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ABSTRACT

Cox bazar international airport is a huge proposed project by the government handled by the civil aviation authority of Bangladesh to provide the international standard facilities to the incomers. The whole master plan of the international airport aims to be finished by 2030 where the international terminal is a major part of the project. The air terminal is in procedure of being moved up to a worldwide airplane terminal, with a specific end goal to pull in more vacationers, which will make it the fourth global air terminal in Bangladesh. Due to the geographical location and tourism characteristic of the area there is a continued air traffic growth that encourages Cox bazar international airport to be design more appropriately and equipped with better facilities. Therefore this dissertation plans to give a reasonable vision to its pursuer about the significance of another air terminal with the developing air activity and load business in the current financial circumstance of Bangladesh. It additionally concentrates on the parts and elements of an air terminal, comprehends the working arrangement of the entire aviation industry, characterises the engineering of terminal in sequential request and tries to look at the effect that it will bring about on the urban fabric of the encompassing zones. Necessary data including site analysis, climatic statistics and other information has been collected from different relevant primary and secondary sources and they were analysed using the average index. The basic aim of the project is to create a futuristic and innovative design using the contemporary modern ideas and techniques which will make the terminal and its master plan area more functionally efficient for the users and the workers as well as add a value to Bangladesh infrastructures.And Cox Bazar airport has been proposed to fulfil the demand.

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Chapter_01: Introduction and Project Background

1.1_Introduction

Airports are places of huge human drama. The more one experiences, the more one is convinced that these structures are a secret city, with its own history, folklore and mythology. But what has surprised till date is that everyone seems to think they are plugged into something majestic.

Tony Parsons

Flying was a fantasy and it started with a creative energy. Individuals were constantly intrigued about flying and it thinks about their artistic creations, representations and compositions. The advancement of air transportation framework lead to the development of the new kind of building structure called airplane terminal.

Bangladesh inherited the leftover wealth and resources, severely damaged during the Independence War, of the territorial office of the Pakistan DCA. It then effectively raised its status to a full-fledged organisation of a sovereign state. Throughout the years, the infrastructure and facilities have been developed to meet the demands of the time, befitting the necessities of an independent State. After that two more airport was build and the fourth one is the proposal of coz bazar international air terminal as it is an attempt to meet the demand of country's growing need,to increase the economy of the country and to provide facilities of international standards to make it a new transit hub of south eastern Asia.

The city of Cox bazar encasing the largest natural sandy beach is one of the largest tourist attraction of bangladesh. Till date it is being one of the biggest tourist spot which receives a huge number of visitor every year and the rate is eventually

increasing day by day (Tourist ministry of Bangladesh). Due to the increasing number of tourist barging in and out, it has become a necessity and a mandate to provide adequate air transport facilities at that area. In keeping with this policy, the GOB approved the Cox's Bazar' Special Development Project which aims to contribute to the international development by attracting new tourist and investments to Cox's Bazar. The focus of the project is to contribute to the country's national promotion of the tourism industry. An essential element for the development of the corridor into an industrial/tourism center is the improvement of air transportation facilities.

The paper covers the advancements and evolution of airplane terminals, some intriguing contextual investigations, brief review of the technical elements of present day air terminals through case study, the investigations of planning and organisation required for an air terminal, schematic charts and the issues to be taken in thought which are important to venture into the building configuration of modern universal air terminal.

1.2_Project Specification

Project Name:	Cox Bazaar International Airport
Location:	Current domestic airport site at Cox Bazar
Client:	Civil Aviation Authority of Bangladesh
Funded by:	Bangladesh government and China
Area: (master plan)	1580 acre
(airport area)	901 acre
Date of completion:	Undetermined (expected date 2030)
Location:	150km south of Chittagong
Cox bazar town area:	6.85 km2
Height from sea level:	3km (max)
Bounded by:	Bakkhali river (north & east), Bay of Bengal (west), Jhinaidah (south)

Location of the site from a broader view to the site boundaries

1.3_Project Background

1.3.1 History and Development:

- Cox's Bazaar airport was first built during the 2nd world war with a land of 219 ZXc./CCCacres. It becomes an important domestic airport in Bangladesh.
- In 1956, It started operation as a domestic airport. It was partially destructed in the liberation war in 1971.
- In the end of 1973 It again commence it operational activity after completion of renovation work. After 1991, Bangladesh enters in the era of free market economy.
- Consequently sky was open for all. With new law, private air operator come forward to obtain AOC and started commercial packs/cargo flight to the dom. and int. route.
- Until the year 2000, Biman Bangladesh airlines was the only air operator at Cox's Bazaar airport which had operated commercial passenger flight with a 3 or 4 flights per week.
- Besides a number of air cargo operators have carried hatched fish to the southern part of the country over a decade.
- Suddenly in March 2012 Biman Bangladesh air lines had stopped it flight to coxs. Despite that occurrence , United, Regent& Novo air are doing business here.
- Three air cargo operator with five aircraft are running the cargo flights to the Cxb-Jsr-Ctg-Cxb route.

1.3.2 Proposed Project :

The proposal of the entire plan of Cox bazar airport is divided into 3 phases to be developed gradually. The 3 phases are decided as follows-

Phase_ 1

The proposal of the project in the 1st phase deals with the upgrading and extension of the runway. This includes increasing its length so that the aircrafts used for international flights can land safely, upgrading the current airport standards.

Phase_2

In the long run the domestic airport would be converted into an international airport. Therefore the second phase deals with the terminal building itself. The terminal building is expected to survive the visitors with proper facilities, comfort and ease.

Phase_3

The whole master plan of the cox's bazar airport is proposed to be completed that includes has functions correspondent to the terminal building such as hotel, commercial complex housing and so on discussed in the later sections.

1.4_Aims and Objectives of the Project

- The objectives of this project is to provide with a fully functioning airport, ensure infrastructural growth and provide with recreational enhancement.
- To provide a domestic and international terminal that serves the purpose and meets the international standards as well as to facilitate all the international tourists with all the international standard facilities
- Design the terminal to be easily expanded in the future when necessary.
- Create a more humanistic, more convenient and more thoughtful environment for

  passengers
- To provide adequate air transport facilities and separate cargo facilities to increase the economy of the country.
- To provide a practice field for the air force.
- To increase the regional development.
- To increase the export growth.
- To increase the employment.
- To attract more tourists towards the city of Cox's bazar to enjoy the largest sea beach in the world.
- To design a landmark for the area as well as for the country.

1.5_Given Programs

Entrance/Concourse	Custom check
▪ Surface parking ▪ Entry ticketing space ▪ Lobby space ▪ Waiting space ▪ Fast food shop ▪ Restaurant ▪ Phone booth ▪ Security office (Search) ▪ Bank ▪ Money exchange ▪ Hotel booking ▪ Rent a car	▪ Lost & Found ▪ Unclaimed baggage ▪ VIP lounge ▪ Baggage taking ▪ Baggage down area ▪ Baggage handle area
Information/Ticket check/ Passport check	Boarding
▪ Search ▪ Custom office ▪ Store ▪ Plant space ▪ Animal space ▪ Electronics ▪ Jewelry ▪ Drug store ▪ Stationary ▪ Red channel office ▪ Green channel office ▪ Stair, Lift, AHU ▪ Toilet ▪ Smoke space	▪ Shop ▪ Ticketing ▪ Restaurant/ first food ▪ Check in counter ▪ Stair, Lift, AHU ▪ Security checking ▪ Police station ▪ In change office ▪ VIP lounge (departure) ▪ VVIP loounge ▪ Gift shop ▪ Air line lounge (departure) ▪ Transit Facilities ▪ Boarding lounge ▪ Departure lounge

Chapter_02: Site Appraisal

2.1_Consideration For Site Selection

Factors affecting site selection:

- Regional plan: Should fit well into the regional plan - Form an integral part of the national network of airport
- Use of airport: Selection of site depends upon the use of an airport Civilian or military operations | During emergency | Should be such that it provides natural protection to the area from air raids.
- Proximity to other airport: Should be at a considerable distance from existing airports. Landing in one airport does not interfere with movement of aircraft at other airport. Required separation between airports mainly depends upon - Volume of air traffic, Type of aircrafts, Circling radius of largest aircrafts, Air traffic control.
- Ground accessibility: Fast and efficient access facilities for passengers and freight. Sites offering convenient road network is better than those with inefficient and inadequate transport system. Best when adjacent to main highway, quick access, availability of public transportation facilities qualifies its suitability. Passenger is more concerned with his door to door time rather than actual time in air travel. Time to reach airport is an important consideration especially for short haul operations.

- Topography: this includes natural features like ground contours trees streams etc. A raised ground a hill top is usually considered to be an ideal site for an airport.

- Obstructions: when aircraft is landing or taking off it loses or gains altitude very slowly as compared to the forward speed. For this reason long clearance areas are provided on either side of runway known as approach areas over which the aircraft can safely gain or loose altitude.

- Visibility: poor visibility lowers the traffic capacity of the airport. The site selected should therefore be free from visibility reducing conditions such as fog smoke and haze. Fog generally settles in the area where wind blows minimum in a valley.

- Wind: runway is so oriented that landing and take off is done by heading into the wind should be collected over a minimum period of about five years.

- Noise nuisance: the extent of noise nuisance depends upon the climb out path of aircraft type of engine propulsion and the gross weight of aircraft. The problem becomes more acute with jet engine aircrafts. Therefore the site should be so selected that the landing and take off paths of the aircrafts pass over the land which is free from residential or industrial developments.

- Grading, drainage and soil characteristics: grading and drainage play an important role in the construction and maintenance of airport which

in turn influences the site selection. The original ground profile of a site together with any grading operations determines the shape of an airport area and the general pattern of the drainage system. The possibility of floods at the valley sites should be investigated. Sites with high water tables which may require costly subsoil drainage should be avoided.

- Future development: considering that the air traffic volume will continue to increase in future more member of runways may have to be provided for an increased traffic.

2.2_Reasons For Recommending The Site

Criteria	Cox,Bazar
Availability of land	8000 acre
Density of population Almost	nil
Future expansion	Possible
Communication with capital city	Not Difficult
Standing Crops Crops	1 time
Distance from main city	8 KM
Land acquisition and rehabilitation	Easier due to less settlement
Road communication	Good
Land acquisition/ Status of land	To be acquired
Social Problem and Condition	Nil
International Air Routes	Closest to the site
Final Recommendation of location or BSMIA	Suitable

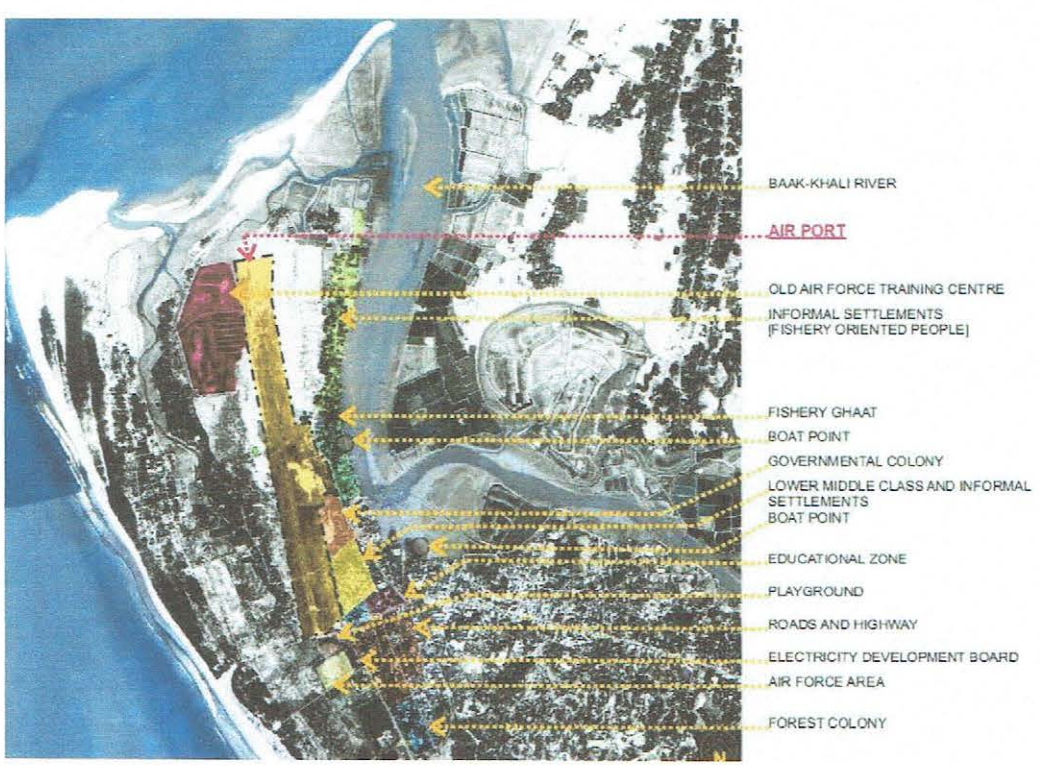
2.3_Site Briefing

The site is located at the northern most periphery of cox bazar, with the sea at its north and west sides and the Bakkhali river in its east side.

beyond the river, the ranges of mountains ascend and descends, hence the view of the site reveals the sea on its east and the mountain beside the Bakkhali river.

2.3.1_Existing Situation Of The Site And Surrounding

land use patterns reveal structures not more than 4 storey on the southern side and structures not exceeding 2 storey on the west side facing the river and the ocean. The structure on the north west side of the site will be cleared for the airport development program.



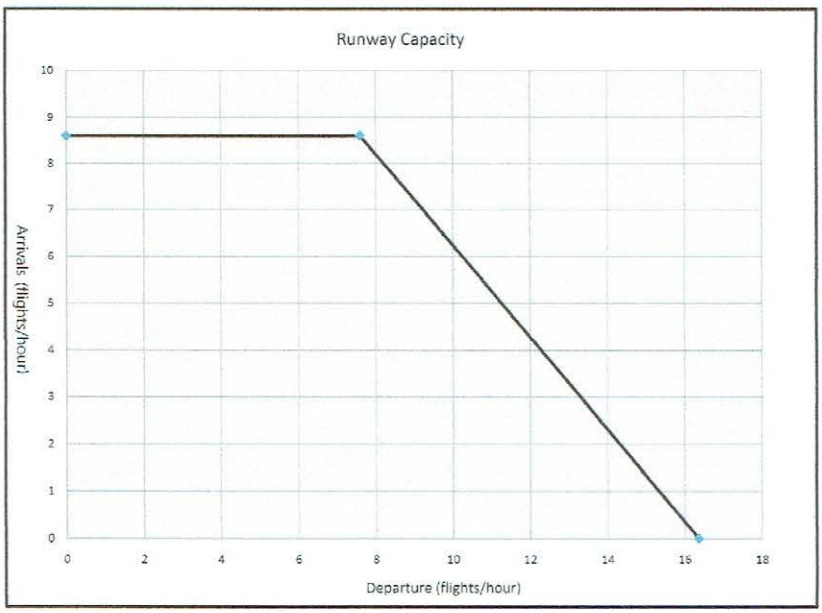
2.3.2_ Existing Airport Complex

The current airport complex consist of passenger terminal, cargo terminal, hangers, and a control tower.

All the functions are located on the east side of the airport running alongside the road and the runway and the apron/ aircraft parking is on the west side. the set back on the the north and south side is too limited.

2.3.2.1_Runway

Runway capacity is expressed by the hourly rate of aircraft operations of landing and departure. At present, CXB is simple single runway without parallel taxiway, but there are two exit taxiway liked apron directly. This layout should be increased runway occupancy time (ROT) for arrival and departure flight.Therefore, the runway capacity of the existing runway is assumed to be 16 operations per hour including both arrival and departure aircraft, based on the calculation with harris model. If annual capacity is considered, it may be 60,000 flights for year.As shown in Figure below, the existing runway will almost its capacity within 2035. However, the annual capacity of runway will be reached almost 65% of the year 2035, so that it is necessary to have plan to improve taxiway system from 2030.



Runway Capacity of CXB

2.3.2.2_Apron

The capacity of aircraft parking stands relates strongly to the ability of process flows of taxingfor spot-in /out, ground service procedure, passenger handling process as well as the size ofthe aircraft and type of flights (turnaround flight, long range flight or multiple stopping lights). This process flow is reflected to the stand occupancy time. Currently, the stand occupancy time at Cox's Bazar is between 30 minutes for the domestic turnaround flights and multiple stopping flights. At present, 6 park stands without boarding bridges for Code C Class are being used for the domestic flights, and these are including 5 cargo aircrafts which are stand for long time over 1 weeks. So actually, there is just 1 stands for domestic during all cargo aircraft are occupied on their apron.

The existing parking stands for the domestic flights will accommodate the maximum 4 flights including arrivals and departures for peak hour, the demand of the year of 2015.

2.3.2.3_Passenger Terminal Building

The passenger terminal building consists of various types of the subsystems such as check-in counter, passport control, waiting lounge, baggage claim area, etc. Among the subsystems, the capacity of the check-in counter is one of key elements to analyze the capacity of the passenger terminal building, because the requirements to increase the number of the check-in counters may cause the necessity of expansion of the terminal building floor area in many cases.

However, there is no international standard for checking capacity of passenger terminal simply, so the general criteria for long-term planning of passenger terminal is applied for analysis CXB terminal facilities.

Area Requirement for Peak Hour

Facilities Area Requirement for Peak hour (㎡)									
Domestic					International				
Level A	Level B	Level C	Level D	Level E	Level A	Level B	Level C	Level D	Level E
12.7	10.9	9.4	7.9	6.5	30.9	26.9	23.1	19.7	17

Terminal Capacity by Service Level

	CXB Passenger Terminal (585 ㎡)				
Service Level	Level A	Level B	Level C	Level D	Level E
Acceptable Passenger for Peak Hour (pax,/ hour)	46	54	62	74	90

According to above table, the existing passenger terminal can be handled maximum 90 passengers for peak hour. However, at present, it seems to be over the 74 passengers at peak hour in this airport considering maximum seat capacity, so that level is almost Service D.

2.4_Swot Analysis

Strength:

- Beside sea. Pleasant view
- Strong urban and economical impact
- Flat land
- Near to tourist spots- Location is ideal to some extent as resorts and other hotels are not too much far from the site
- Wind flow does not affect, runway on north-south direction
- The site is far away from the city center. So it doesn't create sound pollution in the city.
- There's an existing run way which will have to be developed so that can reduce the cost.

Weakness:

- Unplanned urban development
- Existing road is very narrow, Road network is very weak
- No proper parking
- It can hamper the wild life and nature to some extent.
- Climatic condition is sensitive- disaster prone area

Opportunities:

- Land available for acquisition
- High potentiality for tourism
- Can be used as a hub
- It will enhance the tourism in our country.
- Will help to improve the economy of the people of that area as well as the country.

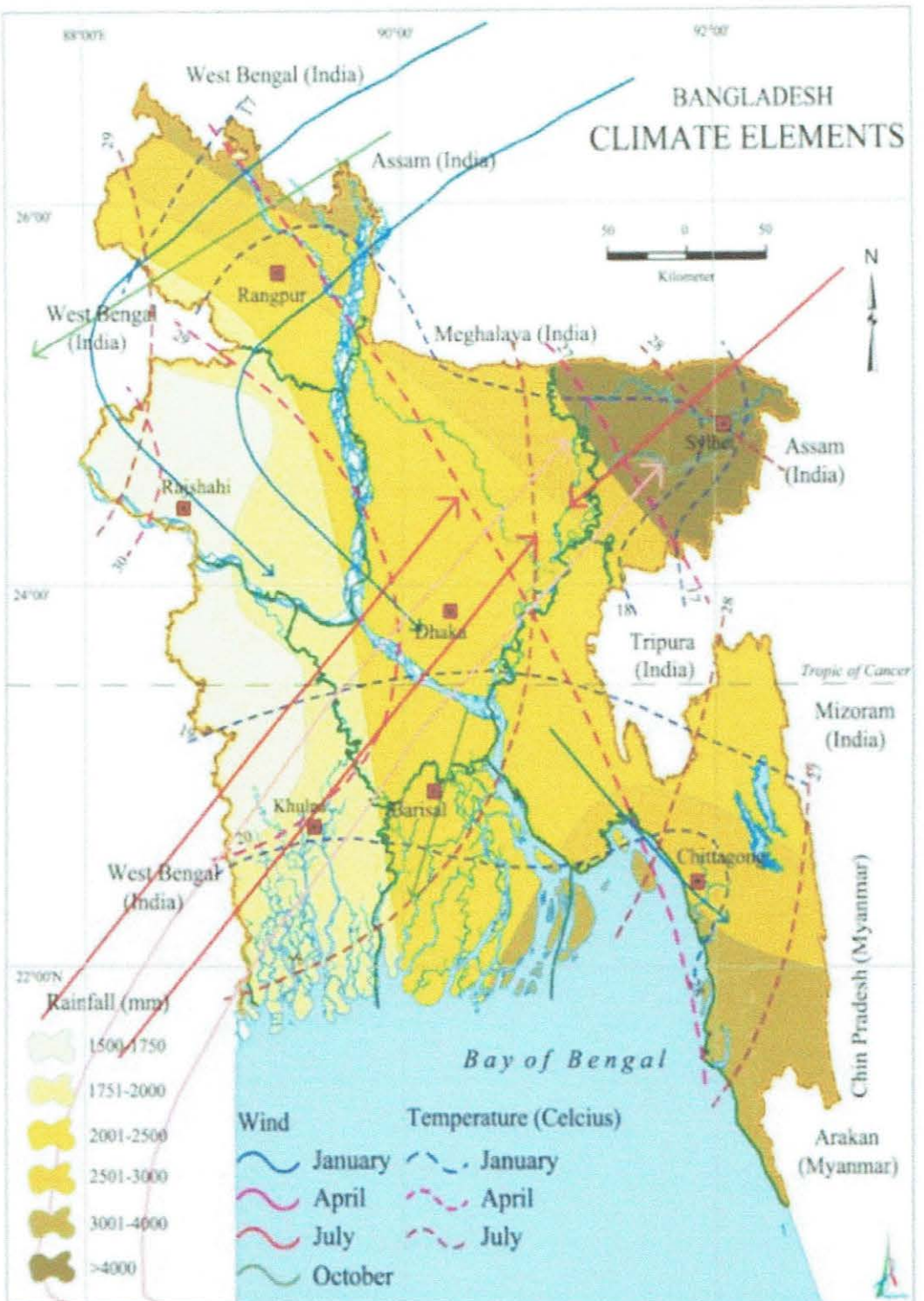
- Will reduce the load of international passengers from other existing international terminals.
- Will expand the export import business of the country.
- Can be a landmark of the city as well as the country.

Threats:

- Getting the land for local people may not be easy
- Can be a threat for the environment of that area - Ecology and environment may be harmed
- At the time of disaster there will a chance of not working properly.

