# SKYSCRAPER'S PROGRAM

## Investigation of The Potential Functions of Highrises: A Vertical Public Space in Hong Kong

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## Investigation of The Potential Functions of Highrises: A Vertical Public Space in Hong Kong


**POLITECNICO DI TORINO**
**ARCHITECTURE & CONSTRUCTION CITY**


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## 0.3. Fifth Generation of High-rises Methodology:
Case of Public Space Skyscraper In Hong Kong

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# ABSTRACT

The Skyscraper is a relatively young concept in the architectural and urban fields. The 150-year-old typology is awaiting intense research to develop in several directions. Indeed, high-rises exist the way we know them today only thanks to the rigorous undergoing developments since the mid-19th century. The research and advancements carried out on vertical structures in the 21st century are especially impressive. Yet, when we analyze the function these structures provide to the city, they are fixed to business, residential, and mixed-use.

The dissertation resembles an attempt to understand the role of skyscraper functionality in developing the twenty-first-century urban model. In this view, a necessary starting point is to study how the existing programs formed through the history of vertical structures, starting in the USA -mainly in New York- to the early 21st century. Following is a study on one of the most creative magazines in the field of developing vertical habitats 'e-Volo Magazine.' The platform invites creative minds to participate in its yearly competition that started in 2009- until now. The main question of the competition is: "*What is a skyscraper in the 21st Century.*" The objective is to reach for innovative ideas of possible development for the vertical structures. In light of the main aim of the research '*What is the possible evolution of skyscrapers in the 21st century in terms of the program?*'

The last part will draw on the findings of the study and the radical conceptual programs proposed by multiple participants of the e-Volo competition. It is a parallel theoretical and empirical attempt to develop vertical structure functionality in response to modern city challenges. It is a call to smash the box of the rigid program of skyscrapers and pave the way for the creative integration of vertical structures in the urban grid.

**Key Words**
Skyscrapers Program, Vertical City, Radical Development, Fifth Generation of High-rises.

0.0.

# INTRODUCTION

The significance of verticality to human notion goes back to early history with the sense of power and knowledge it develops. It is when the functionality of vertical structures altered from symbols of the city to business structures resulting in the development of the skyscraper. In the 21st century, high-rises have been built like no other time, developing what is known now as the vertical city.

With the official world population crossing the limit of 8 billion inhabitants and the increasing rural-urban immigration, the world's urban network will grow and get denser. The city's horizontal expansion to absorb the population boom is not always an option, as lands are too scarce and valuable. Moreover, the city cannot expand horizontally with no consequences. Urban sprawl is one of the causes of congestion and long travel time. These are directly related to the urban and social well-being of the city. The high-rise boom of the 21st century responds to the increasing population: it is plausible to deliver housing and business functions in the vertical dimension of the cities. However, if the housing and business spaces are drastically increasing in the emerging superstructures, are we creating an imbalanced urban fabric with too many dense house/ business spaces and no services meeting these expansions?

In vertical cities, the upward expansion of the urban with the rigid existing programs needs to shift to enable the vertical structures to encompass various urban spaces often rendered in 'horizontal' structures like educational buildings, medical facilities, factories, public spaces, etc.
In the aim to break the inherited box of fixed programs of vertical spaces - like how the airconditioned box form was broken beforecase studies of the most influential high-rises from the 19th century till now are investigated, as how and why they evolved through the past decades. Through studying existing and conceptual programs, theoretical and empirical research take place in Hong Kong to provide a new program typology of vertical form to the city to overcome its imbalance of public space area per person. The main goal of this research is to allow all functions in the urban fabric to pave their way up into the sky along with existing programs.

0.1.

# EVOLUTION OF SKYSCRAPERS FUNCTIONALITY

## 1.0. The Term

The terms Skyline and Skyscraper as we utilize them today were born from several stages of development. By the end of the 19th century, America witnessed the phenomenon of tall buildings formation on various spots of its land, unlike the previous historical tall structures like minarets, bell towers, civic towers, and towers for military architecture, these buildings were occupied with daily functions such as businesses. Till that time these high-rises were called buildings, towers, and tall structures. By the turn of the 20th century, the term Skyscraper was given to the new phenomenon of Highrise architecture. After the birth of the Skyscraper, the term Skyline seized an architectural meaning in America: “outline of skyscrapers on the background of the sky.” Initially, the two terms were used in reference to other conceptions different from their present use. Skyline was a term used to describe the meeting line between the sky and the ground -the horizon-, in other words, it wasn’t used in architectural terms. Likewise, the Skyscraper term formerly was used back in the 18th century in relation to human activities and description of various matters like a high standing-horse, a very tall man, tall ornament on top of a building, etc. (***Maslovskaya O, Ignatov G. 2018***)

1. Lower Manhattan from Jersey City, 1932. Irving Underhill, Courtesy of the Woolworth Building.

## 1.1. Verticality

Judith Dupre in his book skyscraper (1996) stated that "*The interesting question is why does man want to build to the sky. What is there about the desire for domination, or to reach God, or for private pride*" 1

The notion of height and verticality has been vital throughout history. Since the earliest cultures, our brains associate the sought of height in relation to several things, from surrounding nature, trees, mountains, or a flying bird, or in relation to the height of human body or a building. The raw concept of height is essentially context free, as the conception of height is experienced in daily life in all times and histories in every detail of our surrounding environment. Thus, height isn't at all solely an architectural term, instead, it is an ideology-free from any background. In the words of Roland Barthes (1964) "*This common domain of the signified of connotation is that of ideology, which cannot but be single for a given society and history, no matter what signifiers of connotation it may use*" 2 (***Maslovskaya O, Ignatov G. 2018***)

"*The instinct to climb up to some high place, from which you can look down and survey your world, seems to be a fundamental human instinct*."3 Christopher Alexander states the human need for the ability to see and observe from above, seeking knowledge, and satisfying the curiosity of the human mind as a fundamental human instinct. Which he clearly distinguishes from the idea of a vertical city, a concept that he essentially stands against and calls for a low-rise city with exceptions for landmarks and monuments.

In modern times notion of height is mostly related to vertical cities represented in the skyscraper, this was extremely different if we go 150 years back. At that time the urban skyline used to be flat with the exception of monuments, castles, religious, and governmental buildings. These structures stood high in their urban context and they "*towered above everything else in a city or town; they were visible from miles away*." 4 (***Maslovskaya O, Ignatov G. 2018***)

"*Historically, the word tower usually designated the church and the town hall until the birth of the skyscraper. The main evolutionary change has been in function, from a Campanile watchtower of the Renaissance or minaret of Islamic architecture to the office building*."5

In the ancient city, tall buildings were of symbolic vertical dominant elements. The skyline was dominated by a few vertical components, which guaranteed the order of space. In the modern city, the skyscraper becomes the symbol of modernity. In modern times, the concept of verticality and height as a human need is reflected in the initial senses of architecture, the desire to create a city image through the vertical character of skyscrapers.

Skylines give personality to the place, and the greatest is the highest of them all. The skyscraper doesn't just aim to stand tall in the city, instead, it seeks to be number one. Therefore, skyscrapers are a frank reflection of the minarets, towers, and gothic elements in historical towns. Which asset that height is a concept the absolute. (***Maslovskaya O, Ignatov G. 2018***)

2. Luxor Obelisk in the Place de la Concorde, Dennis Jarvis (CC BY-SA), Paris, France.

## 1.2. Technology

The Modern model of the skyscraper was made possible by the technological innovations that flamed in the industrial era. By the mid-19th century, technological development enabled buildings to expand vertically. Some of these inventions were vital for the realization of the skyscraper. Such as mobility, materials, construction speed, evacuation methods, and wind resistance. Two of which were crucial for the advancement of the Skyscraper, which dominates cities' skylines in the modern world. They are elevators and steel frames.

3. The Lujiazui financial hub, Shanghai, China

### 1.2.1. The Elevator

The Elevator as a concept already existed before the mid-19th century. However, the invention had tremendous safety problems. It was only in 1853 when the American Elisha Otis invented the world's first safety lift, later, the inventor presented his innovation at the 1854 Crystal Palace Fair in New York. The invention of the safety break drastically changed the engineering of vertical buildings, which in turn had an impact on the real estate market. For the first time, the higher levels became more desirable, and of higher rent prices. Previously, floors above 4-levels were considered undesirable as the way to reach them was by stairs. However, by the mid-century, the upper floors became more appealing to people. This is directly reflected in the real estate market pricing. The higher the floor, the higher the price and the elevator paved the way for the floors to multiply vertically. From this moment on, the world went in one direction until this very moment. ***(Rem Koolhaas. 1978) & (Craighead, G. 2009)***

4. Elisha Otis Publicly Demonstrates the World's First Safety Elevator, 1854, in Crystal Palace Fair in New York.

### 1.2.2. Steel Frames

"*This new method of construction reduced the thickness of walls, increased valuable floor space, and because it weighed much less than masonry, allowed immense increases in height*" 6 By the 1870s, steel frames were increasingly replacing older building materials. After the Great Chicago Fire in 1871 that destroyed timber buildings, new building materials were widely requested. By the 1880s, with the technological advancements, steel quality became more consistent and more efficient. For the first time, the invention gave builders the ability to replace the old structural systems of timber and the very thick load-bearing walls with the modern slender steel structures. (***Craighead, G. 2009***)

The genius of steel frame technology is that it saved valuable rentable area, enabling larger interior space while weighing much less than the old stone structure system, transforming walls function from load bearing to an envelope of the building's interior. The lightweight slender system made it possible for buildings to go higher. For example, if we take the Pyramid in comparison with Burj Khalifa, Burj Khalifa's height equals the height of 6 Pyramids on top of each other, at the same time, the Pyramid weighs 10 times more than the weight of the Burj Khalifa.
The technological advancement boom of the late 19th century led to building skyward.

