July 2020

Adaptive Airport Architecture

Yash Mehta

ADAPTIVE AIRPORT ARCHITECTURE

A Thesis Presented

By

YASH MAHESHCHANDRA MEHTA

Submitted to the Graduate School of the
University of Massachusetts Amherst in partial fulfillment
of the requirements for the degree of

MASTER OF ARCHITECTURE

May 2020

Architecture

ADAPTIVE AIRPORT ARCHITECTURE

A Thesis Presented

by

YASH MAHESHCHANDRA MEHTA

Approved as to style and content by:

____
Kathleen Lugosch, Chair

____
Sandy Litchfield, Member

____
Professor Stephen Schreiber
Chair, Department of Architecture

ACKNOWLEDGEMENTS

First and foremost, I would like to thank my thesis advisors, Prof. Kathleen Lugosch and thesis committee member Prof. Sandy Litchfield for their constant support and guidance. I applaud them for there constant encouragement and very valuable feedback at every small step of the process. I am incredibly thankful to them for allowing me to explore the direction I was most interested in, there efforts did not only help me in accomplishing this project but also provided me with enough food for thoughts for my upcoming endeavors.

I would like to thank University of Massachusetts, Amherst Department of Architecture for providing the opportunity and the best resources to help me accomplish my graduate studies.

Finally, this thesis is dedicated to my family, friends and loved ones who encourage and incentivize me every day. I thank my parents, and sister Sneha for your endless love and support throughout this journey. Also my mentors, friends and guides without their guidance this would not have been possible.

ABSTRACT

ADAPTIVE AIRPORT ARCHITECTURE

MAY 2020

YASH MAHESHCHANDRA MEHTA

B.ARCH.,INDUS UNIVERSITY, AHMEDABAD

M.ARCH., UNIVERSITY OF MASSACHUSETTS, AMHERST

Directed by: Kathleen Lugosch, Sandy Litchfield

Architecture of Airport terminals is unique in nature as it is linked with a wide range of concerns that go hand in hand to demonstrate efficient functioning of the building. From an inconvenient mode of travel to city center to the congestions in the security screening, concerns varying from urban design to systems engineering have an impact on the user experience. Along with these concerns, the spatial organization of the airport terminals accommodates various commercial, leisure, retail and service based spaces in addition to the core function of aviation. Where the guiding parameters for determining the spatial requirements are dependent on the projected life span, security restrictions and other socio-political influences. An airport terminal is bound to maintain a stable balance between all of the above parameters and disruption in any of the above can cause major fluctuations in the performance of the airport terminals. According to the United states department of transportation, Federal aviation administration(advisory circular 2014) the initial stages of the design for any existing or new airport is derived from the 'Master planning report'. This report is comprised of airport

layout, environmental studies, analysis of runway orientation, land use plans, activity forecasts, capacity analysis, estimates of facilities and more. To achieve a balanced environment capable of satisfying the concerns of various institutions it is important that the positioning of each amenity is carefully curated and is designed to perform as expected for several years.

The vulnerability of terminal buildings to the technological and infrastructural changes is one of the main problems with the airports. This thesis attempts to analyze different components that cause airport terminals to be rigid to the changes. Following the performance analysis for airport terminals this project proposed a design solution that exhibits a potential way of increasing the efficiency and life span of the airport terminals. While flexibility of physical infrastructure is one of the ways to absorb the increasing congestions in the building, it also needs to be organized so that it can ease the tensions in a positive way and do not cause unnecessary complexities. To acknowledge this circumstance and find a fact based resolution to this issue, this project proposes to work out a system of constants and variables where a series of elements can be retained for comparatively longer period and be more stationary than the variables of the design that can be changed over shorter period. Based on the analysis of airport terminals in general and a focused analysis of one particular location this project will propose a unique design solution for the medium hub airport terminals and provide a proof of concept by re-imagining the design of Bradley airport at Hartford.

CONTENT

LIST OF FIGURES

Figure Page

CHAPTER 1
INTRODUCTION

1.1 Position of Airport Terminals in Urban Context

With the rapid technological changes and constantly growing infrastructural needs the boundaries of urbanism and architecture are gradually fading, especially in the case of airports. Global airport infrastructure is now seen as a composition of multiple airports growing in the similar disciplines as they try to match with each other on the common grounds of technological advancements. The interconnection of cities globally is becoming more and more important as technologies are now are capable of shortening the geographical distances and hence we now require infrastructure competent to house all the modern equipments. Although the connection of one place to another is a result to the need of connecting people of one place to another, our development plans are rather merging the technologies more than people.

The airport terminals are now developing into a city in itself, as it accommodates most of the amenities found in a city at much smaller scale. The physical complexities associated with the airports are also increasing more and more everyday, and to facilitate these needs the airports are moving far from the actual cities. When all of the above factors get together they achieve complexities of almost of an urban scale. These makes various airports more connected with one another but distant from cities they are located in. Hence, the network of airports can also be considered as a city having compressed temporarily.

As J.G.Ballard quotes-

I suspect that the airport will be the true city of the 21st century . The great airports are already the suburbs of an invisible world capital, a virtual metropolis whose border towns are named Heathrow, Kennedy, Charles De Gaulle, Nagoya, a centripetal city whose population forever circles its notional center and will never need to gain access to its dark heart.[1]

Even though the network between airports, air corridors and aircrafts wrap and coil around and above the cityscape, it never infiltrates the city. The aircrafts may seem to connect people of one place to another, but considering the true means of connection it is incomplete. As the experience of air travel is becoming a three way connection than the two way connection between cities. After leaving a physical location in one city an individual enters into the global infrastructure of air travel, which seems to be a space designed for accelerated time. It moves and revolves around various cities and often has plug ins and plug outs taking place at different cities. And eventually at one point it puts a person in a physical space where the infrastructure is very much similar to the city of origin. If we attempt to interpret this model in conventional methods of analyzing spatial organization of architecture, it is unlikely to be able to relate to other built forms or other parts

- 1 J.G. Ballard,utne.com ‘Airports: The True Cities of the 21st Century’, of a livable city. Global aviation infrastructure in itself is a city with multiple geographical location comprising of all the amenities of the physical city. It moves parallel to the physical cities but with a different pace. This change can be observed more rapidly than any other built forms of a regular city but at the same time it changes with the pace of various geographical locations where airports are located.

In-between this image of a city, the airport is just another building, but this building is no less than a self-contained city. Multiple airports create an entirely new urban condition, Irrespective of their location- various terminals on this connected loop have the same characteristics like flashing lights and endless transparent walls made of departure gates. A city where any location of the globe is only a nap away. This terminals are nothing but the termination point for a physical city and a starting point of the process of travel.

1.2 Spatial Organization of the Airport Terminals

The spatial organization of the airport terminals can be seen in two separate layers of program zones and circulation loops. Program zones can be defined as the areas with concentration of certain activities, where as circulation loops may not have a physical area defined to all of the spaces but it stands for the sequence in which certain areas need to be connected with the other areas in the terminal building. A program zone consisting of check in area that may hold several activities, like assisted check-in facilities, self check-in computer screens, baggage weighing and tag printing area, baggage drop area, information center and more. All such functions can be assigned a space with certain square feet, but depending on the various months of the year, fluctuating flow of the passengers and changing equipments, these areas may observe certain changes over years. Here the fundamental location of certain program zone in the airport terminal building tends to remain the same. The path in which these program zones or their internal activity areas are connected with one another is a particular non-tangible sequence. These loops represent the sequence of the flow and various types of such sequences need to be defined for effective functioning of any airport terminal building. This sequences could be conceptualized based on the type of travel Domestic/International; it could differ for the movement of passengers, their baggage, airport terminal staff and for the building services. The following map represents fundamentals of spatial organization for airport terminals.

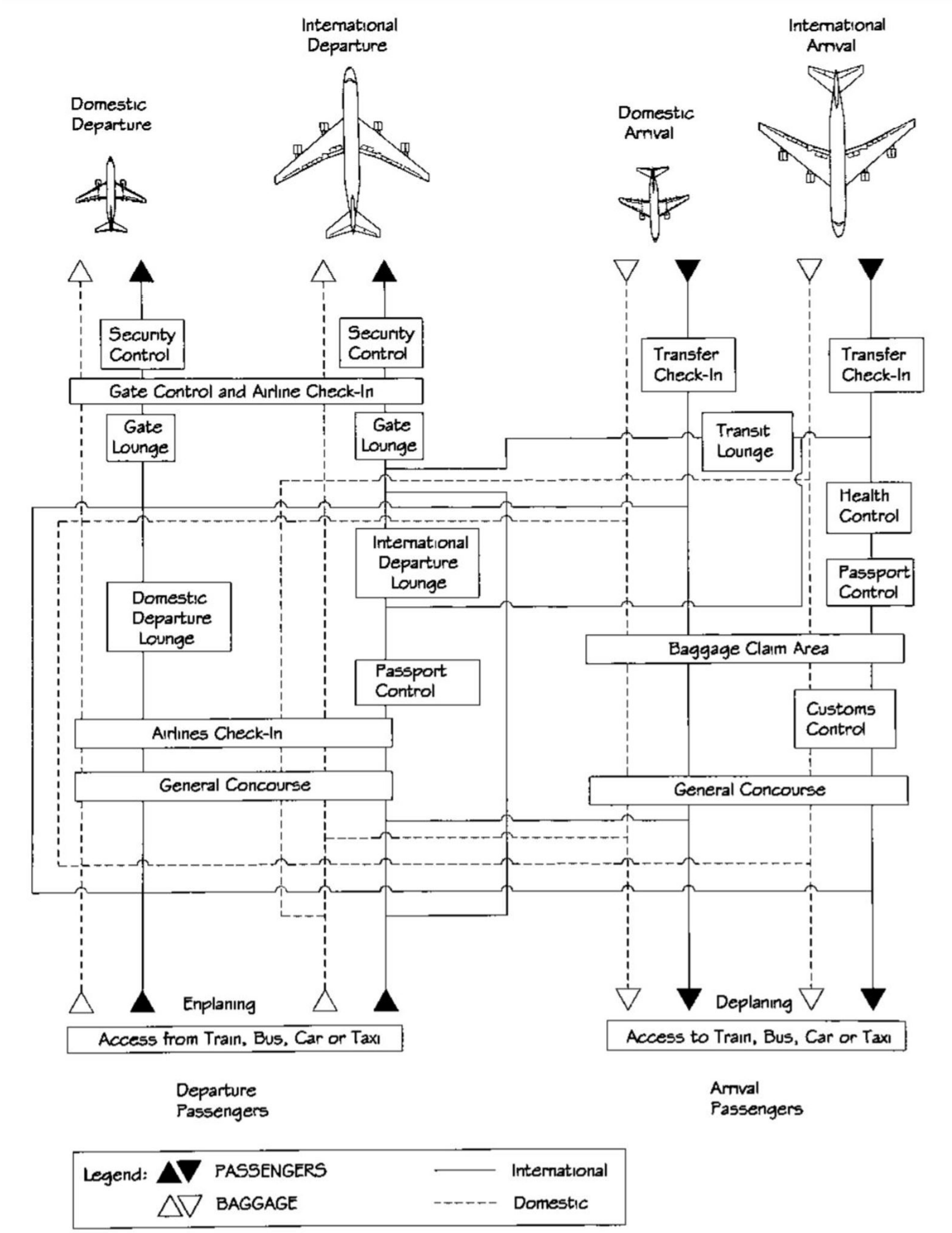

Fig.1. Fundamental spatial organization of airport terminals[1]

1 Chen, Long-Wen, "Airport design" (1999). Thesis. Rochester Institute of Technology. pg 11

1.3 Life Span of the Building and Impact of Changing Technologies

More than the wear and tear of the buildings there are other aspects which over the period of years cause significant difference in performance of the buildings. The aspects like changing technology, economical impacts and more are some of the factors that have significant impact on death and rebirth of various built forms. Often times buildings have to be brought down half way through the life of its structure because of other non-architectural aspects.

One of the ways to examine the sustainability of the building could be through analyzing the capability of buildings to adapt to the changes. But, the issue here is that the buildings are not designed to adapt. The most common approach is to build a building that satisfies the need of the time. They are neither administered, maintained or regulated to adapt because the capability of buildings to adapt is rarely given enough attention. As author Stewart Brand explains some circumstances where functions like art studios or residences are able to adapt to some functions like offices or warehouses, but buildings like churches have a different kind of spatial organization and functions that it is difficult to force such buildings to adapt to the changes.

As he states 'the whole idea of architecture is permanence, the wider use of term architecture always means 'unchanging deep structure''[1]

---

1 How buildings learn, Stewart brand, Chapter 2' pg 12

To support his argument he examines and elaborates multiple examples of buildings that have been unable to adapt as they were unable to tolerate the pressure of changing needs.

With many examples like cliff house at San Francisco and two identical houses on St Charles street at San Francisco he argues that irrespective of the suitability of the building in a particular context the building is going to observe alterations to itself over a period of time. As the occupants change, the building changes. Not necessarily by the dramatic change of form and the aesthetic appeal of the building but maybe in the interiors of the building or with minor changes in the exterior of the building. As stewart brand describes in the chapter 'Flow' the best building is the one that is built with least possible stagnant elements.[1] He gives the example of low-income housing saying that they are the ones with just the basic requirements and hence they are more respectful to the comfort of its user and to the environment.

Stewart brand introduces concept of 'site being eternal'[2] in a very convincing manner. As the reading delineates the diagram by Frank Duffy about the cycle where he describes the layers of buildings shearing and only the site stays in its place is very absolute. In my opinion, the aspects that make site 'the site' are also dependent on the building and the other aspects taking place around the

1 Ibid pg 2
2 Ibid pg 14

building. Many aspects more than the latitudes and the longitudes of the site contribute in making of the site and one of the most important among them is the building. With shearing layers and the upcoming new layers the change caused to the site is far more slower than the change caused to the building. Hence, it may not be the major point of consideration but if the layers of building are re-formed over the period of time the layers of site are also accountable to experience the shearing layers. Which may not be tangible but notional in most of the circumstances.

1.4 Defining the Argument

The design and proper functioning of an airport is combination of multiple parameters, which operate at different scales. In order to achieve a viable resolution this project attempts to concentrate on the aspects mostly related with the architecture of the airport terminal and this may result in overlooking some considerations of bigger scale like traffic engineering, aircraft runways and taxiways and other supporting building infrastructure that is not directly related to the passengers flying through commercial airline services.

1.4.1 Potential Areas of Research

Even though our airport terminals are built as a resolution of complex architectural challenges. It is difficult to cherish the building for its function. No matter how interesting and fascinating an airport terminal may be, unlike other buildings it can never receive the honor of being the destination for any of its user. Airport terminal as a built form itself is more like a threshold and for that reason the primary functioning and ease of its use becomes essential than the architectural character of the space. It is more important for airport terminals to have intricate relationship with different concerns of engineering, management, and security than seductive architectural expression. The idea behind conducting the research and analyzing the integration of architectural spaces and elements with other statistical data is to understand the amalgamation of architecture with other streams and to figuring out a method to propose a solution adaptive to the changing technological and capacity based need of the project.

This raises a critical question for the architecture of airport terminals. It is difficult to say if the airports need to represent the physical needs of the region by designing building concentrated around the weather conditions or cultural preferences or if it is more sustainable for airports to follow the global typology of airport terminals in order to allow coherence and ease of navigation to the users.

1.4.2 Thesis Problem:

Aviation architecture is vulnerable to changes, be it technological advancements or increasing security concerns. A smallest change in the hierarchical spatial design is big enough to result in major disruption, this often makes our airport terminals fail the test of time.

Some of the most common factors that cause the building to under perform and

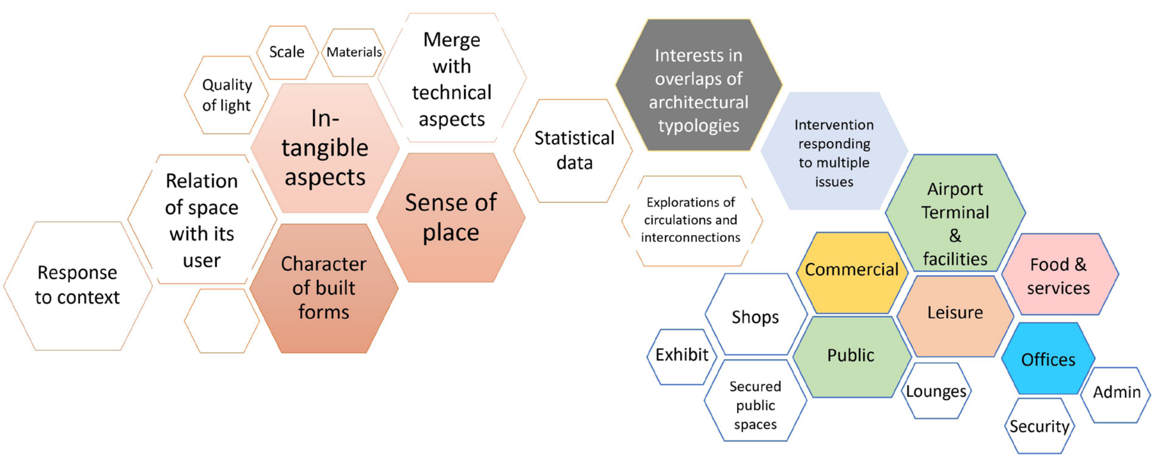

Fig.2. Dependency of design concerns and architectural spaces on quantifiable data

retire are the rapidly changing technological advancements, increasing security concerns and the lack of flexibility in the spatial organization. These changes cause tensions among adjacent programs and a small change like changing the method of screening people can cause delays in the pace of screenings and that can result in chaos at concourse.

1.4.3 Thesis Statement:

The aim of this thesis is to propose a design solution that is adaptable to the changing needs of the future. In order to achieve adaptability and resilience, this thesis focuses on a modular system where each space is capable of hosting a number of functional uses, such as security areas turning into restaurants or hold rooms hosting sleeping pods and for circumstances similar to the ongoing Covid-19 emergency the majority spaces could be converted into medical facilities. Each of these units and is designed to be a flexible structural composition, consisting of access to the major building services. Developed as a potential direction of solution applicable airport terminals at multiple locations- this thesis attempts to provide a proof of concept through the example of Bradley airport, Hartford.

This modular system would be better capable of surviving for longer years while maintaining the performance of the building as it will be designed keeping in mind the concept of adaptability. Seen in two categories of the constants and the variables, the building proposal would aim to have an intentionally placed flexible elements to the design.

By proposing a solution centered around the building systems this project advocates an approach first considerate of its systems and then the function of the space or the form of the building. The advantage of this method makes the built form more adaptable to various kinds of transformation that it may have to go through and eliminates the need of foreseeing the infrastructural or functional requirements of a space.

