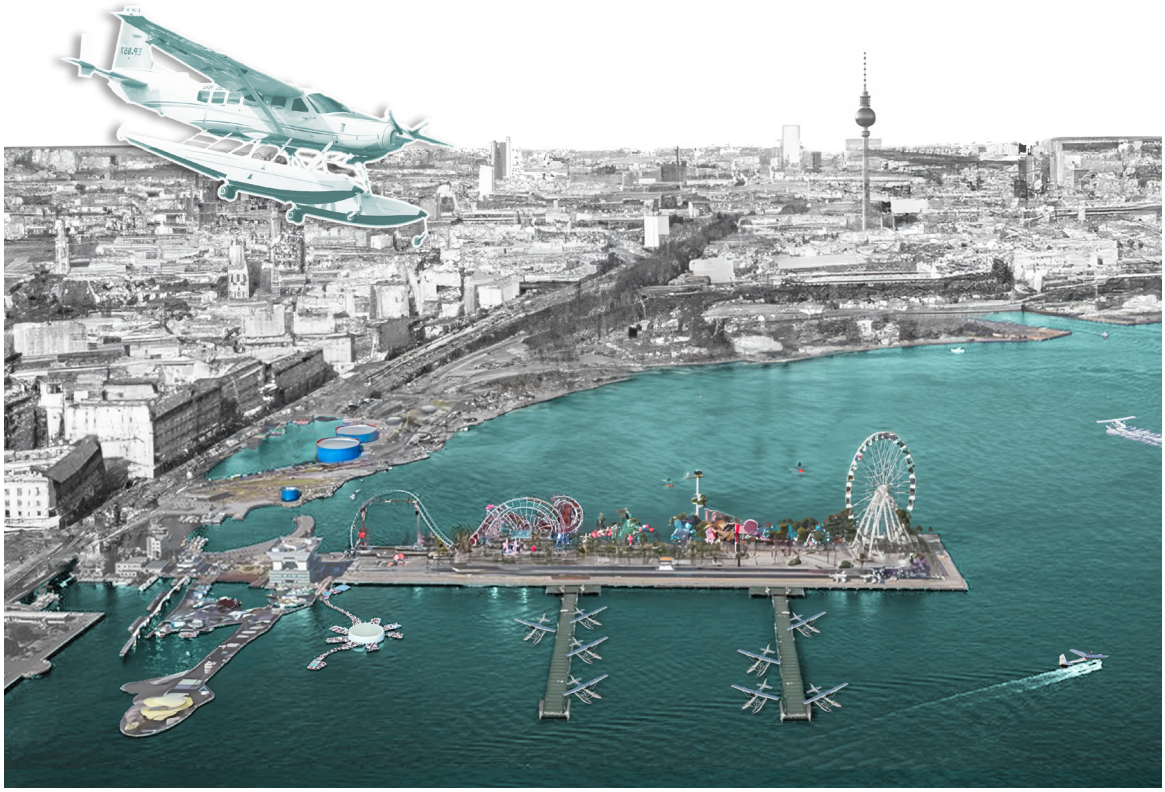


2023 / 24
AR3A010 Design Brief

URBAN TAKEOFF –
WATER AIRPORT OF HEALTH AND PLAY

Chan Cheuk Lam Julia
5802164

2023-24

COMPLEX PROJECTS
Bodies and Building Berlin
AR3CP100

student
Julia Chan

chair
Kees Kaan

studio leader
Hrvoje Smidihen

group tutors
Benjamin Groothuijse
Jan van der Voort
Maruli Heijman

email
infocpstudios@gmail.com

Instagram
https://www.instagram.com/
cp.complexprojects/

website
https://www.tudelft.nl/bk/over-faculteit/
afdelingen/architecture/organisatie/disciplines/
complex-projects/

facebook
https://www.facebook.com/CP_Complex-
Projects-422914291241447

INDEX

INTRODUCTION

01

01.1 Thesis Topic

Airports and cities have been growing closer together. (Fig. 1) This can be attributed to factors such as the advancement of aviation technology, economic growth and population growth since the post war era. With increasing numer of flights and airports in cities, problems regarding environment and health would have to be addressed.

This thesis ***Urban Takeoff - water airport of health and play*** will investigate how architects could acknowledge and adopt to changes in the industry. By rethinking how airports could become, we shall take part in preparing airports for the use in dense urban areas, prioritising health of users and the population nearby with efficient, future-proof designs.

This thesis proposes an inner city hydrogen-powered seaplane port located in Rummelsburger Bucht, near the centre of Berlin. By using seaplanes, the airport would be a small-scaled airport with the approximate size of 50,000 square metres next to the Spree and no runways on ground would be necessary. With innovations of the hydrogen fuel, airports could be more environmentally friendly, sustainable and thus could be located at the heart of Berlin, benefiting medical passengers from rural areas and domestic travellers escaping the city for a break.

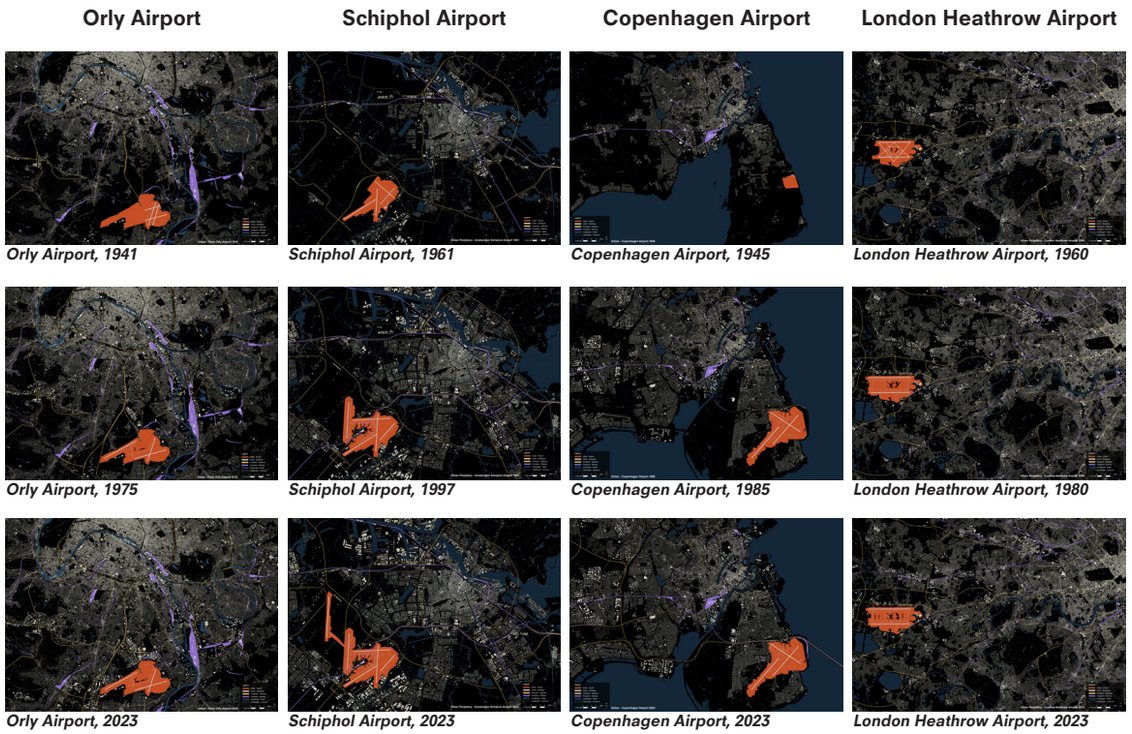


Fig. 1 Change in relationships between airports, cities and infrastructure.

01.2 Problem Statement

Across the globe, air traffic has been quickly rebounding since 2020. (IATA, 2022) Global passenger traffic is forecasted to reach 8.4 billion passengers in 2023 and will keep growing to reach 19.3 billion passengers in 2041. (ACI, 2023) The growth in aviation industry comes together with controversies and challenges on the following different levels which shall be addressed architecturally.

01.2.1 Airport and Berlin (city)

Despite the efforts of trying to separate airports from cities, rapid expansions of both are bringing them closer, posing problems such as high carbon emissions, noise pollutions and inaccessible urban structure in cities.

Together with the advancement of aviation technology, especially hydrogen-powered aircrafts, flights in the future would be made quieter and carbon neutral. Currently, hydrogen-fuelled engines with zero-emissions and low noise are currently being developed and aircrafts powered by hydrogen could be available commercially as soon as 2025. (Fig. 2-3) (ZeroAvia, 2023) This thesis proposes bringing back seaplanes, which would not require kilometre-long asphalt runways but to utilise natural waterbodies. It is high time for architects and planners to rethink the possibility of integrating airports into cities instead of creating more barriers in between.

Fig. 2 Hydrogen fuel for aircrafts.

Fig. 3 Seaplane (amphibious).

01.2.2 Airport and building (infrastructure)

Fig. 4 Yokohama Terminal

> *"(the project) disrupts the sense of monumentality that typifies terminals and contributes to their isolation from daily life."*
> – FMA on Yokohama Terminal

Both as gigantic city infrastructures, airports and cruise terminals are often regarded as a self-contained bubbles isolated from society. The project investigates into breaking the borders between airport infrastructure and society and opening up such massive buildings for the public.

Meanwhile, visions of setting up "hydrogen hub at airports" have been proposed by Airbus in 2020. (Airbus, 2021) Currently, ZeroAvia, developer of zero-emission commercial engines, is already collaborating with Shell, Rotterdam The Hague Airport and Rotterdam The Hague Innovation Airport to develop operations for hydrogen-powered flights and related facilities. (ZeroAvia, 2023) These technological improvements and foreseeable evolutions in the aviation industry would unavoidably induce a series of changes in the architecture of airports. Therefore, it is also the aim of this thesis to look into how hydrogen facilities could be spatially integrated into airport infrastructure.

01.2.3 Airport and bodies (humans)

Travelling by planes has always been regarded as highly controversial in terms of health and climate debates. The World Health Organisation pointed out that residents living in a high noise zone might disturb sleep, which consequentially affect the heart and blood pressure. (Gallagher, 2021) On top of that, by burning petroleum, global passenger and freight aviation accounts for 1.9% of world's greenhouse gas emissions as well as 2.5% of world's CO_2 emissions. (Ritchie & Roser, 2023)

However, instead of health, efficiency of flows and logistics has long been the priority when it comes to airport design. As the project explores the feasibility of partly opening up the water airport for public, different kinds of users are brought into the picture and a seemingly contradicting consideration would have to be examined – playfulness and human centred design.

It is believed that a balance between efficiency and users' well-being shall be achieved in airport design. The project strives to cater for three types of users: rural patients, urban escapers and the public. (Fig. 5-7) Through the introduction of urban-rural flights and playscapes in the building, physical and mental health of users would be improved.

Fig. 5 Rural patients.

Fig. 6 Urban escapers.

Fig. 7 Public visitors.

01.3 Research Questions

Given the current aviation technological advancement, closer relationships between infrastructure and urban developments, and increasing emphasis on well-being, this study looks into the main research question of:

"How to design an airport in the urban context which dedicates its infrastructure for a healthier city?".

In order to answer the research question, qualities and key focuses of a good inner city airport design shall be first identified through the first two sub-questions of: ***"How to design an efficient inner city airport?"*** and ***"How to design a health-oriented inner city airport?"***.

To achieve the goal of designing a decent inner city airport, a balance between the two seemingly contradicting aspects shall be achieved. To conclude this study, the third and final sub-question of ***"How to balance operational efficiency and users' well-being?"*** will be answered so as to address the change in future airport design strategies.

RESEARCH FRAMEWORK

02

02.1 Theoretical Framework

This thesis is structured in a 5-step process shown in Figure 4.

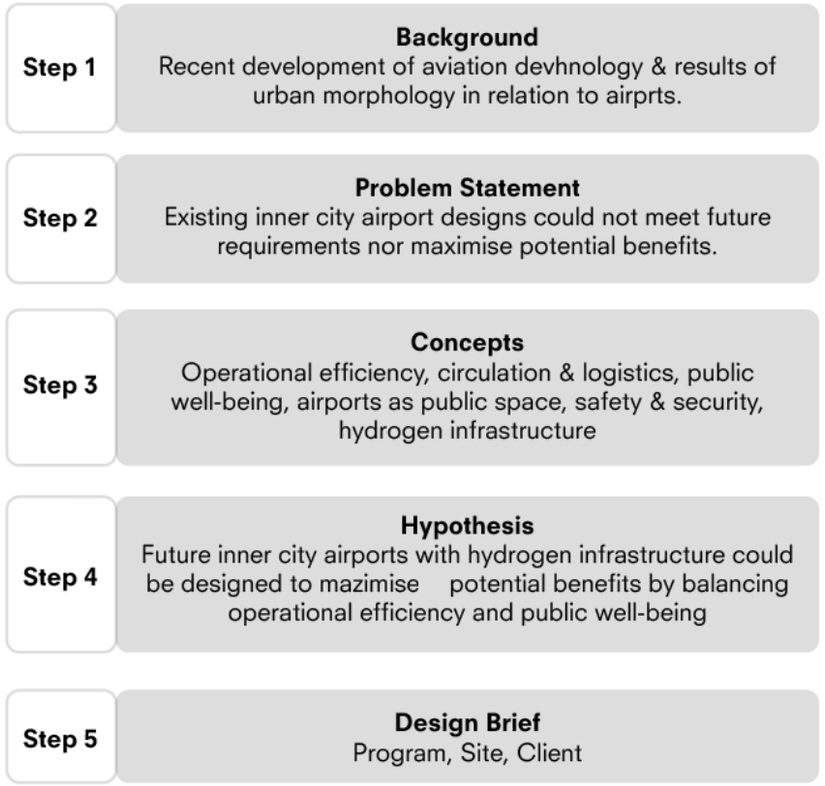


Fig. 8 Step-by-step diagram of research framework

02.1.1 Background

The study starts with background research regarding the relationships between airports and cities throughout the history of aviation in the past century. In addition, aerospace technology is currently progressing rapidly, suggested by the development of sustainable aircraft fuels, aircraft bodies and engines. (Airbus, 2020) Moreover, public health concerns are ever more prominent. The background research would help understanding what and how new designs of airport could respond to technological advancements and health trends.

02.1.2 Problem Statement

Existing strategies for airport planning are mostly in form of setting up boundaries and segregating airports and cities. These infrastructures are not designed to incorporate hydrogen facilities and they seldom respond to users' health. Consequently, it is essential for architects to rethink airport designs that is capable of meeting technological requirements and maximising potential benefits of their geographical centrality, contributing to the city's health and well-being. (World Economic Forum & McKinsey & Company, 2023)

02.1.3 Related Concepts

In order to develop a design for future inner city airports, criteria and requirements are proposed. These could be concluded by two main factors – efficiency and public well-being, supported by other concepts.

Regarding efficiency, airports situating in the urban centre are expected to function smoothly with clear logics of circulation and logistics. Operational efficiency shall be emphasised so that more passengers, and thus more revenue, could be processed and generated in a compact area of the inner city airport. (Romig, 2021)

However, situating in the urban environment implies more intimate relationship between the airport and surrounding populations. Airport designers and operators will have to pay attention to public well-being, of both users and nearby residents. (AD Editorial Team, 2017)

Also, it is possible for airports to unlock more potentials serving society as public spaces, while ensuring safety and security especially with the development of the new hydrogen infrastructure in such a context.

02.1.4 Hypothesis

This study then comes to a hypothesis that efficiency and public well-being are, most of the time, contradicting concepts. However, a future inner city airport needs to address both factors of efficiency in logistics and health of a city. Therefore, it is essential for architects not to prioritise solely efficiency nor users' health. It is unavoidable for inner city airports to be designed with a balance between the two factors.

02.1.5 Design Brief

With the previous steps in mind, the design brief for an inner city seaplane port in Berlin shall be set. Program, site and client shall be developed for the design assignment: an inner city hydrogen-powered seaplane port located in Rummelsburger Bucht, near the centre of Berlin. With innovations of the hydrogen fuel, airports could be more environmentally friendly, sustainable and thus could be located at the heart of Berlin, benefiting medical passengers from rural areas and domestic travellers escaping the city for a break.

However, feasibility and efficiency would not be the only considerations of the airport. Being adjacent to residential districts, the airport would also have to serve residents and help maintain their health and well-being. It is proposed that through play, mental health of airport users could be protected or improved. Thus, a significant portion of floor area would be reserved for developing play and leisure areas for all types of potential users.

02.2 Relevance

This thesis is developed with reference to the latest aviation technology advancements and evolutions. It also corresponds to urban-airport relations and emphasises on promoting users' mental health. Therefore, the study aims to bring about discussions on two main topics: industrial applicability and design ethics.

02.2.1 Industrial Applicability

Modern era aviation expansion has made air transport indispensable for human and goods circulation and mobility. However, environmental downsides of such travelling patterns have been significantly growing with the boom in air traffic. There is a pressing need for the industry to evolve and especially stop fuelling aircrafts with kerosene but with hydrogen, which incurs zero emissions. (World Economic Forum & McKinsey & Company, 2023)

Nowadays, the industry is conceptualising “hydrogen hubs at airports” and is at the stage of bringing them to reality. (Fig. 9) (EASA Eco, 2023) It is possible for findings in this study to be useful references as cross-industries stakeholders are realising hydrogen infrastructures at airports.

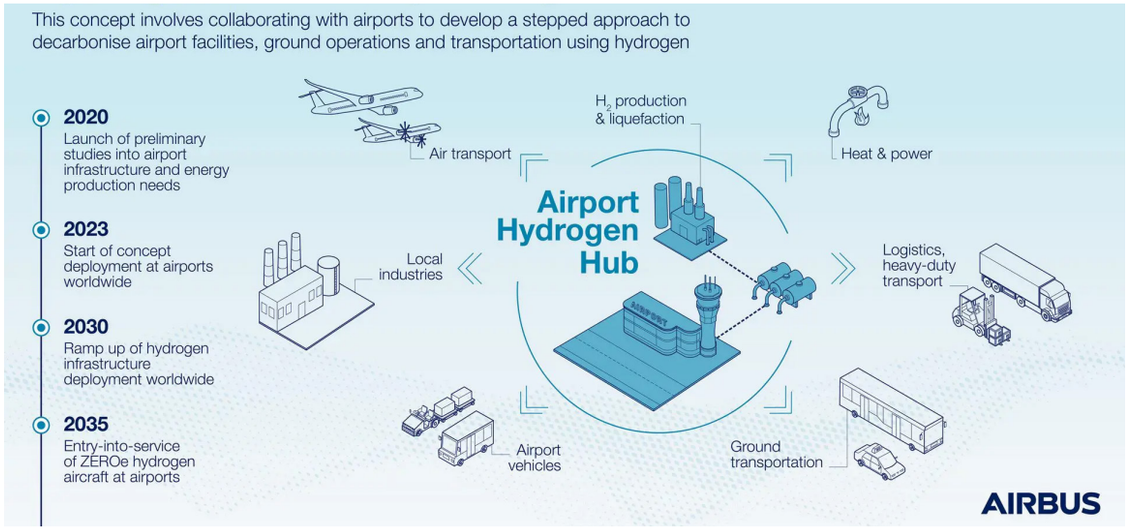


Fig. 9 Hudrogen Hub at Airports by Airbus

02.2.2 Design Ethics

Airports have always been regarded as a piece of urban infrastructure for efficient processes: check-in, security check, baggage handling, streamline operations and minimising costs. (International Airport Review, 2023) Having airport operators as clients, it is very important for architects to make design decisions that lower costs. It is, however, not ethical if architectural practices revolve only around business-centric approaches. (Tanveer, 2022)

As architects, user experiences and public well-being shall not be neglected. For example, cost saving shall not be resolved by using cheaper materials which passengers come into contact with. (Alexander Gutzmer, 2018) Similarly, a pioneering example of a hydrogen airport hub shall evoke awareness of users’ well-being and safety. (Rotterdam Partners, 2023) Therefore, this graduation topic explores one of the ways of providing positive impacts on users’ health: play for mental well-being.