2.5_Site Analysis

2.5.1_Wind Flow And Direction



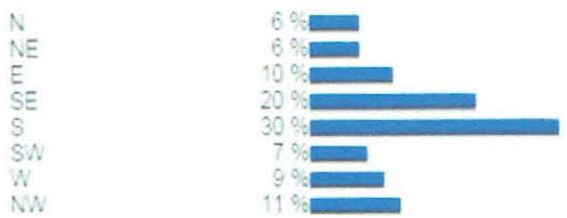
Wind-force per Day (January 2004 - December 2014)

Jan	Feb	Mar	Apr	May	Jun	
2.4	3.2	4.1	5.3	4.7	4.5	[kph]
77	82	83	86	87	74	Data availability[%]

Jul	Aug	Sep	Oct	Nov	Dec	
4.7	3.3	3.1	2.0	1.5	1.6	[kph]
87	87	87	82	90	79	Data availability[%]

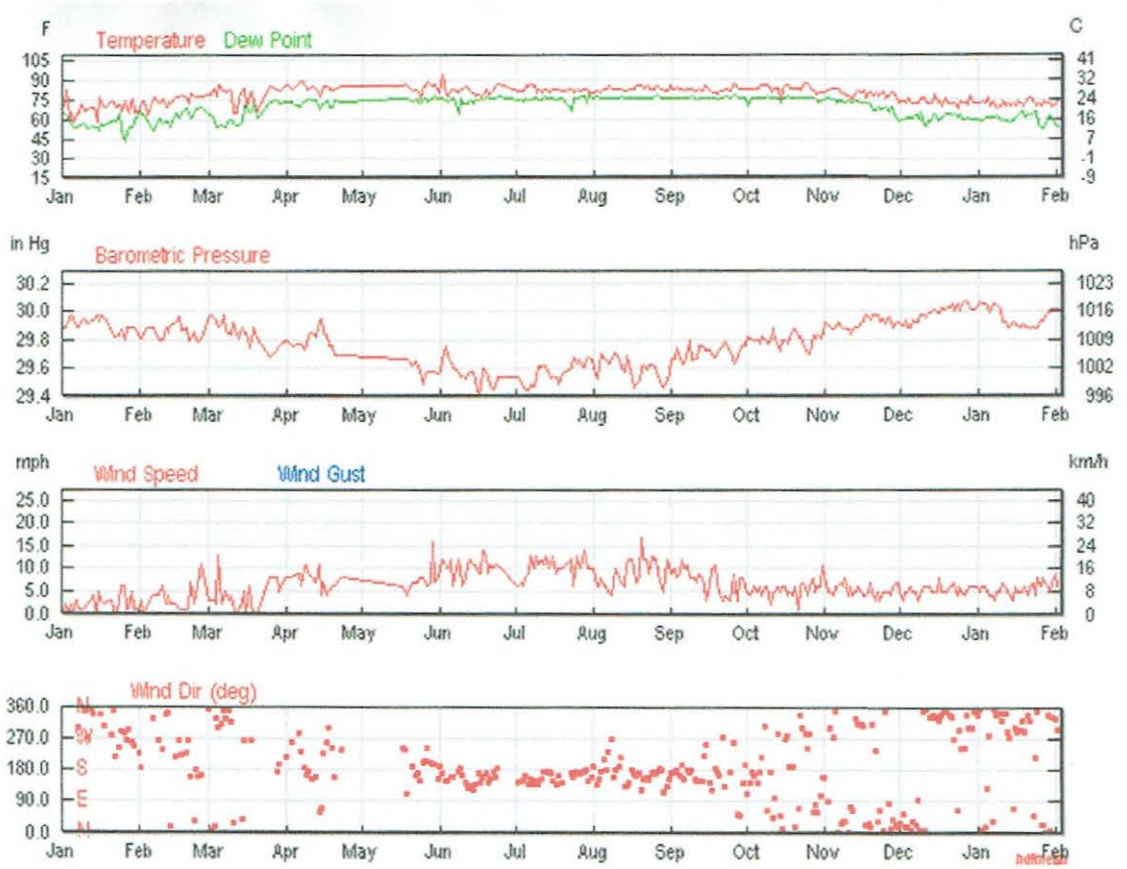
Averaged Value (January 2004 - December 2014) : **3.4 kph**

Wind-direction (January 2004 - December 2014)



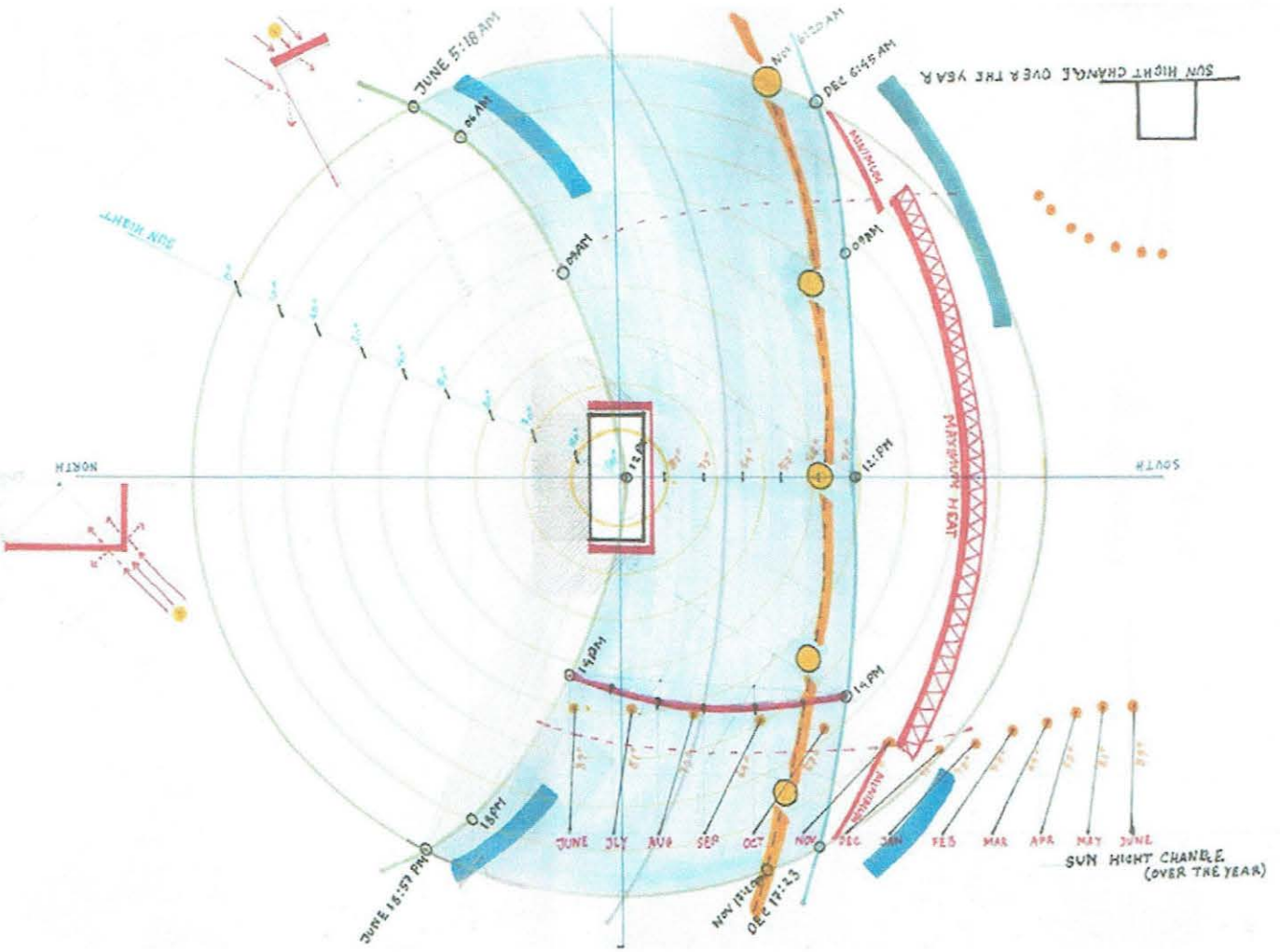
The study of wind flow and direction was a very important factor as structure and other architectural consideration was done based on it.Along with the wind flow factors that where considered are as follows:

- temperature
- barometric pressure
- wind speed



Source: Bangladesh Climate

2.5.2_Sun Path Daigram



As the site was located near the bay of bengal which had no natural shading the sun path and its angle of heat diagram was created to help solve the canopy in a efficient and sustainable way.

Chapter_03: Literature Review

3.1_General Overview Of Airport

Transportation structures are interesting applications of architectural design and of which airports are important and imperative types. Airplane terminal offer an architectural paradox . They're a portion of the greatest, most profoundly used and highly utilised open spaces on the planet, seen by millions amid occupied extends of time(Asli Apaydin,2007). An airport is an aerodrome with facilities for commercial aviation flights to take off and land (Shahadat,Ashanullah,2013).

A vital national resources. Airplane terminals are substantial, complex and by and large exceptionally beneficial modern ventures. They are a piece of a country's vital transportation foundation, which, other than giving a large number of occupations at the airplane terminal itself, underpins a much more extensive gathering of people in social and monetary terms. It has been assessed that for each occupation at the airplane terminal, an extra one is made in the district.They serve a key role in transportation of people and goods and in regional, national, and international commerce. They are where the nation's aviation system connects with other modes of transportation and where federal responsibility for managing and regulating air traffic operations intersects with the role of state and local governments that own and operate most airports. The Airport Cooperative Research Program (ACRP) serves as one of the principal means by which the airport industry can develop innovative near-term solutions to meet demands

placed on it.As large industrial complexes, airports consist primarily of: runways and taxiing areas air traffic control buildings aircraft maintenance buildings passenger terminals and car parks freight warehouses.

3.1.1_HISTORY AND DEVELOPMENT OF AIRPORT

Before airports

- From the 19th century up until the 1950s and 60s, almost all international travel was done by railroad or ocean-liner.
- Ports and railroad stations were major hubs. Victoria station in london, victoria harbour in hong kong. The port of shanghai, new york harbor, grand central terminal, union station, king's cross, paris gare du nord, victoria dock in melbourne; all names which were once as familiar to us today as united airlines, qantas, british airways, singapore airlines, and pan-american.
- We think that the golden age of travel, the era when international large-scale passenger transport was possible for the first time, was confined solely to smoke-belching trains and ocean-liners, but even in the 1910s, airplanes and airports were beginning to make a name for themselves. And this is their story.

3.1.2_DEVELOPEMENT OF AIRPORTS

The first air terminals were close to a building structure and a level ground for landing and departure. It was in 1920s the need of arranging an air terminal came into record with the expanding number of individuals utilizing the building. Airplane terminal soon turned into another structural building task. It is undeniably the very

first point of interaction for travelers arriving in a foreign country ,this is why air terminals are imperative in making the initial introduction of that nation or city. It is not only a building structure any longer.

After World War II, airport design became more sophisticated. Passenger buildings were being grouped together in an island, with runways arranged in groups about the terminal. This arrangement permitted expansion of the facilities. But it also meant that passengers had to travel further to reach their plane.

An improvement in the landing field was the introduction of grooves in the concrete surface. These run perpendicular to the direction of the landing aircraft and serve to draw off excess water in rainy conditions that could build up in front of the plane's wheels.

Airport construction boomed during the 1960s with the increase in jet aircraft traffic. Runways were extended out to 3,000 m (9,800 ft). The fields were constructed out of reinforced concrete using a slip-form machine that produces a continual slab with no disruptions along the length. The early 1960s also saw the introduction of jet bridge systems to modern airport terminals, an innovation which eliminated outdoor passenger boarding. These systems became commonplace in the United States by the 1970s.

3.2_Space Programming

The space programming period of terminal arranging looks to build up gross size necessities for the terminal offices without building up particular areas for the individual segments. The nature of the preparing segments is such, in any case, that estimated areas are shown for new and existing terminal offices due to the successive way of the preparing framework. This segment gives direction concerning the spatial prerequisites to enough oblige the few capacities did inside the different ranges of the airplane terminal (Horonjeff R., McKelvey S.X., eta al, 2010).

3.2.1_TERMINAL CURB

(Young,S.B,1994) The length of curb required for stacking and emptying of things and passenger traffic is dictated by the sort and volume of ground vehicle movement foreseen in the top time frame on the outline day. Air terminals with generally low traveler levels might have the capacity to suit both enplaning and deplaning travelers from one control front. Airplane terminals with higher traveler levels may think that its attractive to physically isolate the enplaning from the deplaning travelers, evenly, if space licenses, or vertically if space is restricted. There is a propensity everywhere airplane terminals to likewise discrete business vehicle activity from private vehicle movement.

The determination of the measure of control space which will be required is identified with air terminal approaches in respect to the task of needs to the utilization of control front and the procurement of arranging regions for taxis, transports, and other open transport vehicles. The parameters required for a preparatory examination of control front needs are the number what's more, sorts of vehicles at the control, the

vehicle length, and the different inhabitance times of various sorts of vehicles at the control front for arriving and leaving travelers. Typically, a space for a private car is thought to be about 25 ft, though for taxis 20 ft, limousines 30 ft, and travel transports 50 ft are utilized. Reported stay times for private cars range from 1 to 2 min at the enplaning control and from 2 to 4 min at the deplaning control. Taxi stay times lie nearer to the lower scope of these qualities, though limousines and transports might be at the control anywhere in the range of 5 to 15 min. These stay times are profoundly affected by the level of movement control and implementation in the region of the check, and ought to be confirmed in particular studies. Ordinarily a wide path, in the request of 18 to 20 ft, is given to suit direct control access, moving, furthermore, standing vehicles. This more often than not shows at least one furthermore, ideally two extra paths in the region of terminal passageways and ways out to give satisfactory ability to through movement. Dependable guidelines which might be connected to decide control front needs show that the full length of the control neighboring the terminal in addition to around 30 percent of the moving path might be considered as the accessible check front. In this manner, a 100-ft control might be considered to give 130 ft of check front in 1 h or 7800 foot-minutes of vehicle inhabitance. On the off chance that 120 cars for each hour request check space for an normal stay time of 2 min, then 6000 foot-minutes of check front is required, or the top hour must give a check length of 100 ft (Sproule W.J., Young, S.B., eta al, 1994).

3.3_The Passenger Terminal System

The traveler terminal framework is the significant connection between the ground access system and the aircraft. The motivation behind this framework is to give the interface between the traveler airplane terminal access mode, to handle the traveler for beginning, end, or continuation of an air transportation trip, and pass on the traveler and stuff to and from the flying machine. For the architect, the passenger terminal is the main airport building and an opportunity for architectural expression. Organisationally, the terminal building is the key element within the airport estate. It is, however, just part of an integrated system, which involves a complex interaction between airline companies, airport authorities and the traveler. The reputation of an airport is, however, determined by the quality of its terminal buildings, not just as architectural imagery but in terms of customer needs. Well-designed terminal buildings enhance the reputation of the airline companies that use it, and the airport itself, and ensure that passengers enjoy a comfortable, stress free start and end to their journey (Long-Wen Chen,1999).

3.3.1_Component of the System :

The traveler terminal framework is made out of three noteworthy segments. These segments and the exercises that happen inside them are as per the following:

1. The entrance interface where the traveler exchanges from the entrance method of go to the traveler handling segment. Dissemination, stopping, and curbside stacking and emptying of traveler are the exercises that happen inside this segment.

2. The handling part where the traveler is prepared in arrangement for beginning, consummation, or continuation of an air transportation trip. The essential exercises

that occur inside this segment are ticketing, things registration, baggage carousel, seat task, government assessment administrations, and security.

3. The flight interface where the traveler exchanges from the handling segment to the flying machine. The exercises that happen here incorporate get together, movement to and from the air ship, and air ship stacking and emptying. Various offices are given to play out the elements of the traveler terminal framework. These offices are demonstrated for each of the segments recognised previously.

3.3.2_ Airport planning basics

There are 5 primary elements that an airport consists of

- The runway
- The parking and service space for the aircraft
- The technical facilities for maintenance of the aircraft
- The flight gates
- Passenger terminals

The secondary elements are

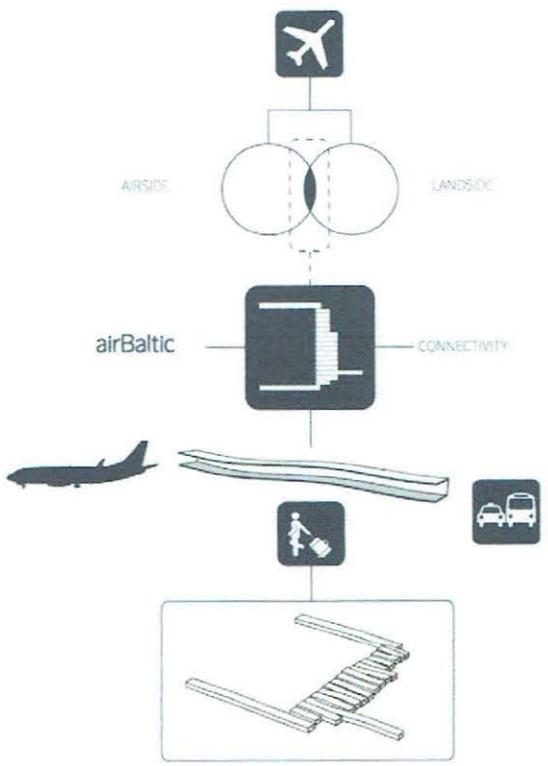
- Tower
- Fire station
- Access drives
- Car parks
- Other buildings

All of these elements should be considered as the part of the airport complex and their position and relation between each other has to be maintained with proper planning and organisations.

3.3.3_Planning of the airport

Zoning wise the whole airport can be divided as three parts as follows:

- Air side
- Terminal building
- Land side



Airside

- Apron
- Taxiway
- Runway

Land side

- Parking curb

Terminal is in between land side and air side allowing passengers to pass through 5 levels

3.3.3.1_ Apron

An apron is a defined area intended to accommodate aircraft for purposes of loading and unloading passengers, mail or cargo, fuelling and parking or maintenance. It's the Portion of an airport usually paved in front of Terminal building, for Parking, Loading & Unloading of

Aircraft. Holding bays are also known as holding aprons, they are provided at busy airports near the runways. They hold Planes Before its Takeoff to wait till the runway is cleared.

Different parts of Aprons

- Terminal Apron
- Cargo Apron
- Parking Apron
- Service and Hanger Apron
- General Aviation Apron
- Transient Apron
- Other Ground Servicing Apron

Terminal Apron- The area designed for aircraft manoeuvring and parking adjacent to passenger terminal facilities. From terminal apron, passengers get into the aircraft.

Cargo Apron- Aircrafts that carry only freight and mail may be provided a separate cargo apron adjacent to cargo terminal building.

Parking Apron- Parking apron is the apron where aircrafts can be parked for a specific period of time. It may be used for light periodic servicing and maintenance. Parking aprons are located as close to the terminal apron as possible.

Service and Hanger Aprons- It is an apron where maintenance and repairing of an aircraft is carried out under a hanger.

General Aviation Apron- General Aviation aircraft's, used for business or private flying which requires several categories of aprons to support different general aviation activities.

Transient Apron- The aprons used for temporary parking of aircrafts is known as transient aprons. This place is used as access to fuelling and other services.

Other Ground Servicing Aprons- Areas for servicing, fueling or loading and unloading should also be provided aprons as needed not all of the apron types are required for every airport, but the need for them and their size should be estimated based on type and volume of forecast airport traffic at the airport.

Service or Hanger Apron

Cargo Apron

Parking Apron

Terminal Apron

Source: CAAB, AIP 2010

3.4_Passenger terminal

Terminal building is the main building where passengers embark and disembark aircrafts. The terminals are the 'front door' to the Airport and serve as the public interface between the airside and landside elements. It can be of two types- domestic and international. Irrespective of the two types the terminal buildings are generally divided by 3 different levels.

- Departure level, generally the ground floor
- Arriving level , generally the 1st floor

- Luggage handling level in most cases the basement

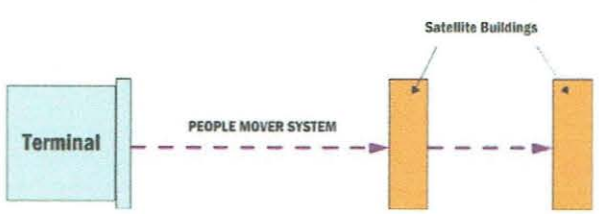
There might be other separate level for other functions such as customs, operating rooms, stuff lounge etc

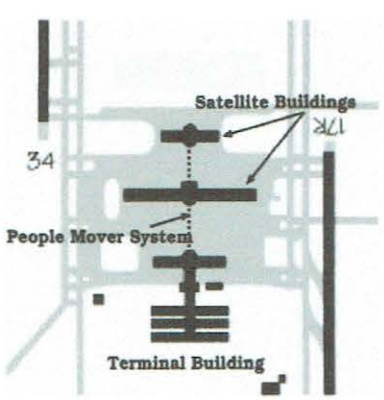
3.4.1 Major Terminal Design Considerations According to strategic Airport Management Program, 2007

- Terminal Configuration
- Terminal Concepts
- Major Design Considerations

3.4.1.1 Terminal Configuration

- Centralised processing building connected by people mover system to satellites. Example: Denver International airport, Heathrow airport alternatives.

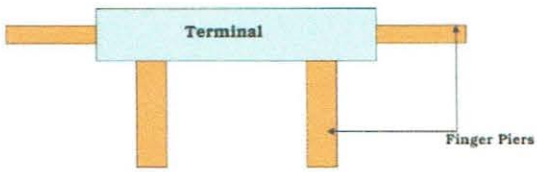


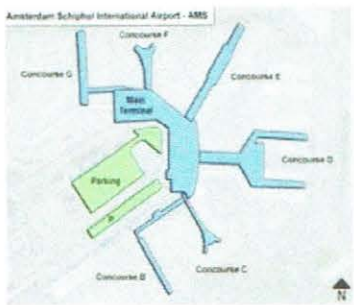


- Centralised passenger processing

terminal building

with finger piers

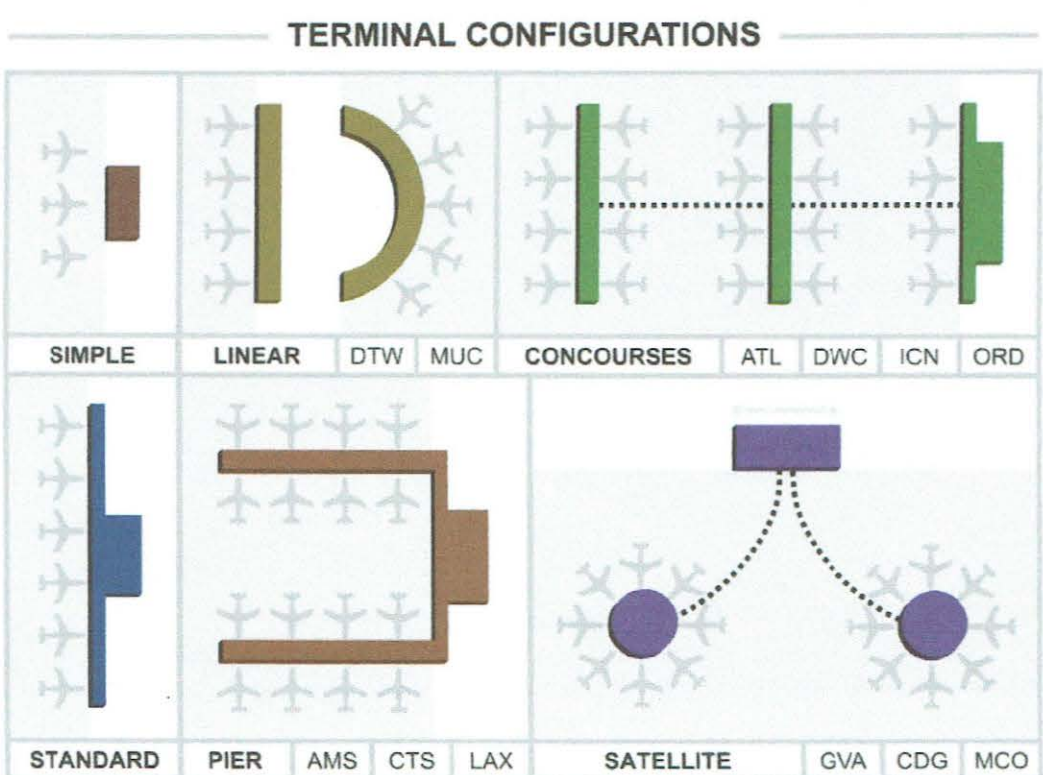




3.4.1.2_Terminal Concepts

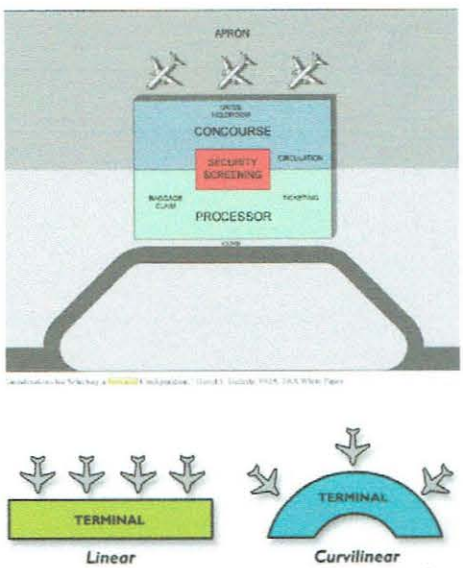
5 Common Terminal Concepts

- Linear
- Pier/Finger
- Transporter
- Satellite
- Compact Module Unit Terminal

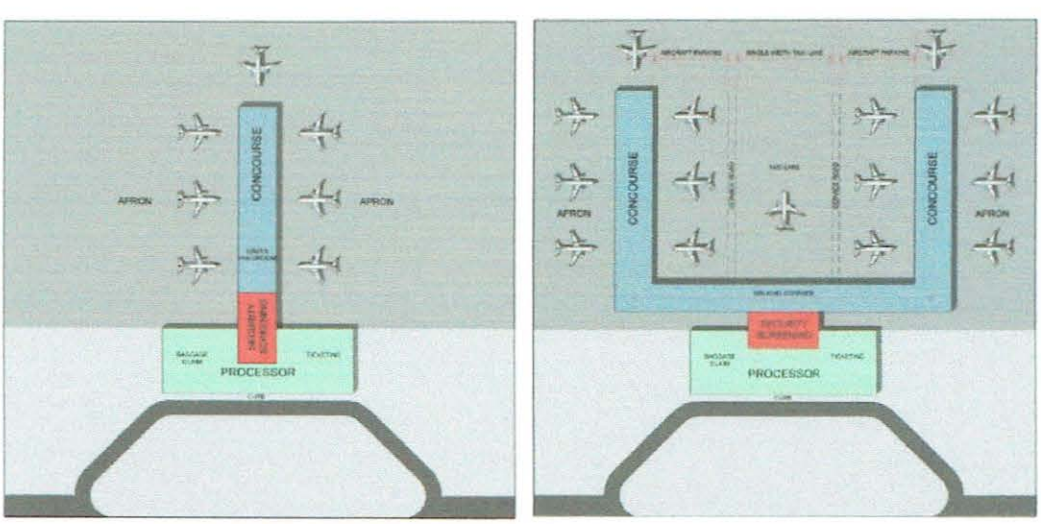


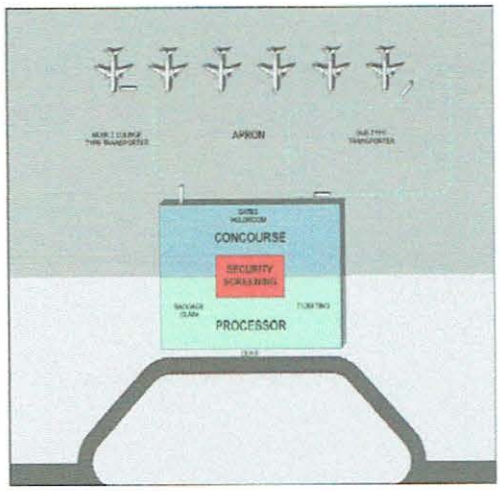
Linear/Curvilinear

- Simplest & Most straight-forward
- Simple organizational principles
- Consists of a single passenger processing area
- Primarily appropriate for low-activity airports
- Direct relationship between curb side and the aircraft.(Short walking distances)
- Centralised passenger processing
- Example- McNamara terminal of Detroit Metro Airport



Pier/ Finger





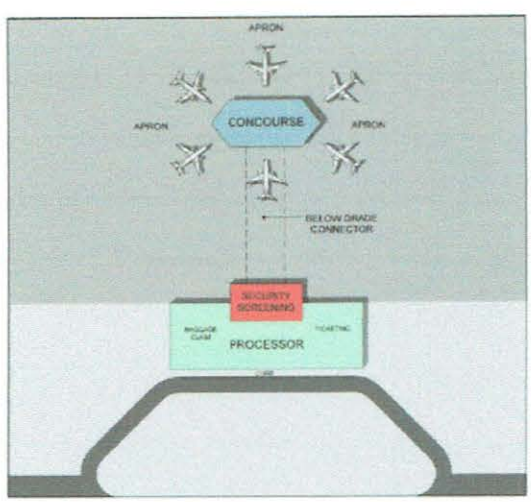
- Air Craft are parked on both side of a concourse.
- Air Craft usually arranged around the axis of the pier in a perpendicular.
- Passengers are usually processed at the simple terminal location and then routed down a "pier" where aircraft are parked in the "finger" slots or gates for boarding. This concept fully separates the passenger processing functions from the concourse activities.
- Compare to linear, this concept type increases passenger walking distances from the processing area.
- Compact arrangements of a/c along the pier, allow efficient servicing of the a/c, thus lowering the operating costs for the airlines.
- Example:- Kansai International Airport

Transporter

- It provides a complete separation of passenger facilities from those required to service and maintain the aircraft.
- Aircraft and a/c-servicing functions are remotely located from the terminal.
- Passengers access the a/c via the mobile lounges that leave from the terminal gates, go directly to the aircraft.