CHAPTER 2

AIRPORTS: CATEGORIZATION AND PERFORMANCE

2.1 Airport Categories and Classifications

2.1.1 Scale of the Built Form

Airport Categories:

According to the Federal Aviation Administration the airports are categorized by the scale and type of activities, this includes,

- Commercial Service Airports are publicly owned airports that have at least 2,500 passenger boardings each calendar year and receive scheduled passenger service
- Non primary: Non-primary Commercial Service Airports are Commercial Service Airports that have at least 2,500 and no more than 10,000 passenger boardings each year.
- Primary Airports are Commercial Service Airports that have more than 10,000 passenger boardings each year.
- Primary airports are further divided in three categories termed as hub,
- Large hub: Observing At least 1 percent of total passenger load among United States
- Medium hub: Observing footfall between 0.25 percent to 1 percent
- Small hub: With total footfall of 0.05 percent to 0.25 percent
- Cargo service: Irrespective of availability of commercial passengers, allowing 100 million pounds of landed weight.

Categories of Airport Activities

Airport Classifications		Hub Type: Percentage of Annual Passenger Boardings	Common Name
Commercial Service: Publicly owned airports that have *at least 2,500* passenger boardings each calendar year and receive scheduled passenger service **§47102(7)**	**Primary:** Have *more than 10,000* passenger boardings each year **§47102(16)**	**Large:** 1% or more	**Large Hub**
		Medium: At least 0.25%, but less than 1%	**Medium Hub**
		Small: At least 0.05%, but less than 0.25%	**Small Hub**
		Nonhub: More than 10,000, but less than 0.05%	**Nonhub Primary**
	Nonprimary	**Nonhub:** At least 2,500 and no more than than 10,000	**Nonprimary Commercial Service**
Nonprimary (Except Commercial Service)		Not Applicable	**Reliever §(47102(23))** **General Aviation (47102(8))**

Fig.3. Classification of airport terminals[1]

General Aviation Airport Categories

Role	Description
National	Supports the national and state system by providing communities with access to national and international markets in multiple states and throughout the United States.
Regional	Supports regional economies by connecting communities to statewide and interstate markets.
Local	Supplements communities by providing access to primarily intrastate and some interstate markets.
Basic	Links the community with the national airport system and supports general aviation activities (e.g., emergency services, charter or critical passenger service, cargo operations, flight training and personal flying).
Unclassified	Provides access to the aviation system.

Fig.4. General aviation categories[2]

1 Classification of airport terminals, "National plan for Integrated Airport Systems-report to congress" (2019-23). pg 42

2 Ibid

- Reliever: Airports designed by FAA to relieve the congestion at commercial service airports
- General aviation airports: Airports that are made for public use but do not have scheduled service or have less than 2500 annual passenger boarding

2.1.2 United states hub airports demographics

- Figure 7 & 8 represent the locations in the united states for the new proposed and existing airports of different scales. This demographics are represent the vast number of facilities in the country which helps in better understanding the connectivity between the locations. Also the following table represents the demographics in terms of the numbers. As the airport infrastructure is liable to live up to the changing requirements, a constant up-gradation is required in addition of the construction of new airports.

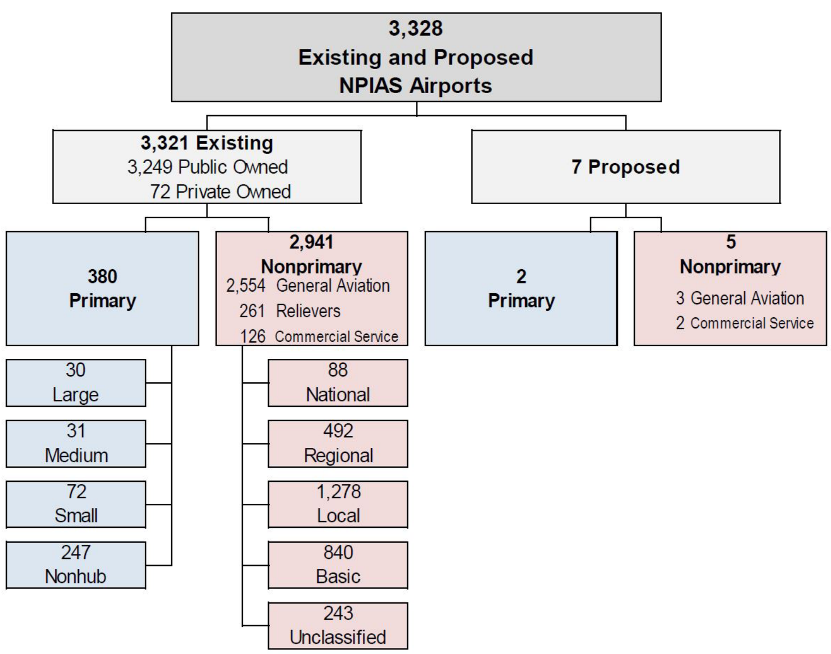

Fig.5. Airport terminal demographics of US[1]

1 Airports of the US demographics, “NPIAS report to congress” (2019-23). pg 4

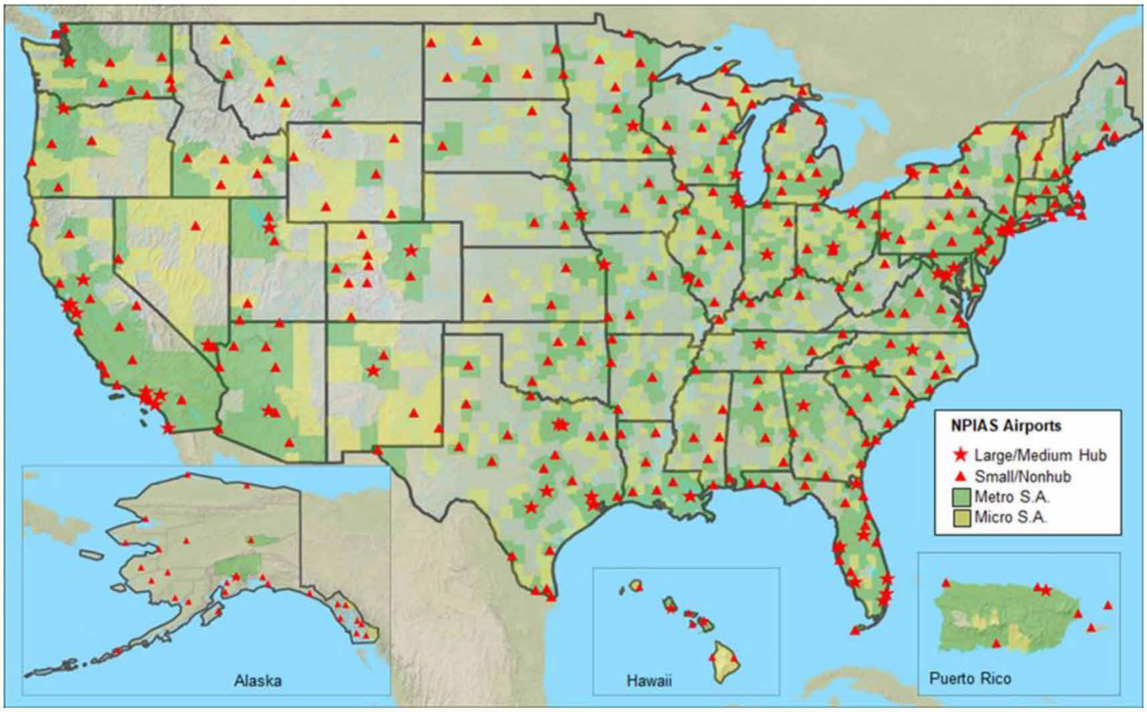

Fig.6. Medium & large hub airports of US[1]

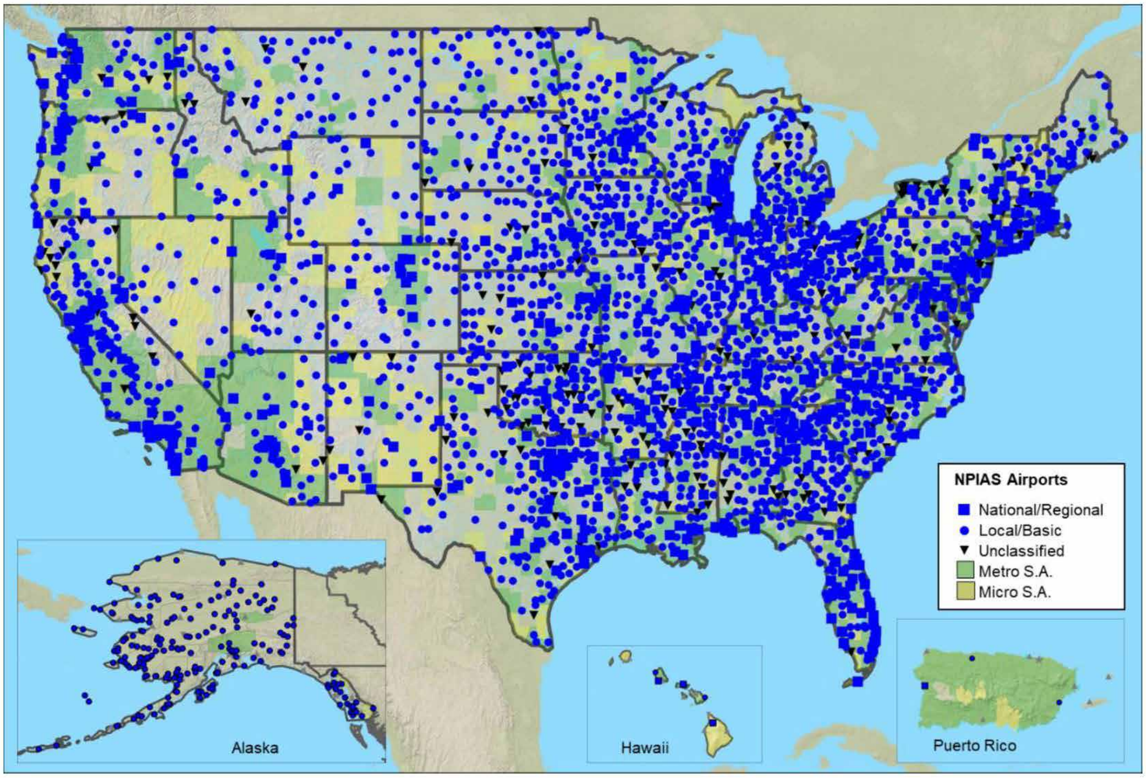

Fig.7. Non primary airports of US[2]

1 Hub airport locations of US, “National Plan for Integrated Airport Systems- report to congress” (2019-23). pg 5

2 Non primary airport locations of US, “National Plan for Integrated Airport Systems- report to congress” (2019-23). pg 7

2.1.3 Parties at stake

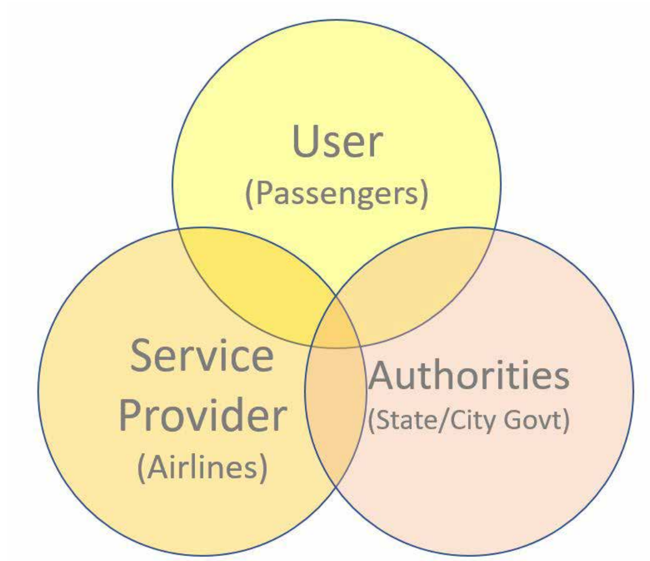

Fig.8. **parties at stake.JPG**

In design, execution and operation of Airport Terminal and the entire airport infrastructure various user groups with different interests come together and have direct or indirect stake in what really takes place and how it operates, mainly these groups and their expectations can be divided as following,

Service Providers (Airlines)[1]

- Reasonable operating costs
- Efficient operations i.e. Passenger processing, baggage handling, aircraft parking, etc.
- Easily accessible hold rooms

  Ability for installing specific technological equipment
- Timely performance of built facilities

1 Thyrone martin, “Resource manual for airport in-terminal concessions” (2011). chapter 2

Users (Passengers and Building Staff)[1]:

- Easy Access from road or rail
- Efficient Baggage Delivery
- Full range of services
- Convenient parking, ground transportation
- Clean building
- Simple procedures that are not confusing
- Safe & Secure Environment

Authorities (State/City Govt) [1]

- Optimal utilization of space
- Segregation of domestic and international passengers
- Rigid division between secure and unsecured areas
- High level of security
- Revenue maximization
- Low operating maintenance costs
- Safe operating environment
- Attractive building

The performance of the airport terminals heavily rely on all of the above at the same time and fluctuations in any of one of the above is capable of resulting in major disruptions.

2.2. Performance and Efficiency of the Airports:

Performance and the efficiency of airports is based on multiple factors out side the scope of architecture which have the ability to affect the infrastructural requirements and it is important for the architecture to be responsible to these factors. For airport terminals to be efficient and sustainable with the change of time and requirements it is important that building facilities adapt to the change and not just require new additions.

Some of the major factors that cause airports to undergo major infrastructural change goes as following,[1]

1. Capacity
2. Congestion and delay
3. Air carrier on-time performance
4. Financial performance

2.2.1 Capacity:

Determining the capacity of a particular airport terminal is dependent on numerous statistical data that is derived from the demographics of previous years. This demographics include detailed study of the smallest components like number of toilet fixtures to the biggest parameters like number of rented boarding gates

1 Capacity, "National Plan for Integrated Airport Systems report to congress" (2019-23). pg 17

and more. A small number of airports where consistent capacity constraints and delays regularly occur, they frequently impact the entire air transportation system. The FAA works with State and local units of government to enhance airport capacity where it is justified by current or anticipated aeronautical demand and where the benefits of additional capacity exceed the costs.[2]

.

2.2.2 Congestions and Delay:

The fluctuations in concentration of aircraft arrivals and departures at an airport can result in congestions and delay. Consistent delays are an indicator that activity levels are approaching or exceeding the maximum capacity of the airport terminals or runways or boarding gates or of other major components of the airport systems.[2] The impacts of delays can be a result of unprecedented reasons as well like weather conditions, Technical mishaps, Bad management, congestions in security check-in and so on. All of these may be smallest of the factors but the impacts they cause are significant and not only for the other passengers but also cause the airlines to result in financial and reputational damage and most importantly result in an unpleasant experience of the airport terminal building.

2.2.3 Air Carrier on time performance

The timely performance of airport terminal operations and aircrafts is one of the key parameter and it is important for both of them to be in harmony because, if

2 Congestions and delay, “National Plan for Integrated Airport Systems- report to congress” (2019-23). pg 17

3 Ibid

the terminals are not able to keep up the pace of operations with the expectations of the airlines there is a possibility of bigger disasters. Just a few delays by controllers in allowing the aircrafts to land and takeoff may result in aircrafts having to fly more and hence increase the fuel costs for that flight, in addition it can cause passengers to miss connections and hence allowance for food and stay and additional compensation for the delay may need to be offered. Disruptions of flow for a few minutes can result in damage of thousands of dollars.

2.2.4 Financial performance

One of the most important criteria to determine the performance of the airport is finances. There are certain charges like landing fees, parking charges, apron charges, fuel charges and more are associated with each landing and take-off for aircrafts of all the sizes. The airlines constantly evaluate the demand of particular connections between different locations and analyze if it is economically profitable to operate between particular locations or not. Similarly the state and federal government authorities also generate revenue by charging taxes to the passengers and airlines. This generated revenue has significant influence on the development plans. Figure 10 represents some of the expenses related to the aircrafts and airport terminals, which indirectly represents the potential recipes of development and disasters.

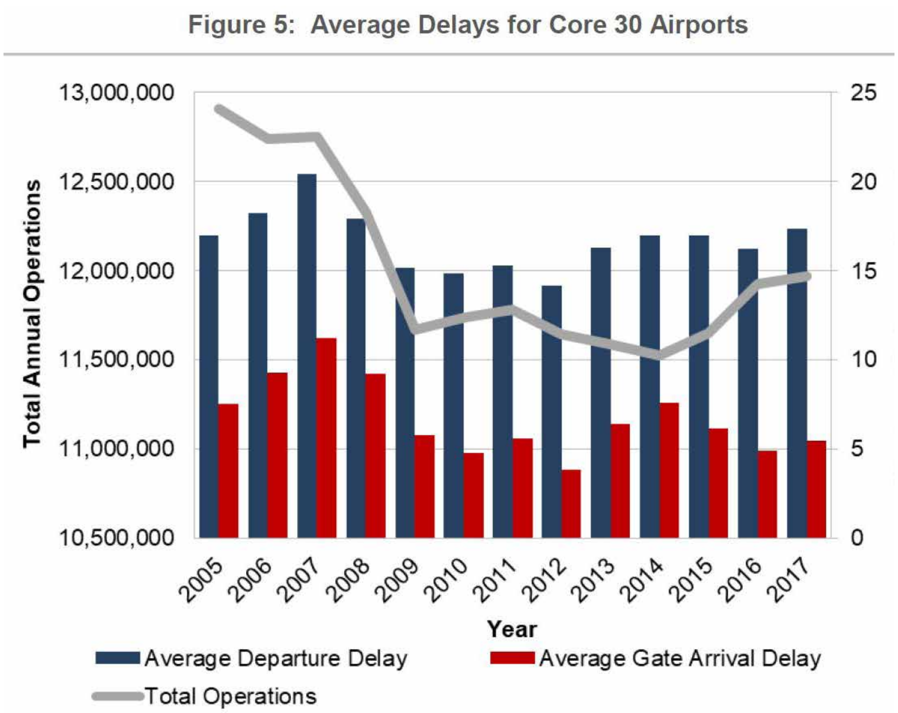

Fig.9. Average of on-time performance for major airports in US[1]

Aeronautical Operating Revenue					
Aeronautical Operating Revenue					
Landing Fees	$2,824	$576	$289	$94	$3,783
Terminal Rents	3,989	678	318	98	$5,083
Cargo and Hangar Rentals	421	77	83	80	$661
Fixed-Base Operator Revenue	107	50	44	58	$259
Apron Charges/Tie Downs	109	53	25	8	$195
Fuel Sales and Taxes	184	42	35	106	$367
Other Aeronautical Fees	806	60	60	77	$1,003
Total Aeronautical Operating Revenue	***$8,440***	***$1,536***	***$854***	***$521***	$11,351
Nonaeronautical Operating Revenue					
Parking and Rental Car	$3,637	$1,204	$765	$228	$5,834
Concessions	1,196	201	87	19	$1,503
Terminal Rents	361	46	38	10	$455
Land Rental and Nonterminal	348	100	107	121	$676
Other Nonaeronautical Fees	938	120	107	58	$1,223
Total Nonaeronautical Operating Revenue	***$6,480***	***$1,671***	***$1,104***	***$436***	***$9,691***
Nonoperating Revenue (Expenses) and Capital					
Passenger Facility Charges	$2,354	$493	$234	$75	$3,156
Grant Receipts	583	272	503	657	$2,015
Interest	268	43	21	7	$339
Other	334	220	160	236	$950
Total Nonoperating Revenue	***$3,539***	***$1,028***	***$918***	***$975***	***$6,460***
TOTAL REVENUE	**$18,459**	**$4,235**	**$2,876**	**$1,932**	**$27,502**
Operating Expenses					
Personnel Compensation and Benefits	$3,586	$818	$640	$429	$5,473
Contractual Services	3,154	695	324	216	4,389
Communications and Utilities	677	170	115	77	1,039
Supplies and Materials	344	95	94	80	$613
Insurance, Claims, and Settlements	129	37	29	25	$220
Other	1138	199	139	120	1,596
Total Operating Expenses	***$9,028***	***$2,014***	***$1,341***	***$947***	***$13,330***
Nonoperating Expenses					
Interest Expense	$2,706	$488	$188	$56	$3,438
Other	0	0	0	0	$0
Total Nonoperating Expenses	***$2,706***	***$488***	***$188***	***$56***	***$3,438***
TOTAL EXPENSES	**$11,734**	**$2,502**	**$1,529**	**$1,003**	**$16,768**
Depreciation	$4,337	$1,119	$910	$566	$6,932
NET INCOME	**$2,388**	**$614**	**$437**	**$363**	**$3,802**

Fig.10. Aspects responsible for financial performance of airports[2]

1 Delay indicators, "NPIAS report to congress" (2019-23). pg 19

2 Financial performance, "NPIAS report to congress" (2019-23). pg 29

2.3 Research Questions

2.3.1 An Organized System in Place of Chaotic Connection of Dots:

The conventional ways of approaching the design of any architectural project begins with determining the requirements of different programmatic areas and arranging them through the connections required between different spaces. Also referred as the bubble diagrams are some of the most initial sketches produced for designing the spatial organization of any building. The issue with the architecture of airport terminals is that they are constantly increasing in size and with the inclusion of number of spaces belonging to different typologies of architecture like commercial, retail, aviation, leisure and more our airports are becoming more like cities. These cities have much better opportunity to adapt to the if different programmatic spaces are arranged in more organized composition like cities then the one way approach of connecting stationary bubbles of various building programs.

