Vibrant spaces

Implementing the concept of vibrant places into a public building

Research paper

Architectural engineering studio

- Second life -

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Thematic research

This research was conducted for the fulfilment of the aE Graduation Studio thematical research within the Master Programme at Delft University of Technology, year 2022-2023.

Course Architectural Engineering Studio

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Abstract: *This paper investigates the factors that can be utilized in the redesign of public buildings to achieve vibrant, sustainable, and social public spaces. The research identifies and examines ten aspects, which are categorized into social and sustainable aspects, following regulations, standards, and recommendations formulated by organizations such as LEED and BREEAM. The social aspects include Human Health, Bio-Diversity, Public Spaces, Accessibility, and Visibility, while the sustainable aspects include Energy, Water, Nature, Materials, and Climate. The paper examines four case studies to demonstrate how these aspects can be used to create vibrant areas within public buildings. The case studies reveal the importance of factors such as ease and diversity of accessibility, biological diversity, and climate control in creating dynamic public spaces. The research aims to provide a guide for designing green and vibrant spaces within public buildings and suggests that future research could focus on developing new strategies for integrating sustainable and social aspects into public buildings more effectively.*

Keywords: *Public buildings, Sustainable, Social interaction, Climate change, Natural elements, Vibrant spaces.*

I. Introduction:

Public spaces within buildings serve as social hubs where people of diverse backgrounds and experiences come together to interact and engage in various activities. These spaces enrich the public life of cities, providing breathing spaces where individuals can relax, socialize, purchase goods, participate in public events, and simply experience the urban environment around them. Due to their critical role in enhancing social cohesion and addressing complex social issues, public spaces have become a fundamental aspect of contemporary urban planning strategies. In particular, these spaces offer a vital means of tackling the growing social problems of overpopulation, air pollution, and climate change. However, the design of public spaces has often neglected the inclusion of natural elements such as green and water spaces. Furthermore, the maintenance and care of such spaces can be challenging, which may exacerbate their exclusion from public spaces. As architects, it is our responsibility to tackle these challenges by re-designing existing buildings to create sustainable, attractive, and socially inclusive environments. This paper aims to explore the ways in which architects can redesign public spaces to incorporate natural elements, promote social inclusivity, and meet the demands of a changing climate.

I. Introduction:

1.1 Problem statement:

Despite the recognized importance of public spaces in promoting social cohesion, many of these spaces in buildings lack natural elements such as green and water spaces. This is a missed opportunity to provide the positive impacts on human well-being and ecosystem services that such elements can bring. In addition, existing buildings often fail to meet new requirements for climate change adaptation and sustainable design principles, leading to negative environmental impacts and social disconnection. These challenges pose a significant challenge for architects and urban planners who must redesign buildings and public spaces to be both attractive and socially engaging, while also being sustainable and adaptable to the changing climate. Therefore, this paper aims to explore ways in which natural elements can be incorporated into the design of public spaces in buildings, while also addressing the challenges of sustainability and climate change adaptation in the urban context.

1.2 Research question:

To address the issue of vacant Dutch buildings and outdated urban environments, this research aims to explore how these buildings can be transformed into open public spaces that are vibrant, energy-neutral, flexible, and adaptable to current climate change. The approach involves upgrading the existing structure and space using a generic module that can be applied to various public building typologies. The research question guiding this study is:

"What aspects can be incorporated into building redesign to achieve vibrant and sustainable social public spaces?"

I. Introduction:

1.3 Methods:

To provide a comprehensive answer to the research question, a case study approach was adopted to analyse some existing architectural precedents. These cases were analysed using a set of criteria established by architectural organizations and institutions concerned with evaluating modern and old architectural buildings and projects. This evaluation process considers the identification and implementation of green building design, construction, maintenance operations, solutions, and the impact of these projects on individuals, society, natural resources, and climate.

In this paper, I used the following key terms, and the coming section gives a definition for every term:

Vibrant: Refers to a lively and dynamic atmosphere that stimulates human senses and emotions and encourages social interaction and engagement in public spaces.

Sustainable: Refers to the capacity to maintain and preserve the natural resources and ecological systems of the environment, while ensuring the long-term viability and well-being of social and economic systems.

Social: Refers to the interaction and relationship between individuals and groups, and their engagement and participation in shared cultural, economic, and political activities and spaces.

Public spaces: Refers to the physical areas and places that are accessible to the public and used for social and cultural activities, such as parks, plazas, streets, markets, and public buildings.

The research consists of two sections: The first one briefly introduces architectural organizations and institutions, their objectives, and areas of focus when evaluating architectural projects. Then, the selected cases are presented for analysis within this research. Afterwards, the process of merging approved standards from those authorities will be presented to form research-specific criteria that will be followed in the analysis process. The second section combines research by design and learning from selected architectural precedents. Using research by design, the distinctive characteristics of sustainability and social interaction are identified and applied to the chosen case studies. The two main sections present a graphical analysis based on the criteria established for the purpose of this research. The last section, the conclusion, will answer the main thematic research question and provide options for future research related to the design of public spaces within buildings.

II. Results

2.1.1 The Architectural certifications:

As is known to all architects nowadays, the buildings and construction sector are responsible for nearly 40 per cent of the global total greenhouse gas emissions. Therefore, both architects and the construction sector work to build and renovate buildings that are sustainable and environmentally friendly. Therefore, Architectural buildings today can obtain certification based on standards legislated and enacted by various organizations and institutions. It is no longer enough for an architectural firm or real estate organization to say that its architectural project is a green/sustainable building. Therefore, there was a need to provide evidence and evidence, and here came the role of certifications. The aim of these certifications is to promote more efficient, sustainable, and cost-effective building practices, as well as reduce vacancy rates and risks associated with building operations. Including commercial buildings, homes, residential neighbourhoods, healthcare buildings, schools and other public buildings. In addition to each stage of the building life cycle including design, construction, operation and maintenance.

The following is a brief listing of the most well-known organizations and certifications across the world concerned with the classification of architectural buildings, which in turn will help in selecting architectural precedents for this research and setting search criteria in the process of analysing these architectural projects.

- **U.S. Green Building Council – USGBC:**

USGBC is a membership-based non-profit organization that promotes sustainability in building design and construction. It was established in 1993. USGBC is known for its development of the Leadership in Energy and Environmental Design (LEED) green building rating systems, Below are the goals of this organization and the prerequisites and credits for obtaining a LEED certification:

- Reduce contribution to global climate change.
- Protect and restore water resources.
- Enhance individual human health.
- Promote sustainable and regenerative materials cycles.
- Enhance community quality of life.
- Protect and enhance the biodiversity and ecosystem services.

II. Results

2.1.1 The Architectural certifications:

- **Building Research Establishment Environmental Assessment Method – BREEAM:**

BREEAM: It is the world's oldest method for assessing, rating and certifying the sustainability of buildings. It was first published by the Building Research Establishment in the UK in 1990. It is an assessment conducted by independent licensees using science-based sustainability metrics and indicators covering a range of environmental issues. Below are the goals of this organization and the prerequisites and credits for obtaining a BREEAM certification:

- Net zero Carbon.
- Health and social impact.
- Biodiversity.
- Whole life performance.
- Circularity and resilience.
- Disclosures and reporting.

- **German Sustainable Building Council – DGNB:**

DGNB: A non-profit, non-governmental organization based in Germany and founded in 2007 by 16 organizations from the construction and real estate industries. Its mission is to develop and promote methods and solutions for sustainable planning, construction and optimal use of buildings. When assessing a building, the DGNB certificate not only includes ecological, economic and socio-cultural aspects. A total of six subject areas were defined that must be taken into account when planning and building a sustainable building:

- Ecological quality
- Economic quality
- Socio-cultural quality
- Technical quality
- Process quality

II. Results

2.1.2 The chosen cases:

Based on the aforementioned certificates and regulations, four architectural projects were selected and approved as architectural precedents for analysis within this research. Due to obtaining a number of these certificates, which in turn achieve the principles of sustainability and social interaction, which are considered as the main research points.

- **Project 1: Crossrail Place - London**

Crossrail Place is a complex built in the North Dock of the West India Docks in London's Canary Wharf. It was designed by Foster + Partners and Arup in 2015. The complex has a railway station, shops and a cinema, as well as a roof garden, which is open to the public. Its roof is the largest timber project in the United Kingdom. The area around the station is designed to encourage people to use the new park and shops at the weekend - as well as during the week - creating a lively new community facility. Four levels of shops, cafes and amenities sit above the underground station.

Figure 1. View bird’s eye of the project

Figure 2. Image of the canopy of the project

Figure 3. Image of the park and its wooden frames canopy

Figure 4. The public path and functions of the ground floor

II. Results

2.1.2 The chosen cases:

- **Project 2: 20 Fenchurch street - London**

20 Fenchurch Street is a commercial skyscraper in London. the building takes its name from its address on Fenchurch Street, in the historic City of London financial district. It has also been nicknamed "The Walkie-Talkie" because of its distinctive shape. Designed by architect Rafael Viñoly in 2014, its sky garden was opened in 2015. Its 34 floors consist of office spaces, topped by a large viewing deck. The roof has 3 extra floors which have a bar, restaurant and the garden. these areas are open to the public with some restrictions.

Figure 5. Image of the tower.

Figure 6. Image of the project's view of London city.

Figure 7. Image of the green public space of the tower.

II. Results

2.1.2 The chosen cases:

- **<u>Project 3: Salesforce Transit Centre - San Francisco</u>**

Salesforce Transit Centre is a transit station in downtown San Francisco. It serves as the primary bus terminal — and potentially as a future rail terminal — for the San Francisco Bay Area. Designed by Pelli Clarke, Pelli Architects (PCPA) in 2018, it is about 440 m long and 50 m wide. The main structure has four levels: the ground floor with entrances, retail space, ticketing, and Muni/Golden Gate Transit boarding platforms; the second floor with retail space, food hall, offices, and Greyhound ticket counter and waiting room; the bus deck with bus bays surrounding a central waiting area and the rooftop park.

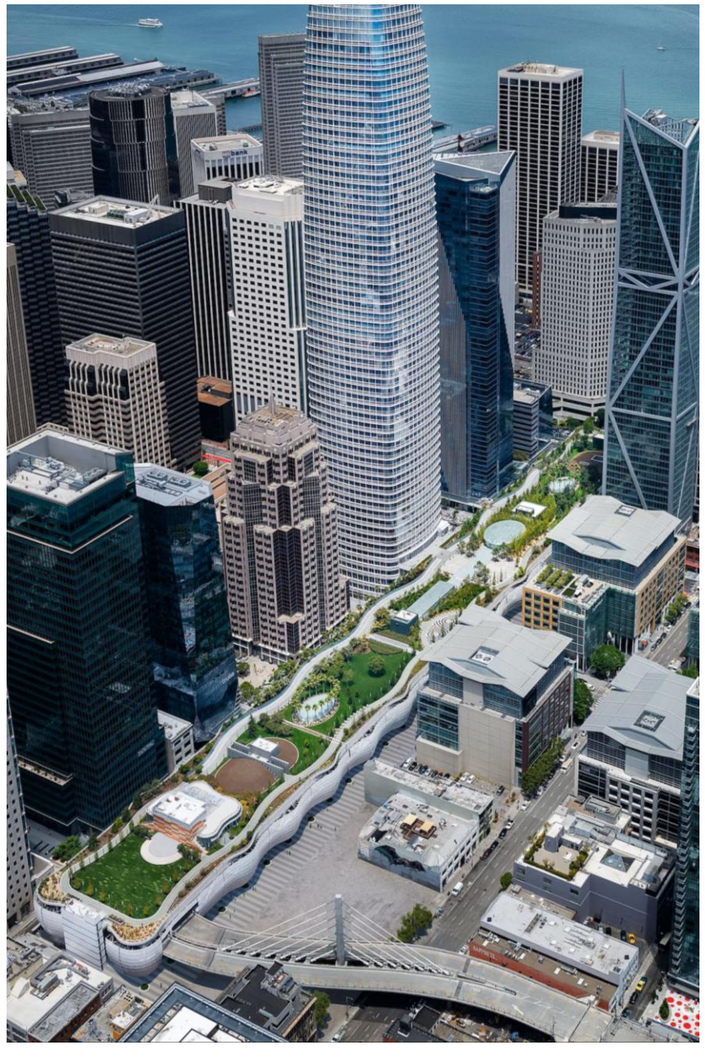


Figure 8. View bird's eye of the project.

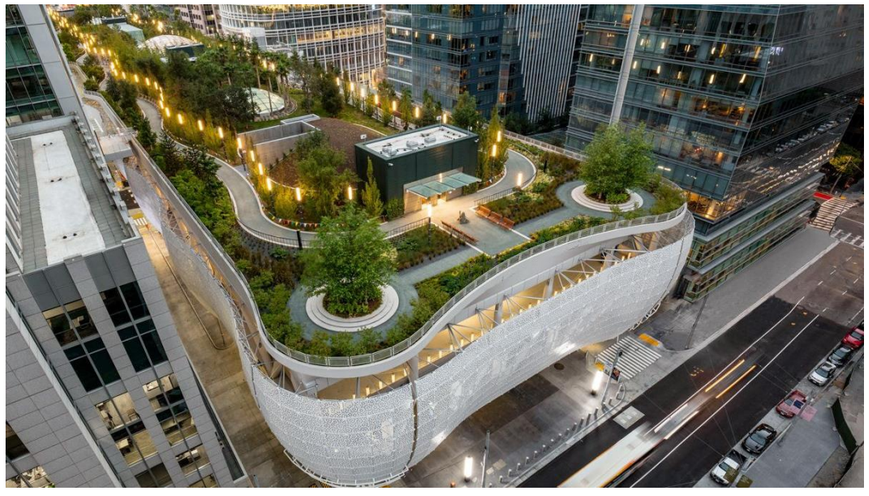


Figure 9. Image of the Park and the public function on the roof

Figure 10. Image of the skylight openings, the light columns.

II. Results

2.1.2 The chosen cases:

- **Project 4: Jewel Airport - Changi**

Jewel is a nature-themed entertainment and retail complex surrounded by and linked to one of the passenger terminals of Changi Airport, Singapore. It has the world's tallest indoor waterfall, the Rain Vortex, surrounded by a terraced forest setting. one of Asia's largest indoor gardens, spanning five stories and approximately 22,000 square metres. Jewel was Designed by a consortium of architects, led by Moshe Safdie in 2019. Jewel Changi consist of Public Gathering Space With Gardens, Retail, Hotel, Restaurants, and Entertainment For Travelers, Airport Community, and Local Residents.

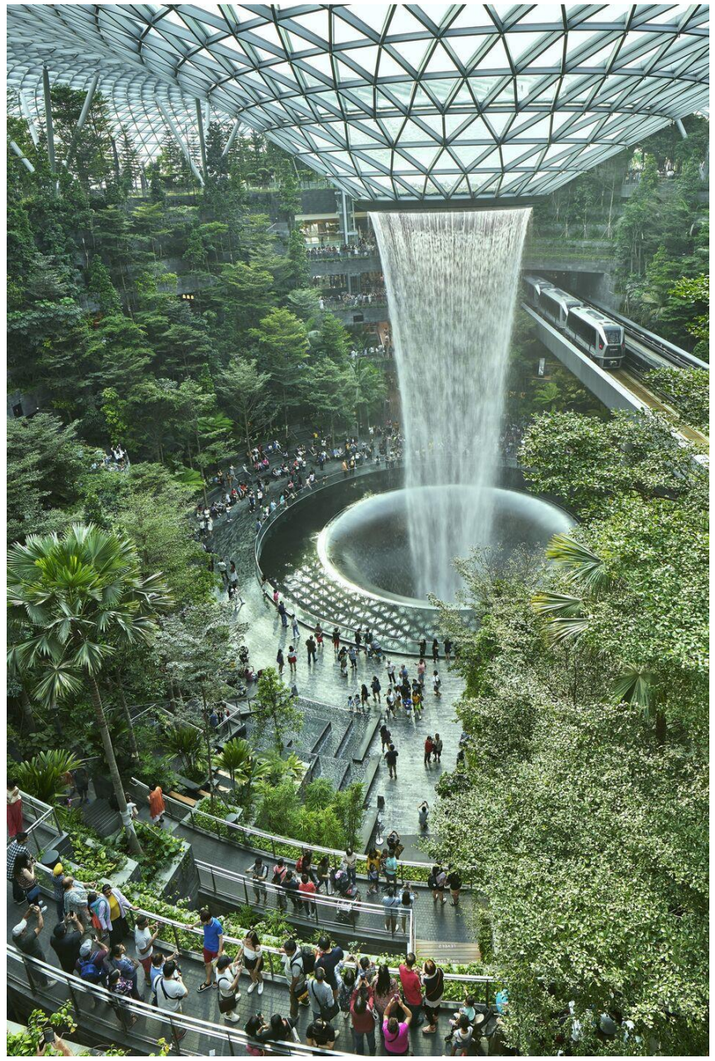


Figure 11. Image of the green public space and the waterfall of the project.

Figure 12. Image of one of the main entrances of the space

Figure 13. View bird’s eye of the project.

II. Results

2.1.3 Merging the criteria:

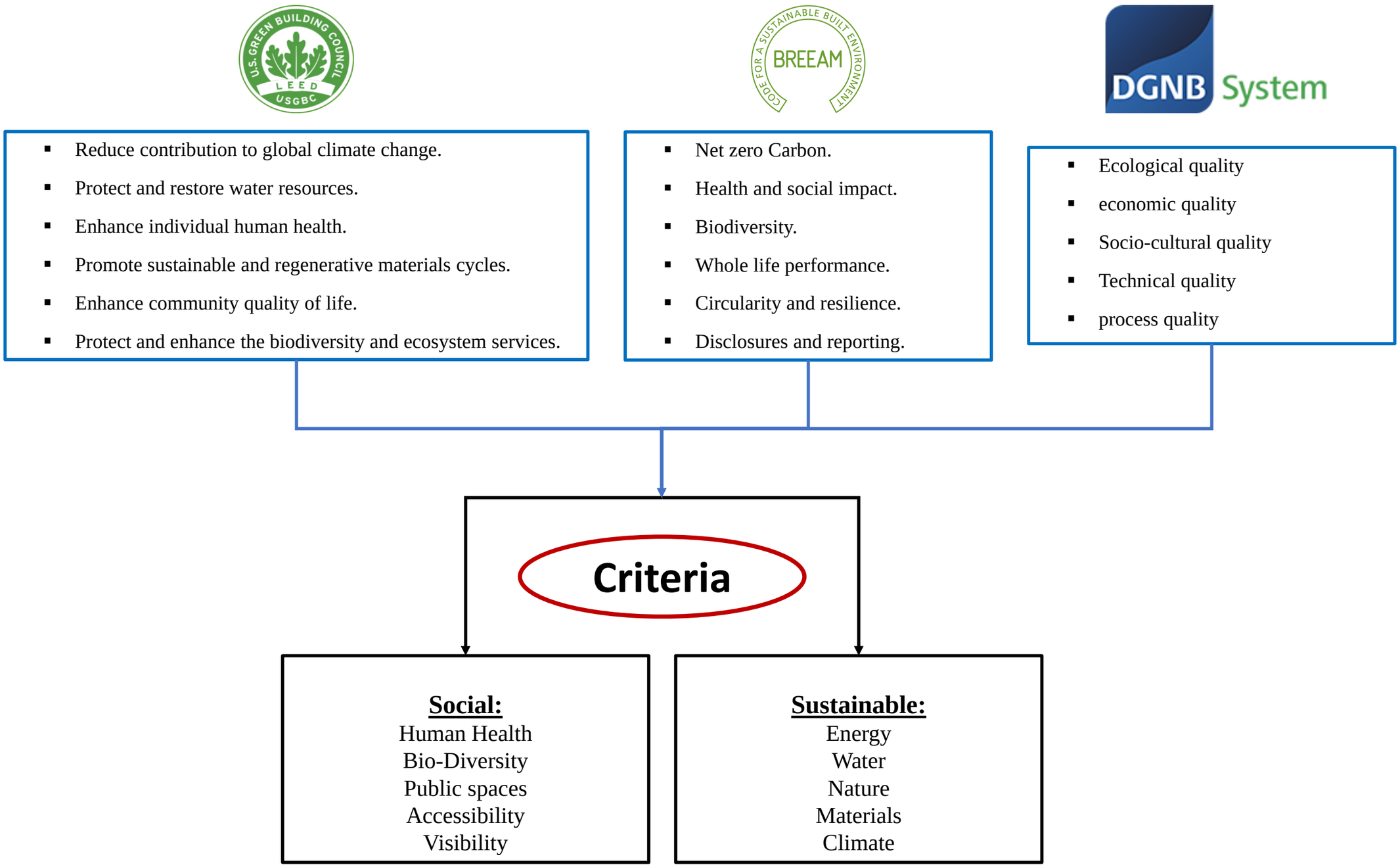


Table 1. An illustrative table of the approved criteria and the newly derived ones..

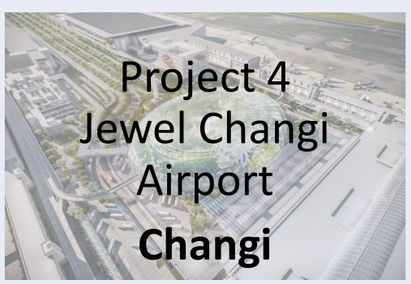
	Social				
	Human Health	Bio-diversity	Public spaces	Architecture	
				Accessibility	Visibility
	The canopy structure helps create a favourable micro-climate that shelters both plants and people.	Places for Human, Flora and Fauna.	**Open And Covered places contain:** • Shops • Cafes • Amenities sit.	people can use the new park and shops **all the time** through: • **Escalators** • **Lifts** • **Staircases.**	**See Diagram**
	• North and South elevations feature glazing to maximize views. • Vertical façade on East and West provide sun shading.	Providing a much-needed plant and insect ecosystem, an important habitat for nesting birds, and valuable green infrastructure.	**Covered place contains:** combines public and private spaces, offering stunning views of London and a new landmark for the capital. • Restaurants • Cafes	**Partially open through:** • **Escalators** • **Lifts** • **Staircases.**	**See Diagram**
	A central "light column" draws natural daylight down from the roof to all building's levels.	Places for Human, Flora.	**Open And Covered places contain:** • walking trails • picnic areas • Benches • fountains • children's areas • performance and art venues. • a 1,000-person amphitheatre.	**The park is fully accessible via:** • **Escalator** • **Elevator** • **Sky bridges** Almost 12 entry for this park.	**See Diagram**
	The aim to create a place where the people of Singapore interact with the people of the world through an indoor landscape and the 40-meter-tall waterfall.	Places for Human, Flora.	**Covered place contains:** • Airport facilities • Indoor gardens • Leisure spaces • Retail offerings • Restaurants • Cafes • Hotel	**Fully accessible via:** • **Escalator** • **Elevator** • **Sky bridges** Each axe is reinforced by gateway gardens that offer visual connections.	**See Diagram**

Table 2. The applications of the criteria within the studied cases in terms of the social aspects.

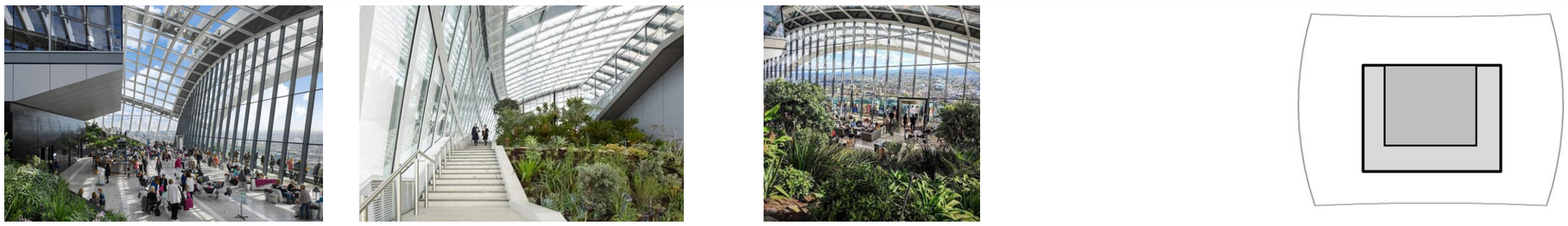
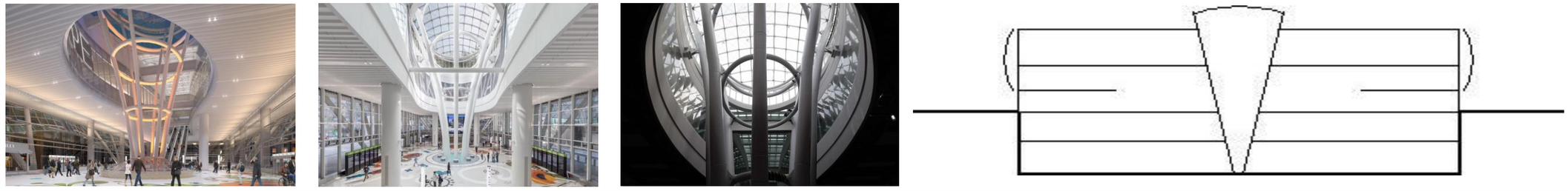
	Sustainable				
	Energy	Water	Nature	Materials	Climate
	• Collecting light for Greenery • minimise energy consumption.	• Collecting rain for natural irrigation • grey-water recycling.	The chosen species are indigenous to countries visited during the 19th century.	• Timber beams • Steel nodes • ETFE air cushions • Aluminium flashing.	• Naturally ventilated • Passive cooling measures.
	• A fuel cell tri-generation system produces simultaneous electricity • Roof mounted solar PV.		UK's **largest green wall.**	• Certified Sustainable Sourced concrete • structural steelwork. • FSC certified timber. • Recycling construction waste.	• Natural and renewable resources to reduce harmful emissions. • Noise and air quality monitoring.
	abundant use of natural daylight, reducing overall energy usage.	• Water and rainwater management. • The green roof build-up system consists of a root barrier and water drainage. • Treats all water from the neighbouring.	anchored by a lush 5.4-acre public park, a central gathering place with native trees and plants. The park will present a wide variety of Bay Area ecologies, from oak trees to a wetland marsh.	• Metal panels reflect lightness and buoyancy. • Angled steel columns. • Application of recycled materials to cut down on construction waste.	• Filters and processes the exhaust from the railways. • Geothermal • Natural ventilation • Radiant systems • Daylighting/shading solutions, • Thermal mass coupling.
		collects significant rainwater to be re-used in and around the building.	200 different species of trees and flora.	• steel members. • custom-shaped solid steel nodes. • glass panels. • Timber. • insulated opaque panels.	• The waterfall aids in the cooling of the landscape environment.

Table 3. The applications of the criteria within the studied cases in terms of the sustainable aspects.

