggage. Typically using cheaper airlines and expecting low-cost facilities
6. **Disabled or Elderly Passengers:** Passengers who need wheelchair access and level ground

In addition to these major categories, there are some other types of traffic that need special attention such as pilgrims. All types of passengers except transit passengers need ground transportation (cars, busses, trains etc.), check-in facilities, security, and other clearances (customs). In addition, they need easy and quick ways to access all the essentials on the landside such as lounges, services, baggage delivery and the aircraft.

In certain airports, special attention should be given to transit passengers because their needs differ from all other types of passengers. For transit passengers it is essential that their connections should be:

1. **Fast:** Airlines need to be competitive with other airlines using other airports. A slow transit experience at an airline's hub will reduce the number of travelers willing to use that airline. In addition, it costs the airline money to hold aircraft on the ground. Aircraft need to spend as much time in the air as possible for maximum profitability.
2. **Reliable:** Stranded passengers and lost or delayed baggage can hurt airlines in two ways. First it costs more to get the passenger and their baggage to their destinations and second it damages the airlines reputation.
3. **Easy to find:** A complicated route to the connecting flight can confuse passengers resulting in delays and stranded passengers resulting in unreliability that needs to be avoided.

### AIRLINES

Airlines are very interested in the configuration of passenger buildings as it affects their operating costs. Bad design can cost airlines deeply while good design can give them an edge over their competitors.

Airlines will do anything possible to reduce their operating costs. For example, they are very interested in keeping aircraft maneuvering to a minimum as it can save them millions per year at a small airport or billions in larger airports. They are willing to pay for improvements if it means they will save money in the long run.

Airlines such as Emirates that run larger transit hubs benefit from the same configurations that passengers benefit from. Namely that connections must be fast, reliable, and easy to find.

### OWNERS

Owners usually want their airports to be amazing feats of architecture. As a major public building that celebrate a vision of the future of their community. Leaders and governments look at airports as a symbol. Airports are the first and last contact anyone will have with a country and as a result it is very important that they leave a lasting impression on their users.

This idea of a monument however, conflicts with the reality that an airport needs to be economically efficient. Beautiful curved organic architecture is difficult and expensive to construct, maintain, and expand in the future. The costs may be worth it for some owners but unbearable for others.

### RETAILERS

Retailers at an airport want the same things they would want at a shopping mall. If planned properly, retailers will want to set up shop at an airport and contribute to its financial success. The criteria retailers look at are:

1. **Traffic:** The main number used by retailers to gauge whether an area is good or not is the amount of people flowing through that area. More people, more customers.
2. **People willing to shop:** People once in the shopping area must be willing to shop. If passengers feel rushed or anxious when they reach the retail area, they are less likely to pause for a moment and buy something. They will be more interested in getting to their plane. However, people who are waiting for their plane with nothing else to do are more likely to make an impulsive decision and buy something are best for retailers.
3. **Visibility:** An unseen store is more difficult to profit off. The retail area and its store must be obvious but also align with the main goal of the airport which is to get passenger to their aircraft.
4. **Easy access:** Retailers must find it easy to sell their products to their customers. At an airport, products must go through security and this process must be as painless as possible for retailer to feel comfortable setting up shop at an airport.

### GOVERNMENT AGENCIES

Government agencies are a stakeholder that must be consulted very carefully. They are very different from other types of stakeholders in that their requirements are very stringent and difficult to be changed. Agencies usually require very tight control over the flow of international passengers and on the interactions between airline crews and airport workers. These requirements can quickly complicate the design of an airport, a building that needs to be as simple as possible all other users.

## GCAA REGULATIONS

In an Aeronautical Information Publication (AIP), the General Civil Aviation Authority (GCAA) outlines rules for the entry, transit, and departure of passengers in the UAE. The following is directly from the GCAA AIP effective 3 December 2020. It has been shortened to only include information relevant to the Emirate of Abu Dhabi.

GEN 1.3 Entry, transit and departure of passengers and crew

1.3.1 Customs requirements

1.3.1.1 Customs requirements in the Emirate of Abu Dhabi

1.3.1.1.1 Arrival

Baggage or articles belonging to disembarking passengers and crew should be immediately released except for items selected by the customs authorities for inspection.

1.3.1.1.2 Transit

Inspection of baggage belonging to transit

passengers is required.

1.3.1.1.3 Departure

Inspection of baggage belonging to embarking passengers is not required.

1.3.2 Immigration requirements

1.3.2.1 Immigration requirements in the Emirate of Abu Dhabi

1.3.2.1.1 Arriving passengers

Persons of most nationalities who hold a valid passport and onward ticket with confirmed reservations for the continuation of their journey may be issued, on arrival in Abu Dhabi, with a transit visa valid for a period of 72 hours only. Such visas will not be extended or converted into visitors' visas. Persons wishing to enter Abu Dhabi for longer than 72 hours must obtain an entry permit. The entry permit must be obtained from the Department of Nationality, Passports and Residence, Abu Dhabi, on the visitors' behalf by a person legally resident in the area. Holders of such entry permits will be entitled to receive visas on arrival in Abu Dhabi.

1.3.2.1.2 Transit passengers

No documents or visas are required of passengers arriving and departing on the same through flight or transferring to another flight at the same airport, provided they do not leave the airport precincts.

1.3.2.1.3 Departing passengers

On departure all passengers must complete an embarkation card and are required to produce their passports for inspection.

1.3.2.1.4 Crew

A flight crew member listed on the crew list who retains his or her license in their possession when embarking and disembarking is not required to present any additional documents provided that they remain at the airport where their aircraft has stopped, or within the confines of the city adjacent thereto, and departs on the same aircraft or on their company's next regularly scheduled flight out of Abu Dhabi is not required to present any additional documents.

1.3.3 Public health requirements

1.3.3.1 Public health requirements in the Emirate of Abu Dhabi

1.3.3.1.1 Arrival

Current certificates are required as follows:

1. Yellow Fever when arriving from infected local areas as defined by WHO.

2. Cholera when arriving from infected local areas as defined by WHO.

1.3.3.1.2 Departure

No health formalities are required.

1.3.4 API (Advanced Passenger Information)

All Air Operators shall submit APP (Advanced Passenger Process) for all Passengers, including inbound/outbound/transit/transfer passengers and crew in advance. The Air Operators shall take measures that the boarding directive received from UAE Government are followed. The Commercial Air Operators will also comply by sharing the PNR (Passenger Name Record) with the authorities at specified frequencies.

# FACILITY DESCRIPTIONS

## AIRPORT TERMINAL FACILITES

### QUEUES

Every passenger handling process at an airport terminal requires a queuing system from people to wait to be served. A general rule of thumb is to allocate 0.6m of queue length per person. This figure assumes that friends and family stand closers to each other than to strangers. The actual number required will depend on if trolleys will be used in that specific queue. In addition, queues tend to compress as more people join them. Finally, the level of service will influence the amount of space given to queues.

Snake queues are more efficient because they involve a single queue that then sends people to a counter where they can be served. They also use space more efficiently than multiple queues. The disadvantage however is that since one person is at the head of queue, they can become bogged down because the person may not notice a counter has become free. This also means productivity is lost as the agent waits for people to walk to the counter.

### CHECK-IN CONCOURSE

The check-in concourse or hall need facilities such as information desks, toilets, flight information screens and cafes in addition to the check-in counters and bad drop off points. These facilities are for those who may want to wait a bit before beginning their travels. Generally, though the design should push people to move forward to security as quickly as possible to avoid crowding and delays.

Self-check-in counters, fast bag drop facilities are also a requirement at the modern airport as they reduce the amount of time spent in the check-in hall.

It is recommended to keep people accompanying passengers away from check-in queues to prevent crowding and overflowing the queue. It is recommended to keep concourses 20 meters wide to allow space for all the queues and circulation.

### CHECK-IN COUNTERS

While check-in counters are usually placed right after the entrance of the terminal, they may also be placed at car parks, train stations, and gate lounges. They can be faced in a straight line parallel to the curb or end-on to the flow of passengers or in an island configuration.