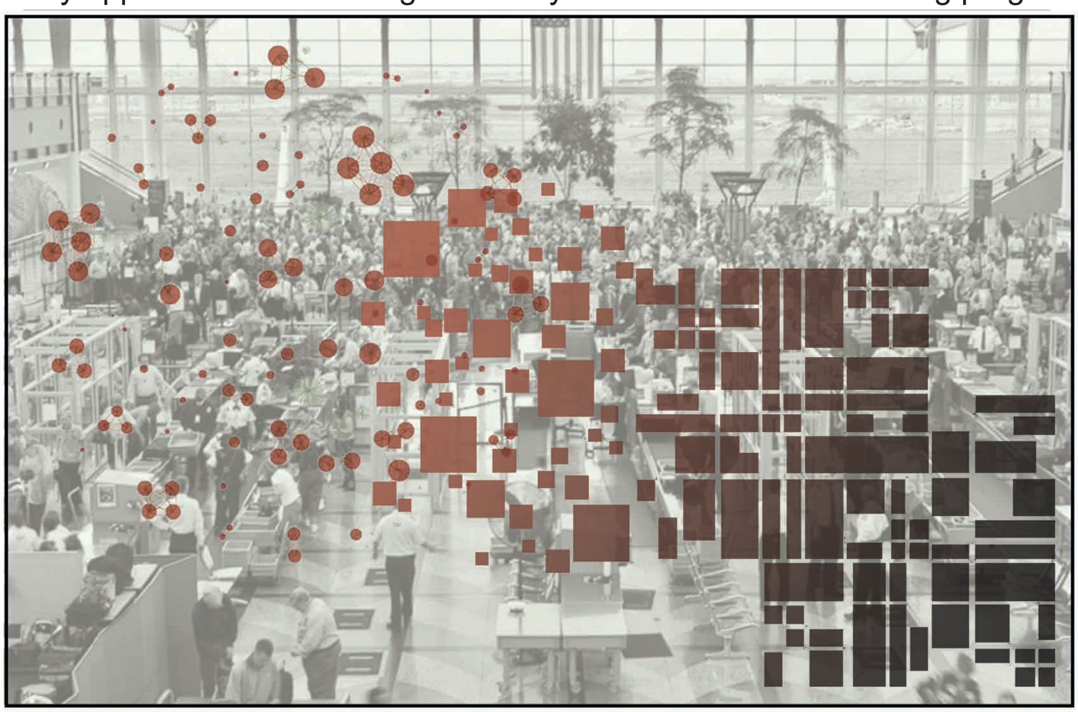

Fig.11. From the approach of connecting dots to the method of organizing systems

2.3.2 A Transparent Maze:

With the increasing complexity of our airport terminals it is becoming more and more difficult for passengers to navigate their path in the airport terminals. Starting from the concourse area to the boarding gate each passenger has to go through check-in areas, security screening, immigration and more. In this path they also have to move through the spilling out duty free shops, restaurant and other facilities that seek for the passengers attention with the use of huge glass storefronts and flashing screens. And instead of the architectural scale of the yellow sign boards become the element that navigates the journey. This thesis attempts to research the potential causes behind such architectural expression and propose a solution that can enhance the user experience.

Fig.12. A transparent maze of glass store fronts, yellow sign boards and bright screens

2.3.3 Prioritizing the Programmatic Requirements:

In addition to the core function of aviation our airports terminals often comprise of several amenities that are meant to enhance the user experience and entertain the users. With the changing times these activities are increasing more and more. Figure 15 attempts to abstractly showcases some amenities like swimming pool, movie theatre, shopping complex and surf pool that are part of various airports around the world. This represents how far we are going in an attempt to lure the passengers. This research questions if developing an amenity like swimming pool at an airport in Qatar is really a value addition to its users or just results to be an unsustainable utilization of resources?

Fig.13. In-between the value additions and disturbances

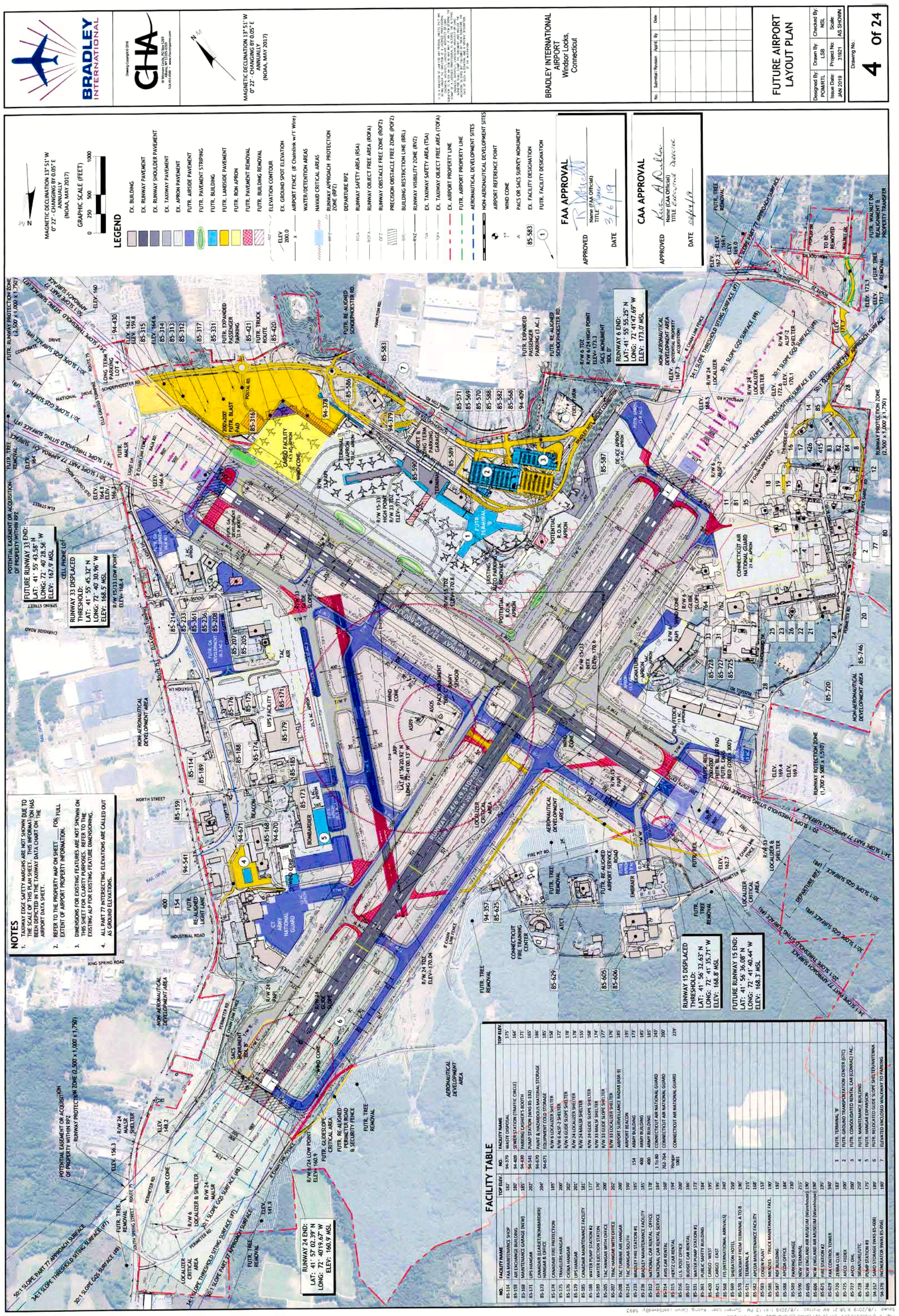

Fig.14. Bradley airport, Hartford- Master plan[1]

1 Site master plan, “Bradley Airport master plan” (2019-23). pg 4

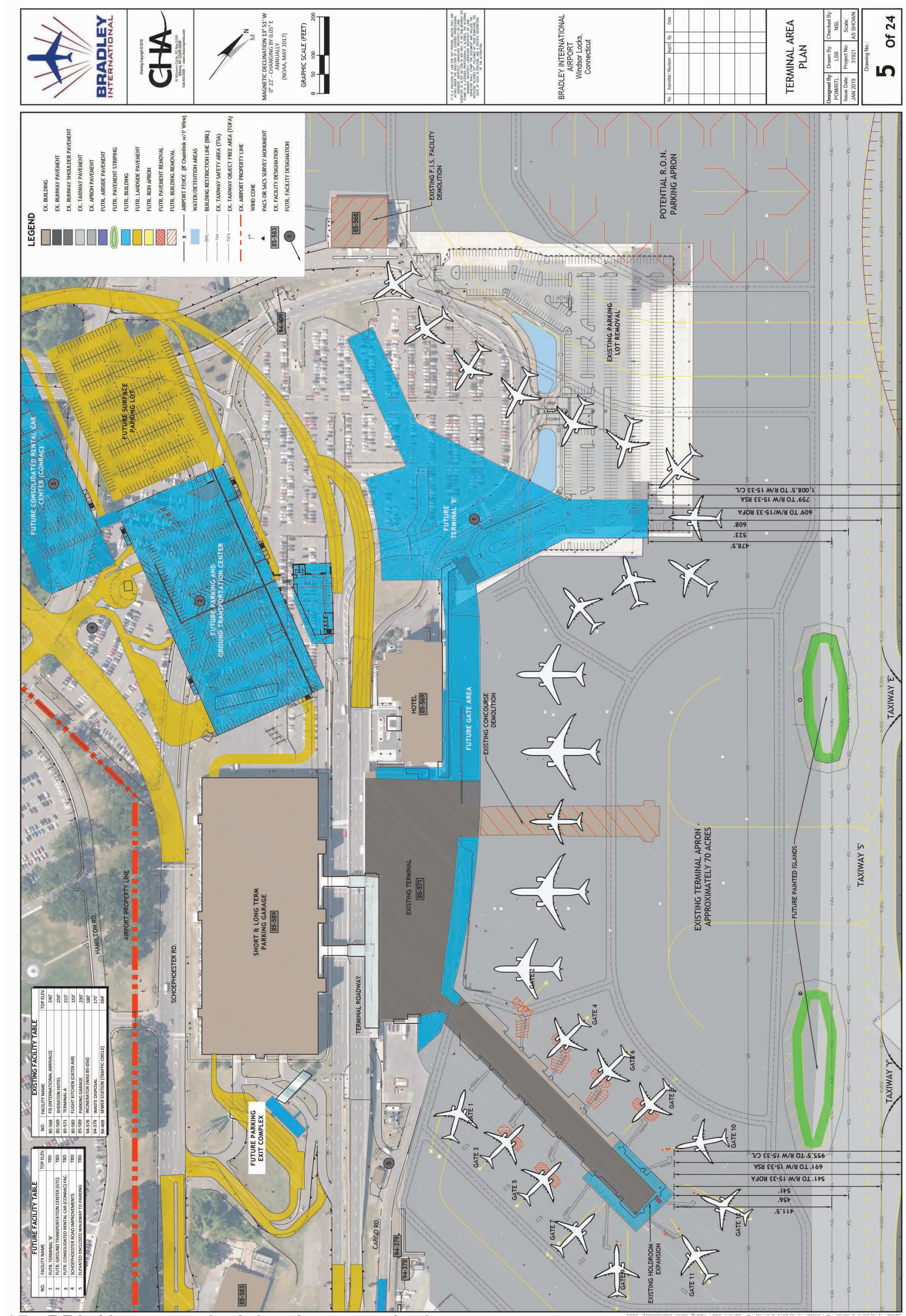

Fig.15. BDL Airport terminal development plan[1]

1 Airport terminal plan, “Bradley Airport master plan” (2019-23). pg 5

Chapter 3
Site Analysis

3.1 Bradley Airport Planning

3.1.1 Existing Scenario

Bradley airport is situated at the distance of 17 miles from the downtown Hartford. The existing airport facility comprises of several buildings which includes main passenger terminal building for all the commercial airlines and an additional smaller terminal mainly catering to the private flights. As a part of a redevelopment and expansion of the current airport building an analysis of the existing facilities and the potential forecasts was prepared in 2017 following which a phase-wise development plan was developed ranging from the year 2017 to 2037 and it was divided in three phases of first 10 years and later two phases of 5 years each. The terminal building currently has around terminal building at Bradley international airport currently serves around 21 gates and over the period of upcoming 20 years the airport is expected to grow by 30 percent and the final completed version in 2037 will be capable of hosting 29 aircrafts.[1]

3.1.2 Proposed Scenario

As published in the master plan by Bradley airport authorities the development proposal for the airport is divided in three phases. First and the longest phase of 10 years includes the demolition of central wing and addition of a new portion as shown in the figure 17. Until 2022 the authorities plan to make major internal additions of hold rooms and other building amenities. And as a part of the final phase the new additions as shown in blue in figure 19 will be added to the terminal.[2]

1 Terminal redevelopment plan, “Bradley Airport master plan handbook” Chapter 1
2 Ibid

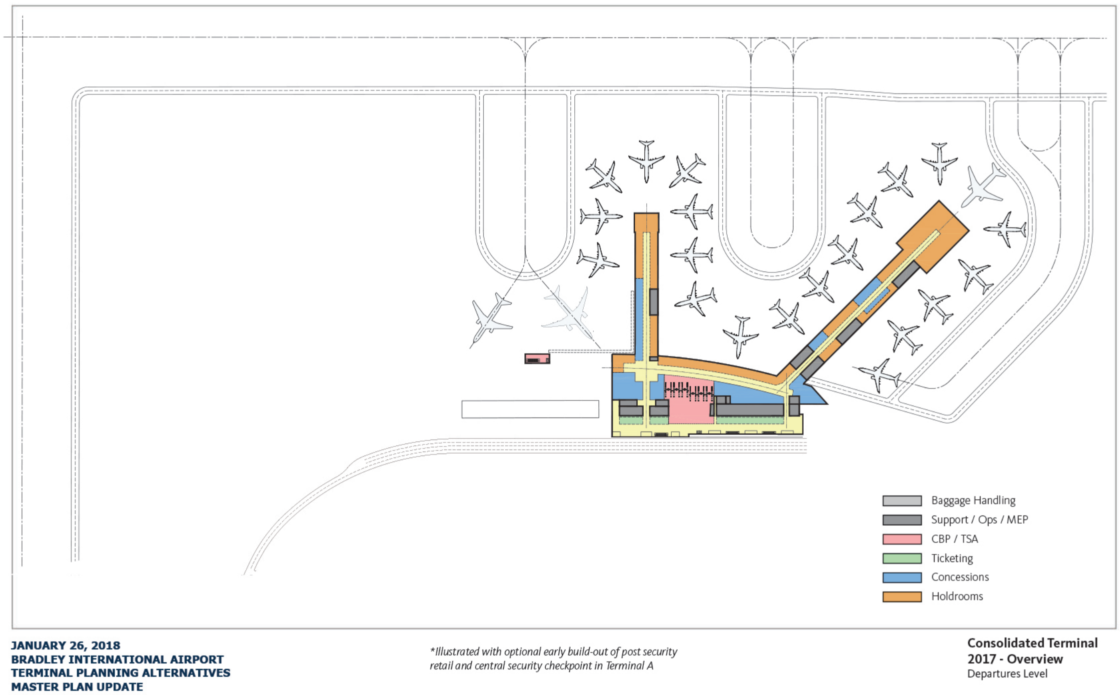

Fig.16. Bradley airport layout-2017[1]

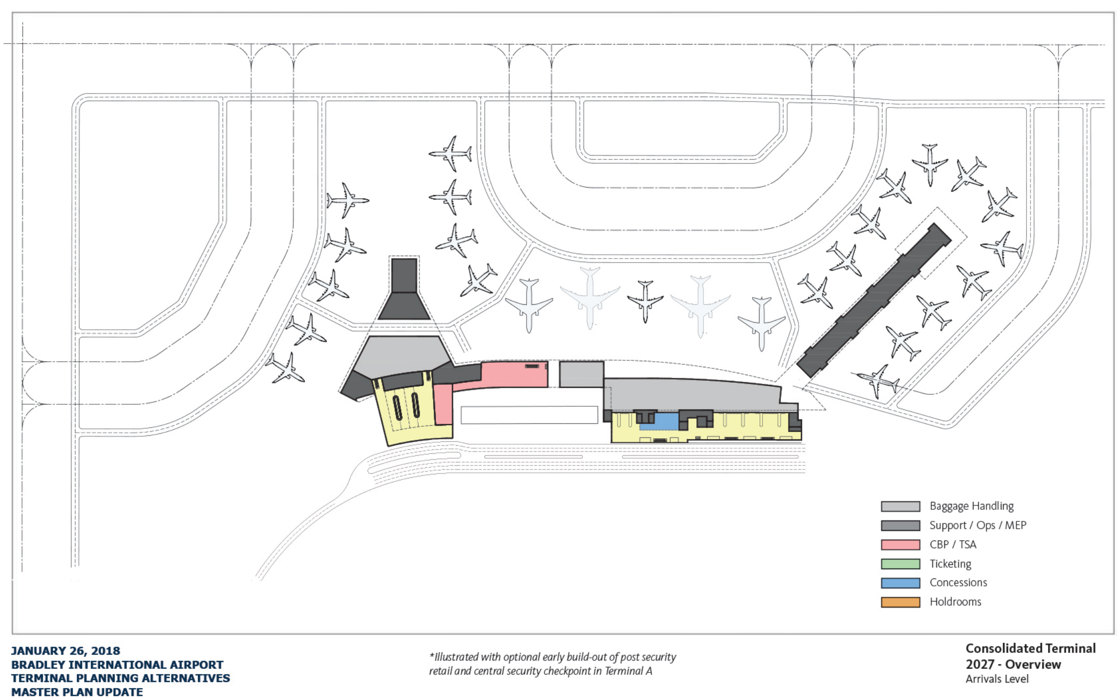

Fig.17. Proposed first phase of redevelopment- 2027[2]