II. Results

2.2.1 The social aspects:

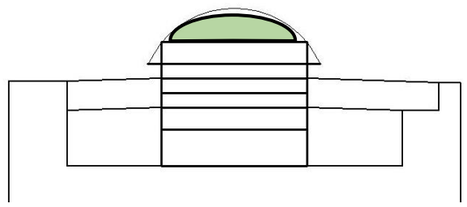
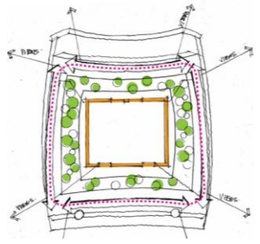
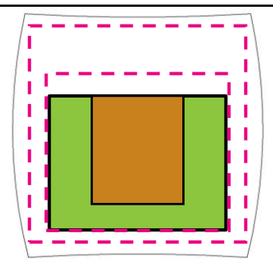
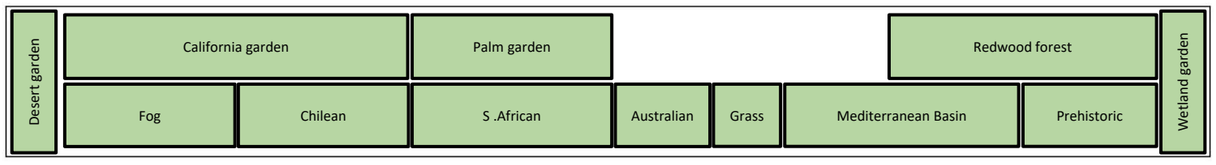
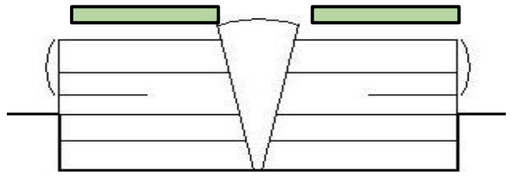
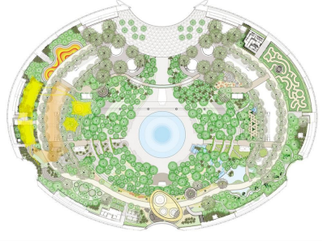
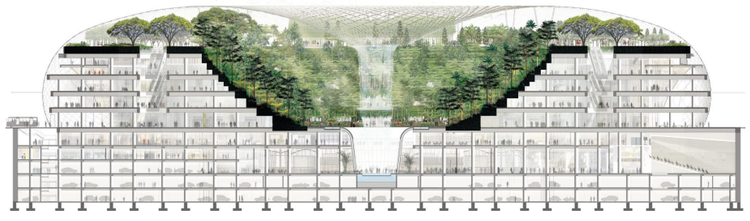
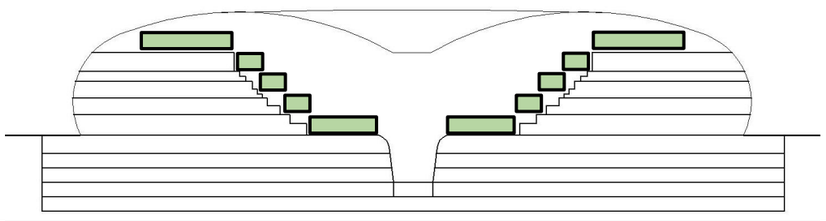
Table 4. A table shows the applications implemented within the studied cases in relation to the human health aspect.

Human Health	The main purpose of creating a garden or a green public space within an architectural building, regardless of the function of the building, is to create an appropriate natural climate capable of containing both plants and animals, sheltering and helping people to interact with each other, either by creating a structure that protects against weather changes, as in cases 2 and 4, or by enhancing the surrounding environment with passive measures like natural lighting and ventilation, as in cases 1 and 3, or semi-air-conditioned as in cases 2 and 4.
Case 1	
Case 2	
Case 3	
Case 4	

II. Results

2.2.1 The social aspects:

Table 5. A table shows the applications implemented within the studied cases in relation to the biodiversity aspect.

Biodiversity	From the images of the cases, it's clear that all of them followed the theory that "greener means more pleasant and clever." To emphasize this, most of the projects incorporated various forms of greenery in their public spaces. Some of them were based on specific historical moments, such as cases 1 and 3, which collected and planted local types of plants not necessarily related to their culture, but rather to their ancestors who lived in different regions during a certain period of time. Others were based on the meaning and identity of the project, like case 2, which has the highest and largest green space in that area, or case 4, which showcases a wide range of different local plants and trees to highlight not only the project's identity but also the place to the public.
Case 1	 
Case 2	   
Case 3	 
Case 4	  

II. Results

2.2.1 The social aspects:

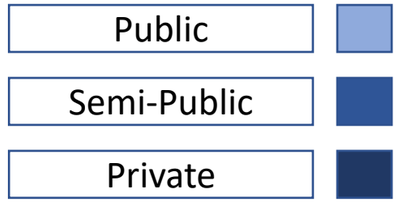
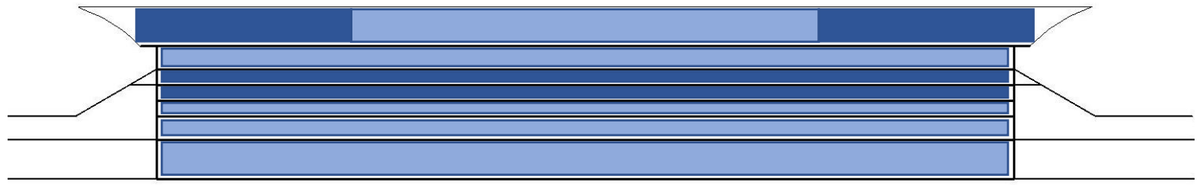
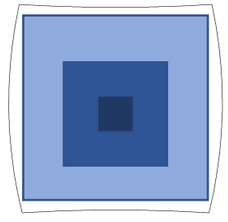
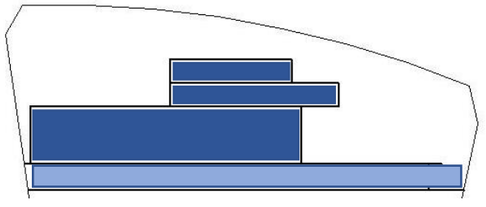
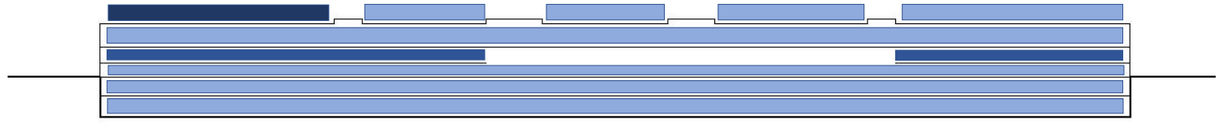
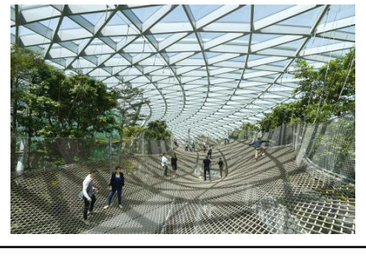
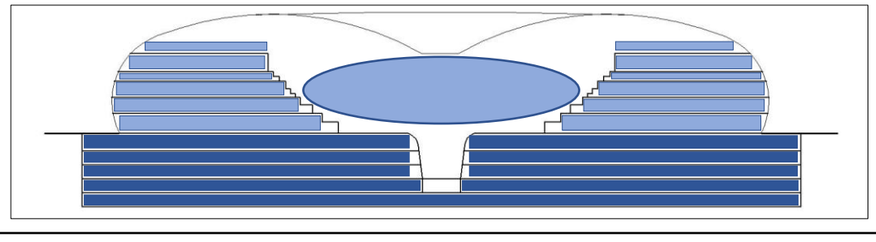


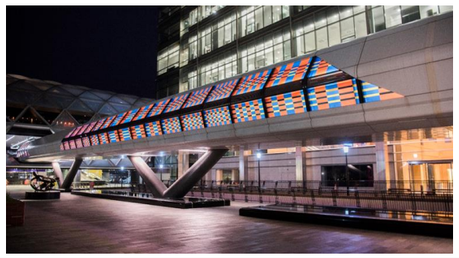
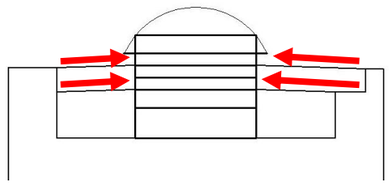
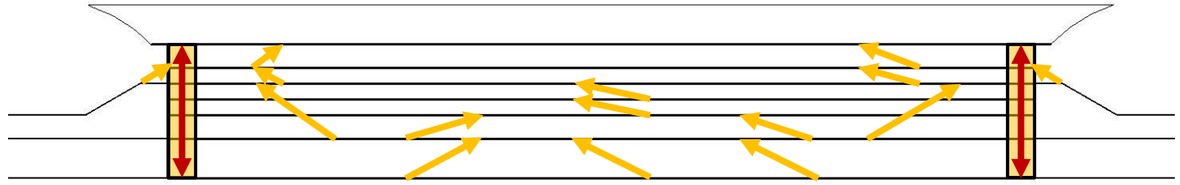
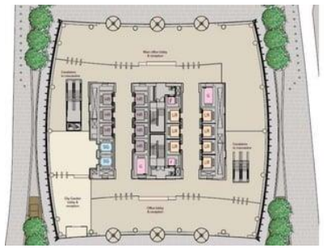
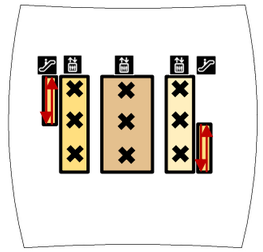
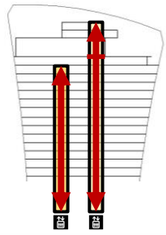
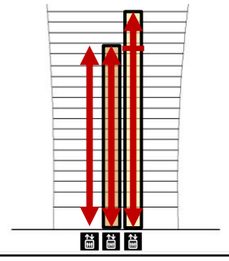
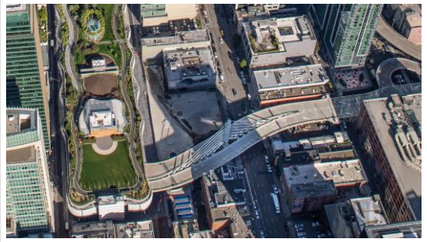
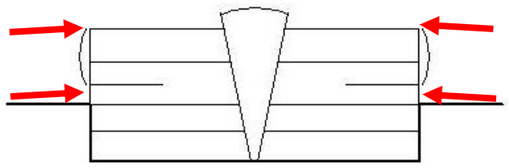
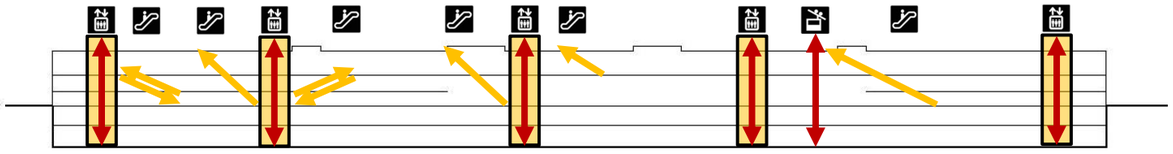
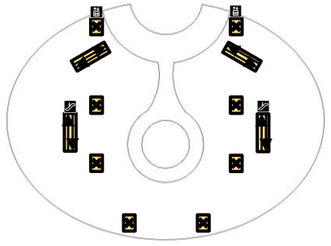
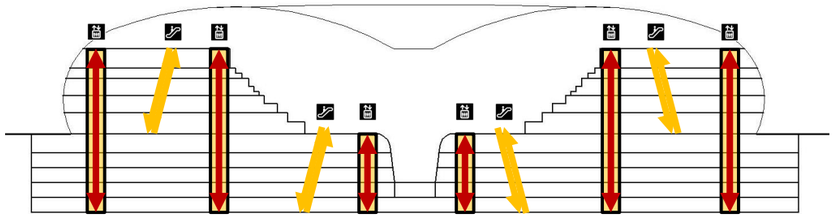
Table 6. A table shows the applications implemented within the studied cases in relation to public spaces aspect.

Public spaces	To gain a better understanding of the cases, the selected projects were categorized based on their function into three types: private, public, and semi-public. From the accompanying drawings, it is evident that most of the cases are public buildings, as a significant percentage of the built area is designated for public or semi-public spaces. However, the location of these spaces varies depending on the hierarchy of building functions. In cases 1, 2, and 3, green/public functions are situated on the building's top floor where the roof provides space for them. In contrast, in case 4, greenery is integrated into the space between the layers of the building, resulting in public places being distributed throughout the building.
Case 1	  
Case 2	   
Case 3	  
Case 4	  

II. Results

2.2.1 The social aspects:

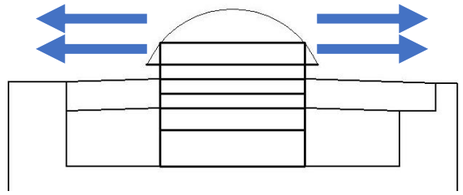
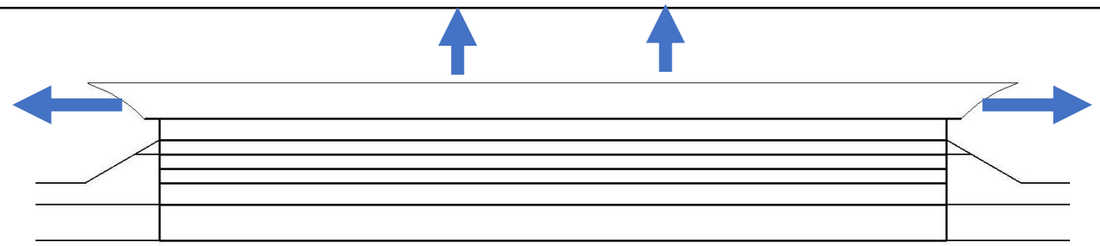
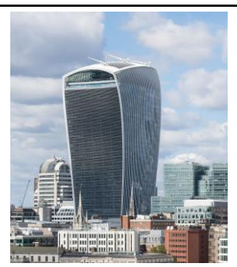
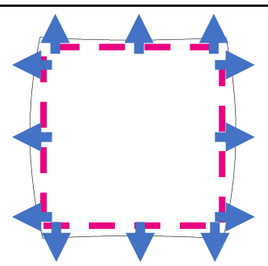
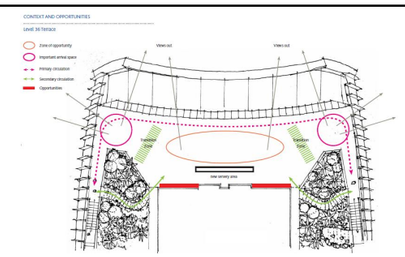
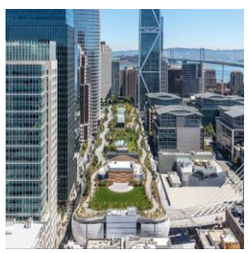
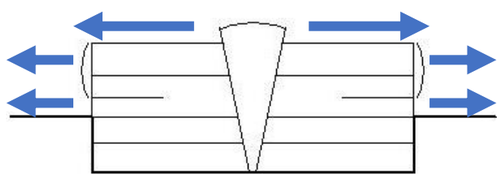
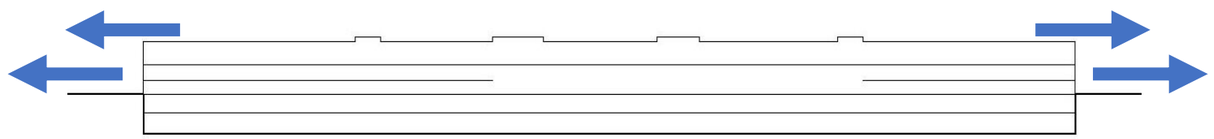
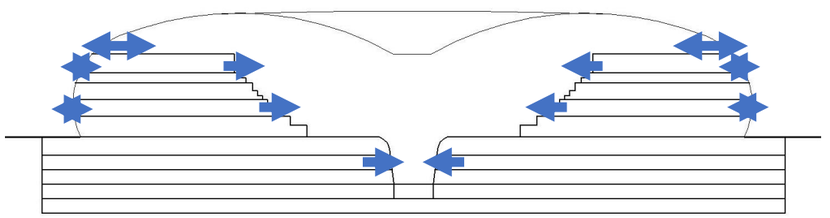
Table 7. A table shows the applications implemented within the studied cases in relation to the accessibility aspect.

Accessibility	Accessibility is a crucial factor that determines the success and efficiency of public spaces in engaging the public and enhancing their quality of life. In all four cases, providing convenient access to public spaces within the building is paramount. This can be accomplished by designing corridors that lead to the public spaces, as depicted in all four cases. Alternatively, separate bridges can be constructed to provide access to the public spaces without the need to enter the building, as seen in cases 1 and 3. Finally, specific paths within the building, such as those demonstrated in cases 2 and 4, can be created to facilitate access to the public spaces.
Case 1	  
Case 2	    
Case 3	  
Case 4	    

II. Results

2.2.1 The social aspects:

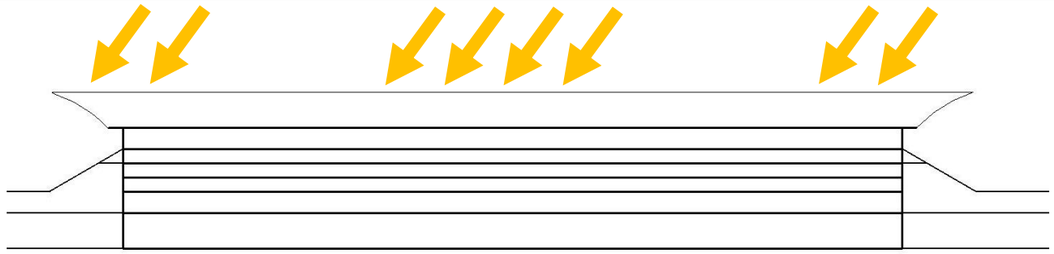
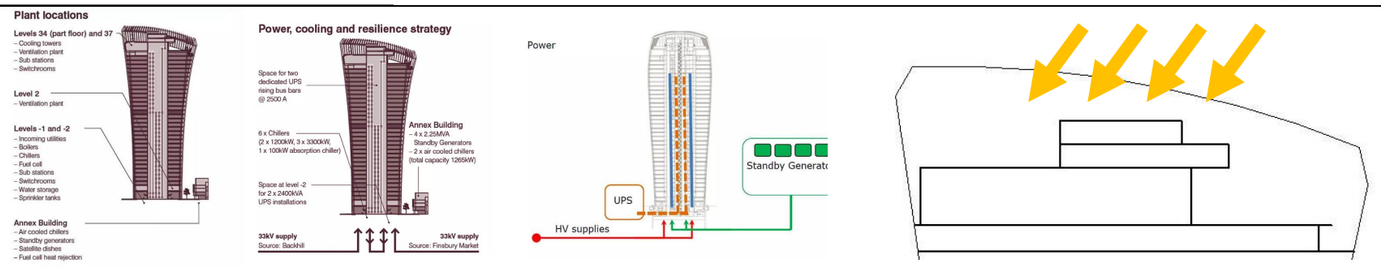
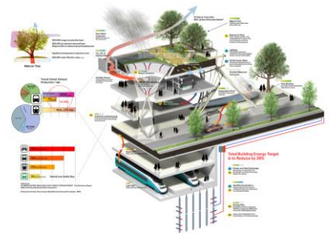
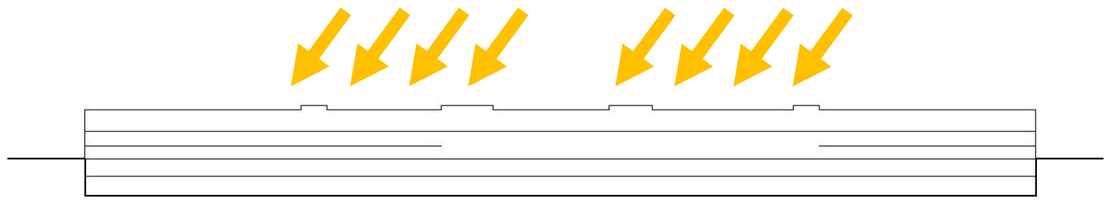
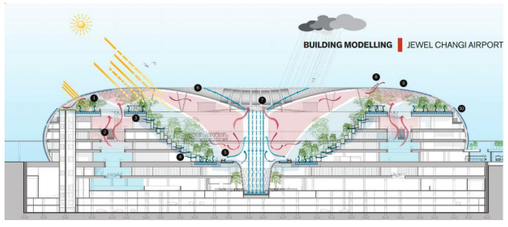
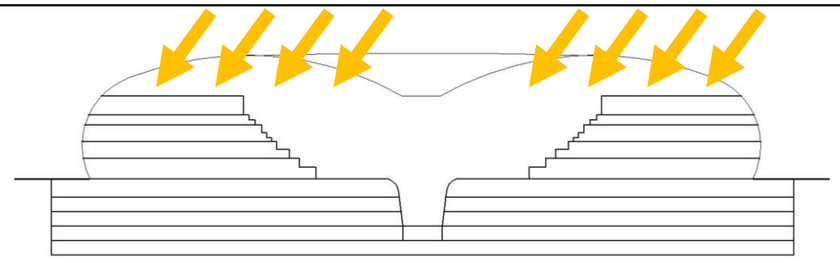
Table 8. A table shows the applications implemented within the studied cases in relation to the Visibility aspect.

Visibility	The drawings and photos of the cases reveal the extent to which public/green spaces are visible and accessible to the public, both from the inside and the outside of the building. In cases 1 and 3, the roof garden is easily visible from the ground floor level, thanks to the roof structure design (as seen in case 1) or facade panels (as in case 2), which include vents that allow views of the greenery on the upper levels. In contrast, the roof garden in cases 2 and 4 is less visible to the public. In case 2, the green spaces are located at a considerable height on the top of the skyscraper and are entirely enclosed, while in case 4, the green space is situated between two large halls in the airport, making it less accessible and visible to the public.
Case 1	  
Case 2	   
Case 3	  
Case 4	  

II. Results

2.2.2 The sustainable aspects:

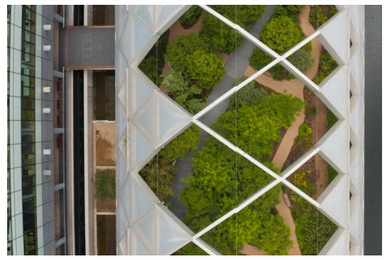
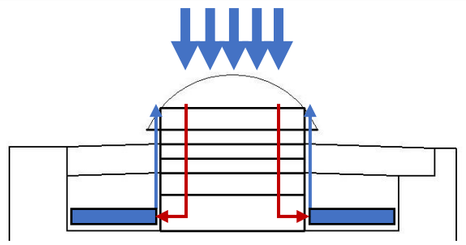
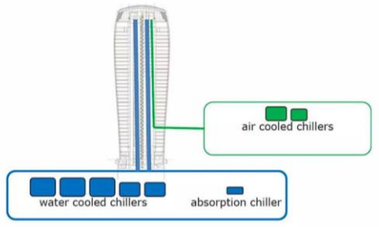
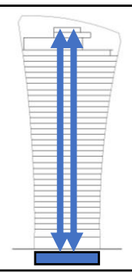
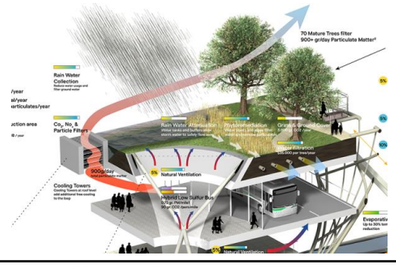
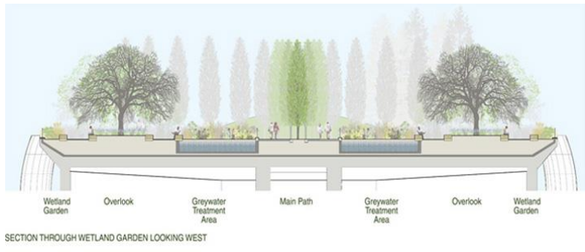
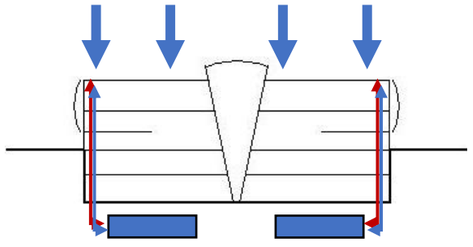
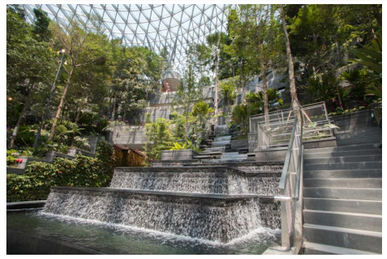
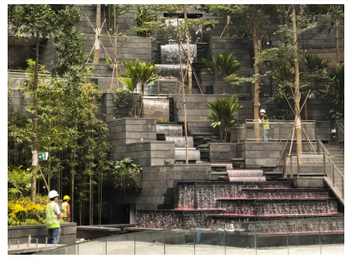
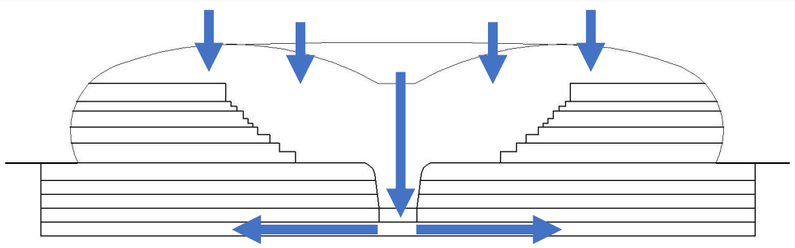
Table 9. A table shows the applications implemented within the studied cases in relation to the energy aspect.

Energy	Based on the location and region of each project, different energy principles and strategies were implemented to minimize energy consumption and maximize efficiency. For instance, in hot regions such as case 4, measures were taken to reduce solar gain by using special types of glass with unique covering, heating, and natural lighting benefits. Similarly, in case 3, a metal canopy was placed on the building facade to provide shading. In cases 1, 2, and 4, PV panels were installed to collect solar energy.
Case 1	
Case 2	
Case 3	 
Case 4	 

II. Results

2.2.2 The sustainable aspects:

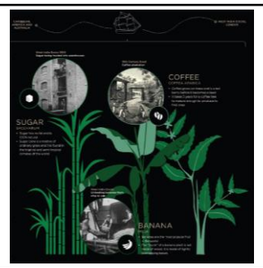
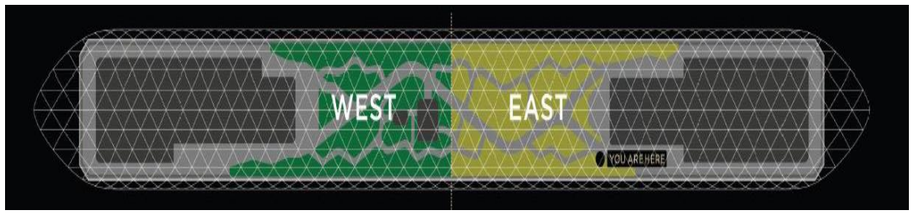
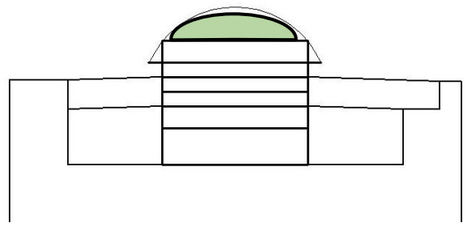
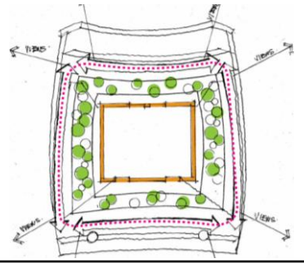
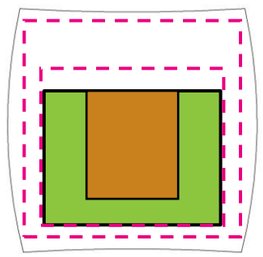
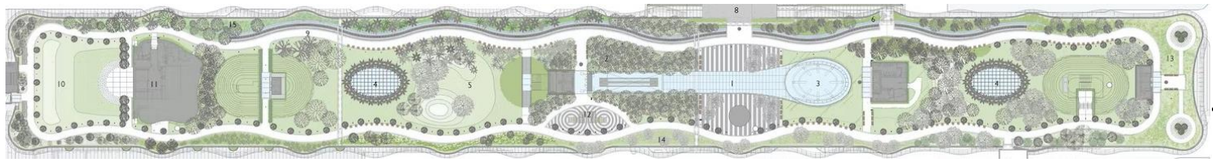
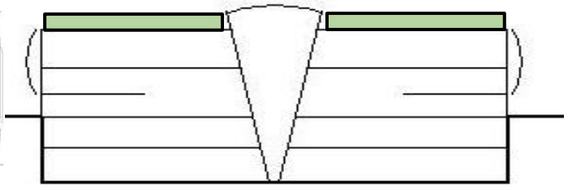
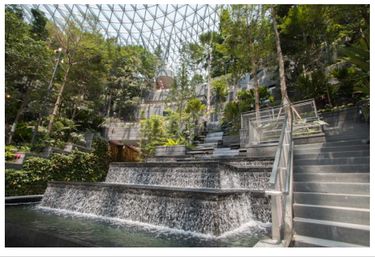
Table 10. A table shows the applications implemented within the studied cases in relation to the water aspect.