These technologies born in different parts of the world came together on American lands contributing to the American invention of skyscrapers. Ascended by the turn of centuries when the elevator and steel frames meet. Now lands can be multiplied vertically. Early examples of buildings using his technology are the Home Insurance Company in Chicago, built on 1885. In New York, 1902, Burnham used steel frames for the flatiron building structural system. (***Pinak R., Subham R. 2019***)

5. Structure of Home Insurance Building, Chicago, William Le Baron Jenney , 1885.

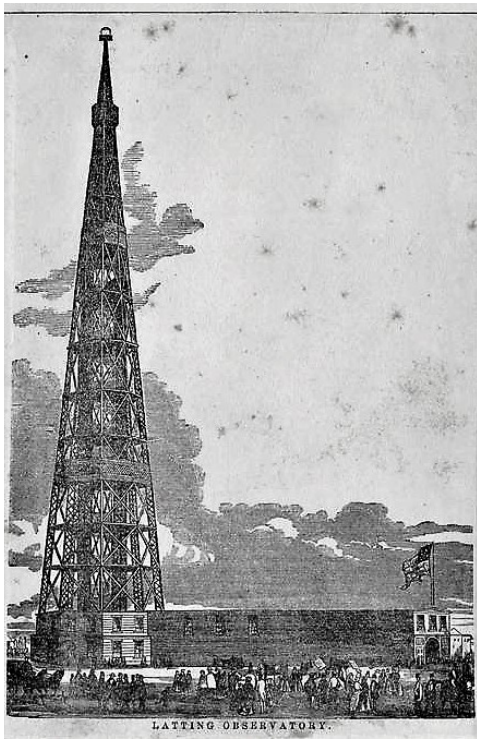
## 1.3. The Start 1850s-1900s.

The modern skyscraper is cumulative of tall building experiments, that took place before towers -skyscrapers- doomed cities' skylines. In America starting 1850s, the dominant ambition was to build high toward the sky. The experiments took place in three main locations, Manhattan, Chicago, and Coney Island. New technologies were tested and improved preamble to the modern skyscraper model. The gradual development of technological practices can be detected following a timeline of tall building constructions from the 1870s to the 1900s. The journey to the realization of a skyscraper could be explained through the analysis of the main tall structures of the 19th century.

### 1.3.1. Manhattan

#### Vertical Entertainment

In 1853, the International Fair in Manhattan - which was inspired by the London's Exhibition in 1851- had a new building dimension. The Fair consisted of two main structures; the first, is a replication of the Crystal Palace in London, and the second, is a tower. The tower stands 106m (350 ft) above the ground. A steam elevator enabled vertical travel through the Latting Observatory Tower. Its name reveals the function of the structure as the first observation deck on the Island of Manhattan. The tower made it possible to have a view of Manhattan. The Fair aimed to represent the supremacy of Manhattan over other American cities. It is also worth mentioning, that Otis's presentation of the first safety elevator in the world took place at that fair. (***Rem Koolhaas. 1978***)



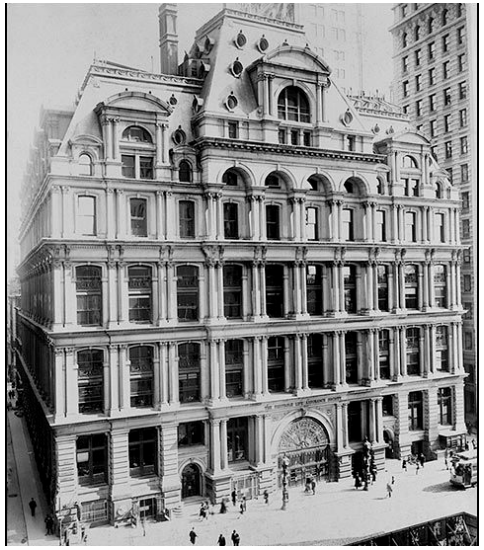

6. Latting Observatory, NYC, temporary structure for Manhattan International Fair, 1853. Program: observation deck. Height: 106 m/ 350 ft, Stories: 2, floors above ground 2 & 0 underground. Structural Mat.: Iron-braced Wood.

## Business Tall Buildings

In 1870, with the ambitions of Manhattan for domination through height. The Island witnessed the formation of its first tall building. The Equitable Life Insurance building, as the first tall building in New York. The 43m (141 ft) high building of 8 stories was the first tall office building with an elevator. Its construction covered the entire block, and the structural system was made of stone and iron columns. It represents the first practical application of new building technologies of the time. The structure was recognized by the New York times as the first skyscraper. 30 years after its opening, and despite taking the lead in its early years, the building was considered out of fashion. In 1912, the building gets destroyed by fire. (***Pinak R., Subham R. 2019)***

Afterward, another tall office building took place on 195 Broadway, Manhattan in 1875. The Western Union Building. The building rises 70m (230 ft) above the ground at the highest point of its clock tower and contains 10 stories of workspaces. The construction system was of stones for the exterior walls, while the interior skeleton was made of iron columns. In 1914, the building was demolished. (***CTBUH***)

Advanced elevators of the period were experimented within the 115 Broadway Boreel Building, in 1879. The building was 30m (98 ft) high and composed of 8 stories. The building was dedicated entirely to business. Boreel is recognized to be one of the first to use the hydraulic passenger elevator. Four Otis standard Hydraulic Elevators were placed in a central light court that is covered with a glass skylight, which was the center point of the 150 offices of the building. (***New York Times archive, Boreel Building***)



7. Equitable life insurance company headquarters, NYC, 1870. Program: offices, Architect, owner, developer, demolition, structure sys. Height, stories. Height: 43 m/ 141 ft, Stories: 8 floors above ground & - underground. Owner & developer: -, Structural Mat: Stone & Iron.

8. Western Union Building, NYC, 1875. Program: offices. Height: 70 m/ 230 ft, Stories: 10 floors above ground & 1 underground. Owner & developer: -, Structural Mat: Iron & Stone.

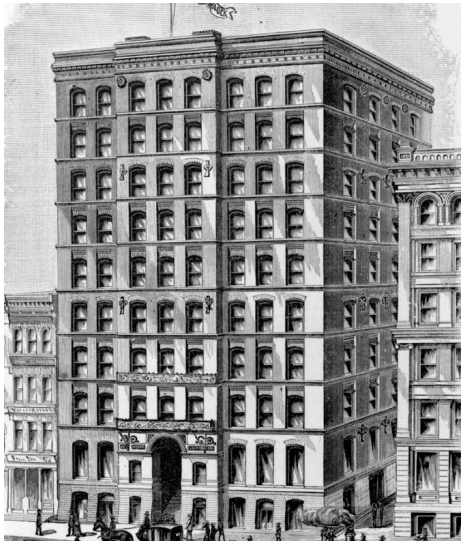




## Business Tall Buildings

In Chicago in 1882, the opening of the Montauk Building took place. Ten years had passed after the great Chicago fire of 1871 before the city was ready to join the New York high-rise building production. Designed by John Wellborn Root Sr. and Daniel Burnham – the latter commissioned to design the Flatiron Building. The building was a massive commercial project, containing ten stories of offices that went 39m (128 ft) above the ground and reached by two passenger elevators. The building was made of steel construction with thick walls which rested on heavy foundations. A decade later, the muddy soil of Chicago resulted in the demolition of the building. The building was considered the first steel structure in Chicago. The construction was an excellent reference for Burnham's successive tall building designs. (***Britannica 2017***)

In 1885, the 10-story Home Insurance Building in Chicago was one of the world's earliest skyscrapers. Designed by William LeBaron Jenney, it was also known as the first building to use the steel beam structure method with reinforced concrete. Therefore, it is one of the earliest to use this technique – if not the first. The use of steel massively reduced the load of the building, making it weigh only one-third of its masonry building version. This new construction method helped reduce the use of walls from being part of the structural system to an envelope that wraps the building and protects it from the outside. The building was later demolished in 1931 and replaced with the Field Skyscraper. ***(Gerard Peet 2011) (CTBUH) (The Guardian 2015)***



10. Montauk Building, Chicago, John Wellborn Root Sr. and Daniel Burnham, 1882. Program: offices. Height: 39 m/ 128 ft, Stories: 10 . Owner & developer: -, Structural Mat: Iron & Stone.

11. Home Insurance Building, William Le Baron Jenney, Chicago, 1885. Program: offices. Height: - m/ -ft, Stories: 10 floors above ground & - underground. Owner & developer: -, Structural Mat: Steel & Concrete.