RESEARCH METHODS

03

03.1 Program

The program requirements of the project would be developed through a series of different methods: literature reviews, site visits, case studies, online research and benchmarking.

03.1.1 Literature review

To start with, literature review of relevant books, such as *Airport Engineering: Planning, Design, and Development of 21st Century Airports*, *Building for Air Travel*, *The Airport Passenger Terminal, Design for Leisure Entertainment,* and *Homo Ludens*. These literatures provide an in-depth analysis of various components of airports and help explore the concept of leisure and play.

03.1.2 Site visits

Site visits would also be done in Berlin Brandenburg Airport (large-scale airport type) and London City Airport (city airport type)(Fig. 10-11). As the only operating airport in the city, visiting Berlin Brandenburg Airport would be essential for understanding airport requirements and operations in Berlin. Meanwhile, London City Airport is the quintessential city airport as it locates at the core of London. It would be inspiring and a great opportunity to grasp the relationship between the airport and the city of London.

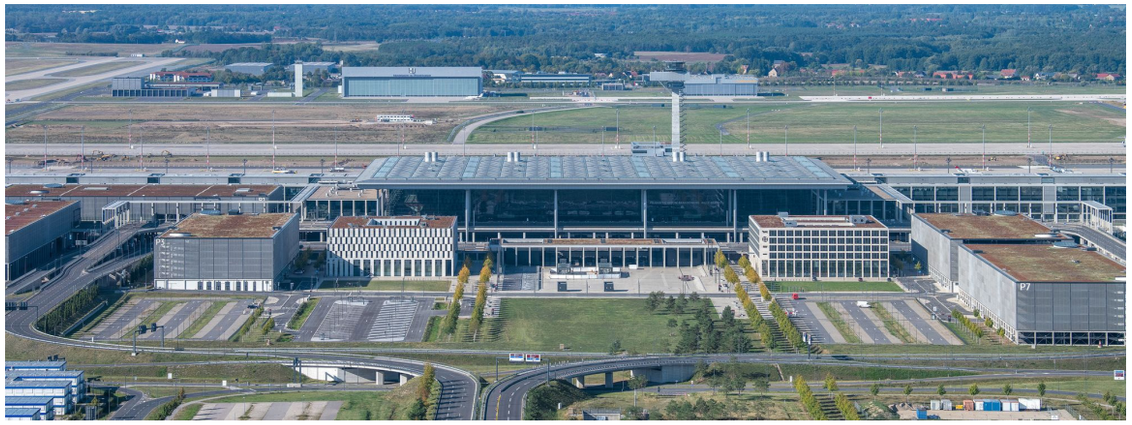


Fig. 10 Berlin Brandenburg Airport.

Fig. 11 London City Airport.

03.1.3 Case studies

Case studies would then be conducted with program bars drawn for different types of relevant projects. They could comprise of city airports, seaplane bases, large and small scale airports, as well as cruise terminals. The different but relevant types would provide a boarder view of what programs could possibly be integrated into the project of the first seaplane port in Berlin. Having analysed five cases, it would also be beneficial to compare their differences and select what programs and area distributions would be most suitable for the project.

Throughout studying different cases, online research would be essential for comprehending floor plans, sections and spatial relationships of multiple programs. Possible sources would be images and text descriptions of visitors. Useful videos could even be found in form of walking tours inside infrastructures to be researched.

Fig. 12 Sea Airport of Elefsina.

Fig. 13 Banyuwangi Airport.

03.1.4 Online research

Online research would be an important part for researching programs. To start with, benefits of hydrogen seaplanes have to be researched in comparison to traditional petroleum-fuelled jet airliners, or even other modes of air transportation. (Fig. 15) This would help justifying the choices made in the project.

Background research would also have to be done as the first step in order to understand capabilities of the aircraft model and possible services the aircrafts could provide. (Fig. 14)

Seaplane Model

Twin Otter
Series 300 / 400

(currently powered by jet fuel used by e.g., Harbour Air Canada, Viking Air)

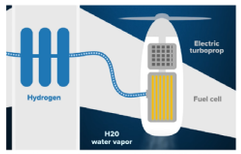
New Fuel / Engine

Hydrogen combustion

Battery electric

Hydrogen-electric - ZA600

(H - Highest energy by mass, zero emissions ~ combustion NOx, more efficient / lighter than electric)



https://www.youtube.com/watch?v=IMb5Frr-520

Engine Provider

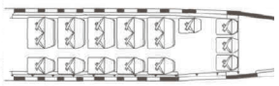
Universal Hydrogen

ZeroAvia

https://www.impala.ventures/post/impala-ventures-portfolio-company-zero-avia-and-the-future-of-hydrogen-powered-aviation

Occupancy

19 - 20 seats



https://www.airlines-inform.com/commercial-aircraft/twin-otter.html

Range

Jet fueled, long range tanks
1542 km

Hydrogen-electric fueled
482 km

Performance

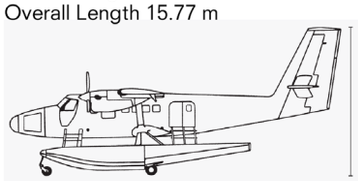
Takeoff field length
598.8 m

Landing field length
564.2 m

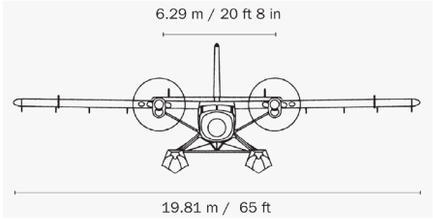
Normal cruise speed
175 kts (324 km/h)

Dimensions

Overall Height 6.90 m
Overall Length 15.77 m



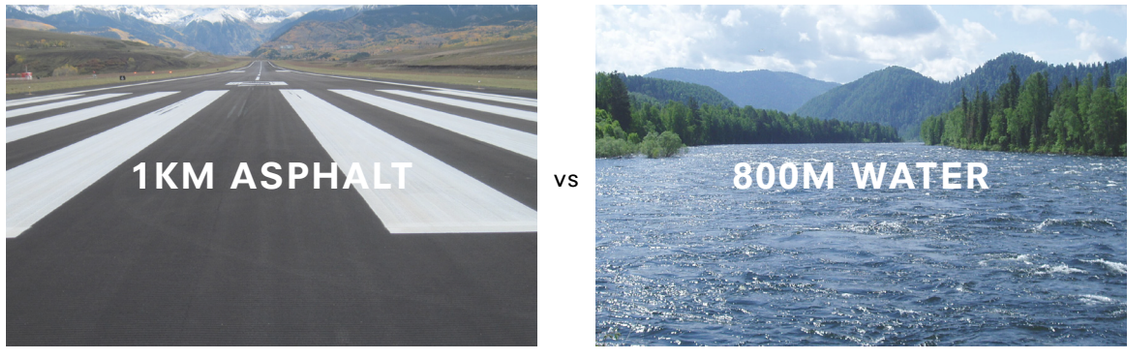
Wing Span 19.81 m

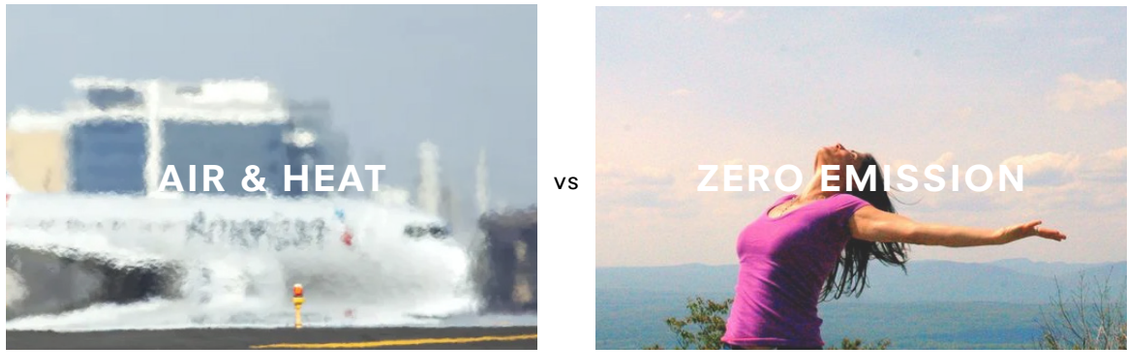


https://rabinaviasi.com/twin-otter-dhc6-400/
https://dehavillandfield.com/wp-content/uploads/2022/08/Twin_Otter_FLOAT_Spec_Sheet_web.pdf

Fig. 14 Specifications of hydrogen seaplane used.

Jet Airliners vs **Hydrogen Seaplanes**





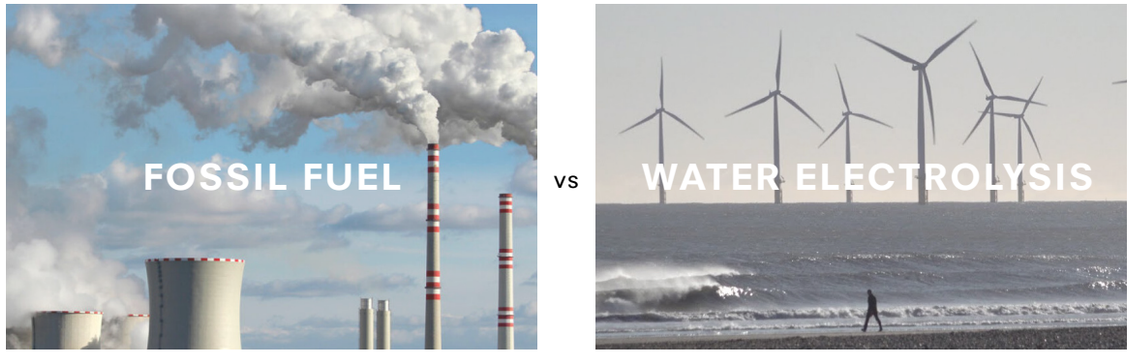


Fig. 15 Comparison between traditional aircrafts and hydrogen seaplanes.

In addition to the functional part, playscape also occupies a large part of this project's program. The idea of play, leisure and related comptemporary issues would have to be studied so as to relate the project to modern context. (Fig. 16-17)

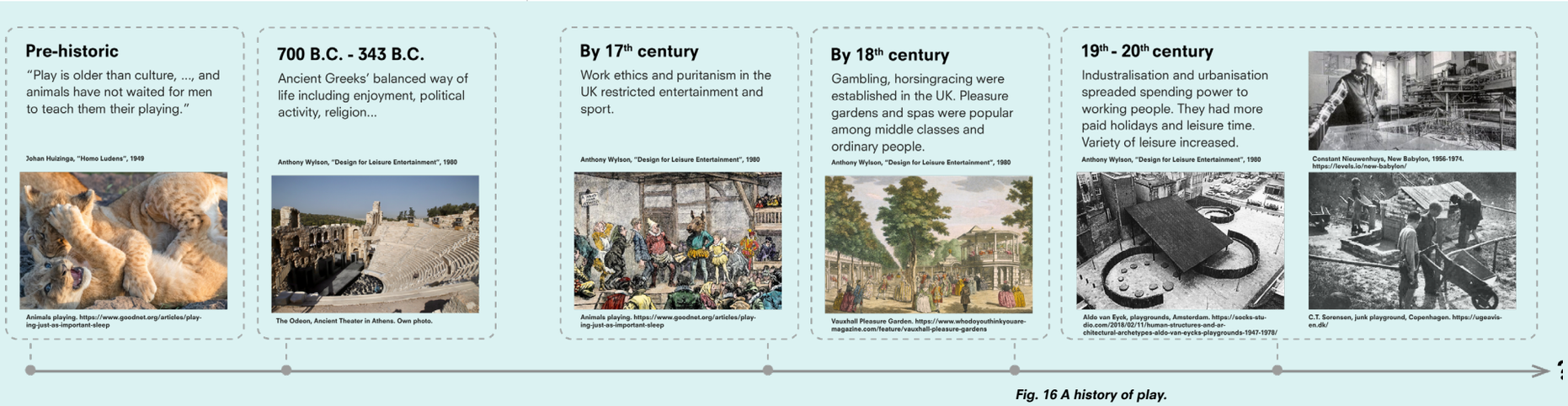
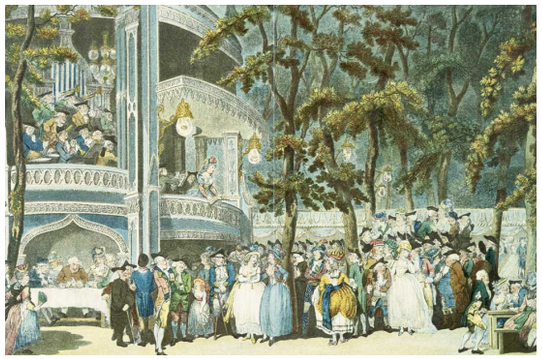


Fig. 16 A history of play.

Pleasure Garden



Vauxhall Pleasure Gardens

Social indications

- **rising income** & growth of urban middle class
- new ideas of how people should socialise
- "commercialised leisure" was trending
- wealth, fashion and high culture were showed off

Activities

- music
- dancing
- eating
- drinking
- fireworks

Theme Park

Expoland, Osaka Expo '70

- Expoland, as a theme park in Expo '70, attracted 40% visitors
  - Expo: 6.4 million visitors
  - Expoland: 2.6 million visitors
- Leisure becoming a basic element of society
- Akira Tamura,
  - "'play' ... is the very essence of human existence."

...everything ... at the Expo is just 'play'"

- rollar coasters
- balloon or rail rides
- squares
- theatres
- waterfalls, ponds and walks

Pier

Brighton Palace Pier

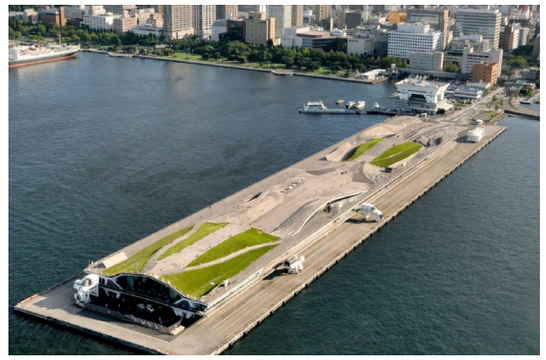
Social indications

- transportation advancement boosted popularity of seaside resorts
  - steam passenger boats
  - railway transport (lower income group)
- working class entitled to **leisure time**
- "seaside holidays" were trending

Activities

- rides
- arcades "palace of fun"
- side shows / stalls
- soft play area for kids
- bird watch cafe "starlingsroost"

Cruise Terminal



Yokohama Terminal

Social indications

- disrupts the sense of monumentality that typifies passenger port terminals and contributes to their isolation from daily life
- the terminal aimed not only to serve as infrastructure but also a **public space**

Activities

- rooftop broadwalk with coastline views
- pop-up concert,markets
- fashion displays
- book fairs

Fig. 17 Case studies on play.

03.1.5 Benchmarking

Last but not least, benchmarking would be an important final step for synthesising the data collected. By comparing the program bars, the minimum area required for different programs could be determined. (Fig. 18) After selecting the best appropriate reference cases for the project, a new program bar could be developed by finding out the average numbers and adjusting them.

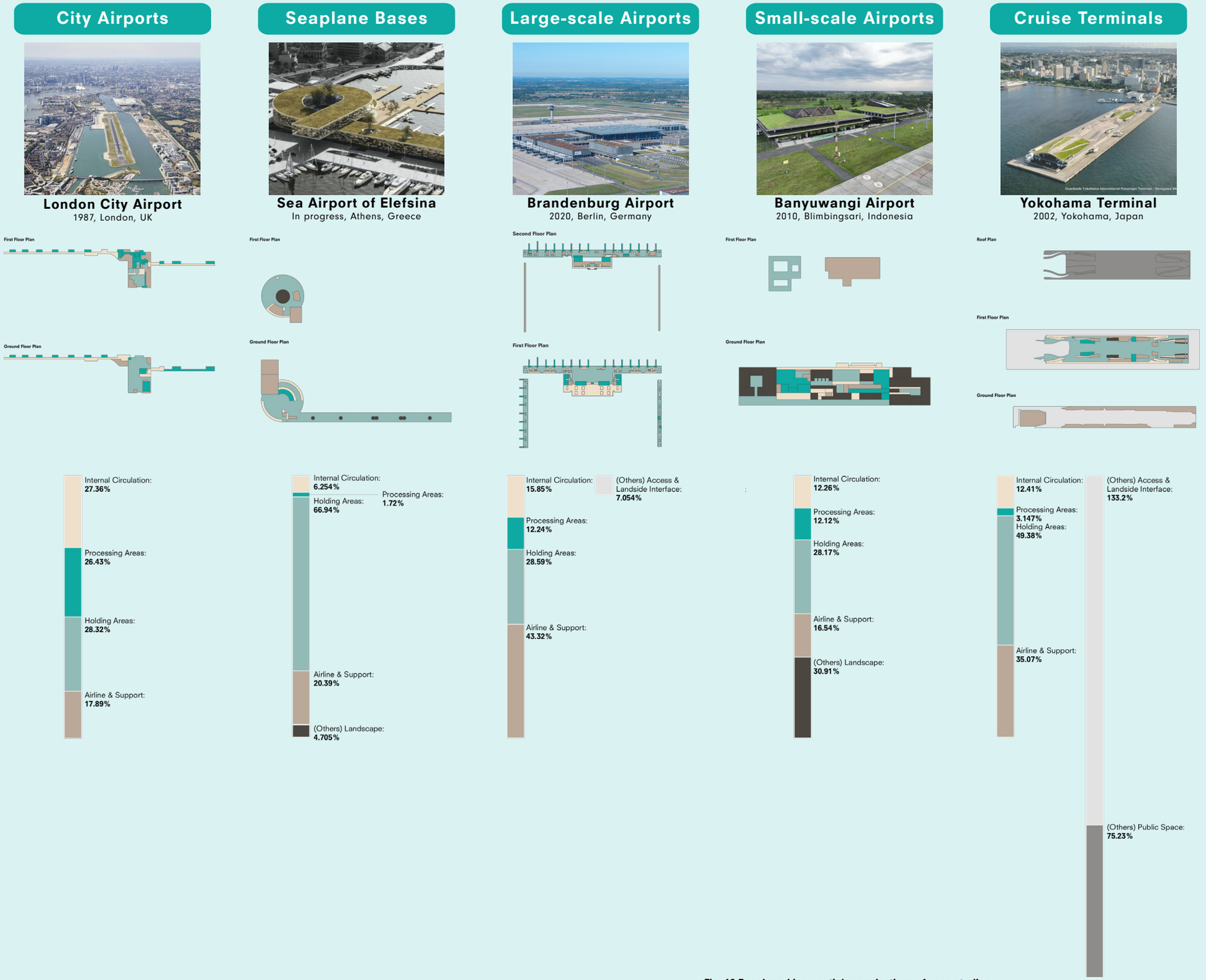


Fig. 18 Benchmarking spatial organisations of case studies.

03.2 Client

To determine the possible clients for the seaplane project in Berlin, literature review, together with online research would be the main methods.