Water	The Water elements play a crucial role in these projects, with rainwater being stored and reused for various purposes such as watering plants, cooling, and aesthetic needs. Nearly all the projects incorporate rainwater harvesting, and some even filter and reuse grey water. The location and form of the water storage/manipulation vary according to the project's function, location, and design. Most projects store water on both ground and underground levels, with some even placing water storage directly under the building, as in cases 2, 3, and 4. Case 1, which is located on a river, utilizes water storage on both sides of the project.
Case 1	   
Case 2	  
Case 3	   SECTION THROUGH WETLAND GARDEN LOOKING WEST 
Case 4	   

II. Results

2.2.2 The sustainable aspects:

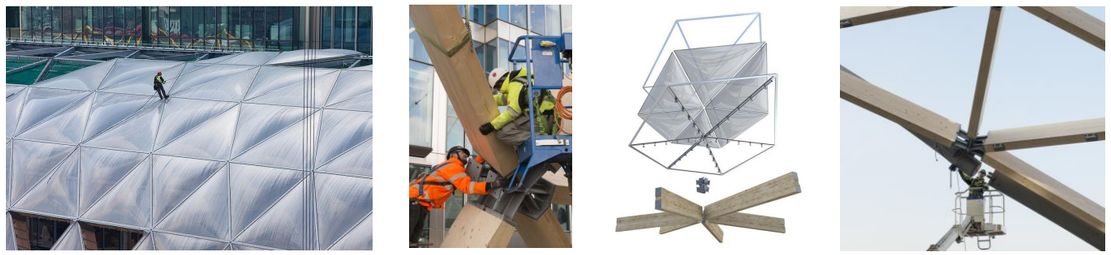
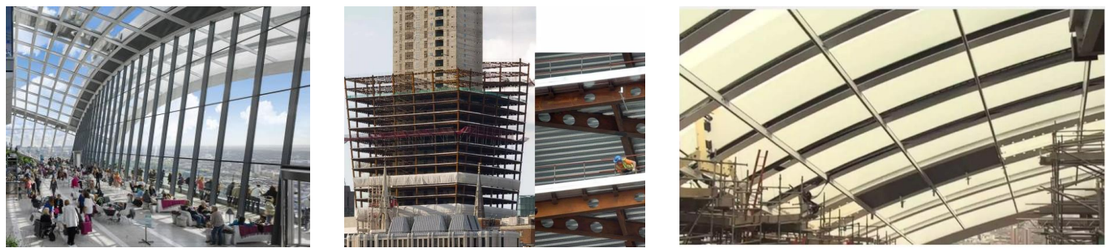
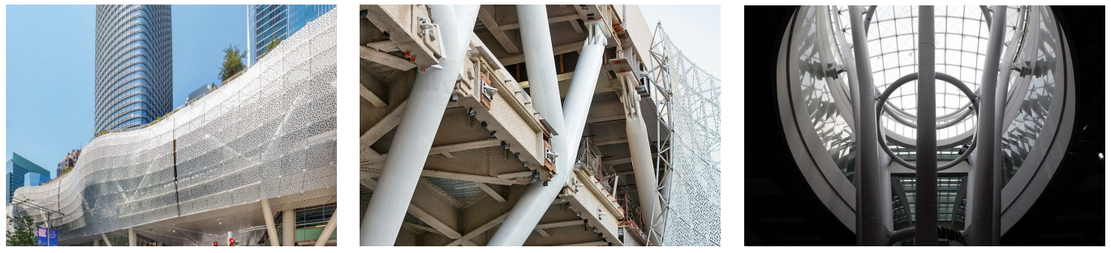
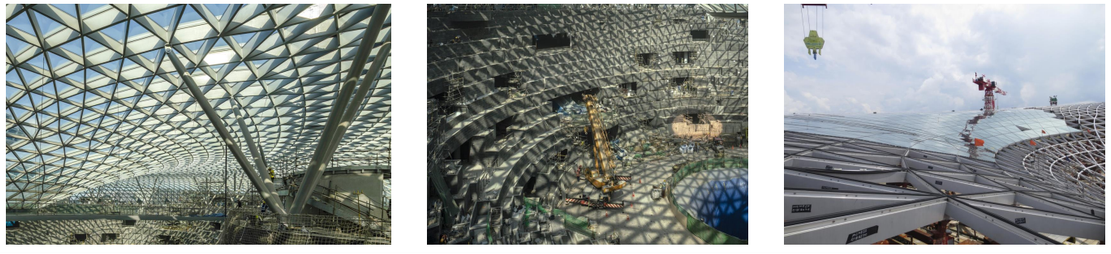
Table 11. A table shows the applications implemented within the studied cases in relation to the nature aspect

Nature	The presence of greenery is a crucial element in all of the cases studied. In some instances, the green component is limited to the roof garden, as seen in the first three cases. However, in other cases, greenery is incorporated throughout the building and can be observed from almost every angle, as is the case in the last example. While the species of plants used varies among the cases, it is important to select species that are well-suited to the prevailing climatic conditions of the architectural space. Additionally, when choosing plant species, it is essential to consider whether the architectural space is open or closed, mechanically or naturally ventilated, and the weather conditions that are likely to be present.
Case 1	   
Case 2	    
Case 3	  
Case 4	   

II. Results

2.2.2 The sustainable aspects:

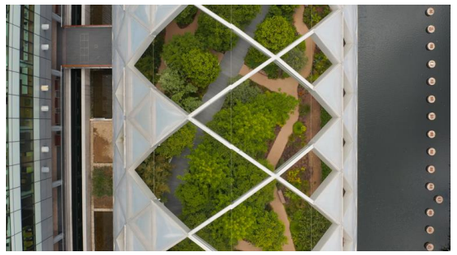
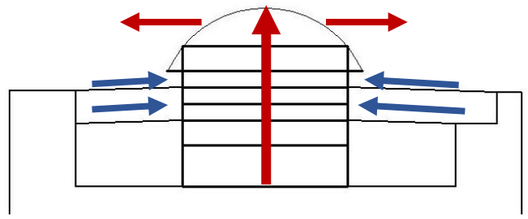
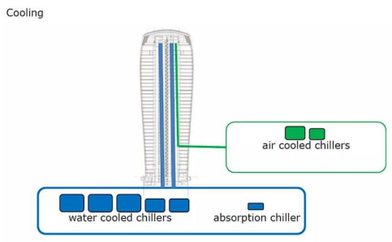
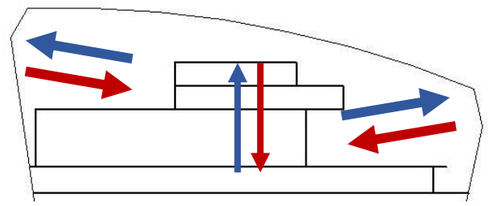
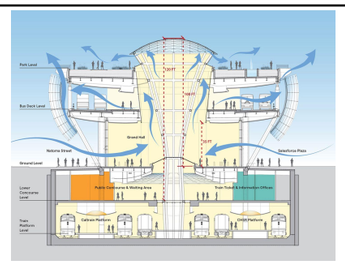
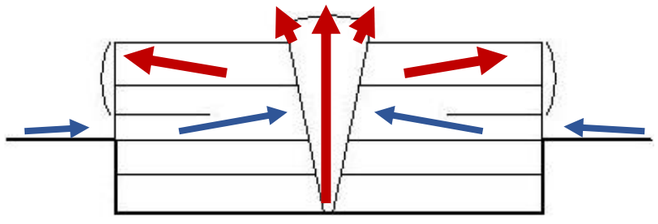
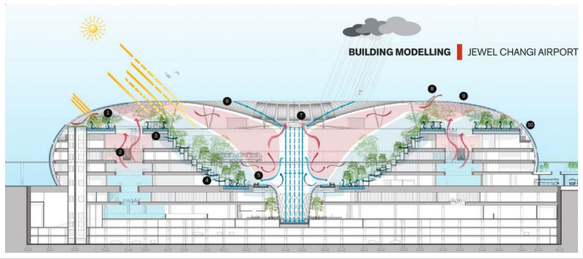
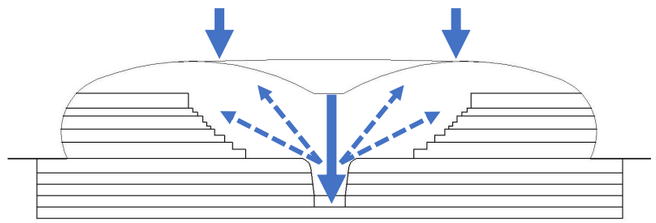
Table 12. A table shows the applications implemented within the studied cases in relation to the materials aspect.

Materials	While the materials used in each case differ, sustainability and the lifecycle of each material are essential themes present in all of them. In Case 1, the structure was constructed using timber and steel nods, and the canopy was made from ETFE air cushions composed of recycled plastic. Case 2 utilized sustainable concrete and steel for the structure, while the roof was covered by glass panels and timber beams. In Case 3, angled steel columns and concrete beams were used for the structure, with metal panels covering the façade and glass panels for roof openings. Finally, Case 4 employed steel members and nods for the structure, with a canopy constructed from glass and plexiglass
Case 1	
Case 2	
Case 3	
Case 4	

II. Results

2.2.2 The sustainable aspects:

Table 13. A table shows the applications implemented within the studied cases in relation to the climate aspect.

Climate	Each case has its own climate principles, with some employing passive cooling, others relying on air conditioning, and some utilizing a combination of both approaches. In Case 1, the park is naturally ventilated by roof openings and a passive cooling system that utilizes air flow controlled between the floors. In Case 2, the use of natural and renewable resources is prioritized to minimize harmful emissions. The space is air-conditioned through machines powered by renewable energy. In Case 3, natural ventilation, radiant systems, and daylighting/shading solutions are used to regulate the climate within the building. In Case 4, the waterfall serves as the primary centre of cooling, with natural light penetrating through the glass panels.
Case 1	 
Case 2	 
Case 3	 
Case 4	 

III. Conclusion

The range of aspects identified and examined in this research can be used as a toolbox to provide a critical evaluation of public buildings and as part of the methodology for designing new social and sustainable projects. The paper follows regulations, standards, and recommendations as formulated for instance by organizations such as LEED and BREEAM. To give an answer to the research question: What aspects can be utilized in the redesign of buildings to achieve vibrant -more specifically- sustainable and social public spaces? Therefore, the factors that play a role in this regard were investigated in two categories. The first category concerns the social aspects: Human Health, Bio-Diversity, Public spaces, Accessibility, and Visibility. While the second category concerns the sustainable aspects: Energy, Water, Nature, Materials, and Climate. These were the basic aspects with which 4 case studies were examined to create vibrant areas within public buildings.

For example, the factor of ease and diversity of accessibility can cause an increase in the demand for these public architectural spaces if it is combined with the process of showing the function of those areas in a correct manner, as is the case in the first studied case in the public building, whose roof garden is visible through the ventilation and lighting vents that located within its coverage. On the other hand, it is open to all segments of society during the week through the various entrances within the project, including stairs, escalators, and adjacent bridges that connect the building directly to the surrounding. Quite the opposite, in the second case in the office tower, which opens the doors of its garden located on the upper floor to the public at specific times during the week, while its garden is hidden due to its high level and the need to enter the office building first in order to access it, not to mention the limited entrances leading to it, which is limited to some elevators only. Also, the biological diversity factor can have an impact on the design factor and climate control prevailing within those architectural spaces, and therefore the relationship between these two factors has been considered and understood. For example, in the fourth case, wide varieties of local plants were collected within the enclosed space in order to display the identity of the place to visitors and to achieve social interaction between local residents and foreign visitors. Therefore, a special strategy had to be adopted to control the climate of this architectural space due to climate fluctuations in that region and the necessity of preserving the diversity and wealth of green cover.

In conclusion, this paper aims to be a guide for designing green and vibrant spaces within public buildings and also to determine whether more contemporary and creative ways to design these in-between and vital areas can be obtained, by finding relationships linking the aspects referred to within the research to each other in a way to achieve architectural public spaces that are visible, easily accessible, naturally lit and energy efficient in terms of collecting and storing the energy, and finally capable of containing and protecting the living and non-living species within it. There are wide-ranging issues associated with the vitality and openness of the building that needs to be examined, although the strategies discussed show ways to provide dynamic and in-between spaces that are in line with the new sustainability requirements and climatic conditions of our life. I suggest that future research could focus on developing new strategies for integrating sustainable and social aspects into public buildings. Moreover, other research is needed to understand the specific challenges associated with designing public spaces in different types of buildings.

III. Conclusion

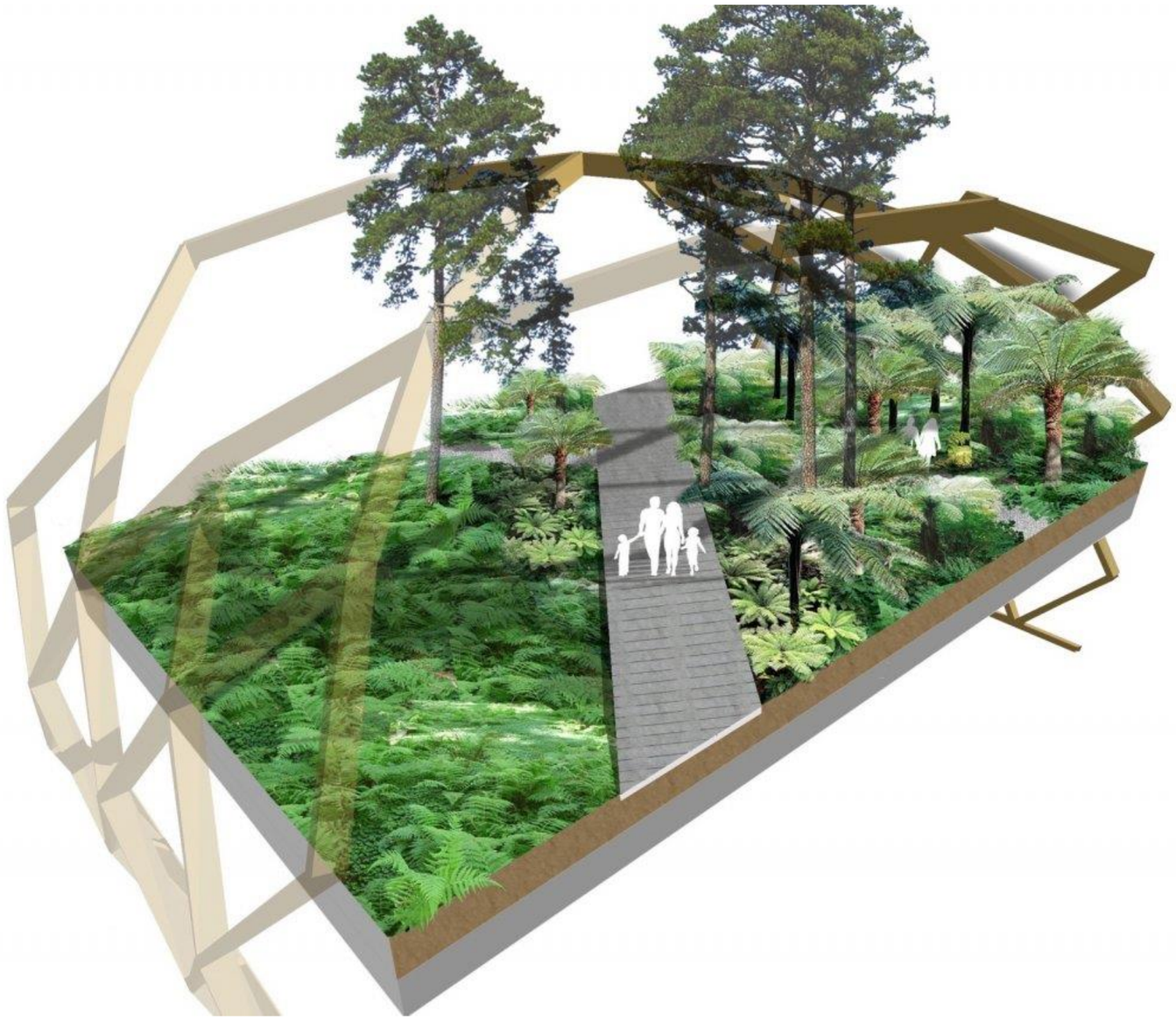


Figure 14. An imaginary collage of the atmosphere to be achieved during the design process.

IV. Discussion

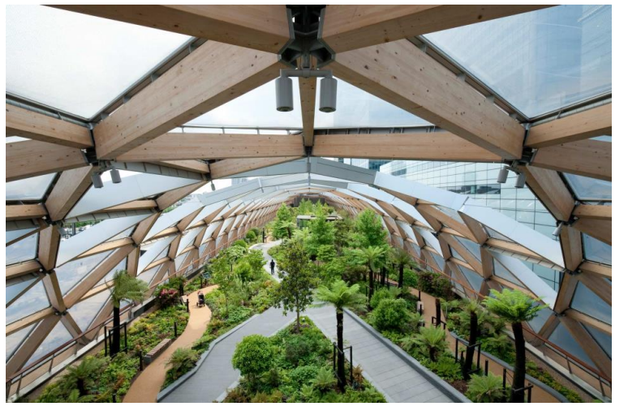
Although this study provides valuable insights into the implementation of vibrant and sustainable social public spaces, there are several limitations that should be considered. Firstly, the study was conducted in a single public building, which may limit the generalizability of our findings. Additionally, time constraints meant that we were unable to conduct a longitudinal study to assess the long-term impacts of the design changes on the building's vibrancy. Finally, the study relied on self-reported data, which may have introduced bias into our findings. Future research in this area should aim to address these limitations by conducting larger, longitudinal studies and utilizing objective measures of vibrancy and sustainability.

V. Appendix

Project 1: **Crossrail Place - London**
Project 2: **Fenchurch street - London**
Project 3: **Salesforce Transit Centre - San Francisco**
Project 4: **Jewel Airport - Changi**

Project 1: **Crossrail Place - London**

Crossrail Place is a complex built in the North Dock of the West India Docks in London's Canary Wharf. It was designed by Foster + Partners and Arup in 2015. The complex has a railway station, shops and a cinema, as well as a roof garden, which is open to the public. Its roof is the largest timber project in the United Kingdom. The area around the station is designed to encourage people to use the new park and shops at the weekend - as well as during the week - creating a lively new community facility. Four levels of shops, cafes and amenities sit above the underground station.



Social aspects

- Human Health

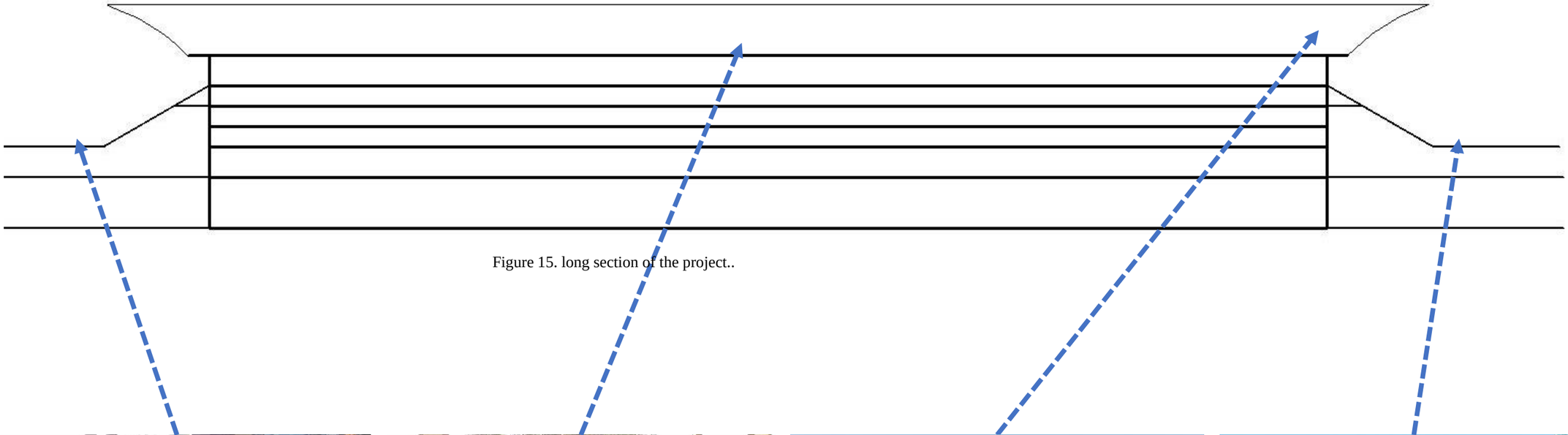


Figure 15. long section of the project..

Figure 16. The public path and functions of the ground floor

Figure 17. café on the garden roof.

Figure 18. the timber construction of the roof.

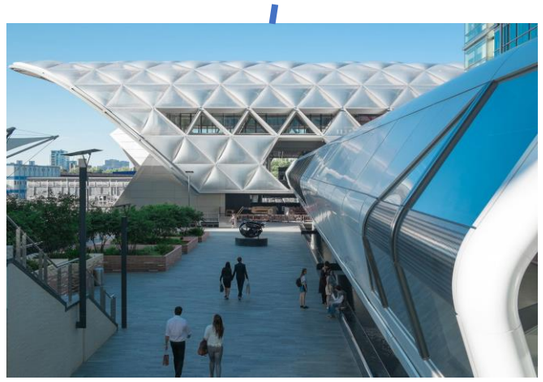


Figure 19. the public space around the project.

Social aspects

- Biodiversity

Figure 20. the position of the greenery on the garden roof.

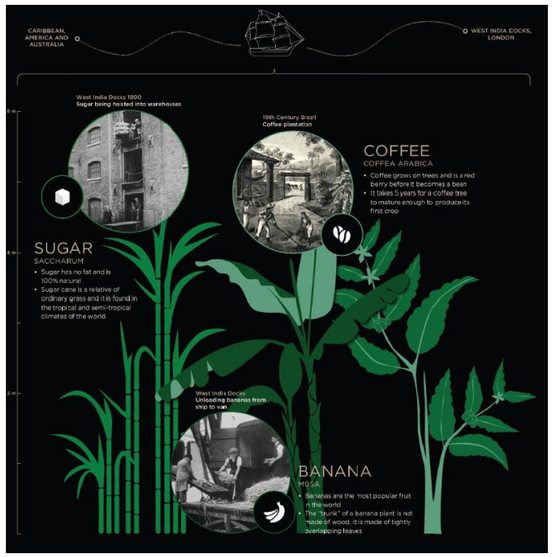


Figure 21. The western plants species on the roof.

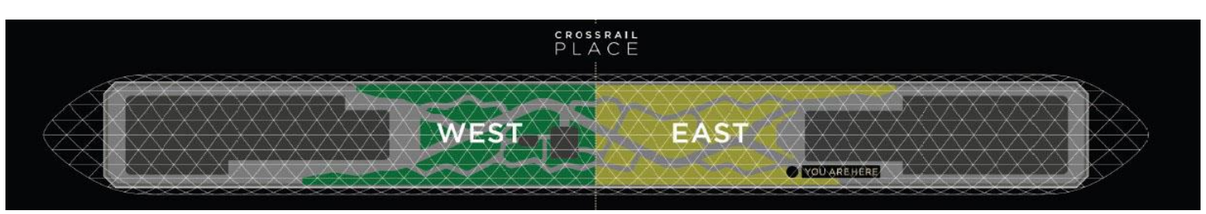


Figure 22. The plan of the roof.

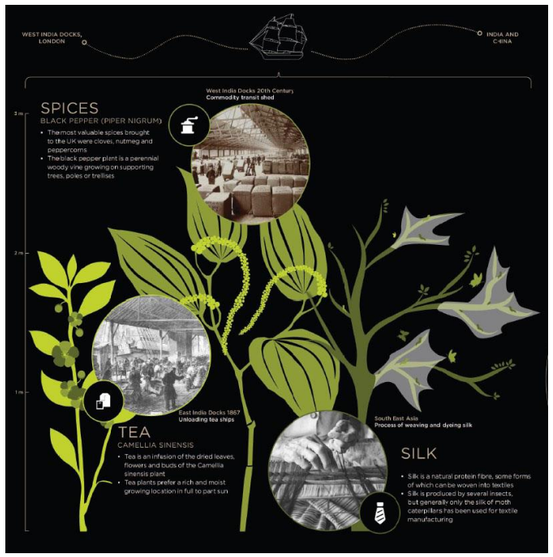


Figure 23. The eastern plants species on the roof.

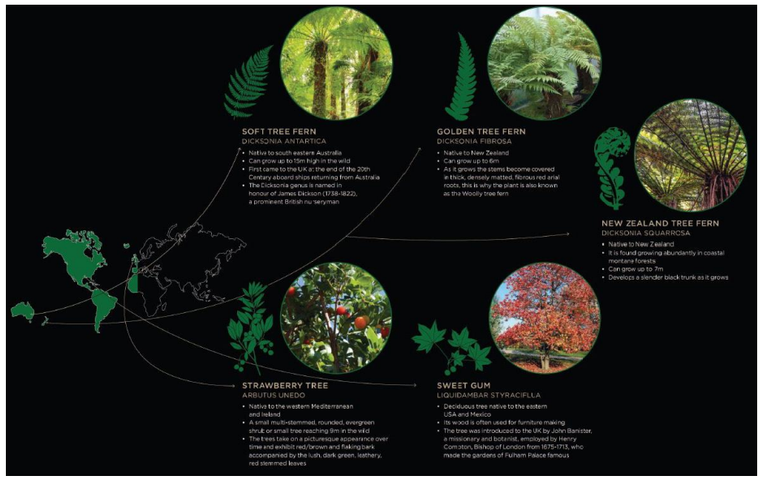


Figure 24. The western trees species on the roof

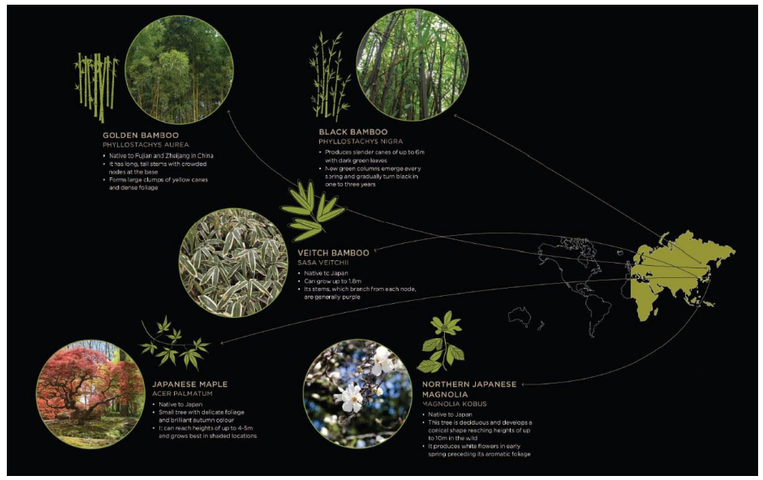


Figure 25. The eastern trees species on the roof

Social aspects

- Public spaces

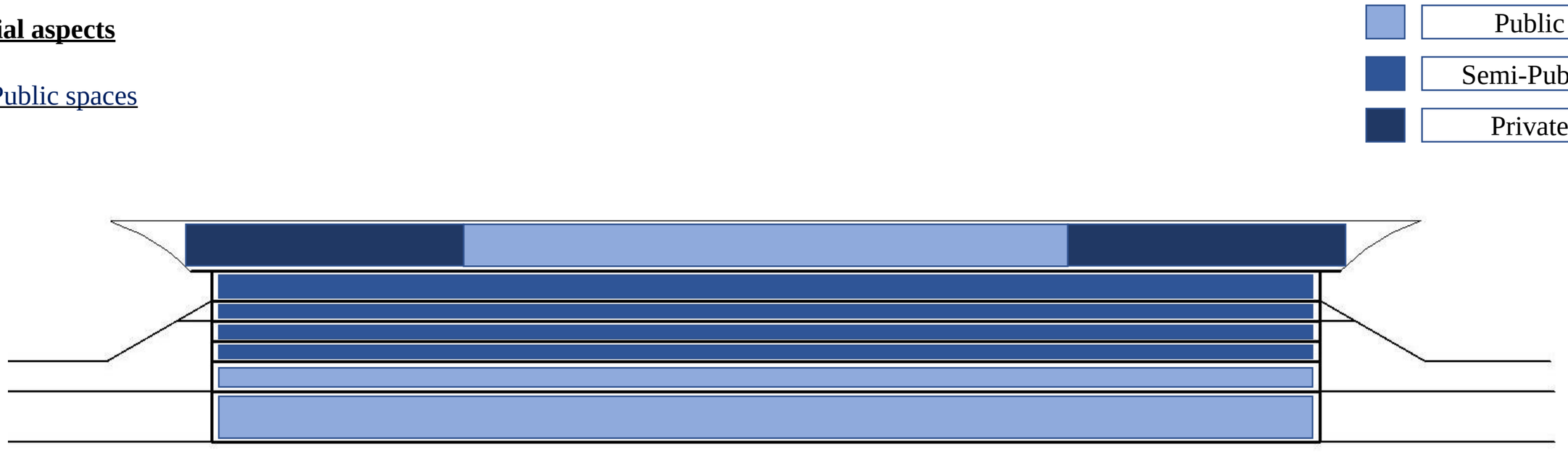


Figure 26. A long section shows the categories of the functions within the floors.