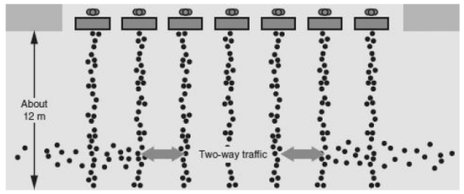



**Figure 41** The issue with linear counters

The linear arrangement should only be used if passengers can pass straight through the counter area to the next step behind. If the must back out and go to a central processing area the linear configuration can cause an issue where people cut through queues. The issue is demonstrated in Figure 41. Cons veyors for baggage are placed behind staff at the counter and are by a short belt feeder that feed the main conveyor.

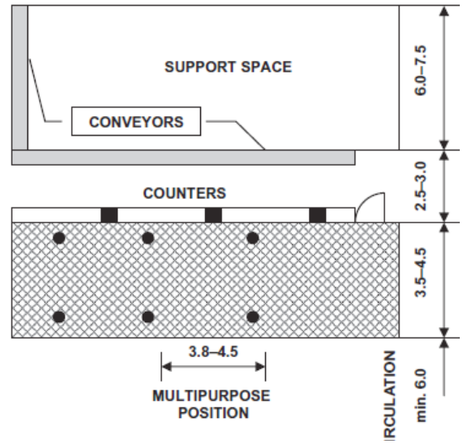



**Figure 42** Linear Check-in Counter Configuration

If a linear arrangement allows passnegers to flow through, it adds complexity and increases the cost to build and maintain the system.

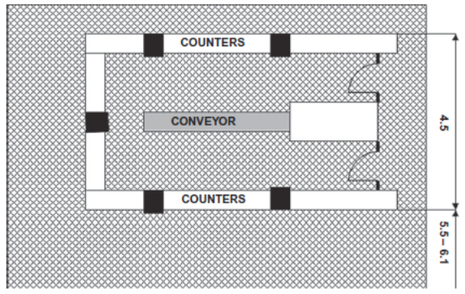



**Figure 43** Flow through Type Linear Configuration

The island configuration places counters in a U shape around the conveyors. They offer an element of flow through without the down side of queue cutting and are effeient as they can be fed with bags from both sides. The IATA recommend the use of island style check-in counters with 10-20 coutners per side and 20-30 meters between islands.

### OUT-GOING BAGGAGE HANDLING

The out-going baggage handling system is typically placed under the departures level and is made up of:

- Conveyor belts with coded trays/vehicles
- Code readers that can decode the information on baggage tags and then route bags to the correct place
- A screening system
- A feed for bags belonging transit passengers
- A storage area for early bags

A robust system will be able to handle up to 2.2 bags per passenger. The system should be able to handle at least 0.8 bags per person. That is 1600-2200 bags per hour.

The IATA recommends that it should take no longer than 9 minutes for a bag to end up at a make-up area and no more than 35 minutes for transfer baggage to end up in the correct location. To achieve these times, it may be required to move the bags directly on the apron.

### SECURITY SCREENING

This area required a walk-through screening device for passengers and an x-ray machine for their hand luggage. In addition, space is needed for manual searches and recovery of x-rayed items. The FAA recommends that each security station in the area have 10-15m$^2$ allocated to it, serving 500-600 passengers per hour (Figure 44).

### OUTBOUND PASSPORT CONTROL

Immigration services can get their processing times down to an average of 20 seconds per person. For a service level C, passengers get 1 square meter of space and the queue length per passenger is 0.8-0.9 meters. Space needs to available for a queue to develop in the check in hall if it gets larger than expected. It should not take more than 5 minutes to clear immigration.

### INBOUND PASSPORT CONTROL

These functions support government immi-

gration, customs, public health, and livestock and plant health control services. The area needs at least 750 m$^2$ per 1,000 peak hour international passengers. The IATA says a maximum wait time is 9 minutes. Officials can process a passenger every 30 seconds.

A separate reception lounge may be included to entertain important people while their paperwork is sorted out.

### DEPARTURE LOUNGES

At minimum, departure lounges should have space for essentials while passengers wait for flights and space for queuing and checking while a flight boards. There should be seating, telephones, charging stations, toilets, and some sort of catering like a small café.

In general, there should be 1.5-2.0m$^2$ of space per seat on the plane waiting to be boarded. Seating should be provided for at least 50 percent of passengers. 1.5-1.8m$^2$ are required for circulation in the seating area.

### GATE LOUNGES

Should be placed where they are required. Should have seating capacity for 80% of aircraft capacity at 1.7m$^2$ per seat. There must be room for an airline counter and queuing during boarding for checking of boarding passes and baggage. There is a conflict between airlines and passengers here that airlines would like to have all passenger in the lounge as soon as possible while passengers do not want to be confined to a smaller space while they wait. Airports typically do all checking necessary while the aircraft is being prepared then simply release passengers to the plane when it is ready. This reduces boarding times and leads to quicker turn arounds for aircraft. In this case, toilets should be provided as one in passengers cannot leave.

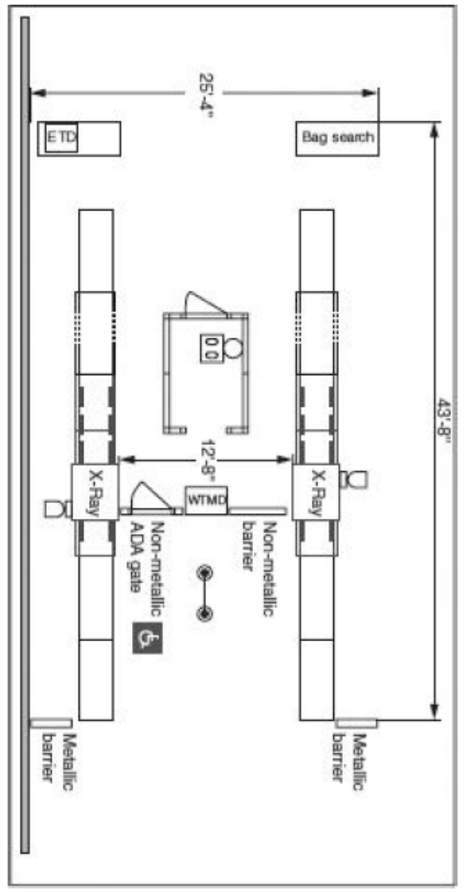



**Figure 44** Typical Screening Checkpoint

If there is a change of level between the lounge and airbridge an escalator should not be used as queues can back up on to it.

If built to accommodate a Code F aircraft the gate room will be attached to a pair 26 meters in width.

### EXECUTIVE LOUNGES

Executive lounges are important for businesspeople who will need to conduct business while they wait for their aircraft. The area needs to be suitable for business. Sometimes theses lounges are shared with first class loungers. The sizes should be quadrupled any standards to achieve the expected levels of service. Lounges should be placed near gates for easy access.





### RETAIL SPACES

In the 1950's duty free spaces began to pop up at airports and were the only space with retail shops present. Today retail is a part of the reason airports work. It is one of their major sources of income.

Retailers need to easily be able to get their product on to their shelves despite customs. This is typically done by having a separate back of house for these sorts of things.

Retail spaces need to balance being in the way of passengers but also need to be in view to function. If passengers cannot see the shops or they are too far out of reach they will simply not bother shopping leading to missed impulse buys.

Passengers also spend more the more relaxed they are so something needs to calm them down after what could be stressful security. Centralized security helps to keep noise away from the rest of the airport helping to create the calming mood.

Airport shopping is not the same as shopping at a mall. Passengers do not have unlimited time, they cannot come back, and shopping is not the main reason for being at the airport. To encourage people to buy in a place they are not primed to, products need to be visible, well-lit, and appealing.

60% of space should be reserved for shopping while the other 40% is for cafes and restaurants. Retail space is usually 700-1000m$^2$ per million annual passengers. The FAA suggests 350m$^2$ per million annual passengers for restaurants. 20-40% of that space is used for seating inside the restaurants.