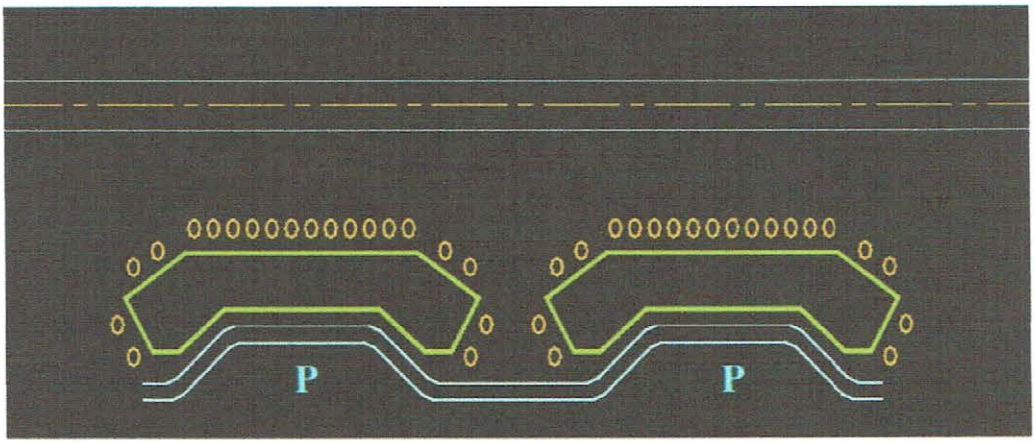
- The use of buses that drop off the passengers adjacent to the a/c on the apron.
- Airplane taxiing time to and from the runway is decreased as well as reduces the amount of aircraft engine noise around the terminal.
- Example:- Dulles International Airport, Tampa International Airport

Satellite



- It is completely surrounded by aircraft.
- Connected to the processing areas of the terminal via underground, at-grade, or overhead connector.
- Parked in a nose-in arrangement around the satellite.
- Passenger processing is handled in a
- separate terminal facility. It is work well for heavy-activity airport with O&D and large percentage of connecting passengers.

Compact Module Unit



Defined by the IATA as 2 or more separate, self-contained building, each housing a single airline or group of airlines, each having direct access to ground transportation.

Example:-Kennedy International Airport, NY , London Heathrow

Comparison of the 5 terminal

No.	Terminal Concept	Advantages	Disadvantages
1.	Pier/Finger **Limited Expansion capability**	• Economical to build • Efficient use of land • Centralized resources, economies of scale (human,facilities, amenities)	• Long walking distances • Limited expansion capability • Reduced aircraft circulation & manoeuvrability
2.	Linear **Longer walking distance**	• Shortest walking distances • Simple construction • Lower baggage systems costs (conveying/sorting) using decentralized system	• Duplication of terminal facilities/amenities • Longer walking distances for transfer pax • Longer minimum connecting time
3.	Satellite **Expensive**	• Centralized resources (human, facilities and amenities) • Facilitates pax management	• Requires high technology, underground transportation system • High capital, maintenance & operating cost • Increases minimum connecting times
4.	Transporter **Expensive**	• Ease of aircraft manoeuvrability • Ease of expansion capability for aircraft stands • Simple and smaller central terminal • Cost savings	• Higher instances of pax delays • High capital, maintenance & operating costs • Increased minimum connecting times
5.	Compact module unit terminal **Higher operating cost**	• Short walking distances • Simple pax & baggage transportation/sorting systems within each module	• Multi-compact module units require pax and bag transfer systems between terminals • Duplication of facilities, higher operating costs

3.4.1.3_ Major Design Considerations

- Passenger Flow
- Walking Distance
- Level of service for passengers
- Performance standards
- Traffic peaking characteristics
- Future growth
- Sophisticated and costly airport systems
- Ease of way finding
- Processing times
- Retail

Basic Planning Criteria in Development of Passenger Terminals

- Easy orientation
- Simplicity
- Minimise walking distances
- Minimise level changes
- Minimise pax cross-flows
- Compatibility of facilities with aircraft characteristics
- Built-in flexibility to accommodate future changes in dynamic industry

- Traffic peaking characteristics
- Transfer volume and connecting times

Defining the objectives first for management

- Type of airport operations: hub, point-to point, low cost, charters, general aviation
- Demographics of pax: international/domestic, business/tourists
- Level of service
- Establish key design criteria/parameters = design brief: simplicity, clarity, efficiency, minimum change in level, comfort, ambience, architectural statement/icon, state-of-the-art technology, low operating costs
- Prioritise design criteria/parameters

3.4.2_ Functions of Terminal Building

3.4.2.1_Main Function of Terminal Airport

- Change of Movement Type-From car, train or bus to plane
- Processing (passenger processing space)-Ticket, check-in, security check
- Provide Passenger Facilities-Shopping, toilets, eating, meeting & greeting, business & conference.

- Other Functions are-
- To provide circulation, processing and holding space
- To operate smoothly
- To ensure the premium level of service

Parts of Terminal Building

A terminal building could be made for passengers, cargo and for any other specific purposes.

It comprises the basic physical parts as

- Front side of the Terminal
- Visitors Area and Check-in Area
- Shop retails
- Security Hold Area & Baggage Make Up area
- Passengers Meet and Greet area
- Airlines offices, counters for Tour and Travel agencies counters for Taxi services
- Lounges of Business class or Executive Class passengers

3.4.2.2_Terminal facilities and services

- Access and Land-side Interface.
- Processing.

- Holding Areas.
- Airlines and Support Activities.

Access and Landside Interface

To ease the transfer of passenger flow. The facilities include:

- Curb side loading and unloading.
- Curb side baggage check-in where this is permitted.
- Shuttle services to parking lots and other terminal.
- Loading and unloading areas for car, buses, taxis, limousines and rapid surface modes.

Processing

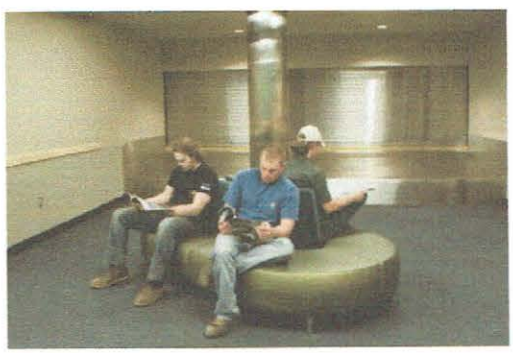
Areas are designated for the formalities associated with processing passenger The facilities include:

- Airline ticket and passenger check-in.
- Baggage check-in.
- Gate check-in.
- Incoming and outgoing customs.
- Immigration control.
- Security checks areas.

- Baggage claim.

Holding Areas

The areas where passengers wait, in some case with airport visitors, between period occupied by passing through the various process. The facilities required:



- Passenger Lounges -general, departure and gate lounges
- Passenger Services Areas -wash rooms, internet access and public telephone.
- Concessions -restaurant, bar and duty-free shop.
- Observation Decks and Visitors' Lobbies

Airlines and Support Activities

The design must also cater to the need of airlines, airport and support personal working in the terminal area. The facilities must be provided:

- Airlines offices -rest and refreshment areas for pilot and crew.
- Airport management offices -security, services.

- Governmental office -police, health, immigration.
- Offices and support areas for maintenance staff.

3.4.2.3_Service Required at Terminal Building

Check-in:

Airport Check-in are service counters found at commercial airports handling commercial air travel. The check-in is normally handled by an airline or a handling agent working on behalf of an airline. Passengers usually hand over any baggage they do not wish or are not allowed to carry-on to the aircraft's cabin and receive a boarding pass before they can proceed to board their aircraft.

Immigration Duties

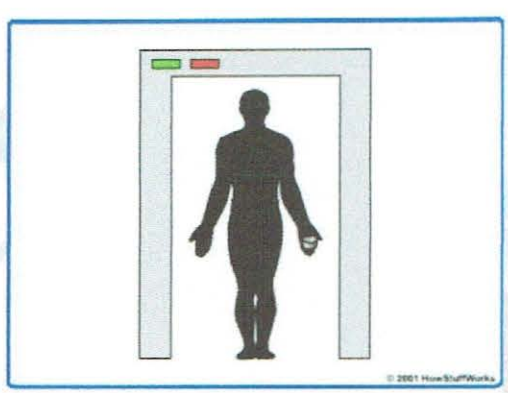
- Monitor persons who leave or enter the country,
- Checking for appropriate documentation,
- Arresting people wanted by international arrest warrants.
- Block the entry of dangerous people to the country.

Security Checks

- Passenger Screening:
- Confirming the identity of travelers, Checking a photo ID & transports.
- Body Screening using Metal Detector Gate
- Baggage Screening using X-ray machine

Passenger Screening

- Purpose: to ensure that certain prohibited items don't board commercial airliners.
- Every passenger thus is screened by airport security staff using the latest screening techniques to prevent any terrorist or criminal activity.
- Every piece of luggage is screened for explosives using the latest technology and equipment before being placed on a plane



Baggage Screening

- Place all carry-on baggage and any items you are carrying with you on the belt of the X-ray machine.
- Laptop computers and video cameras with cassettes must be removed from their carrying cases and placed in one of the bins provided.
- You will also need to remove your coat, jacket, suit jacket or blazer and place it in one of the bins.
- These items go through the X-ray machine

Parking Facilities

- Public Parking Facility-for airline passengers. Near terminal building.
- Off-Airport Parking-for airline passengers. Far away from terminal building, with lower charges.
- Separate Parking-for airport employee Far away from terminal area, airport workers using bus go to the terminal.

- Car Rental Parking-for taxi or airport limousine. Close to the terminal building. Pick-up / Drop-off

Public Transportation

- Taxis and limousine -Airport taxis or airport limousines are provided by Airport Limo. The taxis and limousines are readily available at the Taxi and Limousine counters.

- Bus -Both public and private buses connect KLIA to several points in Kuala Lumpur and beyond.

- Express Train-Kuala Lumpur International Airport can be reached by the KLIA Express (ERL) and the KLIA Transit train services.

- Aerotrain-Main Terminal Building to Satellite Terminal A. The journey between terminals takes under two minutes train is able to transport 250passengers one time.

3.5_INTERNATIONAL FACILITIES:

Airplane terminals with universal operations require space for the investigation of travelers, group, things, air ship, and payload. The range required for traditions, movement, farming, and general wellbeing administrations might be in a different office or in the terminal building itself. These offices should be composed with the goal that traveler stream between the air ship and the introductory preparing station is unrestricted and as short as could reasonably be expected, there is no probability of contact with residential travelers or any unapproved work force until handling is finished, there is no conceivable way for a global entry to sidestep preparing, and there is an isolated region for in-travel worldwide travelers. The extent of this office depends on the projection of hourly travelers requiring handling. It is suggested that the proper authorities what's more, organizations be reached amid the preparatory stoop stage to decide particular configuration necessities.

3.5.1_PASSENGER AMENITIES:

The variables which impact the degree of traveler courtesies incorporate the traveler volume, group estimate, the area and degree of off-air terminal administrations, interests and capacities of potential concessionaires, what's more, rental rates. These by and large incorporate

1. Sustenance and refreshment administrations, and newspaper kiosks
2. An assortment of stores and administrations
3. Counters for auto rental and flight insurance agencies
4. Open lockers and open and utility phones

5. Amusement arcades and vending machines

6. Open restrooms

3.6_Consideration Of The Traveller's Perception

There is no emotion within us without a place, just as there is no place that does not generate somatic commotions, as mild as they may be says john henry a regular traveller. Traveler's, in general, now appreciate architecture more, and airports are the foremost landmarks in their journeys. they expect smooth flow through a terminal to be more than just about efficiency, but as much about spaciousness and views as well as human comfort." We emphasis on natural light plants and vernacular elements to create an attractive ambience for the travellers" by architect Kaufmann.

the airport that gives traveler pleasure of the trip is, first of all one that creates cultural identity of the country where they arrive at. So with ambience being how travellers feel about their experience of these facilities, the modern architects has to be discerning in understanding every element the way a traveler will perceive it - in utilising latest technology to achieve state of the art and recognising that could achieve the modern travellers inspiration only if first captivate the interest in architecture of a traveler.

3.6.1_Design Considerations

In creating criteria for the configuration of the traveler terminal complex, it is essential to understand that there are various distinctive variables which go into an announcement of general outline destinations. From these elements general and

particular objectives are built up which set the structure on which plan advances.Intercontinental Airport, the general design objectives included

1. Development and sizing to accomplish the stated mission of the airport within the parameters defined in the master plan

2. Capability to meet the demands for the medium- and long-run time frames

3. Functional, practical, and financial feasibility

4. Maximise the use of existing facilities

5. Achievement of a balanced flow between access, terminal, and airfield facilities during the peak hour

6. Consideration of environmental sensitivity

7. Maintenance of the flexibility to meet future requirements beyond the current planning horizon

8. Capability to anticipate and implement significant improvements in aviation technology.

3.7_ Airports In Bangladesh

•World War II brought modern aviation to Bangladesh when the first military airstrip was built in Tajgaon by the British Raj to facilitate access for warplanes in the battlefields of Burma and Kohima in India.

•The construction of other airstrips soon followed in Feni, Chittagong,Comilla, Chakaria, Sylhet, Cox's Bazar, Jessore, Lalmonirhat and Rajshahi. These military

airstrips provided a base for the RAF Third Tactical Air Force throughout World War II.

•At the conclusion of the war, the colonial government built at airport at the original Tajgaon airstrips, as well as a landing strip at Kurmitola to accommodate the Royal Indian Air Force (RIAF) stationed in the city of Dhaka.

•Kurmitola later developed into the Shahjalal International Airport, the largest airport in Bangladesh.

•Culcutta-based Orient Airways was formed in 1946 and was the first commercial airline to use Tajgaon airport for civilian traffic, with flights between Karachi and Dhaka starting on June 7, 1954. The British Overseas Airways Corporation and Pan American Airways both established flight routes out of Dhaka by 1960 and former Royal Air Force airstrips at Chittagong , Thakurgaon, Jessore, Ishwardi and Comilla were developed into airports.

•The Liberation War of 1971 saw extensive aerial battles taking place in the skies over Bangladesh between the Pakistan Air Force (PAF) and the Indian Air Force (IAF). The Bangladesh Air Force was established in late July 1971, with training taking place in India, and a number of ex-PAF pilots joining its ranks. Strikes on various key targets were carried out by the Bangladesh Air Force during the Liberation War..

•Following the Independence of Bangladesh civil aviation was resumed with the first flight from Tajgaon Airport on January 1, 1972. Established in 1972, Biman Bangladesh Airlines was the independent country's first commercial passenger

airline. Fully state-owned, the airline held the monopoly for more than twenty years. Today, private passenger and cargo airlines in Bangladesh include Aero Bengal Airlines, GMG Airlines, Bismillah Airlines, Best Aviation, Zoom Airways, Air Bangladesh, Royal Bengal Airline, Regent Airways and United Airways.

•

HISTORY OF AIRPORT IN BANGLADESH

Tejgaon airport

Shahjalal internationalairport

Barishal airport

Rajshahi airport

Sylhet osmani airport

Cox's bazar airport

INTERNATIONAL AIRPORTS

1. Hazrat Shahjalal International Airport, Dhaka.

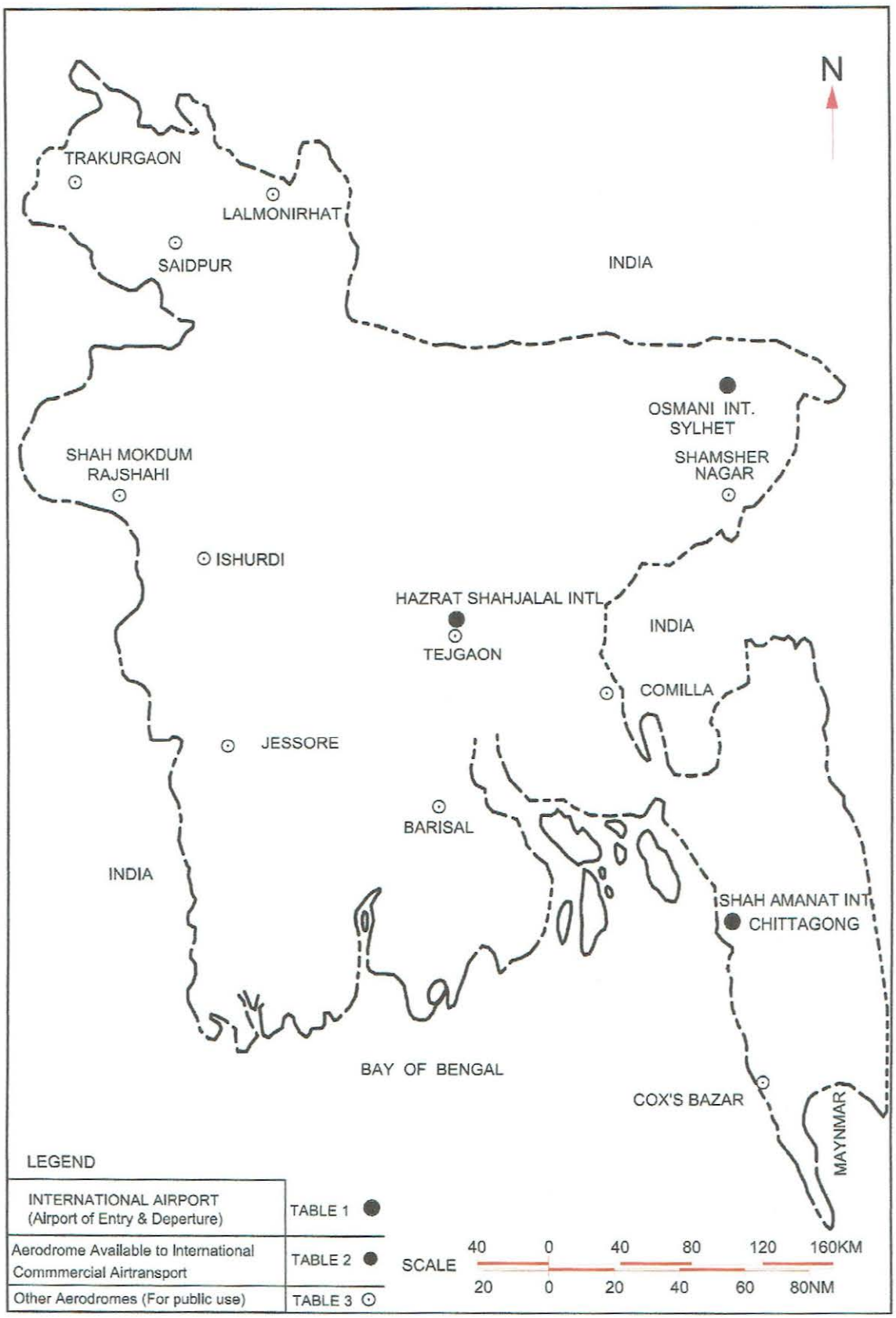
The largest and the principal international airport of the country situated in Dhaka. More than 90% of aeronautical functions of CAAB is carried out from it.

2. Shah Amanat International Airport, Chittagong.

Situated in the port city of Chittagong. It is the second largest airport and the alternate airport to HSIA.

3. Osmani International Airport, Sylhet.

Situated at the city of Sylhet. Upgraded to an international one in order to facilitate the people of the district which have a large number of UK residents.


N
TRAKURGAON
LALMONIRHAT
SAIDPUR
INDIA
OSMANI INT.
SYLHET
SHAH MOKDUM
RAJSHAHI
SHAMSHER
NAGAR
ISHURDI
HAZRAT SHAHJALAL INTL
TEJGAON
INDIA
COMILLA
JESSORE
BARISAL
INDIA
SHAH AMANAT INT.
CHITTAGONG
BAY OF BENGAL
COX'S BAZAR
MAYNMAR
LEGEND
INTERNATIONAL AIRPORT
(Airport of Entry & Deperture)
TABLE 1
Aerodrome Available to International
Commmercial Airtransport
TABLE 2
Other Aerodromes (For public use)
TABLE 3
SCALE
40 0 40 80 120 160KM
20 0 20 40 60 80NM

Chapter_04: Case Studies

CASE STUDY_01
CHHATRAPATI SHIVAJI INTERNATIONAL AIRPORT, MUMBAI INDIA

INTRODUCTION

Mumbai is the world's most crowded city. The city is situated on an island with a deep natural harbor and is the country's business capital.

Mumbai has dependably served as a gateway for visitors to the nation. Consistently, a large number of visitors arrive in Mumbai to get their share of the "Dream". The city's ocean port and air terminal associate India to all edges of the globe, encouraging exchange, business and social trades with rest of the world.

With production of new integrated Terminal, there is a hope to give Mumbai an airplane terminal deserving of its legacy. The airplane terminal won't just serve as a

focal point of transportation however will likewise also carry with it the essence , the qualities and the legacy of the city and the nation.

Chhatrapati Shivaji International Airport is the primary international airport serving the Mumbai Metropolitan Area, India. It is the second busiest airport in the country in terms of passenger traffic and international traffic. It is situated across the suburbs of Santacruz, Vile Parle and Sahar village in Andheri.

The new integrated terminal was opened for international operations on 12 February 2014. The new terminal combines international and domestic passenger services under one roof, optimizing terminal operations and reducing passenger walking distances. It capable of handling 40 million passengers and 1 million metric tonnes of cargo annually.

CONCEPT AND INSPIRATION

Inspired by the type of conventional Indian structures, the new four-story terminal stacks a grand "headhouse," or central processing podium, on top of very adaptable and modular concourses underneath. As opposed to compartmentalizing terminal capacities, all concourses radiate outwards from a central processing core allowing them to swing between domestic and international.

Just as the terminal celebrates a new global, high-tech identity for Mumbai, the structure is instilled with reactions to the neighborhood setting, history,culture, and society. Gracious curbside drop-off zones intended for huge gatherings of going with well-wishers accommodate traditional Indian arrival and departure ceremonies.Regional patterns and textures are subtly incorporated into the terminal's design at all scales.From the articulated coffered treatment on the

headhouse segments and rooftop surfaces to the complex jali window screens that filter dappled light into the concourses, Terminal 2 shows the potential for a a modern airport.

The project likewise makes a noteworthy positive commitment to the nearby fabric. By integrating into the current transportation fabric and by advancing availability through the simultaneous development of a new road network to service the airport, the terminal sews together the notable and historic heart of Mumbai toward the south with the city's thriving peripheries toward the east and north.The development site of the new terminal building is situated inside close to the current terminal that needed to stay operational amid development, which brought about a elongated X-shaped plan utilizing repetitive, modular designs that accommodate construction phasing and permit rapid construction.

CURRENT TERMINAL CHARACTERISTICS

The airport consists of two passenger terminals:

Terminal 1 at Santacruz for domestic flights and Terminal 2 at Sahar for both international and domestic flights. While both terminals use the same airside facilities, they are physically separated on the cityside, requiring a 15–20-minute (landside) drive between them. It has coach shuttle services between the two terminals for the convenience of transit passengers.

- Larsen & Toubro was awarded the contract to construct the new Terminal 2. Skidmore, Owings & Merrill (SOM) was the architectural designer of the project and also provided the schematic design of structure.

- The terminal covers a land area of 210,000 square metres and replaced the existing International Terminal.
- The X-shaped terminal has a total floor area of 450,000 square metres across four floors and eventually handle both domestic and international passengers.
- It includes new taxiways and apron areas for aircraft parking designed to cater to 40 million passengers annually.
- The iconic structure have boarding gates on two piers extending southwards from a central processing building featuring a 42-metre high roof employing over 20,000 metric tonnes of fabricated steel covering 30 acres.
- The new T2 terminal building operates Multiple Aircraft Ramp System stands and swing gates, so that a single stand can accommodate either one wide body aircraft or two narrow body aircraft, in either domestic or international configuration.
- The new terminal is connected by the six-lane Sahar Elevated Access Road to the Western Express Highway. A metro rail link to the terminal is also planned.
- The new terminal has around 21,000 square meters of retail space, lounges and travel services, over 5,000 square meters of landscaping and a multi level car park for 5,000 cars.
- It has 192 check-in counters and 60 immigration counters for departing passengers, and 14 baggage carousels and 76 immigration counters for arriving passengers.
- To transfer passengers across its four levels, the building has 48 escalators and 75 elevators. The terminal also features 42 travelators.

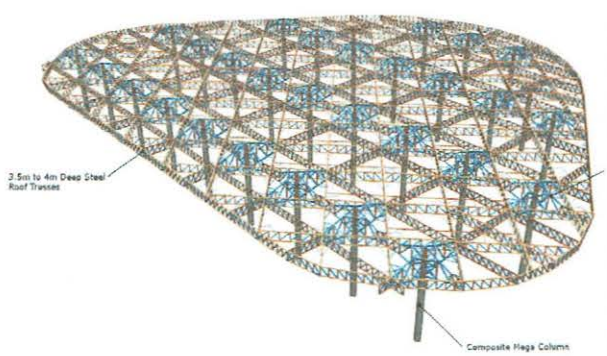
- The airport houses India's largest art museum called 'Jaya He' which has over 6500 artifacts and artworks of several artists.
- The GVK Lounge, the first common luxury lounge at an airport in India, opened to First class and Business class travellers and can accommodate 440 guests at a time. It is spread over 30,000 square feet across two levels of the terminal and has a library, a business centre and fine-dining options, apart from the usual facilities like concierge services, smoking zone, Food and Beverage, bar, luxury spa, shower area and a relaxation area.
- The terminal also houses the Niranta Airport Transit Hotel and the 32 room hotel is the first of its kind in the country.[61] It is located on Level 1 of the terminal and rooms may be booked by passengers who have checked into the airport.