Figure 27. public passageway on the roof

Figure 28. sitting places on the roof

Figure 29. cafe/bar on the roof gareden.

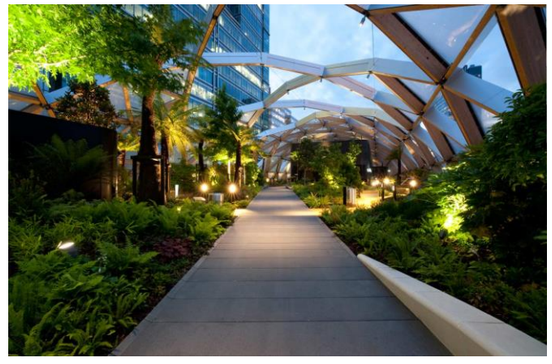


Figure 30. passageway for public

Figure 31. floor plan of the roof shows the positions of the public functions.

Social aspects

- Accessibility

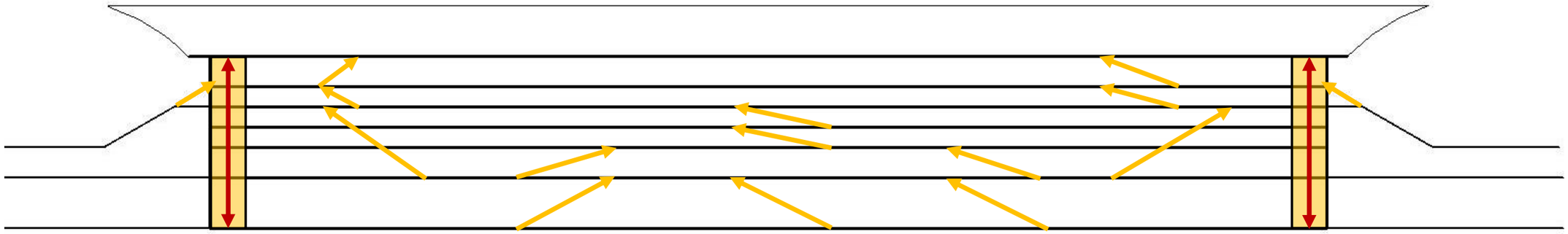


Figure 32. long section shows the vertical transition within the building.

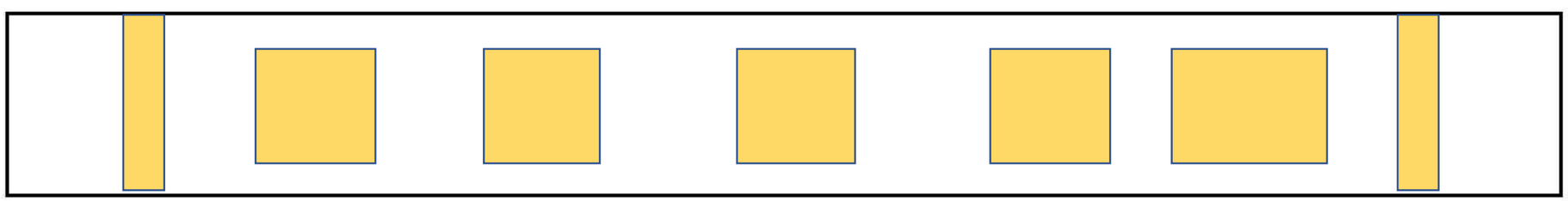


Figure 33. Floor plan of the project shows the positions of the vertical transition.

Social aspects

- Accessibility

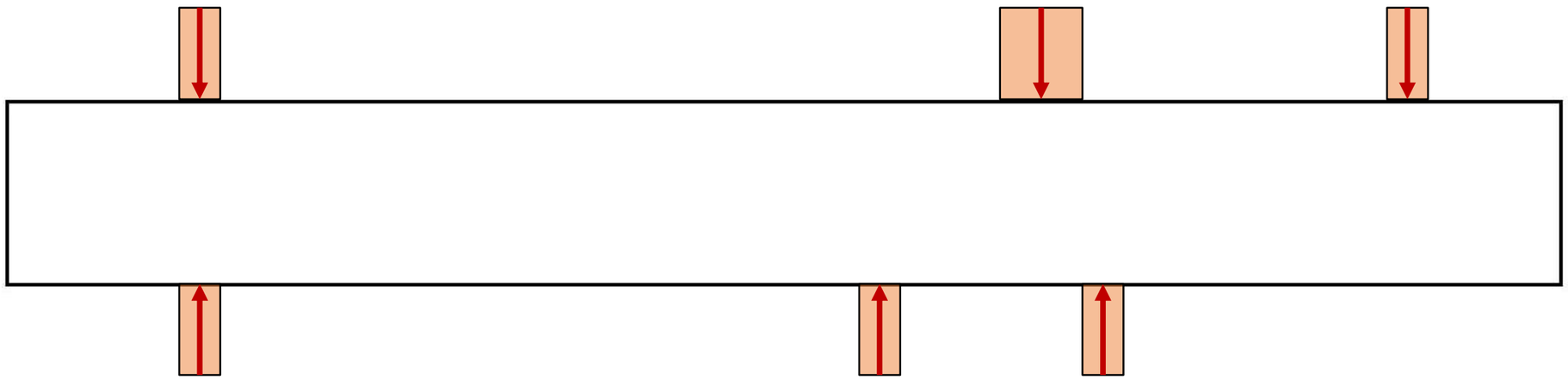


Figure 34. plan shows the position of the entry points of the building.

Figure 35. Bridge that connect the building with the surroundings.

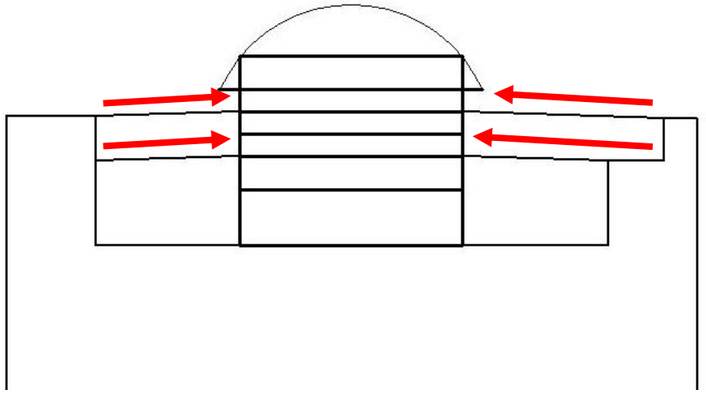


Figure 36. short section shows the paths of the bridges that lead to the project.

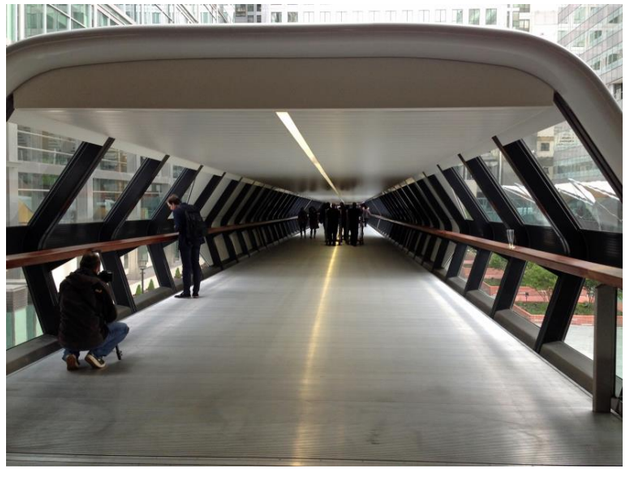


Figure 37. Bridge that connect the building with the surroundings.

Social aspects

- Visibility

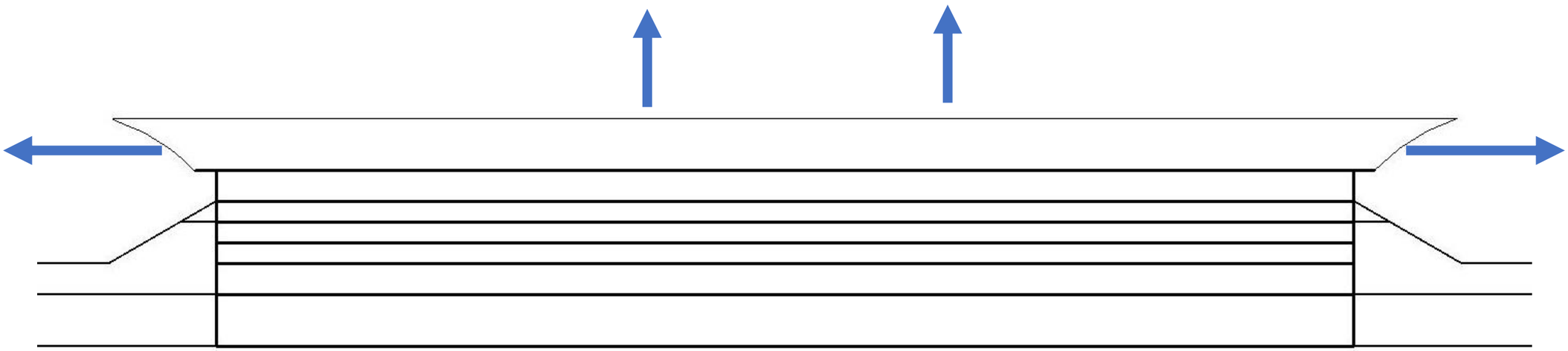


Figure 38. long section shows the axes of vision from the roof.

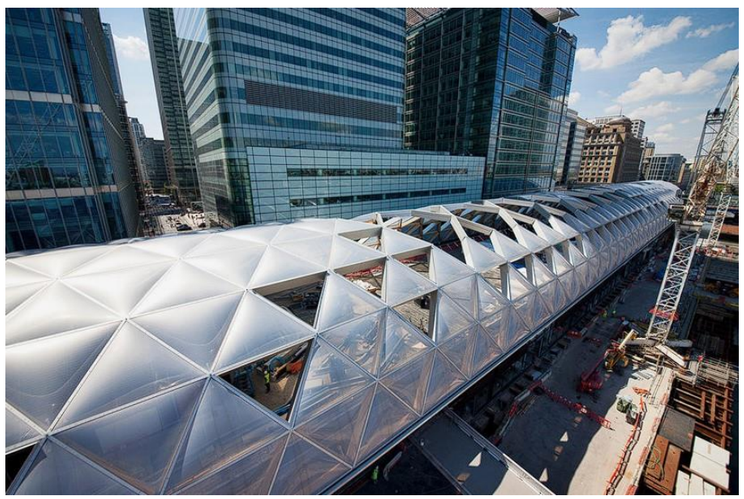


Figure 39. The openings within the canopy of the roof.

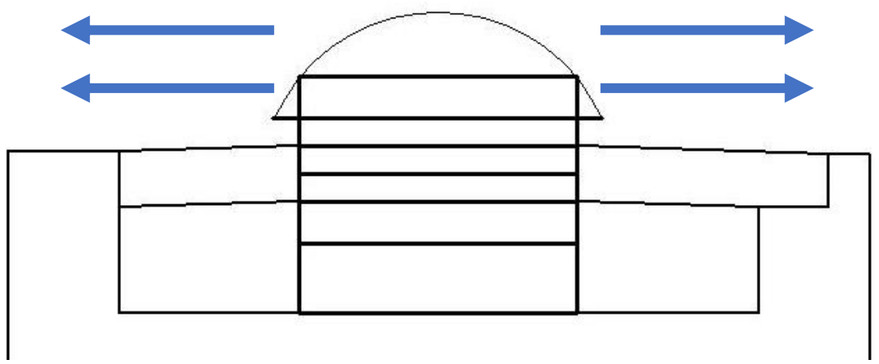


Figure 40. Short section shows the axes of vision from the roof.

Figure 41. View of the building from one of its sides on the adjacent river.

Sustainable aspects

- Energy

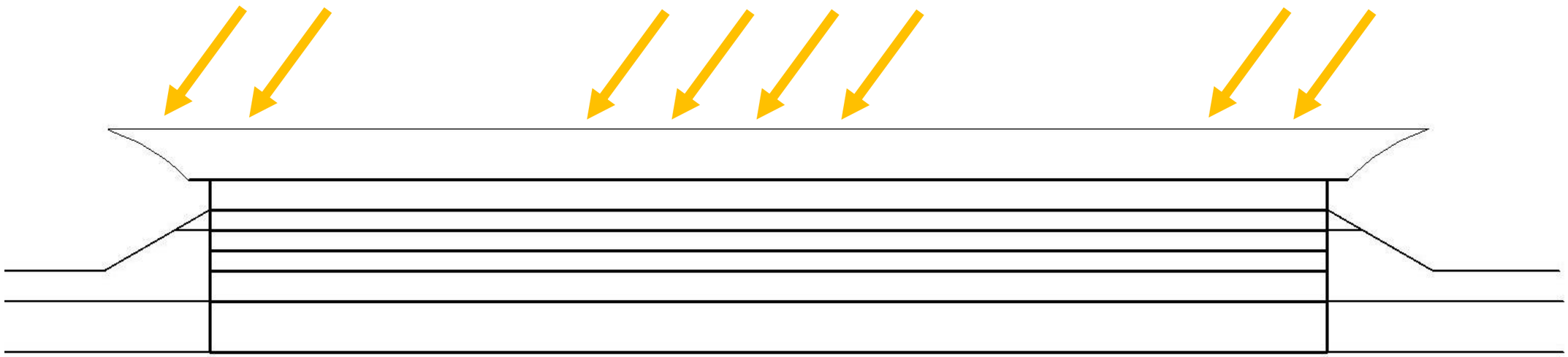


Figure 42. Long section show the natural light access points to the roof canopy.

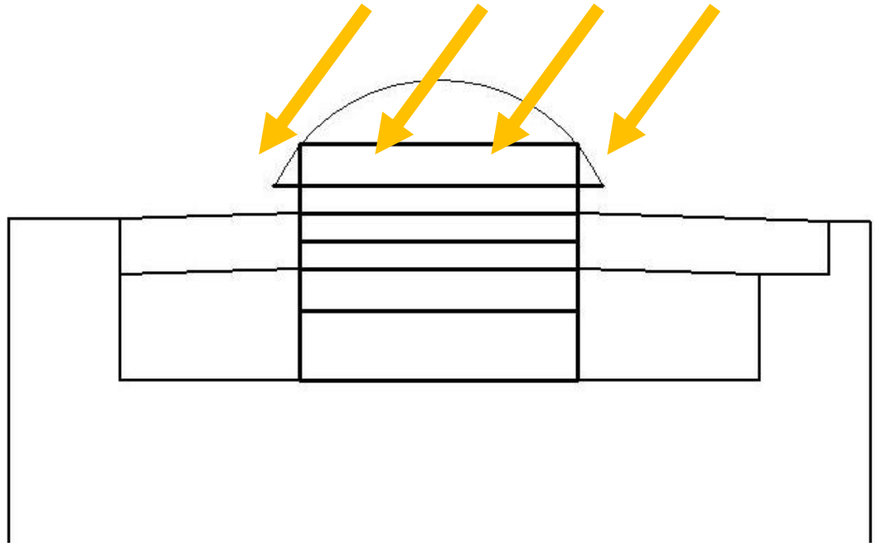


Figure 43. Short section show the natural light access points to the roof canopy.

Sustainable aspects

- Water

Figure 44. The places where rain water is collected.

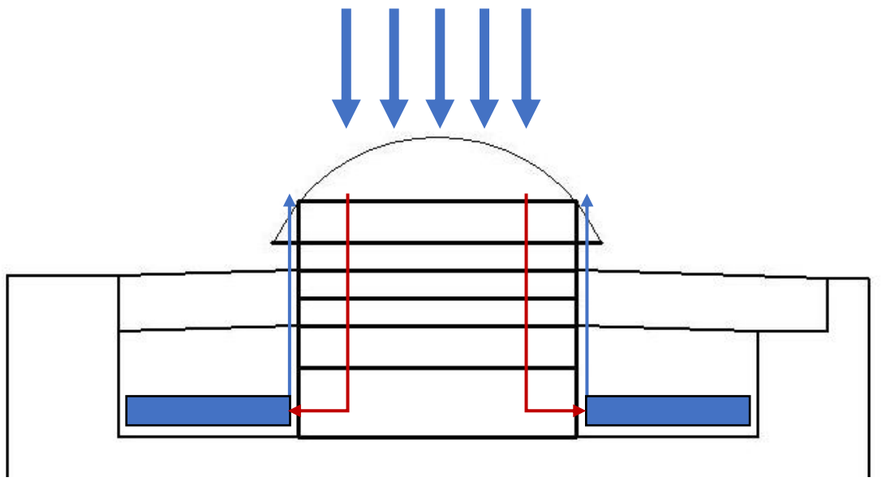


Figure 45. diagram shows the process of storing and reusing the rainwater.

Figure 46. The places of the water storages on the both sides of the building.

Sustainable aspects

- Nature

Figure 47. Floor plan shows the position of the greenery on the roof.

Figure 48. View of the roof garden.

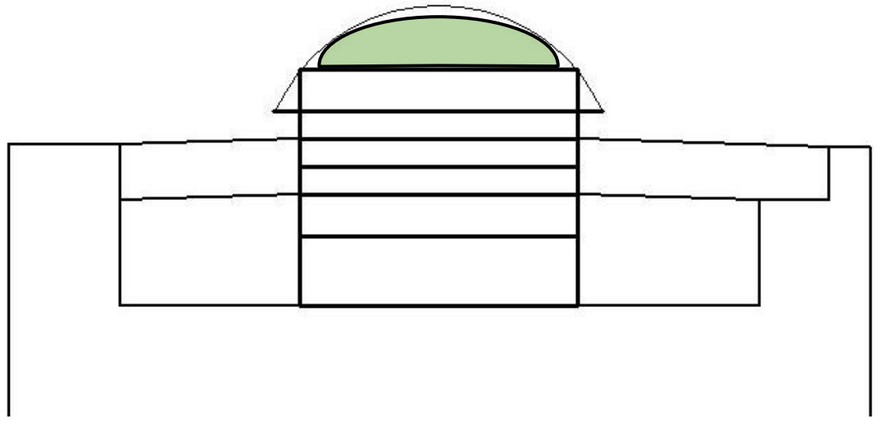


Figure 49. Short section show where the greenery is located in the building.

Figure 50. view of the roof garden.

Sustainable aspects

- Materials

Figure 51.

Figure 52.

Figure 53.

Figure 54.

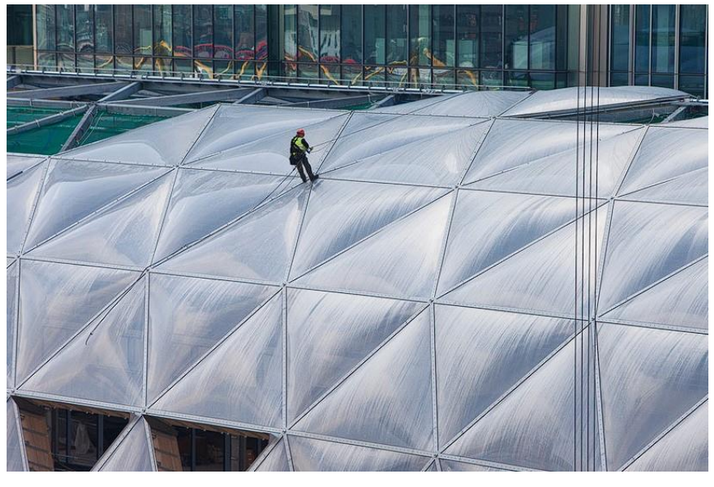


Figure 55.

Sustainable aspects

- Climate

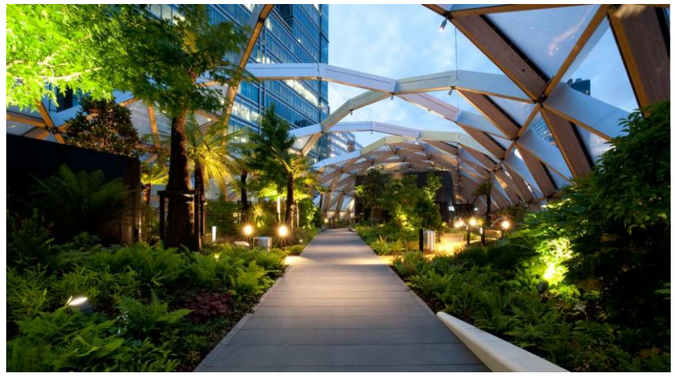


Figure 56.

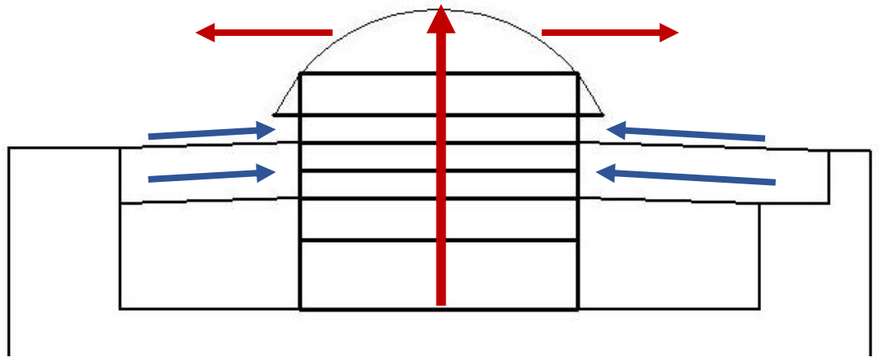


Figure 57.

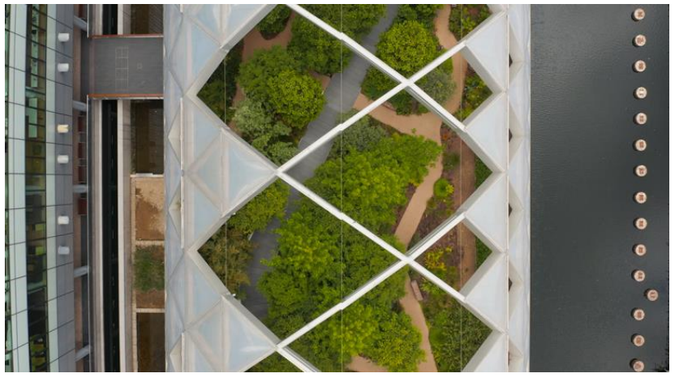


Figure 58.

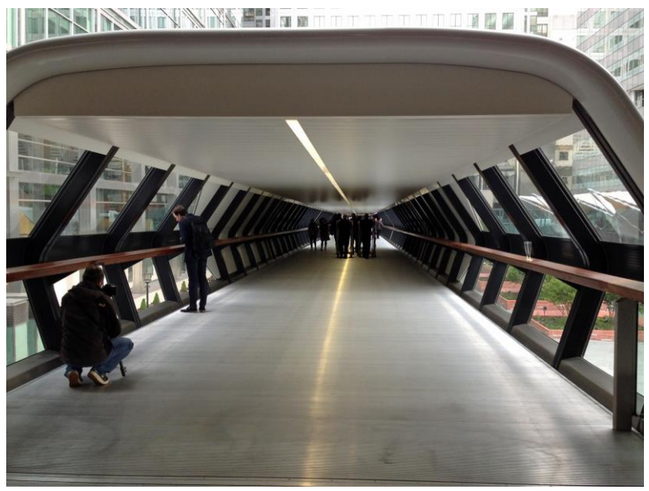


Figure 59.

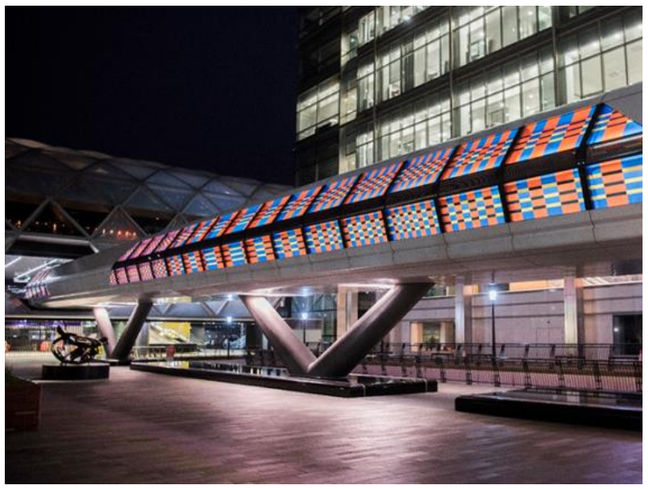


Figure 60.

Project 2: **Fenchurch street - London**

20 Fenchurch Street is a commercial skyscraper in London. the building takes its name from its address on Fenchurch Street, in the historic City of London financial district. It has also been nicknamed "The Walkie-Talkie" because of its distinctive shape. Designed by architect Rafael Viñoly in 2014, its sky garden was opened in 2015. Its 34 floors consist of office spaces, topped by a large viewing deck. The roof has 3 extra floors which have a bar, restaurant and the garden. these areas are open to the public with some restrictions.