### BAGGAGE CLAIM AREAS

The halls need to be close to the airside road system to easily move bags to the carousels. It also needs to be close to the landside so the walk from the hall to the arrival's hall is not too long.it is important to provide currency exchange and toilets in the area.

The reclaim hall area should be approximately 9 m$^2$ per meter of claim frontage, to include storage of bag trolleys, lost bag facilities and airline offices.

There should be about 12m between each carousel. The IATA says passengers should wait a maximum of 12 minutes for their bags. The size of carousel frontage depends on the size of aircraft. The A380 requires between 75-90 meters of frontage. It is best if bags start arriving before passengers' clear customs and immigration.

### ARRIVALS HALL

The arrivals hall should allow easy exit and essential facilities such as currency exchange, meeting points, hotel and tourism bookings, car hire, ticketing, cafes, flight information, phones, and car parks. Sizing requirements are like check-in halls where the long queues will be formed by people meeting arriving passengers.

### AIRLINE OFFICES

Offices are required for cabin service and personnel, aircraft line maintenance, managerial offices, flight operations, flight crew and cabin staff, secure and volatile storage. Some airports have separate buildings for these uses.

## PARKING

Airport parking is not only necessary, but also big business. Parking accounted for 18% of airport revenues in the US in 2007.

### SHORT TERM PARKING

Usually charged by the hour. Meant for people dropping or meeting arriving passengers. These users want the parking to be close to the building so bags do not have to be carried a long way. If they do, they tend to wait on the curb and cause delays. The area for this kind of parking does not need to be large as people do not stay for long. As single space will serve about 1000 cars a year. Long term parking may serve only 250.

### PREMIUM PARKING

This is a way for airports to generate more revenue from better parking spot or parking service such as valet parking, shaded parking or even car detailing.

## AIRCRAFT

The following figures detail various aircraft sizes.

In Figure 49 the largest currently flying aircraft are shown. Of these only the Boeing 747 and Airbus A380 need apply. Both aircraft are Code F aircraft and have their own standards to follow if they need to be accomodated. However, today airlines are phasing large aircraft out in favor of smaller, more effieceint aircraft like the Boeing 777-9X and Airbus A350.

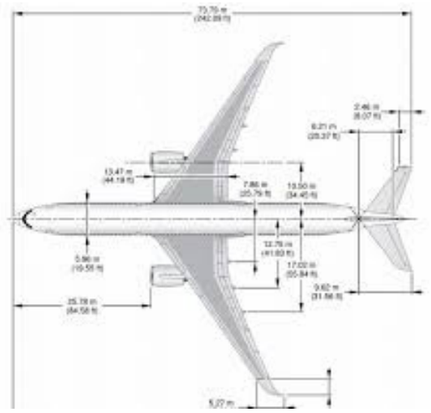


**Figure 45** Airbus A350 Dimensions

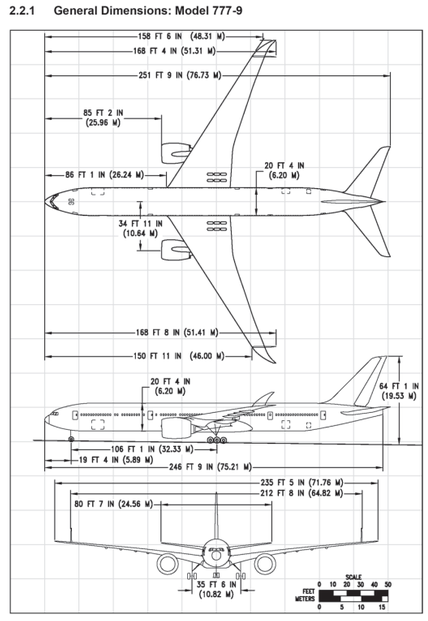



**Figure 46** Boeing 777-9X Dimensions

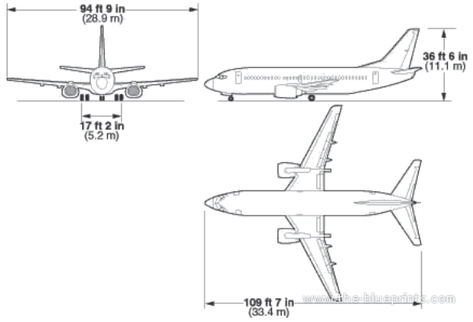



**Figure 48** Boeing 737-300 Dimensions

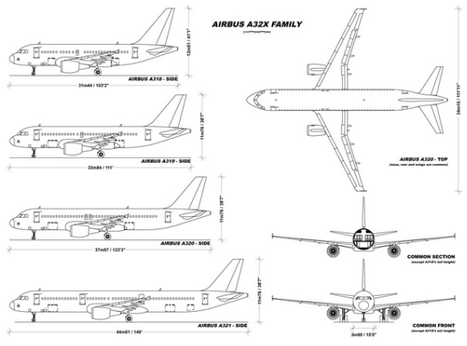



**Figure 47** Airbus A320 Family Dimensions





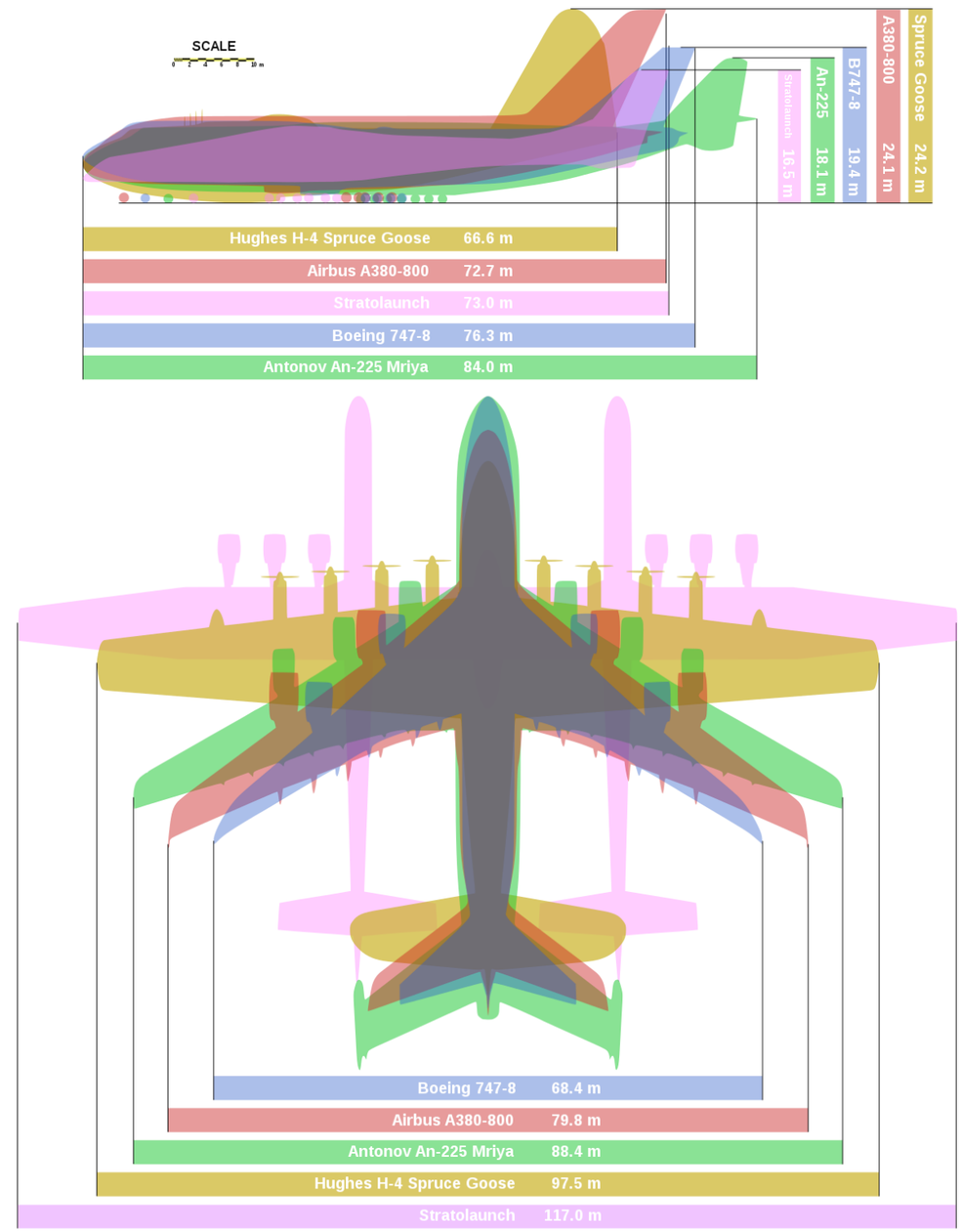



**Figure 49** Largest Flying Aircraft

# PART 5
## PROGRAM

## PROGRAM DESCRIPTION

The program is derived from the programs of the airport case studies in addition to generic data from airport design manuals and airport operations books. It is designed to suit the sites context and Al Ain's customs and traditions. It also complies with the GCAA's requirements for security, space, and circulation.