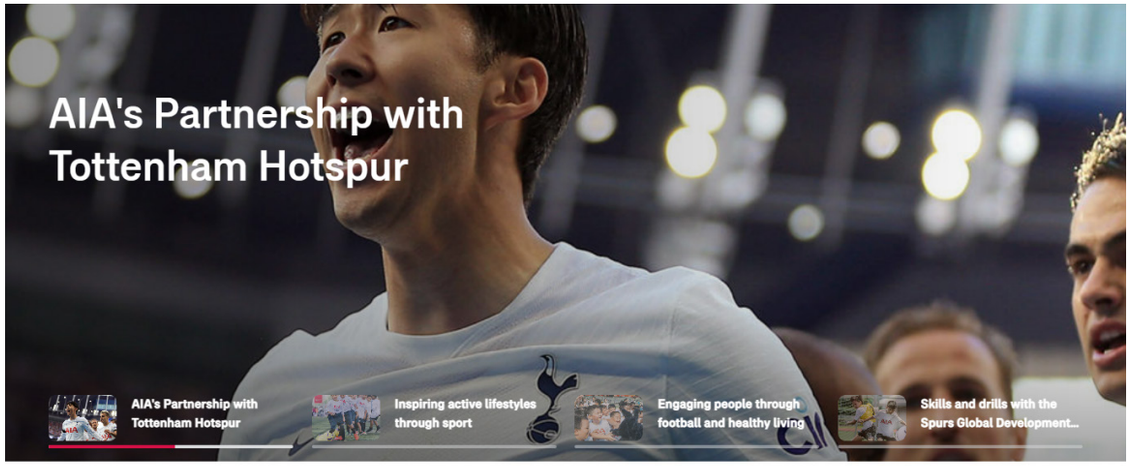


Fig. 19 Partnership between AIA and Tottenham Hotspur

03.2.1 Literature review

As a part of studying potential users, literature reviews, for example, *Regional differences in health care of patients with inflammatory bowel disease in Germany*, would be useful in providing more numbers and figures about Berlin and the country's healthcare situation. (Lange et al., 2015) This could help improve the reliability of information and help developing a convincing narrative.

03.2.2 Online research

After understanding and deciding on the nature of this project, potential investors and operators would be investigated. It would be useful to figure out whether the potential clients had similar engagements previously. (Fig. 19) The structure of airport organisations were also studied so as to understand what kind of clients would be beneficial for implementing such a project.

03.3 Site

As far as site selection is concerned, the development of site selection criteria is divided into two parts: individual criteria and health-oriented group criteria. Both parts of the research would require larger-scale quantitative and smaller-scale qualitative analysis. Site visits and mapping would be helpful for the different types of research.

03.3.1 Site visit

Site visit to Berlin would be an essential part of research on site. As a group with health-driven strategies to be developed, all group members would individually make video record of potential positive and negative “health stimuli”. This would contribute to our group research looking into what triggers Berliners the most and what would be the desired urban spaces for them. For developing individual site criteria, pre-selected potential sites would be visited. Photo and video records would be done individually. Based on personal on-site experience, multiple sites could be better qualitatively understood in terms of land use, atmosphere and accessibility.

03.3.2 Mapping

While not being able to visit Berlin, online materials found on Environmental Atlas Berlin, would become important sources. (State of Berlin, 2023) Environmental data of Berlin would be a major part of the quantitative research, for example: traffic infrastructure, noise pollution and air pollution, which are all stimuli highly related to the topic of health. With the aid of geographic information system (GIS) software, it would be possible to map out relevant urban elements. (Fig. 20) After that, by integrating different sets of maps, site requirements and urban strategies of the group could be drawn.

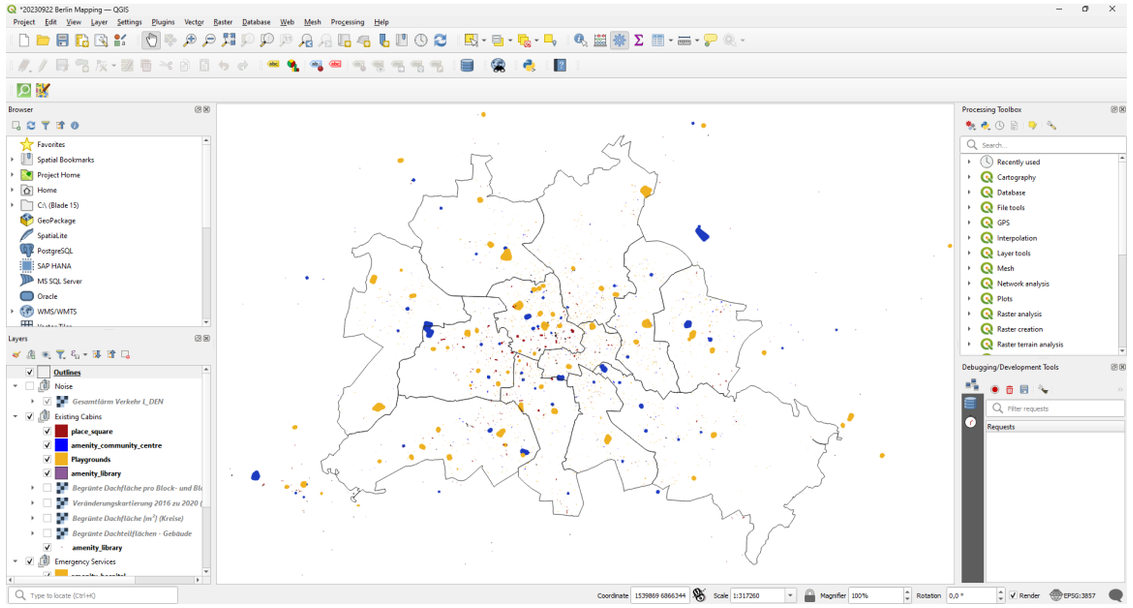


Fig. 20 Mapping exercises for analysis.

DESIGN BRIEF

04

04.1 Site

Site investigations would be divided into 5 scales: XXl, XL, L, M and S. From a larger scale, relationships between Berlin and Germany, or even neighbouring countries would be explored according to the theme of this thesis. Zooming in, potential sites would be selected and through a process of analysis, one of the sites would be selected for this project. At the smallest scales, the selected site would be analysed in order to prepare for the later stages of placing programs and massing schemes.

04.1.1 XXL: Germany

In search of possible connections through the water airport in Berlin, analysis would be done according to the needs of two types of users: rural patients and urban escapers. As medical escorts would be provided for rural patients, German cities with the most number of patients, elderly and lthe least number of medical staff would be selected as the first destinations. (Fig. 21-22) As for urban escapers, a selection of travelling destinations in the rural area were mapped out so as to benefit Berliners who desire to take a break from the city.

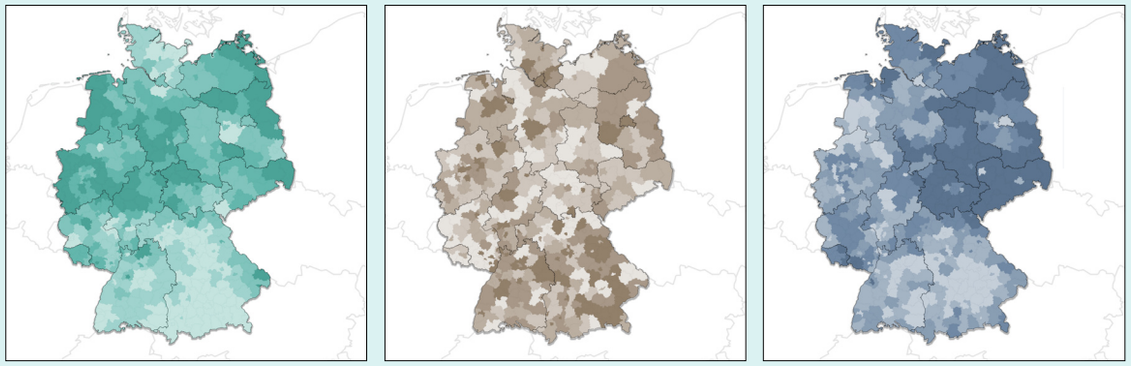


Fig. 21 Mappings of cities with medical needs.

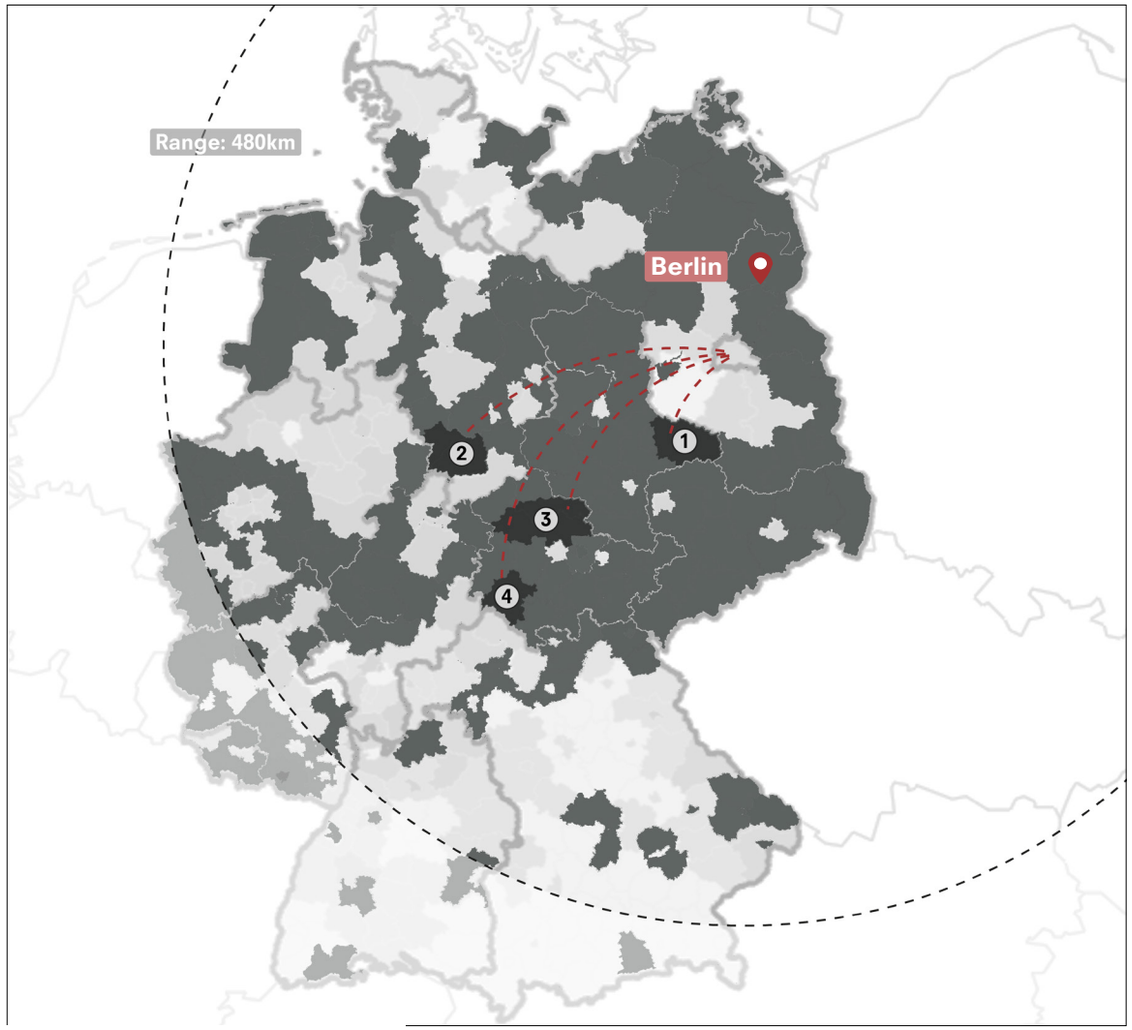


Fig. 22 Mapping of cities with medical need as first destinations of medical escorts.

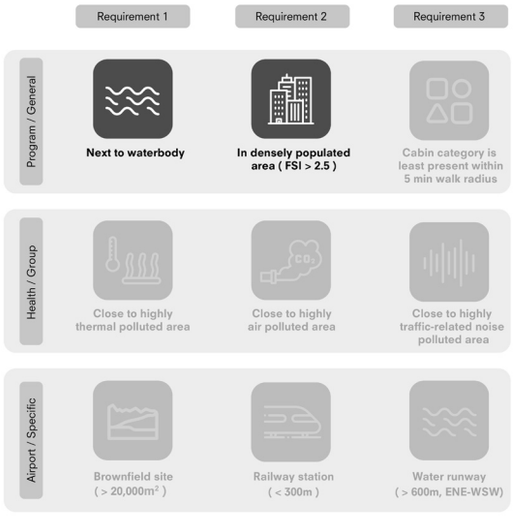


Fig. 23 Site selection criteria.

04.1.2.1 XL: Berlin (set 1)

In the scale of XL, waterbodies in Berlin would be mapped out so as to locate the project at a site with close proximity to water for aircrafts take off and landing. In order to illustrate an urban situation for the project to take place, it would also be necessary for the airport to be in a highly populated area. (Fig. 23-24)

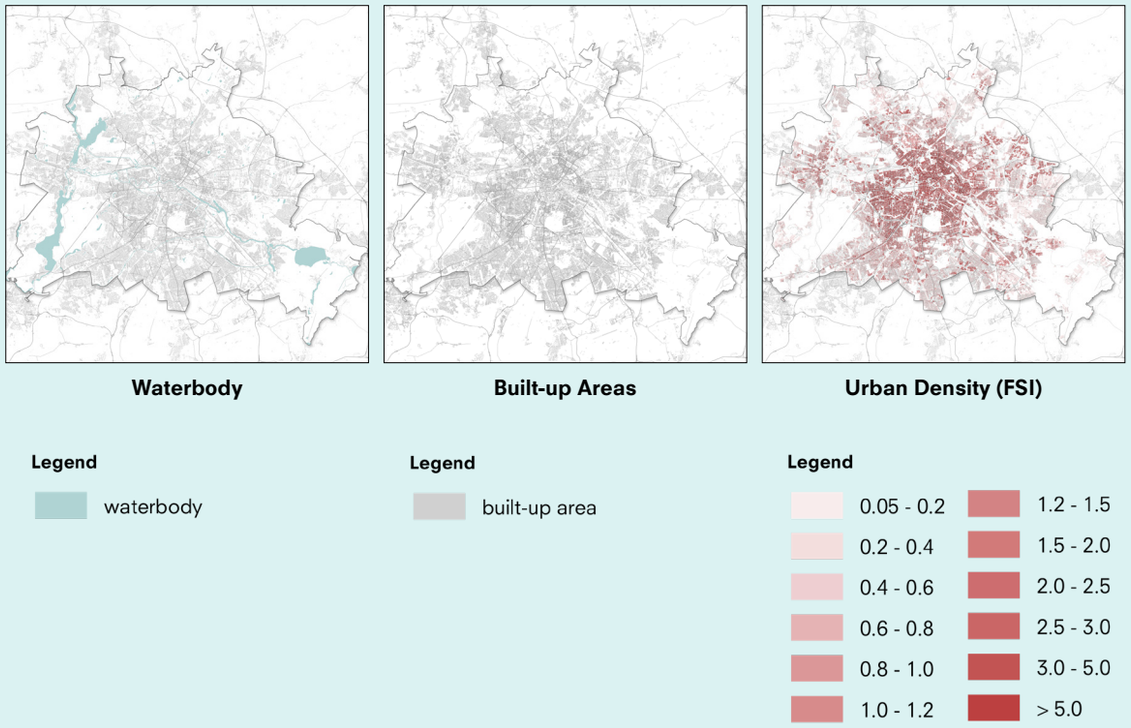
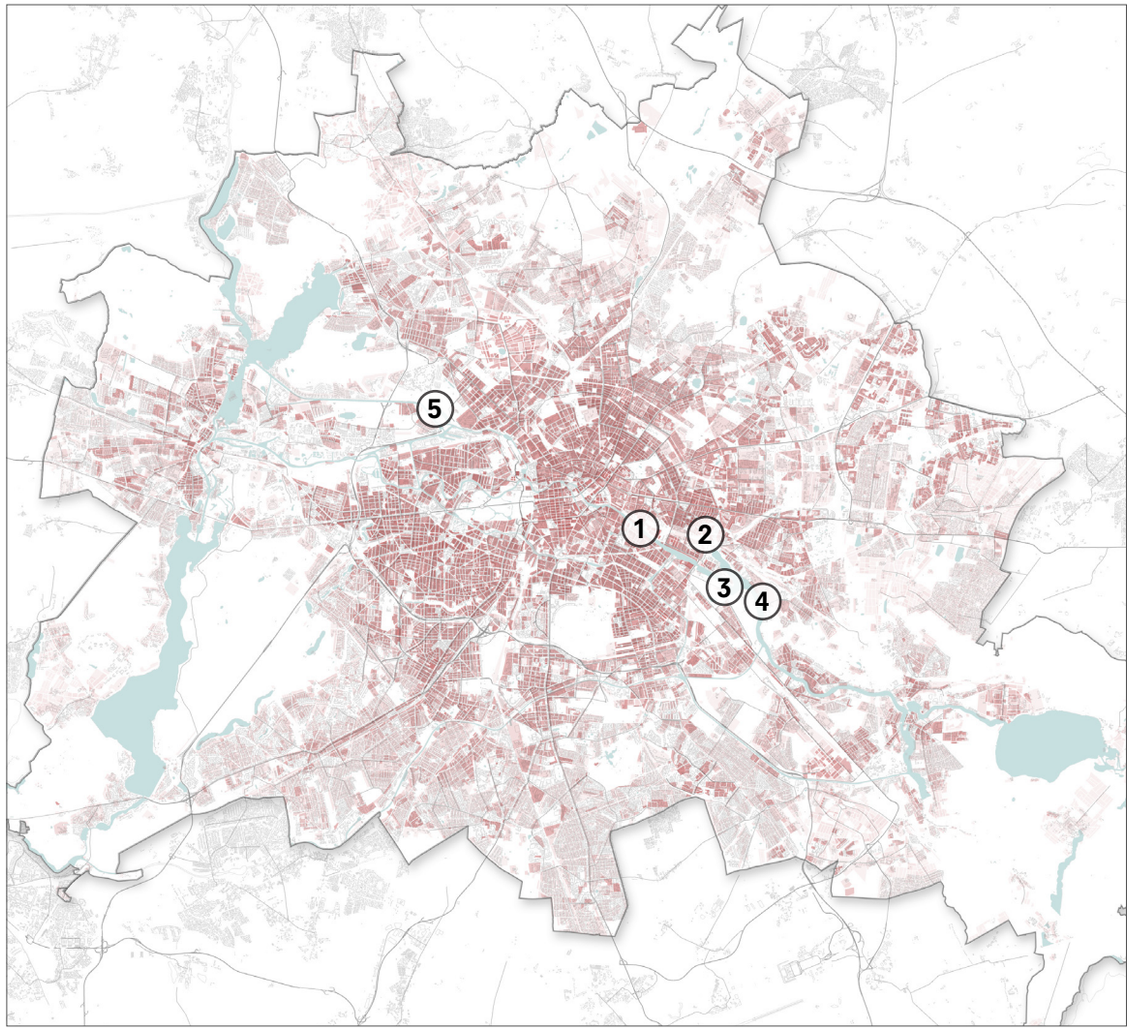


Fig. 23 Mappings of waterbody, built-up areas and urban density (FSI).



Legend

1. Park an der Spree
2. Rummelsburger Bucht
3. Regattaufer
4. Köpenicker
5. Goethe Park

Fig. 24 Five preliminary sites.

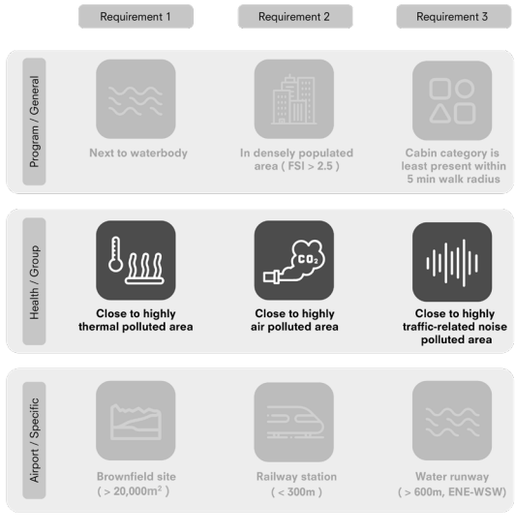


Fig. 23 Site selection criteria.