Social aspects

- Human Health

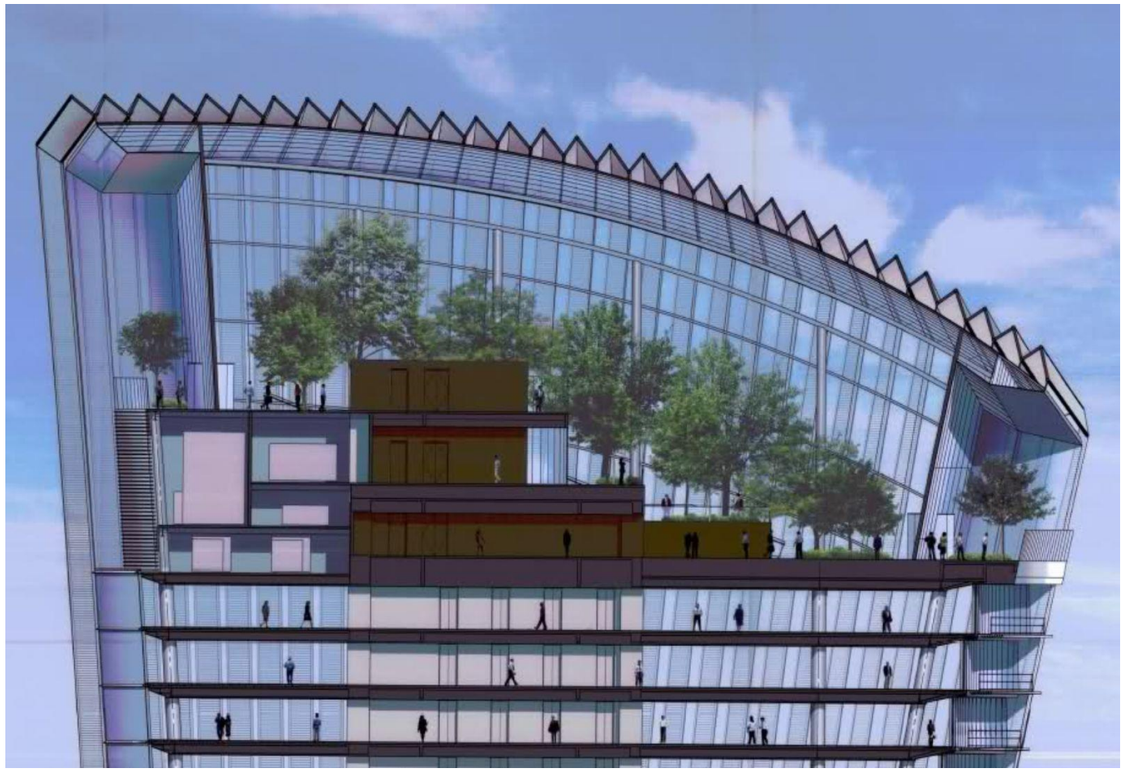


Figure 61.

Figure 62.

Figure 63.

Figure 64.

Social aspects

- Biodiversity

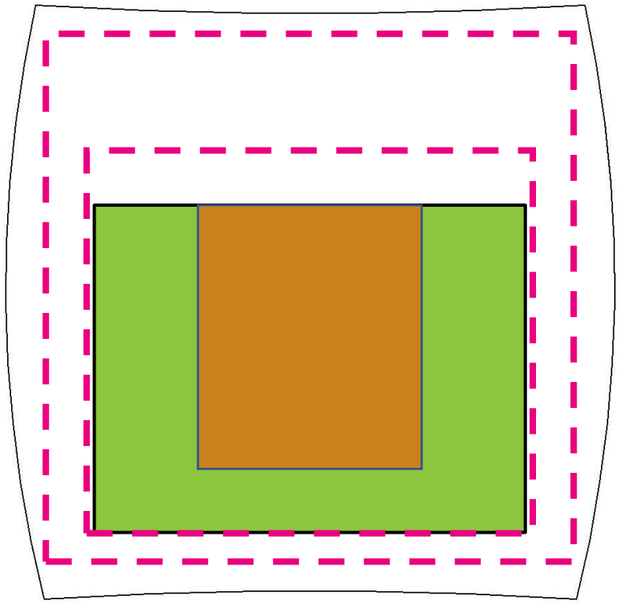


Figure 65.

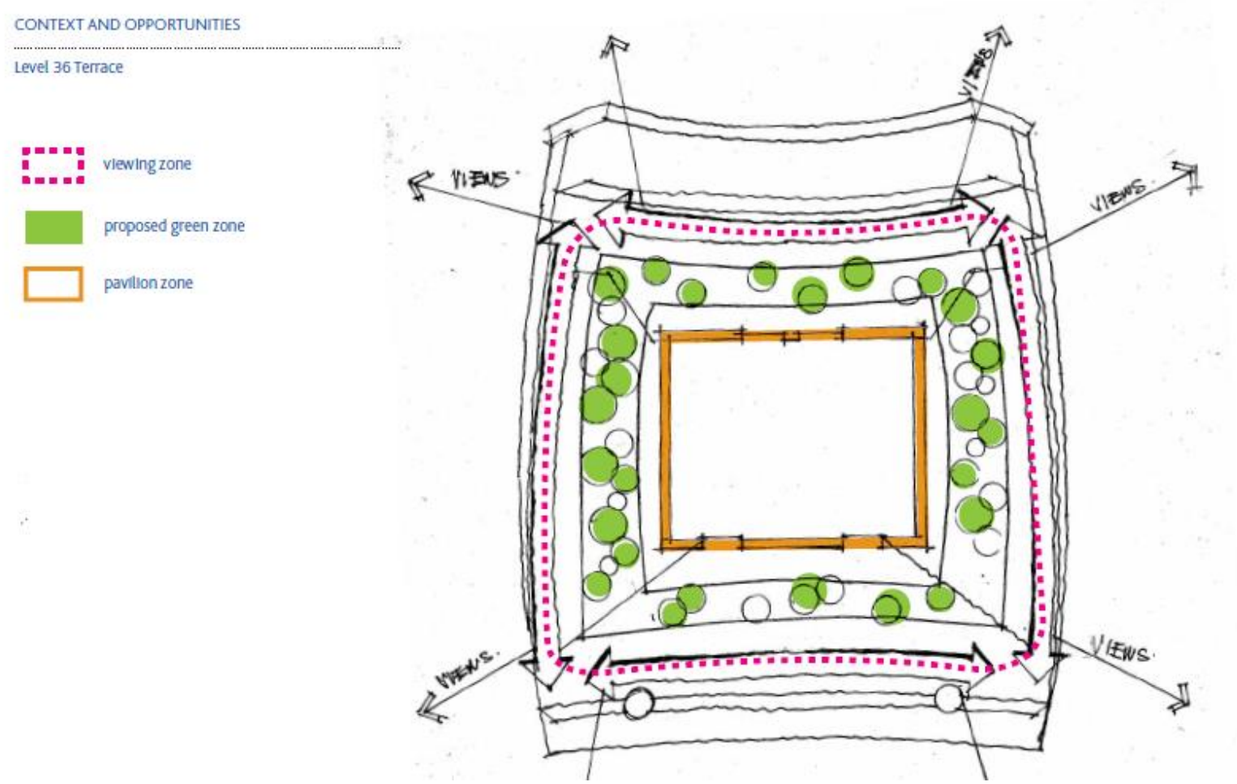


Figure 66.

Social aspects

- Public spaces

Figure 67.

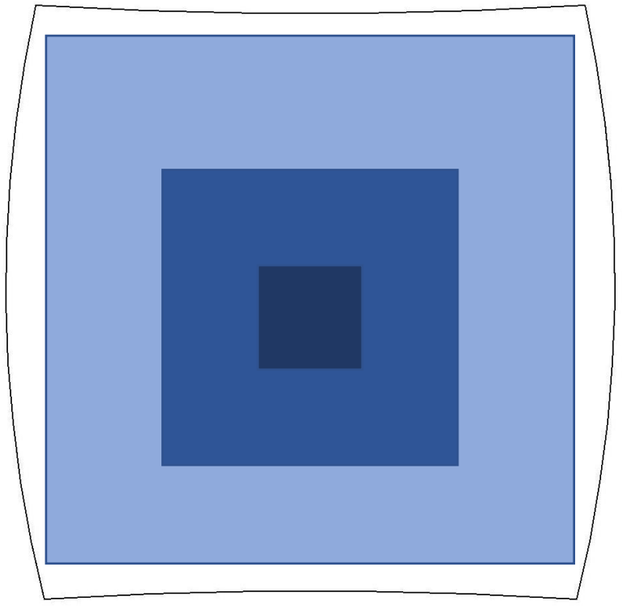


Figure 68.

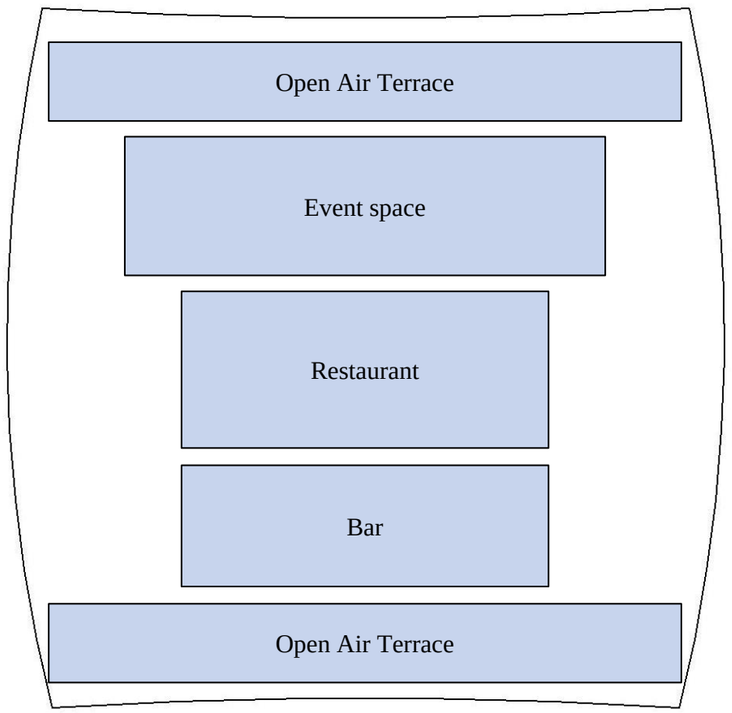


Figure 69.

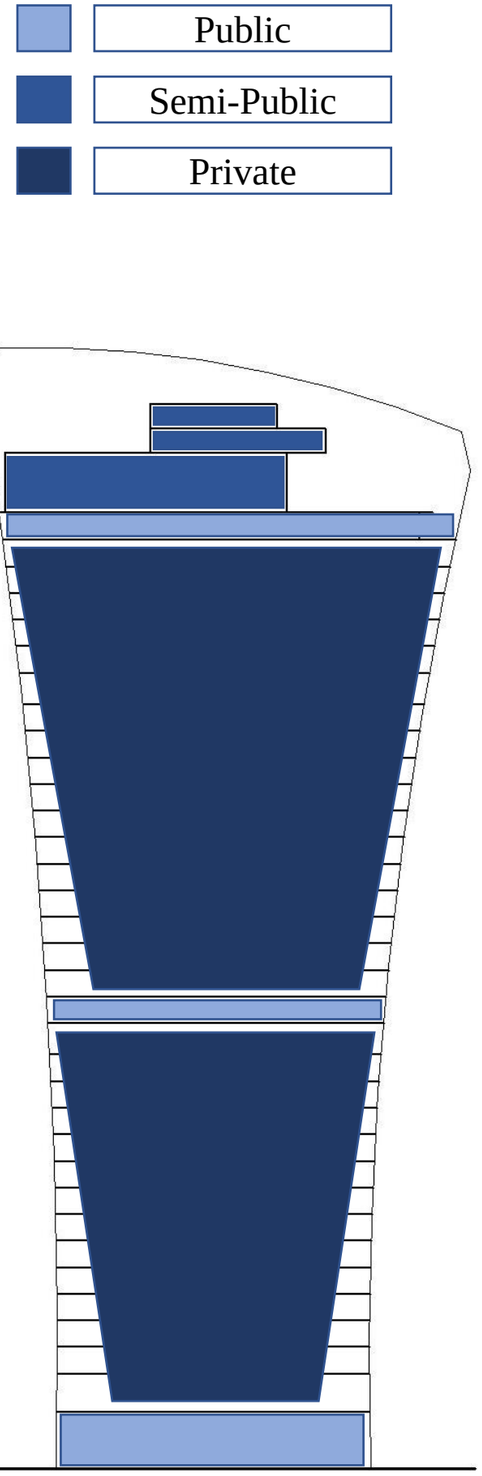
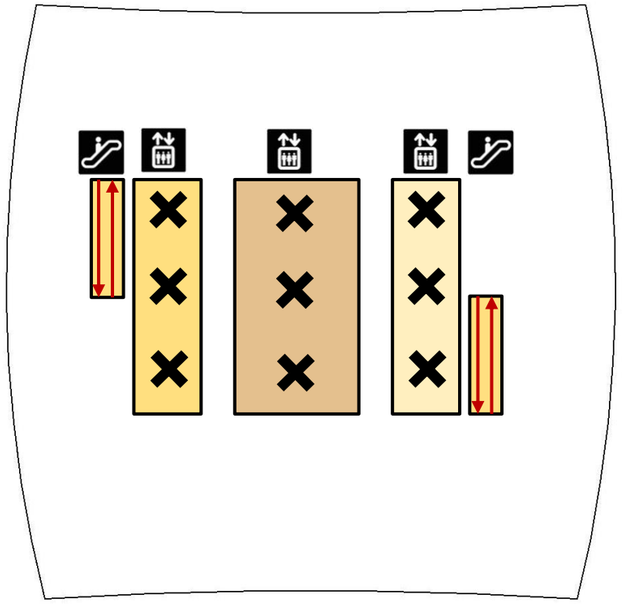


Figure 70.

Social aspects

- Accessibility



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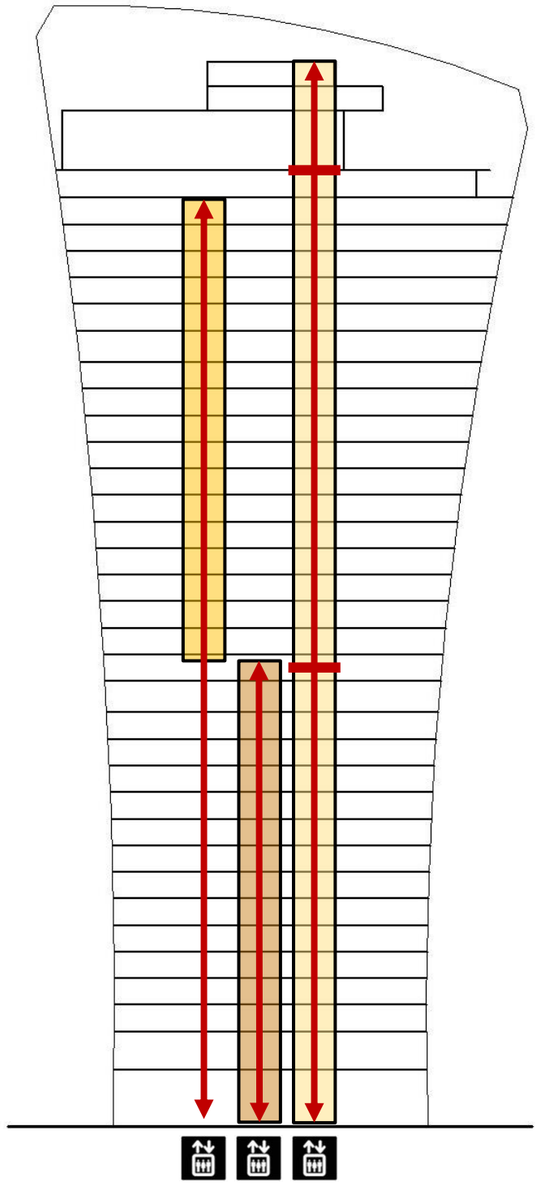
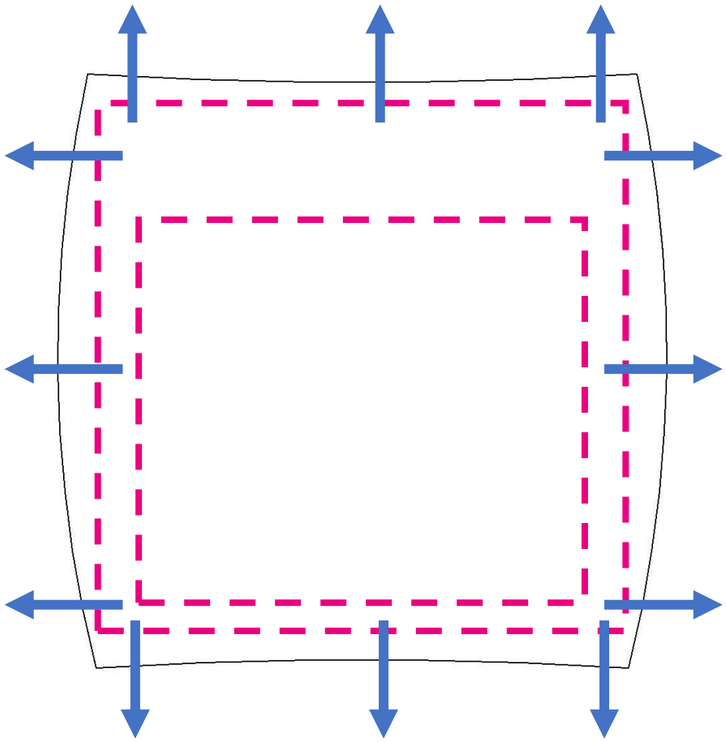


Figure 72.

Social aspects

- Visibility



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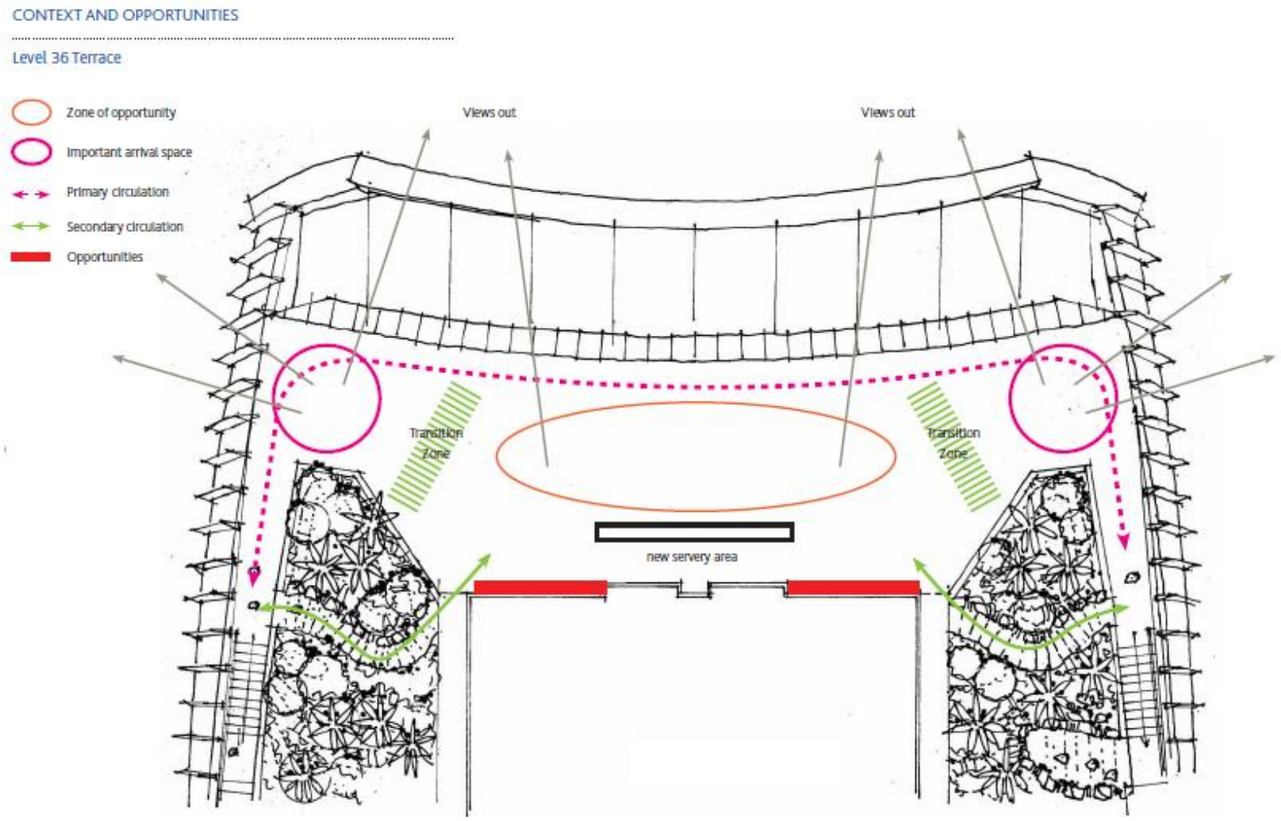


Figure 74.

Figure 75.

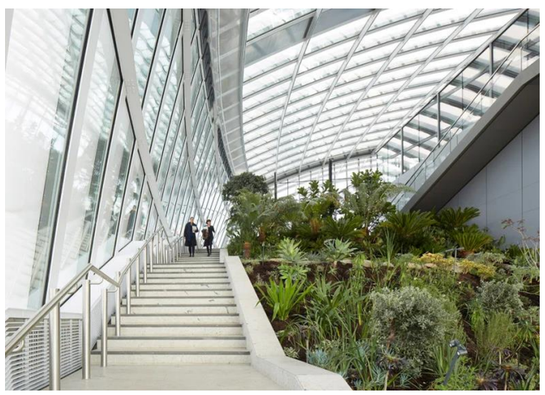


Figure 76.

Figure 77.

Sustainable aspects

- Energy

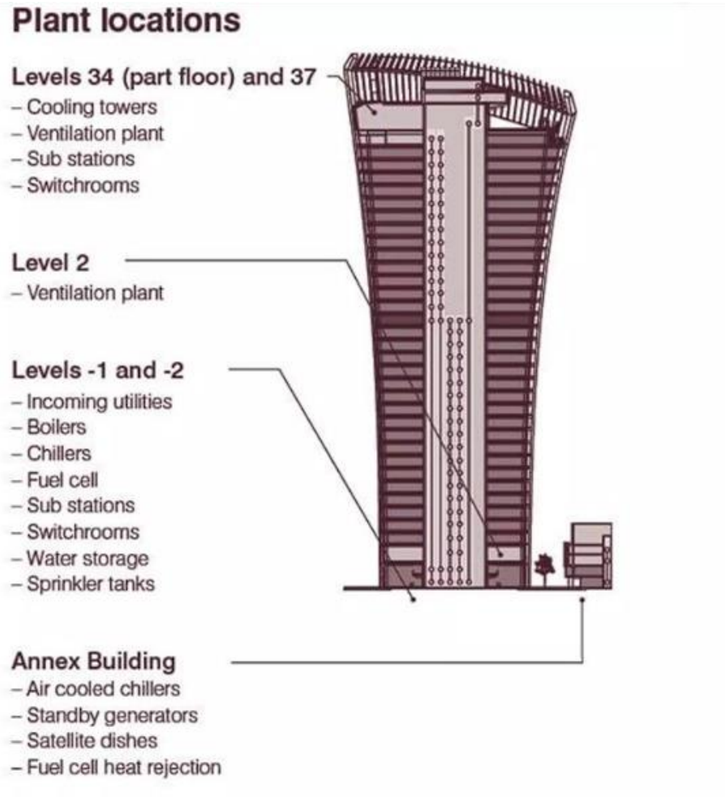


Figure 78.

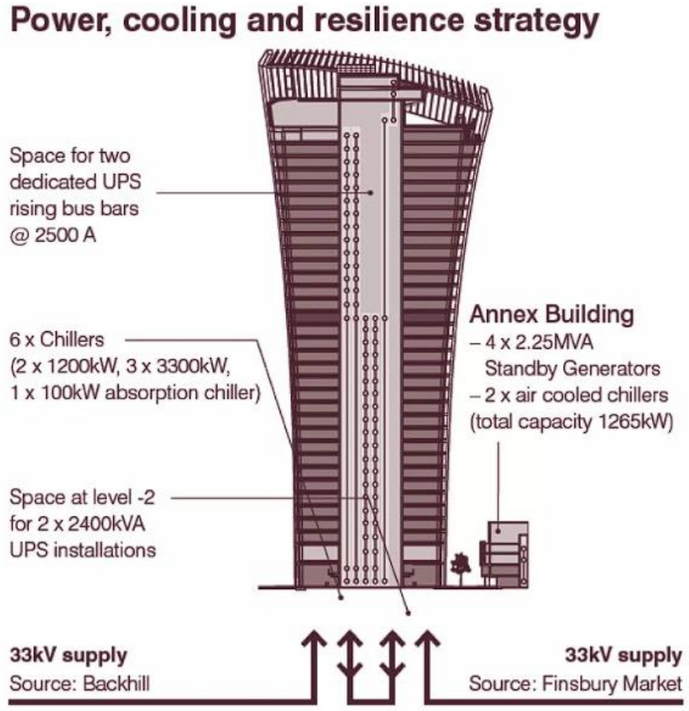


Figure 79.

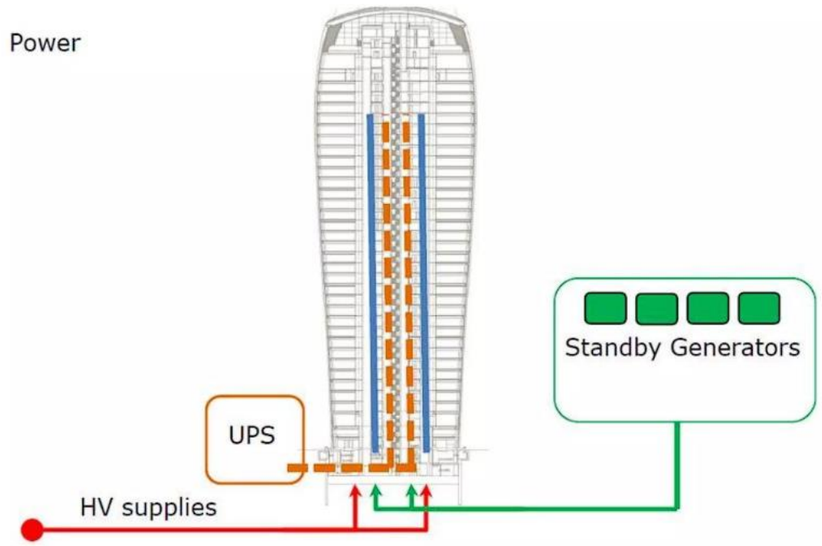


Figure 80.

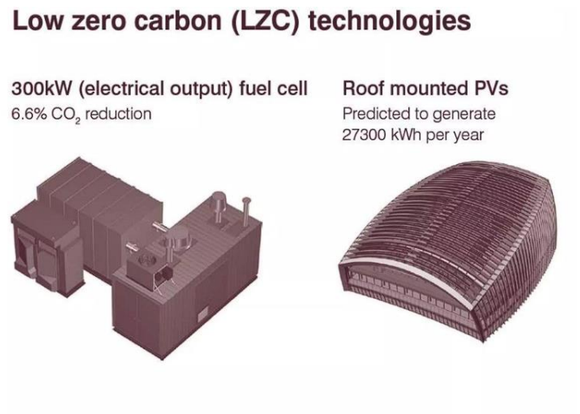


Figure 81.

Sustainable aspects

- Water

Figure 82.