During research it was made clear that since the airport building is a relatively new type of build that is quickly evolving with changes in technology, there are many spaces that cannot have a standard applied to them as any standard would vary widely with location, cultures, values, budgets and other factors. The best thing to do to is to use what works. This is why studying the programs of the different cases was so important and it gave insight in to how much space is needed where standards cannot help. Nevertheless, some spaces do have standards and best practices which are applied.

## CALCULATIONS DESCRIPTION

The program has been calculated by first generating a full program for each of the airports used as a case study. Maps for each airport were downloaded from the respective airport authority websites and stitched together to get complete maps. These maps were them moved to a BIM program where they were traced over. Once traced over, information was added to the spaces generated to get areas by the type of space. Finally, schedules were created that contained all the information generated.

Once this was complete, the data gathered was moved and combined with standards and a resultant area per peak hour passenger and per gate was generated. Next these numbers were used to generate a rough program for this project. Finally, the numbers were tweaked to ensure they met all requirements and made sense.

The finalized program is shown next as a table and as a treemap that shows the spaces required by proportion. A program matrix shows the relationship between the spaces.



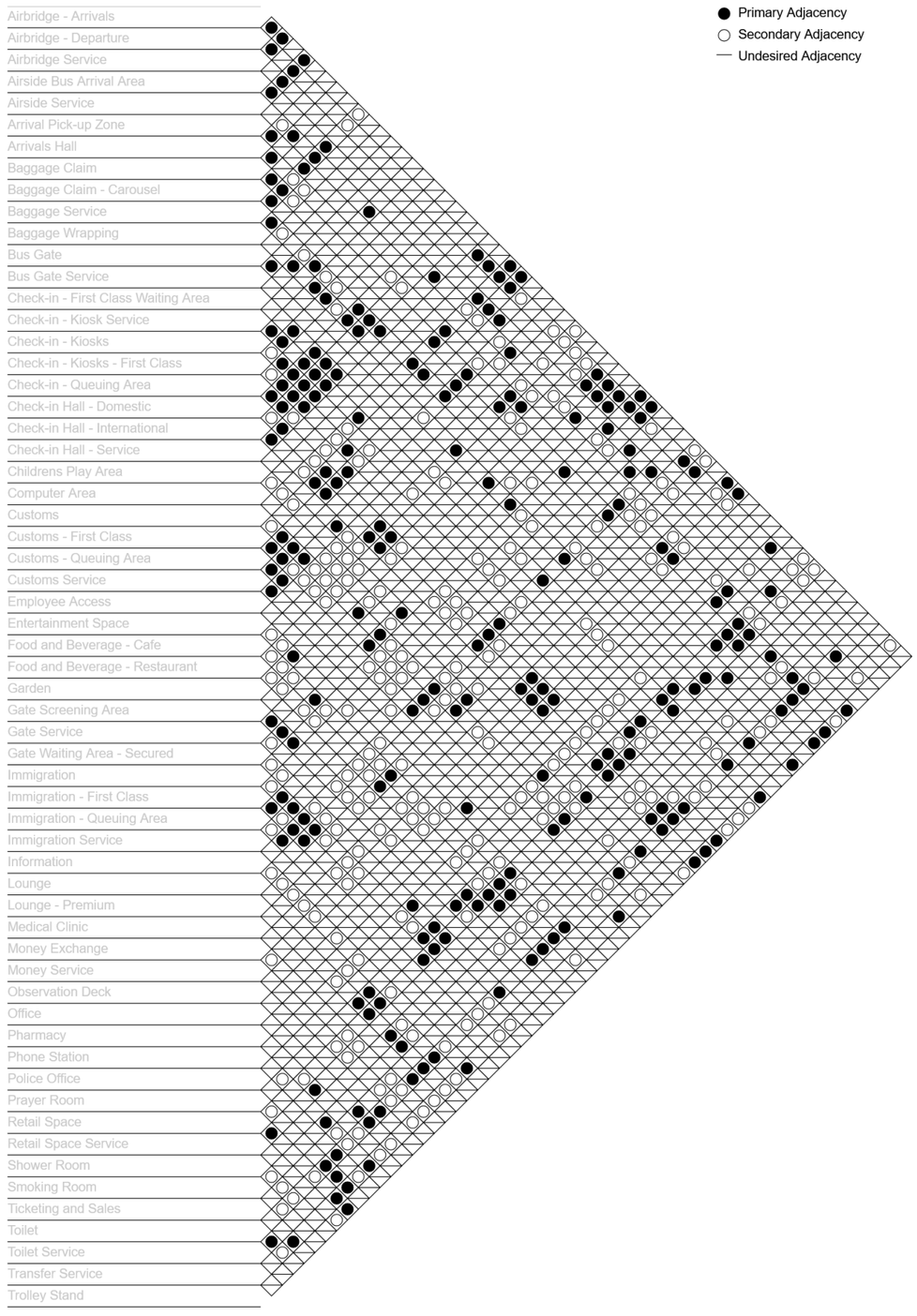


| Space | Average Area | Space Total | Space Count | Zone | Comments |
|---|---|---|---|---|---|
| Airbridge - Arrivals | 350 | 5600 | 16 | Airside | Includes Pier Area |
| Airbridge - Departure | 350 | 5600 | 16 | Airside | Includes Pier Area |
| Airbridge Service | 70 | 1120 | 16 | Airside | Adjacent to Airbridge |
| Airside Bus Arrival Area | 200 | 200 | 1 | Airside | On Ground Level |
| Airside Service | 47000 | 47000 | 1 | Airside | On Ground Level |
| Arrival Pick-up Zone | 6000 | 6000 | 1 | Landside | External |
| Arrivals Hall | 5000 | 5000 | 1 | Landside | Adjacent to Curb |
| Baggage Claim | 6000 | 6000 | 1 | Landside | Adjacent to Airside and Close to Arrivals Hall |
| Baggage Claim - Carousel | 250 | 1000 | 4 | Landside | |
| Baggage Service | 2700 | 2700 | 1 | Landside | Adjacent to Baggage Claim |
| Baggage Wrapping | 25 | 50 | 2 | Landside | Easy access for late passengers |
| Bus Gate | 150 | 300 | 2 | Airside | On Ground Level |
| Bus Gate Service | 25 | 50 | 2 | Airside | Adjacent to Bus Gate |
| Check-in - First Class Waiting Area | 1000 | 1000 | 1 | Landside | |
| Check-in - Kiosk Service | 100 | 300 | 3 | Landside | |
| Check-in - Kiosks | 265 | 795 | 3 | Landside | |
| Check-in - Kiosks - First Class | 110 | 110 | 1 | Landside | |
| Check-in - Queuing Area | 330 | 1980 | 6 | Landside | |
| Check-in Hall - Domestic | 1000 | 1000 | 1 | Landside | |
| Check-in Hall - International | 7000 | 7000 | 1 | Landside | |
| Check-in Hall - Service | - | 260 | - | Landside | |
| Childrens Play Area | 200 | 400 | 2 | Airside | |
| Computer Area | 120 | 360 | 3 | Airside | |
| Customs | 460 | 920 | 2 | Government Controls | |
| Customs - First Class | 200 | 200 | 1 | Government Controls | |
| Customs - Queuing Area | 500 | 1500 | 3 | Government Controls | |
| Customs Service | 40 | 240 | 6 | Government Controls | |
| Employee Access | 50 | 100 | 2 | Government Controls | |
| Entertainment Space | 140 | 420 | 3 | Airside | |
| Food and Beverage - Cafe | 90 | 1800 | 20 | Airside + Landside | 16 located in secured gate areas |
| Food and Beverage - Restaurant | 160 | 2080 | 13 | Airside | |
| Garden | 320 | 320 | 1 | Airside | |
| Gate Screening Area | 150 | 2400 | 16 | Airside | |