1 Terminal redevelopment plan, “Bradley Airport master plan handbook” pg G2
2 Terminal redevelopment plan, “Bradley Airport master plan handbook” pg G3

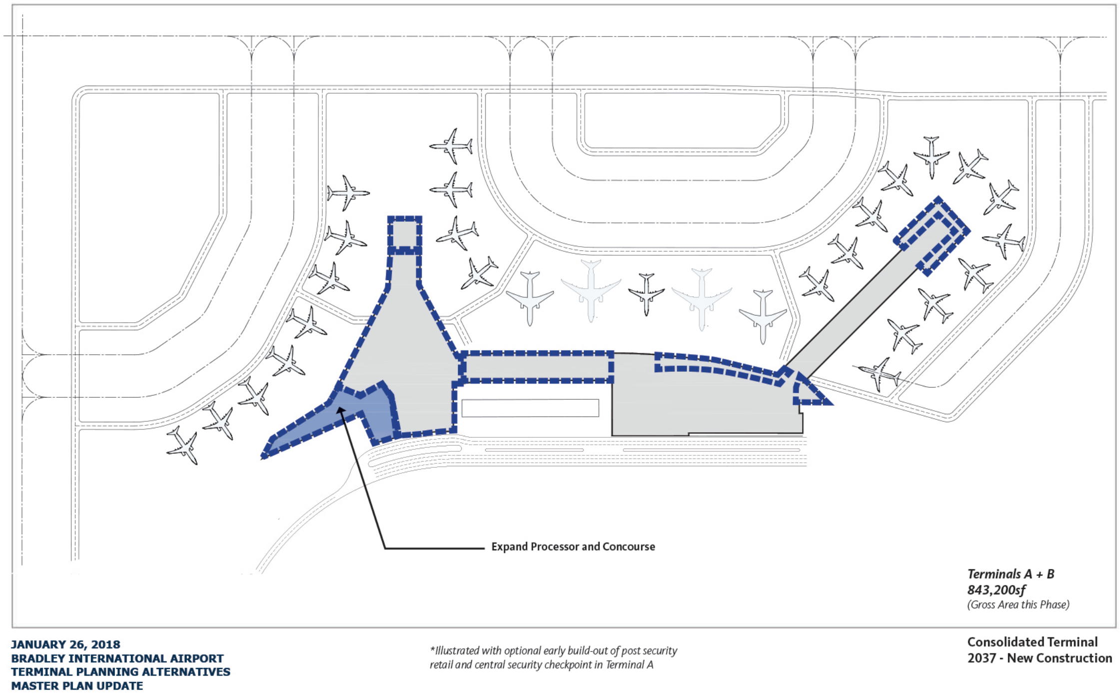

Fig.18. Proposed second phase of redevelopment- 2032[1]

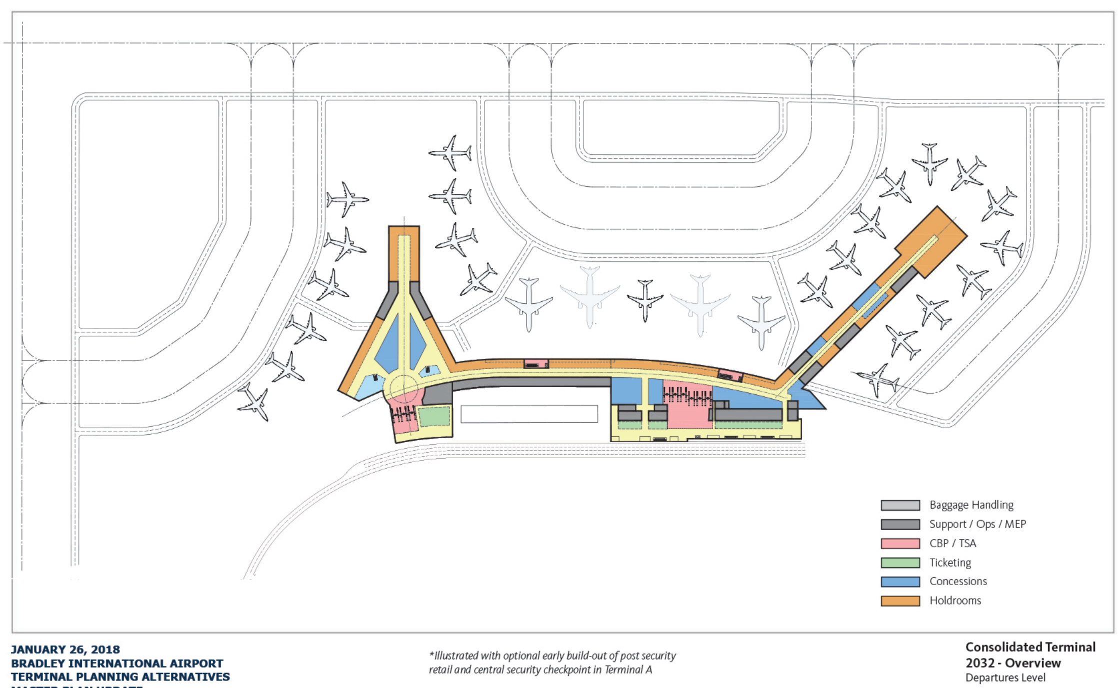

Fig.19. Proposed second phase of redevelopment- 2037[2]

1 Terminal redevelopment plan, “Bradley Airport master plan handbook” pg G4
2 Terminal redevelopment plan, “Bradley Airport master plan handbook” pg G5

3.2 Opportunities and Challenges

3.2.1 Challenges associated with the current proposal of Master plan

The master plan for the proposed extension of Bradley airport, Hartford is developed through an approach very similar to the other airport terminals. The design of the airport is based on the current projections of the requirements for the year 2037. Over the period of years this requirements and the associated technological advancement is more likely to change, as the changes in technology are just becoming more and more rapid with the changing times. As a result it may so happen that the proposed projections may not come out as expected and the terminal building may fail or under perform significantly. Although there is a chance that forecasts may go as expected over the period of upcoming 20 years, but if they do not go as expected the repercussions associated with that can be immense.

3.2.2 Towards a potential solution

In the time of rapid change everything from the long term master plans to the designed buildings need to be adaptive to the changing needs of the time. Then and only the buildings will be able to survive for longer periods. More than the approach that advocates the idea of constructing a new terminal building with the increasing/changing needs, it is important that architects and designers look for a solution flexible enough to adjust to any changes that may occur. Or if the changes are drastic enough that the infrastructure is incapable of managing, the built environment should at least be considerate of sustainable ways of deconstruction.

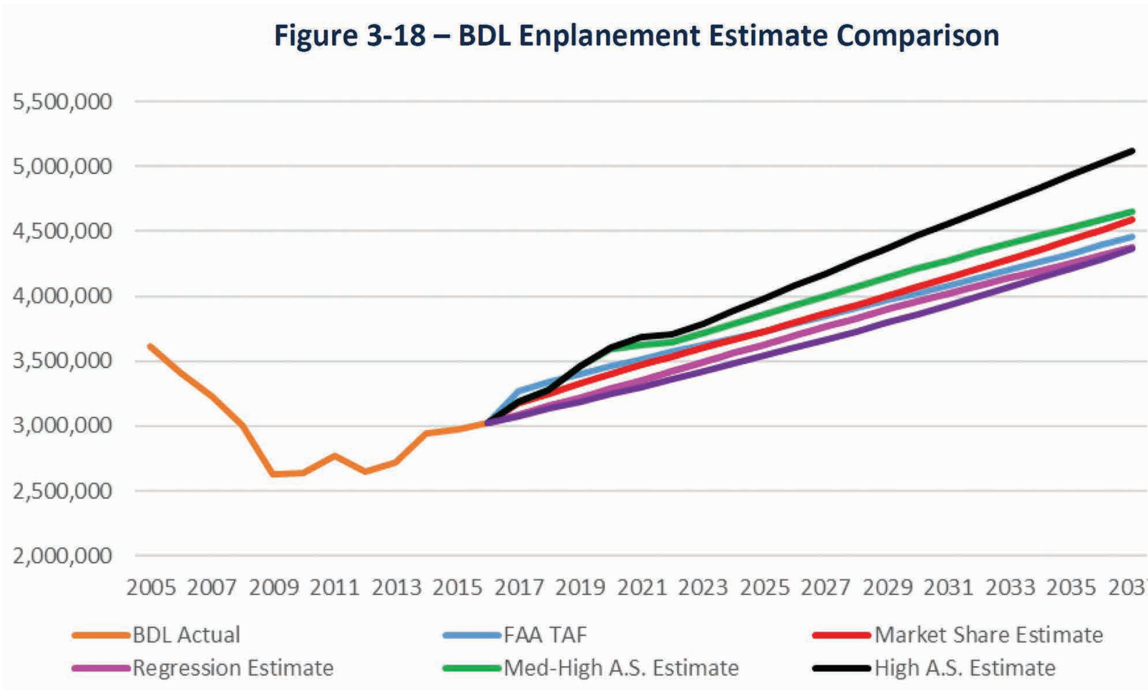

Fig.21. Forecast of expected enplanements until 2037

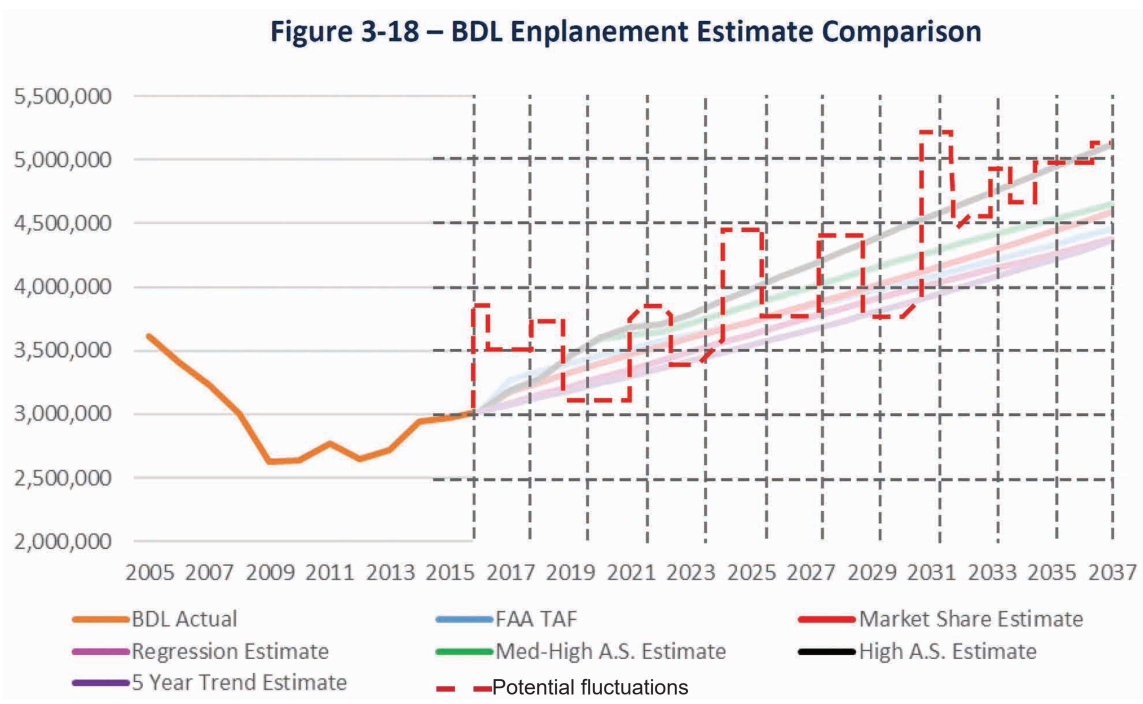

Fig.20. How the actual curve of enplanements may fluctuate[2]

1 Enplanements estimate comparison, “Bradley Airport master plan handbook” pg 3-18
2 Ibid

The adjacent graph represents the projections forecasted by federal aviation administration under various situations and depending on the analysis of all of the considered situation the planning authorities come up with a definitive requirement for the next 20 years and considering the same architects and planners design and build airport terminal building in various phases which will eventually be capable of the performing as per the project needs of 2037. But, this process has observed some fluctuations in past as well. As the actual enplanements visible on the same graph for the year 2005-2017 show a major downfall in the years 2008-09 and only after 2013 the airport has observed a rise in the numbers. This scenarios like the recession of 2008-09 or the ongoing pandemic of Covid-19 are some of the circumstances which have a major impact on the terminal buildings and the unpredictability of these situations are proof that the circumstances and accordingly built infrastructure are not constants and in the situations of such failing or unprecedented circumstances if the infrastructure is built while keeping flexibility at the center, there is a better possibility of building being able to perform as expected.

The followed graph is an example of how the increase and decrease in enplanements may take place over the period of years, without any supporting statistics this graph only represents the possible fluctuations and denies the linear progression of the increase in the enplanements. In order for the airport terminals to be able to adapt to the fluctuations the building infrastructure has to be flexible to take care of changes over the period of upcoming years.

3.2.3 Forecast for check-in hall:

The check-in hall is one of the areas of the airport terminals which has observed a major technological change over the period of last few years. A facility like in-person check-in which used to be just one place where the terminal staff would check the details of the travel and weigh and accept the check-in luggage, has now become a three way facility where in addition of such full services positions like self check-in kiosks and self baggage drop areas are introduced. As a result of this change the passengers are gradually performing some of the formalities by themselves. Such changes have effects on the behind the curtain operations as well. And because of this modification, baggage now moves through an auto-

Table 4-30 –Check-In Hall Summary

	2017	2022	2027	2032	2037
Public Concourse	21,035sf	23,415sf	26,320sf	28,070sf	30,555sf
Meeter/Greeter Area	5,091sf	5,831sf	6,387sf	6,942sf	7,405sf
Full-Service Positions	2,326sf	2,606sf	2,110sf	2,316sf	2,509sf
Bag Drop Positions	3,155sf	3,564sf	4,177sf	4,425sf	4,801sf
Self Service Kiosks	2,918sf	3,338sf	3,951sf	4,264sf	4,565sf
Airline Ticket Offices	5,039sf	5,620sf	5,813sf	6,201sf	6,783sf
Check-In Restrooms	1,165sf	1,288sf	1,330sf	1,401sf	1,444sf
Meeter/Greeter Restrooms	355sf	355sf	355sf	355sf	355sf
Customer Services	200sf	200sf	300sf	300sf	300sf
Public Concourse Ops and Support	700sf	800sf	900sf	1,000sf	1,000sf
Total Area	*41,984sf*	*47,017sf*	*51,643sf*	*55,274sf*	*59,717sf*

1.1x

Table 4-28 – Bag Drop Check-In Demand

	2017	2022	2027	2032	2037
Bag Drop Positions	16	18	21	22	24
Bag Scales	8	9	11	11	12
Maximum Passengers in Queue	67	76	90	97	104
Bag Drop Area	2,035sf	2,293sf	2,670sf	2,799sf	3,057sf
Queue Area	1,120sf	1,271sf	1,507sf	1,626sf	1,744sf
Total Area	*3,155sf*	*3,564sf*	*4,177sf*	*4,425sf*	*4,801sf*

1.5x

Table 4-29 – Self-Service Check-In Demand

	2017	2022	2027	2032	2037
Kiosk Positions	66	76	90	97	103
Maximum Passengers in Queue	83	95	112	121	130
Kiosk Processing Area	1,045sf	1,195sf	1,421sf	1,529sf	1,626sf
Queue Area	1,873sf	2,143sf	2,530sf	2,735sf	2,939sf
Total Area	*2,918sf*	*3,338sf*	*3,951sf*	*4,264sf*	*4,565sf*

1.6x

Fig.22. Check-in hall demographics- Bradley airport,Hartford [1]

1 Check-in hall summary "Bradley Airport master plan handbook" pg 4-29,30

mated system of moving belts and brings the luggage to the designated loading units. With the increasing demand of automation the bag-drop area and self service area are foretasted to grow around 1.5-1.6 times over next 20 years whereas the manual facility is only forecasted to grow 1.1 times of what exists currently. These demands may not be precise as these forecasts are based on the technologies available at the time of the study. Over the upcoming years when the new technological equipments like face scanners and more are already under testing there is a possibility that the numbers and requirements may not exactly go as expected. Perhaps, it is more favorable to make the airport terminals adaptable to changing infrastructural demands.