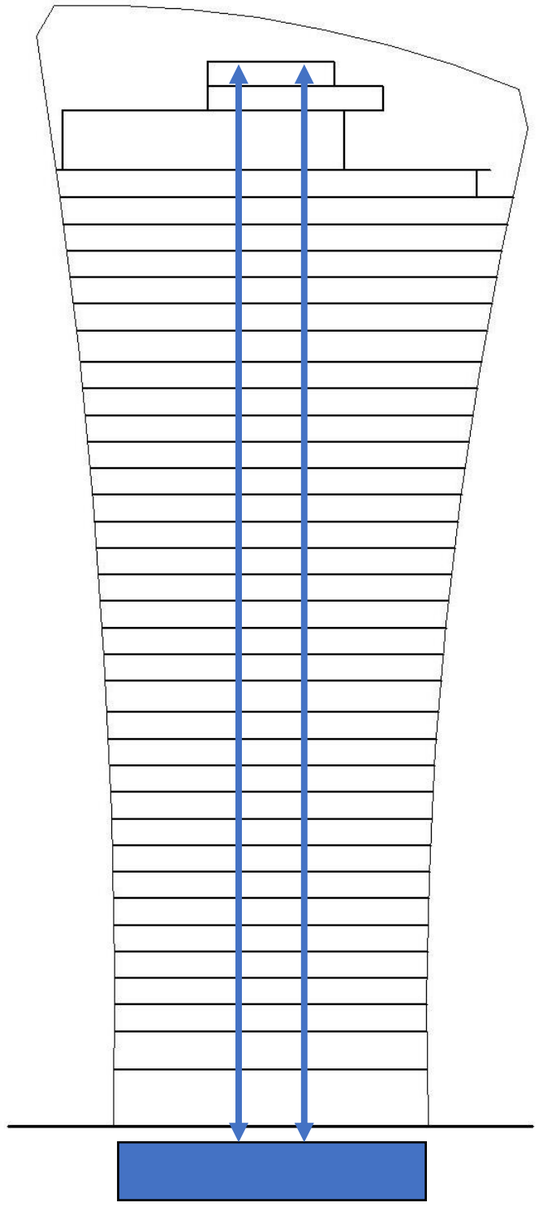


Figure 83.

Sustainable aspects

- Nature

Figure 84.

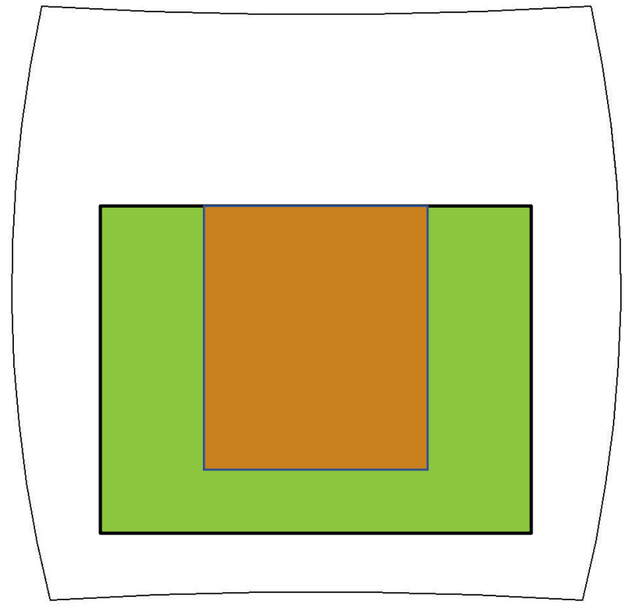


Figure 85.

Sustainable aspects

- Materials

Figure 86.

Figure 87.

Figure 88.

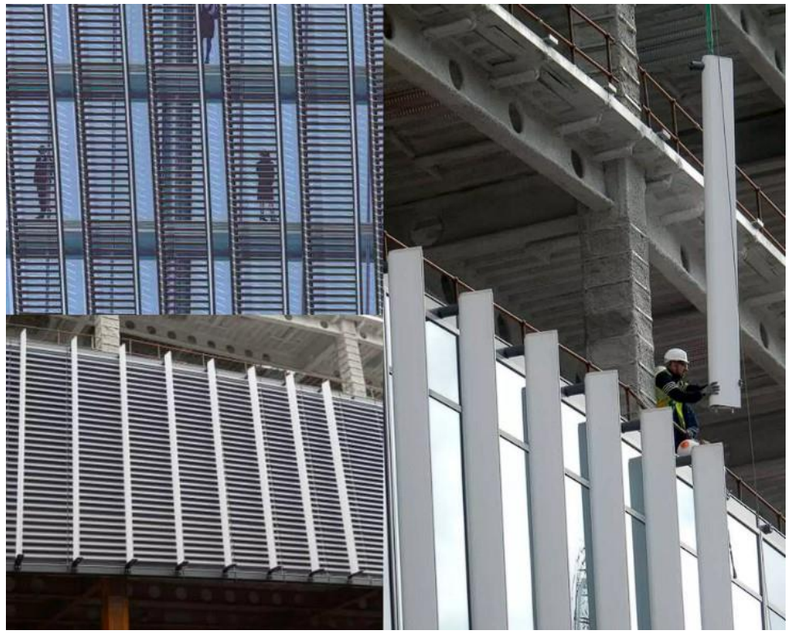


Figure 89.

Sustainable aspects

- Climate

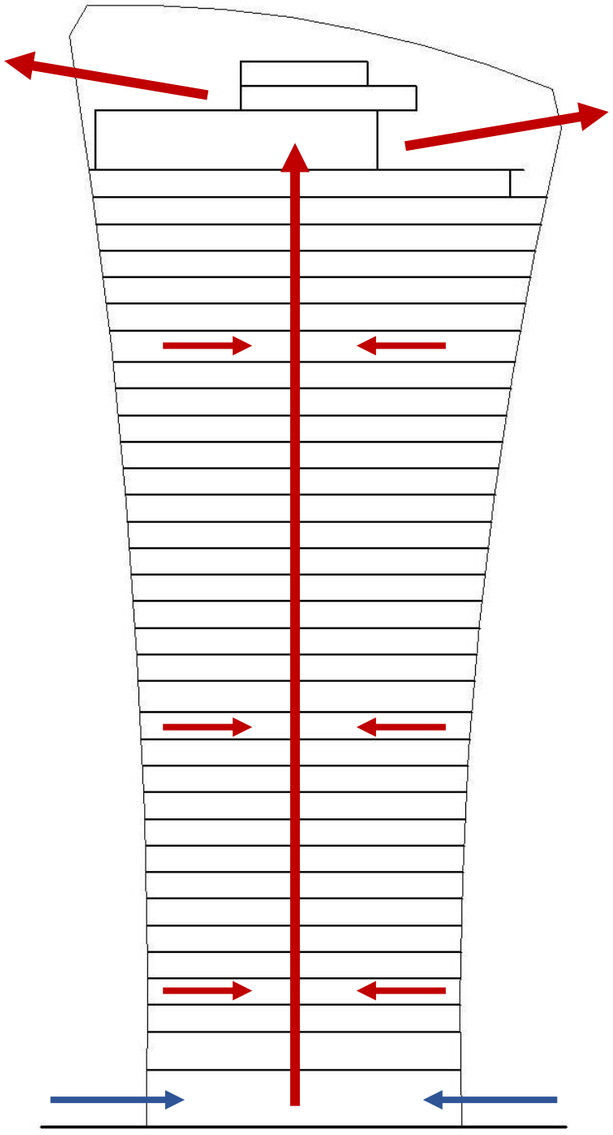


Figure 90.

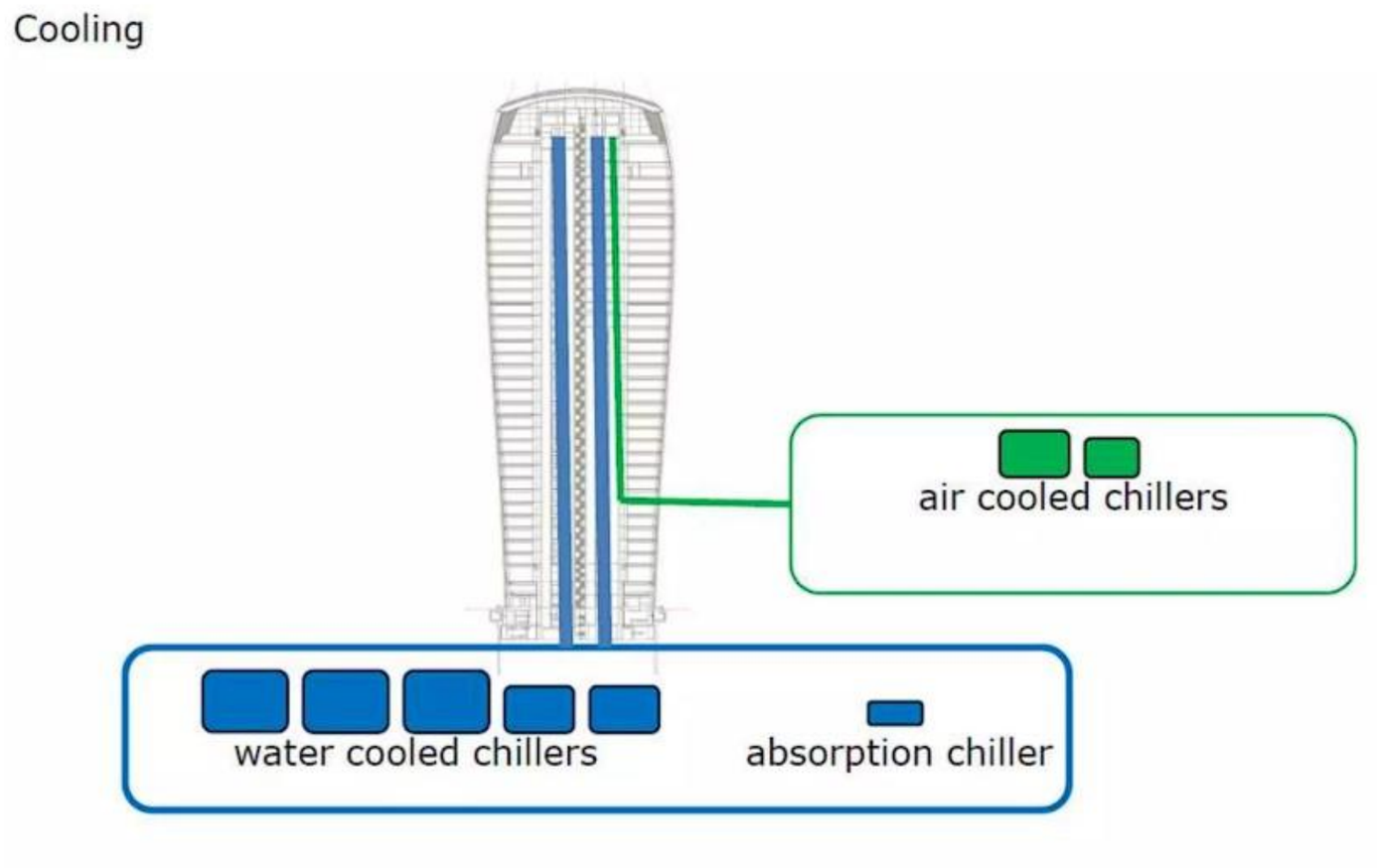
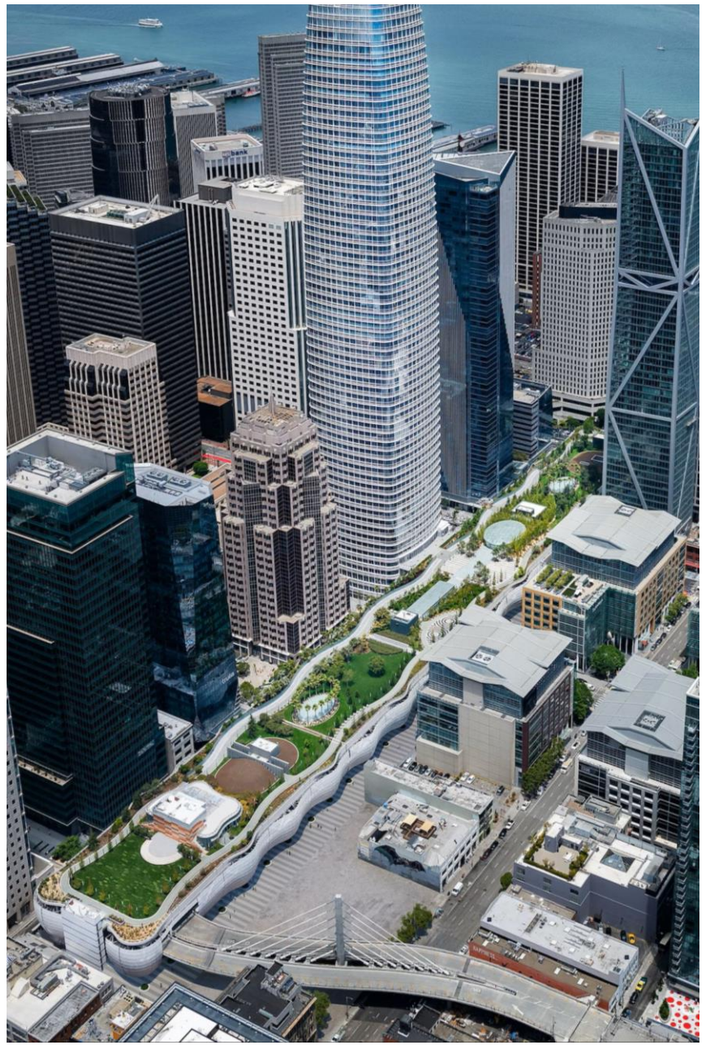
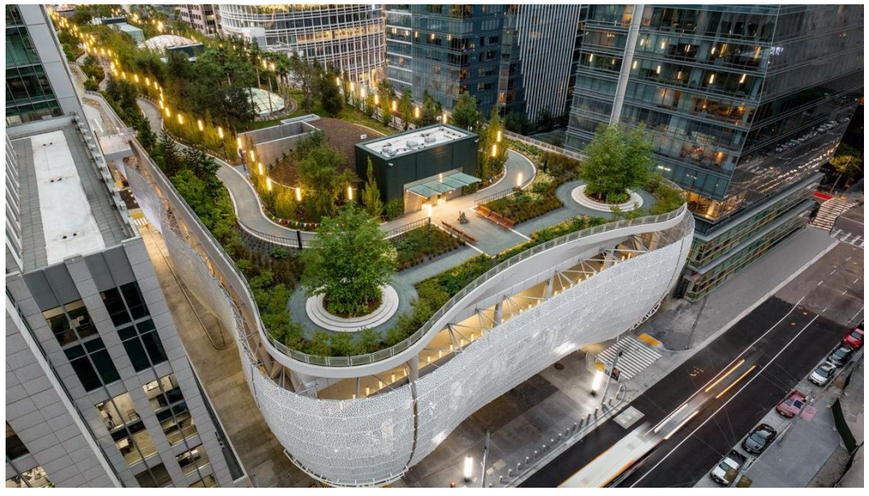


Figure 91.

Project 3: **Salesforce Transit Centre - San Francisco**

Salesforce Transit Centre is a transit station in downtown San Francisco. It serves as the primary bus terminal — and potentially as a future rail terminal — for the San Francisco Bay Area. Designed by Pelli Clarke, Pelli Architects (PCPA) in 2018, it is about 440 m long and 50 m wide. The main structure has four levels: the ground floor with entrances, retail space, ticketing, and Muni/Golden Gate Transit boarding platforms; the second floor with retail space, food hall, offices, and Greyhound ticket counter and waiting room; the bus deck with bus bays surrounding a central waiting area and the rooftop park.





Social aspects

- Human Health

Figure 92.

Social aspects

- Biodiversity

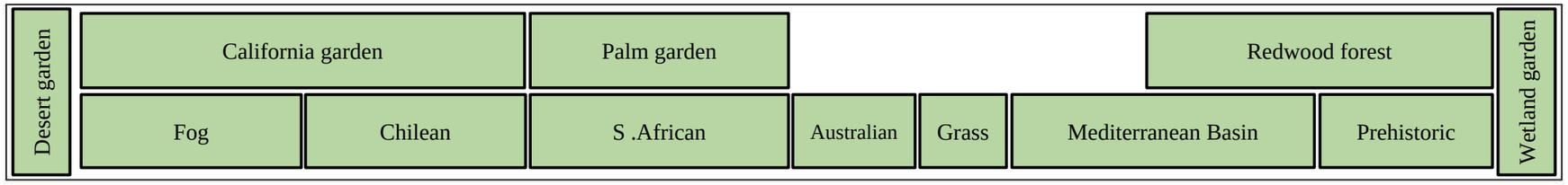


Figure 93.

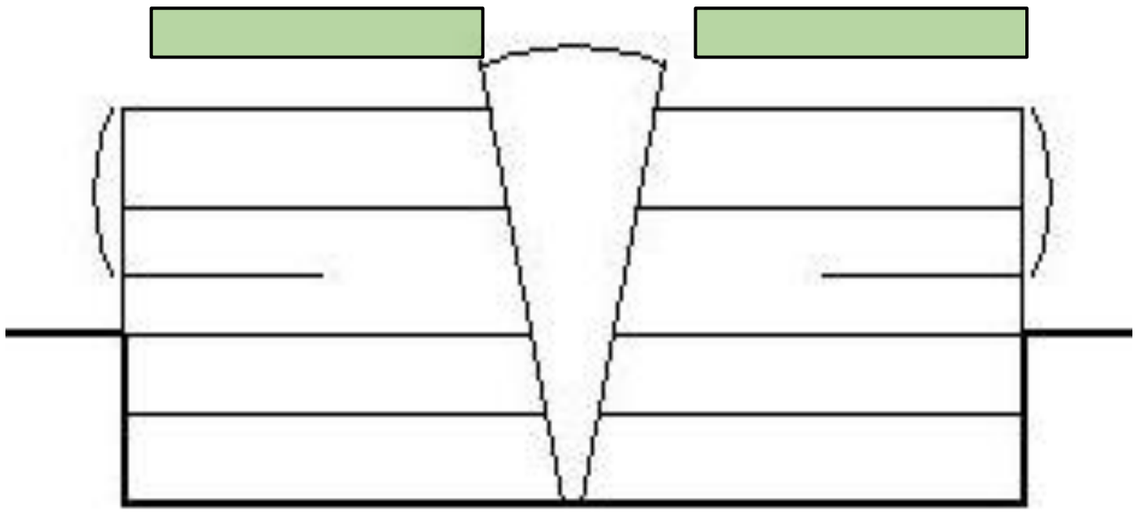


Figure 94.

Social aspects

- Public spaces

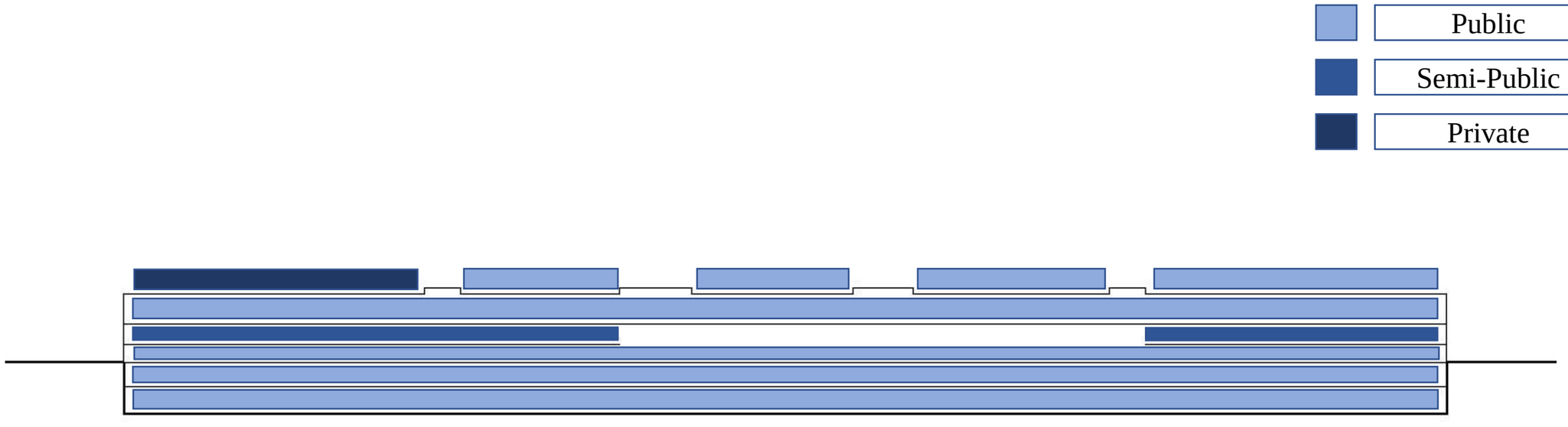


Figure 95.

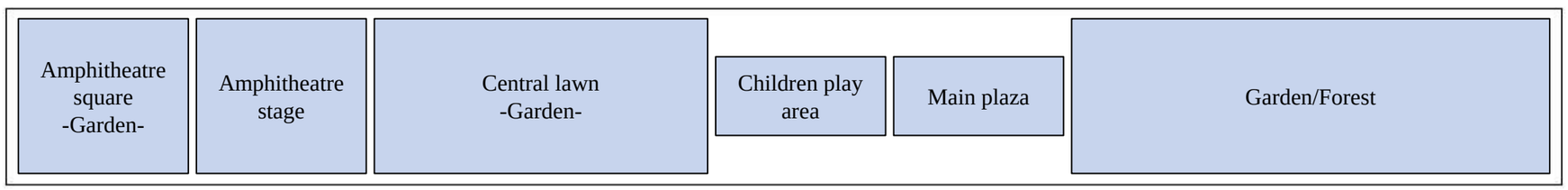


Figure 96.

Social aspects

- Accessibility

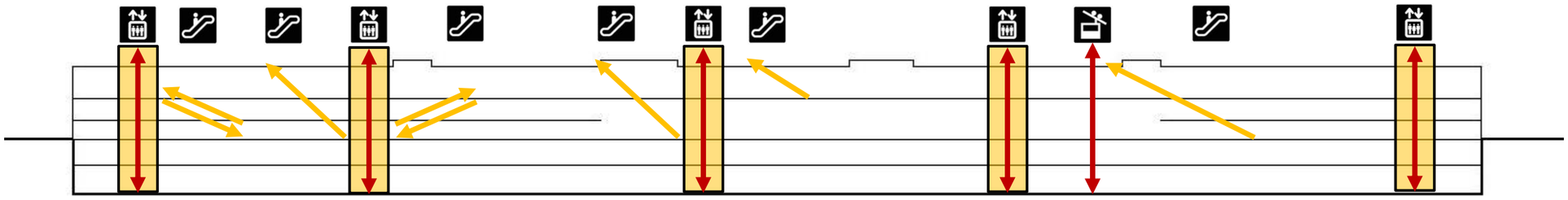


Figure 97.

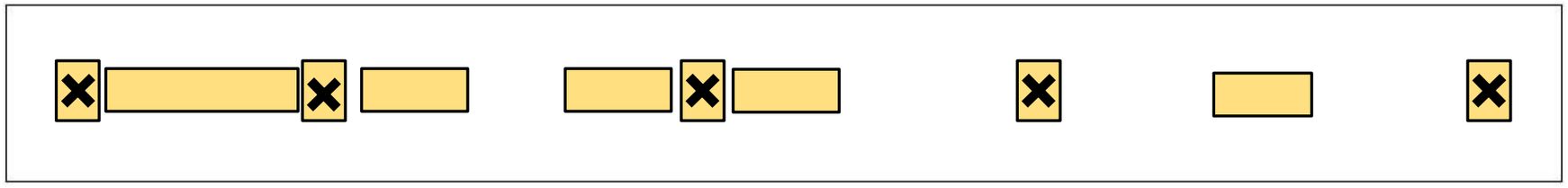


Figure 98.

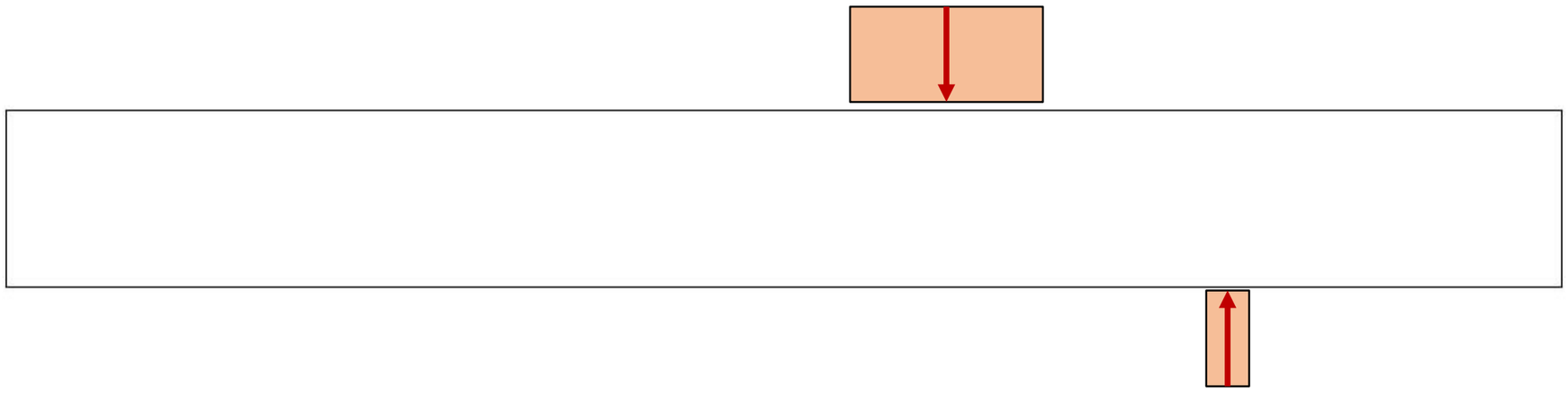


Figure 99.

Social aspects

- Visibility

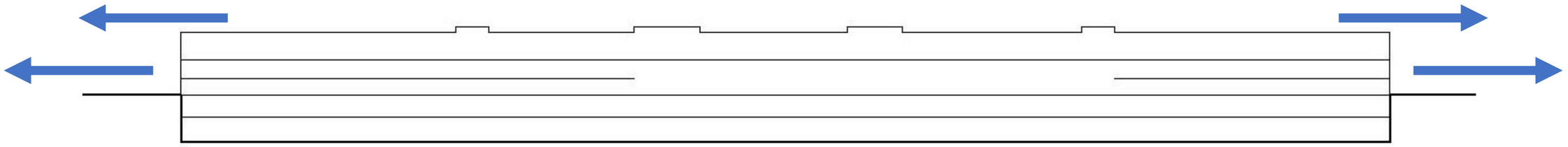


Figure 100.

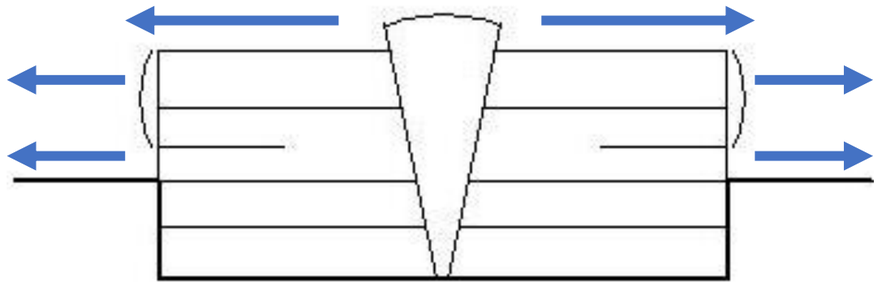


Figure 101.

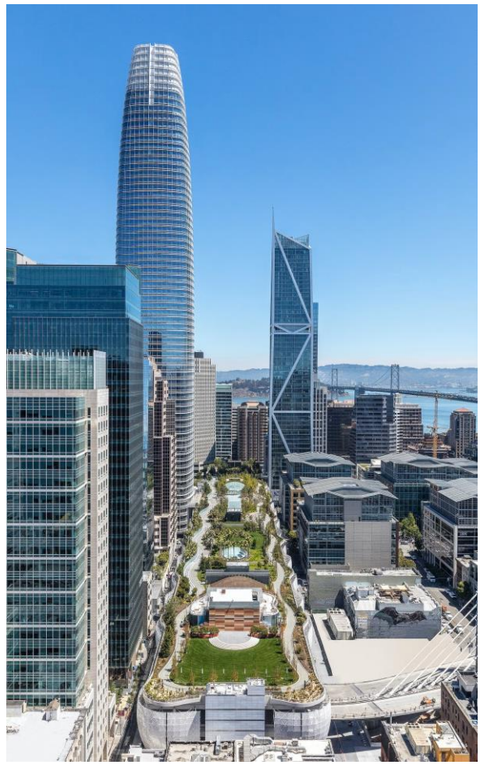


Figure 102.