## 1.3.4. Coney Island

### Vertical Entertainment

As Manhattan was transitioning from a ciy to a metropolis, the pressure of everyday life was increasing. And the need for escape points especially for the summer period dominated. By the 1870s, Coney Island turned into a spot for entertainment. Influenced by the technologies of the industrial era entertainment was dependent on the new technologies as much as the tall new architecture was. The Steeplechase Park was the first to be constructed on the island, designed upon the concept of "*The Technology of the fantastic.*"7 ***(Koolhaas 1978)*** Mechanical tracks extended largely on the island along with a 91m (300 ft) high tower assembled in 1876 in the middle of Coney Island. Successive to the 1853, Latting Observatory Tower in Manhattan, with the same function of providing observation decks for the masses. the structure offered a view of both Coney and Manhattan islands.

13. Luna Park, Coney Island, Frederic Thompson, 1903. Program: Recreational.

A second park was open for the public in 1903, Luna Park. Influenced by Steeplechase Park, and notions of verticality, the Park offers a particular type of vertical vision through the Luna VI ship, a literal application of the "Technology of the fantastic", the idea is to provide the opportunity of a panoramic view through a trip to the moon that ascends 30m (100 ft) above the ground.
Luna Park was designed by Thompson as a manifesto, Thompson was the first designer to build on the Island, and he used this opportunity to apply his architectural theories by randomly using spires and minarets whenever possible. To him these structures even if they didn't hold a function in themselves -as they were too narrow to have functions inside- but they did their entertainment goal from being tools of arousing human emotions. For Thompson, Luna's skyline is the focal point. The uniqueness of this design is that he replaced the natural vertical element of trees with a forest of towers. In Coney, the vertical structure had an entertainment function, different from the business in Manhattan. The Parks functioned as escape points from Manhattan yet were influenced by it and by the same technologies that shaped the new typology of vertical structures. In 1914 Luna Park goes up in flames. ***(Rem Koolhaas. 1978)***

In 1904, Dreamland was founded by the real estate developer William H. Reynolds. It was built in competition with Luna Park, and like its ancestors, the Park was seeking uniqueness. Being the last of the three big parks of Coney Island, consequently, was influenced by them. To distinguish itself from the other amusement parks -with a touch of early modernity-, Dreamland paints itself entirely in white, contrasting itself from the earlier parks, and fading away any influence of the surroundings. Dreamland's architectural theme is elegant, large, and more expansive when compared with Luna's chaotic randomness of the forest tower. The Park was dominated by one large central tower 'The Beacon Tower'. That tower rose 114m (375 ft) above the park, equipped with two elevators that carry the visitors to the top point where they can enjoy the view of the sea and the island. The Beacon Tower -for a year- was titled the finest tower ever built. ***(Rem Koolhaas. 1978)***

On a visit to Coney Island by Maxim Gorky – a socialist reporter-, misjudges the urbanism of the island and reads the amusement parks produced there as artificial and should be replaced by natural parks, not caring about the public opinion that 'People love Coney as it is.' By 1938, Coney Island faced an unfortunate transformation of 50% of its land into parks. A decision was made by Parks Department led by Robert Moses. Dreamland turns into a parking lot. Steeplechase withstands the changes, but its attraction points dissolve with the new changes. The time of the model of modernity comes to an end. By the turn of the century, following a period of about half a century of technological experiments of vertical buildings, the modern skyscraper starts to shape in Manhattan. ***(Rem Koolhaas. 1978)***

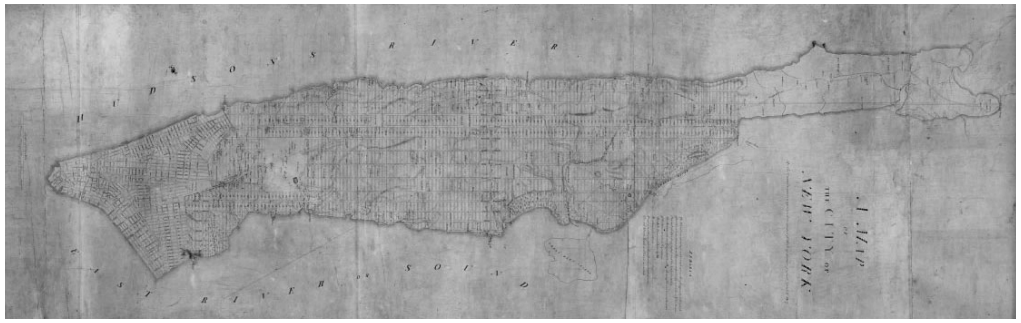

14. Dreamland Park, Coney Island, William H. Reynolds, 1904. Program: Recreational.

## 1.4. Evolution of Manhattan Skyscrapers 1900s- 1940s

"*In the American self-image of the 1920s, the icon of modern was the modern city, the icon of the modern city was New York City, and the icon of New York City was the skyscraper. the skyscraper symbolized the go-go and up-up drive that "America" meant to itself and much of the world.*" 7 The 1900s, mark the beginning of the skyscraper age in New York. Nevertheless, it was mostly in Manhattan where the competition for the tallest building took place. Thus, it developed into the creation of the building like a city, development of skyscrapers typologies, skyscrapers also became hotels and residential.

### 1.4.1. The Grid

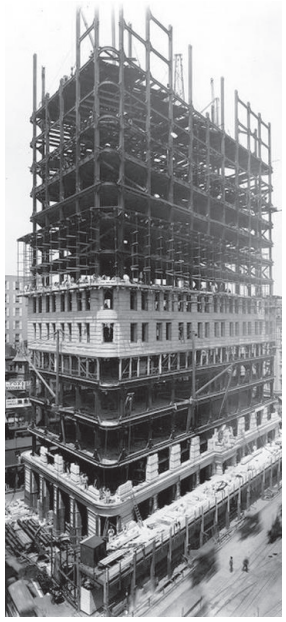
In reference to the Commissioners (1811) "*A city is to be composed principally of the habitations of men and strait-sided and right-angled houses are the most cheap to build and the most convenient to live in.*"8 To understand the logic of Manhattan's skyscraper is to grasp the logic of The Grid. Manhattan's urban design model was commissioned to Simeon Dewitt, John Rutherford, and Gouverneur Morris in 1807. Four years later, the commissioners announced The Manhattan Grid model. It is composed of 12 avenues intersected with 155 streets that divide the Island into an even 2,028 blocks. The Grid came out as a statement. It is simple yet extraordinary, precise yet flexible. As the Grid was designed for relatively empty land, it was a prediction for the future of the city. Its effects still reflect on all urban life aspects. "The land it divides, unoccupied; the population it describes, conjectural, the buildings it locates, phantoms; the activities it frames, nonexistent." 9 Now the metropolis architecture, infrastructure, transportation, utilities, and all urban aspects are following the pattern of the gird. The two-dimensional fixation of the grid – besides the fact that Manhattan is an island- gave freedom, or a reason for the city to expand vertically. ***(Rem Koolhaas, 1978)***



15. The Grid, Manhattan, the 1811 Plan.

## 1.4.2. Early 1900s'

With the technological conception of the elevator meets the steel frame one cannot simply ignore the ability to vertically multiply the floor areas of a single land. With the excuse that Manhattan is a financial district where the demand for business space is always increasing, along with the fact that Manhattan is an island with fixed dimensions. Developers and investors were able to gain the license to vertically extrude this rigid grid exceptionally high into the sky beyond the control of the architects and known urbanism. It was a time when the real estate business found its utopian city. In a city where developers assemble the projects, architects no longer design, they only build skyward.



16. Fuller Flatiron Building, NYC, Daniel Burnham, 1902. Program: offices. Height: 93.7 m/ 307 ft, Stories: 22 floors above ground & - underground. Owner & developer: GFP Real Estate, Structural Mat: Steel.

### Business Tall Buildings

The first decade of the 20th century marks the transition phase between the experimental phase of building tall structures and the official birth of the Skyscraper in Manhattan. An important example of the early 1900s is the Flatiron Building, as it represents the meeting of the elevator with the developed technology of steel frames. Beside the dominance of the developer's management of lands over urban and architectural design. Mr. Daniel Burnham was commissioned to build a 22-story building on a very narrow triangular-shaped block in New York. This building was only possible to achieve when Burnham decided to use steel for the skeleton, which was made of interlocking steel beams and columns, that he was able to develop from the lessons learned from the Montauk Block. A stone system would have been impossible, the masonry system supports the floor slabs on their walls, and as the building goes higher, the walls will grow thicker and eat up the entire ground floor. The brilliance of the Flatiron Building is that it was the first to use this technology. Built by Burnham a pioneer in skyscraper development, he was subsequently considered the Father of Skyscrapers. In the 1900s, steel technology, highland prices, and elevators opened the realm of the skyscraper era. ***(Rem Koolhaas. 1978) (ArchDaily 03 Feb 2011) (History-Daily)***



## 1.4.3. When Building became Tower: Late 1900s

One of the most significant variances between the high-rises of Chicago, Manhattan, and Coney Island is the different ratios between the width and height of their structures. With the exception of the late Flatiron Building, Coney Island had slender needle-like towers. On the contrary, buildings in Manhattan and Chicago were generally a literal extrusion of their lands resulting in cubic-shaped structures. It's for that reason, that despite the buildings in both cities standing higher than the towers of Coney Island, they would still be called buildings, while structures in Coney Island were called towers.