<u>10 years back:</u>

Fig.23. In-person check-in facility

<u>Present:</u>


Fig.24. In-person check in


Fig.25. Baggage drop area

Fig.26. Self check-in screens

CHAPTER 4
PRECEDENT ANALYSIS

4.1 Built Reference: Ramon International Airport:

The Asaf and Ilan Ramon international airport is a unique example of the medium hub airports. Completed in 2019 it is one of the most recent built from scratch example for the airport architecture. The airport hosts one terminal building, two additional support buildings and one control tower. The unique aspect about the project is that it was commissioned to the architects in a way where the architects were also the design managers of the entire project and this resulted in architects being responsible for the budget, program, planning and the scheduling of the airport. This opportunity allows the architects to provide a long term vision for the airport facility. As a result, coherence among all the buildings and the potentially upcoming additions can be observed for the project. This can be achieved in such fairly small airport projects, but for the larger projects where finances, time and many other resources, do not allow the project to take place in a holistic way

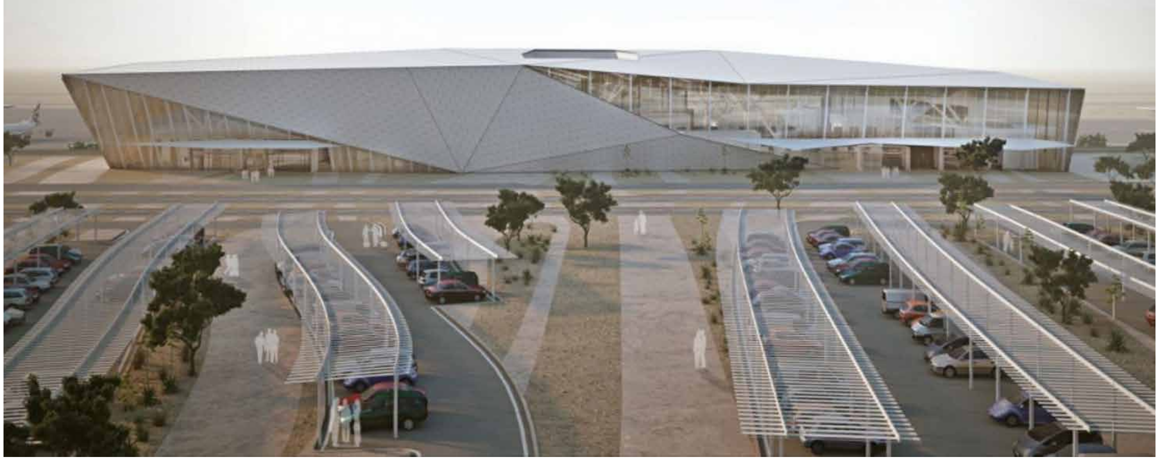

Fig.27. Ramon-airport terminal-building front elevation[1]

1 Front view- Ramon airport,archdaily.com “Image credits: Hufton+crow”
2 Ibid

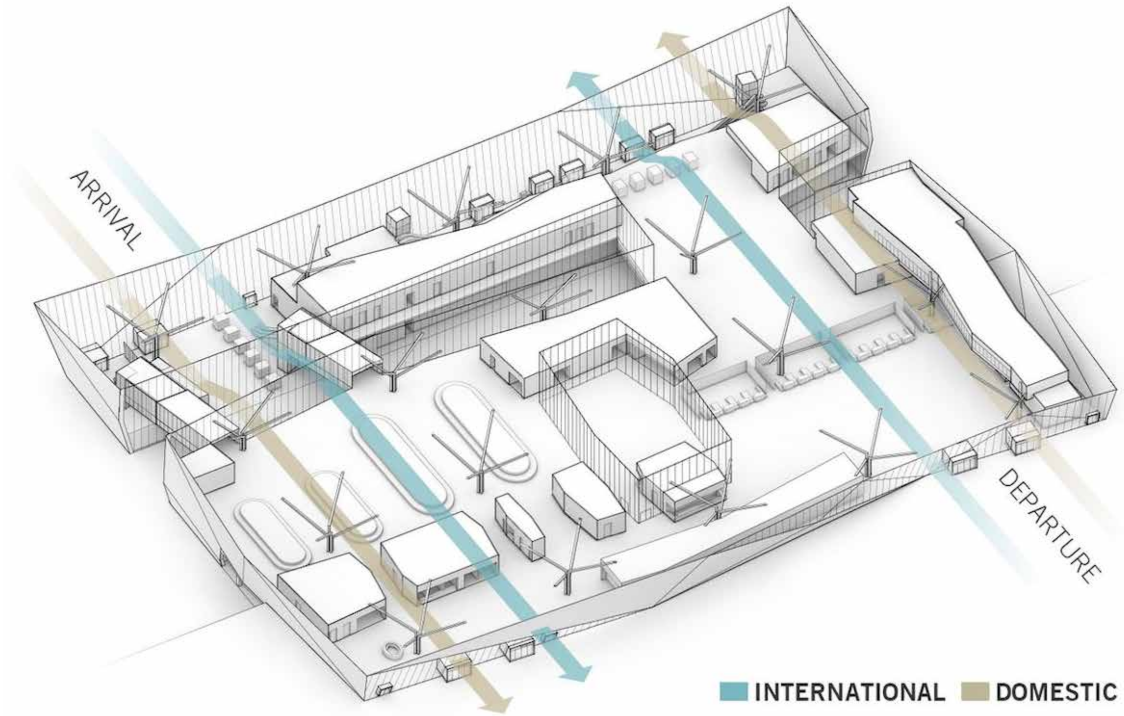

Fig.28. Concourse to boarding gate circulation of the airport terminal[1]

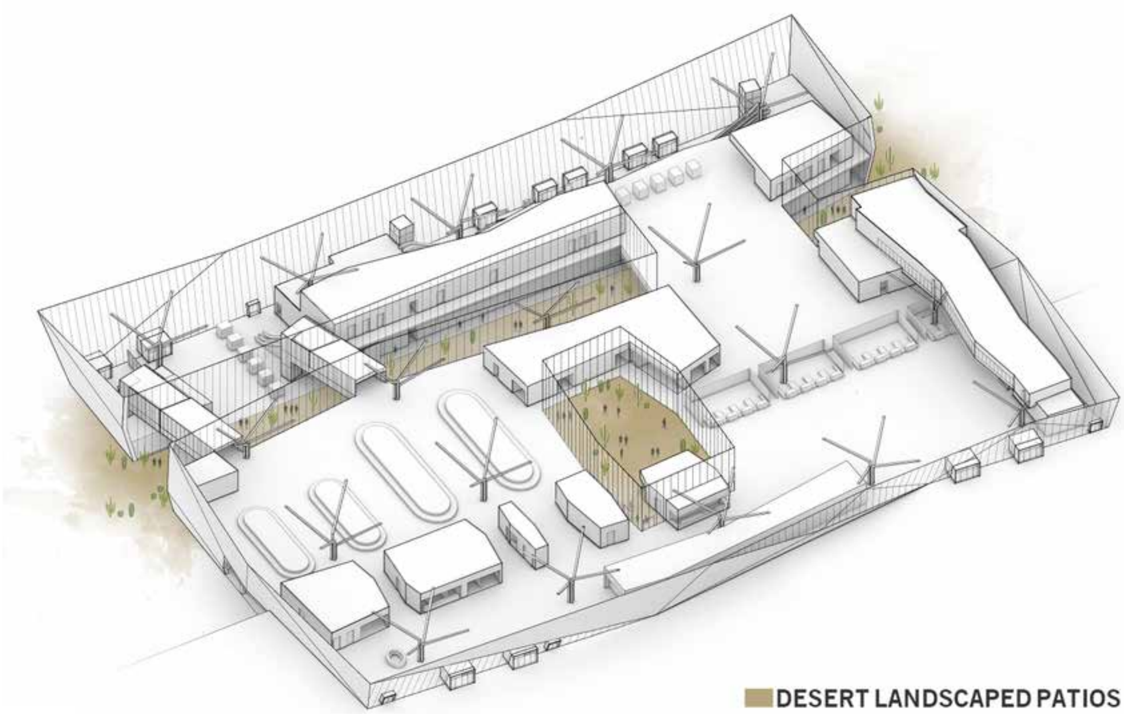

Fig.29. Built-unbuilt relationship of airport terminal and landscape courtyards[2]

1 Spatial organization Ramon airport,archdaily.com "Amir mann+Ami shinar architects+Moshe zur architects"
2 Desert landscape patios Ramon airport,archdaily.com "Amir mann+Ami shinar architects+Moshe zur architects"

there are possibilities that the only factor of coherence could be found in statistical data and eventually the a city may end up having a complicated network of multiple airport terminals few miles away from each other.[2]

The form of the Ramon international airport is inspired from the rocks found in the national park of the timma which achieve their form due to the constant run offs from the wind and water. In addition the central carved out courtyards are open spaces which provide partial glimpse of the surrounding landscape. The attempt to merge a minimalistic modern building with the harsh landscape of the surrounding is also an example of architecture being a central element in the design of the airport, as it is difficult to observe a sense of place in the airport terminal building as the need of the infrastructure seeks for similarities between different airports of the world. And as a result the moment of pleasure is achieved through the attractive interiors, glass facades and bright lighting and not through the character of its geographic location. Ramon airport takes care of the aesthetic appeal and the architecture of the building not just through four faces but also through the roof of the building. As the services of the building are hidden in the basement so that the view from the airplane window of the fifth facade also has an attractive appeal.

Fig.30. Bird’s eye view of ramon international airport[1]

1 Bird’s eye view- Ramon airport,archdaily.com “Image credits: Hufton+crow”

4.2 Visionary References(Competition Entries):

4.2.1 The Infinity Airport - Daoru Wang

The concept for the following winning proposal presented by Daoru Wang was centered around making the airport a 'drive through airport' where the concourse extends in a continuous loop inspired by torus knot. The aircrafts here are hosted under the continuing concourse loop. The terminal building for the proposed project takes form of a tower which would comprise of all the building facilities. This proposal is an example of how differently airports can be seen and helps in opening up the vision for airport of the future which is most travel friendly as the walking distances are decreased to minimum and passengers could be dropped directly next to their designated flights. In the world of automation where the technologies are making vehicles and portions of the buildings automated facilitating the humans should be central and with such approach the limits of not just the buildings but also the individuals ability to think creatively are tested[2].

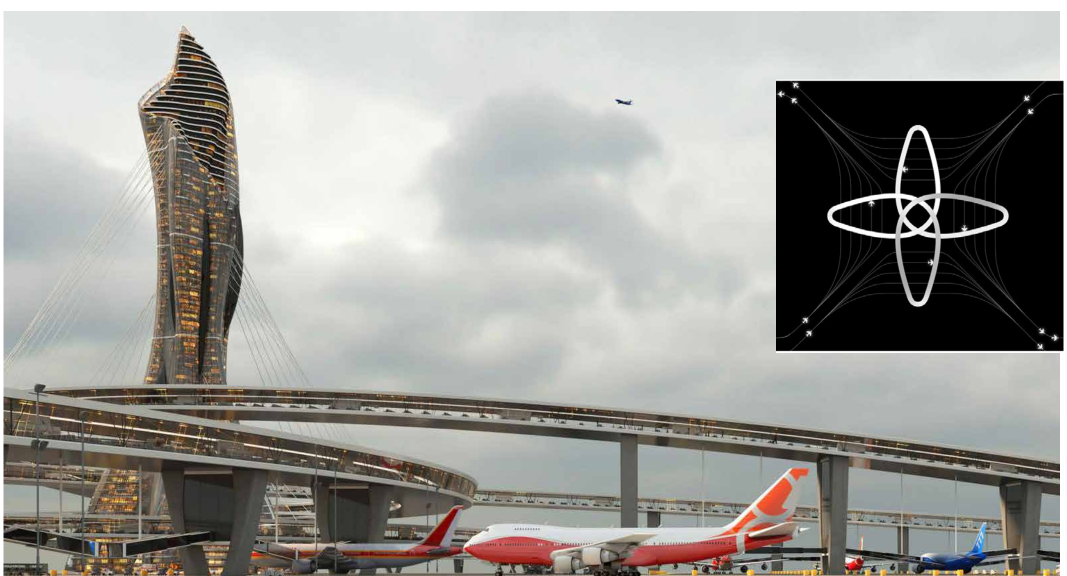

Fig.31. Fentress global challenge winning proposal by Daoru Wang[1]

1 The infinity airport,fentressglobalchallenge.com "Image credits: Daoru Wang"
2 Ibid

4.2.2 Densifying Airport Complexes - Christopher Johnson

The vision for the following proposal looks forward to resolving a very important issue related to the increasing congestion. The heathrow airport is surrounded by multiple neighborhoods and hence it has reached its limits of expanding the site and the airport currently has to work at the maximum capacity with no margin for errors and with the growing population and technological advancements there is a good possibility that the existing airport may become incapable of serving the need in such situation taking the advantage of the available height and densifying the airport buildings is a solution that the designer is proposing. The approach towards densifying the functions of airport in smaller foot print was a thought provoking influence as it also encouraged to consider the vertical movement which could lead to the smaller traveling distances and result in the ease the accessibility to various facilities[2].

Fig.32. Fentress global challenge proposal by Christopher Johnson[1]

1 Densifying the airport complexes,fentressglobalchallenge,com “Image credits: Christopher Johnson”
2 Ibid

4.2.3 Six Lane City- Riki Rozenberg, Evelyn Kreslavsky, Mai Whiteson

Designed with the intention of making airports above the ground level the designers for the following proposal are taking an approach where the airport terminal in itself comprises of many other facilities like residential, commercial and cultural amenities in addition to the core function of aviation and all these facilities are built 650 feet above the ground level. The aircrafts being docked hundreds of feet above the ground raises a lot of questions relating to the functionality but the imagination in itself of being able to use more space then what is available on the ground opens up a big realm of possibilities. The reference to this proposal was helpful in imagining the extremes of air travel and the spatial organization of the associated activities[2].

Fig.33. Fentress global challenge proposal by Riki, Evelyn and Mai[1]

1 The six lane city,fentressglobalchallenge.com “Image credits: Riki,Evelyn and Mai”
2 Ibid

4.3 Theoretical References and the Idea of Adaptability

4.3.1 Agricultural City - Kisho Kurokawa

Developed in the 1960 by the architect Kisho Kurokawa the ‘Agricultural city was intended to replace the agricultural tows in Aichi which were destroyed by the Ise Bay Typhoon around a year ago. The architect looked at the agricultural cities as rural communities where just the means of production were different from the major cities. In order to allow an organized expansion in future he developed a basic module which could grow with increasing demand. A composition of basic unit proposed by Kisho Kurokawa was for the rural area in japan which would comprise of a community, spread in the distance of 500m x 500m. This arrangement was proposed to have a religious and educational institution in the heart of the layout and all the other spaces were connected through a network of services like water services, electricity and monorails over the height of 4m from the ground. This was supposed to enable all common handling and administering of the agricultural works[2].

This composition of services related to agriculture and the arrangement for the users to live in the organized adjacent squares were some of the most inspiring elements. What was implemented for a rural setting is identically what is required for our airports which are becoming more or less like smaller cities. In order to see the opportunities associated with the grid, there was an attempt to trace the arrangement of the grid and trying to see the squares and rectangles of different sizes as the spaces for respective activities and the bays formed from the un-built portions of the structure as the way of organizing the building services.

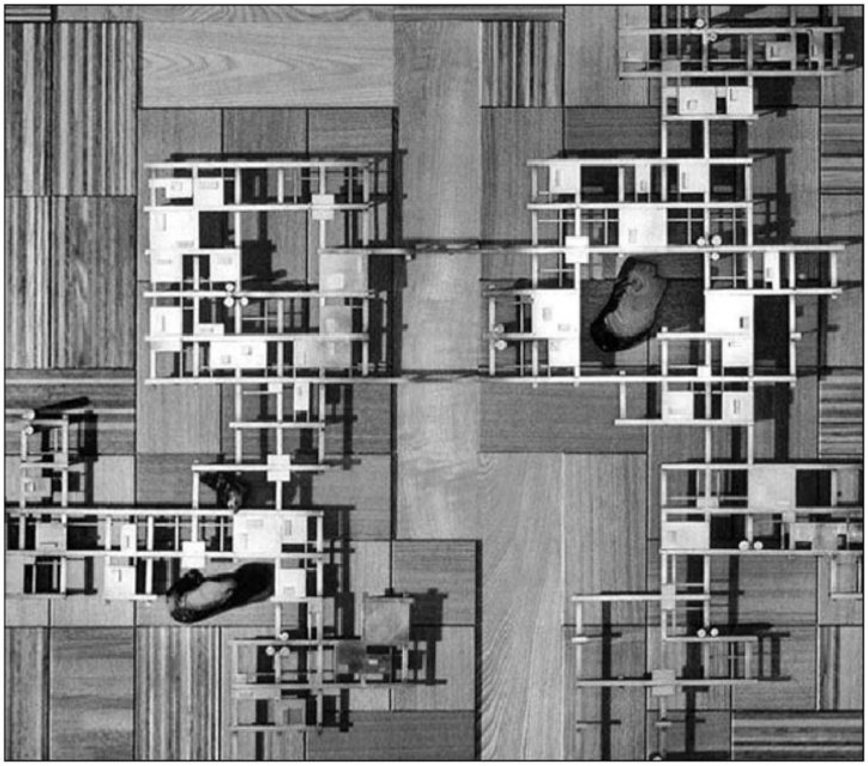

Fig.34. Model of the agricultural city by Kisho Kurokawa[1]

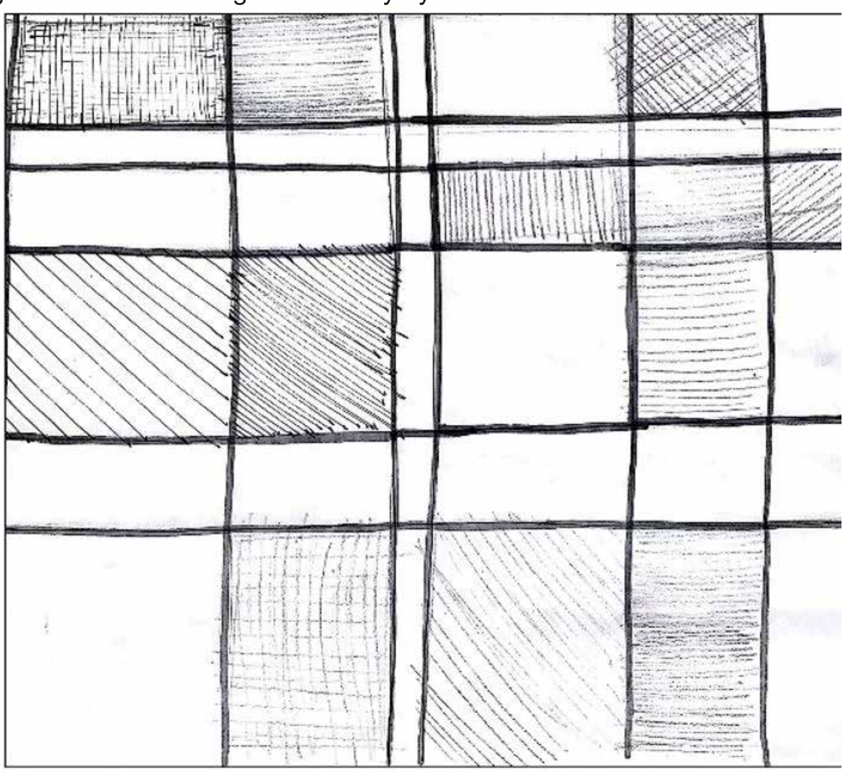

Fig.35. A mass and void diagram centered around channels for building services

1 The agricultural city,archeyes.com "Image credits:kisho kurokawa-c"
2 Ibid

4.3.2 Gandhi Smarak Sangrahalaya - Ahmedabad

Designed and built by the architect Charles Correa in 1958, Gandhi Smarak Sangrahalaya is a museum building, situated at a historic site next to the Sabarmati River in Ahmedabad. The museum building was built around the ideology of optimum living endorsed by Mahatma Gandhi. The structure consists a square module which spanned 6m and had a 'U'-shaped cast in place concrete girders which served the dual purpose of holding the roof structure and also acted as the rain water drainage lines. The museum had six different areas which included various exhibit and office spaces. Whereas the central area consisted of semi open spaces and open courtyards. This modular arrangement had open ends on all the different corners which had the extended beam girders acting as spout for the rain water.[1] The building was organized in such a way so that it can seamlessly incorporate future extensions whenever required. Although the activities of the built form did not require any extensions till date.

In an attempt to understand the opportunity for future extension a study of the built and unbuilt spaces was conducted. As represented in the followed sketch the immediate negative spaces resulting from the built spaces were also modular in nature and just with addition of the roof on top the central courtyard could be covered and the space beneath could be utilized for any activity. This nature of being able to transform a physical space as per the changing needs while maintaining the language of the built form was striking and can be seen as one of the strategies that airport terminals could adopt.