| | | | | | |
|---|---|---|---|---|---|
| **Gate Service** | 80 | 1280 | 16 | Airside | |
| **Gate Waiting Area - Secured** | 800 | 12800 | 16 | Airside | |
| **Horizontal Circulation** | - | 25500 | - | Airside + Landside | |
| **Horizontal Circulation - Travelator** | 175 | 1400 | 8 | Airside + Landside | |
| **Immigration** | 775 | 1550 | 2 | Government Controls | |
| **Immigration - First Class** | 90 | 90 | 1 | Government Controls | |
| **Immigration - Queuing Area** | 1500 | 3000 | 2 | Government Controls | |
| **Immigration Service** | 205 | 410 | 2 | Government Controls | |
| **Information** | 70 | 350 | 5 | Airside + Landside | |
| **Lounge** | 230 | 1150 | 5 | Airside | |
| **Lounge - Premium** | 5200 | 5200 | 1 | Airside | |
| **Medical Clinic** | 190 | 190 | 1 | Airside | |
| **Money Exchange** | 35 | 140 | 4 | Airside + Landside | |
| **Money Service** | 25 | 150 | 6 | Airside + Landside | |
| **Observation Deck** | 3000 | 3000 | 1 | Landside | |
| **Office** | 15 | 750 | 50 | Landside | |
| **Pharmacy** | 45 | 45 | 1 | Airside | |
| **Phone Station** | 10 | 60 | 6 | Airside + Landside | |
| **Police Office** | 100 | 100 | 1 | Airside | |
| **Prayer Room** | 150 | 750 | 5 | Airside + Landside | |
| **Retail Space** | 130 | 5200 | 40 | Airside + Landside | Majority Airside |
| **Retail Space Service** | 145 | 725 | 5 | Airside | |
| **Service** | - | 12000 | - | Airside + Landside | Majority Airside |
| **Shower Room** | 330 | 330 | 1 | Landside/Airside | Depends on users |
| **Smoking Room** | 100 | 200 | 2 | Airside | |
| **Ticketing and Sales** | 40 | 80 | 2 | Landside | |
| **Toilet** | 135 | 3240 | 24 | Airside + Landside | 16 in secured gates |
| **Toilet Service** | 35 | 840 | 24 | Airside + Landside | |
| **Transfer Service** | 400 | 400 | 1 | Airside | |
| **Trolley Stand** | 20 | 200 | 10 | Landside | |
| **Vertical Circulation - Elevator** | 30 | 600 | 20 | Circulation | |
| **Vertical Circulation - Escalator** | 50 | 1000 | 20 | Circulation | |
| **Vertical Circulation - Large Stairs** | 30 | 480 | 16 | Circulation | |
| **Waiting Area** | - | 1400 | - | Airside + Landside | Depends on Requirements |
| **Total** | | **187015** | **450** | | |

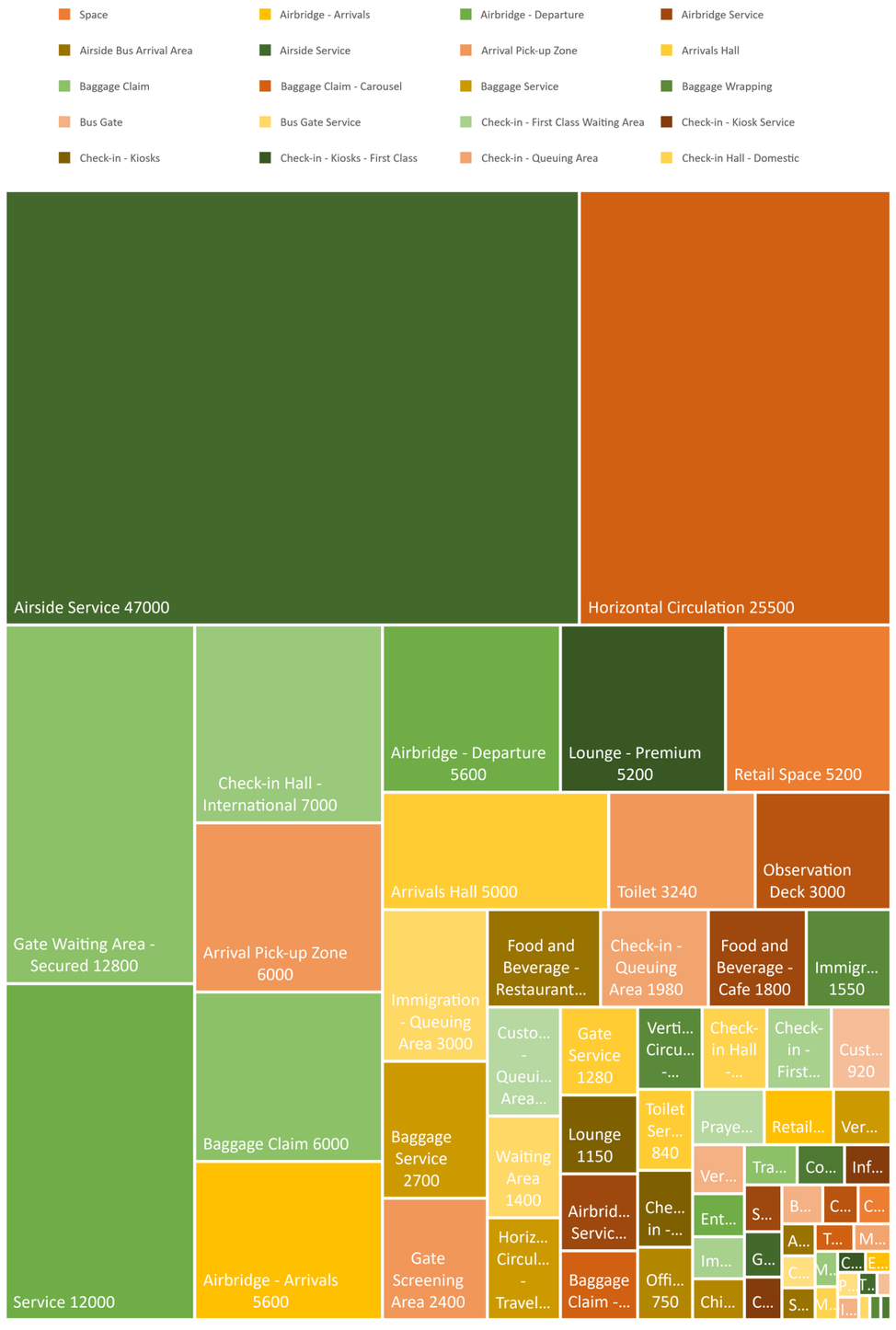






PROGRAM

## Program Areas - Tree Map



# PART 6
## CONCEPT

# DEVELOPING PREMISE

The project is an airport terminal. The client, Abu Dhabi Airports Company (ADAC) needs a new airport to place the ageing Al Ain International Terminal. As an Abu Dhabi Company and government entity ADAC will require the airport to be a state-of-the-art facility even though it might not be their flagship facility. It holds a special place in the company's portfolio of airport because it is located in Al Ain, the home of the UAE ruling family and plays a role as a military base making it among the most important airports in Abu Dhabi and the UAE.