By the turn of centuries, the goal was to convert the building term into the title of a tower or skyscraper. In 1902, with the completion of the 22 stories triangular slim shape Flatiron Building, it was the first building to unintentionally claim this title in New York. In the late 1900s, the supremacy of skyscrapers became significant. Businesses started to pursue the image of a robust industry through high-rise structures. ***(Rem Koolhaas. 1978)***

### Business Tall Buildings

The Singer Building is considered the first building to intentionally attempt to transform itself from a building into a tower. Built-in two phases, in 1899, the structure consisted of 14 stories of red bricks and stones and was topped with a mansard roof. Later in 1908, Ernest Flagg designed a 'Tower' and placed it on top of the building. A thin structure of 27 stories, raising the final height of the office building to 187m (612 ft). The concept was to stretch the existing building in an alternative way to the typical block edge risen tall buildings of the time. Flagg anticipated in an article in 1907, that the city is to become "a city of towers" accordingly, the skyscrapers/tower going higher than ten of the island and reads the amusement parks produced there as artificial and should be replaced by natural parks, not caring about the public opinion that 'People love Coney as it is.' By 1938, Coney Island faced an unfortunate transformation of 50% of its land into parks. A decision was made by Parks Department led by Robert Moses. Dreamland turns into a parking lot. Steeplechase withstands the changes, but its attraction points dissolve with the new changes. The time of the model of modernity comes to an end. By the turn of the century, following a period of about half a century of technological experiments of vertical buildings, the modern skyscraper starts to shape in Manhattan. ***(Rem Koolhaas. 1978)***

17. Singer Building, NYC, Ernest Flagg, two stages: lower 14 stories in 1899, Tower of 27 stories added on top, in1908. Program: offices. Height: 187 m/ 612 ft, Stories: 41 floors above ground & 1 underground. Owner & developer: -, Structural Mat: Stone & Steel.

In 1909, The Metropolitan Life Building was the second company to apply the concept of transforming a building into a Tower. With various similarities to Singer Building, it was built on two phases. First, in 1893, where ten stories building typically occupied the lot. The second phase took place in 1909 when the company sought to expand vertically with a 50 stories tower, which took place on the northwest corner of the existing building. The Tower reached a height of 213m (700 ft) above the ground, transforming the tall old building into a tower. With this significant height, The Metropolitan Life Building seized the title of the tallest building in the world from the Singer Building, and for four years it held the title until the construction of the Woolworth Building company. ***(Rem Koolhaas. 1978) (Skyscraper Museum)***

18. The Metropolitan Life Building. NYC, Napoleon LeBrun and Sons, main ten story block in 1893, Metropolitan Tower in 1909. Program: offices. Height: 213 m/ 700 ft, Stories: 50 floors above ground & - underground. Owner & developer: Metropolitan Life Insurance Company, Structural Mat: Steel.

## 1.4.4. Birth of The Term: Skyscraper

Stepping into the second decade of the 20th century, Manhattan was ready to build higher. It was considered the time for skyscrapers. Now, building technologies are more advanced, developers are pursuing more and more profit, and corporations are in a skyward competition seeking power and dominance. In addition, now architects have more experience with high-rise structures, but it isn't up to them to decide the height of the next skyscraper or the square meters it occupies, instead, they are commissioned by the clients, developers, and builders to create skyscrapers decided by the latter parties. It was a time of building up-up and fast-fast. "There is no manifesto, no architectural debate, no doctrine, no law, no planning, no ideology, no theory; there is only - Skyscraper."10 and the most potent is the tallest of them all.

### Business Tall Buildings

In 1913, the construction of The Woolworth Building was finalized. At that time, the theoretical height of a skyscraper reaches up to 100 floors. The Woolworth is composed of 60 stories, entirely equipped by businesses. The structure was divided into 30 lower floors which occupied the entire block, they were topped by a 30-story tower producing a final height of 241m (792 ft). The building is considered an early skyscraper that rose high dominating New York's skyline and it was the tallest building in the world at the time, The



19. Woolworth Building, NYC, Cass Gilbert, 1913. Program: offices. Height: 241 m/ 792 ft, Stories: 58 floors above ground & 3 underground. Owner & developer: F.W. Woolworth Company; Irving National Exchange Bank, Structural Mat: Steel.

20. Equitable life insurance company headquarter, NYC, 1915. Program: offices. Height: 169 m/ 555 ft, Stories: 40 floors above ground & - underground. Owner & developer: -, Structural Mat: -.

neo-gothic building held the title from 1913-1930. The distinctive characteristic of The Woolworth is its classical envelope, a historic exterior, wrapping a tower of steel structure, and the modern model of business. With this concept, the skyscraper was termed 'The Cathedral of Commerce.' Later, The New York World titled the Woolworth the "*American architectural masterpiece of the twentieth century.*"11 It was an essential reference for the setting for the coming 1916 zoning low.
Another new concept that the Woolworth established is that the building doesn't have to only house it's own business, but can also rent spaces for other businesses. Land now becomes multiplied and stacked. Cass gilbert the architect of the building stated that: "*The Skyscraper is the machine that makes the land pay*"12 ***(Rem Koolhaas. 1978) (ArchDaily17 Feb 2014) (Skyscraper Museum)***

In 1915, the new Equitable Building life replaced the old 1870 Equitable Building that was destroyed in a fire in 1912. The new office building took place in the same block as the previous Equitable Building. The new Equitable Building is a literal extrusion of the whole block it occupies. The skyscraper grows 169m (555 ft) of 40 stories into the sky, generating a massive area of 111,500 sqm (1.2 million square ft) of rentable space. It is nothing less than an enormous structure that can house about 16,000 people every day. The building is 'a City within a City.' An enormous shadow formed due to the immense bulk of the building, affecting the quality of the environment in a large area of its urban context. Making it one of the first buildings resulting in the demand of light and air rights. The impacts of this new skyscraper played a primary role in the creation of the 1916 Zoning Law, the building that changed New York City's zoning laws. ***( Koolhaas. 1978) (CTBUH) (New York Times, 2016)***

## 1.4.5. Residential Skyscraper

The 1916 Zoning Law, led by chief architects: George Mcaneny, and Edward M. Bassett. "*The time has come when effort should be made to regulate the height, size and arrangement of buildings*"12 ***(George McAneny)***
1915, Equitable Building was blamed to be responsible for the new zoning law. But the Equitable building was just the ultimate reason the call for restriction became so urgent. While the law is regulating future buildings to not create another equitable building, it takes Woolworth as a reference. Therefore, a tower can occupy one-quarter of its lot. The zoning law was put to control height, step-back rules, bulk, and envelopes of buildings to conserve the right of air and light for everyone, preserving a healthy environment. Imaginary envelopes were drawn on the map of Manhattan to restrict further construction of the blocks. The 1916 law was mainly a tool to control the congestion caused by the business population. "The reduction of density in Manhattan is directly a product of the 1916 Zoning Resolution," Mr. Weisbrod said. "*The 1910 population of Manhattan was 2,331,542, or 164 people per acre. In 2010, the population was 1,585,873, or 109 people per acre*."13

Following the zoning law there were efforts by architects of the time led by Hugh Ferris who published his book The Metropolis of Tomorrow in 1929. The noticeable common point in all efforts of regulations and theories is that they take the skyscraper as a role that all the laws and theories should adjust to it. Barclay-Vesey Building, 32 floors, 1926, 152m, by Voorhees, Gemlin & Walker. The Art-Deco skyscraper was the first to apply the new zoning law, resulting in a design of a tall building with setbacks from all sides as it grows upward. ***(Rem Koolhaas. 1978) (New York Times, 2016) (Skyscraper Museum, 2016)***

In 1930, Manhattan's skyline was topped by the first building to exceed the height of 1000 feet. Chrysler Building, with a needle-like top ornament of 56m, makes the final height of 319m (1,046 ft). The building was built by Walter P. Chrysler and designed by William van Alen who wanted to build the world's tallest building. The Art-Deco monument gained this title from 1929-1931 when it was eclipsed by the 381m Empire State Building – built to put Chrysler in second place in the height race. The skyscraper design typically followed the city's zoning low; however, it is most famous for the top ornamental beauty expressing the Jazz Age in New York. ***(ArchDaily 22 Dec 2010) (Skyscraper Museum) (CTBUH)***

21. Chrysler Building, NYC, William van Alen,1930. Program: offices. Height: 319 m/ 1,046 ft, Stories: 77 floors above ground & - underground. Developer: WP Chrysler, Structural Mat: Steel.



25. Ritz Tower, NYC, First Modern Residential High-Rise, Carrere & Hastings; Emery Roth & Sons, 1926. Program: Residential. Height: 165 m/ 540 ft, Stories: 41 floors above ground & - underground. Owner & developer: -, Structural Mat: Steel.