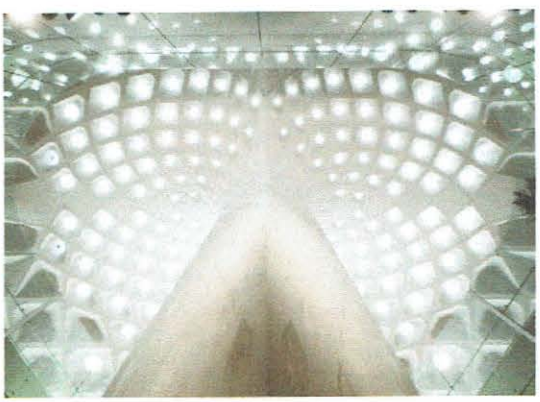
STRUCTURAL SYSYTEM OF THE AIRPORT

An overall truss depth of only 4 m. In response to site constraints and proximity of the existing operational terminal building, the mega-columns are also designed to serve as hoist mechanisms such that the entire roof can be constructed without tower cranes. The Terminal Building also includes the largest and longest cable wall system in the world. The structural studies completed include solid finite element analysis of connections to optimize material efficiency. Furthermore, the structural design prioritizes modular construction for economy and facilitation of an accelerated construction schedule.

Long-Span Structural Steel Headhouse Roof The primary design feature of the Terminal Building is a long-span roof covering the departures roadway, check-in hall, security, and passport control functions. The architectural cladding of the roof and

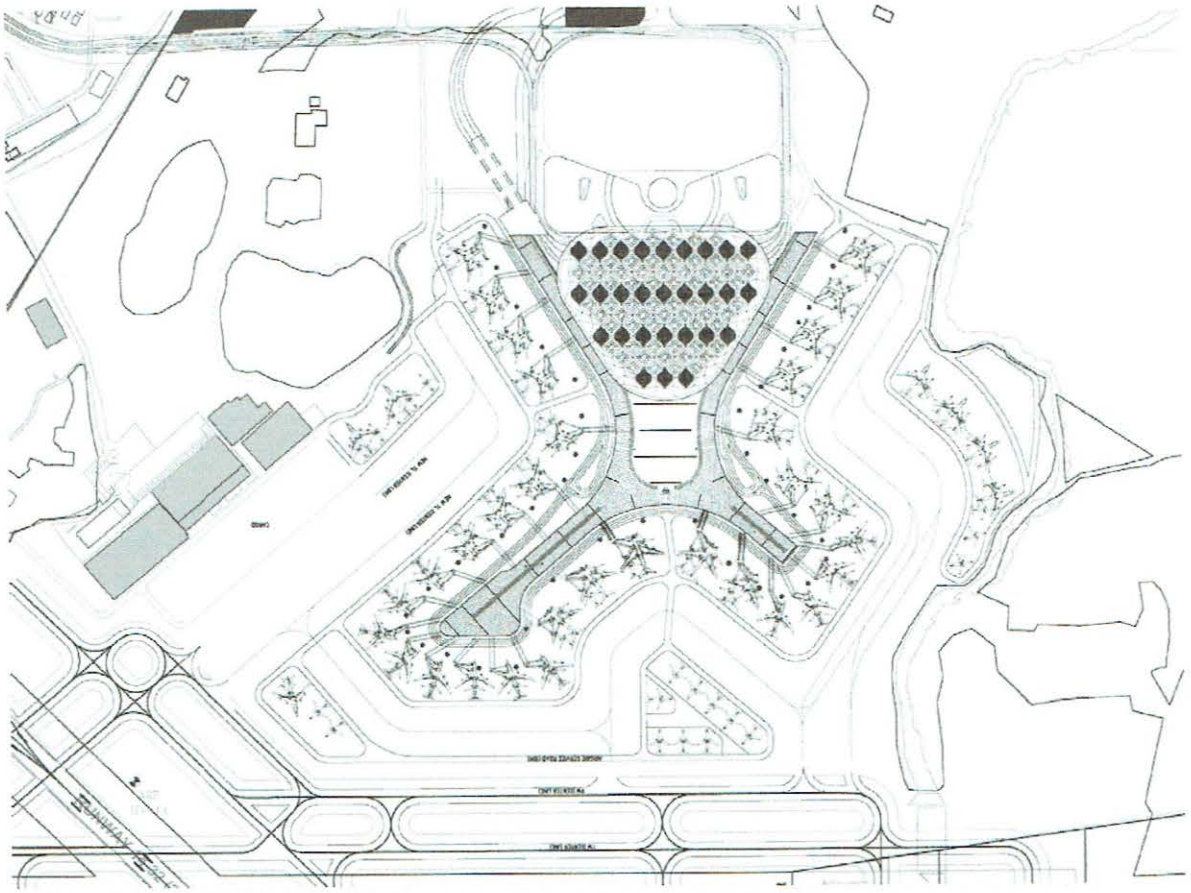
ceiling features a molded surface and skylights over the column locations and throughout the terminal ceiling, allowing natural light to flood into the main hall. The Headhouse Roof, covering 70 000 m2 and spanning over seven individual concrete base structures, is supported by only 30 composite megacolumns. Beyond typical gravity and seismic loads on the roof, special loading considerations were taken for the cable wall which applies a significant wind load to the roof structure and whose cables are pre-stressed against the roof trusses at the northern end of the terminal. The wind loading also presented challenges as a significant portion of the Headhouse Roof is open to the outdoors and behaves as a canopy.



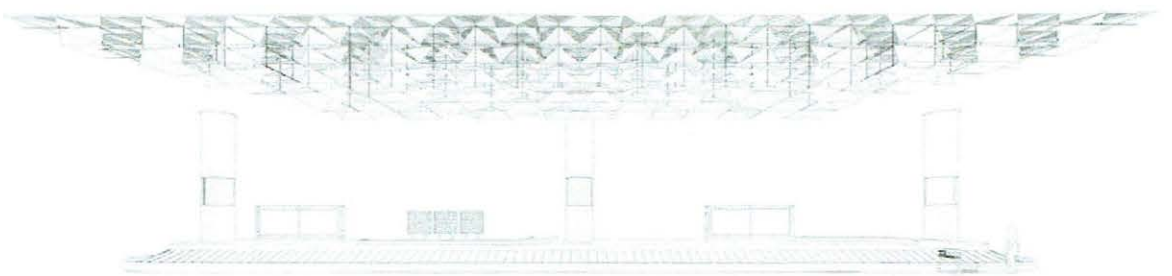


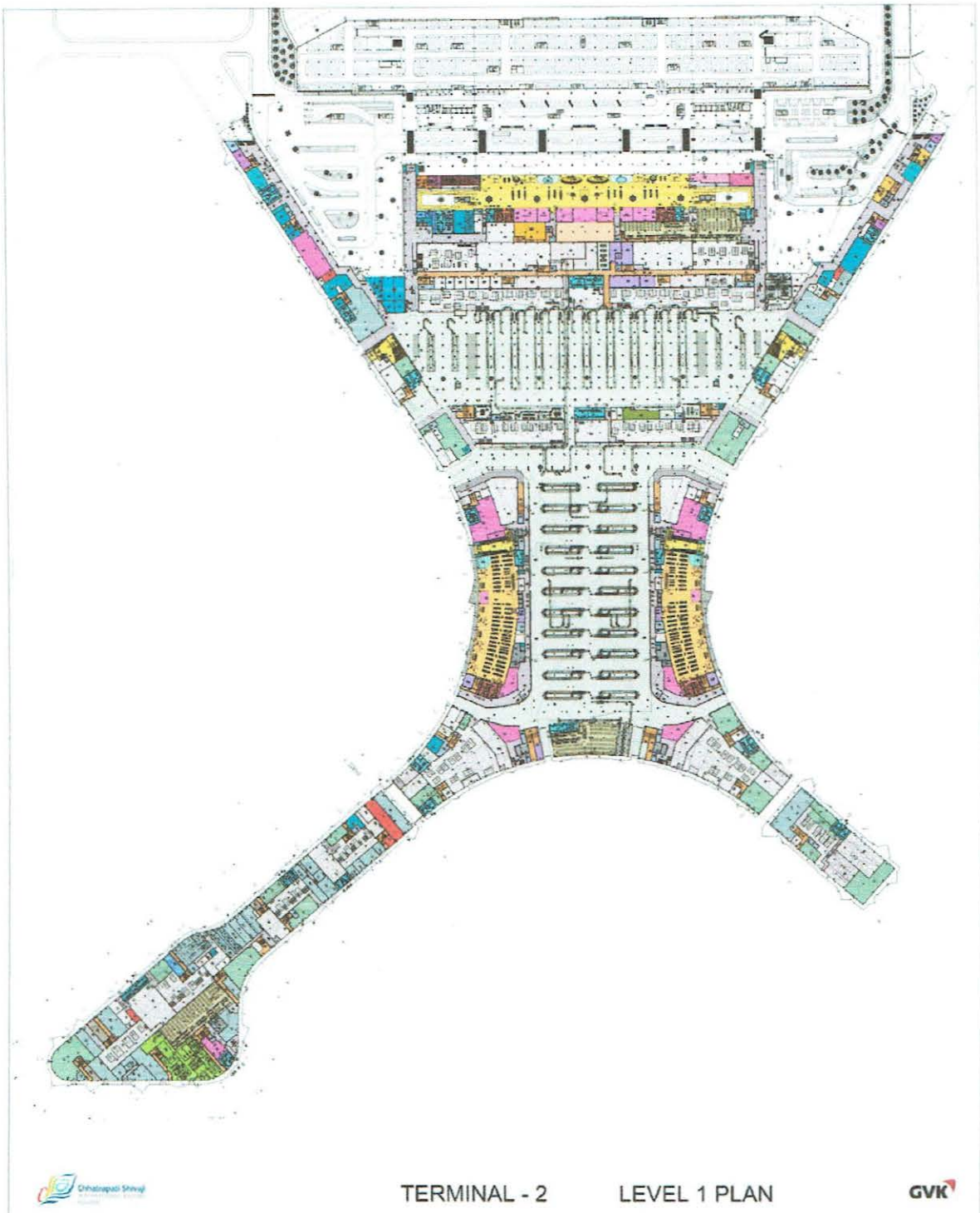
In order to create one of the largest roofs in the world without an expansion joint, the roof mega-columns and steel roof structure were kept completely independent from the base concrete structures below. Large openings in the concrete base structure allow the mega-columns to pass through as well as create architectural design features. This allows the Headhouse Roof structure to move independently in response to loads, particularly expansion and contraction caused by temperature variation. In response to the functional requirement of the space below the roof, the

entire Headhouse Roof in departure hall entirely free of columns through the use of composite mega-columns spaced 64 m in one direction and 34 m in the perpendicular direction. The structural system for the Headhouse Roof is akin to a two-way flat slab system. Increasing the depth of the trusses near the columns and running trusses in an orthogonal grid as well as along a 45° grid results in an overall truss depth of 4 m for the roof system. The greater truss depths near the columns create "column pod" areas which seamlessly integrate into the pyramidal skylights that serve as major architectural features. The lateral system for the Head house Roof comprises steel moment-r existing frames consisting of composite mega columns and long-span steel roof trusses. Frame action is achieved between the primary roof trusses and the composite mega-columns in the North–South direction and between the secondary roof trusses and the composite mega-columns in the East– West direction. Additional trusses running at 45° to the orthogonal grid provide additional stability and diaphragm stiffness. The weaving of the orthogonal and diagonal trusses, in addition to ensuring diaphragm action of the roof, was also extremely useful .

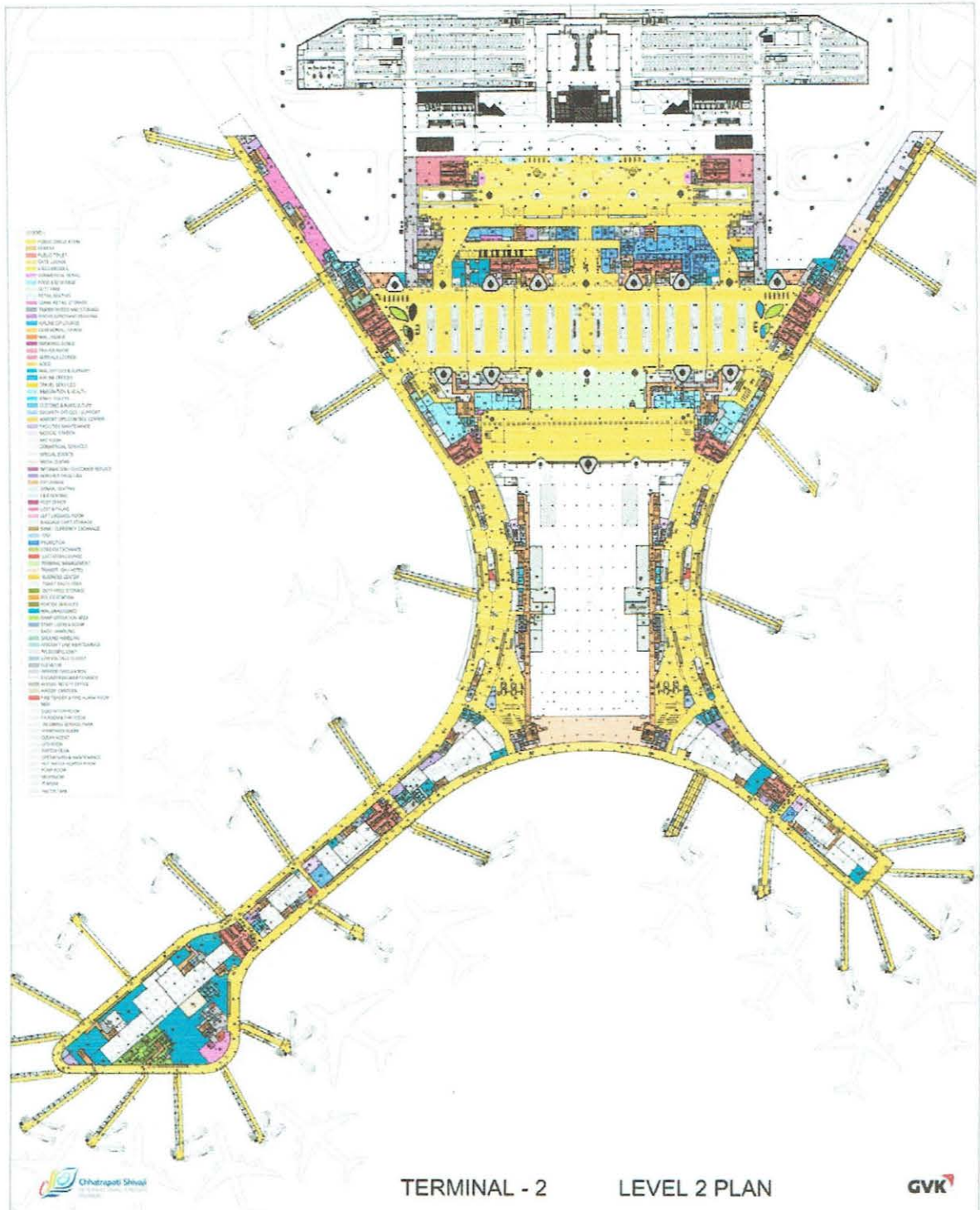


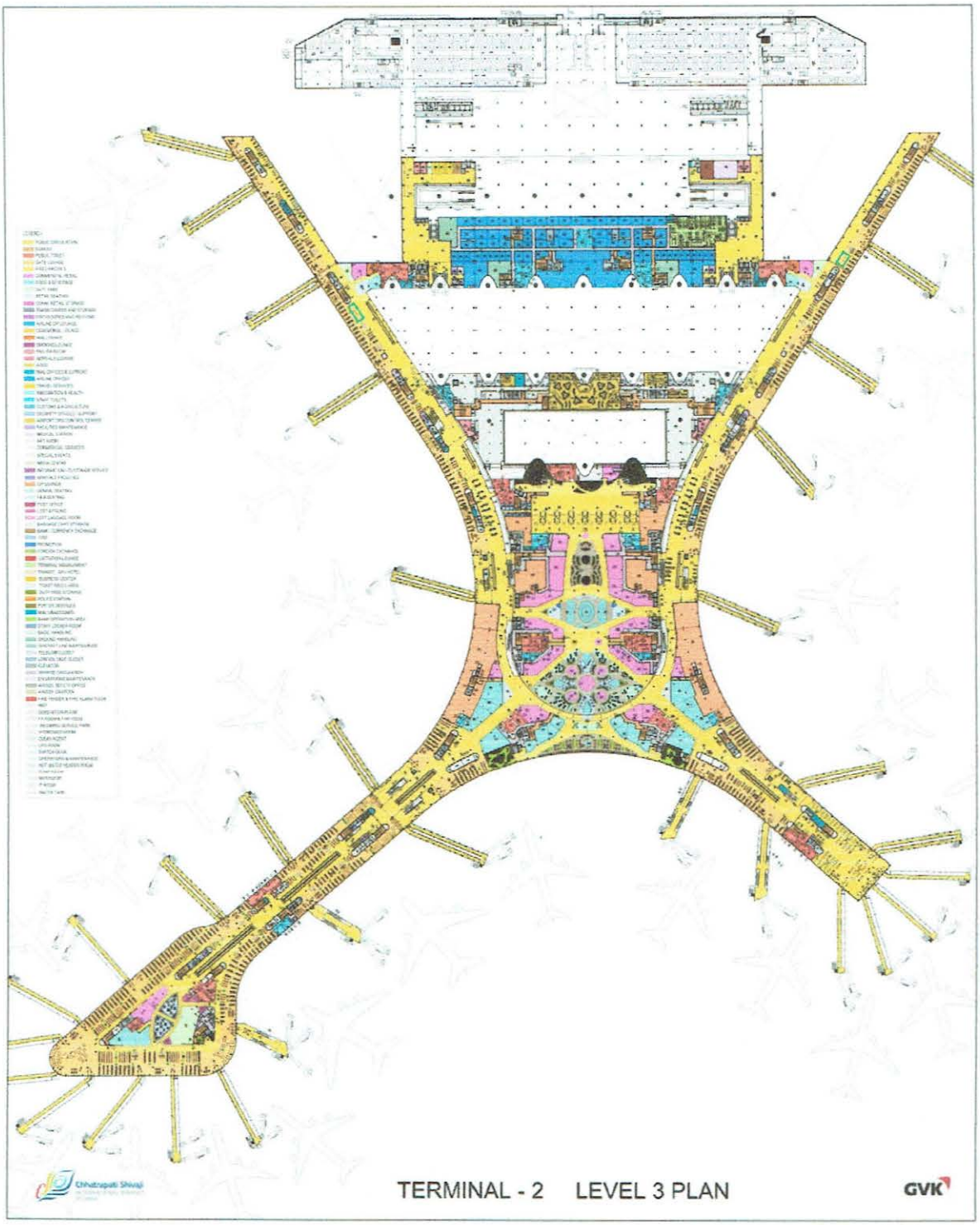

INTERNATIONAL RETAIL
DOMESTIC RETAIL
DOMESTIC RETAIL
MUSEUM
CURIO
BOOK GARDEN





TERMINAL - 2 LEVEL 1 PLAN


TERMINAL - 2
LEVEL 2 PLAN
GVK

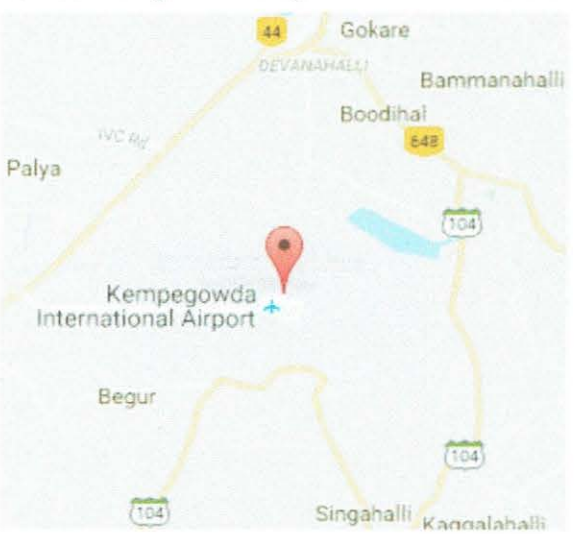


CASE STUDY_02

KEMPEGOWDA INTERNATIONAL AIRPORT, BANGALORE INDIA

INTRODUCTION

Bangalore is known as the silicon valley of India and is one of the largest biotechnology hubs in the country and as well as the garden city because it is filled with lush green parks, offering a respite from the stifling Indian heat. Bangalore developed a reputation as being a progressive, well-designed and green city.



Kempegowda, Airport is international airport serving Bangalore, the capital of the Indian state of Karnataka. Spread over 4,000 acres (1,600 ha), it is located about 40 kilometres (25 mi) north of the city near the village of Devanahalli.

As of 2015, Kempegowda Airport is the third busiest airport by passenger traffic in the country, behind the airports in Delhi and Mumbai. It handled roughly 18 million passengers in 2015 with 400 aircraft movements per day. The airport also handled about 287,000 tonnes (316,000 short tons) of cargo.

GVK has worked on fast tracking Kempegowda International Airport's development to transform it into a world-class iconic airport in terms of quality and efficiency and set a benchmark for the future commercial development of Indian airports. In a significant development, Kempegowda International Airport's terminal, enhanced in design, exteriors, facilities and infrastructure, was inaugurated in December 2013.

CONCEPT AND INSPIRATION

The new Terminal not only reflects the city's dreams of being India's first Greenfield airport but also the culture, ethos and landscape of Karnataka. Built on existing facilities efficient and passenger-friendly design, the new infrastructure is at par with best in the world in terms of conveniences, with double the existing area, facilities to host some of the largest aircrafts and world class technologies. Airside infrastructure has also been further strengthened to cater to increased number of Aircraft movements. The new AOCC (Airport Operational Control Centre) serves as the nerve-centre of the airport and helps both airlines and concessionaires to streamline processes. This ensures smart decision-making and faster turnaround making the operations as well as travel through the airport more efficient and economical for passengers. As Bengaluru is called the 'Garden City', GVK has highlighted this aspect of the city's character in the airport's surroundings. Over 100 acres has been beautifully landscaped reflecting the essence of the city as a tranquil and green zone.

The terminal roof, inspired by a smile, is a wavy-swooping roof forming a canopy at the main entrance. The terminal's interior is decorated with Mysore paintings symbolising Karnataka art.

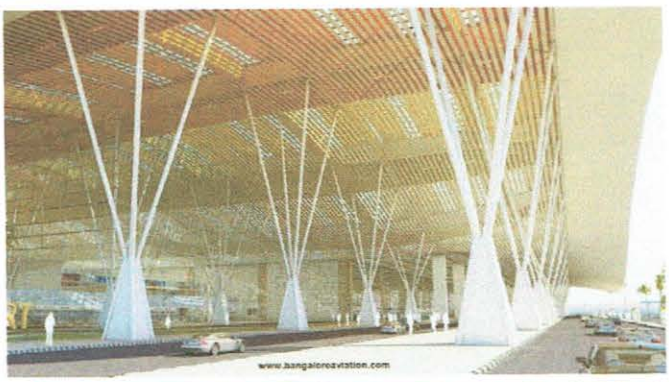
The design blends with the ethos of the Bangalore garden city and is rich in flora and fauna including local plants, trees and shrubs. The new terminal is expected to achieve gold certification in leadership in energy and environmental design (LEED) from the US Green Building Council by mid-2014.

CURRENT TERMINAL CHARACTERISTICS

- The passenger terminal is a single, four-level building capable of accommodating international and domestic operations.
- The basement houses the retail storage, rest areas and services.
- The arrival and departure areas are separated vertically with a modern, simple, straight-ahead flow system.
- The terminal is designed for ease of operation and minimum maintenance.
- The total floor area is approximately 73,347m². The terminal building is designed to accommodate 2,300 passengers at peak times. The design reflects the best industry practice and caters for 24-hour operations, under all weather conditions. All facilities meet IATA standards.
- The passenger terminal accommodates both domestic and international operations. Common-use terminal equipment (CUTE) enabled check-in counters: 53 and 18 self check-in counters.

- Check-in and baggage reclaim are situated on the lower floor, while all departure gates are located on the upper floor. There is a total of twelve gates: six domestic gates and six international gates. Gate 25-26 is equipped to serve the world's largest passenger aircraft, the Airbus A380.
- Lounges are provided by Above Ground Level and Plaza Premium Lounge, which also operates a day hotel in the terminal. For VIPs there is a separate 930-square-metre (10,000 sq ft) lounge.
- A car park for 2,000 cars was built in front of the terminal building at ground level.
- The airport currently has one runway, which can accommodate all types of aircraft including the Airbus A380. There are plans to build a second runway when the annual traffic of the airport reaches 18 million passengers a year which is currently estimated to reach around 2013-2014.
- The runway, orientated 09/27, is 4,900m (16,076ft) by 45m (150ft) with light paved shoulders making it 60m (200ft).
- An expansion of the passenger Terminal 1 began in June 2011 This expansion will double the terminal space and increase the airport's passenger handling capacity from the present 11.6 million to 17 million per year.
- The construction partners in the project include Larsen & Toubro. Designed by HOK, the expanded terminal is 150,556m² in size and have 90 check-in counters, 30 Common Use Self Service (CUSS) kiosks, 24 emigration and 24 immigration counters, 48 security pedestals and 15 baggage reclaim belts. The seating capacity will be increased to 5,300. A new VVIP building to the west of the terminal is also being built.

- The terminal has been opened in phases starting from early 2013.



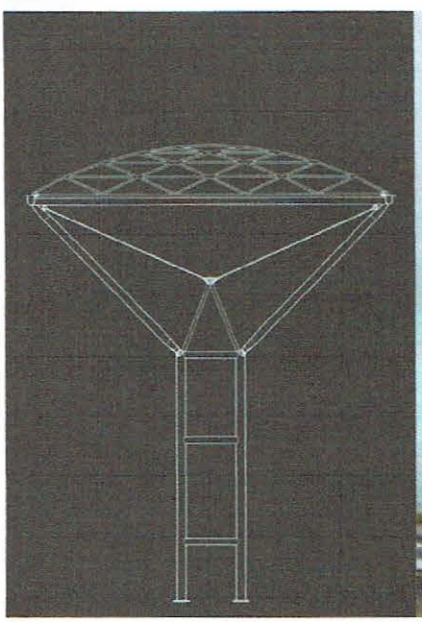
STRUCTURAL SYSTEM

The structure makes an amazing, dramatic presence that flawlessly blends with the current terminal. A richly bended rooftop serves as the bringing together component for the new and existing offices, creating a strong physical presence and visual identity for the airpor. The rooftop's undulating shape frames a covering that shields travelers and guests from the components. Its basic framework incorporates a solid plinth with rich steel branches that go through a suspended roof to meet the structure above.