The new terminal will be an exciting addition for the residents of Al Ain. At the moment, Al Ain International serves only five destinations. A total of 14 flights with 4000 passengers a week. If travelers wish to travel to other destinations, they are forced to make a long trip to a different airport in the UAE making their trips more stressful. The development of a new terminal could be the catalyst needed to expand international travel in Al Ain. However, it must be recognized that that alone will not be enough to get airlines to add routes to Al Ain. As such, even if the terminal cannot increase the number of destinations, existing users will still get a more modern, and user-friendly airport out of the project. One that will be designed for travel in the 21st century and accommodate passengers needs now and into the future.

My goal is to create something that first and foremost solves the major issues facing any airport project. That is to reduce walking distances and aircraft manuevering as much as possible.

In terms of passenger experience, I want the terminal to evoke a sense of awe and amazement on arrival to the terminal, whether it be from the land or airside. In other words, from the outside the terminal will look futuristic. However, once inside the terminal needs to function as a space that can quickly and efficiently get passengers to their destinations (gates or exit). Its focus will shift from awe-inspiring to calm and transparent. The materials used will feel solid and warm. Many airports go for very open, light, and airy feels because it reflects the nature of flight. I find that the issue with this approach is that it can lead to

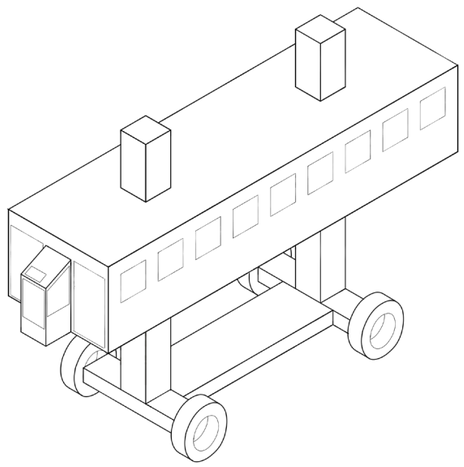


**Figure 50** A mobile lounge like one at Washington Dulles

uncertainty and a lack of a clear direction. In my research I have found example of airports that, through their use of materials, color and building element placement make the place feel calmer and less anxiety inducing.

The challenge will be combining both aspirations into one cohesive and functional terminal building. In addition, the question of whether the form will be organic, angular, or clean and straight will be decided later in the design stage.

Passengers using the terminal buildings are

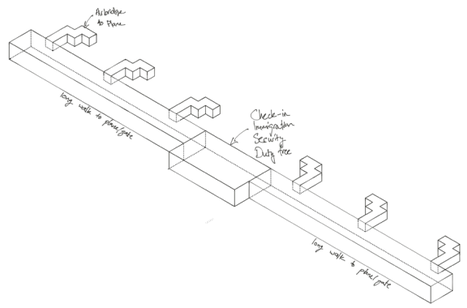



**Figure 51** A diagram showing the linear configuration with airbridges

usually arriving, departing, or transferring. At Al Ain International, transit passengers are unlikely due to its scale. They will be kept in mind during the design process to maintain flexibility for future expansion.

Arriving passengers come from the sub-continent or the Arab World as those are the only destinations served now. They are typically quite reserved. They will however expect great things on arrival as the UAE is known globally for its world class architecture and aviation sectors. As a Muslim country, visitors will expect the airport to have certain facilities and amenities as prayer rooms. Some may expect a certain degree of segregation for men and women in places like customs and immigration. These will need to be accounted for.

I think this project suits me as a reserved and quiet individual. The projects most basic requirement is to have a reliable and controlled flow of people to and from their destination. In my design work I tend to lean more towards planning and making sure the system works than trying crazy organic forms they may or may not work. I do realize the importance of an awe-inspiring form and will try to incorporate it, but it will be a secondary priority. The most important thing is making sure the goals of the project and the needs of the stakeholders are met.

The project will be in the area that was predetermined by 2014 ADAC masterplan for a new terminal for Al Ain International. The airport itself is located north of Al Ain City. The project site will expand past the limits defined by the 2014 master plan to incorporate the site of the current terminal and some additional area.

Al Ain is green, sandy, rocky, and mountainous all at the same time. The city is quite toned down compared to other cities in the UAE like Dubai, Sharjah and even Abu Dhabi. That is one its best attributes and the reason so many people choose to live there. The lifestyle is quiet and laidback. This is reflected on the current, low transit rates of Al Ain International. At the same time, Al Ain is a part of the Emirate of Abu Dhabi and as such modern and futuristic architecture has its place in the city. At the entrance of the airport for example is a

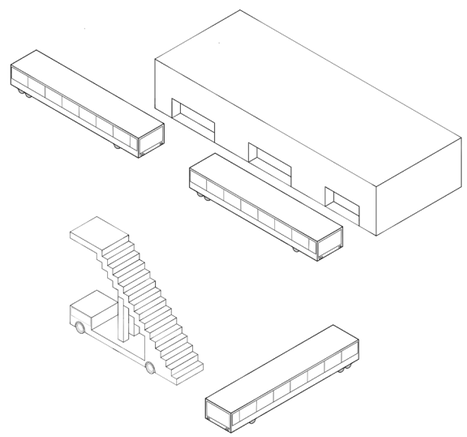


**Figure 52** A diagram showing how buses are used to transport passengers to their plane

beautiful futuristic sculpture of a supersonic aircraft like the concord. At the time when the airport was constructed, supersonic flight was the dream that had just come to reality. Today we have other aspiration that can be reflected in the architecture of the building.

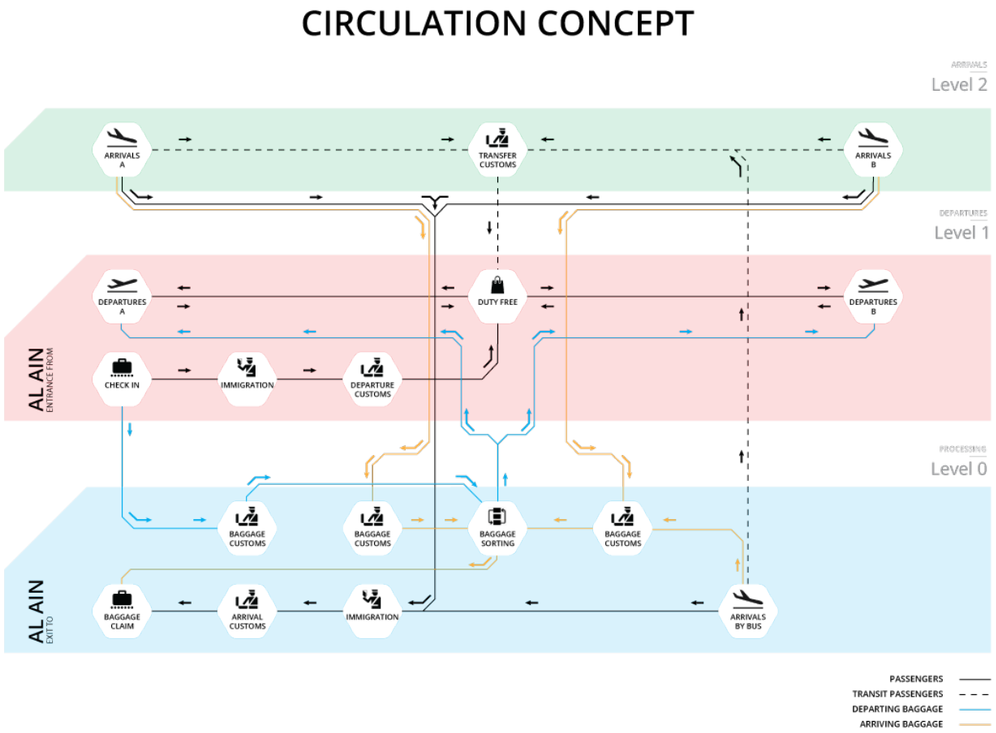
Again this reflects on my goal to have a futuristic looking terminal on the outside but one that turns calm and quiet once you enter to make it as easy and stress free as possible to get to your destination.

The project will be occupied 24/7 as airlines fly when it is most convenient and cost effective for them. The airport will experience more traffic in the typical holiday seasons and during the Hajj and Umrah seasons when more airlines tend to fly from the airport to fill demand.