The dominant function of high-rises or early skyscrapers was business, the reason for this was that besides the demand for working space in a business city was used as an excuse to go skyward. Along with Manhattan's fixed land dimension, it was also in the interest of business owners to create an image of their companies and developers to make maximum profit. By the mid-19th century, residential developers and builders sought to profit. They constructed higher buildings, as now -with the elevator- the real estate residential market changed, the upper floors coasting more than lower stories, as they have fresher air, better light, and view. While the first two decades of the 20th century witnessed the rise of the business skyscraper. It was only in the mid-1920s that the first residential skyscraper was realized. The Ritz Tower, the residential skyscraper was financed by the developer Artur Brisbane -who commissioned Ritz Carlton Company to manage the structure -and aimed to be the highest residential building in Manhattan.
"*People have lived in apartment buildings with elevators since the 1860s. But until the [nineteen] twenties they did not exceed about 15 floors. These "sky scratchers" were laughable to Emery Roth. To him is owed the Ritz Tower built in 1926, the first modern residential skyscraper, 41 stories, 165 meters (540 feet) high. The Ritz Tower rapidly became the prototype for a new lifestyle. Half hotel, half apartment block, it was particularly suited to the nomadic world of business and to people who were already deciding to move to the country and to maintain only a pied-a-terre in town*"14 ***(Craighead, G. 2009) (CTBUH)***

## 1.4.6. Hotel Skyscraper: The Waldorf-Astoria Hotel and Empire State Building blocks

1893, the Waldorf hotel was finalized. Three years later, on the same block, the Astoria hotel reached completion. Astoria hotel leveled its ground floor to match the Waldorf's, and they both went 16 stories above the ground. The idea was to unite the two hotels, transforming them into one, the Waldorf-Astoria Hotel. In 1897, the two hotels officially merge. Three decades later, the hotel was deemed old-fashioned, and not following the age of modernity. In 1924, plans were made to replace the old Waldorf-Astoria Hotel with a further impressive, 'Modern' structure. The cubic-shaped building can develop into a tower, now the hotel can be a skyscraper. In 1929, the Waldorf-Astoria hotel is demolished to be replaced by the Empire State Building. The hotel will be reconstructed in another block of Manhattan's grid. It is a period of urbanism where skyscrapers are eating buildings. ***(Rem Koolhaas. 1978) (CTBUH)***

22. Waldorf-Astoria Hotel, NYC, Henry J. Hardenbergh,1893-1896. Program: Hotel. Height: 65.2 m/ 214 ft, Stories: 16 floors above ground & - underground. Owner & developer: -, Structural Mat: Steel.

1931, The Empire State Building occupies the entire block of the Waldorf-Astoria Hotel. The original building gets demolished to make way for the 'Model of Modernity' of the skyscraper. The destruction of the hotel was intended as a part of the construction plan. The building was finalized within a year and 45 days. This accomplishment was made possible due to the simple scheme of the skyscraper's design. The program consists of a centric core, where elevators and utilities take place. The remaining space contains offices. The floors get narrower as the building grows skyward. The Empire State Building encompasses 102 stories of business, reaching a height of 381m (1,250 ft) into the sky. The new structure is designed to be the world's tallest skyscraper, overshadowing the Woolworth and Chrysler Buildings. It held the title till 1972. It was the first skyscraper to exceed 100 stories. ***(Rem Koolhaas. 1978) (Skyscraper Museum) (Craighead, G. 2009)***

The current Art Deco Waldorf-Astoria Hotel took place in another block in Manhattan's grid in 1931. Designed by Schultze & Weaver, the architects were commissioned to design the greatest hotel ever built. The hotel occupied the whole block and became the most expensive hotel, surpassing all the imaginary expectations of the time. The unofficial palace housed the most famous figures, royals, and movie stars.
The skyscraper comprises two linked twin towers, rising 191m/625 ft above the ground. Unlike the Empire State Building, the hotel mass is bulky. ***(Rem Koolhaas. 1978) (Waldorf towers) (CTBUH)***

23. Empire State Building, NYC, SL & H, Shreve, Lamb & Harmon Architects, 1931. Program: offices. Height: 381 m/ 1,250 ft, Stories: 102 floors above ground & 1 underground. Owner & developer: W&H Properties, Alfred E. Smith; John J. Raskob, Structural Mat: Steel.

24. Waldorf Astoria hotel, NYC, 1931. Program: Hotel. Height: 191 m/ 625ft, Stories: 47 floors above ground & - underground. Owner & developer: Hilton Worldwide, Structural Mat: Steel.

## 1.4.7. Horizontal Skyscraper

Designed by Le Corbusier, the Cartesian/ Horizontal Skyscraper is naked. It is naked from customs, stone facades, ornaments, and technologies. It is a theoretical replacement for the Manhattan skyscraper and a revolutionary scheme that was not built. In contrast with the Manhattan skyscraper, Le Corbusier proposed a plain, symmetrical, repeated model of horizontal towers that stretches 220m upwards. The stone facades are replaced with glass walls, resulting in the creation of a radical glass wall. Simply put, The Cartesian skyscraper is a Manhattan anti-skyscraper model, in which the American model of skyscraper fades. Even though the typology is anti-Manhattan, the function is pro-Manhattan. The Cartesian scraper accommodates business, and business only. "*To say skyscraper is to say offices, that is businessmen and automobiles…*."15

Afterward, he creates a city of grouped Cartesian Skyscrapers and calls it the Radiant City, which was to emerge from a tabula rasa, meaning to be built on demolished European cities. Le Corbusier developed his design for various places, including France, Antwerp, Morocco, Moscow, India, Germany, Brazil, and Algiers. Outside of Manhattan, the new typology offered other functions distant from the business role. In fact, the Radiant City was the main inspiration for postwar housing districts that aim to cover the housing shortage caused by WWII. By the late 20th century, Radiant City urban-influenced numerous housing projects around the world. Today, the majority of Cartesian-inspired projects have been demolished or remodeled. ***(Rem Koolhaas. 1978) (ArchDaily 11 Aug 2013)***

26. The Cartesian/Horizontal Skyscraper. The Radiant City model, Le Corbusier, 1920s. Height: - m/ -ft, Stories: - floors above ground & - underground. Owner & developer: -, Structural Mat: -.



## 1.4.8. New Typology: The Rockefeller Center

"*There is a movement in the design and construction industry called 'integrated design,' where architects, engineers, specialists, contractors and building operations staff are in on the design process from the outset. Tower designers have been designing this way for years: there is no other way.*"16

### First Mixed-use

The story of the Rockefeller Center goes back to 1928, when John D. Rockefeller purchase land of Columbia University. Three neighboring blocks in Manhattan's Grid. The intention was to create "a City within the City." Rockefeller is not just a skyscraper it is a Complex of 14 buildings where the three blocks only meet in the underground to preserve the rigid Grid of the city. The underground is dedicated for shops, restaurants. The program is to create a theatre for the Metropolitan Opera Company, press building, the Elgin Botanic Garden, and business complex.

The Rockefeller Complex is one of the largest privately owned business projects. The Complex designed through many phases and minds. It is "*a masterpiece without a genius… an example of architecture by committee*"17 Although it's the 1930s, nonetheless, the influence of the early tall buildings concept of a literal extrusion of the site remains feasible for the lower floors of the early 20th century's skyscrapers model. The unconscious architecture of the time followed the notion of supremacy which was applied through height and the mass of the skyscraper. It needs to be the largest the tallest, the biggest. The building reaches a height of 259m (850 ft) and was open in 1939. The Center is considered to be the first mixed-use skyscraper. After the Empire State Building and Rockefeller Center and due to the WWII, the skyscraper race came to an end. ***(Rem Koolhaas. 1978) (Rockefeller Center)***

27. Rockefeller Center, NYC,1939. Program: Mixed-use. Height: 259 m/ 850 ft, Stories: 70 floors above ground & - underground. Owner & developer: John D. Rockefeller, Structural Mat: -.

## 1.5. Modern Skyscraper in the late 20th Century: The International Style

By the end of the 1930s, the skyscraper boom came to an end. The 1940s WWII affected everything; the building industry went through a pause phase. To later start again by the 1950s. "*Skyscrapers began to appear in Shanghai, Hong Kong, São Paulo, and other major Asian and Latin American cities in the 1930s, with Europe and Australia joining in by mid-century.*"18

The American invention -the skyscraper- was being globalized by the 1950s. Skyscrapers became the symbol of the economic power of a city and the capitalist age. Aesthetics, efficiency, and economy play the major factors of the skyscraper success. Skyscrapers of the 50's onward, tended to distinguish themselves from the pre-war period by being modern. Modernism played an essential role on both cities planning and architectural design. Modernity, (like older skyscraper development) was to depend on & keep up with technological advancements of the time.

### 1.5.1. The 1950s

#### Business Tall Buildings

One of the main technological advancements that changed the face of architecture and skyscrapers was glass technology. The invention resulted in the birth of the next generation of high rises, the Modern Skyscraper. By that time, glass was more durable and was produced in large-scaled sheets. The glass technology also included the production of heat and glare-resistant glass. Large glass sheets became a sign of modernity, and people loved being in glass spaces. The 50s were a turning point for how we perceive architecture and the skyscraper's envelope.
The Lever House in New York resembles the modern evolution of skyscrapers. In 1952, the structure of twenty-one stories with all-glass facades -considered to be the first glass skyscraper- went 94m (308 ft) above the ground. A scheme by Skidmore, Owings, and Merrill the structure was Unilever's headquarters. A modernist building that is composed of a podium that occupied the entire site, topped with an offset tower of the horizontal base. The city's landmark fascinated people through time, developed a legacy, and turn into a monument of skyscraper evolution. ***(Archdaily 26 May 2010) (dezeen 2022) (CTBUH)***

28. Lever House, NYC, SOM, 1952. Program: offices. Height: 94 m/ 308 ft, Stories: 21 floors above ground & - underground. Owner & developer: Lever Brothers Company; RFR Realty LLC, Structural Mat: Steel.