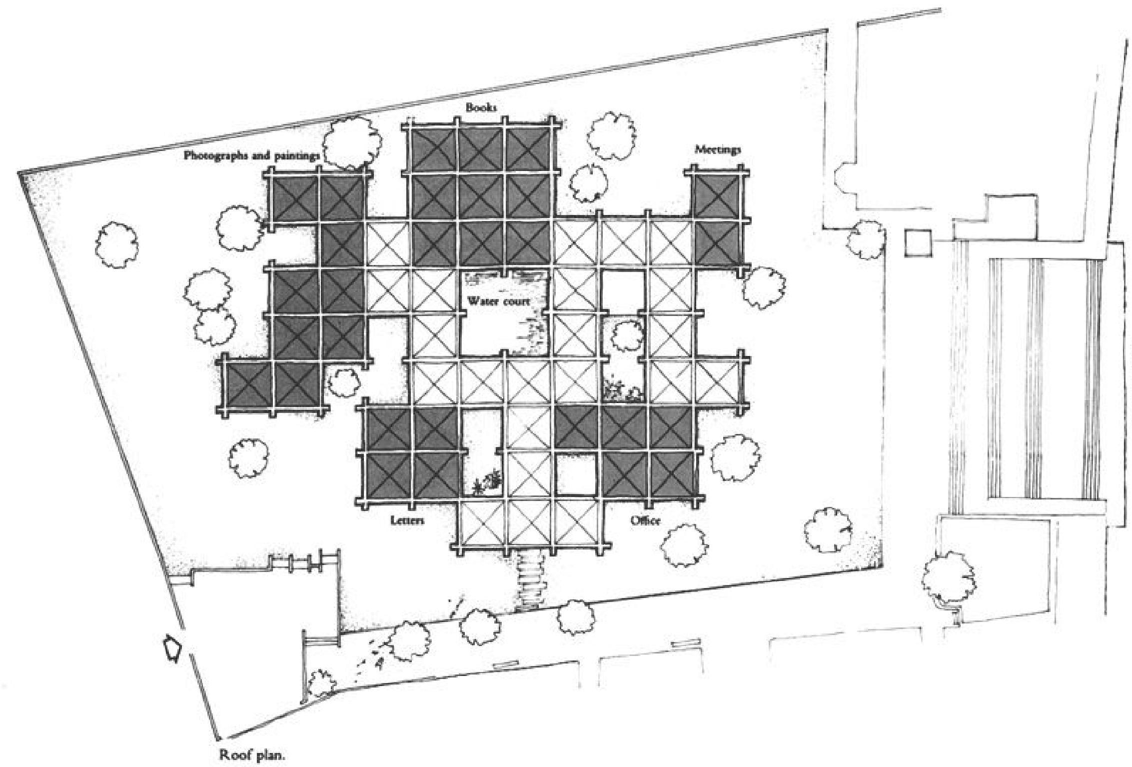

Fig.36. Gandhi Smarak Sangrahalaya site plan[2]

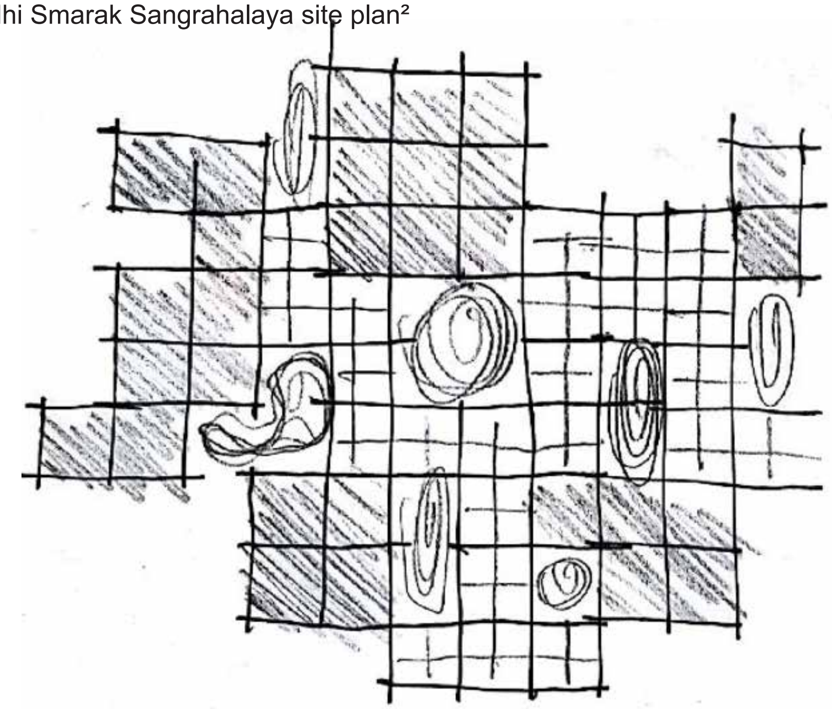

Fig.37. Gandhi Smarak Sangrahalaya built to open relationship

1 Gandhi Smarak Sangrahalaya,archeyes.com “Charles Correa foundation”
2 Ibid

4.3.3 Plan of the Tokyo City

One of the most effective example of the ideals of Metabolist manifesto was exhibited in the Plan of Tokyo by Kenzo Tange in 1960. When the population of Tokyo city almost tripled in the span of 15 years from 1945 to 1960s the Tokyo Regional Plan was proposed which introduced a series of satellite cities and general decentralization, which was not the ideal solution as per Kenzo Tange and he opposed the plan as he believed that with introduction of automobiles people's perception had changed and with the new possibilities a new vision for the spatial order was necessary instead of continuing the same practices of radical zoning. With this Kenzo Tange proposed a linear mega structure that comprised of some constants like highways and subways and as the time and the opinion of people dictated a 'transient' program could be developed which would be hosted adjacent to the planned highways. This plan was also situated in the middle of the Tokyo bay and connected the two sides of the bay.[1]

The contrast of black and white in the following images is a representation of how the constant arteries and the later coming built spaces could be seen differently for the same proposal. Some of the major takeaways from this reference were (1) how a growth could be guided in a certain direction without having to detail out all the potential possibilities (2) In order for the growth to observe a particular language not even all the proposed constants need to be in a completely built state but just enough initial construction that defines the language (3) An aim to achieve organized physical environment that can survive for decades to come.

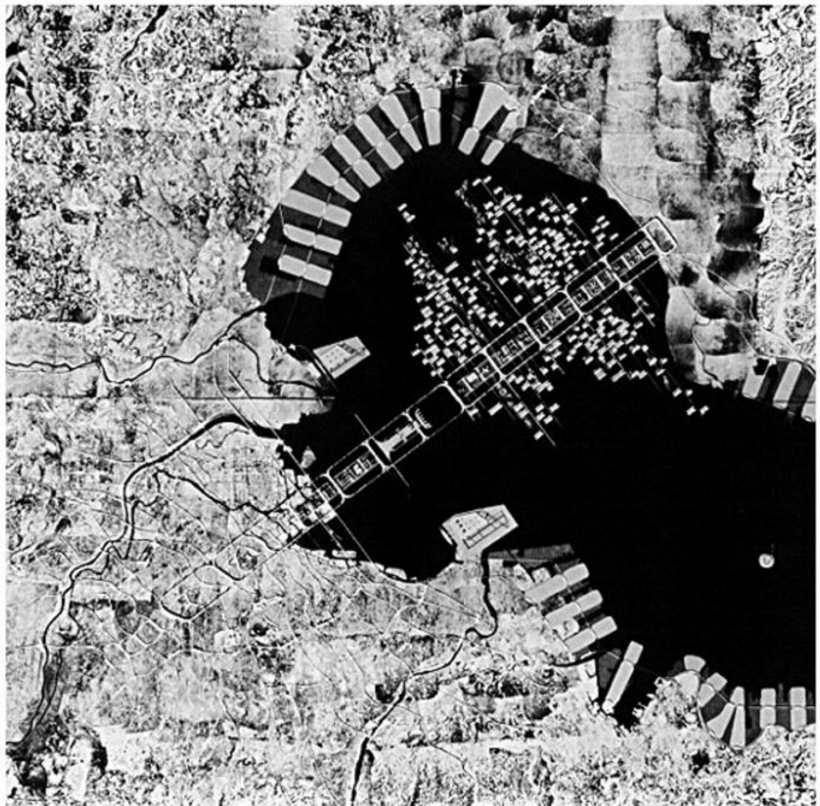

Fig.38. Plan of the Tokyo city by Kenzo Tange[2]

Fig.39. Plan of the Tokyo city by Kenzo Tange[3]

1 Plan of the Tokyo city,archeyes.com “Image credits:Kenzo Tange”
2 Ibid
3 Ibid

CHAPTER 5
CONCEPT & DESIGN

5.1 Concept Development

5.1.1 Concept Abstract

As a result of initial research this project proposes a resolution to the vulnerability of airports in the concept of adaptability. Achieving resilience to the changing technology and infrastructure was essential not only to achieve a hassle free operation of the terminal building, but also to facilitate and encourage the rapid evolution of technological equipment. Since the early 20th century and times of De stijl, the idea of flexibility has been considered in the course of Architecture. But over time, and with the interpretations of the same on different scales, this concept and related influences on design has changed significantly. Around mid century when Metabolist architects advocated the idea of adaptability at bigger scale of high rise buildings and city planning, the design for the similar concept was very different. With projects of larger scales this concept becomes more intangible and goes through the adjustments caused by several parameters. To encompass the idea of adaptability in airport terminals, this project took an approach of drawing references to the Metabolist planning projects not only through the theory, but also through the drawings and graphics produced. Here the figures on the right represent some of the explorations where Plan of Tokyo city as designed by Kenzo Tange was re-drawn keeping in place the idea of a core consisting of highways and major roads, whereas branch roads and built forms extending from the core represented variables that can be developed over time.

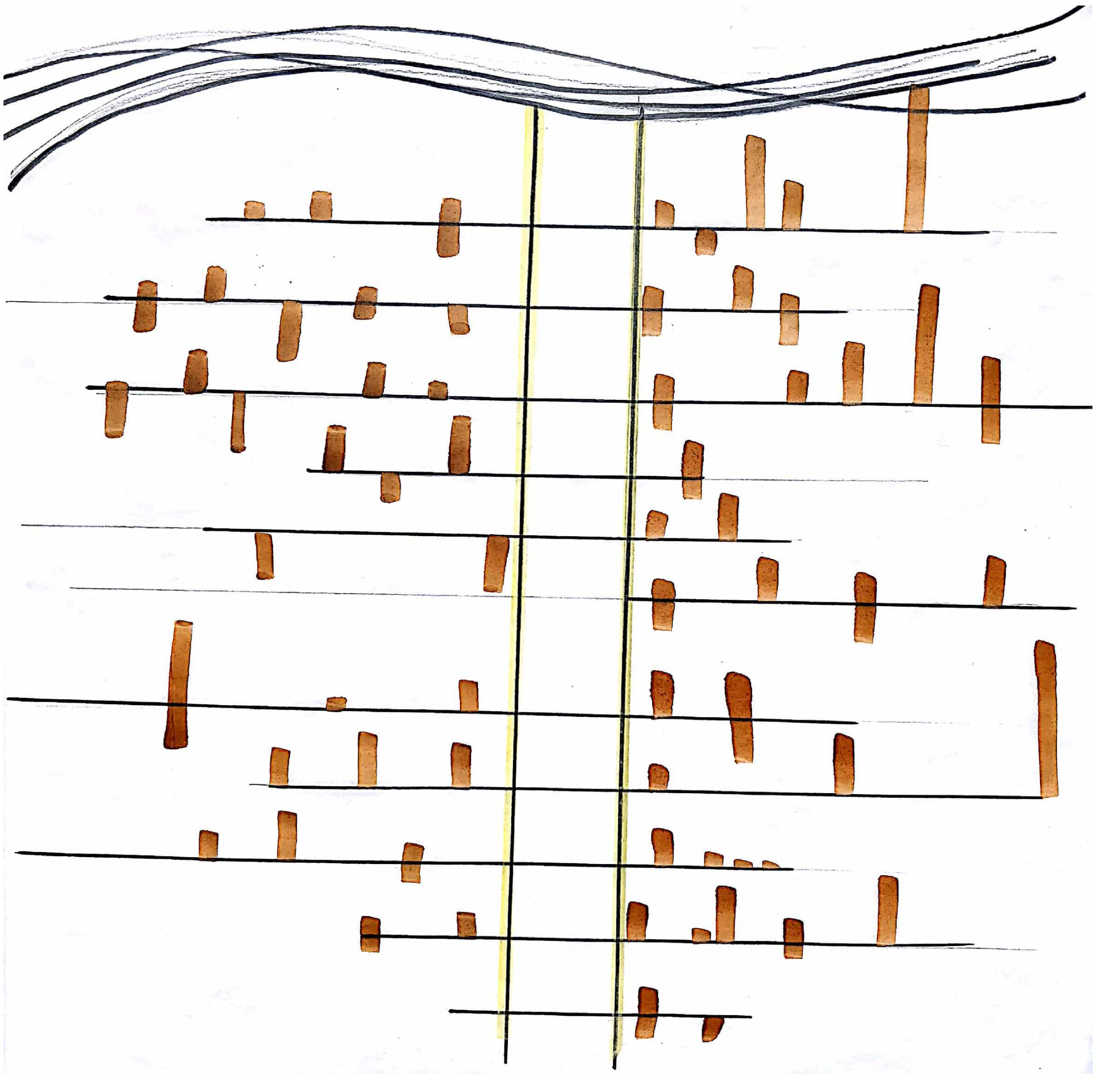

Fig.40. The concept of core and components in the plan of Tokyo city

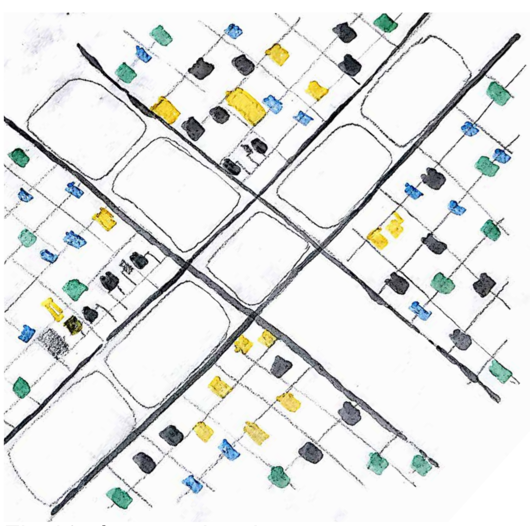

Fig.41. Intersecting the cores

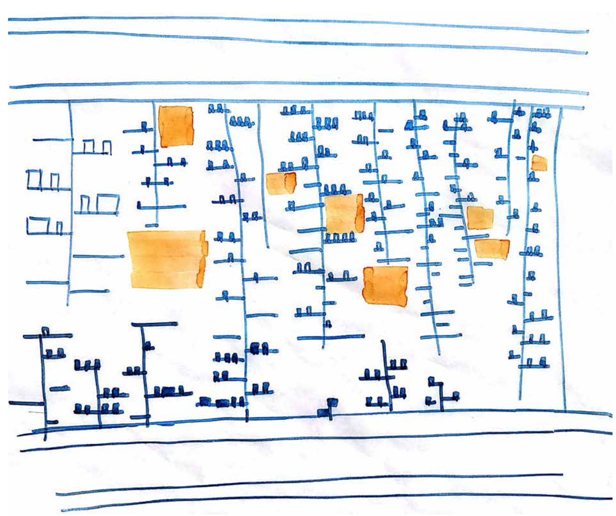

Fig.42. Abstract representation of the Parallel running cores

5.1.2 Concept Development

The figure 45 represents how multiple components of the design could be targeted in cohesive manner. The thick dark arch to the very top representing an overarching umbrella that provides shelter to the multiple components of the design. Underneath this umbrella structure a composition of various structural and non-structural building elements are choreographed in a way where certain elements retain their function and position over long time in comparison with others that can switch over shorter periods. But as the idea of an umbrella structure brings rigidity to the design and hence the idea of a modular roof was developed further to endorse the concept of adaptability in all the components of the terminal design. Here some of the vertical elements are anchored to the ground and with their adjacent members where as other members observe indirect connection with the ground thus their internal connection and the connection with ground remain volatile. This diagram also represents the human figures of various scales to represent the same composition being repeated at multiple scales.

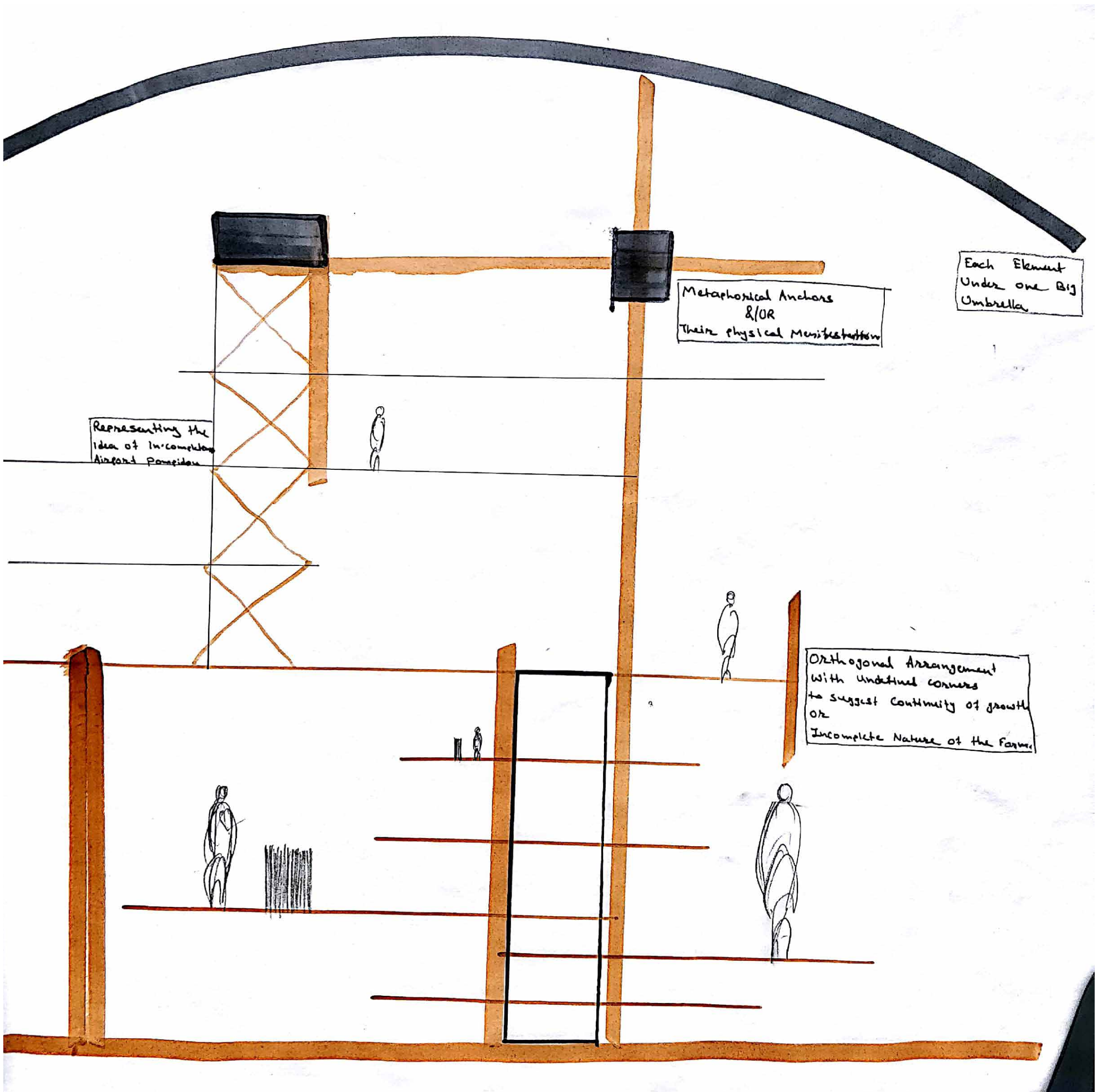

Fig.43. Abstraction representing an adaptive system of constants and variables

5.1.3 3D Manifestations

Following the 2Dimensional conceptual explorations, the translation of the same was developed in 3Dimensions. Where the volumes shown in the orange and green color representing the floors at different levels were created as variables of the built form and the columns remained to be the constant members of the system. With the regular repetition of columns the horizontal and vertical floor planes could expand and contract as the need arises. This system would allow alterations of various sizes but they would have to be dependent on a particular module consisting of the column grid. Different from the idea of Metabolist architecture, this concept was grounded and quantified with one particular module. This configuration had the potential to resolve a significant amount of technical concerns like ease of construction, opportunity for modifications and more. At the same time, this also had a downside of limiting the architectural appeal as with an increase of predictability of the structure a decrease in the element of surprise was possible. To provide enough room for the spatial organization to be dynamic while being adaptable the same organization was proposed to be divided in at two different scales.