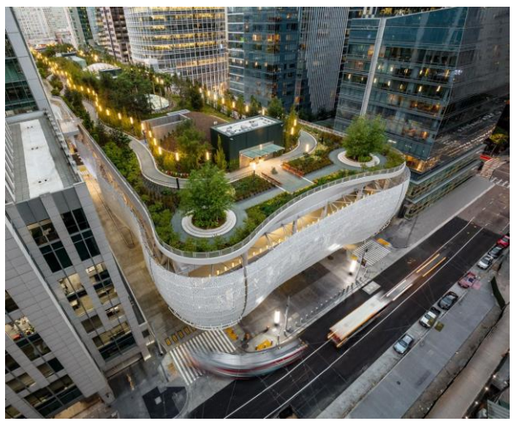


Figure 103.

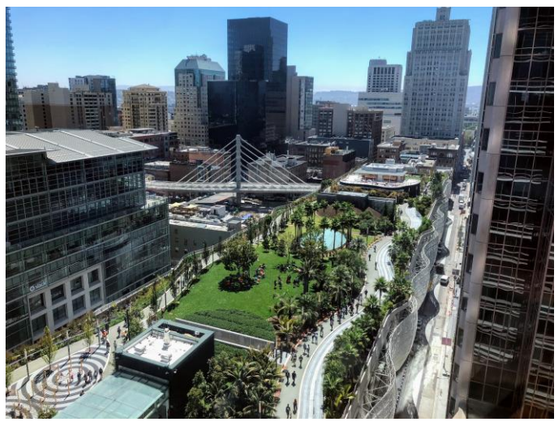


Figure 104.

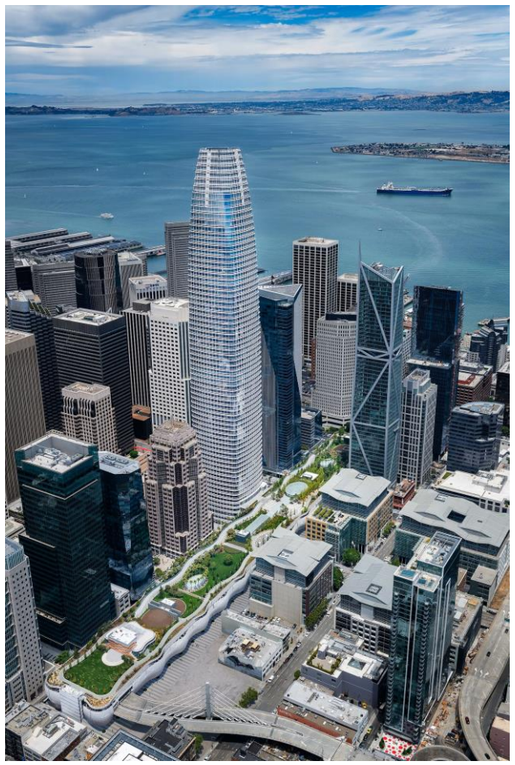


Figure 105.

Sustainable aspects

- Energy

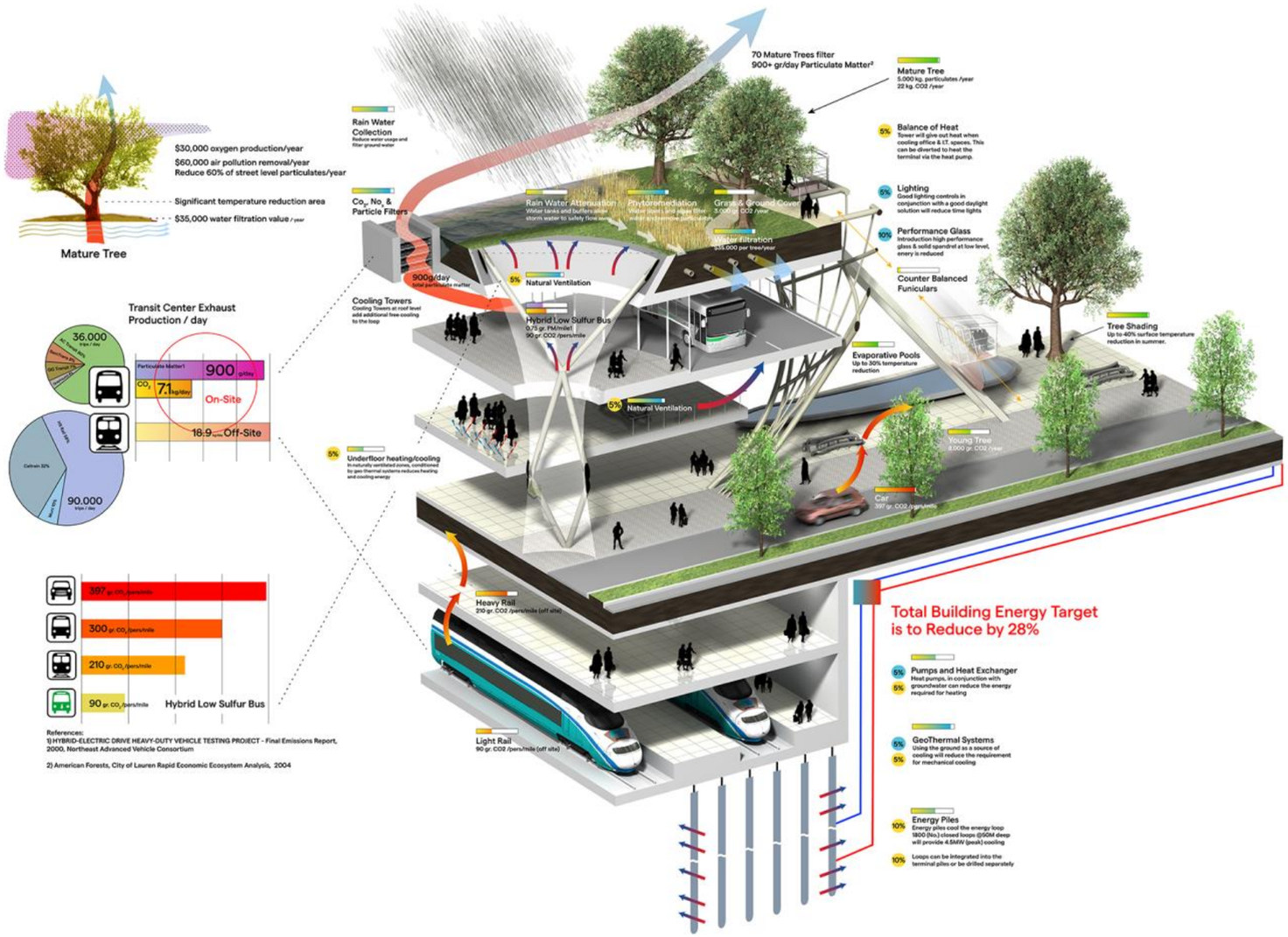


Figure 106.

Sustainable aspects

- Water

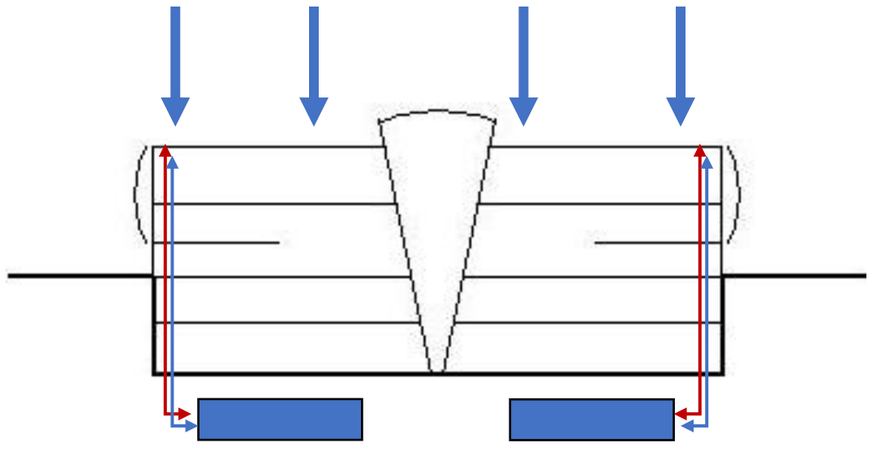


Figure 107.

Figure 108.

Sustainable aspects

- Nature

Figure 109.

Figure 110.

Figure 111.

Sustainable aspects

- Materials

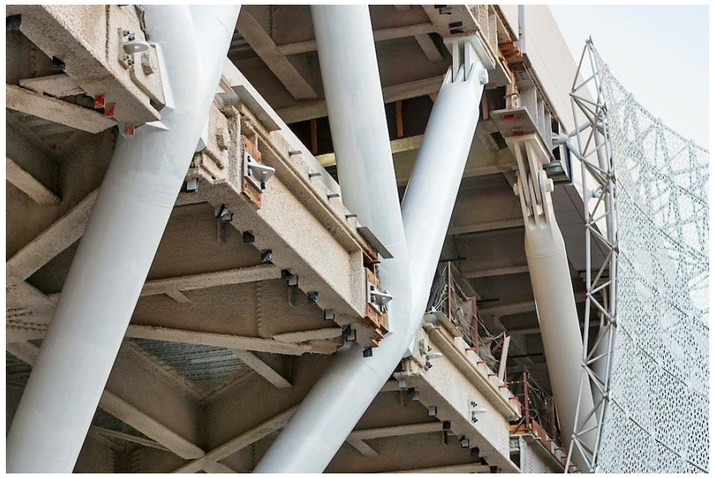


Figure 112.

Figure 113.

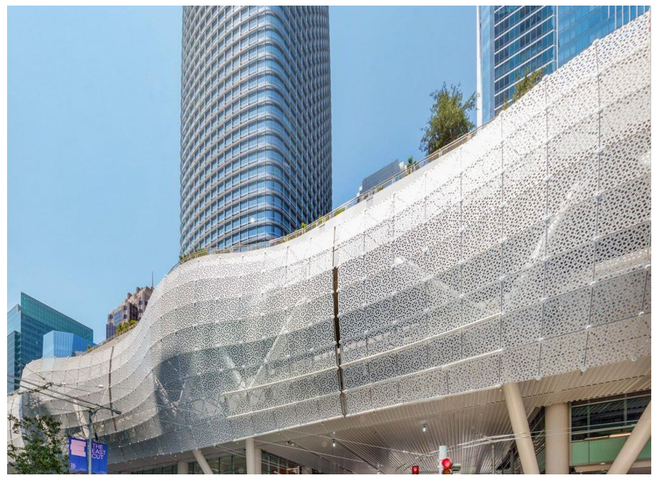


Figure 114.

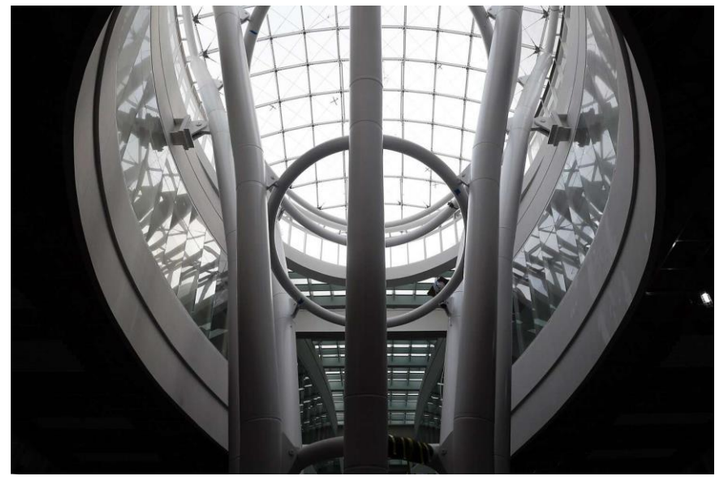


Figure 115.

Sustainable aspects

- Climate

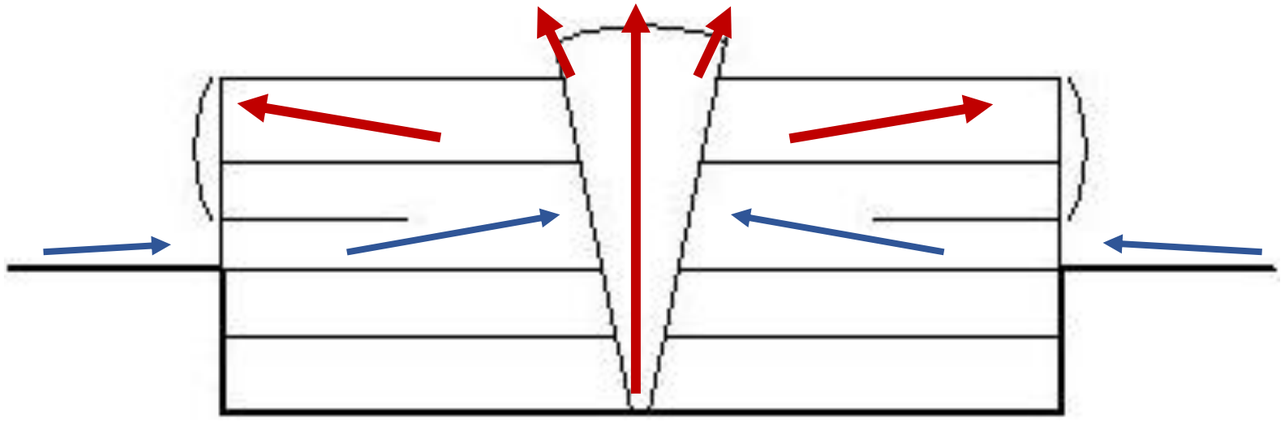


Figure 116.

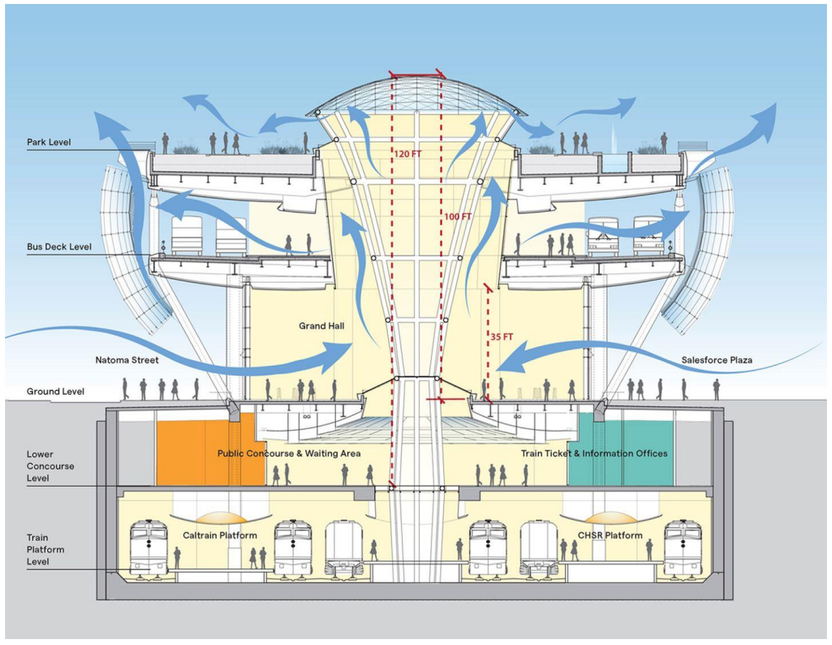
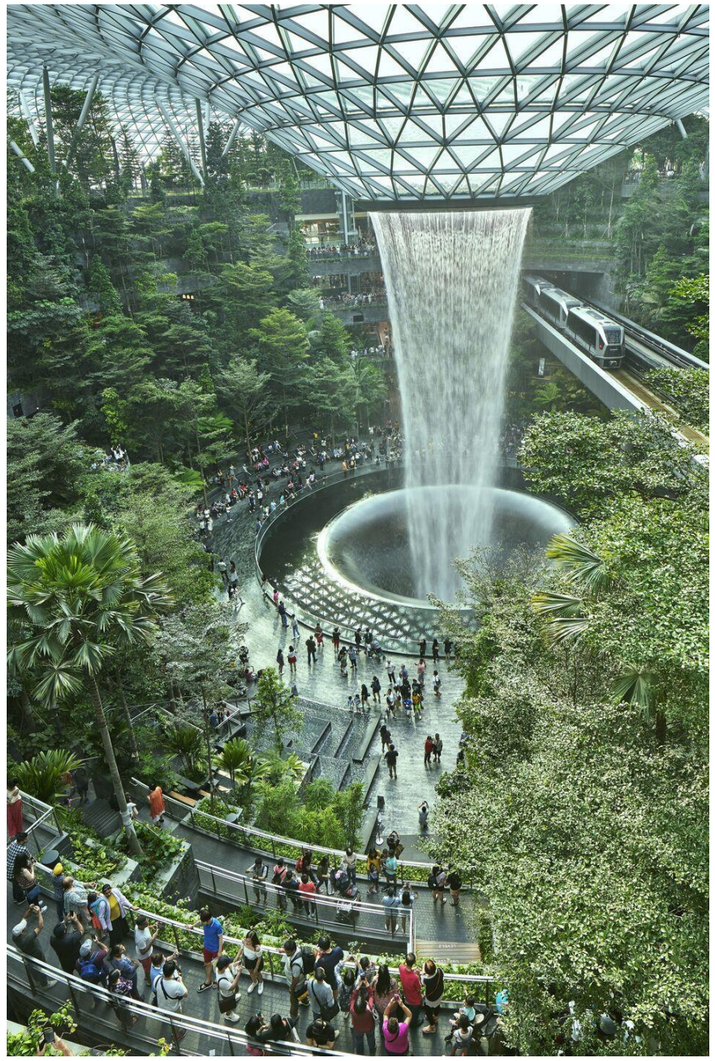


Figure 117.

Project 4: **Jewel Airport - Changi**

Jewel is a nature-themed entertainment and retail complex surrounded by and linked to one of the passenger terminals of Changi Airport, Singapore. It has the world's tallest indoor waterfall, the Rain Vortex, surrounded by a terraced forest setting. one of Asia's largest indoor gardens, spanning five stories and approximately 22,000 square metres. Jewel was Designed by a consortium of architects, led by Moshe Safdie in 2019. Jewel Changi consist of Public Gathering Space With Gardens, Retail, Hotel, Restaurants, and Entertainment For Travelers, Airport Community, and Local Residents.



Social aspects

- Human Health

Figure 118.

Social aspects

- Biodiversity

Figure 119.

Social aspects

- Public spaces

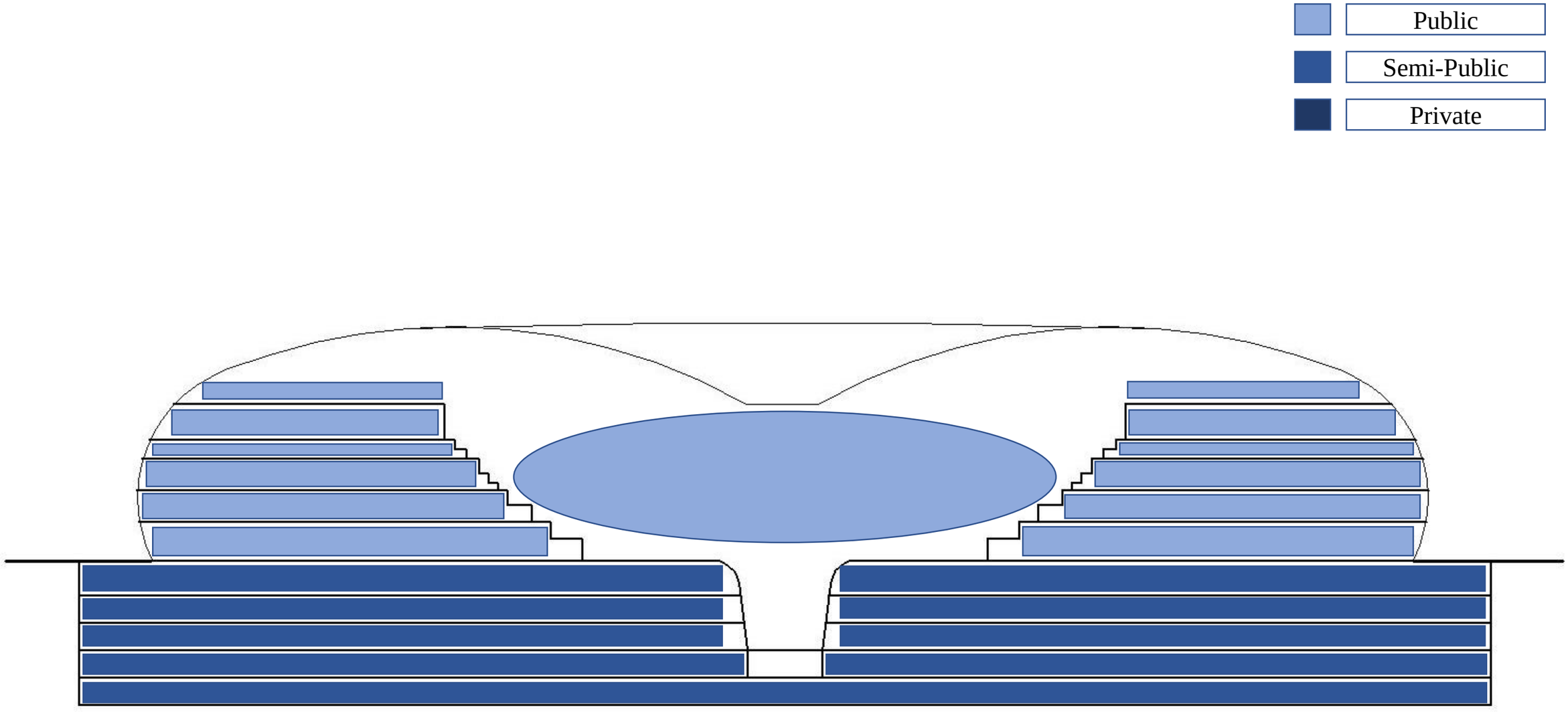


Figure 120.

Social aspects

- Public spaces

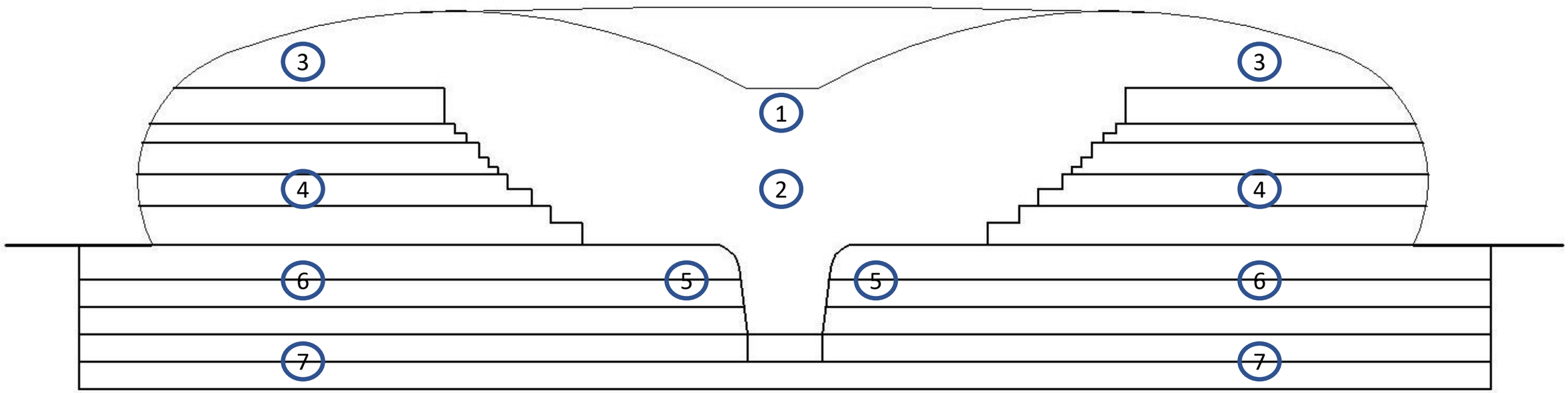


Figure 121.

1. Rain vortex
2. Forest valley
3. Canopy park
4. Retail
5. Immersion park
6. Food hall
7. Carpark

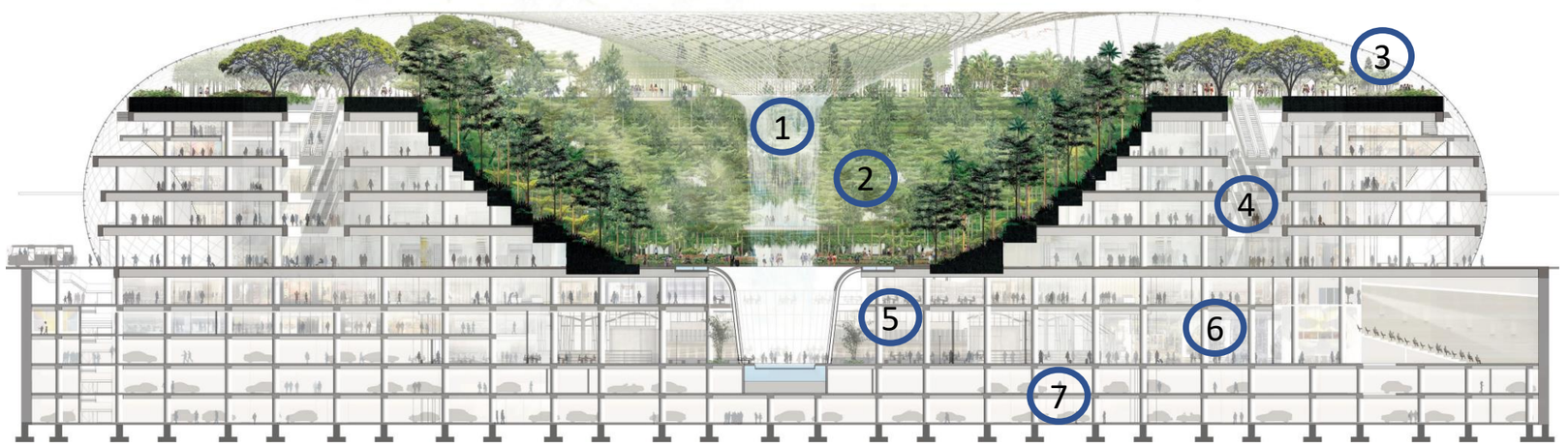


Figure 122.