## 1.5.2. Residential Skyscraper

Mies van der Rohe, a pioneer modernist, gave New York a timeless monument and the millennium's most significant building. Seagram Building, completed in 1958, resembles the postwar architectural shift from stone to glass. The 38 stories, 157m (515 ft), is one of the first glass skyscrapers, it is the result of reinforced concrete, steel frames, and glass. A glass technological façade of bronze and dark glass was used for sun and heat protection, a solution that set a standard for a modern skyscraper. The office building provided a street-level plaza with 100 feet offset of the site, the plaza equipped with two fountains raises the engagement between the building and the city. In its all notions, the Seagram became a prototype for modern architecture and skyscrapers. ***(ArchDaily 2010) (CTBUH) (New York Times, 1999)***

Skyscrapers are a symbol of economic growth and power everywhere. In Milan, in 1958, during the postwar period and after the Fascist era, The Pirelli Tower was constructed. Gio Ponti got commissioned to design an American skyscraper that symbolizes the power and economic growth of the decade and a symbol of a nation's hope. Inspired by the Modern movement, Ponti designed a business tower with glass facades and used aluminum mullions to create a seamless curtain wall. Unlike the American rectilinear approach, Ponti suggested an extrusion of a tapered plan that goes 127m (416 ft) into the sky. The structure provided a 32 stories space dedicated entirely to business. The genius of the tower is that it was the first to use a 25m span frame. Moreover, the design offers a small footprinted skyscraper occupying a small portion of its block, thus, providing natural ventilation and light. For almost four decades, the building was Italy's tallest structure. ***(ArchDaily 27 Feb 2014)***

29. Seagram Building, NYC, Mies van der Rohe & Philip Johnson, 1958. Program: offices. Height: 157 m/ 515 ft, Stories: 38 floors above ground & - underground. Owner & developer: Seagram Building, Structural Mat: Steel.

30. Pirelli Tower, Milan, Gio Ponti & Pier luigi Nervi,1958 Program: offices. Height: - m/ -ft, Stories: - floors above ground & - underground. Owner & developer: -, Structural Mat: -.



31. 860-880 Lake Shore Drive, Mies van der Rohe, Chicago,1952. Program: Residential. Height: 82.3 m/ 270 ft, Stories: 26 floors above ground & - underground. Owner & developer: -, Structural Mat: Steel.

It is evident that, except for a few examples, the dominant function of the skyscraper before the mid-20th century was devoted to business. Nonetheless, the office building remained the primal function of the late 20th-century skyscraper. However, the period witnessed a broader increase in other purposes, such as housing skyscrapers. Throughout the century, the concept of tall buildings was spreading around the world. The effects of WWII were evident in the housing shortage it caused. Therefore, the residential skyscraper was seen as a perfect solution to the post-war housing problem. There was a worldwide spread of the residential skyscraper which even became an essential function beside the office skyscraper.

In 1952, in the city of Chicago, Mies van der Rohe responded to the housing shortage with his innovative 860-880 Lake Shore Drive towers. A two radical 82.3 m (270 ft) of 26 stories apartment skyscraper as a new post-war typology. The neighboring towers were constructed on one block, representing a statement of independent architecture from the site it occupies. The significance of this building lies in the fact it was a very early modern skyscraper to be dedicated entirely to housing. The glass and steel structures are known as one of the most iconic residential skyscrapers of the 20th century. Mies's genius was to use the post-war demands as an opportunity to redefine the residential high-rise architecture. ***(ArchDaily 10 May 2010) (CTBUH)***

Across the Atlantic Ocean, in the same year ostructure intended to provide public services for the dwellers. The genius of the "vertical garden city" is that it didn't only create residential units, but it designed the community. The roof turns into a service area that accommodates gathering spaces like, a garden, gym, pool, and kindergarten. As per the podium, the architect supported the entire structure on immense pilotis providing a free space below the building for additional gardens and gathering areas. The building is made of reinforced Beton-brut concrete (rough-cast concrete), low-cost material for post-war construction. Unite d' Habitation inspired a series of public housing that spread across the continent. In 1959, the fourth in the series Unite d' Habitate took place in Berlin, Germany. Corbusierhaus came as a sign of a new modern Germany. The design is almost a copy of Marseille's structure. This series developed a new model for public housing in Europe and across the world. It is considered one of the most innovative public residential buildings. ***(ArchDaily 5 Nov 2010) (ArchDaily 6 Nov 2010)***

By the 1960s, high-rise residential clusters vastly spread as a typology for low-cost public housing neighborhoods around the globe. St. James Town, located in Toronto, Canada, is a high-rise habitat that is considered one of the densest in Canada with more than 17,000 official inhabitants. Nineteen towers with an average height of 20 stories come together on land of 130,000m2 (32.1 acres).

32. Unite d'Habitat, Corbusierhaus, Berlin, Le Corbusier, 1959. Program: Residential. Height: - m/ -ft, Stories: 8 floors above ground & - underground. Owner & developer: -, Structural Mat: -Concrete

A few communal services of greenery, parking, and playgrounds are inserted in-between the towers. The typology of the residential high-rises comes as a consequence of the evolution of the skyscraper in Manhattan, the Radiant City by Le Corbusier, the response to the post-war housing shortage. ***(Canadian Architect 2020) (St. James Town 2021)***

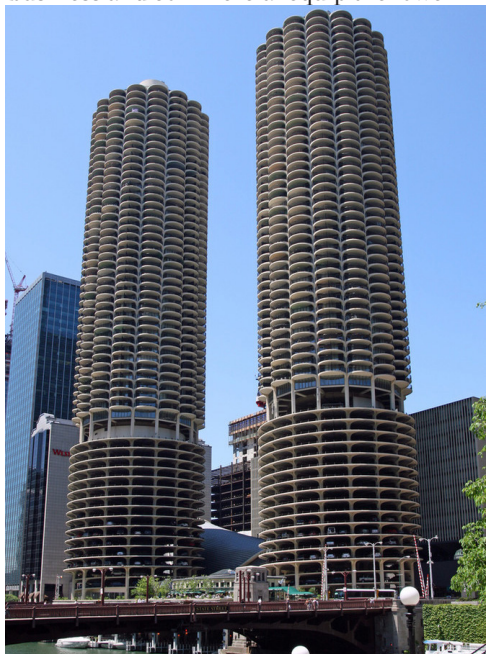
33. St. James Town, Toronto, Canada, 1960s.

## 1.5.3. Mixed-Use Skyscrapers

A Mixed-Use Skyscraper typology evolved from combining the office and residential functions of skyscrapers, along with recreational functions. The emergence of this typology came for two reasons. First, it was noticed that office skyscrapers were left empty at night times and during weekends. Second, it is the literal application of 'city within a city' that provides everyday needs and services, all on one block. It is the creation of a 24/7 community. A revolutionary typology that developed by the mid-20th century, and became dominant in the 21st century.

In 1964, Chicago witnessed the formation of one of the first mixed-use high-rises. Marina City, designed by Bertrand Goldberg, was to combine diverse programs in residential, business, parking, and recreational areas. Goldberg was commissioned by the developer, William McFetridge, to design a complex that provides an attraction point to the city. He creates Twin towers that go up to 180m (587 ft) into the sky and contain 61 stories. The first 19 floors are spiral parking, the 20th floor is storage and laundry services, four floors of the auditorium, 16-floor office spaces, along with 450 apartment units in each tower, making a sum of 900 units in the complex. The corncob-like design is based on the architect's trademark of prohibiting the use of right angles. The cylindrical shape of the structure resulted in 360-degree views. The corncob facades gave the towers a unique silhouette in the skyline of Chicago. ***(ArchDaily 11 Nov 2010) (Britannica 7 Dec 2017)***

875 North Michigan Avenue (previously the John Hancock Building),1969. An icon of Chicago's supreme skyline. The structure stands to be not just the tallest building in the city at the time, more importantly, its innovative engineering and mixed-use supertall typol ogy. The building is a mix of residential, offices, and commercial functions that distribute over 100 floors of the building, where business and commercial equip the lower part, giving way for residential units to go upward away from street noises. It is a structural engineering wonder that goes 343.7m (1,128 ft) in the air, a marvel result of the collaboration between Bruce Graham and the structural engineer Fazlur Khan. The collab resulted in the first experiment of an exterior brace-tube structural system in a supertall structure. The framed tube system was specifically developed for the building. This innovative system allowed us to save around half of the steel quantity when compared with other structures. "*The John Hancock Center isn't just important to Chicago; it's important to city skylines across the world. When it was completed 50 years ago, it changed what architects and engineers' thought was possible*"19 Jesse Dukes, WBEZ Chicago. ***(SOM) (CTBUH) (Britannica 13 Apr 2018)***



34. Marina City, Chicago, Bertrand Goldberg, 1964. Program: Mixed-use. Height: 180 m/ 587 ft, Stories: 61 floors above ground & - underground. Owner: Marina City Tower Condo Association, Structural Mat: Concrete.