Along with the building's large overhang, the use of low-e glazing reduces unwanted heat gain to create an energy-efficient, high-performance structure. Skylights enable natural light to penetrate from above, linking the atmosphere and spacious feeling of

the original building with the expansion. At the east and west finishes of the terminal, 65-foot-high glass dividers surge the space with characteristic light while making directing perspectives to the outside.

Silver metallic and bright white finishes recall the high-tech nature of the city. Interior landscape features and plantings reinforce Bengaluru's reputation as India's "Garden City."



CASE STUDY 03

KANSAI INTERNATIONAL AIRPORT, JAPAN

INTRODUCTION:

Kansai International Airport is an international airport located on an artificial island in the middle of Osaka Bay, 38 km (24 mi) southwest of Ōsaka Station.

Project Name: Kansai Airport

Architect: Renzo Piano

Location: Osaka, Japan

Date of starting: 1987

Date of completion: 1994

Cost: $20 billion

Area: 511 hectare artificial island in Osaka bay

Construction system: Steel and Glass

Style: High-tech Modern

FORM:

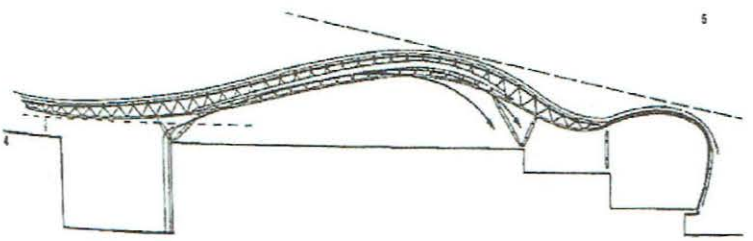
Stretched linear, vertically stacked and segregated form. The island is 4 km (2.5 mi) long and 2.5 km (1.6 mi) wide, was proposed. Engineers needed to overcome the extremely high risks of earthquakes and typhoons. Datum is 5 m. The total cost of Kansai Airport so far is $20 billion. This includes land reclamation, two runways, terminal and facilities. Sink rate of the island for taking heavy load has fallen from 50cm- 7cm. The passenger terminal is designed by Renzo Piano Building Workshop (Renzo Piano and Noriaki Okabe) and has a gross floor space of 296,043 square meters /3,186,580 sq ft. It is the longest airport terminal in the world, at a total length of 1.7 km (1.1 mi) from end to end. Multilevel nature terminal.The terminal is a four-storey building possible extension in to the sea.

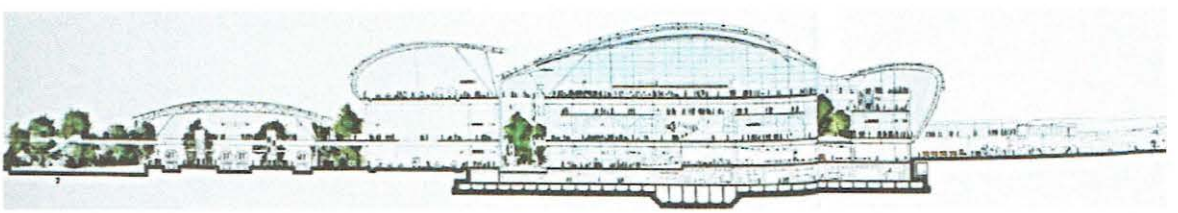
GEOMETRY OF THE TERMINAL

• Conceptually the boarding wing was given a radius of 4-6 km inclined at 68.2 degree.

• Clad is a curving carapace of stainless steel, dark glasses

• Outer space is like a bubble blown up of the





interior space.

• Curves are derive from many trial and error.

• When we see the building from the air side it seems like progeny and mother ship, because of hugeness of terminal then planes. Series of space under a roof, geometrical solution of the building take form of a curve.

• Molded around the movements guide the passenger. some of the curves symbols

the flow of air, provide scale and structure, the line of truss lead a person to the boarding bridge, three curves achieve extraordinary organic quality having synthesis between roof wall ceiling .

• curves are designed in away so that it does not interrupt the visual clarity from terminal to airside.

• Curves are also holding the structure and other servicees.

CIRCULATION

Ground floor: international arrival

1st floor : domestic arrival and departure.

2nd floor: immigration,restaurent

3rd floor: international departure

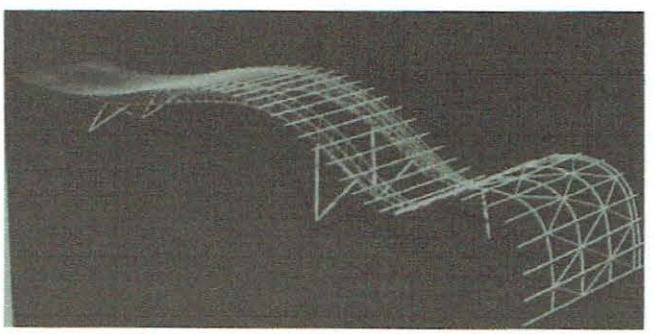
• All planes connected with boarding wings in first floor,land side is connected with three levels Drop off and passenger entry in the top floor outside the international departure, ground floor having canyon and international arrival, most of the arrived passenger take the train using the existing station via foot bridge.

• Arrival passenger of domestic passenger check in ,baggage taking in first floor and international passenger use the top floor

STRUCTURAL ANALYSIS

Building made quickly- joint work shop peter rice and Tom Berker, Rengo Peano, relatively cheaply in a island. Cantilever end of main trusses and over hanging roofs

were upon the departure and shortened at 4 meter long. Also the flanged box section over the main truss was replaced by I sections and extra cross beam hidden carefully by the suspended roof. There are asymmetrical curves 4m at their deepest. Span 82.4 m between supports, 6m cantilever at the land side, external vertical columns, and the structure can be named as melting as their principle members are fused together. Exception is the boarding wing which is a slender curve that tie the ribs that act as the diaphragms of a lattice shell structure. The steel of boarding wings were fabricated in Britain and shipped to japan

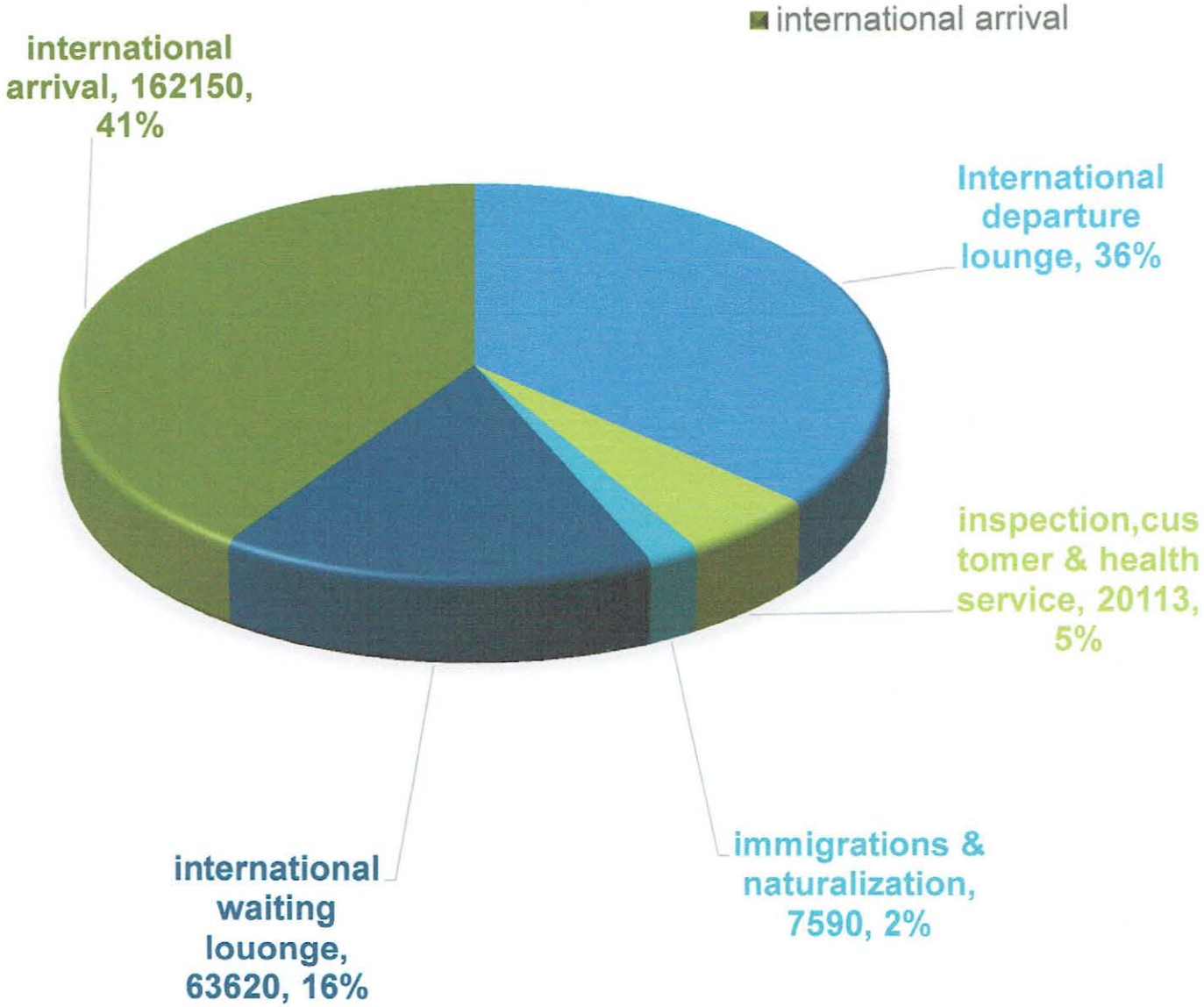


CHAPTER_05: PROGRAM DEVELOPMENT

Facilities for International passengers

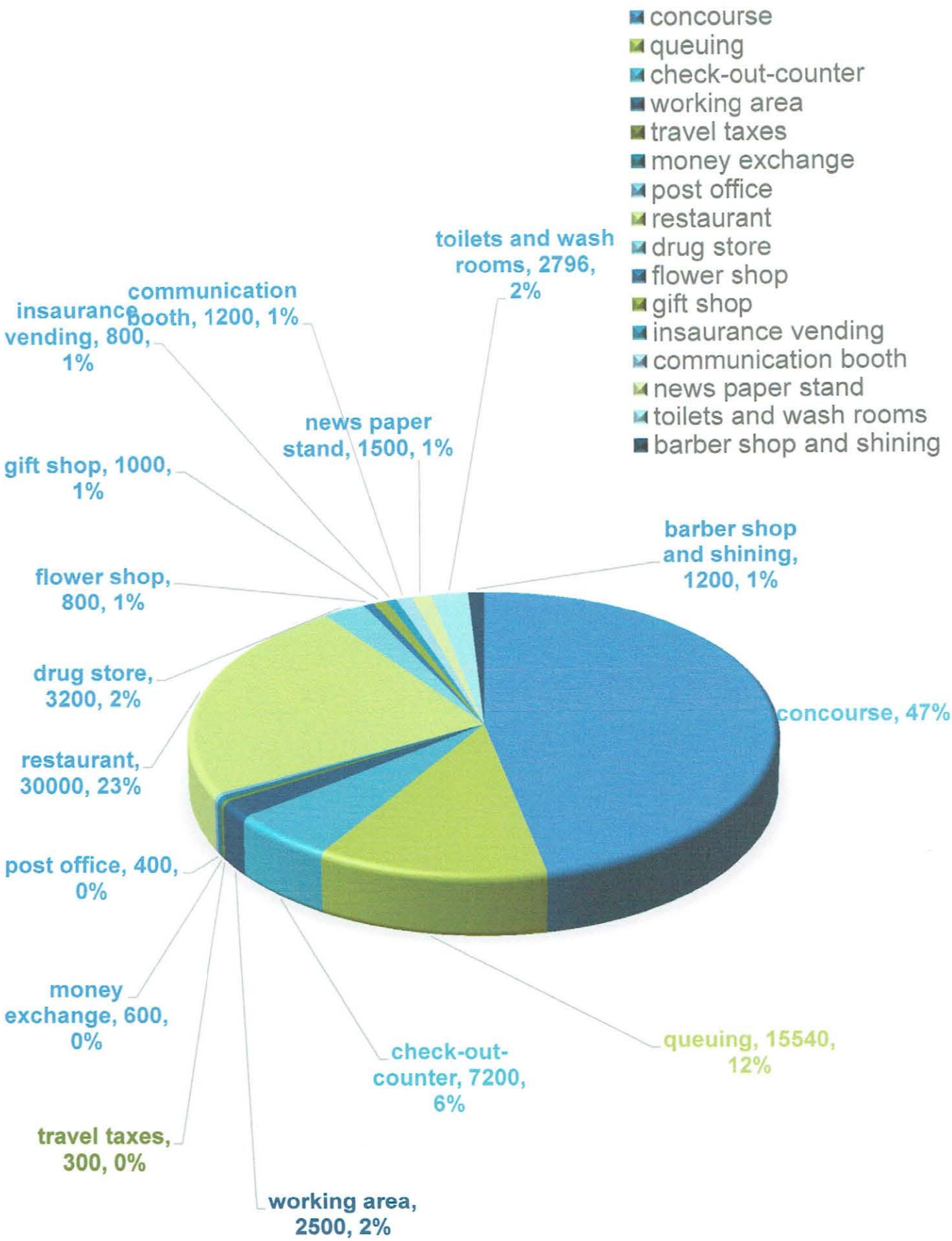
Pie chart:

- International departure lounge. (145626 sft)
- Inspection, customer and health service. (20113 sft)
- Immigration & naturalization. (7590 sft)
- International waiting lounge. (6620 sft)
- International arrival. (162150 sft)

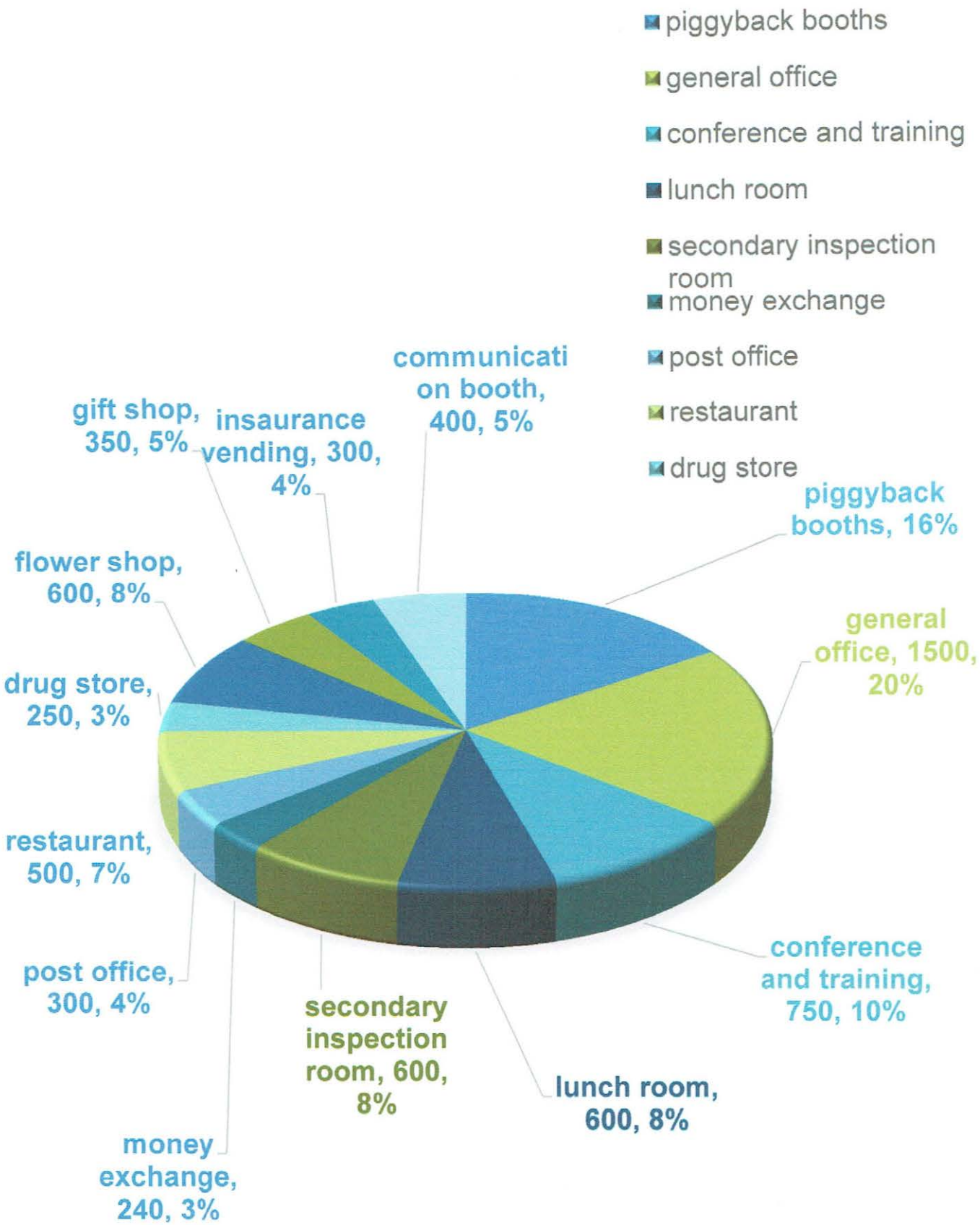


International Departure

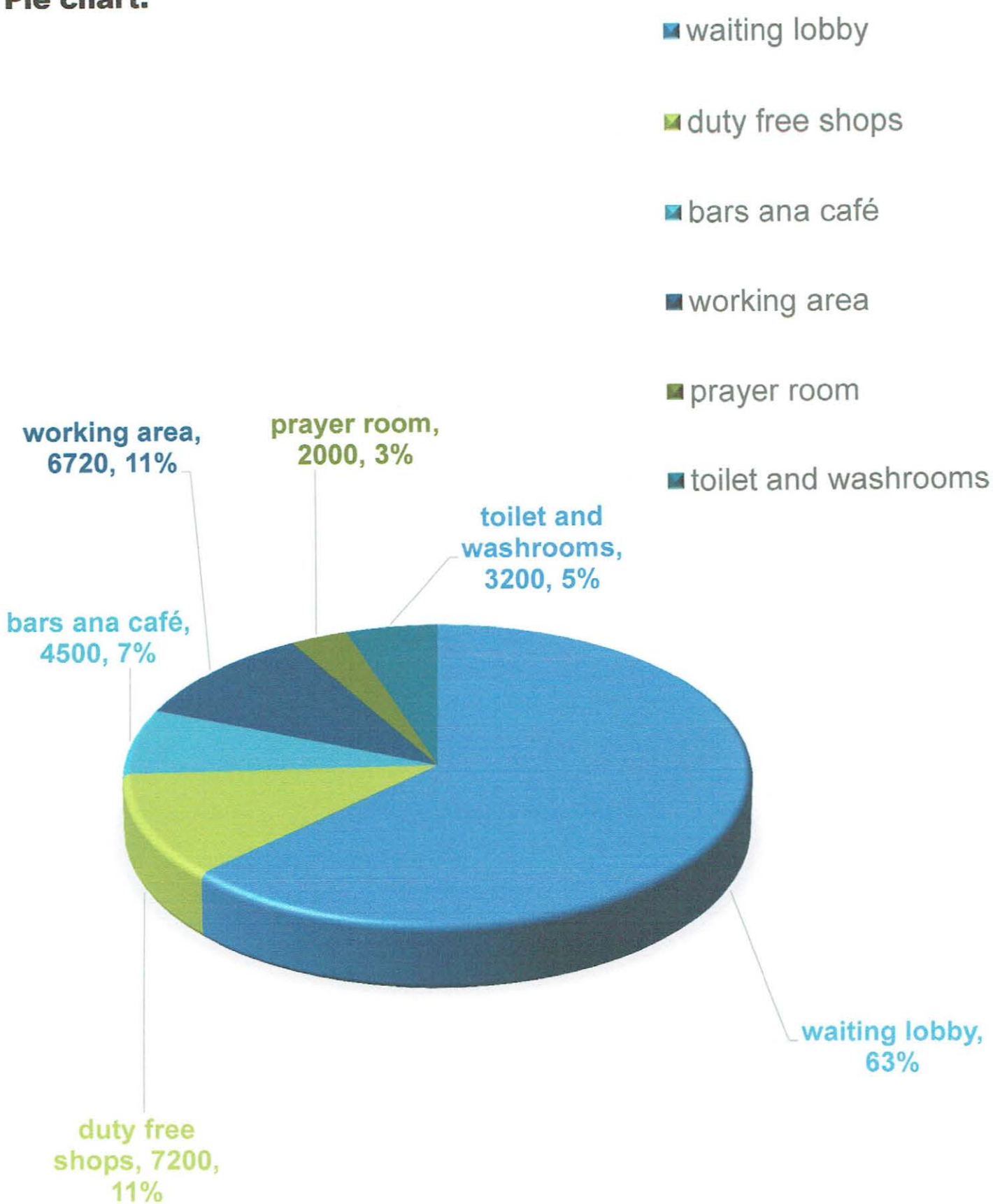
Pie chart:



Immigration and naturalization Pie chart:

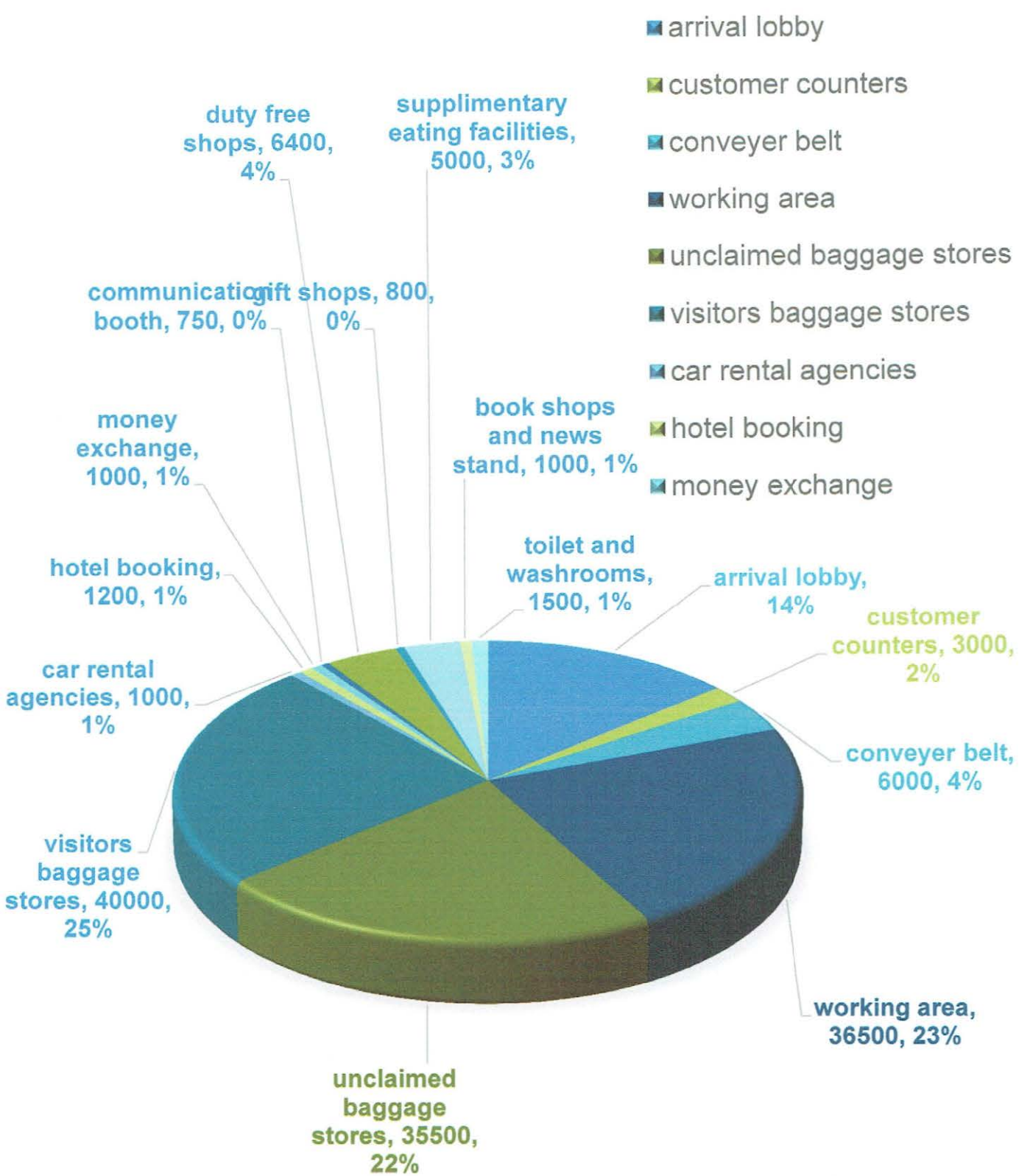


International waiting lounge
Pie chart:



International arrival passengers

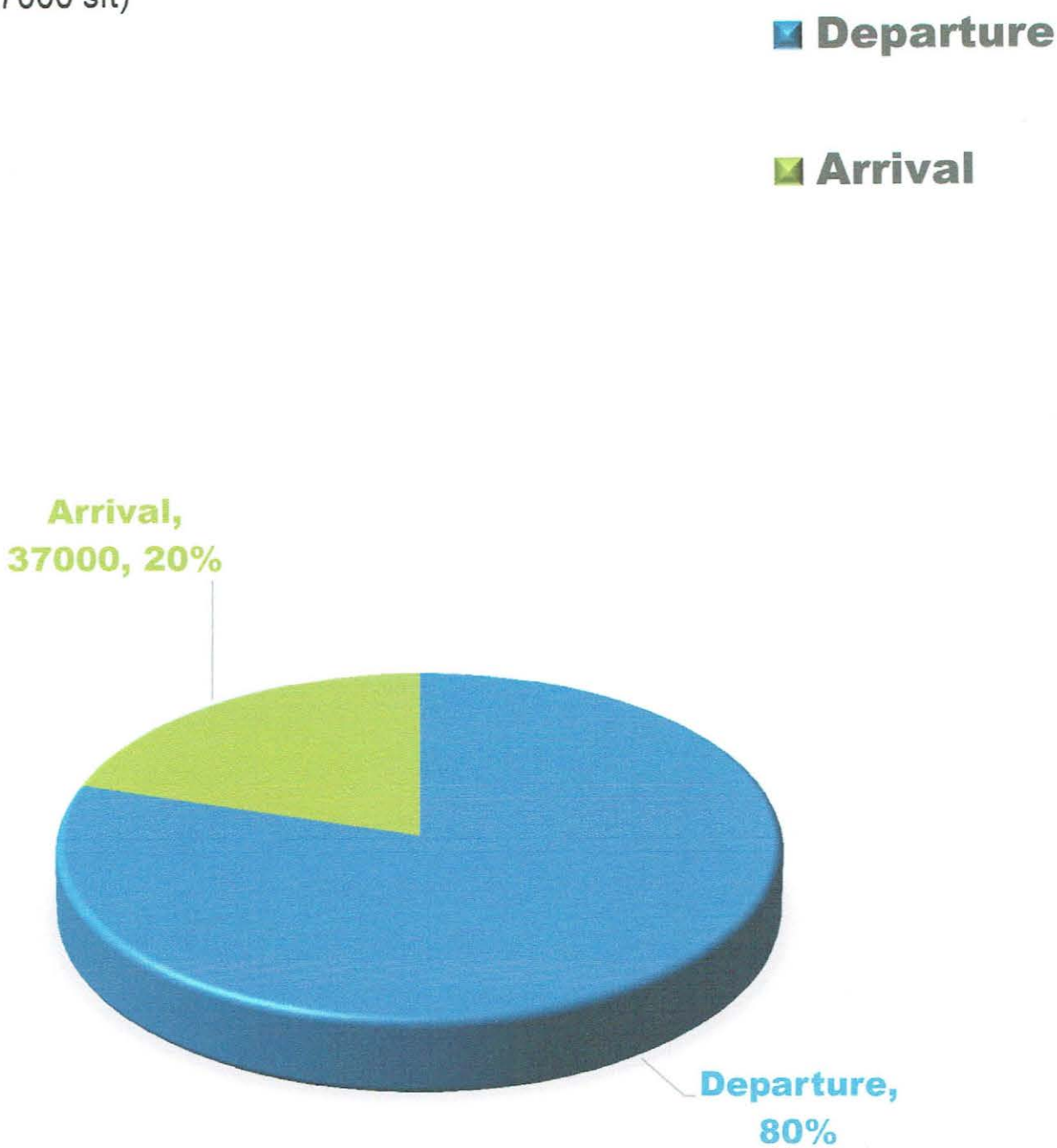
Pie chart:



Facilities for Domestic passengers

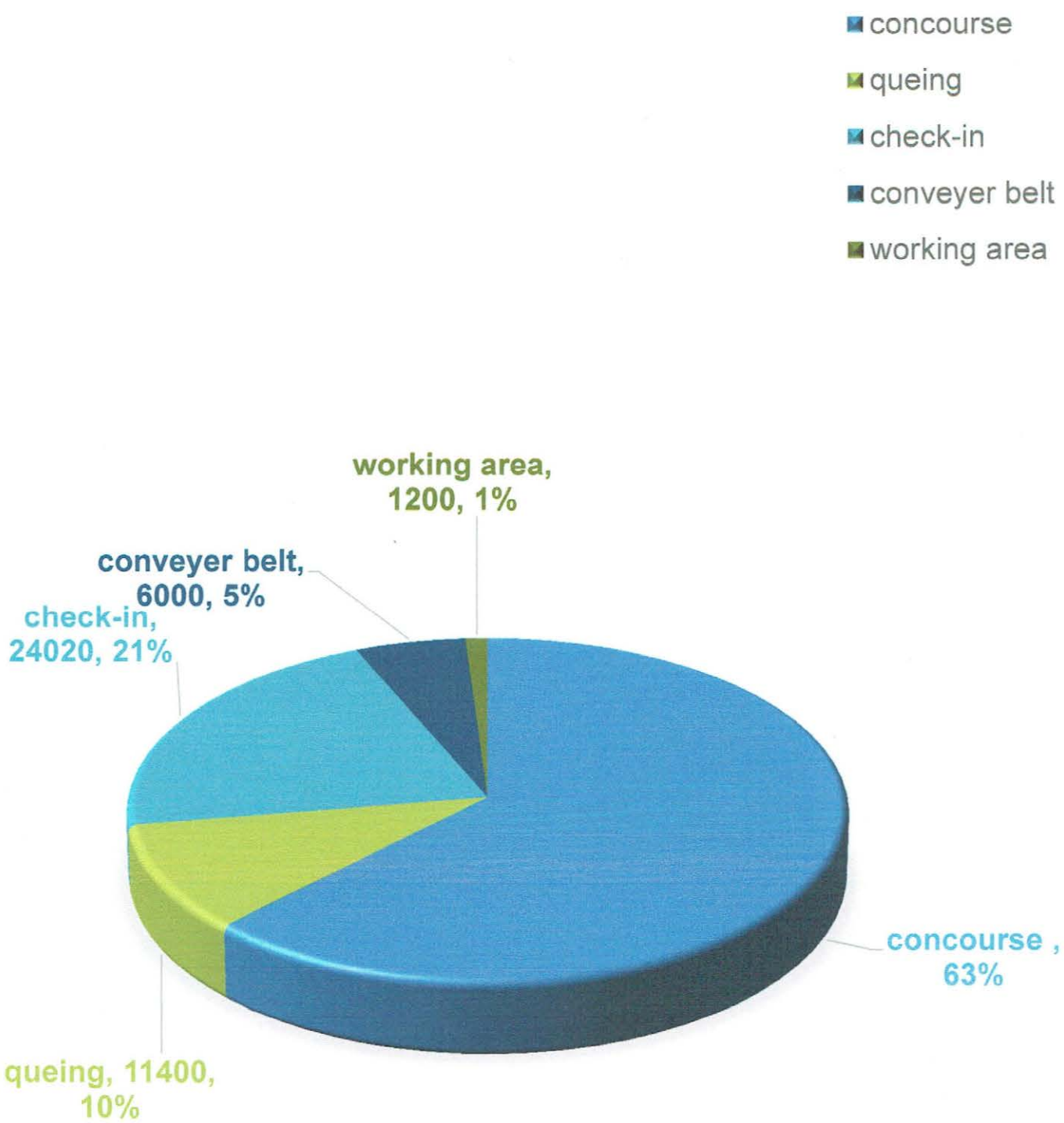
Pie chart:

- Departure. (146700 sft)
- Arrival . (37000 sft)



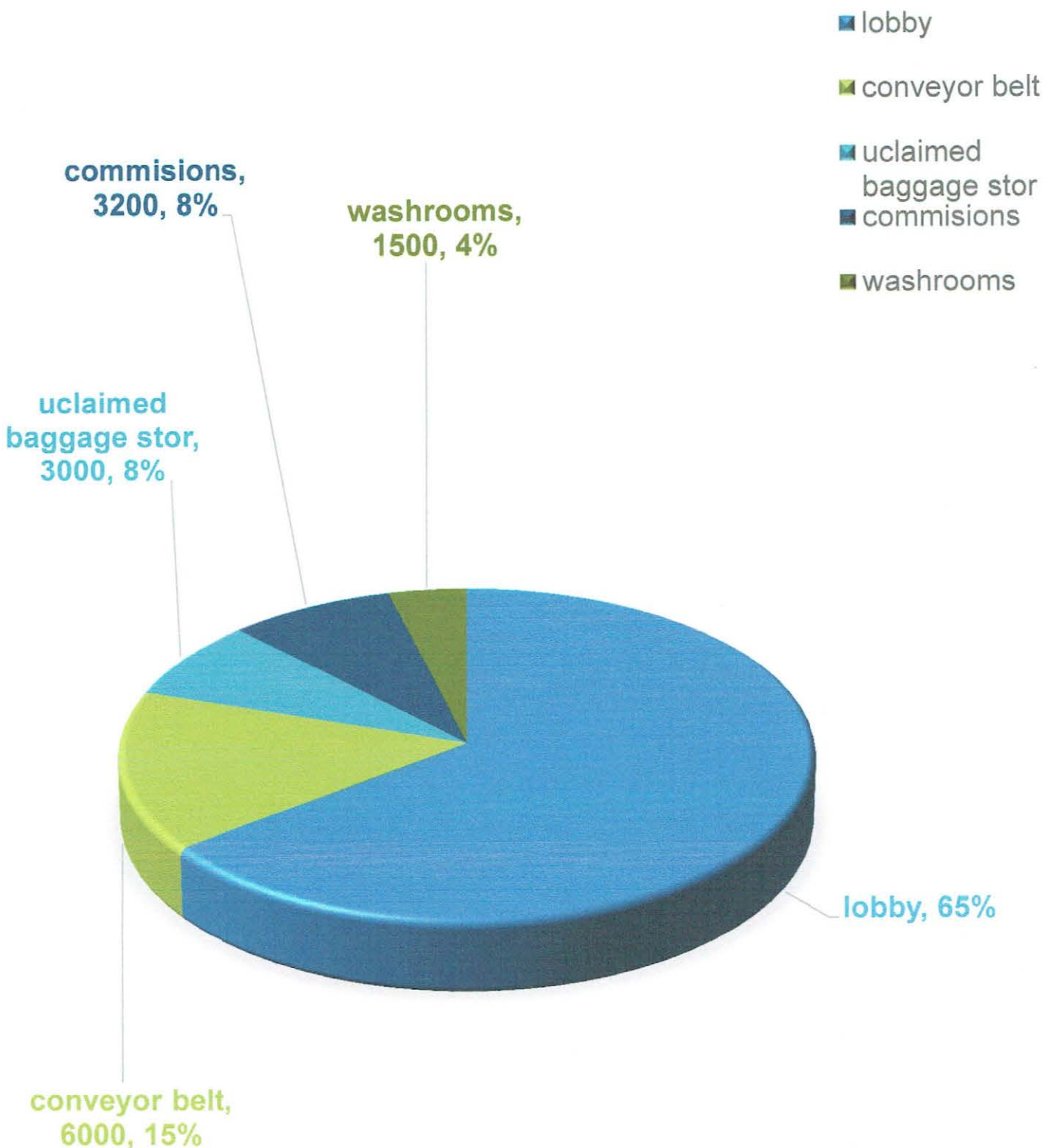
Facilities for Domestic passengers

Pie chart:
Departure



Facilities for Domestic passengers

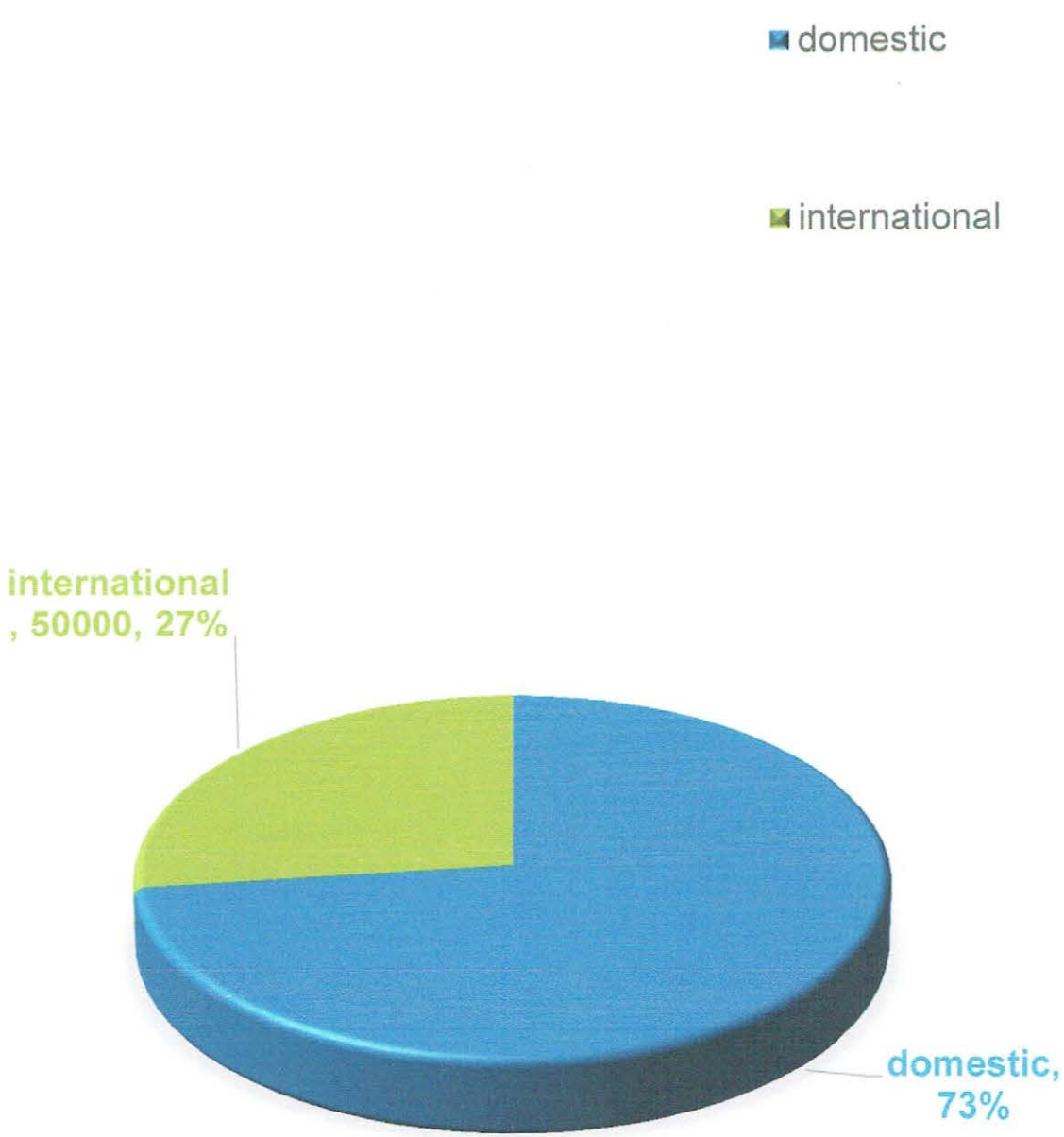
Pie chart:
Arrival



Cargo facilities

Pie chart:

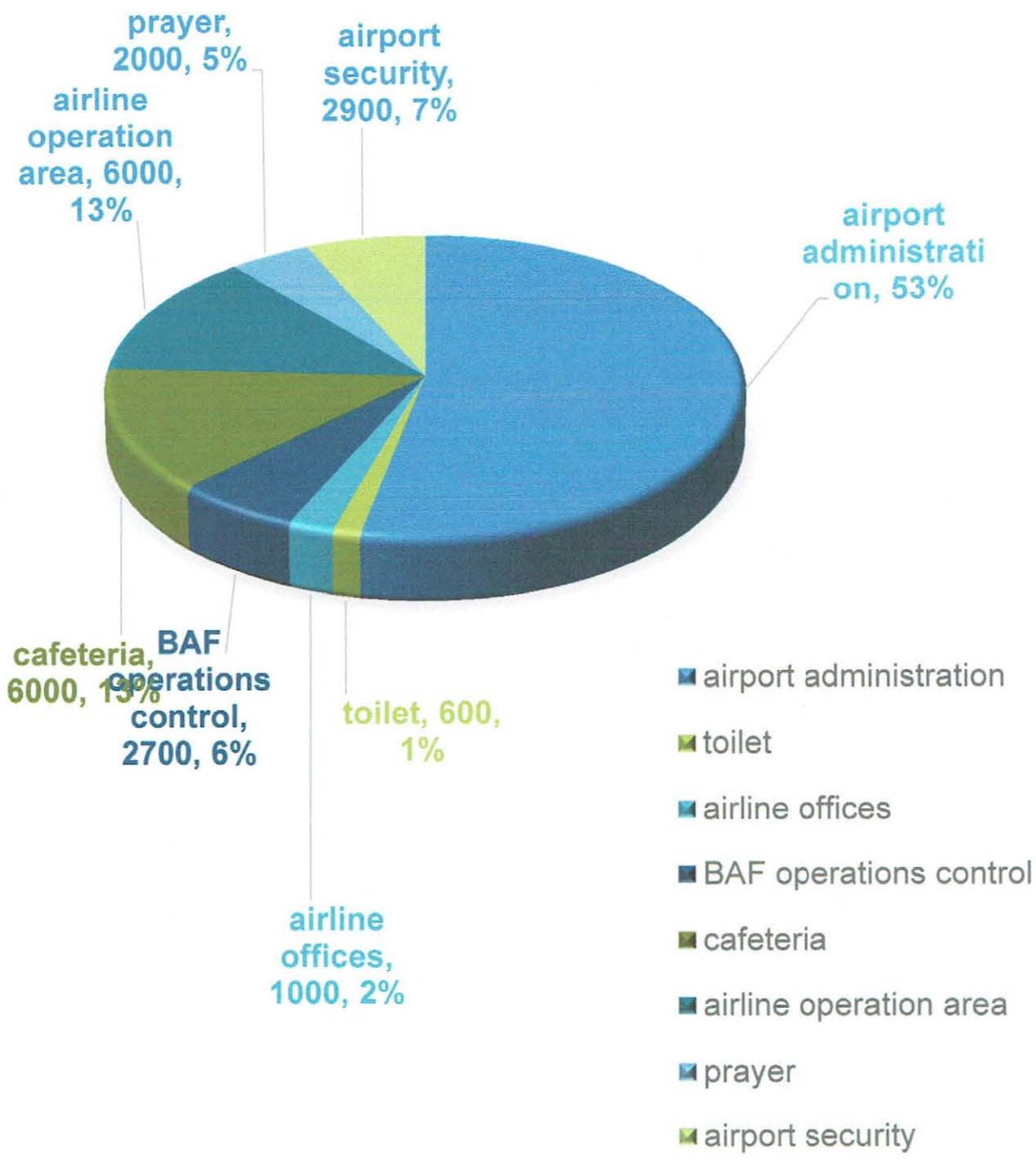
- Domestic. (135000 sft)
- International . (50000 sft)



Ancillary facilities

Pie chart:

- Airport administration. (24000 sft)
- Airline offices . (1000 sft)
- BAF operation control. (2700 sft)
- Cafeteria. (6000 sft)
- Airline operation area. (6000 sft)
- Prayer. (2000 sft)
- Airport security (2900 sft)



Program Zoning

A. International Terminal:

1.Concourse
2.Check in counters
3.Immigration
4.customs
5.Finances
6.Offices
7.Waiting Lounges
8.Restaurant / Cafe
9.9.Stores/ Shops
10.Medical Facilities

B. Domestic Terminal:

1.Concourse
2.Check in Counters
3.Waiting Lounges
4.Offices
5.Restaurant
6.Prayer room
7.Shops

C. Other:

1.Control Tower
2.Flight kitchen
3.Hangers
4.Apron
5.Taxiway
6.Runway
7.Helipad
8.Parking lot
9.Cargo Terminal
10.Fire Station
11.VIP Terminal

Zoning

Public

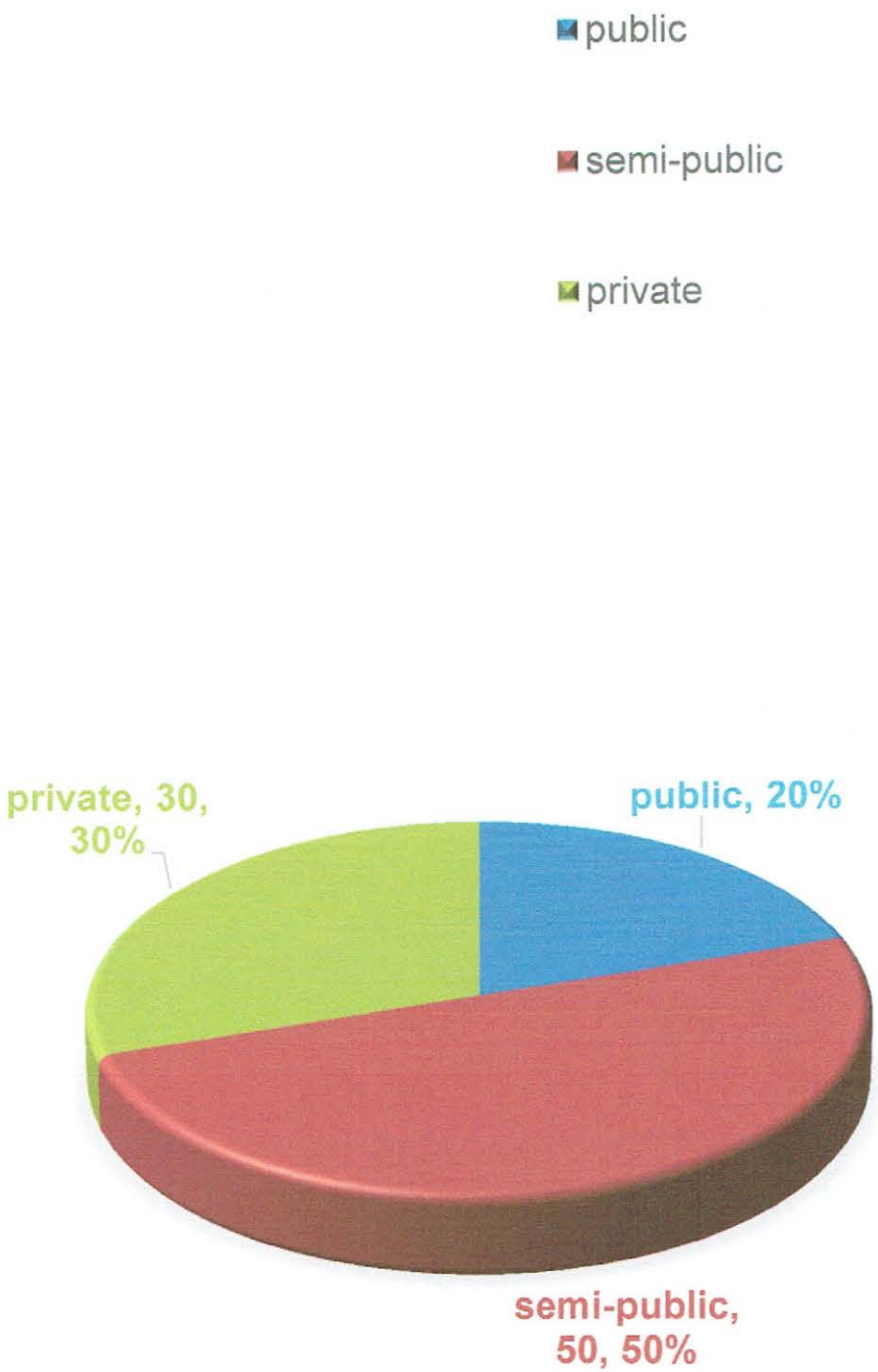
- Concourse hall
- Ticket counters
- Cafeteria
- Check in counters
- Airlines and hotel both
- Prayer room
- parking

Semi-Public

- Arrival lounge and facilities
- Departure lounge and facilities
- Immigration
- Custom
- Lost and found

Private

- Tower building
- Office
- Cargo building
- Work station



Zoning

Zoning wise airport can be divided into three parts

- Air side
- Terminal building
- Land side

Airside

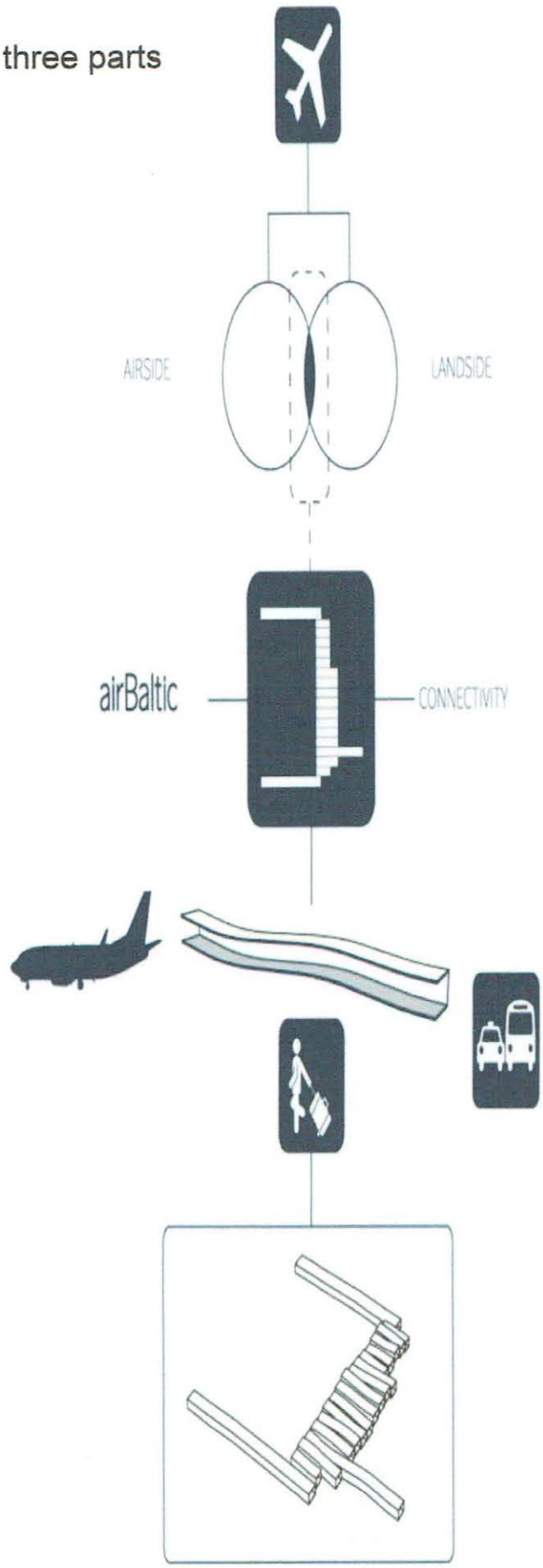
- Apron
- Runway
- Taxiway

Landside

- Parking curb

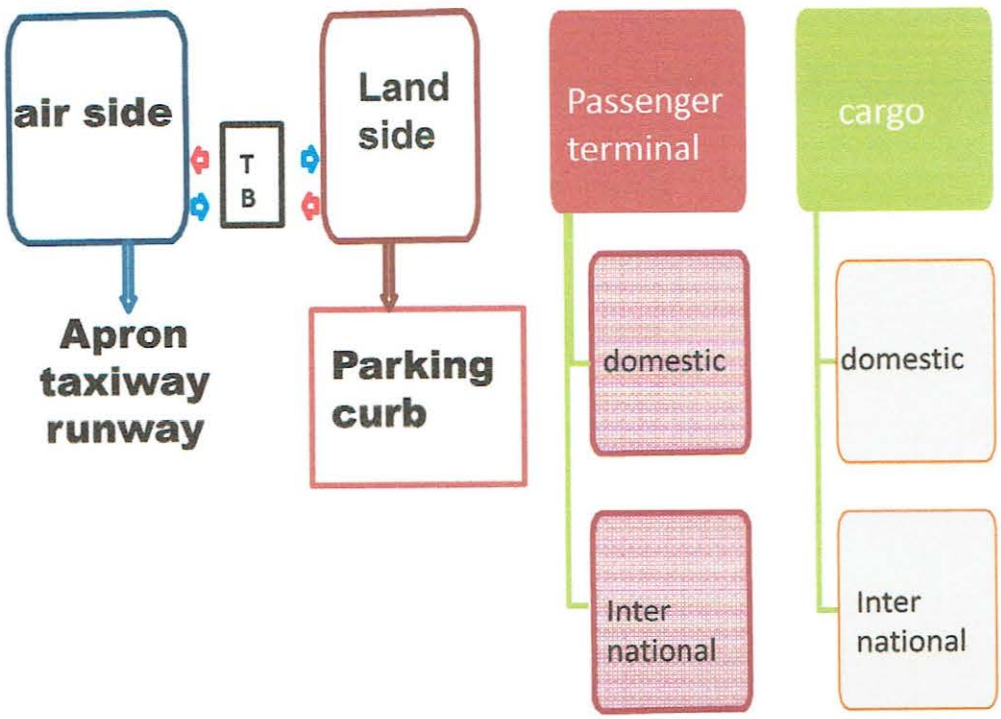
Terminal building

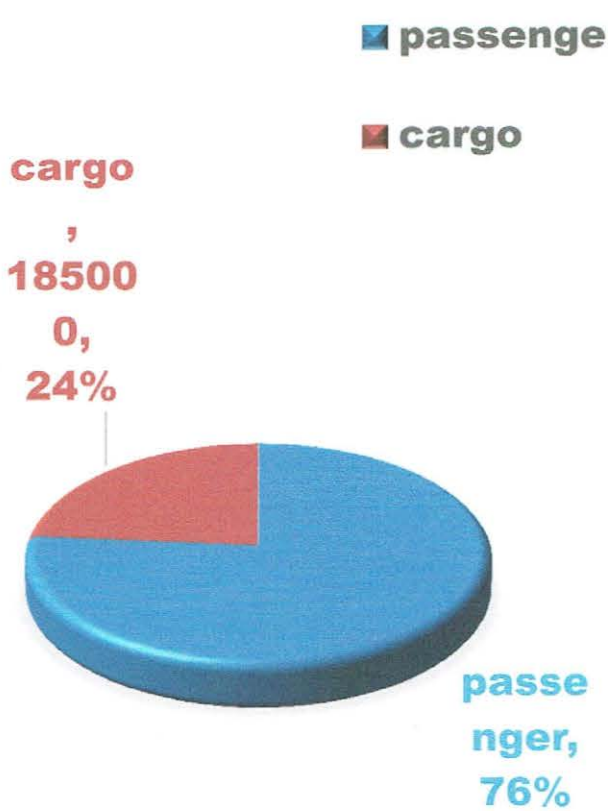
terminal building is between land side and air side allowing passengers to pass through different security levels.