04.1.2.2 XL: Berlin (set 2)

In response to the health group strategy, projects would be aiming to tackle pollution problems in the urban area. Areas with high thermal pollution, air pollution and traffic-related noise pollution would be considered. (Fig. 25)

As a result of these analysis, 5 possible sites would be concluded and then reduced to 2 for further selection process. (Fig. 26)

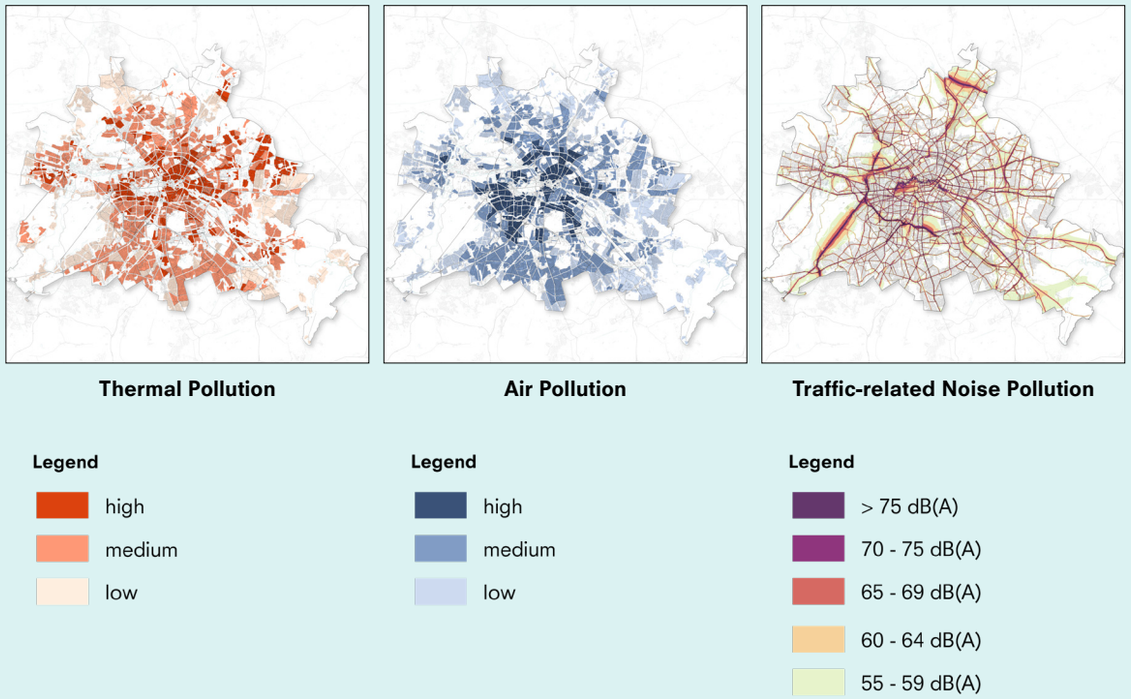
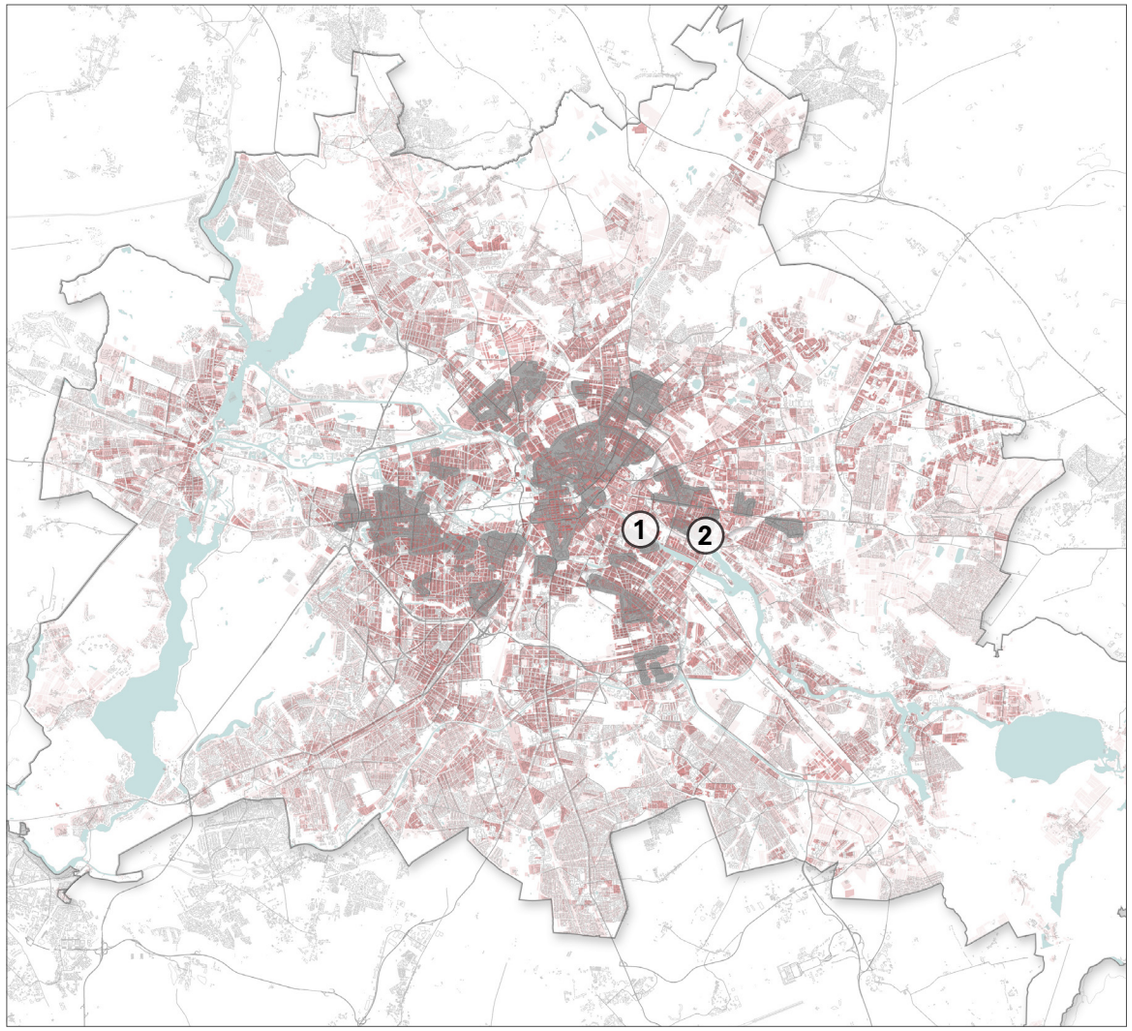


Fig. 25 Mappings of thermal pollution, air pollution and traffic-related noise pollution.



Legend

1 Park an der Spree

2 Rummelsburger Bucht

Fig. 26 Five preliminary sites reduced to two possible.

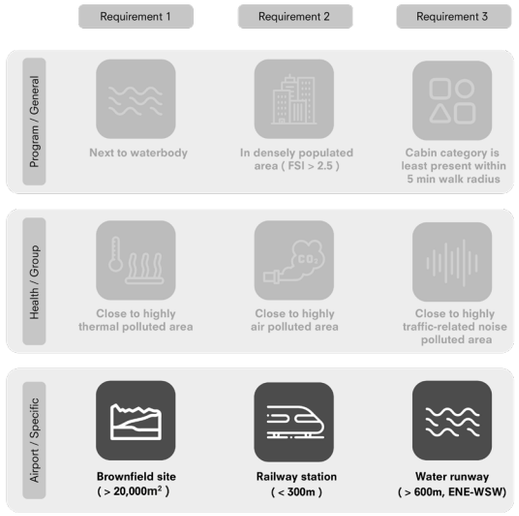


Fig. 23 Site selection criteria.

04.1.2.3 XL: Berlin (set 3)

With two possible sites remaining, the types of plot, plot sizes, distance from railway station and availibility of water runway would be analysed. (Fig. 27-29)

It was discovered that the plot Park an der Spree would be reletively small and construction would cause removal of a number of trees.

Meanwhile, the site at Rummelsburger Bucht would fulfill all requirements and would be selected as the final site for the water airport.

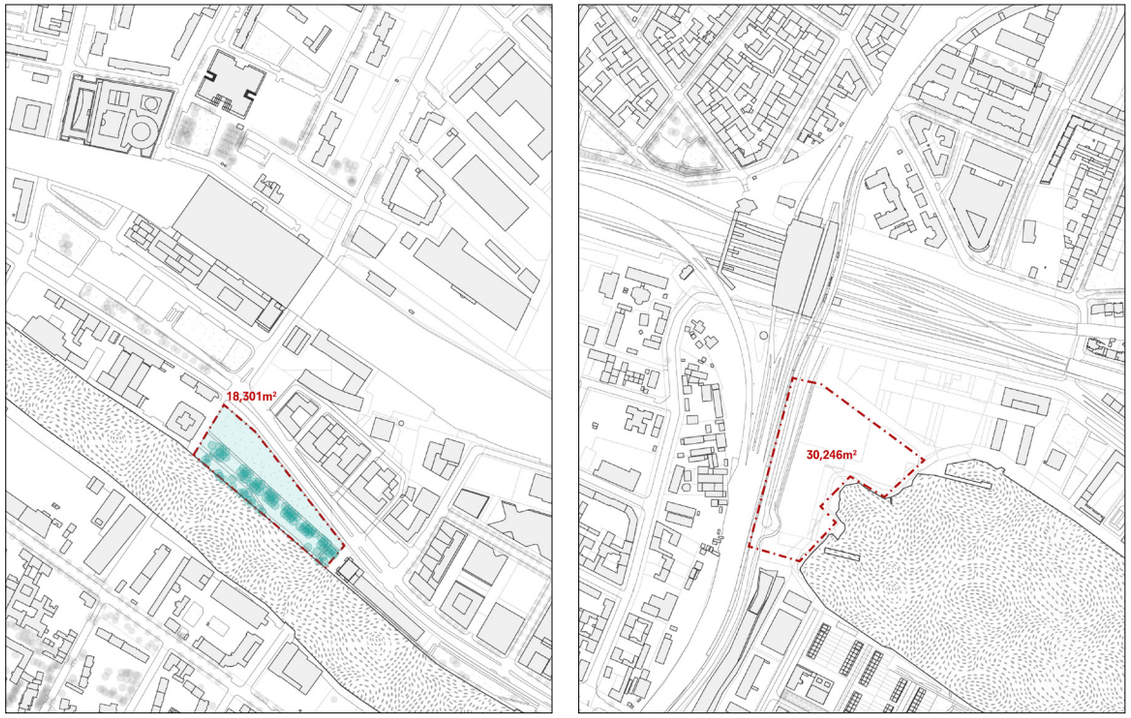


Fig. 27 Analysis of plot sizes and types (Left: Park an der Spree; Right: Rummelsburger Bucht).

Fig. 28 Distances from transportation hub. (Left: Park an der Spree; Right: Rummelsburger Bucht).

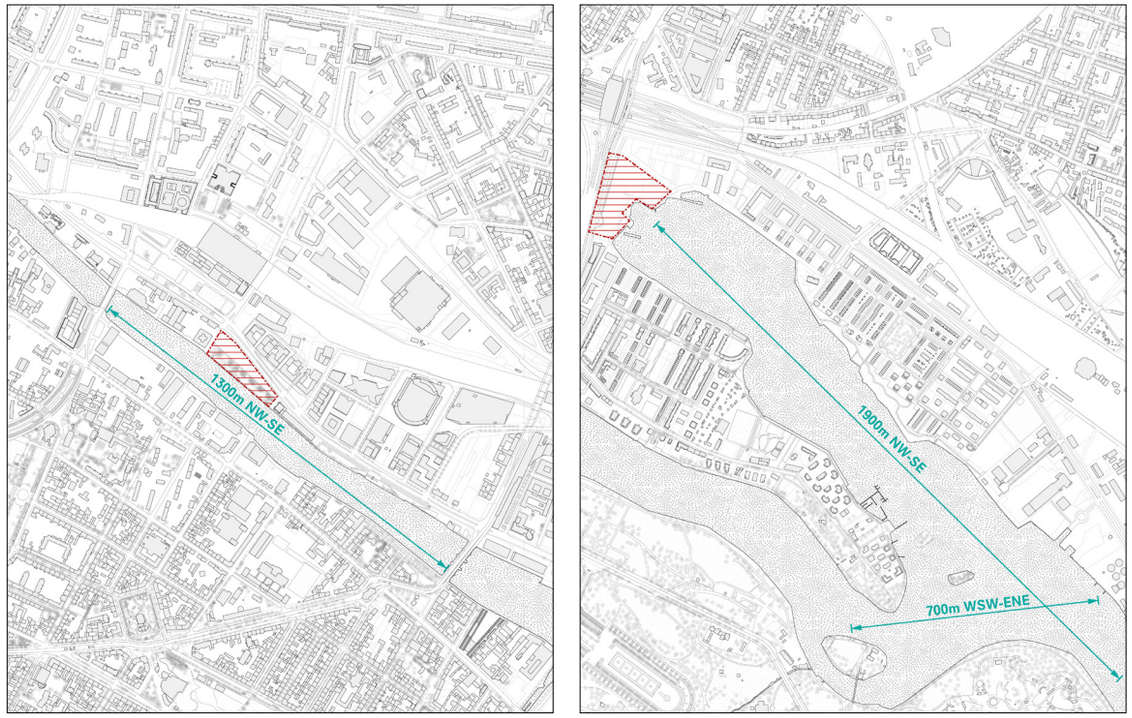
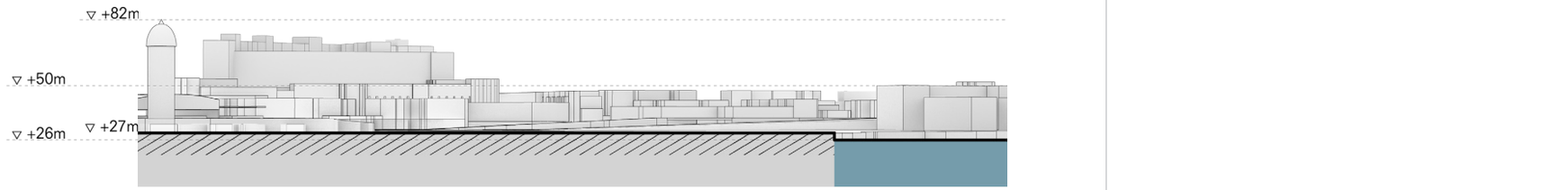


Fig. 29 Availibility of water runways (Left: Park an der Spree; Right: Rummelsburger Bucht).



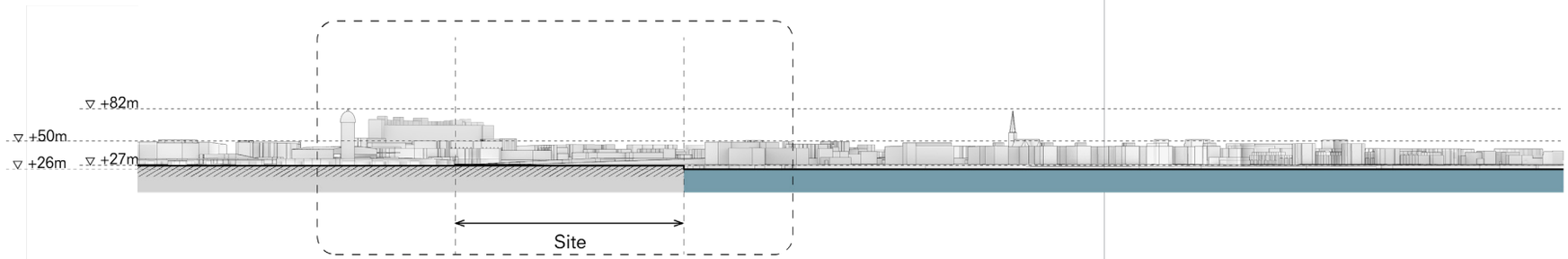
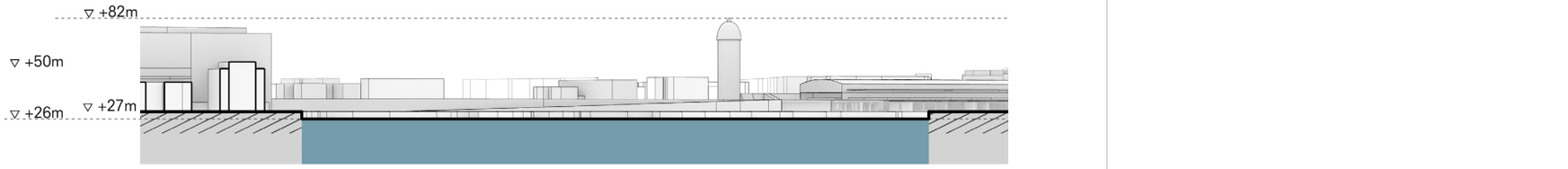


Fig. 30 Section of site (A-A').



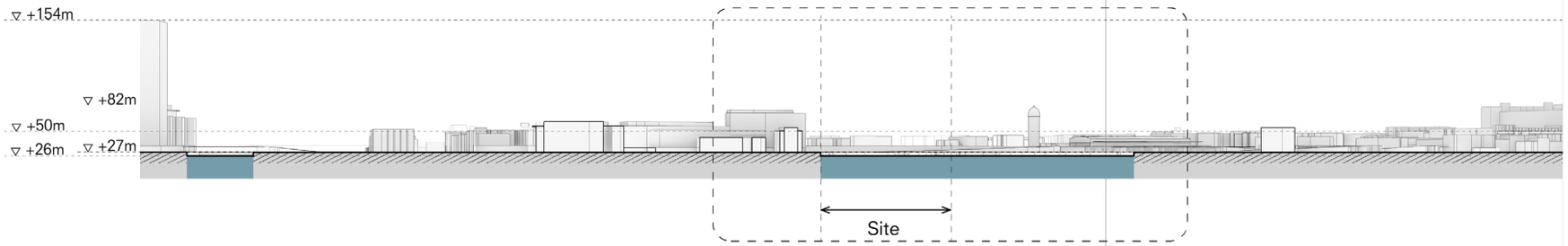
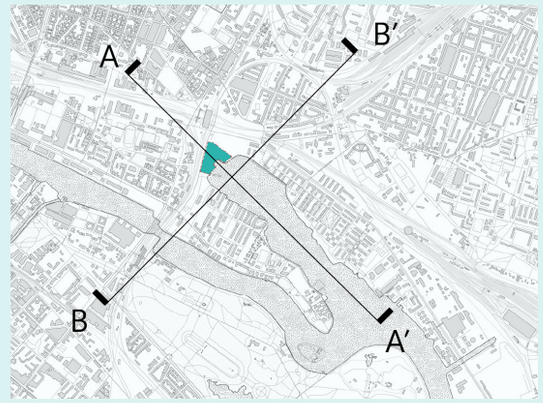


Fig. 31 Section of site (B-B').

04.1.3 L: Boroughs

Rummelsburger Bucht locates at a site where three boroughs: Fredrichshain-Kreuzberg, Lichtenberg and Treptow-Köpenick intersect. In order to understand the profiles of the site, two sections across the plot would be drawn. (Fig. 30-31)

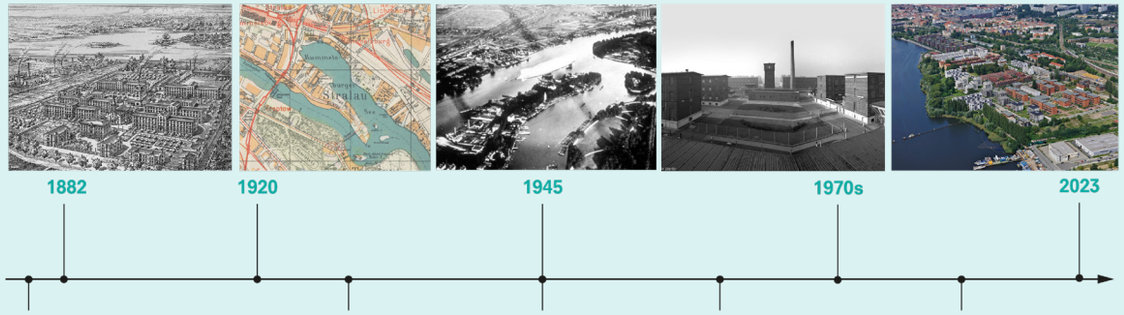
From these sections, it could be concluded that most neighbouring buildings (residential) are relatively low with only a few storeys. However, the monumental water tower stands out at the height of 85m. In the background, a shopping mall could be seen from the site.