35. 875 North Michigan Avenue, Chicago, SOM, 1970. Program: Mixed-use. Height: 343.7 m/ 1,128 ft, Stories: 100 floors above ground & 1 underground. Developer: Jerry Wolman Associates; John Hancock Mutual Life Insurance Co., Structural Mat: Steel.

## 1.5.4. The 1970s-1990s

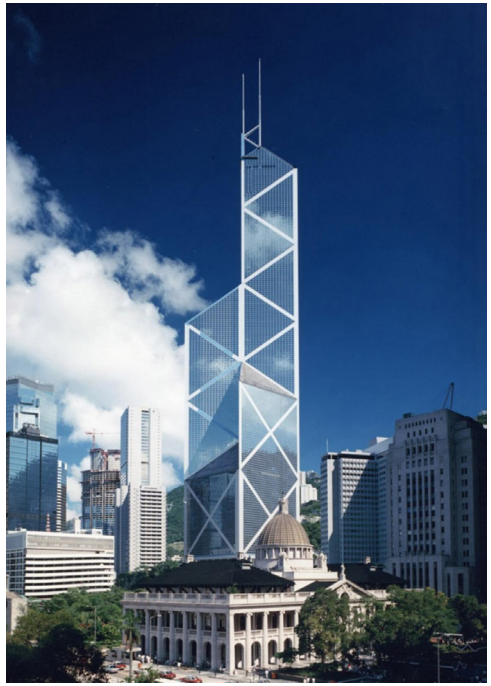
By the 70s, the skyscraper functions had been already formed, despite that residential high-rises had significantly increased in this period, along with the mixed-use typology, the most remarkable high-rises of the period go for business functions. The race now is once again focused on the highest, most technologically advanced structures, and unique modern aesthetics. In 1896 Louis Sullivan wrote "*What is the chief characteristic of the tall office building? And at once we answer, it is lofty. This loftiness is to the artist-nature its thrilling aspect... It must be tall, every inch of it tall. The force and power of altitude must be in it the glory and pride of exaltation must be in it. It must be every inch a proud and soaring thing, rising in sheer exultation that from bottom to top it is a unit without a single dissenting line...*" 20

### Business Tall Buildings

Chicago's Willis Tower (formerly Sears Tower) conquered the skyline of the city and the world upon its completion in 1974. With a height of 442.1m (1,451 ft), the skyscraper seized the title of the tallest building in the world and held it for over 20 years until it lost it in 1998 to the Petronas Towers in Kuala Lumpur. The supremacy of the Sears Tower wasn't only thanks to its height. Its innovative engineering set the timing for a new era in skyscrapers design. The collaboration of the geniuses Bruce Graham and Fazlur R. Khan of SOM was once again fruitful for the future development of skyscraper engineering that provides the ultimate aesthetics and exceptional designs. The design introduced a revolutionary structure of nine squares that come together as one, the square tubes then vary in height beyond the fiftieth level. Resulting in the birth of the first bundled-tube structure, a typology that influenced various superstructures, and the current world's tallest building, Burj Khalifa, which uses the same principle developed by the Willis Tower. The height variation responds to the setback laws, and at the same time, creates a new strategy to increase the wind resistance of the structure in the windy city of Chicago. The distinctive stepped silhouette of the building and the Skydeck Chicago located on the 103rd level still attracts around 1.4 million tourists every year. ***(ArchDaily 1 Jun 2010) (SOM) (Skyscraper Museum) (CTBUH)***

36. Willis Tower (formerly Sears Tower), Chicago, Bruce Graham, SOM, Fazlur Khan, 1974. Program: offices. Height: 442.1 m/ 1,451 ft, Stories: 108 floors above ground & 3 underground. Owner & developer: The Moinian Group, Sears Roebuck and Company, Structural Mat: Steel.





37. Bank of China, Hong Kong, I.M. Pei, 1990. Program: offices. Height: 367.4 m/ 1,205 ft, Stories: 72 floors above ground & 4 underground. Owner & developer: -, Structural Mat: Concrete-Steel Composite

38. Petrona Towers, Kuala Lumpur, Malaysia, Cesar Pelli & Associates, 1998. Program: offices. Height:451.9 m/ 1,483 ft, Stories: 88 floors above ground & 5 underground. Owner & developer: KLCC Property Holdings Berhad, Structural Mat: Concrete-Steel Composite.

Bank Of China, 1990, was designed by the Pritzker Prize winner I.M. Pei when he was commissioned to develop a high-rise representative of the Chinese ambitions. Influenced by innovative engineering, he mixes the technologies applied in the 875 NMA and the Willis Tower. The architect alternates the X-shaped brace tube developed by Fazlur Khan with an exterior bracing system inspired by the growth of the bamboo plant. The system transfers the structural loads to five steel columns positioned at the building corners. The clever use of a bamboo-inspired brace as it is a symbol of growth, strength, and wealth in China. Additionally, it is an ingenious substitute for the X shape that represents death in Chinese culture. Willis Tower's influence is observed in the four shafts of the building that alternate in length from the height of 52m until only one of the four masses reaches the peak at 367.4m (1,205 ft). The design of the building not only creates a distinctively modern structure in the skyline of Hong Kong but also significantly resists wind velocity. For three years, the bank of China was stated as the highest structure in Hong Kong and Asia. Moreover, it is the first building to exceed the height of 305m (1000 ft) outside America. ***(ArchDaily 23 Aug 2011) (Britannica 15 Oct 2013) (CTBUH)***

A turning point for Malaysia and Asia was in 1998 when the Petronas Towers in Kuala Lumpur put them a milestone ahead on the

list of architectural developments. Created by Cesar Pelli, the design aspires to reflect the Islamic culture of the country by applying Rub el Hizb -an Islamic symbol- as the tower's footprints. When extruded it creates a façade with unique 8-points of Islamic patterns. The twin towers rise 451.9 m (1. 483 ft), and the upper levels start to narrow down towards the antennas giving more structural stability against wind loads and remarkable esthetics for the towers in the Malaysian skyline. Besides the skyline, the structure has the world's largest foundation that goes 120 m (400 ft) below surface level to ensure the stability of the high strength reinforced concrete material used for realizing the foundation and the structure. The twin towers are connected by a double-floor bridge on the 42-43 levels. The bridge and podium are accessible to the public, while the rest of the skyscraper is entirely business. The developers found their answers in The Petronas Towers. They stand as a representation of the heritage and future, rich culture, and commercial strength of Malaysia. Moreover, they exceeded their ambitions when they surpassed the Willis Tower architectural height and became the tallest building in the world until they lost the title for Taipei 101 in Taipei, Taiwan. ***(ArchDaily 24 Jan 2011) (Skyscraper Museum) (Britannica 15 Oct 2013)***

## 1.6. Program Typologies of The 19th & 20th Centuries

"*You can tell what's informing a society by what the tallest building is ... when you approach a modern city, the tallest places are the office buildings, the centers of economic life.*" 21

With these words, Joseph Campbell describes the dominance of office skyscrapers. The business high-rise justifies itself by the fact that developers, investors, and business owners had a reason for building tall structures that serve their businesses. This concept went to the next level in the late 20th century when not only industries sought after skyscrapers development but also countries. As a product of capitalism, the superstructures have the power to draw a country's image as a commercial capital that drives investment. Furthermore, regions and continents are categorized as modern when joining the skyscraper race.

To summarize, after the evolution of business skyscrapers, the residential tall buildings emerged as a typology following the housing shortage after WWII. The mixed-use typology evolved from combining business and residential typologies in one tall structure. This merge occurred as a reason the office skyscrapers are left empty during the night times and on the weekends. Therefore, merging the residential and business typologies was seen as a solution to create a 24/7 active community. The inclusion of commercial spaces came afterward to provide more services and activities in the building.

An Extinct Typology (Recreational Typology, the recreational typology as seen in the latting observatory provided an observation point to the city of New York -the only observation point. In Coney Island, the recreational typology didn't provide architectural space within its walls. Instead, it was anelement of excitement in the Island's parks, besides providing some observation points. The concept of an observation deck was later applied in almost every modern skyscraper or mixed-use zona. The idea of having a high-rise solely for entertainment or public use disappeared. There is a race of height, technologies, and creative design that cares for aesthetics and representation of the countries.

About what has been discussed in the chapter, the following tables 1,2, and 3 gather the most influential high-rises that evolved in the 19th & 20th centuries. They provide; buildings' descriptions, functions, location, time, typology, height, and status of the skyscrapers.