The current airport was built in 1992 and is in serious need for a renovation to keep the UAE's image of an architecture and aerospace powerhouse. The old building does not have the significance of buildings like Bateen Mall and the Abu Dhabi Bus Terminal which are architectural icons of Abu Dhabi. As such the need to modernize trumps the need to preserve history.

As it will be built in the UAE, no cost should be spared. In addition, the fact that it is being built where the ruling family originates the terminal should lean towards to the more luxurious side. In addition, it is an aspiration

**Figure 53** Circulation Concept








of mine to try and bring back the 'glory days' of flying when it was reserved for the rich but bring that experience to your average Joe. As the industry progressed from those day, flying became cheaper and cheaper until it became a chore. It went from an experience worth having to an experience dreaded by most. That has a lot to do with the planes themselves, but I also believe it can be countered by building luxurious airport terminals.

The program is like programs from past projects in terms of circulation requirements. The current program will be stricter in controlling the flow passengers. Which leads to a stark difference from past projects which is the requirement to fulfill immigration and security protocols. In addition, the site is different because if the military presence in the area.

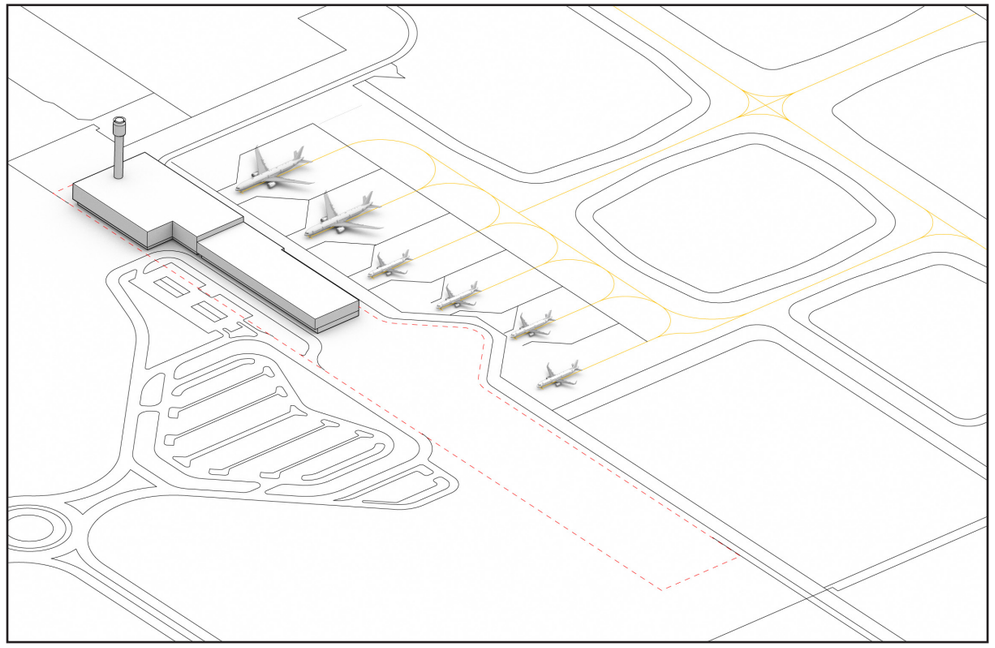
The biggest difference will be the users. In the past all users have wanted to be at the building and even further, wanted to spend time there. This changes for airports as most users what to spend as little time as possible there. They might want to be there, but only to leave on a plane or get out as soon as possible.

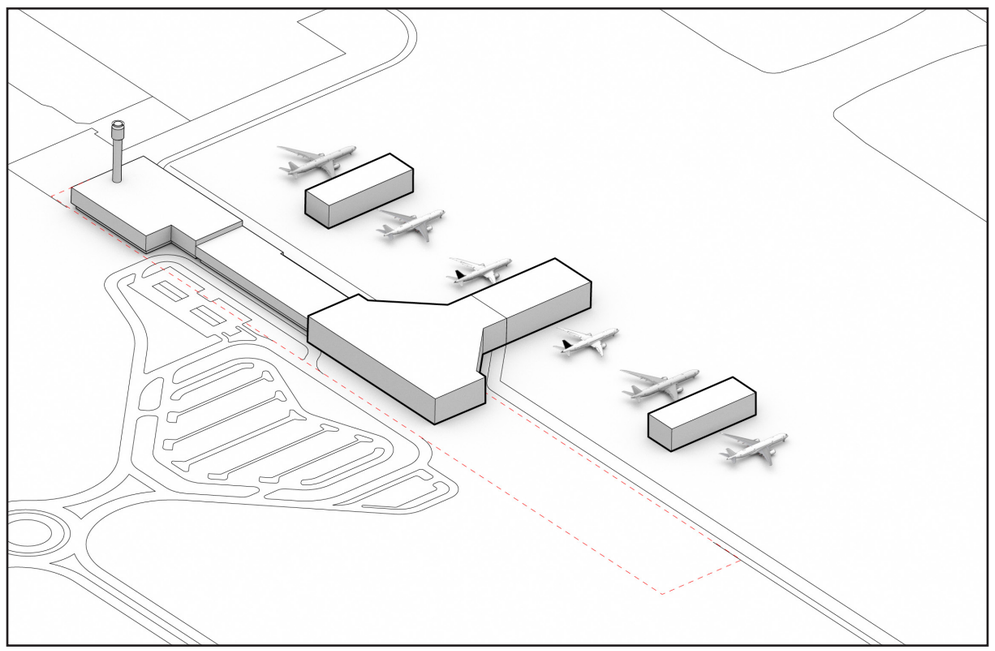
### CIRCULATION CONCEPT

The concept for the circulation of people and baggage seen in the diagram below (Figure 53) is derived from contextual and cultural elements on the site and the research done on airports built in the past few years. The diagram describes passenger and baggage movement throughout the project.

It attempts keep in mind the goal to reduce passenger walking distances and aircraft maneuvering and design to achieve these goals.

# THE MAIN CONCEPT









**SITE CONTEXT AND GOALS**

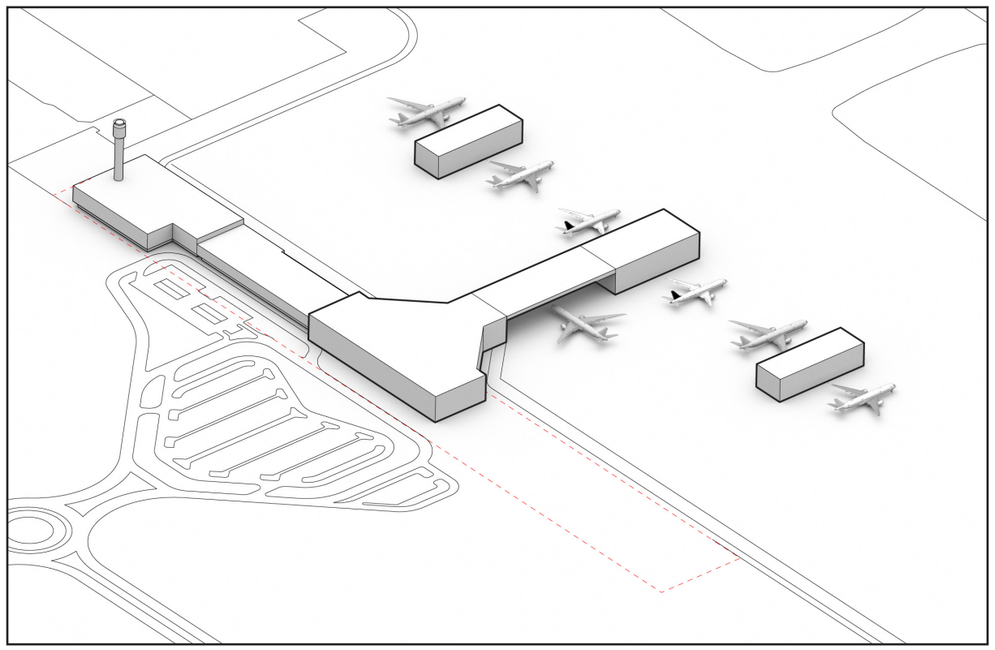
The concept begins with the site context and goal of building an airport passenger terminal that reduces walking time and reduces aircraft maneuvering.