04.1.4 M: Neighbourhood

In the neighbourhood scale of site analysis, the history would firstly be researched. Initially as an area for a city workhouse, there had been multiple transformations and the red brick buildings even housed a penal institution for a few decades. However, the area is slowing being transformed into a residential and leisure area. (Fig. 32)

Then, the current situation of site would be investigated through lenses of public transportations, land uses and waterways. As a future water airport location, obstacle limitation surfaces (OLS) for runways would also be placed across the site. Buildings taller than 45m under the OLS zone would require extra installation of top lights. (Fig. 33)



1882

1879 - 1933

City Workhouse

19 plain brick buildings housed 1600 homeless, beggars, prostitutes, old, disreputable and arrested men and women.

The site was overcrowded with nmates to be adjusted to societal norms through "work and corrective measures".

1920

1933 - 1945

Workhouse & Protection Hostel

Nazis labelled imates as "asocial" and "psychologically disturbed" and forced them to do labour works.

Even moreore inmates were brought in (Jewish and homosexual people), some of them even exterminated under the Euthanasia campaign.

1945

1945 - 1951

Damage & Transformation

Rummelsburger bucht suffered series damage due to air raids. Meanwhile, the workhouse continued after WW2, housing also refugees.

After German Democratic Republic (GDR) was founded, the site was transformed into penal and pre-trial detention institutions.

1970s

1951 - 1990

Penal Institution Berlin 1

Many inmates received heavy punishments here under unofficial political imprisonments. Number of inmates of detention centre was highest ever (2500 inmates in 900 jail spaces).

Prisoners were employed as cheap labour for physically hard or health threatening work.

2023

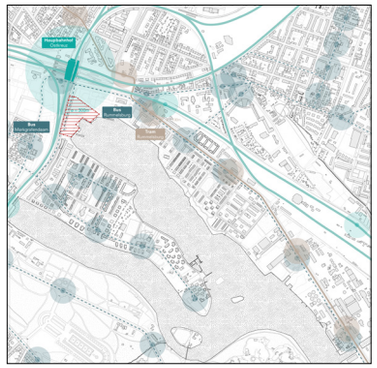
1990 - Now

Residential & leisure area

Rummelsburg Prison was closed in 1990 and remained unused until 2007. It was then converted into a residential complex.

The old red-brick building that survived were turned into flats and new-builds were intertwined. The area is now full of families, pet dogs, bird feeders and joggers.

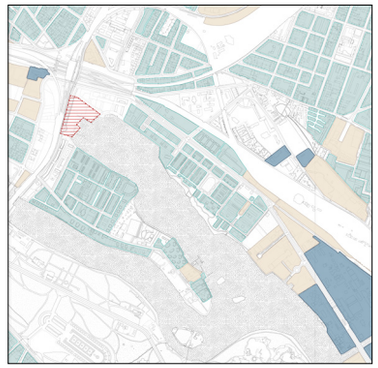
Fig. 32 Site History 1879 - now.



Public Transportations

Legend

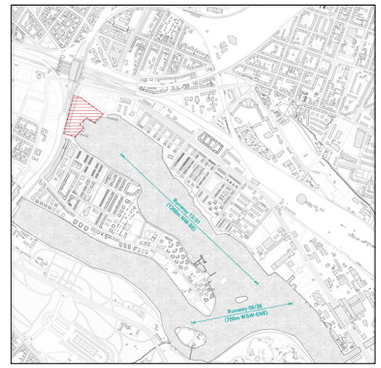
- Railway
- Tram
- Bus



Land Uses

Legend

- Residential
- Commercial / Industrial
- Waste Treatment



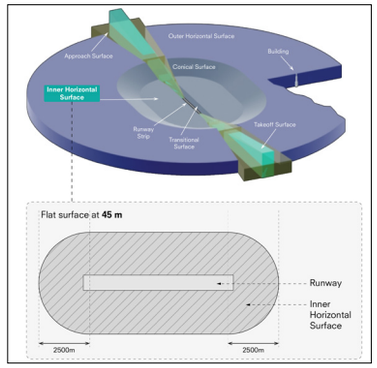
Waterways

Runway 13/31

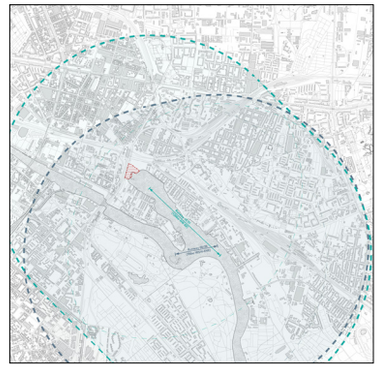
Length: 1,200 m
Orientation: NW - SE
Type: Non-instrument
Code: 2

Runway 06/26

Length: 700 m
Orientation: WSW - ENE
Type: Non-instrument
Code: 2



Obstacle Limitation Surfaces



Zones under OLS

Legend

- OLS for runway 13/31
- OLS for runway 06/26

Building Heights

Legend

- <= 6m
- > 6m - 12m
- > 12m - 22m
- > 22m - 40m
- > 40m - 50m
- > 60m - 75m

Fig. 33 Site Analysis at scale M.

04.1.5 S: Site

On the smallest scale of site analysis, more specific site history would be further explored. (Fig. 34) Looking at the current context, neighbouring buildings would be researched which includes communal uses, commercial uses, transportation and monuments. (Fig. 35-37)

It is important to note that most of the neighbouring buildings are for residential uses. This also lead to multiple uses and activities carried out by local residents along the riverside. (Fig. 38)

Lastly, this site study would conclude by determining the site boundaries. (Fig. 39)

Fig. 34 Site History 1882 - now.

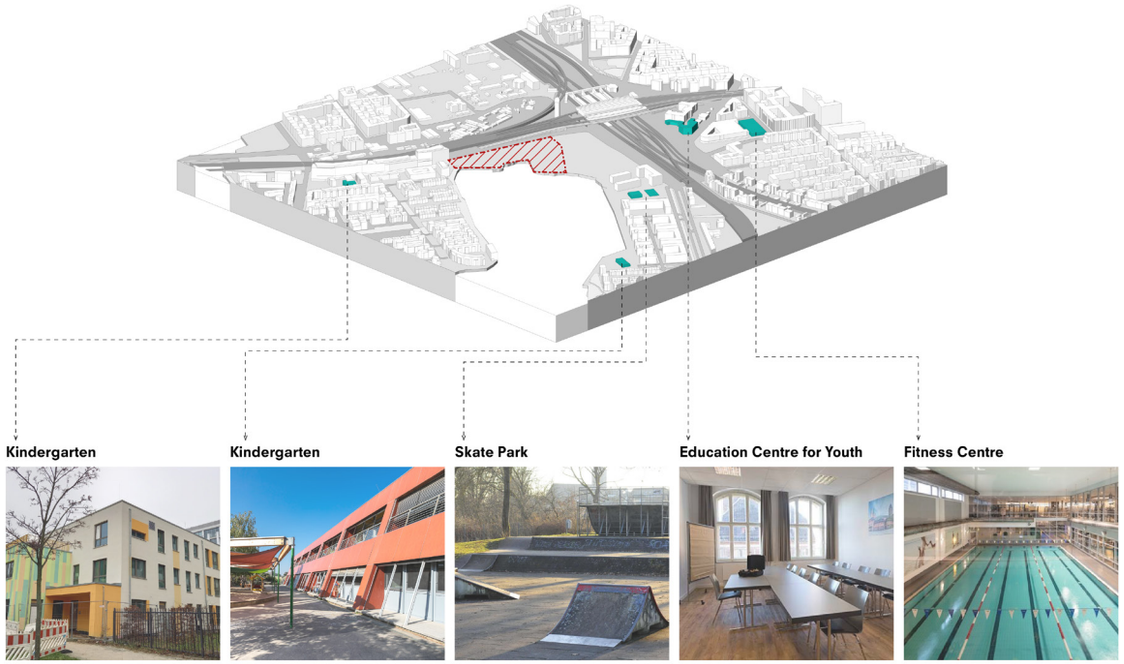


Fig. 35 Neighbouring buildings: communal.

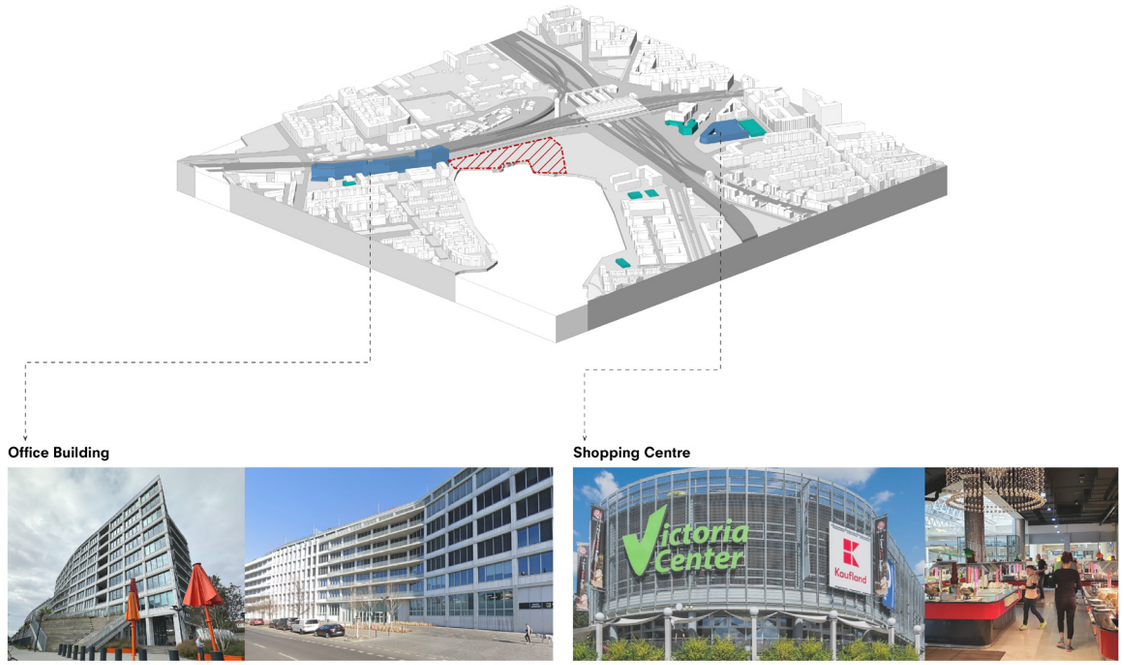
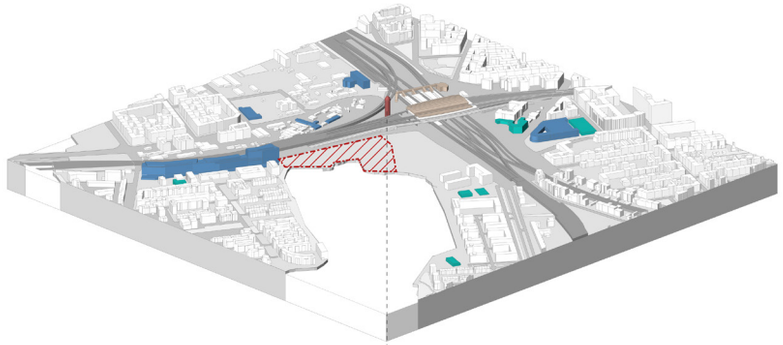


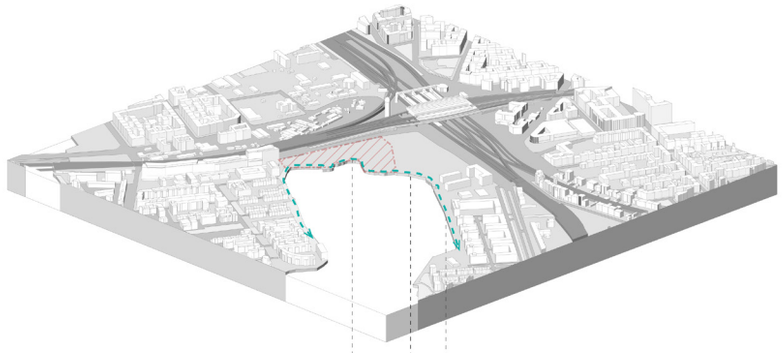
Fig. 36 Neighbouring buildings: commercial.



Train Station

Water Tower

Fig. 37 Neighbouring buildings: transport & monumental.



Cycling

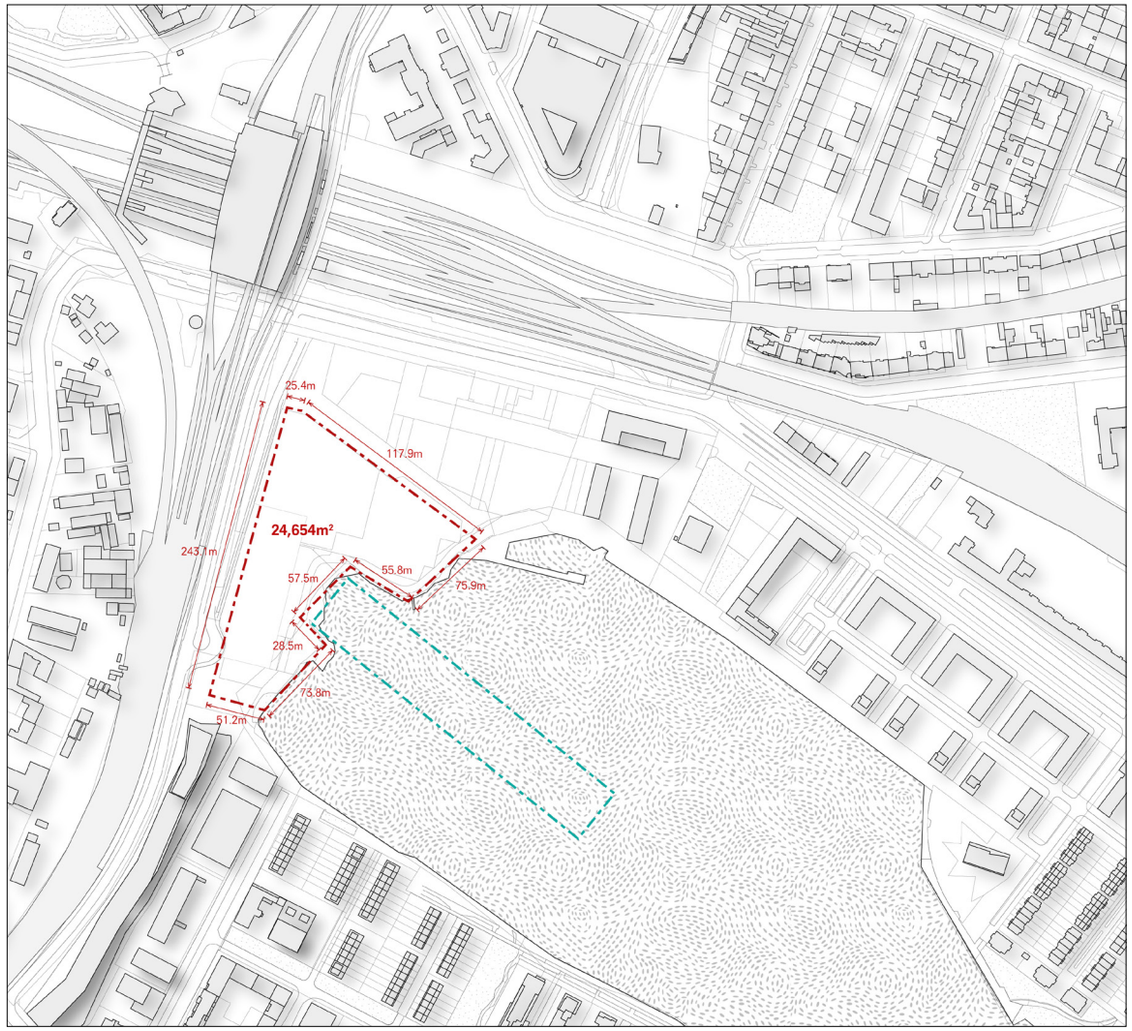
Jogging

Viewing

Walking

Walking / Boat touring

Fig. 38 Neighbouring activities.



Size requirement from program analysis:
50,500 m²

Current site area:
24,654 m²

Fig. 39 Site plan with site boundaries.

04.2 Program

To develop a thorough program for the seaplane port, hydrogen facilities and playscape would be determined. Then, size requirements would be developed. relation scheme and flow diagram would be designed.

04.2.1 Hydrogen at airport

To begin with, airside area is investigated by studying the requirements for hydrogen facilities and various models of hydrogen infrastructure in airports.

With reference to a case study done in Paris Charles De Gaulle Airport, installation of water electrolysis, hydrogen liquefaction and storage facilities could be done within the premises of an airport. (World Economic Forum & McKinsey & Company, 2023)

Therefore, in the water airport, hydrogen facilities would include: water electrolysis, pipeline, liquefaction, storage, capsule / bowser, and fuelling equipments. (Fig. 40)

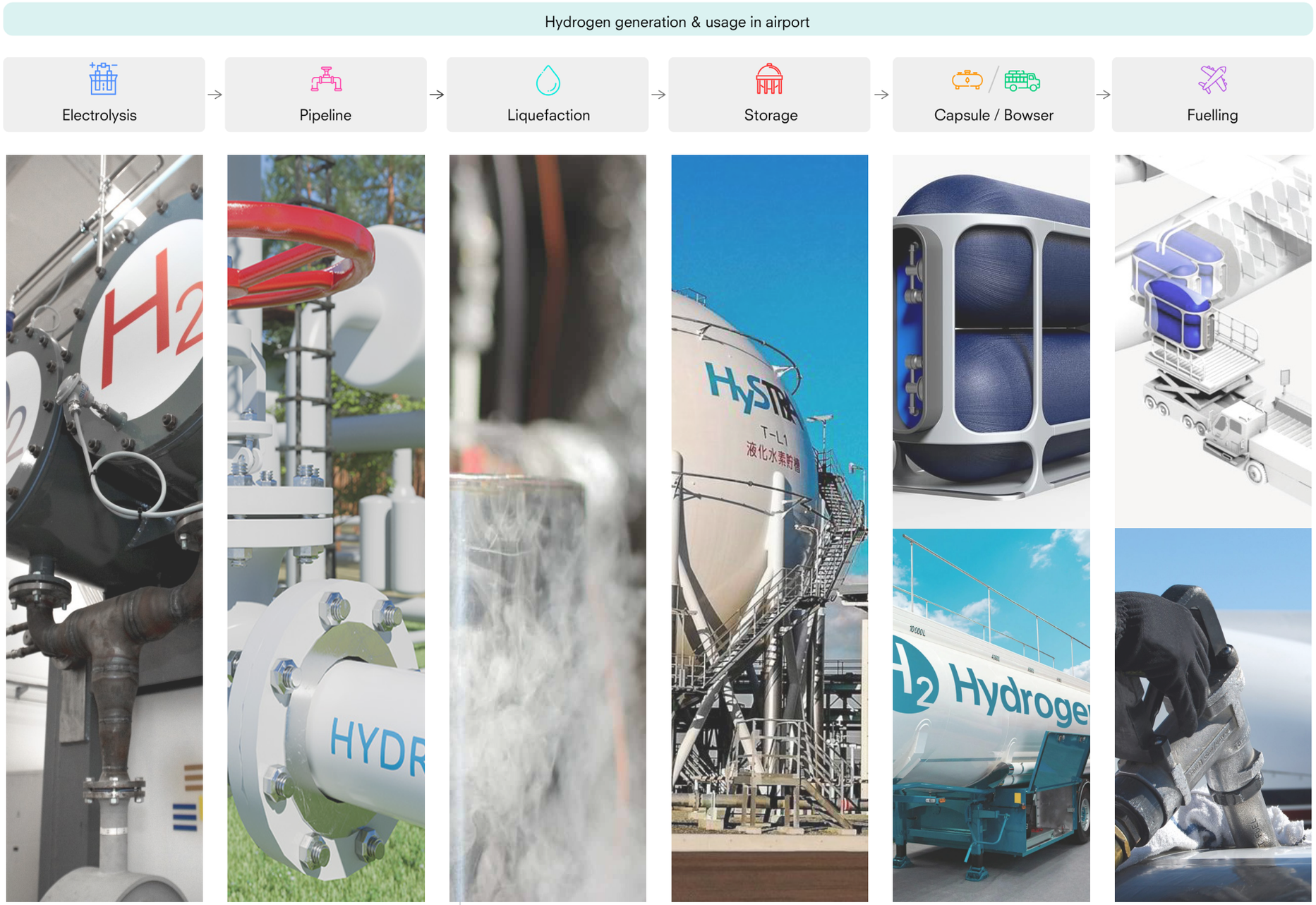


Fig. 40 Six steps of hydrogen fuelling at airport.