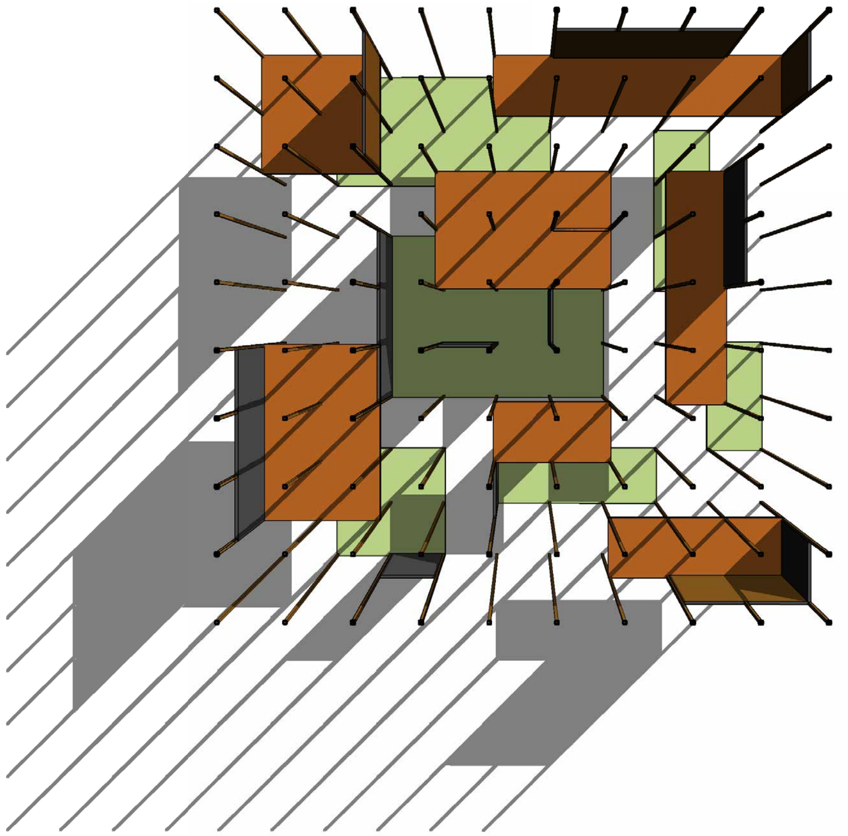

Fig.44. 3D exploration for constant & variable components plan view

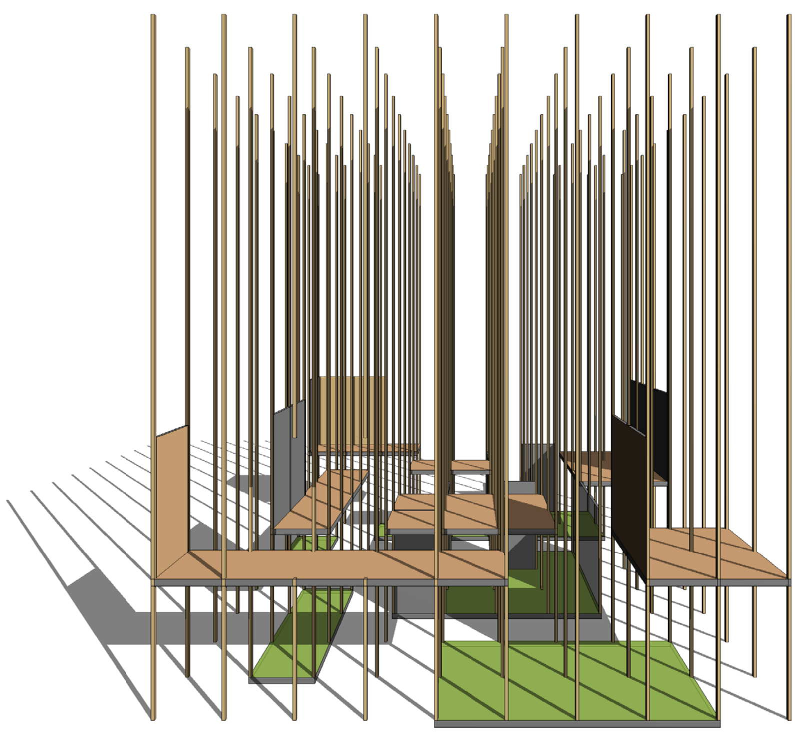

Fig.45. 3D exploration for constant & variable components side view

5.2 Design Development:

5.2.1 Developing a Module:

As shown in the following diagram 48 the terminal building was organized around a module consisting of the primary grid of 60ftx60ft and the secondary grid or internal floor structure which was divided in the partitions internally placed at distance of 15’, 20’ and 30’ from the preliminary structural grid. These diagram represent composition of one module of the system, this module comprises of a structural column that is connected with 8ft wide bays of two parallel beams in between which all the building services could be laid out. In the portions where the building services would require vertical transportation, the structural columns would be covered with a partition covering up the column up to 8 ft in width. As each member of the structure included or had the opportunity to include building services of all the different types, the structure would be capable of hosting different activities of the building in any part of the building. These internal building services would also be flexible to change as the tangible surfaces like flooring of the building was based on the building services, allowing them to be operated by accessing designated areas of flooring in the building. The series of diagram 49 to 56 showcases the gradual progression of how each module is built.

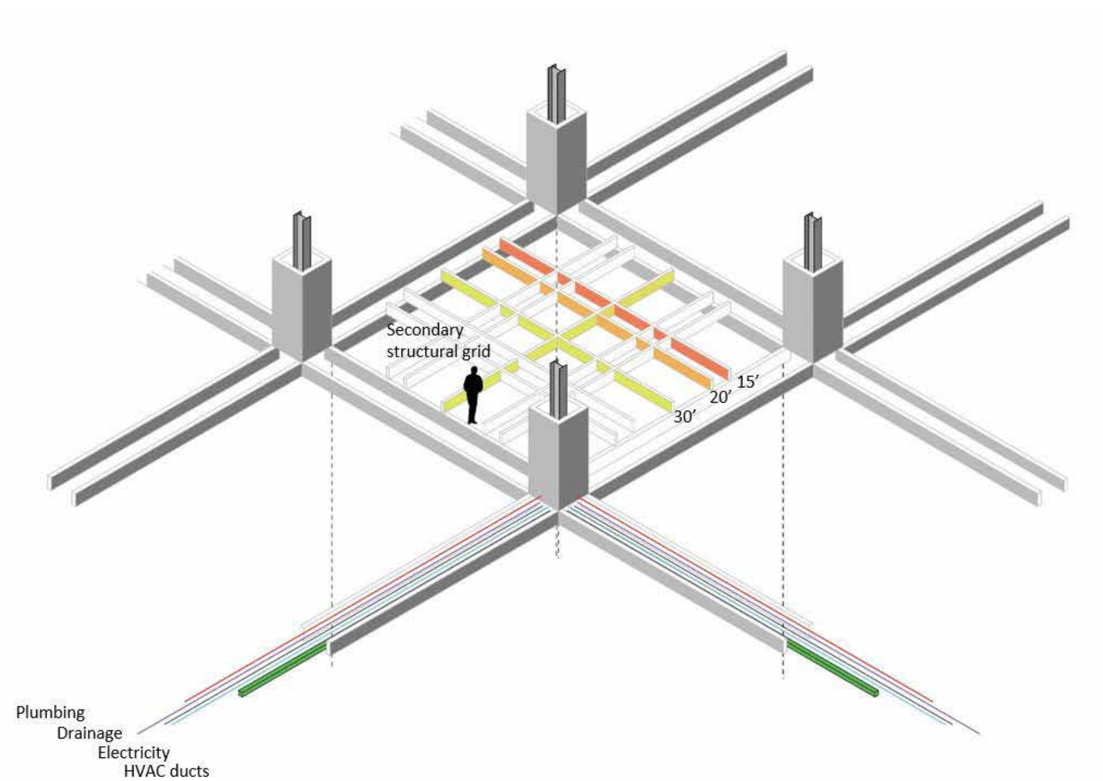

Fig.46. A repetitive module comprising of building structure and systems

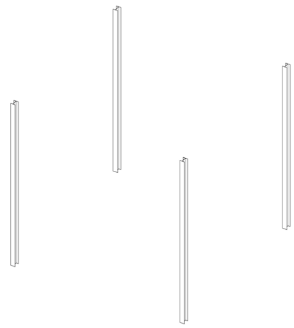

Fig.47. Module consisting columns

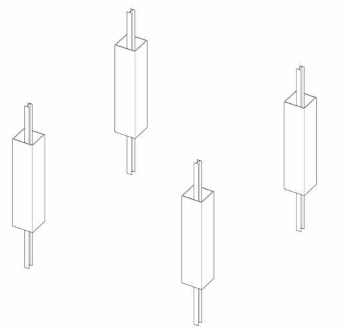

Fig.48. Building services moving parallel to columns

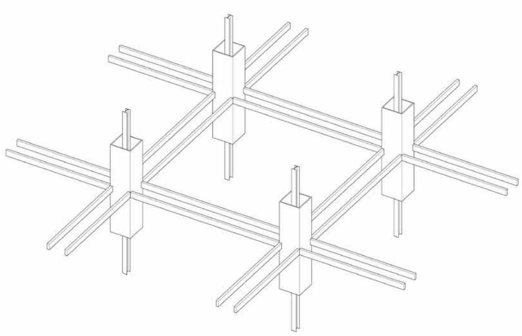

Fig.49. Columns with beam bays

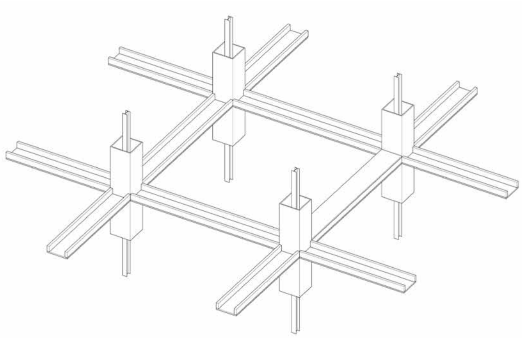

Fig.50. Coverings on beam bays

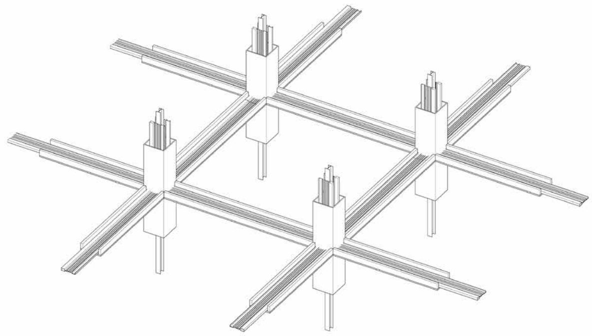

Fig.51. Internal building services in-between structural beams

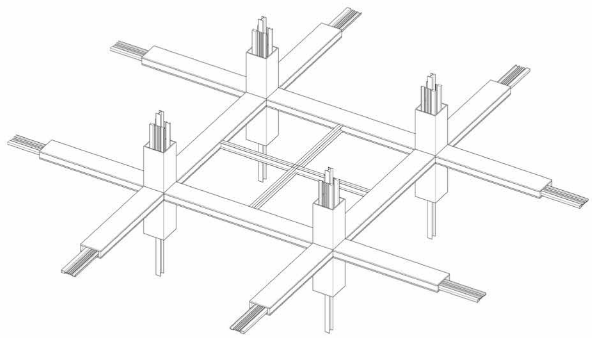

Fig.52. Internal structure of floor divided in two segments spanning 30’

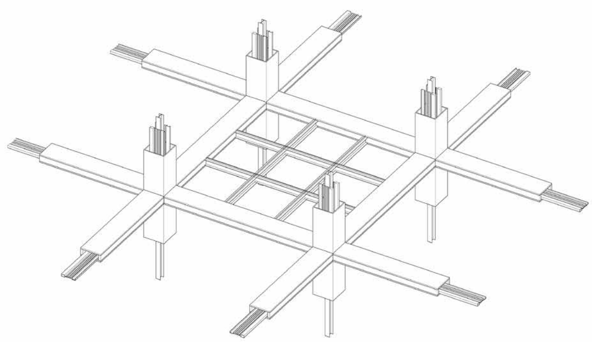

Fig.53. Internal structure of floor divided in three segments spanning 20’

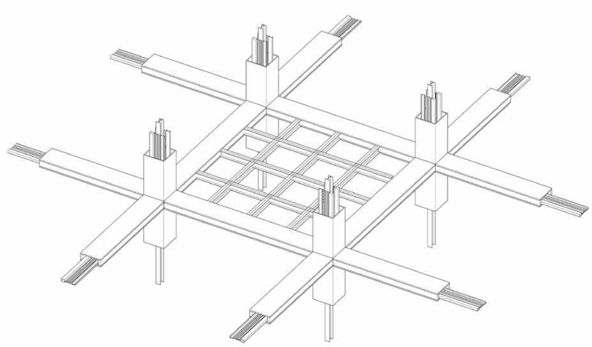

Fig.54. Internal structure of floor divided in four segments spanning 15’

Fig.55. An interior view of the hold room area

Fig.56. An example of a possible addition

5.2.2 Design development

The series of illustrations show how the internal parts of the building could adapt to the changing need of the infrastructure. An internal space like a hold room as shown in the image on the left may be designed considering the requirements of the current time but over time if the spaces needs to increase its capacity and additions like a sleeping lounge needs to take place in the same area, there is an opportunity to allow an addition of the structure by making additions based on the internal structural grid of the floors. The illustration below represents how this change can take place. As shown the floor has in-built internal secondary grid laid out on top of which the secondary columns as shown in red are erected to house the new addition. And as such components are built they can also be deconstructed as all the portions of the design are flexible.

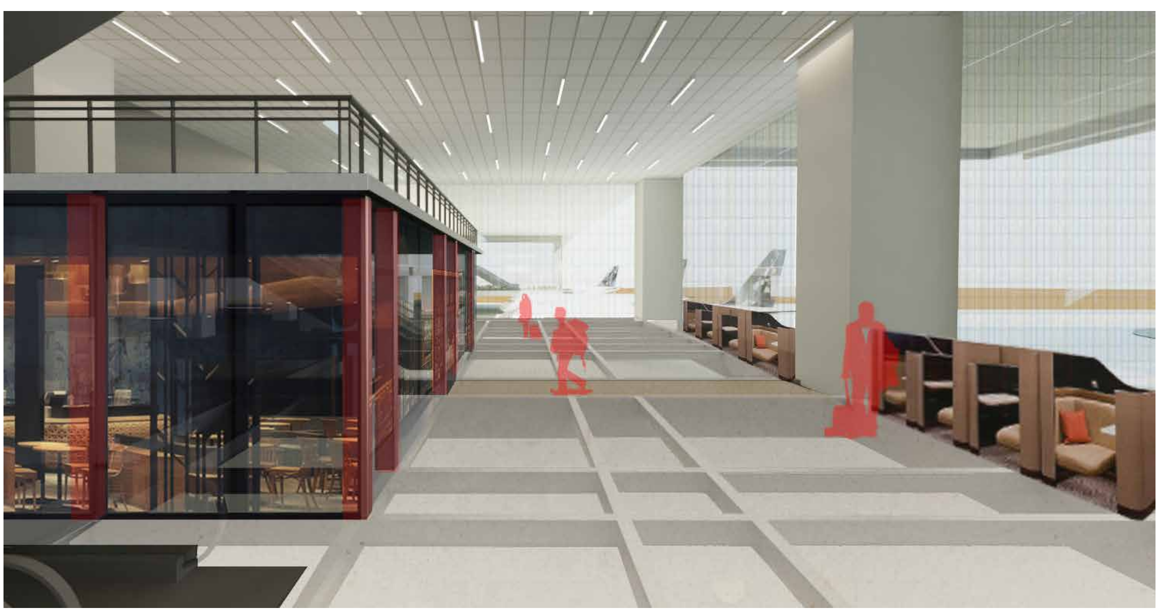

Fig.57. A possible method showcasing structural flexibility supporting the addition

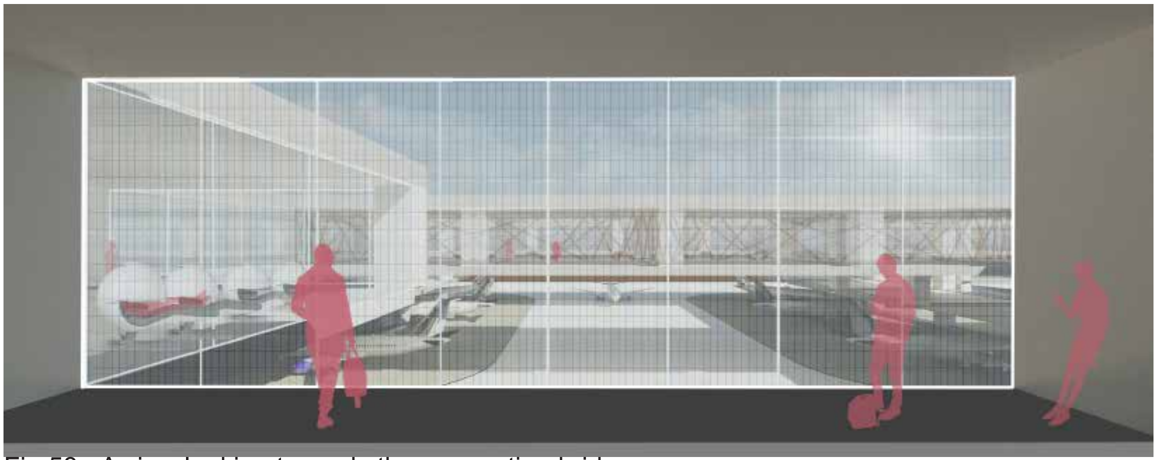
Fig.58. A view looking towards the connection bridge

The above image represents how airport terminal might look like when looked outside from one of the facades of the building. The portion in the front looks towards the connection bridge connecting the two different areas housing the hold rooms and boarding gates. This can further be extended with the increasing demand. One of the major reason behind connecting these spaces through the bridges was to allow aircrafts to reach to the terminal building rather than the terminal expanding out in the form of long narrow wings to reach to the aircrafts. This doesn’t just facilitate the building expansion but also results in shorter walking distances inside the terminal building.