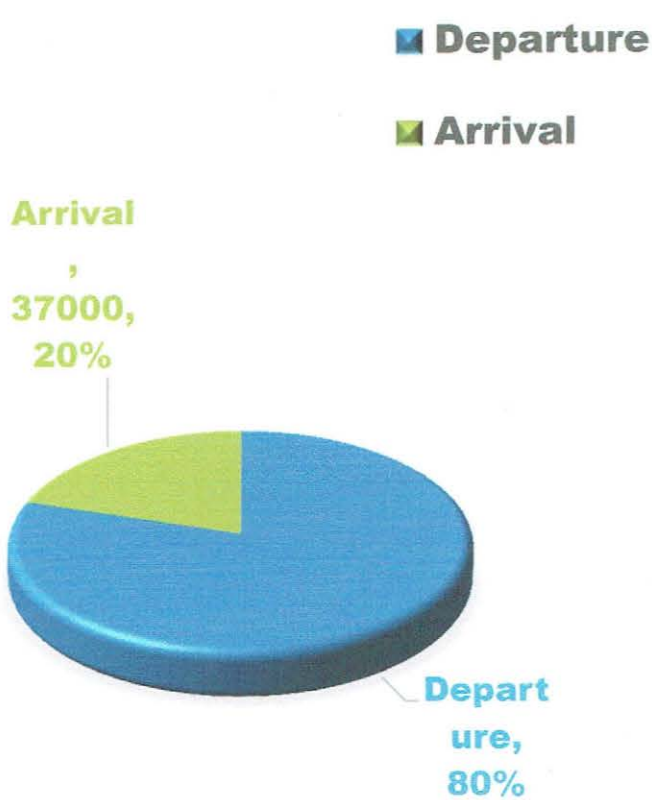
Key divisions of the international airport-

- Terminal building
- Runway
- tower



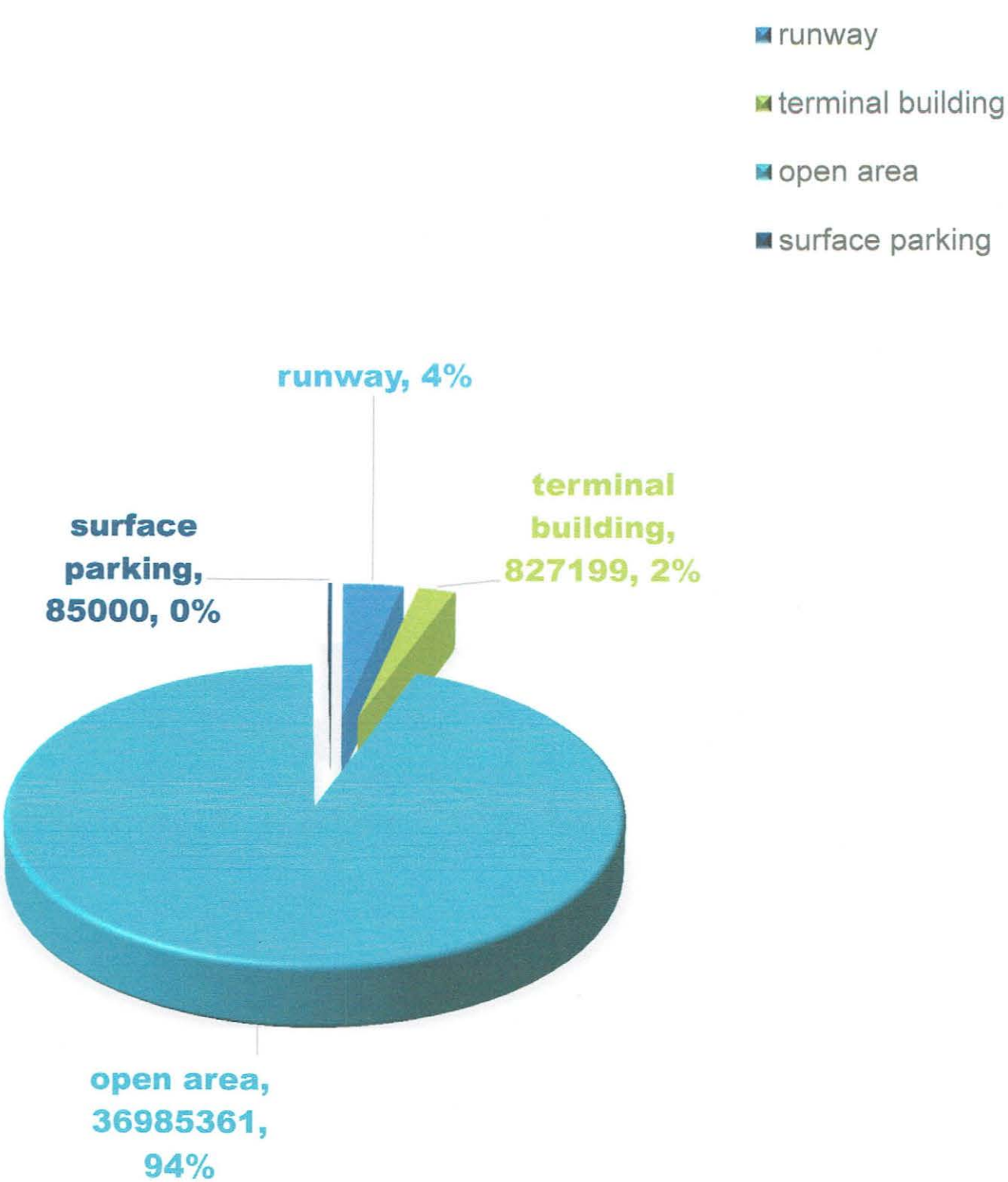


Percentage of terminal and cargo facilities

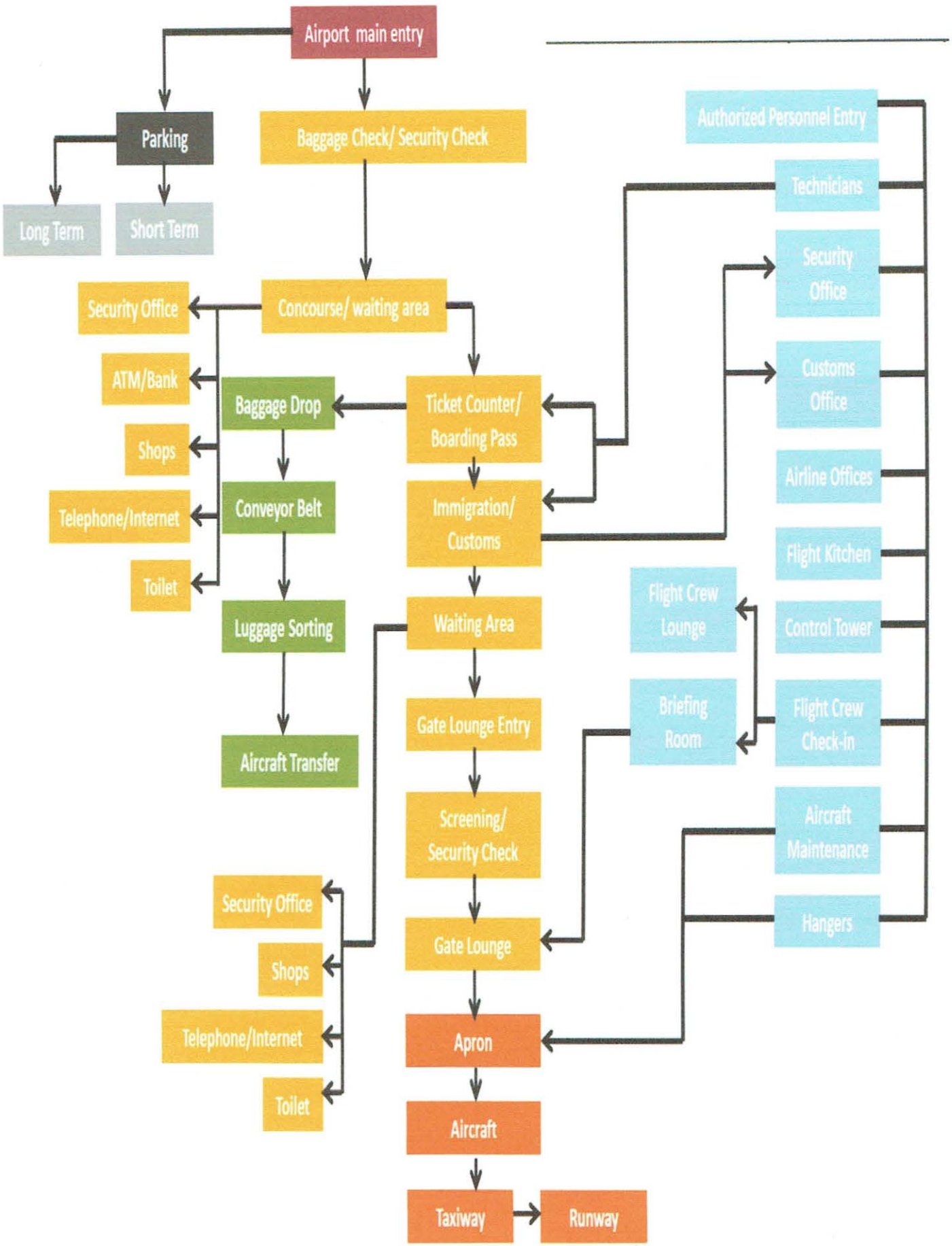


Space required for Departure and Arrival

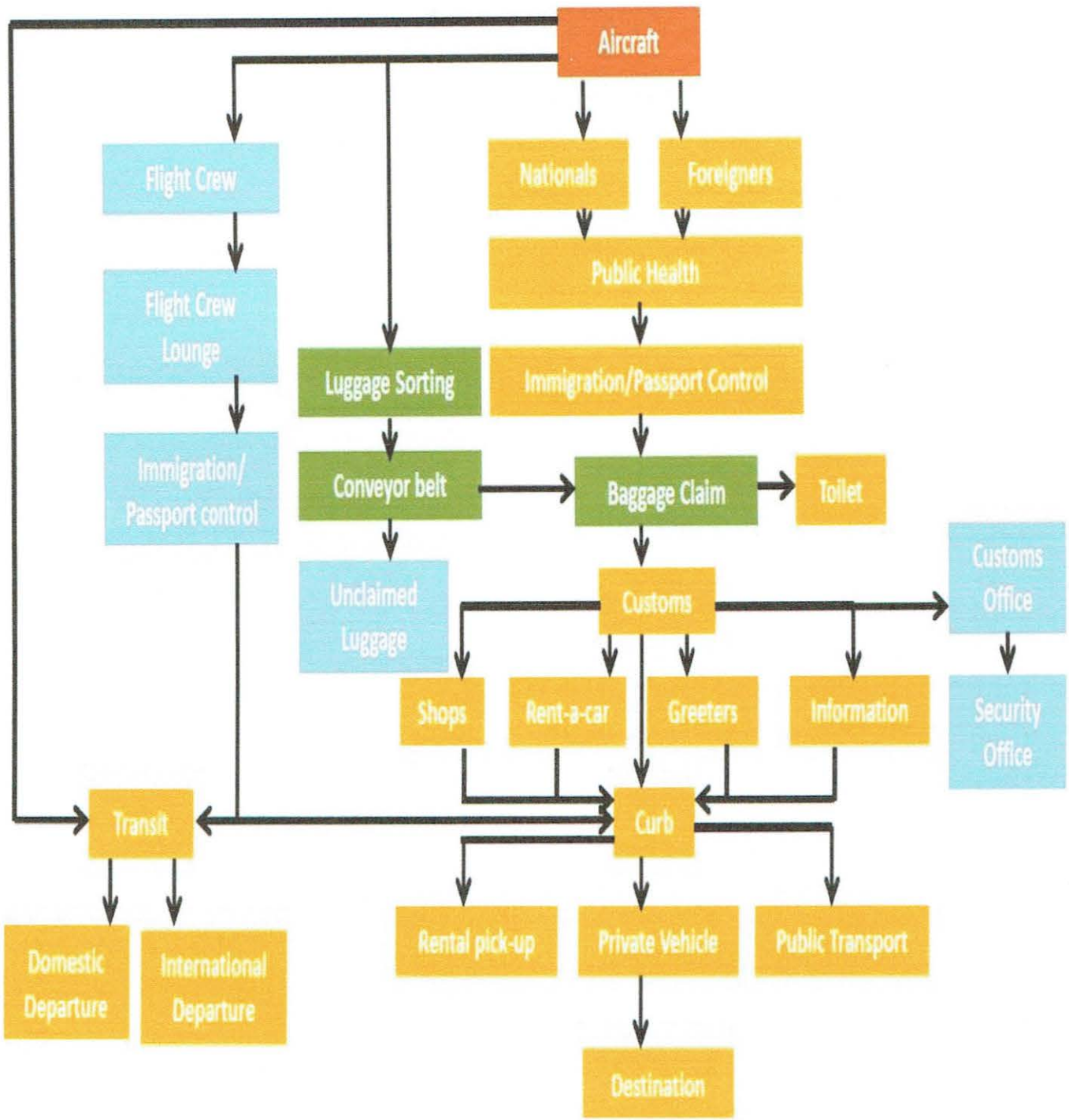
Built and open area ratio:
Total site area: 39247560 sft
Runway : 1350000 sft
Terminal building : 827199 sft
Surface parking : 85000 sft
Open area: 36985361 sft

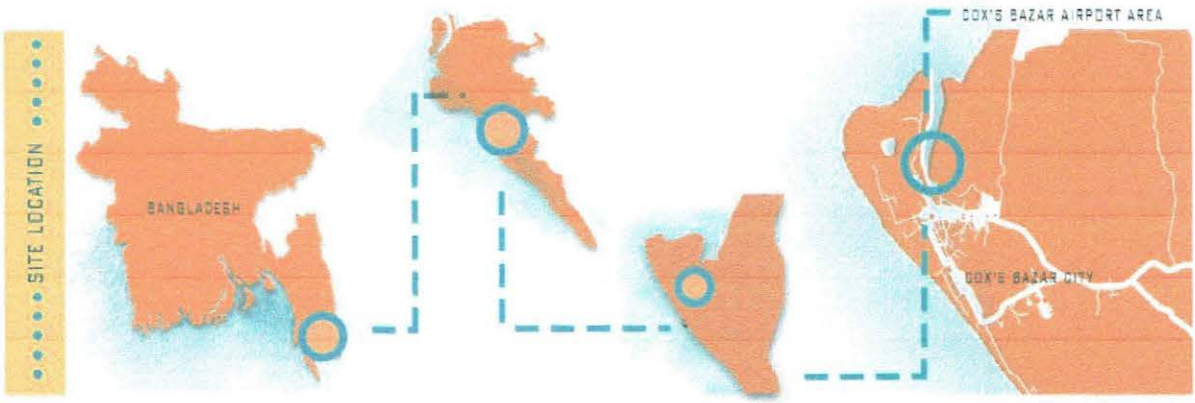


Departure Passenger Flow



Arrival Passenger Flow





The site location and and the site informations are provided in the following figures. The site location itself was a great inspiration for the project.

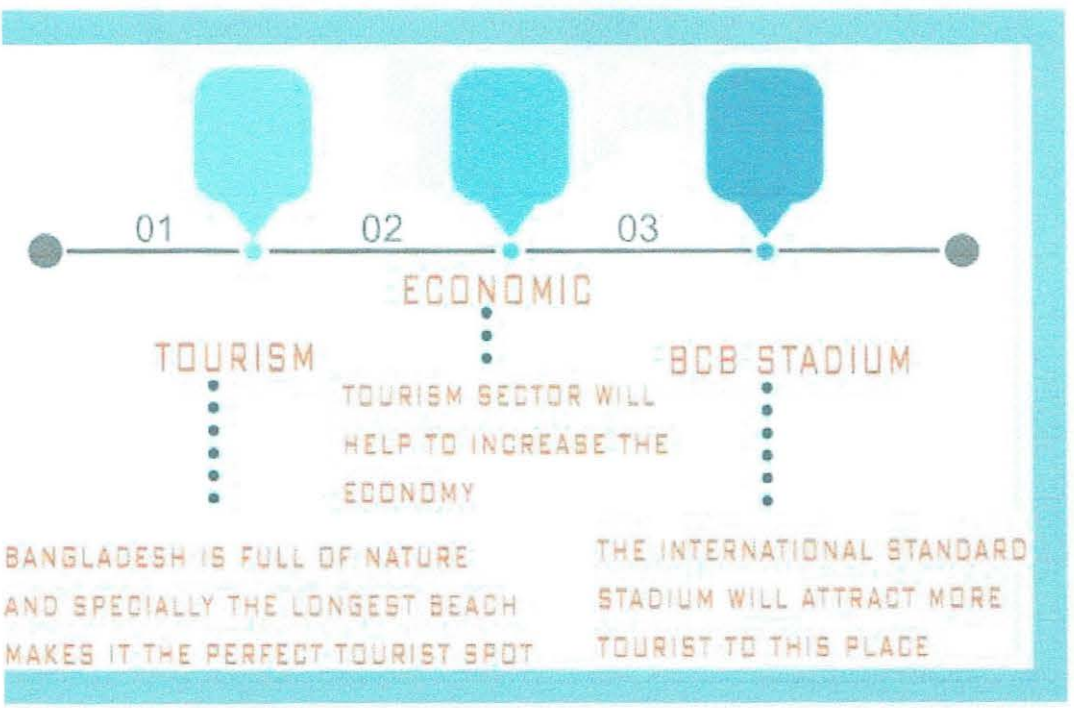
The most important task was to determine the feasibility of an airport in cox bazar. The question of why an international airport in cox bazar rose.

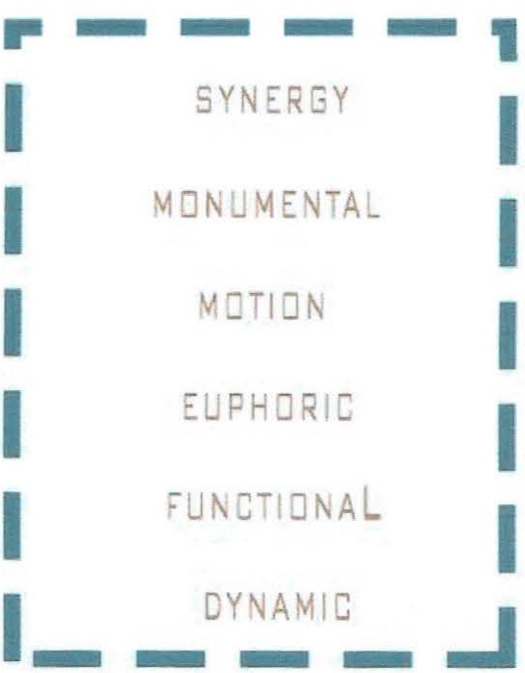
The other international airports such as in dhaka,chittagong and shyly are all used as multi-dimensional popularity airports that means they are used as all purpose zonal airports. Whereas cox bazar is the only area determine as a solely tourism popularity area just like Phuket or Bali.

In recent years the number of tourist has increased drastically, more increase in the number was seen after the beach in this particular area was announced as the longest beach of the world. This change in number shows the possibility of Bangladesh attracting more visitors and becoming a tourist area.

Due to the following reasons the tourist ministry of Bangladesh announced the year 2016 as the tourism year of Bangladesh.

Therefore Cox bazar in Bangladesh can be a landmark as a solely tourists spot in the development sector for the progression of Bangladesh and its people.

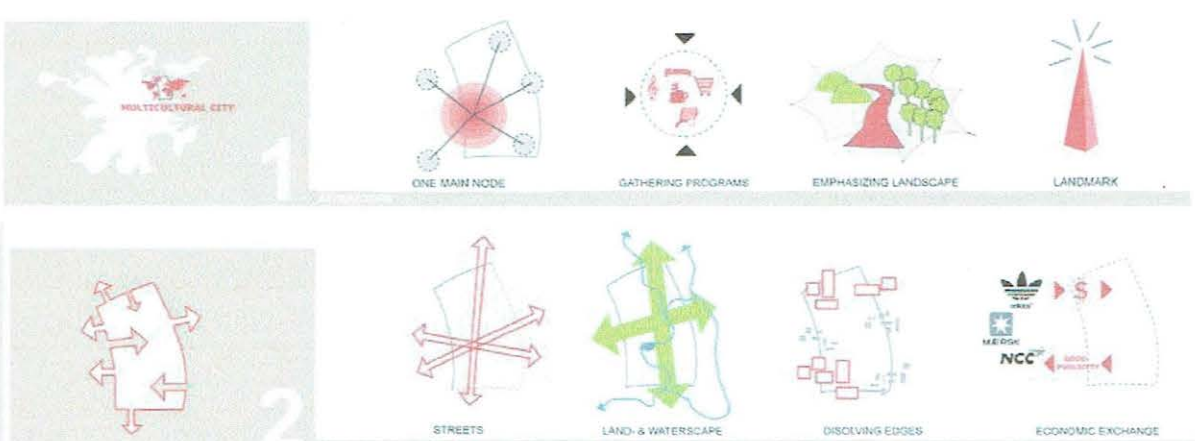




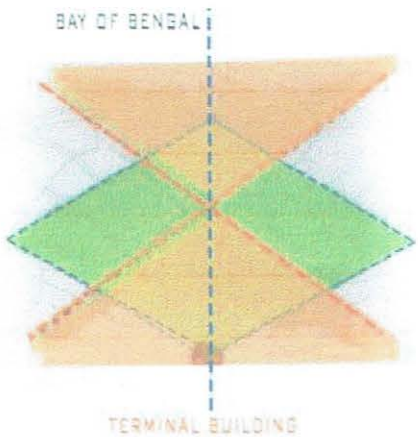
The following functions were already proposed in the development plan of the whole master plan of the airport.

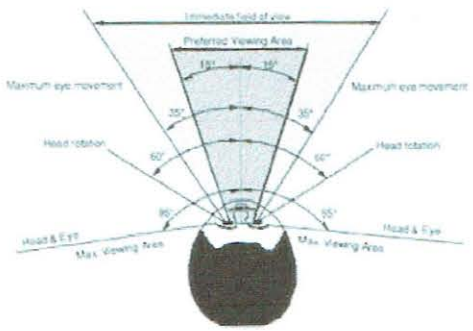
The following requirements were given for the international terminal as per the CAAB guide book which was used as a reference to building this project

Considerations of Master Plan

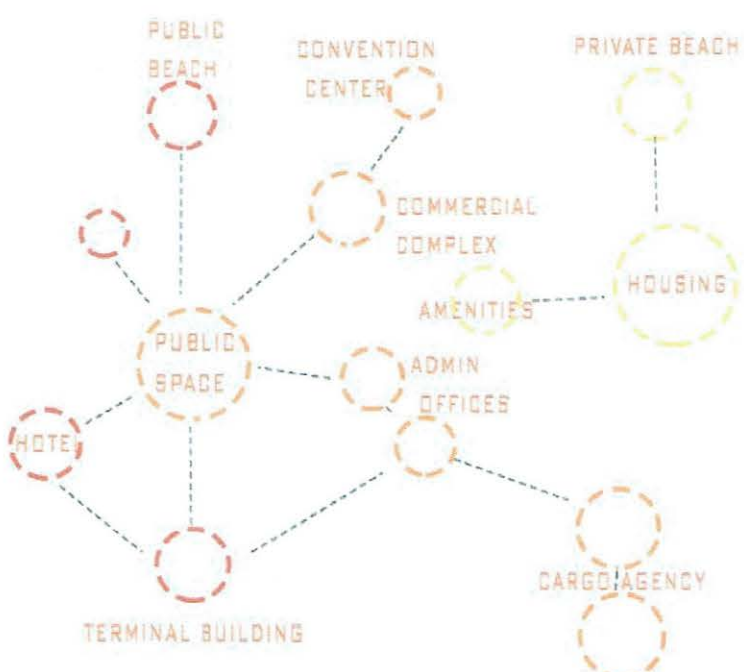


The main two key points considered while designing the master plan is shown in the above diagram. The two point where the main influence of introducing the required new function to generate the space as an active place.