Typology 1: **Ages**	**Elderly**	**Adults**	**Children**
How do they usually play?	- With minimum effort / strength - In order to maintain physique	(At first) - Half-heartedly, unnoticed - After being nudged	- Earnestly, whole-heartedly - With high energy
Example of play & venue	- In elderly homes  - At outdoor gyms 	- At public installations  - Designated play events / areas 	- With “loose parts”  - At (fixed) playgrounds 

Fig. 41 Types of play for different ages.

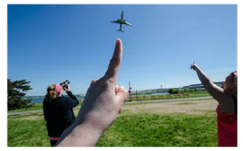
Typology 2: **Users**	**Rural patients**	**Urban escapers**	**Non-flying public**
How & when do they usually play?	- With minimum effort / strength - Watch the play & enjoy the atmosphere during escort	- Smaller installations & shorter playing time - While waiting to board	- Passers-by: stop & play shortly - As a leisure destination
Example of play & venue	- On the way being escorted  - To reduce anxiety during wait 	- Small, scattered installations  - Short play to kill time 	- While passing by  - Airport as destination for public 

Fig. 42 Types of play for different airport users.

04.2.2 Airport for play

The project aims to become the first seaplane port in Berlin, specifically contributing to a healthier city. As mentioned before, different users would be involved and they shall all be engaged in play. It is the aim of this section to further develop how these users could be involved in play for a better mental health. Therefore, these users would be categorised into different ages and different uses. Their different ways and times of engaging play would be demonstrated in a timeline of airport circulation which would help to further develop playscape and its spatial relationships with other airport facilities. (Fig. 41-43)

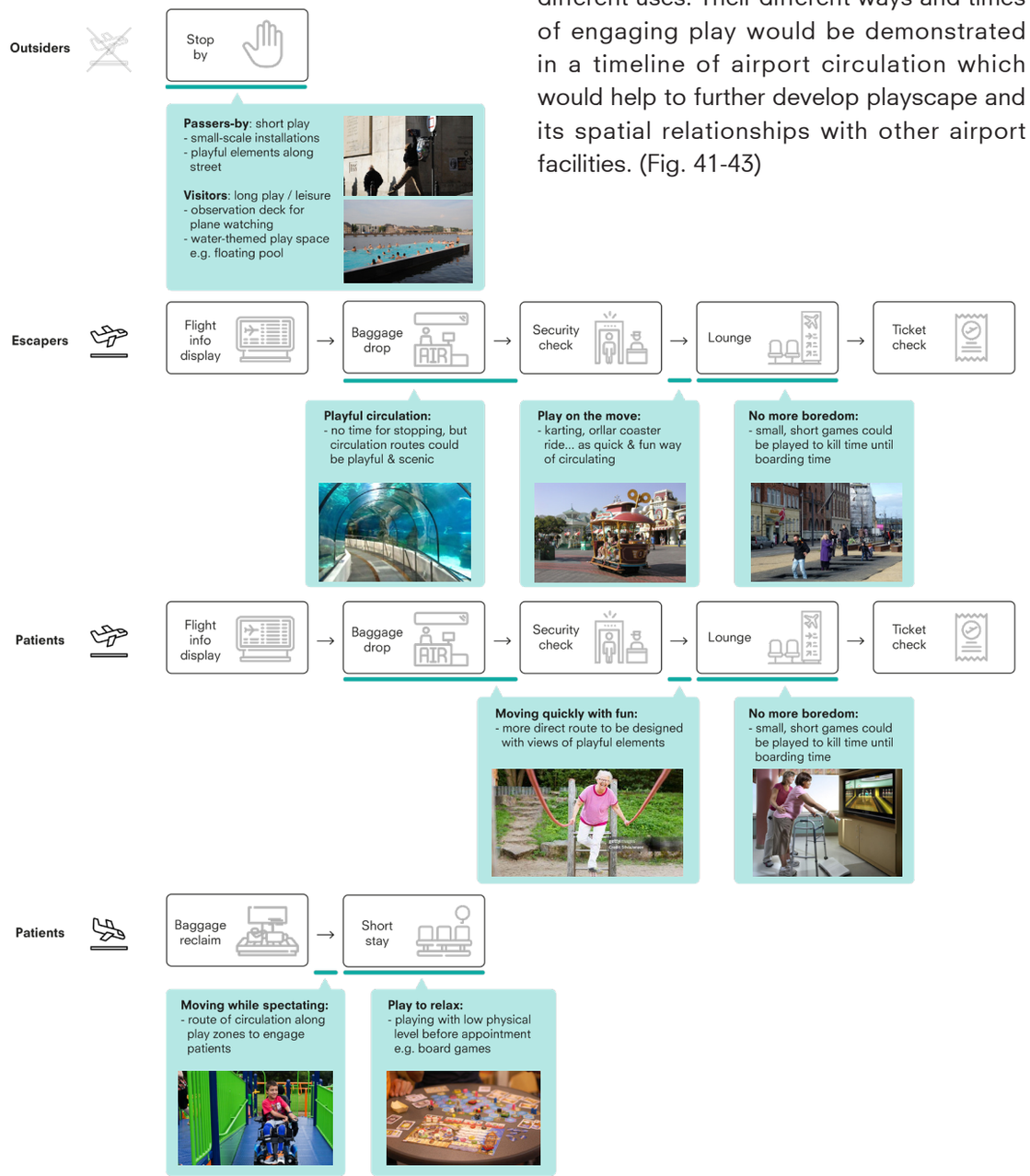


Fig. 43 Timeline of play for different airport users.

It is proposed that the playscape could be in form of designated play area, scattered installations or even integrated with airport facilities. (Fig. 44) These three forms of playscape would all be considered during the design phase so as to cater all airport users as well as the public.

Designated Play Area

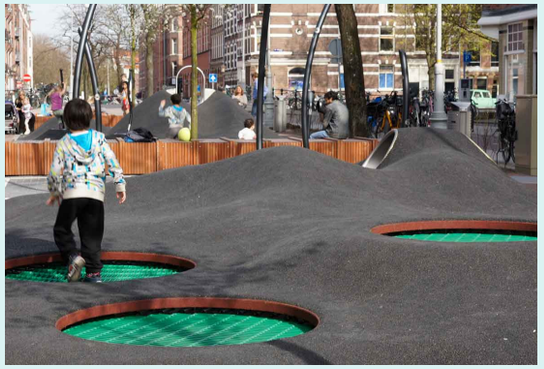
+

=

Generated with AI
Prompt: theme park at schiphol plaza amsterdam airport

Scattered Installations

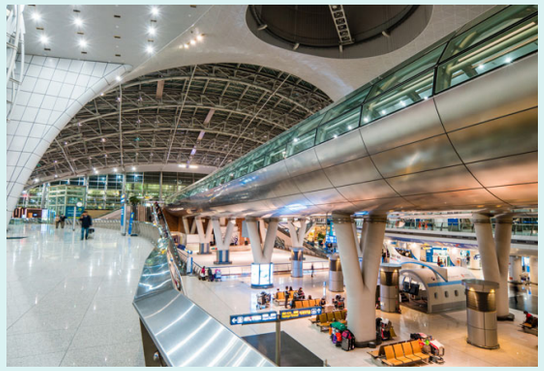
+



=

Generated with AI
Prompt: floor integrated trampolinw scattered, unoticed at schiphol airport waiting gate

Integrated Airport Facilities



+

=

Generated with AI
Prompt: rollar coaster replacing trains at airport

Fig. 44 Possible ways of integrating playscape in airport.

04.2.3 Size calculations

To figure out the total area needed for the water airport, a lot of data would be needed from online research and literature review, such as spaces needed for hydrogen facilities, carparking and floor area of terminal needed per passenger. (Fig. 45-46)

In addition to these numbers, some assumptions would have to be made, such as the percentage of rural patients, and the percentage of local tourist who would takethe seaplane to Berlin for medical treatment. However, these assumptions were made in reference to healthcare and tourism data in Berlin.

Exterior leisure area:

Jewel Changi

10.86 m²
leisure area per visitor

135,700 m²
total area

12,500
visitor per hour

Disneyland HK

8.09 m²
leisure area per visitor

275,000 m²
total area

34,000
visitor per day

Assumption:

1000
visitors per hour

Exterior leisure area required:

9,400 m²

Number of aircrafts:

Passenger Enplanements

660,000
passengers per annum

95
movements per day

1,808
passengers per day

19
passengers per aircraft

Aircraft Turnover

324 km/h
cruise speed

480 km
max. range

2.5 hrs
max. time needed per trip

1.5 hrs
max. cruise time

0.5 hr
max. refulling time

0.5 hr
passenger disembarking / boarding / cleaning / catering

Operation

12 hrs
per day (9am - 9pm)

4.8
movements per day per aircraft

Minimum no. of aircrafts needed:
movements per day ÷ movements per day per aircraft

95 ÷ 4 = 23.8

No. of seaplanes in airport:

25

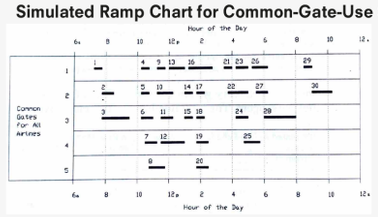
Number of docks & ramps:

Airline Schedule & Ramp Chart

Simulated Airline Schedule

Ref. no	Airline code*	Flight number	Time: Arrival time	Time: Departure time	Aircraft
1	CL	64	7:15 a.m.	7:45 a.m.	737
2	CL	9999	7:45 a.m.	8:30 a.m.	737
3	RX	161	10:15 a.m.	10:45 a.m.	MD-8
4	CL	489	11:15 a.m.	11:45 a.m.	737
5	CL	9999	11:15 a.m.	12:15 p.m.	737
6	CL	41	11:30 a.m.	12:15 p.m.	737
7	CL	9999	1:15 p.m.	2:45 p.m.	737
8	CL	50	1:45 p.m.	2:15 p.m.	737
9	CL	936	1:45 p.m.	2:15 p.m.	737
10	CL	81	4:15 p.m.	5:00 p.m.	737
11	RX	321/844	4:45 p.m.	5:45 p.m.	MD-8
12	CL	493	8:30 p.m.	9:00 p.m.	737

Simulated Ramp Chart for Common-Gate-Use Strategy



Assumption: flight schedule evenly distributed

Dock Occupancy

45 mins
dock usage per aircraft

30 mins
dock occupancy time

15 mins
gap b/w usage for aircraft maneuvering

17
aircrafts handled per dock per day

780 mins
daily operation time (9am - 9pm)

Minimum no. of docks needed:
movements per day ÷ aircrafts handled per date per day

95 ÷ 17 = 5.6

No. of docks in airport:

8

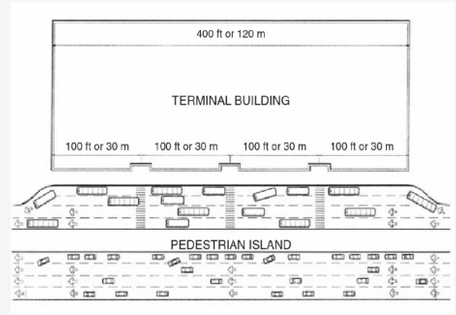
Area needed for playscape is divided into indoors and outdoors. These numbers were calculated based on similar architectural proejcts which involved also in leisure and play activities: Banyuwangi Airport, Jewel at Changi Airport and Hong Kong Disneyland. The area needed per visitor would be used as references for predicting floor space needed in this project.

Last but not least, a program bar would be drawn to show area distributed to each program. (Fig. 47)

Length of curbfront:

Pick-up / Drop-off Curbfront

Typical Curbfront Layout



TAXI

35 m
curb length per million passengers

Minimum curb length needed:
million passengers X curb length per million passengers

0.66 x 35 = 23.1

Length of curbfront at airport:

≥23.1m

Fig. 45 Facilities needed and size calculations.

Required airside area:

Aircraft fuel

5,000 m²
for liquid H_2 electrolysis, storage, liquefaction

Maintanence

5,000 m²
for hangar for 25 seaplanes

Others

500 m²
for fire station

Minimum area required on airside:

10,500 m²

Required (landside) terminal area:

Population

84.08 million
total population

18.70 million
rural population

Healthcare

19.9%
registered patients per total population

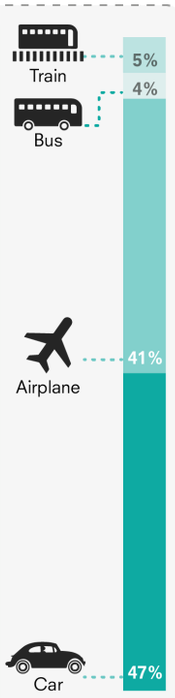
3.86 million
estimated rural patients

Tourism

18.57 million
yearly domestic trips

5.01 million
yearly trips to rural areas

Mode of transport for Domestic Tourists



Assumption:

5%
of total rural tourists travels to & from Berlin by seaplanes

2%
of total rural patients receives medical treatments in Berlin

If all passengers travel to and from Berlin, Total number of passengers in a year:

660,000

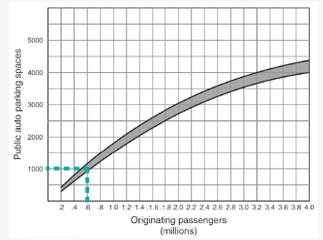
"Rule of thumb for the provision of terminal space ... is to supply **10000 m² of floor space per 1 million passengers per annum** (mppa)."

Minimum area required in the terminal:

6,600 m²

Required (landside) curb area:

Car parks



30,000 m²
for 1,000 car parking spaces

Others

1,000 m²
for public transport access

Minimum area required on landside curb:

31,000 m²

Indoors play area:

Banyuwangi

30%
landscaping of total terminal area

Jewel Changi

10.86 m²
leisure area per visitor

135,700 m²
total area

12,500
visitor per hour

Disneyland HK

8.09 m²
leisure area per visitor

275,000 m²
total area

34,000
visitor per day

Assumption:

250
visitors per hour

Indoors play area required:

2,400 m²

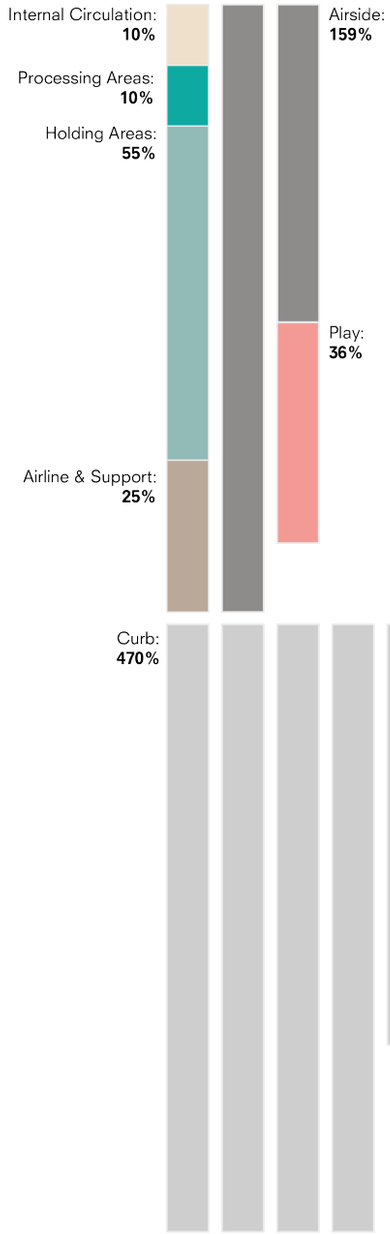
Total functional area required:

48,100 m²

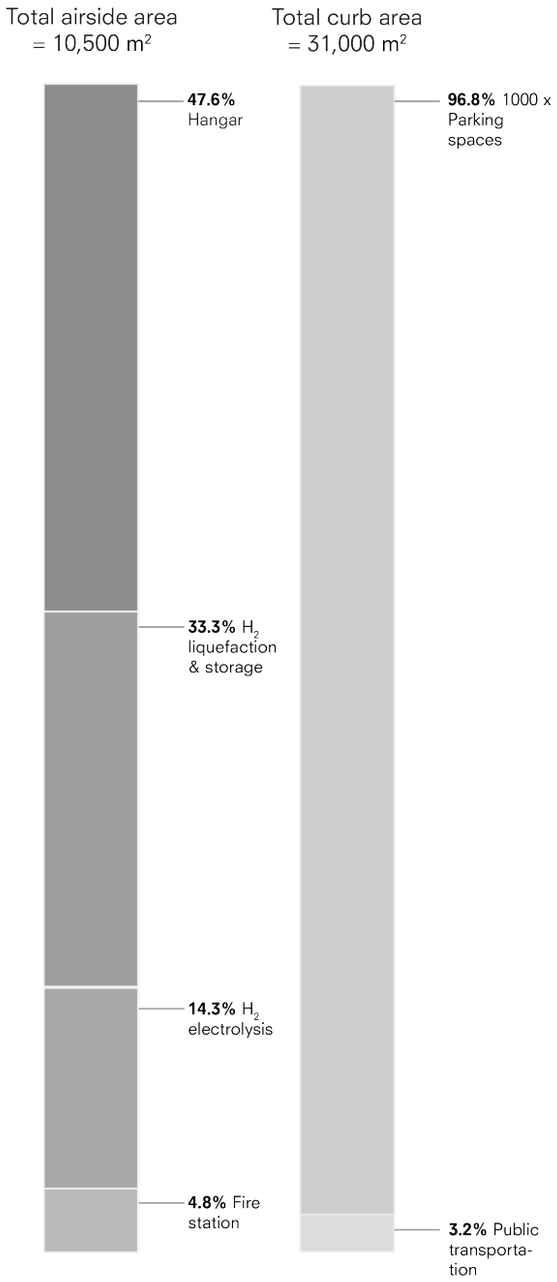
Total airport area required: 50,500 m²

Fig. 46 Size calculations.