The diagram shows the site as its right now with the current arrangement of the terminal and apron.

**MAIN TERMINAL & TRANSPORTER**

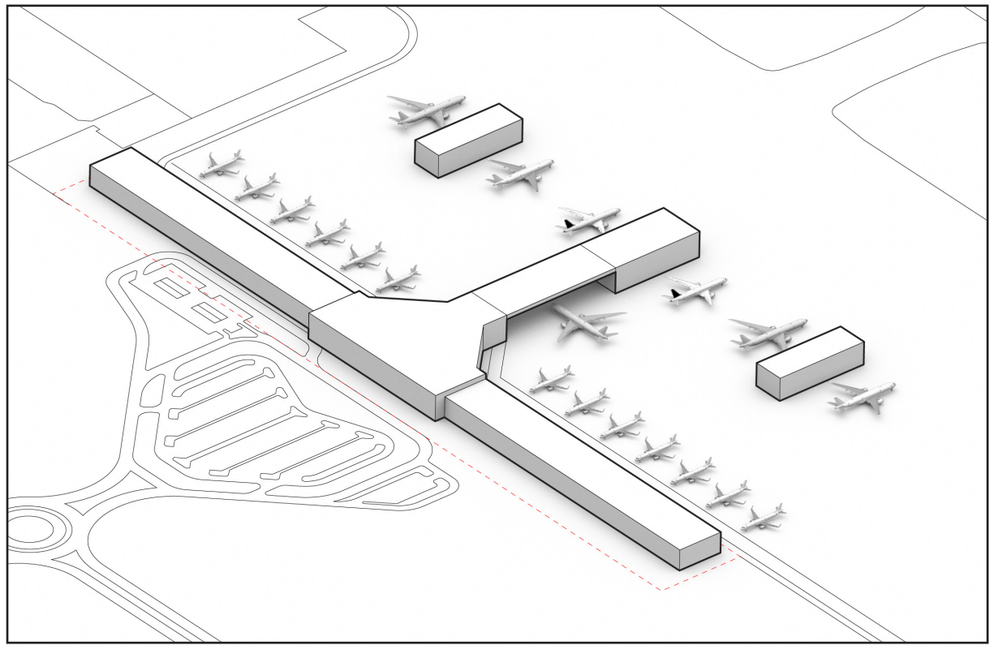
The central area of the site was extruded to create the mass for the main terminal building. This is where all common functions like check-in, immigration, customs and arrivals hall will be placed.

In addition, a mass is extruded ahead on the existing apron. This serves as a transporter hub where passengers ride a train underground to their plane, reducing walking time.



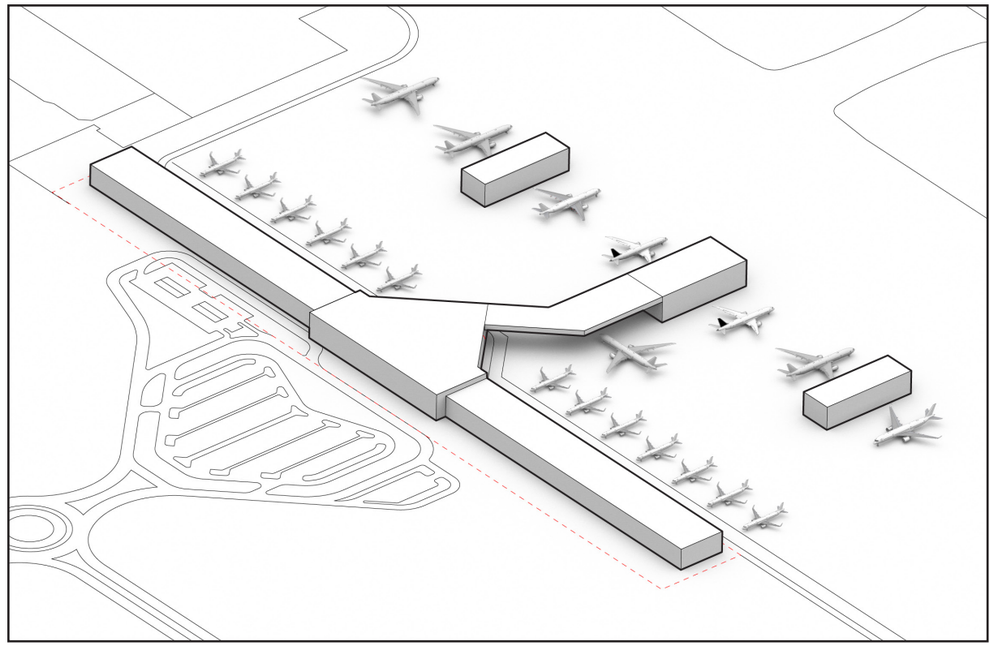
**MAKE WAY**

The transporter mass was pushed further out to make space for a taxiway which aircraft can use to make their way to the required gate. The advantage here is that on departure aircraft maneuvering is kept to a minimum.



**ADDITION OF LINEAR CONCOURSES**

Two wings were created on each side of the main terminal mass to house two additional concourses. These concourses will only serve small aircraft, keeping passenger walking to a minimum.



## OTHER CONCEPTS

### THE MOTHERSHIP CONCEPT

The concept of a mothership is pretty much universal in any futuristic vision or sci-fi story. These ships are essentially cities that are centers for craft to land and take off. In addition, they are places that have all the facilities people would need to live luxurious and comfortable lives. These ships are dreamed to float in the sky and rarely if ever land on the ground.

### THE DELTA WING CONCEPT

The form of the delta wing could be used as a repeating pattern for design elements at the airport. They can be used as to shape the form of the roof. They can inform the shape of:

- The overall shape of the concourse
- The shape of the form over the piers

**Figure 54** A mothership from Star Citizen





### SPACE TO TAXI

The transporter masses are shifted sightly to make space for a full loop for taxiing aircraft. This has the added benefit of adding a bit of flare to the basic mass.

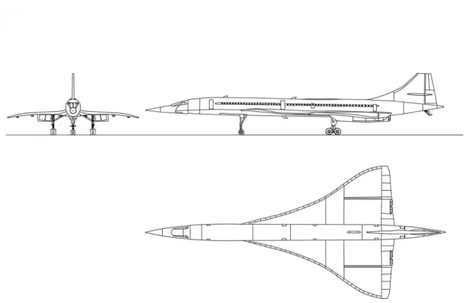
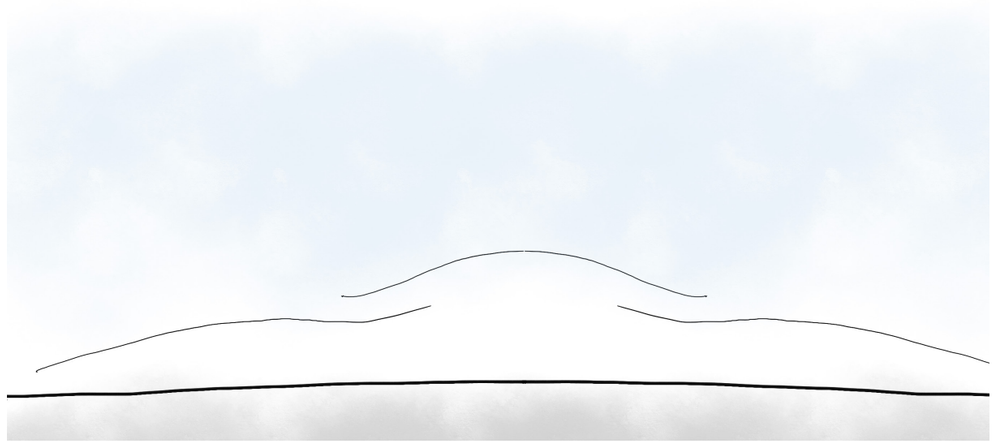


**Figure 55** Ideas of form stemming from the delta wing of the concord.



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