Social aspects

- Accessibility

Tram line
Pedestrian bridge

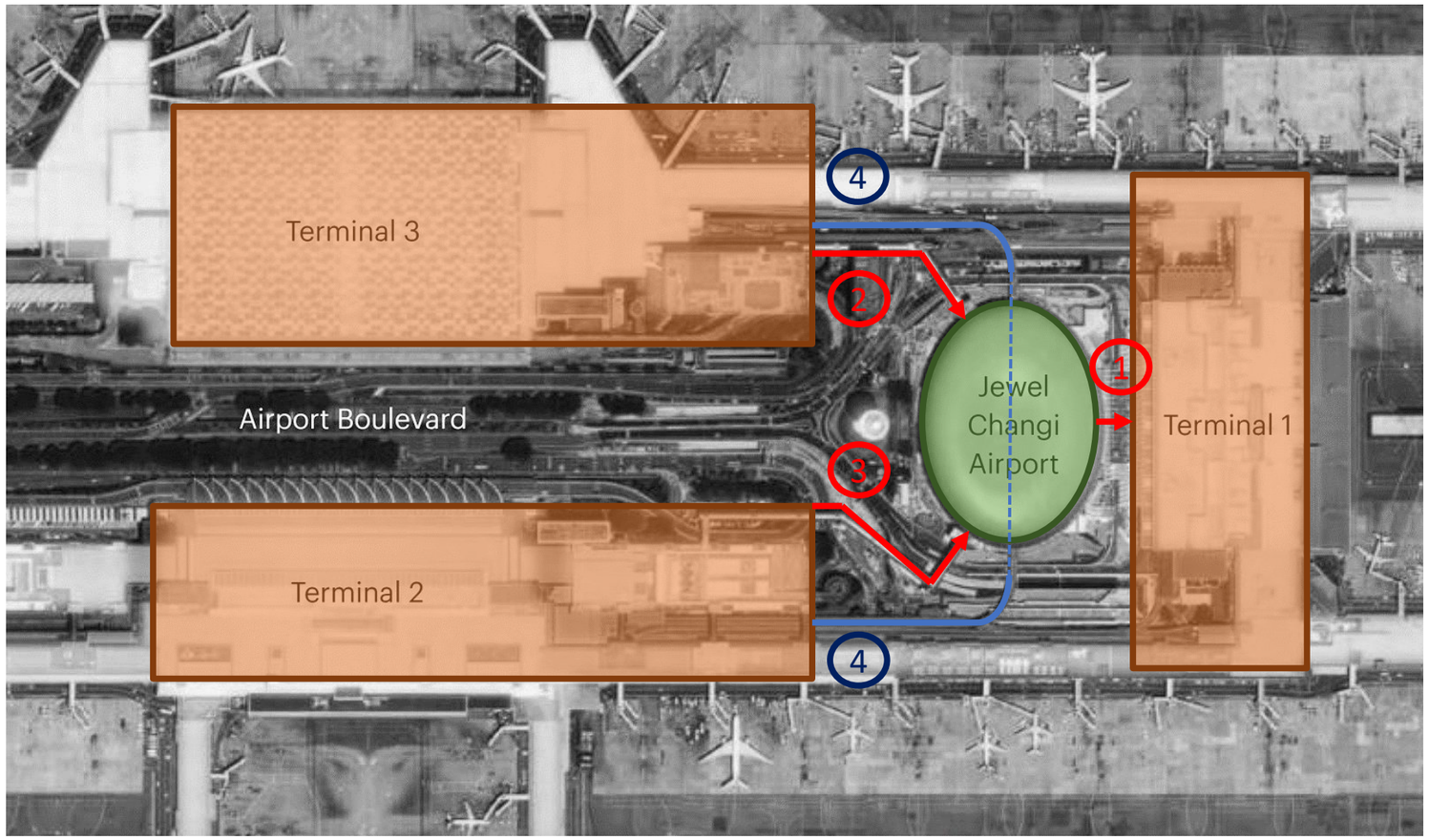


Figure 123.

Figure 124.

Figure 125.

Figure 126.

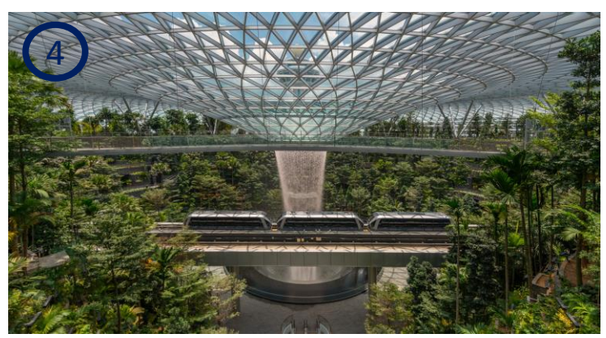


Figure 127.

Social aspects

- Accessibility

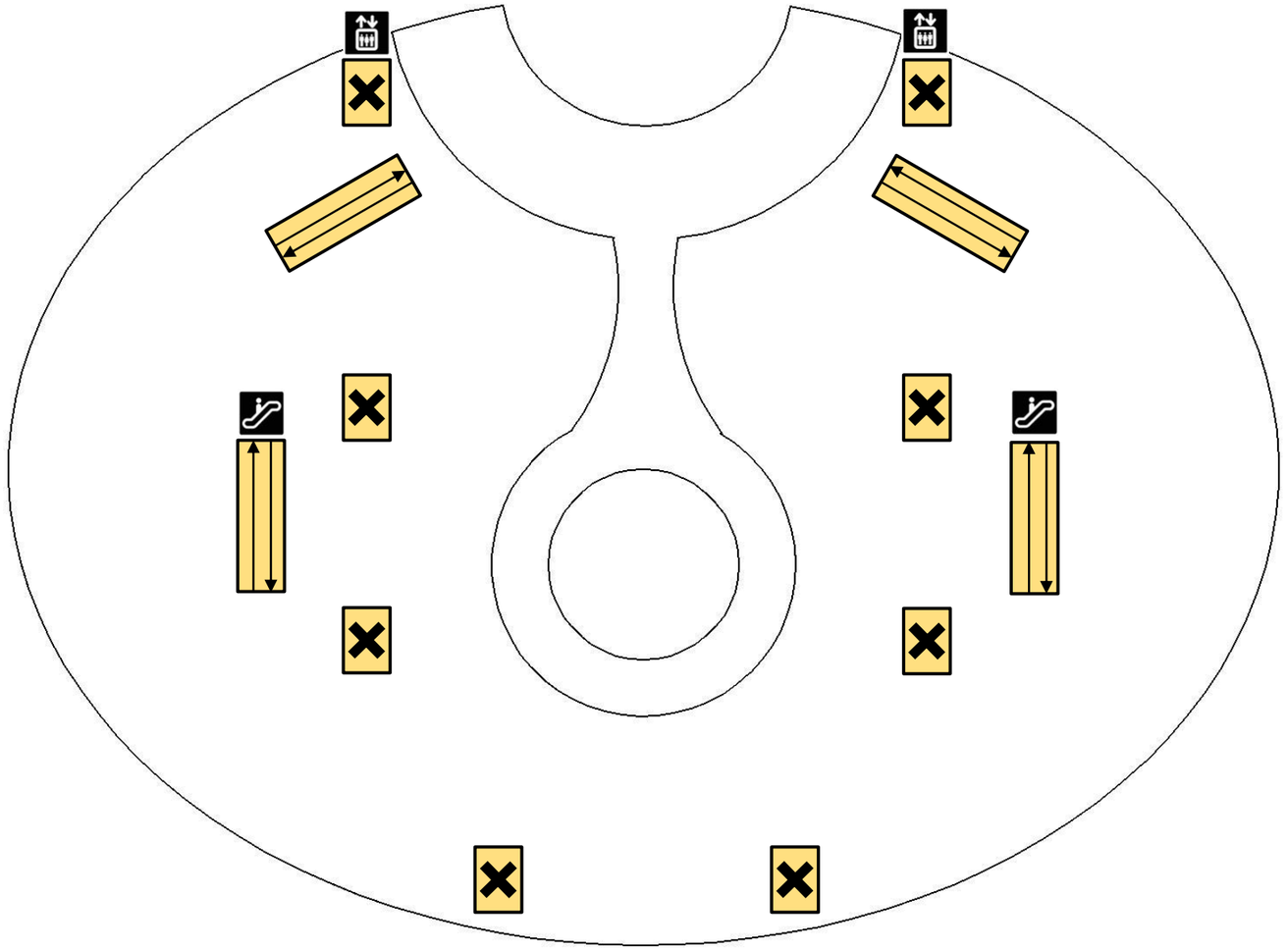


Figure 128.

Social aspects

- Accessibility

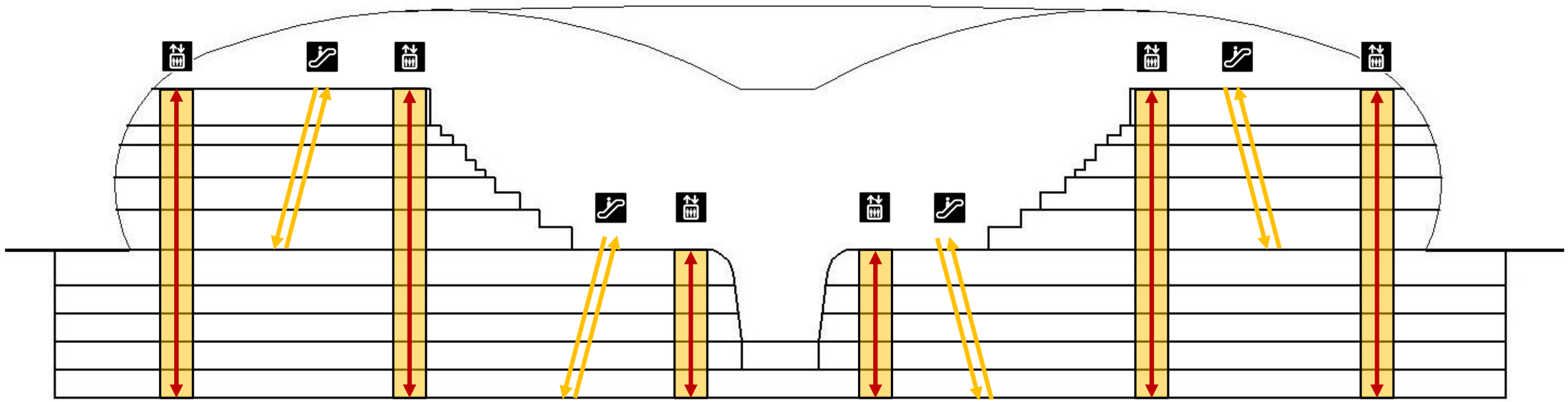


Figure 129.

Figure 130.

Figure 131.

Figure 132.

Social aspects

- Visibility

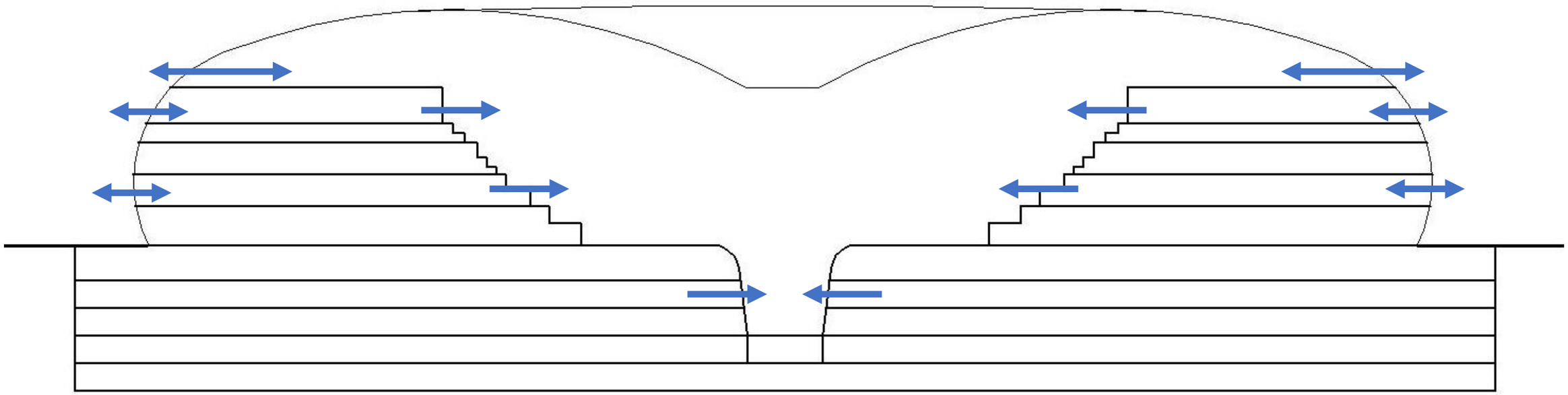


Figure 133.

Figure 134.

Figure 135.

Figure 136.

Sustainable aspects

- Energy

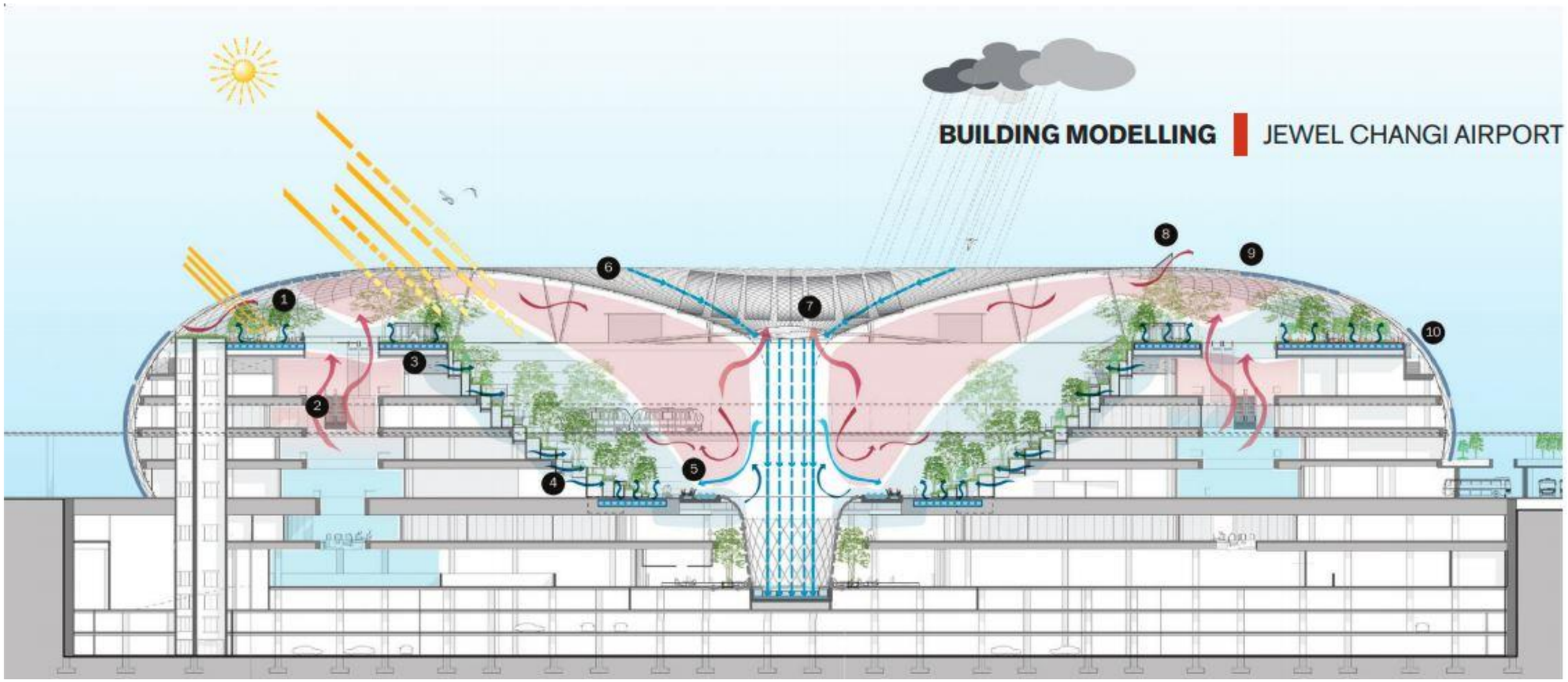


Figure 137.

Sustainable aspects

- Water

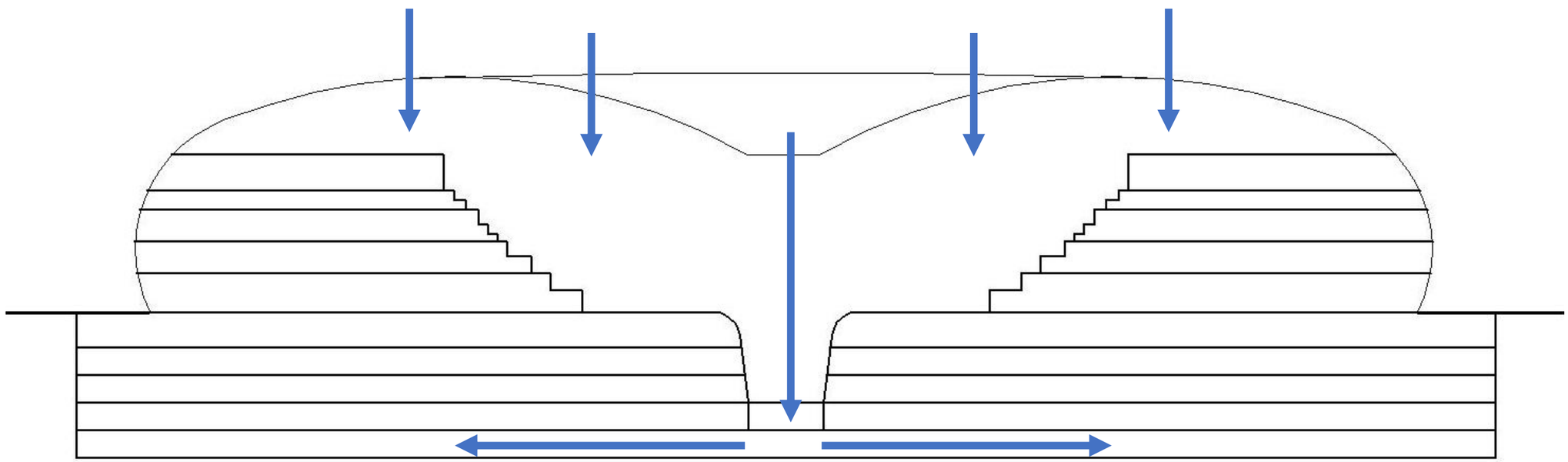


Figure 138.

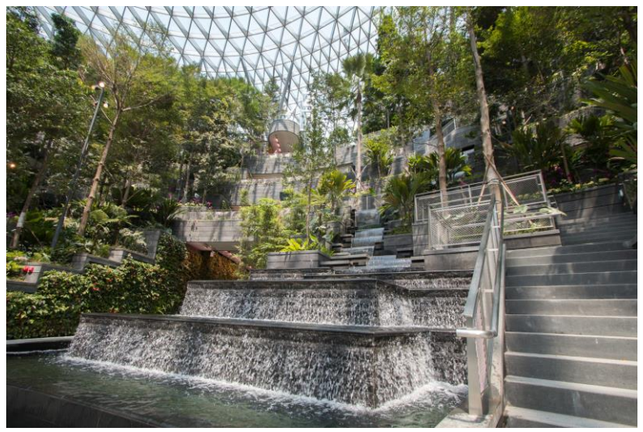


Figure 139.

Figure 140.

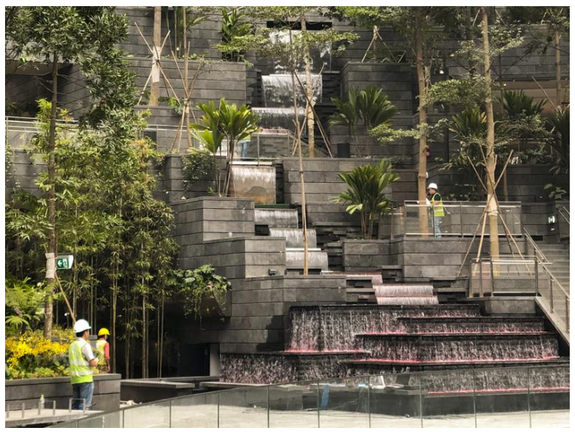


Figure 141.

Sustainable aspects

- Nature

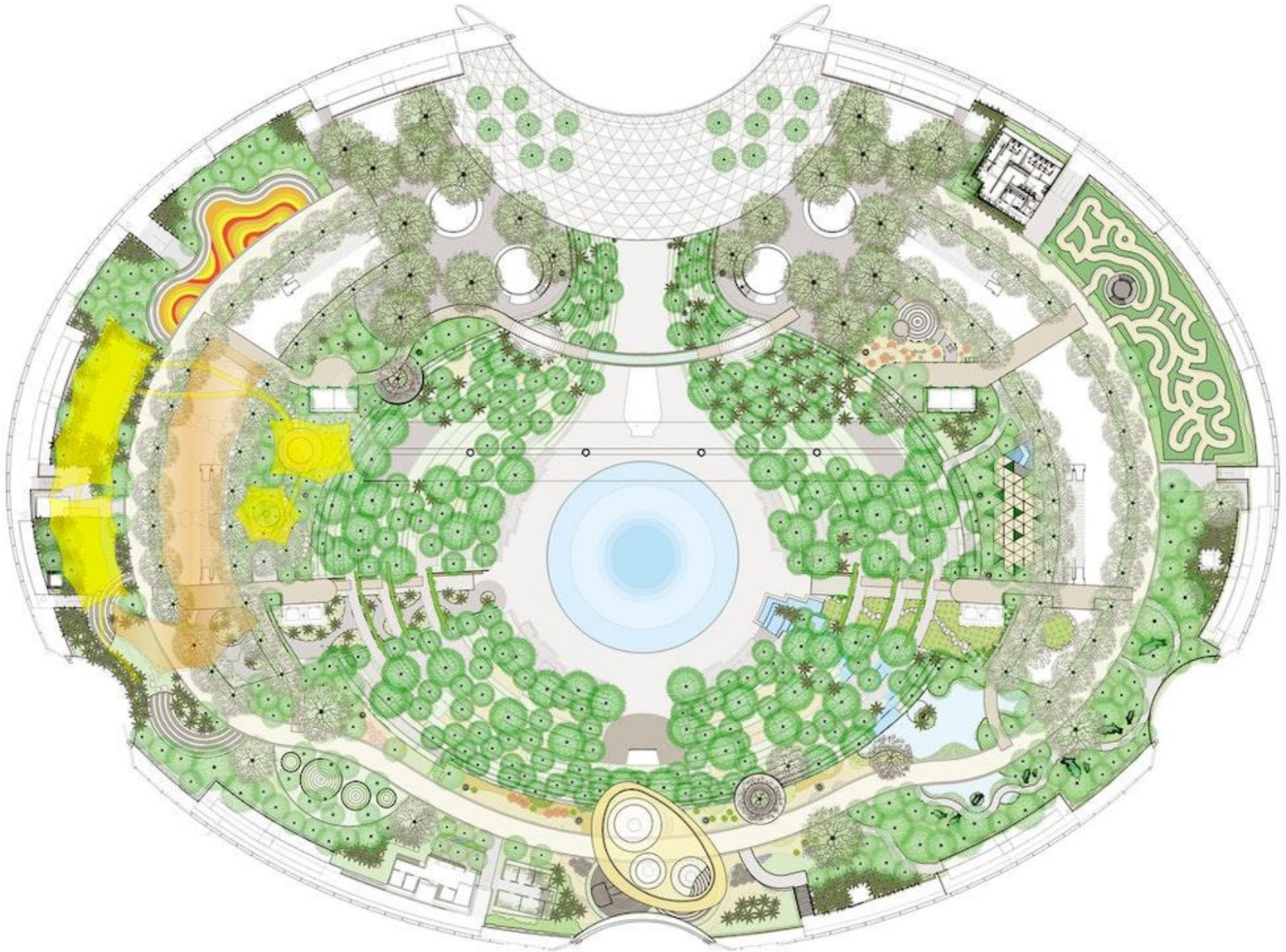


Figure 142.

Sustainable aspects

- Materials

Figure 143.

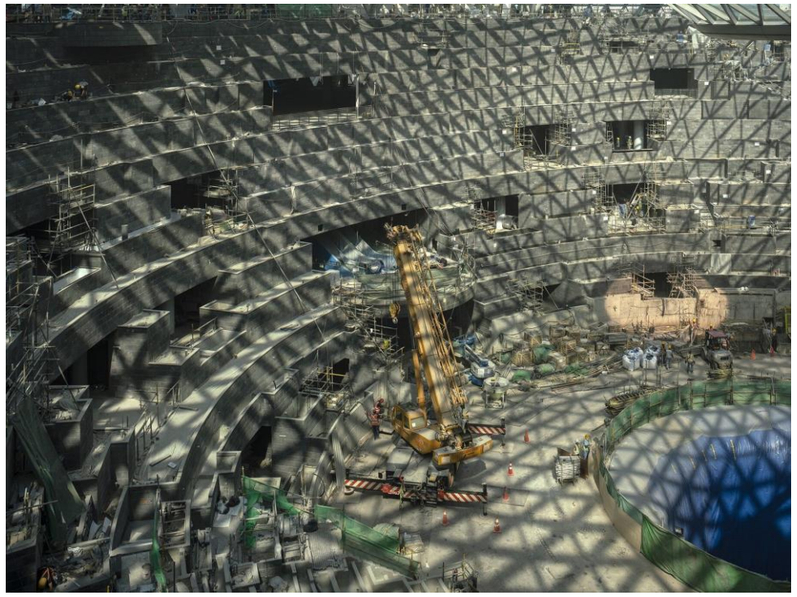


Figure 144.

Figure 145.

Figure 146.

Sustainable aspects

- Climate

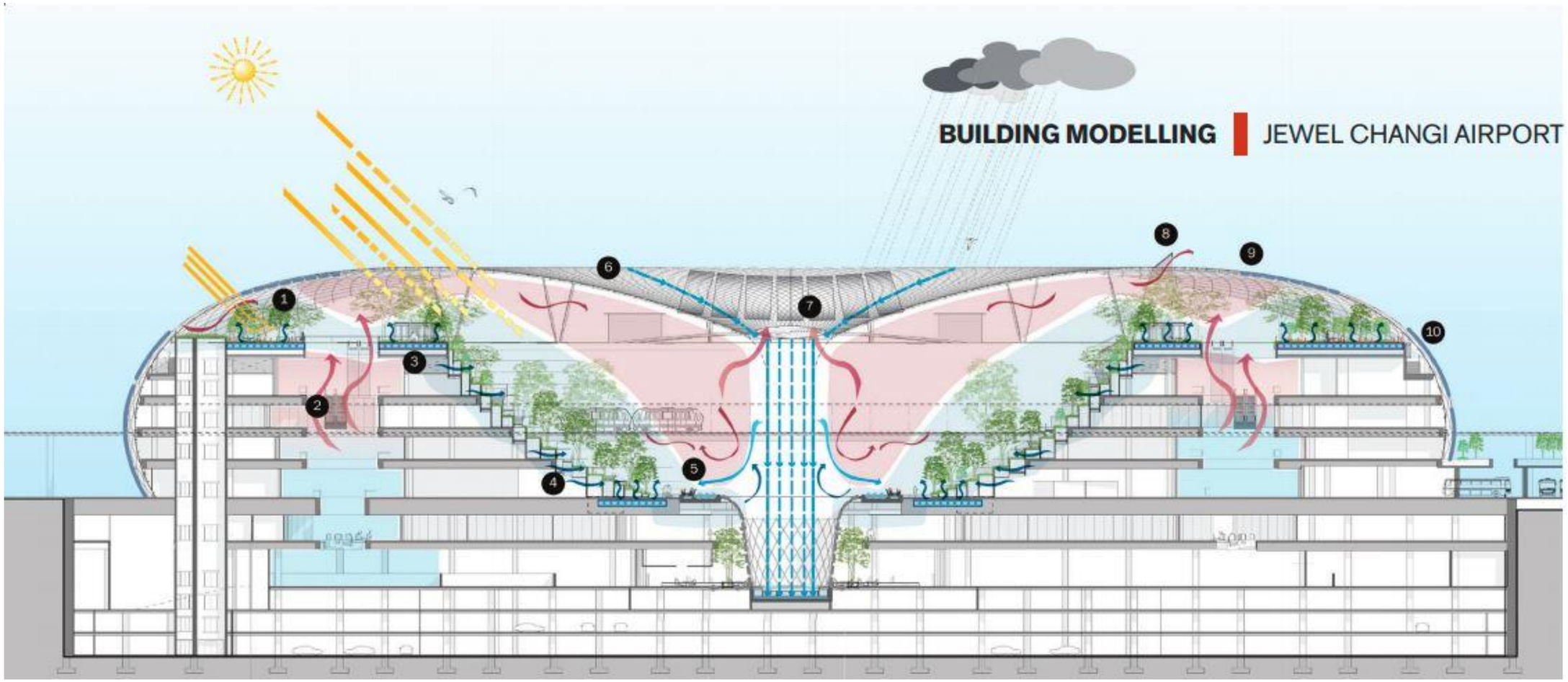


Figure 147.

End of the Research