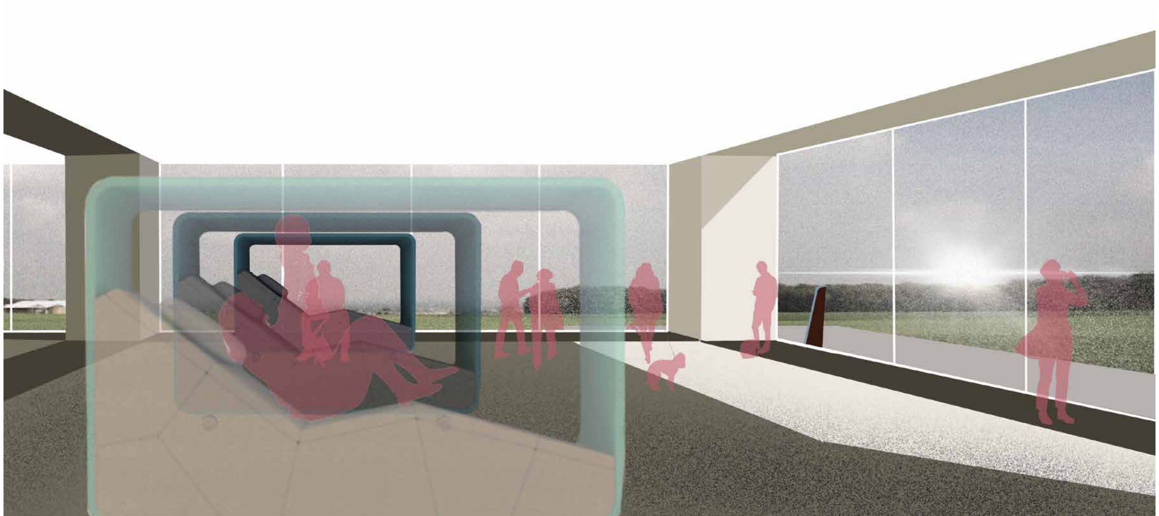

Fig.59. A vista from the building edge looking towards the landscape

As the terminal building will observe internal changes, unique infrastructural requirements responding to the changing technology may come up and it will be essential for the infrastructure to meet up to these needs. Above view shows how the designed airport terminal is independent of stationary architectural elements and how elements like resting pods can be incorporated in the design. This view also shows how there can be a better opportunity to have views extending to the natural landscape rather than the windows looking at the aircrafts and the ground operations taking place next to windows. This could be achieved in the proposed design as the aircrafts come underneath the buildings allowing the terminal to float over the docked aircrafts.

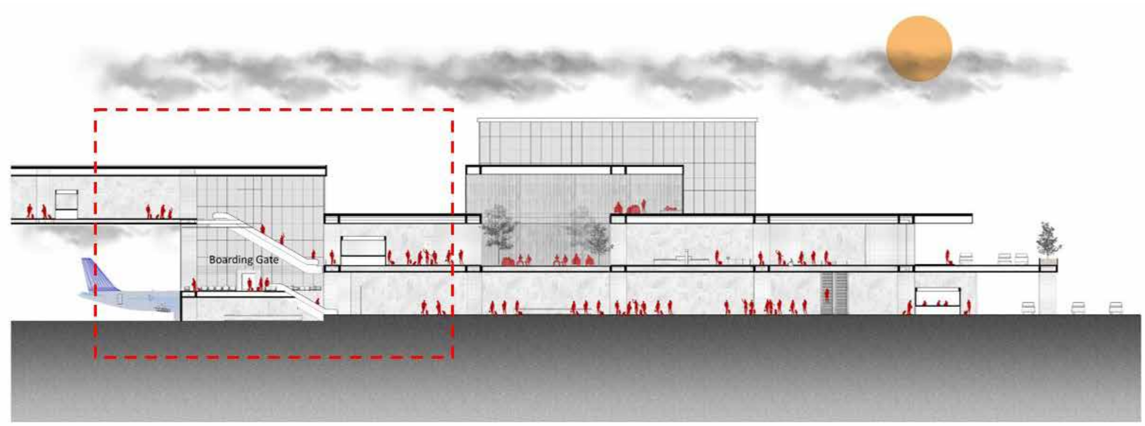

Fig.60. Section through hold room to concourse

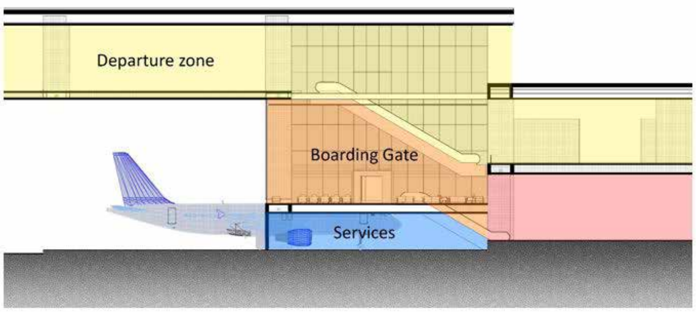

Fig.61. Proposed scenario

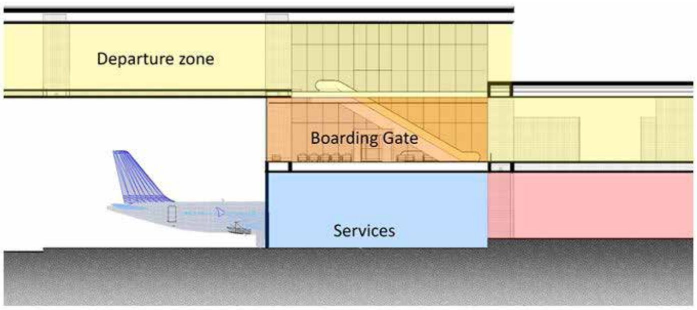

Fig.62. Potential adaptation 1

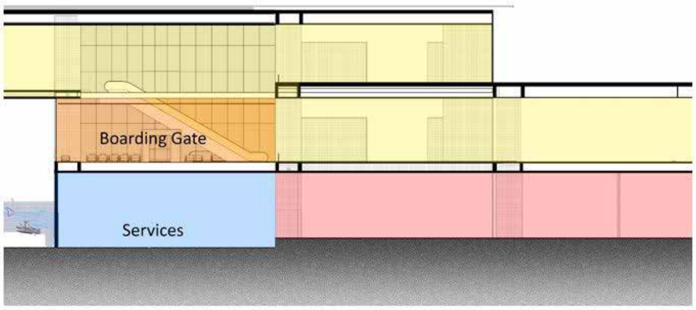

Fig.63. Potential adaptation 2

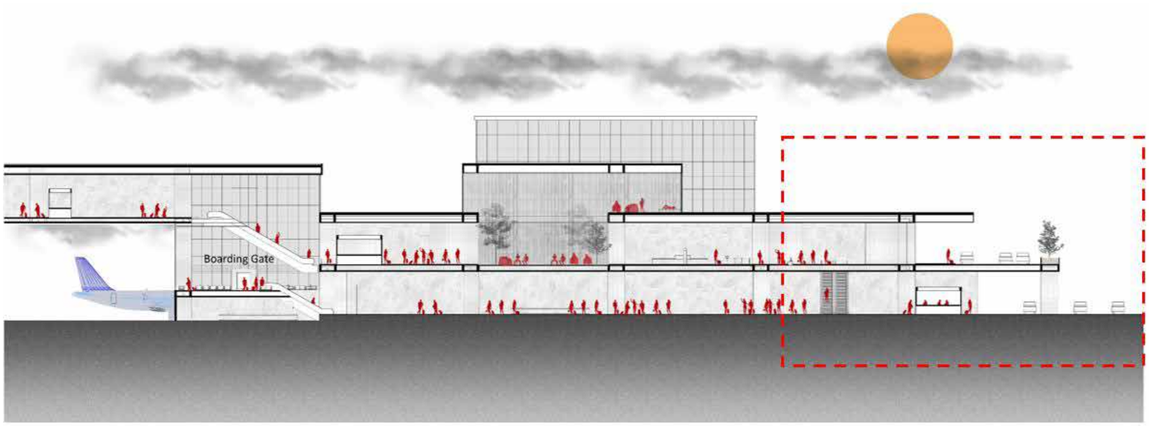

Fig.64. Section through hold room to concourse

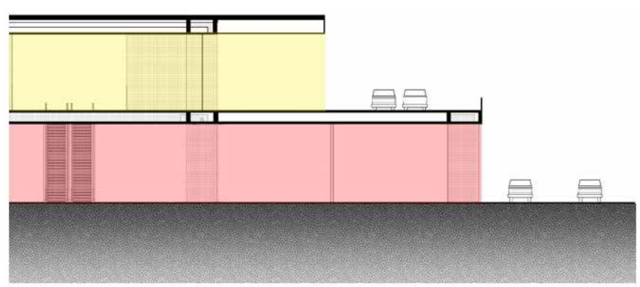

Fig.65. Proposed scenario

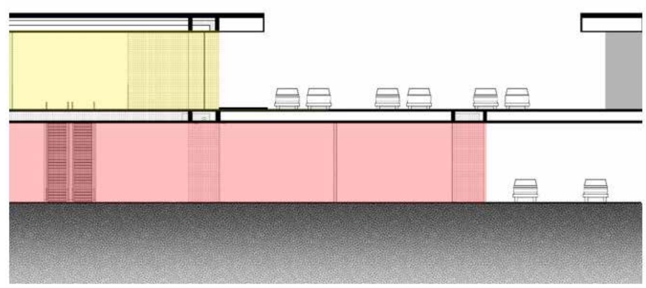

Fig.66. Potential adaptation 1

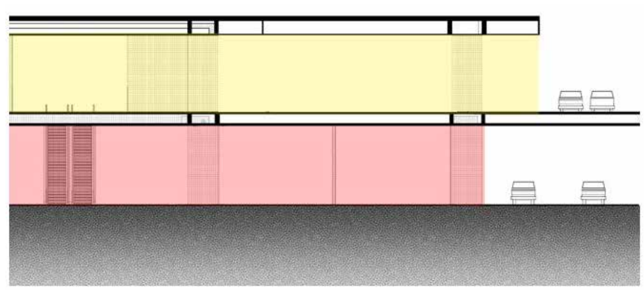

Fig.67. Potential adaptation 2

The figure 59 represents a part of the airport terminal that cuts through the concourse area to the hold room of the terminal building. Here the floor above holds all the activities related to the departure area like security screening, check-in area, ticketing and concessions. Whereas the floor on the bottom holds all the activities of arrival zone like baggage claim area, customs area and other activities. As shown in the sequential part sections if the building goes through a change and requires new additions or alterations the building can adapt to that. Figures of the part sections showcase how the hold room-boarding gate area can adapt to changes over the period of years as all the spaces are based on a particular module. Similarly in the concourse area when the building needs to respond to the fluctuating vehicular demands the proposed configuration has an opportunity to expand the vehicular lanes in the drop off area or could also allow for a new addition of a parking building on the other side or extension of the terminal building.

The axonometric layout shown in the figure 66 represents how the spaces around structural members can be transformed for different uses as the columns consist of all the building services in addition to the structural components. Thus a space next to a column can also host only furniture or it could also be transformed in a small cafeteria. When such modules are repeated in an organized pattern it would result in a composition as shown in the bottom axonometric graphic.

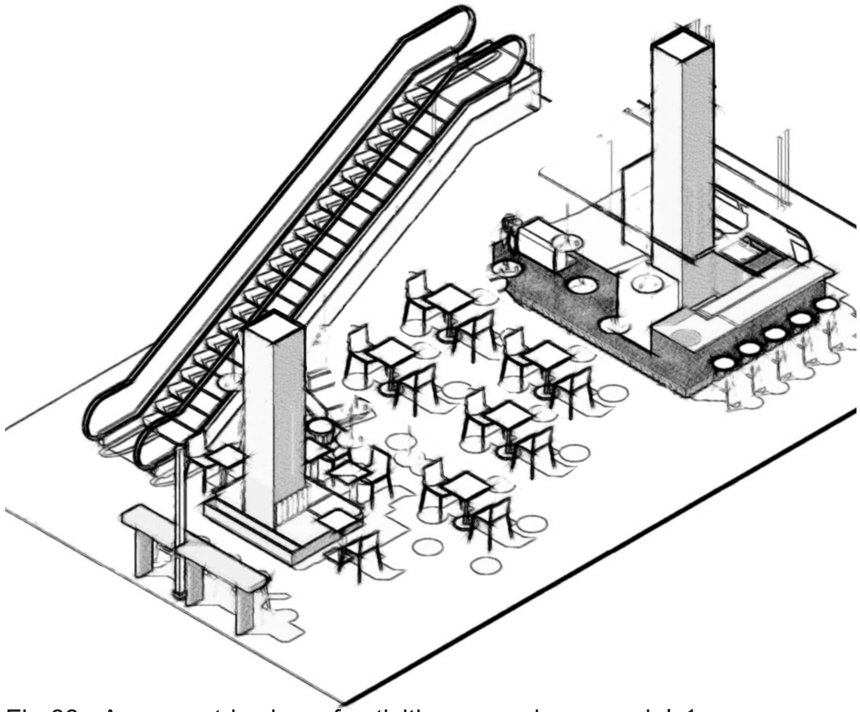

Fig.68. Axonometric view of activities around one module[1]

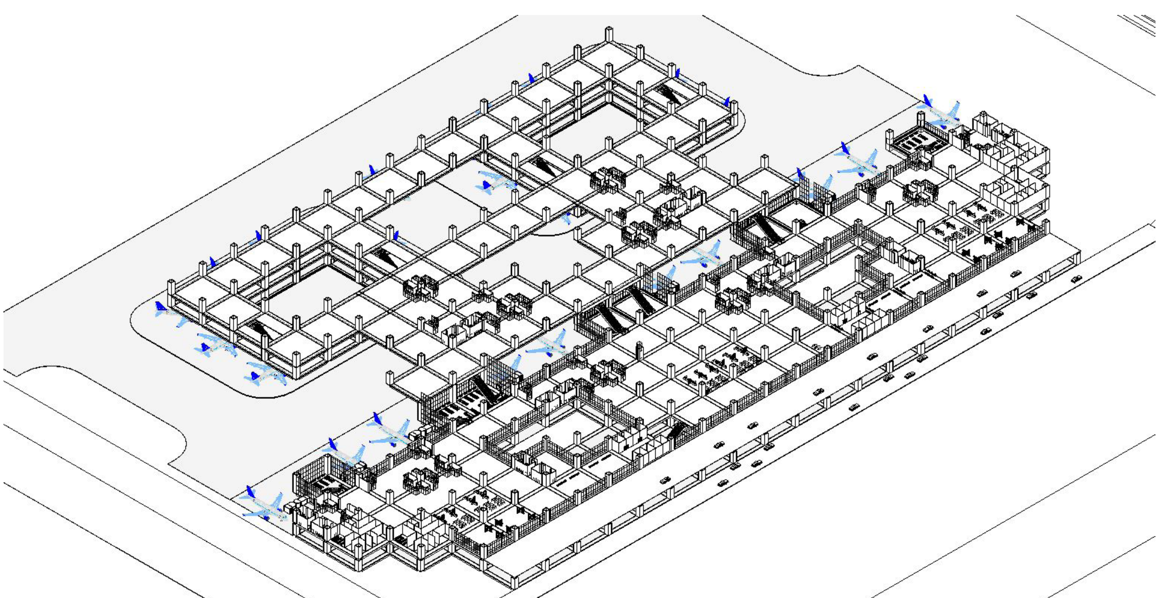

Fig.69. Axonometric view- second level

1 Hazel coffee shop,Lubish design “base Image credits:lubish design”

6. CONCLUSION

Fig.70. Side elevation of the proposed airport terminal

This thesis project began with examining conventional approaches of designing and operating airport terminals. As the airport terminals face unprecedented challenges frequently, it is difficult for architects and engineers to design an ideal building that can perform as expected for decades. This project attempted to overlay some of the theoretical approaches of adaptability on airport terminals in pursuit of a flexible airport building. In order to find balance between architectural and urban scale this project also draws references from the adaptive ideologies experimented at distinct scales, from small scale of De-stijl projects to the larger scale proposals of Metabolist architecture. Unlike most other projects airport terminals are critical as they have to keep altering various parts of the system with the rapid changes of technologies without disturbing the ongoing operations. Hence, in true terms they require to be living buildings.

To achieve a potential direction for resolution the initial research speculated all the various parameters like finances, urban design, traffic engineering, aircraft operations and more that impact the architecture of the airports. Following the learnings from the above this project moved towards achieving a modular system where each module would comprise of all the essential building services that could host any function. Even though this approach reflected flexibility associated with physical spaces of the building it had a certain limitations. All the spaces were still based on a module and in-order for the module to be constructed it required to have a physical dimension to it. Because of the drastic variations of the scale observed in the built form there was a potential that this dimensions may not be able to do complete justice to all the requirements of today and of future. In addition of the above, the modular system was found to have another behavioral constraint. Although the modular approach has the potential of resolve a lot of technical issues and it can result in ease of transformation, modularity results in predictability and with an increase in predictability it loses the element of surprise. This loss is significant from an architect's perspective as the aesthetic appeal is incredibly important to provide a rich spatial experience. If this project moved forward with additional filtration to achieve a detailed adaptive resolution, it could be considerate of defining a hierarchical spatial order of modules that are interconnected to achieve a definitive spatial order and at the same time the varying scale of modules could be a solution to more flexible building composition.

BIBLIOGRAPHY

1. Conway, McKinley. 2000. The Airport City: Development concepts for the 21st Century. Conway Data.

2. 2019. design.ncsu.edu. March 24. https://design.ncsu.edu/architecture-studio-honored-with-award-during-venice-biennale/.

3. Edwards, Brian. 2005. The modern airport terminal- New approaches to airport architecture. Spon press.

4. hill, Jonathan. 1998. Occupying Architecture between architect and user. Psychology Press.

5. Jung Hye Jin, Shin ye kyeong. 2016. “Spatial characteristics of the infrastructure integrated with architectural space focused on international hub airport.” Suistanable cities and society.

6. Pallasmaa Juhani, Alberto Perez Gomez, Steven Holl. 2006. Questions of perception. a+u Publishing Co.

7. Pallasmaa, Juhani. 1996. The eyes of the skin: Architecture and Experience. John Wiley and Sons.

8. Sarah, Suchi. 2016. A Novel concept for Airport Terminal Design Integrating Flexibility. University of Queensland.

9. Seremetis, Constantine. 1986. Terminal of Malpensa International airport, Milan. Massachusetts Institute of Technology.

10. Tuan, Yi Fu. 1977. Space and Place: The perspective of experience. University of Minnesota Press.

11. uffelen, Chris van. 2012. Airport Architecture. BRAUN.

12. Administration, Federal Aviation. 2020. Federal Aviation Administration. March 30. Accessed April 27, 2020. https://www.faa.gov/airports/planning_capacity/passenger_allcargo_stats/categories/