Airport as a whole



Program breakdown



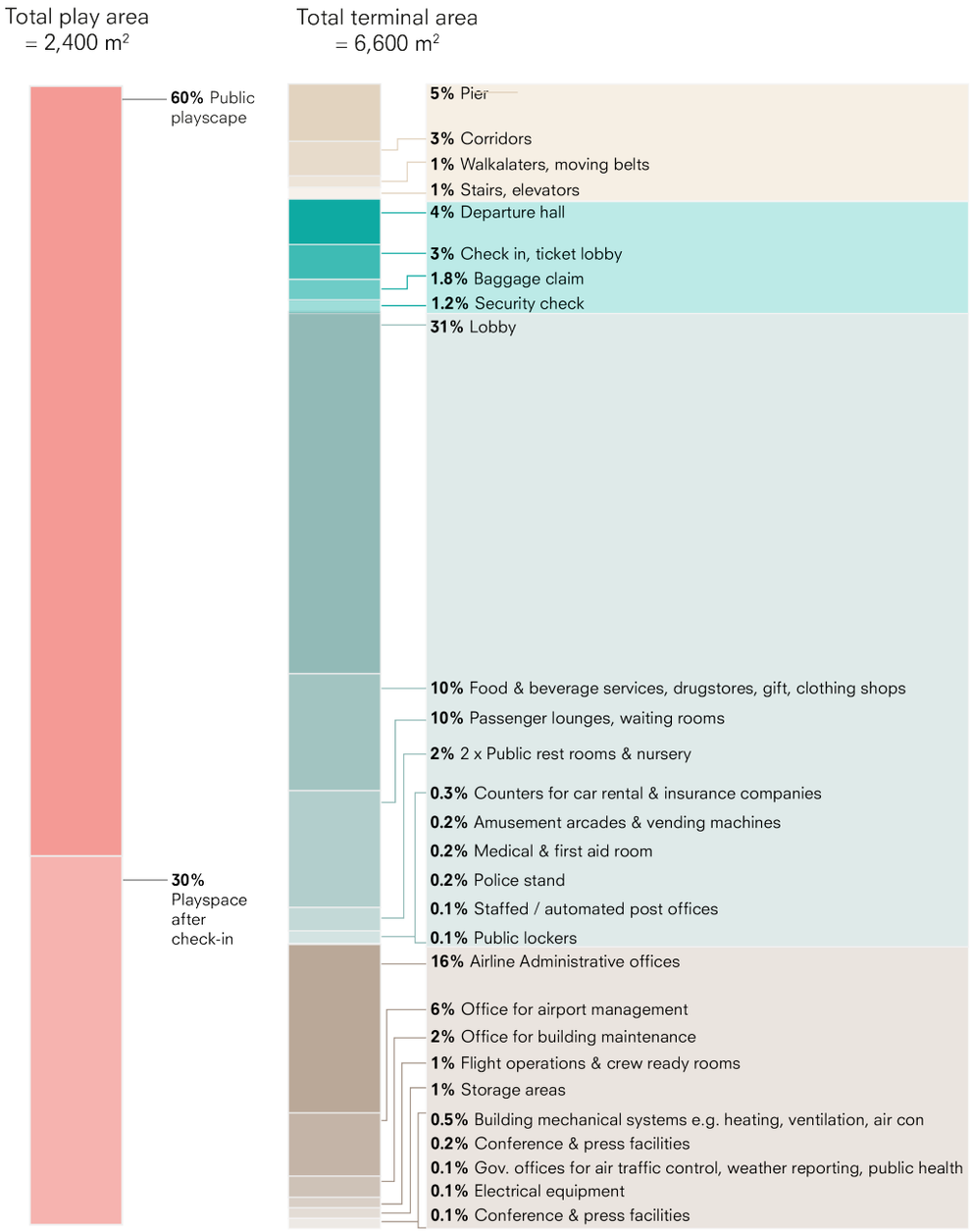


Fig. 47 Program bar.

04.2.4 Spatial organisations

Following the calculation of area needed, the spatial organisation of airport would be developed. (Fig. 48) This would be based on previously done case studies with adjustments and interventions with added programs for hydrogen and play.

Furthermore, the flows of passengers, urban escapers, rural patients, public visitors, crew members and hydrogen would be demonstrated on the relation scheme to indicate the spaces used by different users. (Fig. 49-54)

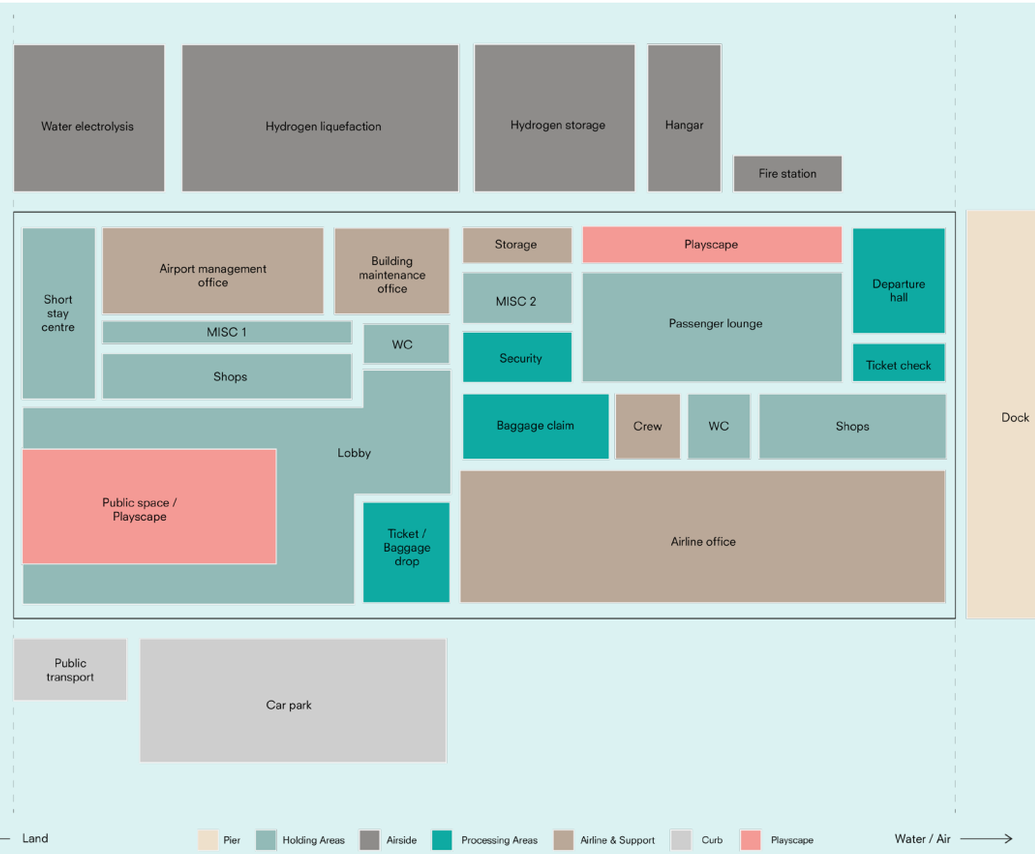


Fig. 48 Relations scheme.

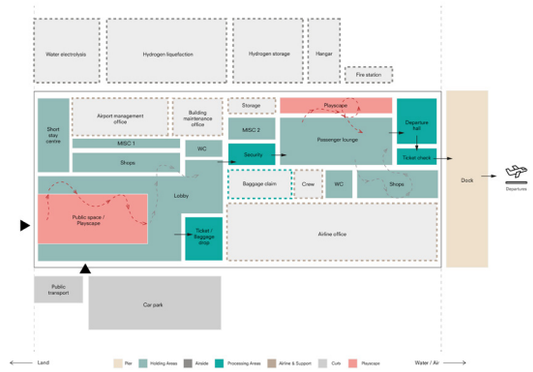


Fig. 49 Departure flow: all passengers.

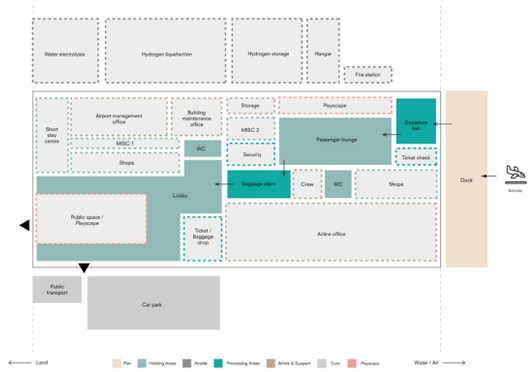


Fig. 50 Arrival flow: urban escapers.

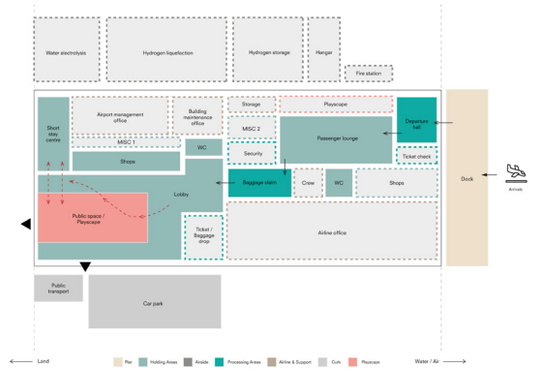


Fig. 51 Arrival flow: rural patients.

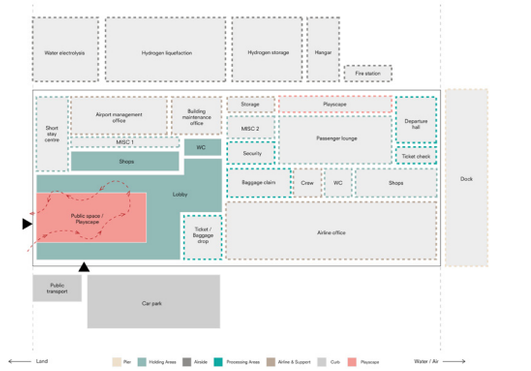


Fig. 52 Flow: public visitors.

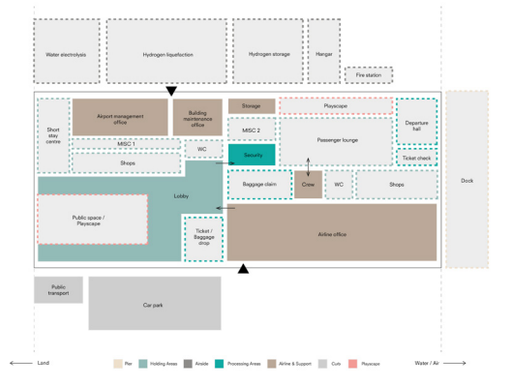


Fig. 53 Flow: crew and employee.

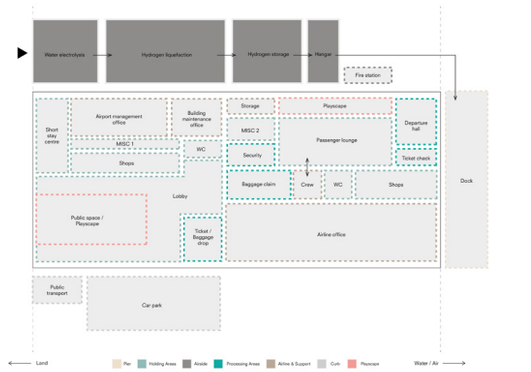


Fig. 53 Flow: crew and employee.

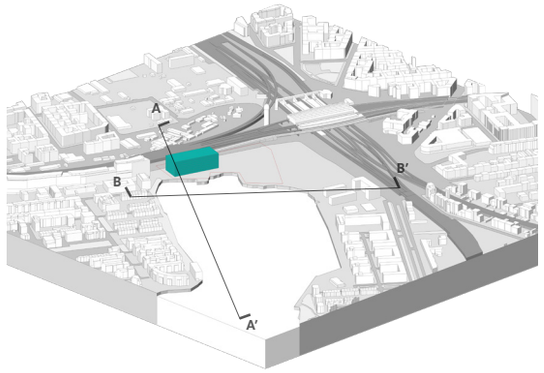
04.2.5 Massing strategies

Massing strategies would be developed firstly to explore the impacts on the projects' program as well as the impacts on the whole neighbourhood. (Fig. 54) By drawing sections and elevations, the relationship betwen the buidling mass and the site would be clearly demonstrated in terms of building height or sightlines.

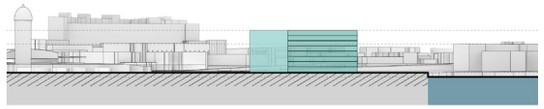
Among the three concepts, pier would be the most suitable form of building as a water airport. It demonstrated high connectivity with the local residents while maintaining a large portion in contact with water, which would be essential for a seaplane port.

Concept 1: **Mid-rise**

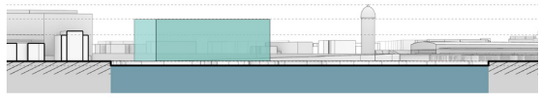
GFA: **50,500 m²**
Footprint: **6310 m²**
Number of storey: **8**



A - A'

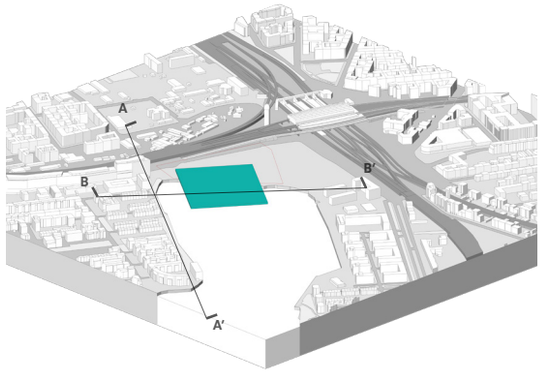


B - B'

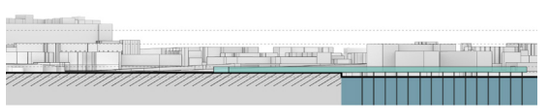


Concept 2: **Low-rise**

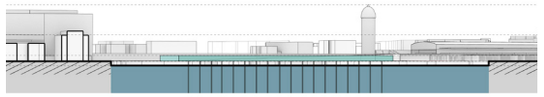
GFA: **50,500 m²**
Footprint: **50,500 m²**
Number of storey: **1**



A - A'

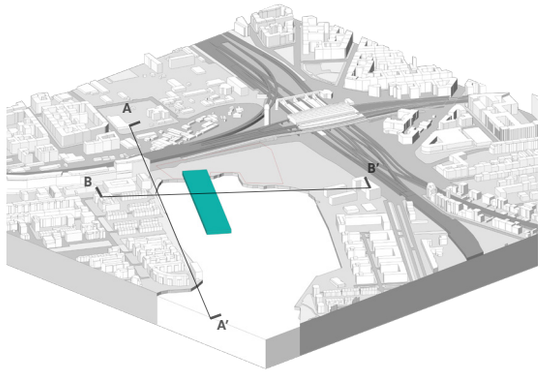


B - B'

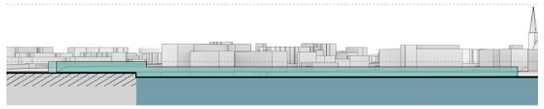


Concept 3: **Pier**

GFA: **50,500 m²**
Footprint: **25,250 m²**
Number of storey: **2**



A - A'



B - B'

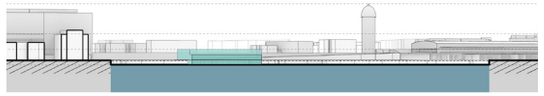


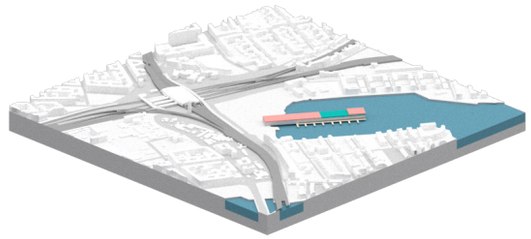
Fig. 54 Massing strategies: mid-rise, low-rise, pier.

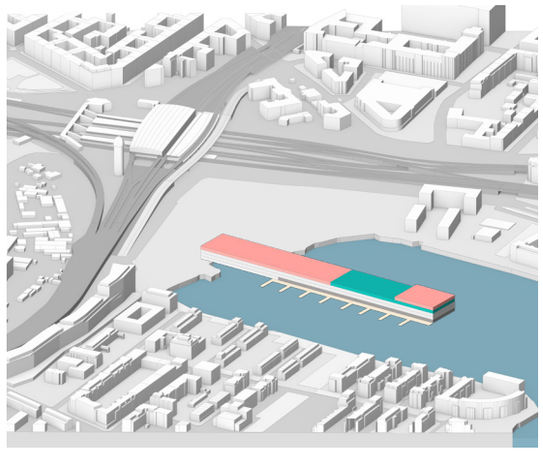
Within the concept of a pier, three more massings would be suggested: all-in-one, isolated carpark and isolated carpark & H_2 facilities. (Fig. 55)

As their names suggest, these massings would be aiming to explore the possibility of having multiple buildings for different programs. Before coming to a conclusion, their pros and cons would be further explored in the design stage.

All-in-one

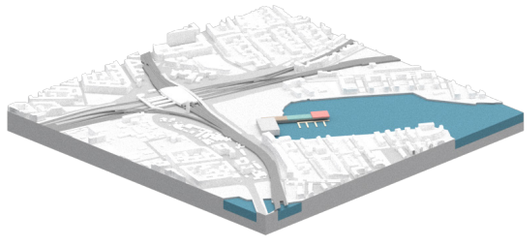
GFA: **59,900 m²**
Footprint: **15,000 m²**
Number of storey: **5**

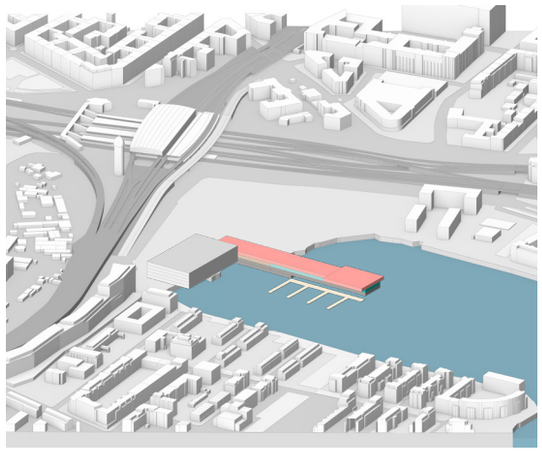




Isolated carpark

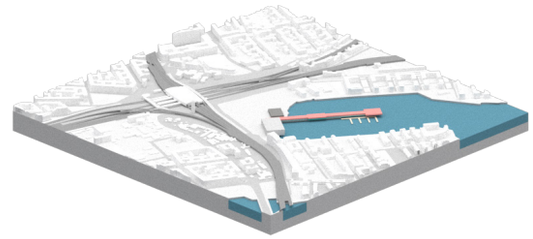
GFA: **59,900 m²**
Footprint: **9,400 m²**
Number of storey: **5, 4**





Isolated carpark & H_2 facilities

GFA: **59,900 m²**
Footprint: **13,520 m²**
Number of storey: **5, 3, 2**



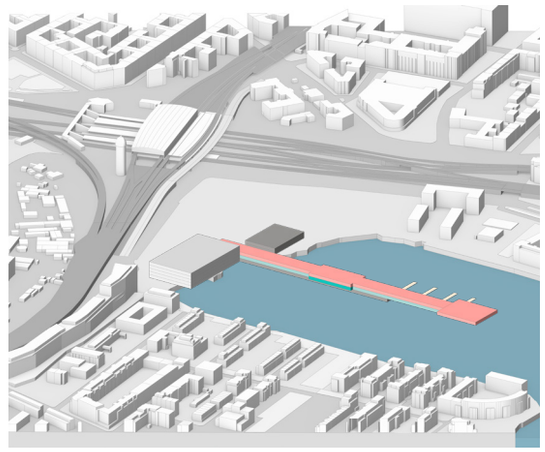


Fig. 55 Massing strategies: all-in-one, carpark isolated, H_2 facilities isolated.