The human eye level reference was another key consideration taken into account. The functions where set according giving importance to the terminal building to stand as an individual structure without any interruption of other structures.

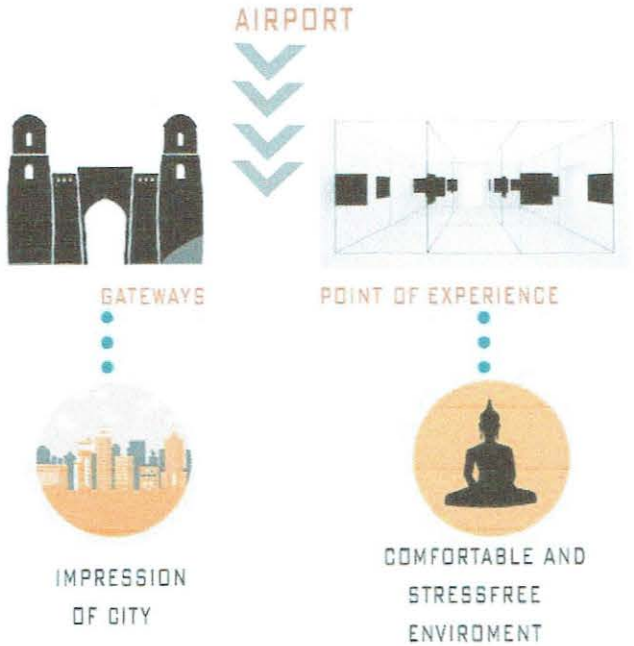


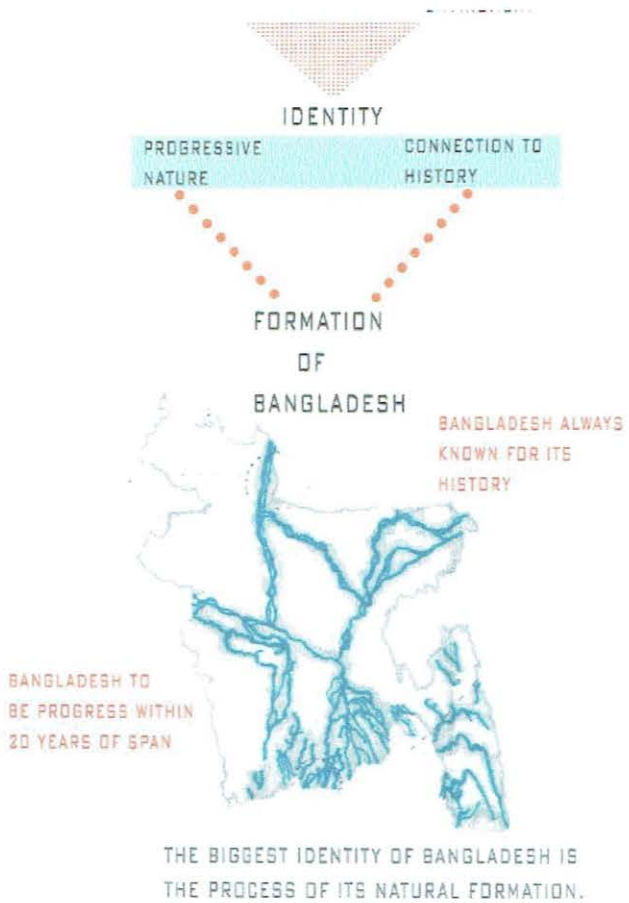
Zoning of the Master Plan:

Concept:

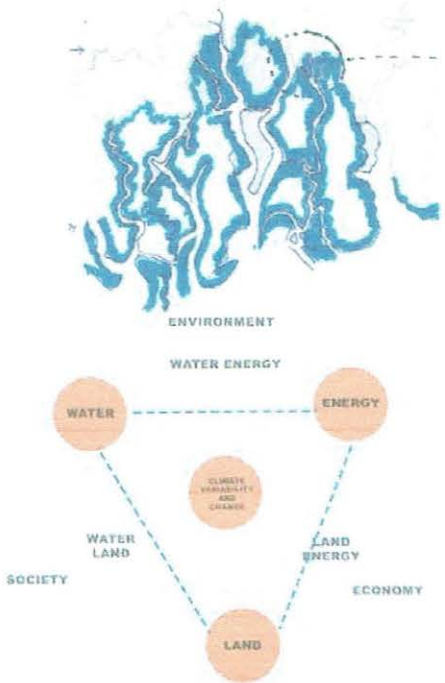
Airports are taken as gateways,these are the most important structure considered in a city, as they give the first impression of the city to the visitors coming in.

On the other hand airport is a place of emotion and drama, a perfect point of experience. Being such a sensitive area the journey needs to be comfortable and stressful environment.





Airports need to represent the identity of a country, therefore the search was for something that shows the progressive nature of Bangladesh and also which connects to past. The main Inspiration was therefore taken from the formation of Bangladesh the delta formation as it relates to both the point mention before.



DELTA FORMATION

INTER-RELATION OF RIVER AND LAND

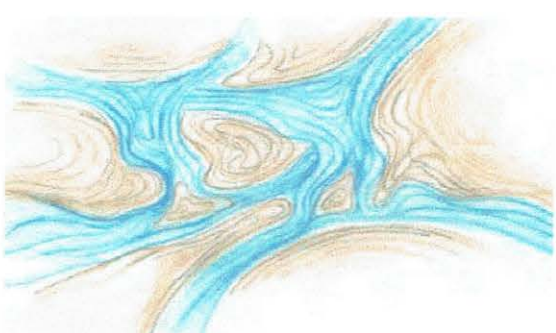
FLUIDITY

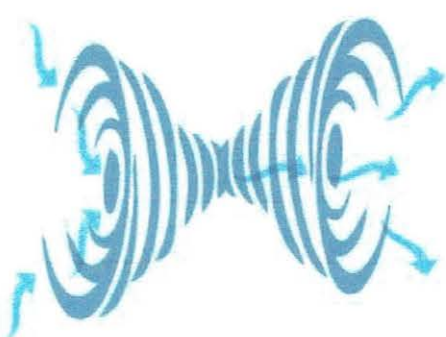
DUE TO MOTION OF RIVERS

AS ARESULT OF A MOTION AT A POINT

The whole master plan and the terminal was design from the inspiration of the delta formation. The terminal being the point of dispersion and the point of immersion both at the same point.

Terminal Building Inspiration : Land Water Relationship

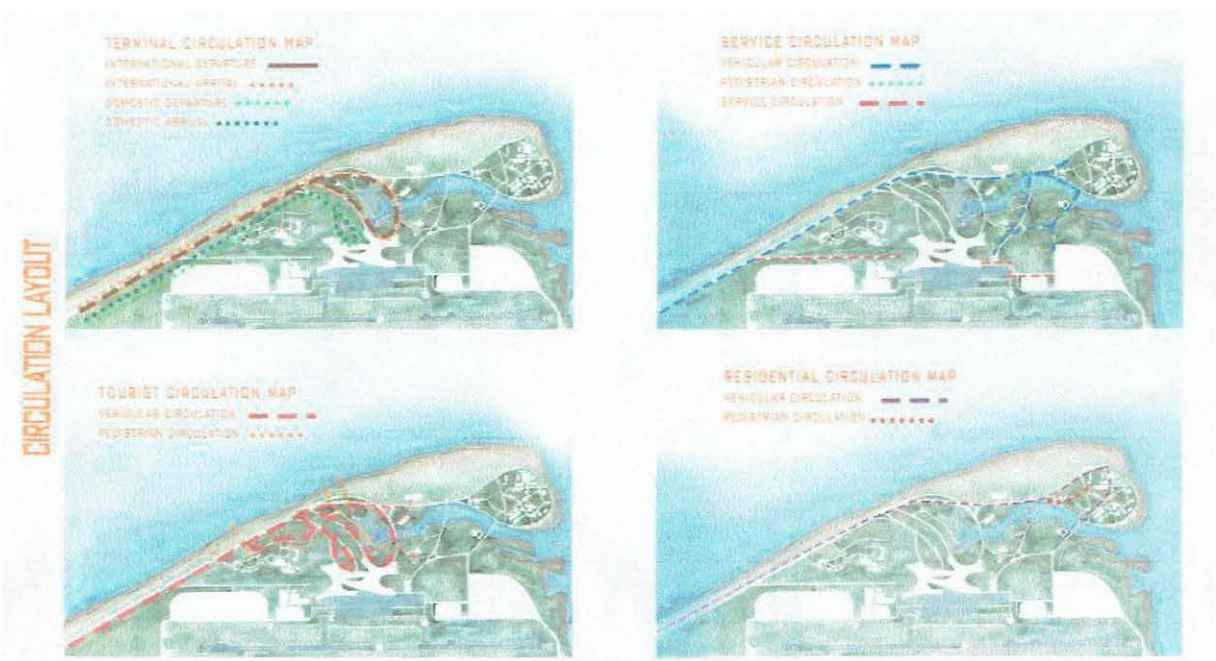




The whole terminal building was develop from the inspiration of water and land relationship.

Chapter_07: Drawings

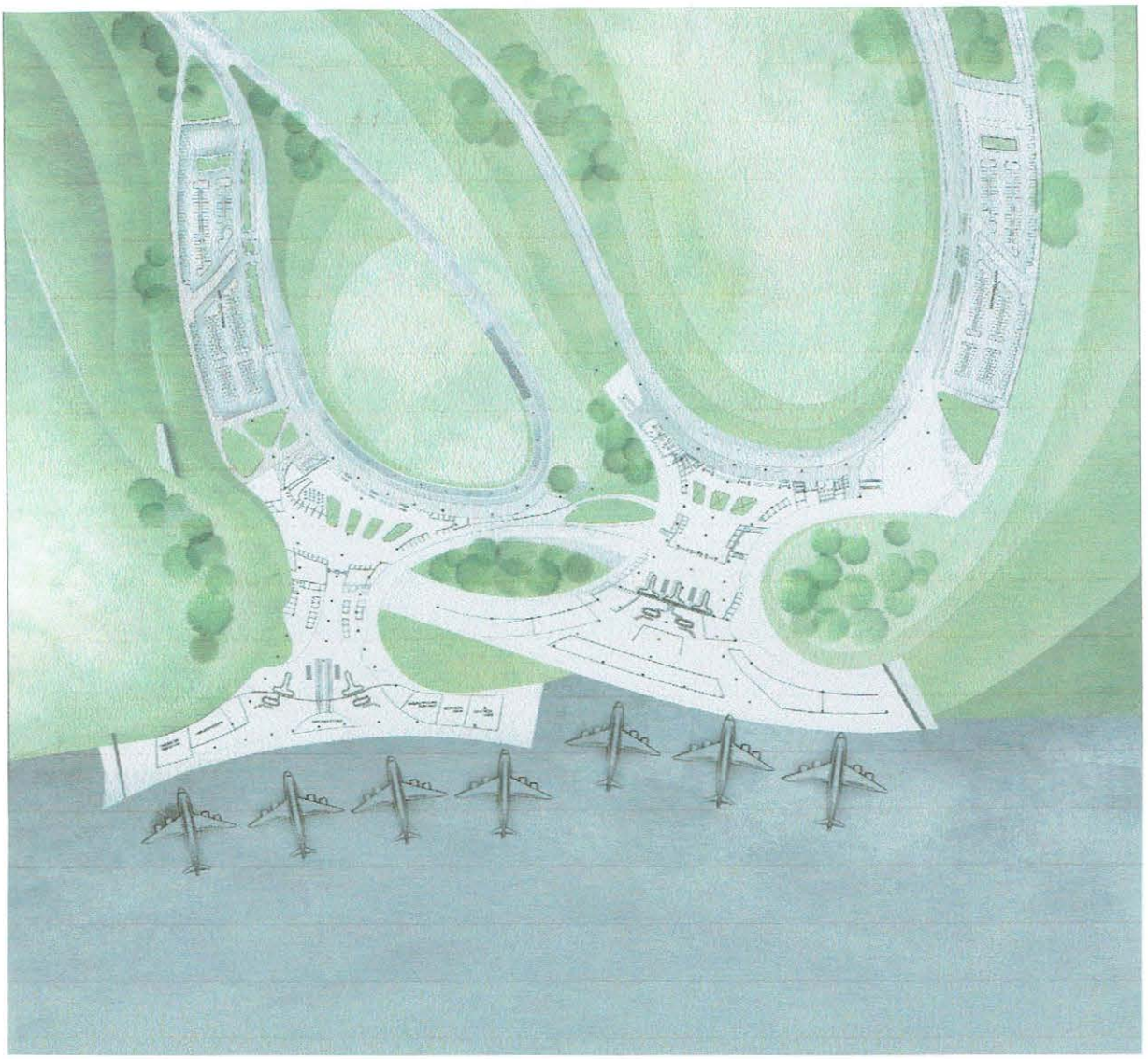
Master Plan And Its Circulation Layout



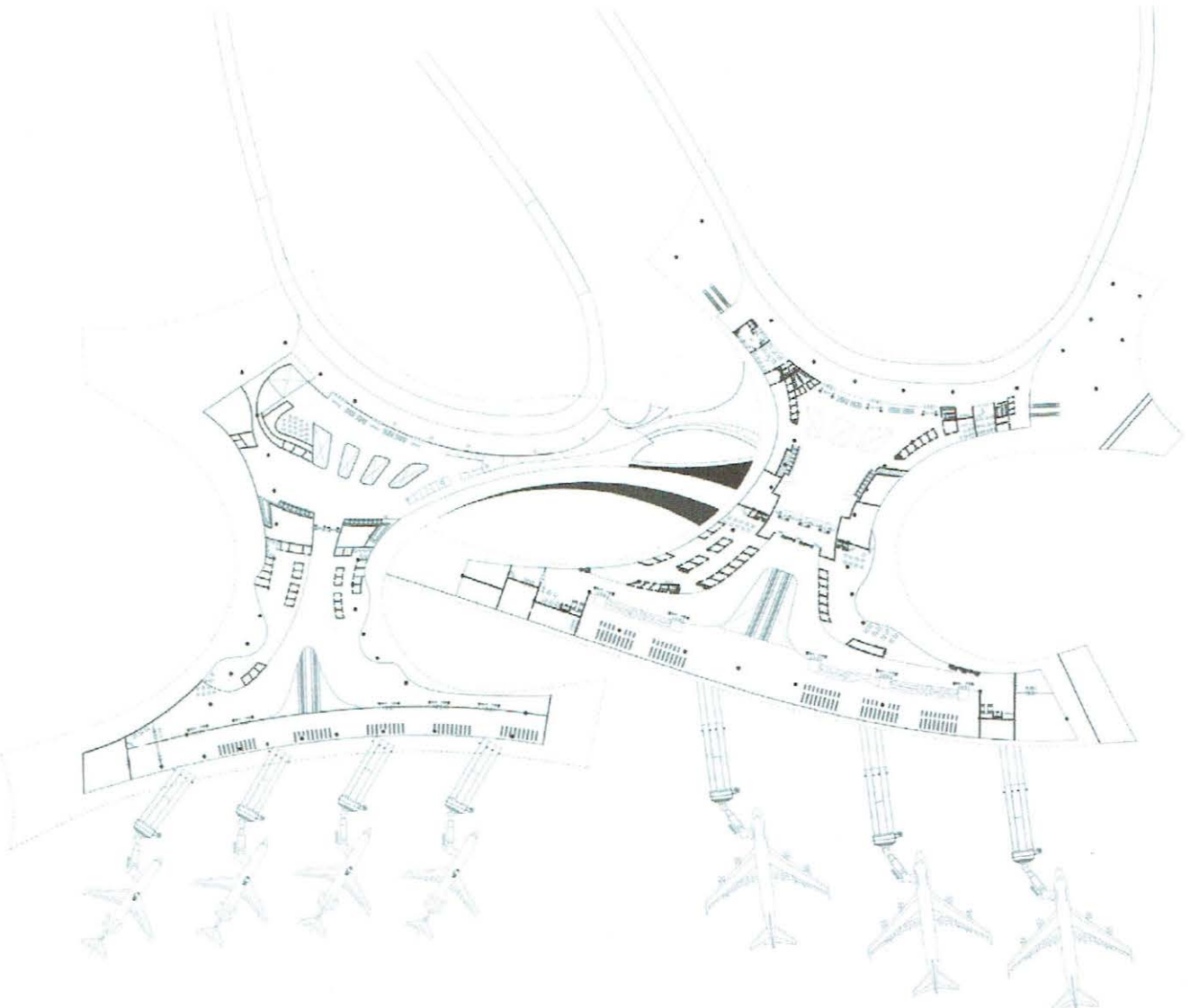
Conceptual Image of Areas In The Master Plan

1. Mosque
2. Housing
3. Hotel Area
4. Terminal
5. Public Space
6. Public Space

Plan of Terminal Building

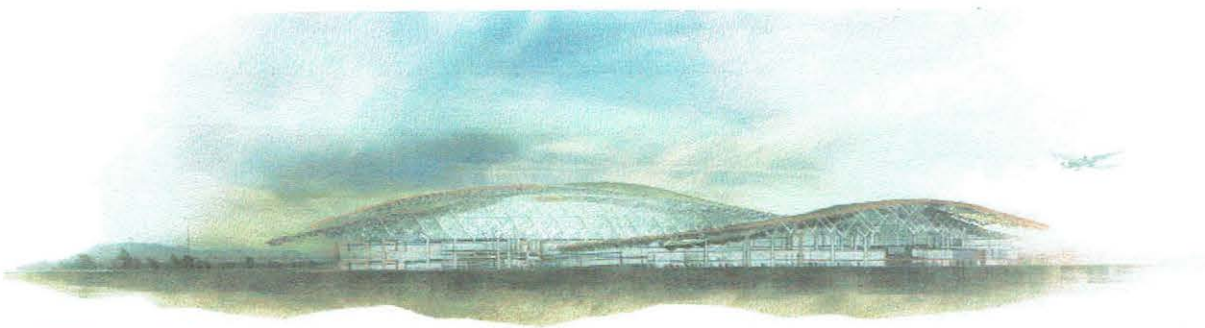


Ground Floor Plan



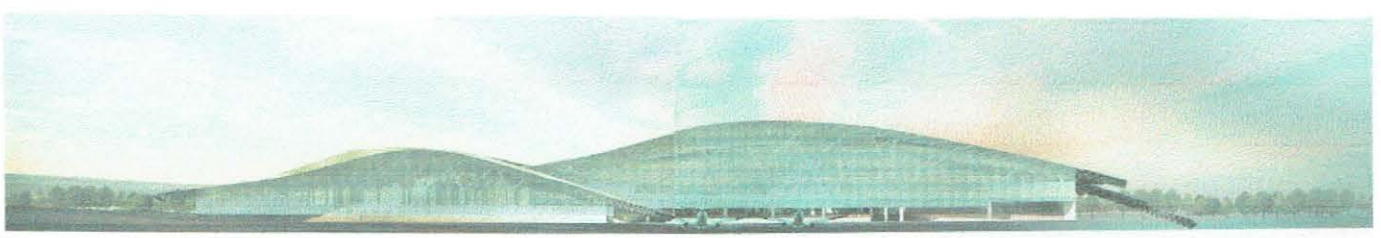
First Floor Plan

SECTION A-A'



SECTION B-B'

SECTION C-C'



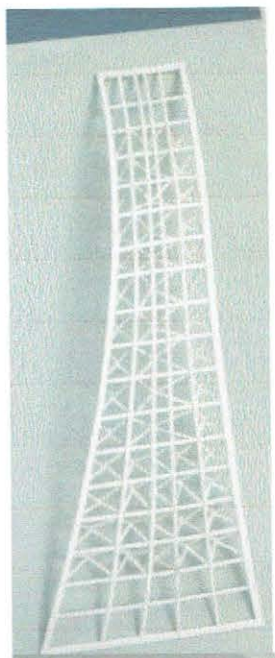
SOUTHEAST ELEVATION

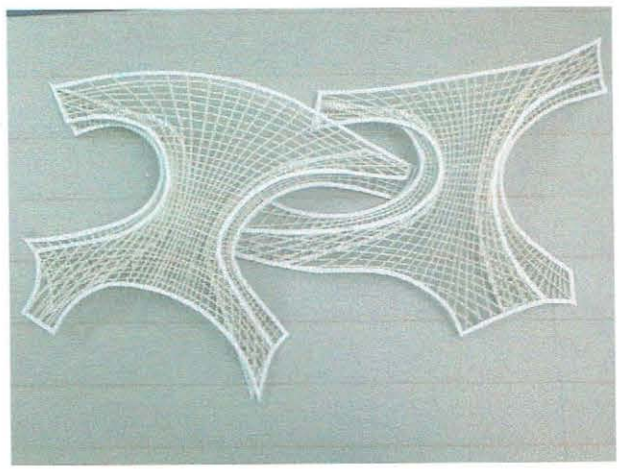
Chapter_08: Model Image

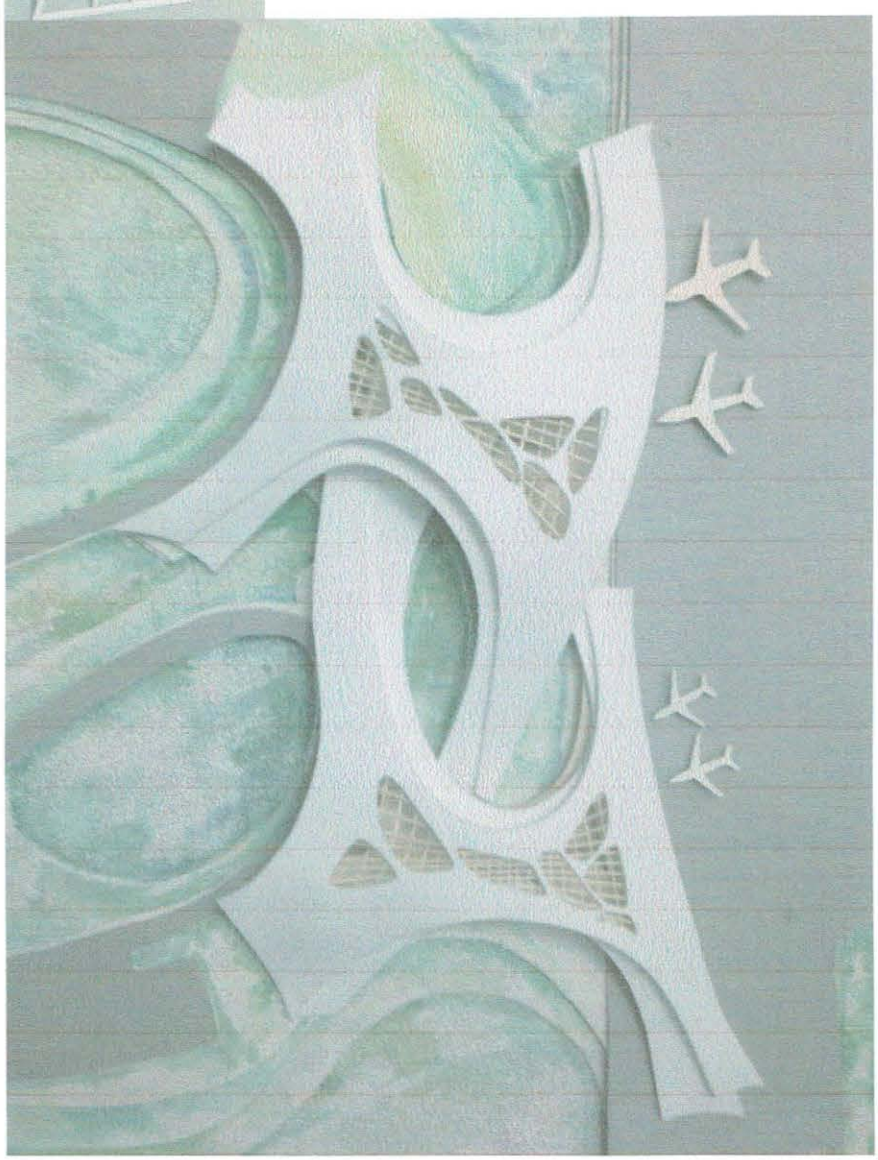
Structural Model

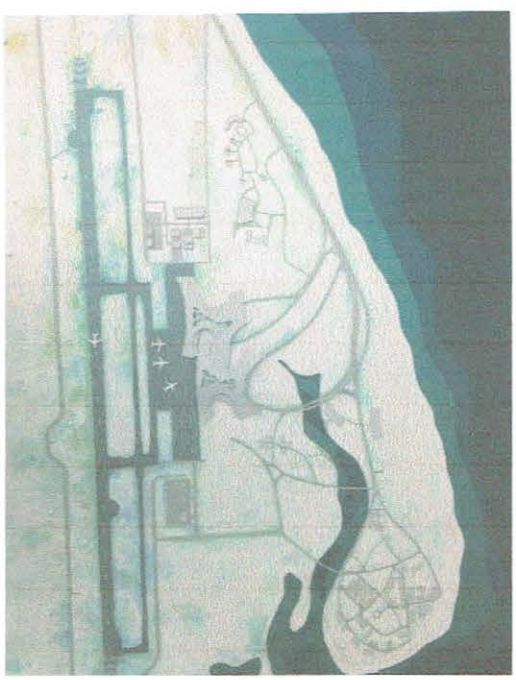
Maine Form Model

Master Plan Model









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