04.3 Client

Like most of the existing airports, the seaplane port would be owned by a public limited company named Berlin Water Airport. By privatising the airport, its efficiency would be generally higher than public ones. Decisions making regarding the airport would be done quicker which would be very important to a small-scale airport focusing on contributing to a healthier Berlin. (Airport Gurus, 2023)

As far as the shares of this company is concerned, the largest shareholders would be the federal government of Germany and the state government of Berlin. However, the nature of this project would be health- and leisure-oriented. In light of this, private investors would be involved. According to research done, insurance companies would be willing to invest in health-oriented projects so as to increase exposure and to promote a healthy lifestyle. (Fig. 56)

Allianz, the largest German insurance company would take part in investing in this project. In addition, leisure activities and rural travel packages could be provided and managed by TUI Group, one of the largest German tour operators. Given that they also operate airlines and cruises, they would be interested in managing a seaplane fleet of 25 planes. This would help expanding their business. On top of that, medical tourism could also be one of their considerations so as to extend their scope of business. (Fig. 58)

Lastly, directors for different areas in an airport would be researched. Based on that, a list of staff members at an airport would be collected and categorised into 7 workspaces. (Fig. 57)

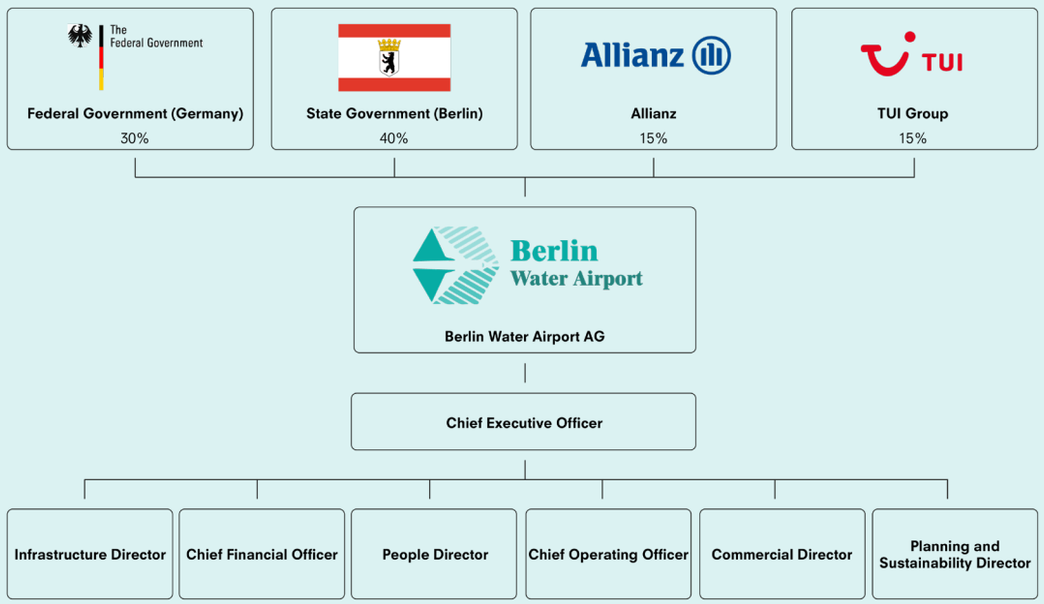


Fig. 56 Organisational structure of Berlin Water Airport AG.

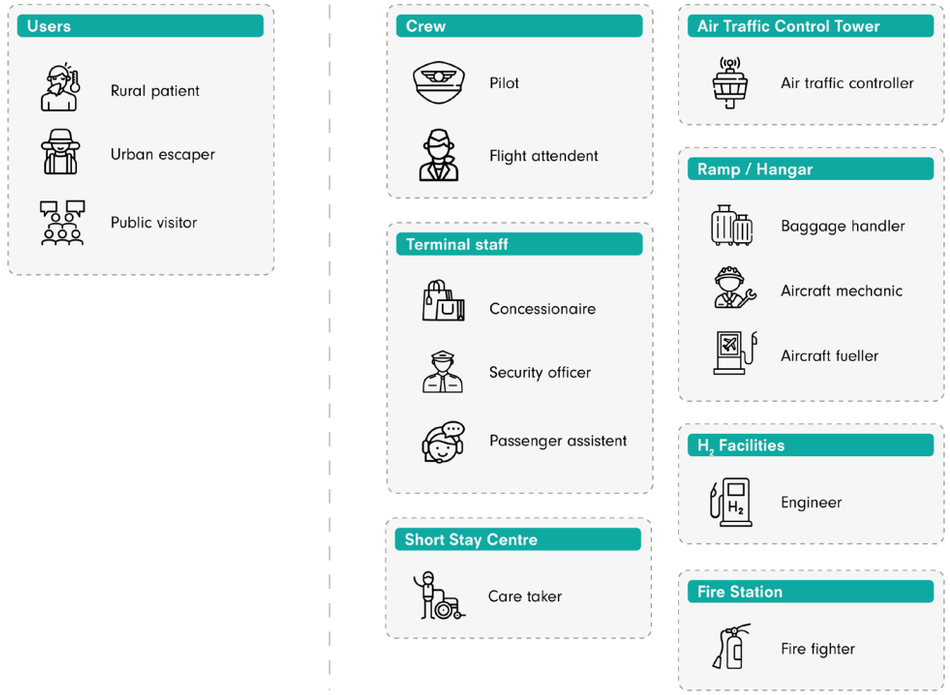


Fig. 57 Users and staff members in an airport according to workspaces.

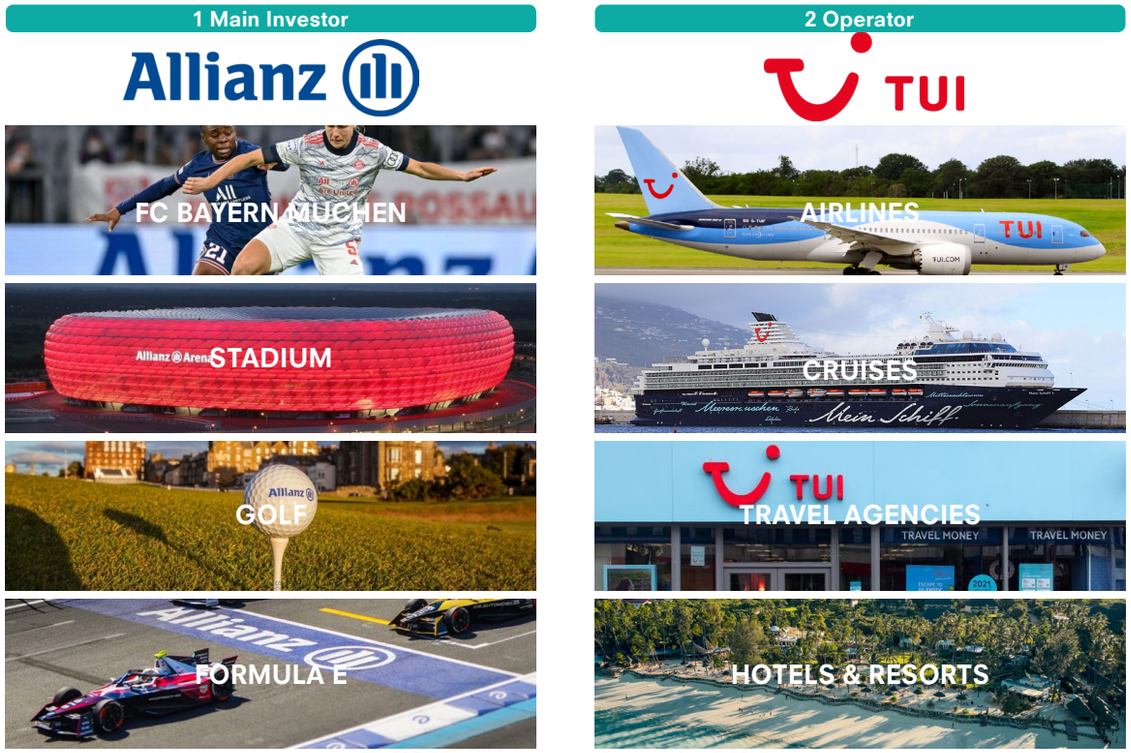


Fig. 58 Relevant engagements of private shareholders.

BIBLIOGRAPHY

05

05.1 Bibliographical References

ACI. (2023, February 22). *What to expect: Latest Air Travel Outlook reveals short- and long-term demand*. ACI World. https://aci.aero/2023/02/22/what-to-expect-latest-air-travel-outlook-reveals-short-and-long-term-demand/#:~:text=Passenger%20traffic%20worldwide%20is%20expected%20to%20reach%2019.3,will%20see%20153.8%20million%20aircraft%20movements%20by%202041.

AD Editorial Team (Ed.). (2017, January 19). *Considering the airport terminal of Tomorrow.* ArchDaily. https://www.archdaily.com/803677/aerial-futures-grounded-visions-the-airport-terminal-of-tomorrow?ad_source=search&ad_medium=search_result_all

Airbus. (2020, October 8). *Hydrogen in aviation: how close is it?*. Airbus.com. https://www.airbus.com/en/newsroom/stories/2020-10-hydrogen-in-aviation-how-close-is-it#:~:text=Hydrogen%20is%20increasingly%20considered%20as%20one%20of%20the,must%20be%20addressed%20before%20widespread%20adoption%20can%20happen.

Airbus. (2021, June 21). *Tomorrow's airports: future energy ecosystems?* Airbus.com. https://www.airbus.com/en/newsroom/news/2021-06-tomorrows-airports-future-energy-ecosystems

Airport Gurus. (2023, December 18). Privatising airports: Analysing benefits, advantages, and disadvantages. https://www.airportgurus.com/en/privatising-airports-benefits-advantanges-disanvantage/

Alexander Gutzmer, L. F. (2018, April 11). *When it comes to building a better airport, "it never pays to use cheap materials."* ArchDaily. https://www.archdaily.com/892303/when-it-comes-to-building-a-better-airport-it-never-pays-to-use-cheap-materials

Ashford, N., Mumayiz, S. A., & Wright, P. H. (2011). *Airport engineering: Design, planning, and development of 21st Century airports.* Wiley.

EASA Eco. (2023). *Green Airport Infrastructure.* https://www.easa.europa.eu/eco/eaer/topics/airports/green-airport-infrastructure#:~:text=The%20Airbus%20%E2%80%9CHydrogen%20Hub%20at%20Airports%E2%80%99%E2%80%99%20concept%20brings,a%20stepped%20approach%20to%20decarbonise%20all%20airport-associated%20infrastructure.

Expats Germany. (2023, November). German statutory health insurance. https://expats.de/en/health-insurance/public-health-insurance/

Federal Ministry of Economic Affiars and Energy. (2020). Facts and figures 2020 facts - germany. 2020 Facts and figures . https://www.germany.travel/media/redaktion/pdf/ueber_uns/2021/DZT_ZahlenFlyer2021_EN.pdf

Gallagher, T. (2021). *Noise pollution: How are airports and airlines addressing the issue?*. euronews. https://www.euronews.com/next/2021/11/16/noise-pollution-how-are-airports-and-airlines-addressing-the-issue

IATA. (2021, October 4). *Net-zero carbon emissions by 2050*. https://www.iata.org/en/pressroom/pressroom-archive/2021-releases/2021-10-04-03/

IATA. (2022, December). Air passenger market analysis - IATA. Air Passenger Market Analysis. https://www.iata.org/en/iata-repository/publications/economic-reports/air-passenger-market-analysis---december-2022/

International Airport Review. (2023, August 18). *Guide to...operational efficiency.* https://www.internationalairportreview.com/article/188738/guide-to-operational-efficiency/#:~:text=Operational%20efficiency%20is%20crucial%20for%20airports%20as%20it,handling%2C%20streamline%20operations%2C%20lower%20costs%2C%20and%20enhance%20safety.

Lange, A., Prenzler, A., Bachmann, O., Linder, R., Neubauer, S., Zeidler, J., Manns, M. P., & von der Schulenburg, J.-M. (2015). *Regional differences in health care of patients with inflammatory bowel disease in Germany*. Health Economics Review, 5(1). https://doi.org/10.1186/s13561-015-0067-1

London City Airport. (2020). *London City Airport Master Plan | London City Airport.* A future vision for London City Airport. https://www.londoncityairport.com/corporate/corporate-info/future-airport-and-planning/master-plan

Ritchie, H., & Roser, M. (2023, September 27). *Climate change and flying: What share of Global CO2 Emissions Come From Aviation?.* Our World in Data. https://ourworldindata.org/co2-emissions-from-aviation

Romig, T. (2021, November 12). *The path towards Airport Operational Efficiency: Total Airport Management.* International Airport Review. https://www.internationalairportreview.com/article/167398/total-airport-management/

Rotterdam Partners. (2023, October 30). *Flying on hydrogen from Rotterdam The Hague Airport: Almost ready for boarding*. https://en.rotterdampartners.nl/articles/hc-commercial-hydrogen-air-travel-from-rotterdam-2025/

State of Berlin. (2023). *Environmental atlas.* Berlin.de Startseite. https://www.berlin.de/umweltatlas/en/

Tanveer, S. (2022, January 15). *Architecture and ethics - RTF: Rethinking the future*. RTF | Rethinking The Future. https://www.re-thinkingthefuture.com/architectural-community/a2558-ethics-in-architecture/

World Economic Forum, & McKinsey & Company. (2023, April). T*arget true zero: Delivering the infrastructure for battery and hydrogen-powered flight.* World Economic Forum. https://www.weforum.org/publications/target-true-zero-delivering-the-infrastructure-for-battery-and-hydrogen-powered-flight/

ZeroAvia. (2023, February 7). *Zeroavia, Shell, Rhia and Rotterdam the hague airport advance plans for hydrogen-electric flights by 2025.* https://zeroavia.com/rotterdam/

05.2 Figures

Cover page: Impression of the first seaplane port in Berlin (Illustration by author)

Fig. 1 Change in relationships between airports, cities and infrastructure (Illustration by author)

Fig. 2 Hydrogen fuel for aircrafts. U.S. Department of Energy. (n.d.). The U.S. Department of Energy (DOE) hydrogen shot summit. First Choice Detective Agency. https://firstchoicedetectiveagency.com/the-u-s-department-of-energy-doe-hydrogen-shot-summit/

Fig. 3 Seaplane (amphibious). Viking Air Ltd. (2018, July 16). Viking floats “400s” seaplane derivative of series 400 twin otter. Viking Air Ltd. https://www.vikingair.com/viking-news/media-centre/viking-floats-400s-seaplane-derivative-series-400-twin-otter

Fig. 4 Yokohama Terminal. Arukikata. Co, & Bringer Japan Z. (2021, September 18). Osanbashi Yokohama international passenger terminal - must-see, access, hours & price. Good Luck Trip. https://www.gltjp.com/en/directory/item/11137/

Fig. 5 Rural patients. Bacon, J. (2019, November 24). All-terrain wheelchairs arriving soon at Nene Park. Nene Valley. https://nenevalley.net/all-terrain-wheelchairs-arriving-soon-at-nene-park/

Fig. 6 Urban escapers. Sheehy, S. (2022, April 11). Take a hike in the sawtooths: 3 beautiful trails near Redfish Lake. Visit Idaho. https://visitidaho.org/trip-guides/take-hike-sawtooths-3-beautiful-trails-near-redfish-lake/

Fig. 7 Public visitors. Notte, J. (2022, July 1). 25 amusement parks that aren’t horrible for parents. Cheapism. https://blog.cheapism.com/amusement-parks-for-adults/

Fig. 8 Step-by-step diagram of research framework (Illustration by author)

Fig. 9 Hudrogen Hub at Airports by Airbus. Airbus. (2021, June 21). *Tomorrow’s airports: future energy ecosystems?* Airbus.com. https://www.airbus.com/en/newsroom/news/2021-06-tomorrows-airports-future-energy-ecosystems

Fig. 10 Berlin Brandenburg Airport. Aviator. (2020, July 24). Opening of the Ber Airport on 31 October 2020. AVIATOR. https://newsroom.aviator.aero/for-the-opening-of-the-berlin-brandenburg-airport-ber/

Fig. 11 London City Airport. Turner, S. (2017, August 31). After 30 years, City Airport in London takes off in New Directions. Forbes. https://www.forbes.com/sites/sarahturner/2017/08/31/after-30-years-city-airport-in-london-takes-off-in-new-directions/

Fig. 12 Sea Airport of Elefsina. Aasa. (2020, December 11). New metropolitan sea airport of elefsina by pieris.architects. aasarchitecture. https://aasarchitecture.com/2020/12/new-metropolitan-sea-airport-of-elefsina-by-pieris-architects/

Fig. 13 Banyuwangi International Airport. Welch, A. (2023, July 31). Banyuwangi International Airport, East Java - e-architect. e-architect. https://www.e-architect.com/indonesia/banyuwangi-international-airport-east-java

Fig. 14 Specifications of aircraft (Illustration by author)

Fig. 15 Comparison between traditional aircrafts and hyderogen seaplanes. **(1)** Applied Pavement Technology. (n.d.). Airport Pavement Management. Applied Pavement Technology, Inc. https://www.appliedpavement.com/airport-pavement-management/ **(2)** Author, G. (n.d.). Relax and flow like a river. Anmol Mehta | Mastery of Meditation and Yoga | Free Online Meditation and Yoga. https://anmolmehta.com/what-can-we-learn-from-the-experience-of-a-river/ **(3)** Hopkins, S. (2016, April 18). Police launch appeal to Trace Drone Pilot after British Airways incident. HuffPost UK. https://www.huffingtonpost.co.uk/entry/british-airways-drone-incident-at-heathrow-leads-to-police-appeal-to-trace-pilot_uk_57151bbde4b0636a3f6d1707 **(4)** Dane, K. (2021, August 27). Best hiking books: 12 Great Outdoor Adventure Books for hikers. Hiking Mastery. https://hikingmastery.com/basics/best-hiking-books.html **(5)** Curtis, C. (2020, August 10). “a record nobody really wants”: Phoenix surpasses most days at or over 110 degrees. The Arizona Republic. https://www.azcentral.com/story/news/local/phoenix-weather/2020/08/09/phoenix-track-break-record-most-days-110-degrees-over/3331321001/ **(6)** Pransky, J. (2019, July 1). Welcome! it’s safe to land here. Jillian Pransky. https://jillianpransky.squarespace.com/blog/2019/4/16/welcome-its-safe-to-land-here **(7)** Franck, J., & Møller, K. J. (2014, September 1). Denmark aims to be rid of fossil fuels by 2050. ScienceNordic. https://sciencenordic.com/biofuel-denmark-esof2014/denmark-aims-to-be-rid-of-fossil-fuels-by-2050/1406304 **(8)** Parkinson, J. N. (2019, March 18). North Sea Offshore Wind Turbines. YouTube. https://www.youtube.com/watch?v=sQxdI0qBrbE

Fig. 16 A history of play. (Illustration by author)

Fig. 17 Example of studying play. (Illustration by author)

Fig. 18 Benchmarking spatial organisations of case studies (Illustration by author)

Fig. 19 Partnership between AIA and Tottenham Hotspur. AIA. (2024). AIA - Lucas Moura - Workout_Master_SUB_V2 (1). AIA Group Limited - Asia’s Leading Insurance Company. https://www.aia.com/en/about-aia/csr/partnership-tottenham-hotspur

Fig. 20 Mapping exercises for analysis (Illustration by author)

Fig. 21 Mappings of cities with medical needs (Illustration by author)

Fig. 22 Mappings of cities with medical needs as first destinations of medical escorts (Illustration by author)

Fig. 23 Mappings of waterbody, built-up areas and urban density (FSI). (Illustration by author)

Fig. 24 Five preliminary sites. (Illustration by author)

Fig. 25 Mappings of thermal pollution, air pollution and traffic-related noise pollution. (Illustration by author)

Fig. 26 Five preliminary sites reduced to two possible. (Illustration by author)

Fig. 27 Analysis of plot sizes and types (Left: Park an der Spree; Right: Rummelsburger Bucht). (Illustration by author)

05.2 Figures

Fig. 53 Flow: crew and employee. (Illustration by author)