Table 1. Tall Building Function in the Mid-19th Century

| Mid-19th Century | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Project | Year | Height | Stories | Location | Function | Status |
| | The Latting Observatory | 1854 | 106 m/ 350 ft | - | NYC | Recreational | Temporary structure for the 1853 Fair |
| | Equitable Life Insurance company | 1870 | 43m/141 ft | 8 | NYC | Business | Demolished, 1912 |
| | Western Union Building | 1875 | 70m/230 ft | 10 | NYC | Business | Demolished, 1890 |
| | Boreel Building | 1879 | 30m/98 ft | 8 | NYC | Business | |
| | Montauk Building | 1882 | 39m /28 ft | 10 | Chicago | Business | Demolished, 1892 |
| | Home Insurance Building | 1885 | - | 10 | Chicago | Business | Demolished, 1931 |
| | Eiffel Tower | 1888 | 330m/1,083ft | 3 | Paris | Recreational | Present |
| | Waldorf-Astoria | 1896 | - | 16 | NYC | Hotel | Demolished, 1929 |

Table 2. Tall Building Function in the 20th Century Prewar

| 20th Century Prewar | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Project | Year | Height | Stories | Location | Function | Status |
| | Fuller Flatiron Building | 1902 | 93.6 m/307 ft | 22 | NYC | Business | Present |
| | Luna Park | 1903 | - | - | Coney Island | Recreational | Demolished, 1914 |
| | Beacon Tower | 1904 | 114m/375 ft | - | Coney Island | Recreational | Demolished, 1938 |
| | Singer Building | 1899 & 1908 | 30m/98 ft | 14 then added 27 | NYC | Business | Demolished, 1967 |
| | The Metropolitan Life Building | 1893 & 1909 | 213m/700ft | 39 | NYC | Business | Present |
| | Woolworth Building | 1913 | 241m/792 ft | 60 | NYC | Business | Present |
| | Equitable Life Insurance company | 1915 | 169m/555 ft | 40 | NYC | Business | Present |
| | Ritz Tower | 1926 | 165m/540 ft | 41 | NYC | Residential | Present |
| | Chrysler Building | 1930 | 319m/1,048 ft | 77 | NYC | Business | Present |
| | 40 Wall Street | 1930 | 255m/836 ft | 70 | NYC | Business | Present |
| | Empire State Building | 1931 | 381m/1,250 ft | 102 | NYC | Business | Present |
| | Waldorf Astoria | 1931 | 191m/725 ft | 47 | NYC | Hotel | Present |
| | Rockefeller Center | 1939 | 259m/850 ft | 70 | NYC | Mixed-use | Present |

Table 3. Tall Building Function in the 20th Century Postwar

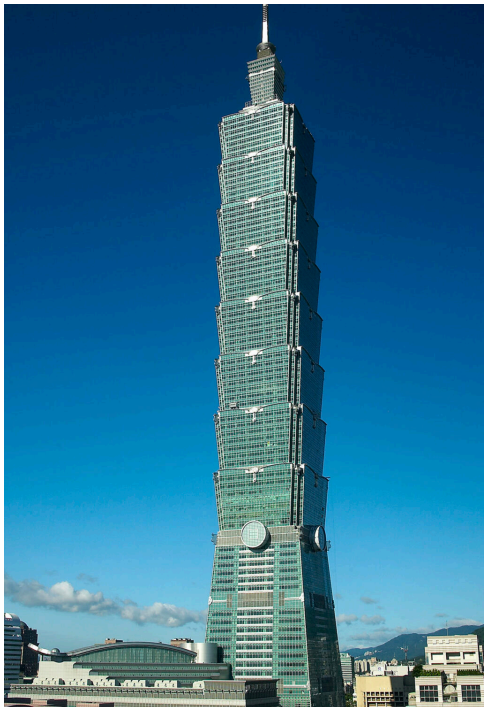
| 20th Century Post-war | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Project | Year | Height | Stories | Location | Function | Status |
| | John Hancock Building | 1949 | 151m/495 ft | 26 | Boston | Business | Present |
| | Lever House | 1952 | 94m/308 ft | 21 | NYC | Business | Present |
| | 860-880 Lake Shore Drive | 1952 | 87m/284 ft | 26 | Chicago | Residential | Present |
| | Unite d'Habitat | 1952 | | 8 | Marseille | Residential | Present |
| | Seagram Building | 1958 | 157m/515 ft | 38 | NYC | Business | Present |
| | Pirelli Tower | 1958 | 127m/416 ft | 32 | Milan | Business | Present |
| | Corbusier haus | 1959 | 53m/ ft | 8 | Berlin | Residential | Present |
| | St. James Town | 1960s | - | - | Toronto | Residential area | Present |
| | Marina City | 1964 | 180m/787 ft | 64 | Chicago | Mixed-use | Present |
| | Dewitt-Chestnut | 1966 | 120.4m/396 ft | 43 | Chicago | Residential | Present |
| | 875 North Michigan Avenue | 1970 | 343.7m/1,128 ft | 100 | Chicago | Mixed-use | Present |
| | Mid-Levels | 1970s | - | - | Hong Kong | Residential area | Present |
| | AMA Plaza | 1972 | 211.8m/695 ft | 52 | Chicago | Mixed-use | Present |
| | Jardine House | 1973 | 178.5m/586 ft | 52 | Hong Kong | Business | Present |
| | Willis Tower | 1974 | 442m/1,451 ft | 110 | Chicago | Business | Present |
| | CN Tower | 1975 | 553.3m/ 1.815 ft | - | Toronto | Mixed-use | Present |
| | World Trade Center | 1976 | 417m/1,368ft | 110 | NYC | Business | Destroyed, 2001 |
| | 601 Lexington | 1977 | 278.9 m/915 ft | 65 | NYC | Business | Present |
| | 333 Wacker Drive | 1983 | 148.6 m/487 ft | 36 | Chicago | Business | Present |
| | Lloyd's Building | 1986 | 951m/312 ft | 14 | London | Business | Present |
| | Bank of China | 1990 | 367.m/1,205 ft | 75 | Hong Kong | Business | Present |
| | Petronas Towers | 1998 | 452m/1,483 ft | 92 | Kuala Lumpur | Business | Present |
| | Burj Al Arab | 1999 | 321 m/1,053 ft | 59 | Dubai | Hotel | Present |
| | Jin Mao Tower | 1999 | 420.5m/1,380 ft | 88 | Shanghai | Mixed-use | Present |

0.2.

# The High Rise In The 21st Century

## 2.0. Early 21st Century: 2000s-2020s

In 2004, Taipei 101 in Taipei, Taiwan, was the first construction in the world to go above 500 meters mark, reaching a height of 508m/1,667 ft. As the name indicates, the structure is divided into 101 stories dedicated mainly to business. A shopping mall is located in the lower five stories of the tower, an observation deck of indoor and outdoor zones occupies the three levels of 89th to 91st floors and some restaurants. Following its ancestors (the Bank of China in Hong Kong and the Petronas Towers in Malaysia), Asians tend to design modern skyscrapers with local inspiration. Designed by C.Y. Lee & Partners, the structure is divided into eight sections that blossom outwards, replicating the Chinese pagoda, while the number eight symbolizes wealth and fortune in China. Structurally, the eight levels effortlessly break down the strong wind-loads on the skyscraper. The structure gained the Platinum LEED certification in 2011. ***(Skyscraper Museum) (CTBUH) (Taipei-101.)***



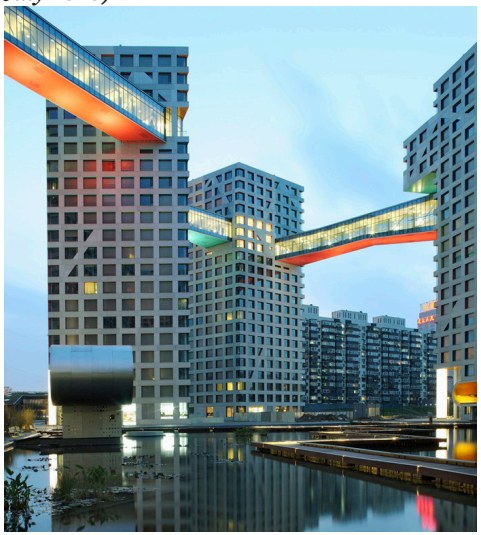
1. Taipei 101 Tower, Taipei, Taiwan, C.Y. Lee & Partners, 2004. Program: offices & commercial. Height: 508m/1.666 ft, Stories: 101 floors above ground & 5 underground. Owner & developer: Taipei Financial Center Corporation, Structural Mat: Composite.

## 2.0.1. New Designs & Typologies

The design of the high-rises in the 21st century took another step in exploring what is possible. For instance, the skyscraper's shape got out of the restriction of the rectilinear silhouette. Technological advances, sustainable factors, and aesthetic factors resulted in a new era of tall structures. Moreover, tower connectivity entered a new era post the lamentable 9/11 attack. The connecting sky bridges are an essential means of safety and evacuation the carried research resulted in altering the typical linking bridge of two masses into multiple scenarios of sky connectivity. Additionally, skyscrapers reached unprecedented new heights. Conceptual heights now vary from 1-4km above the ground – and even more fictitious heights. Several projects are selected to discuss the innovation of high-rises in the 21st century to date.

Linked Hybrid, Beijing, China, is designed as an open residential complex of eight linked towers. The 220.000sqm linked project develops the concept of creating a "city within the city" into an "open city within the city." A residential unit and a hotel program is integrated with various public spaces including commercial shops, roof parks, recreational services, a kindergarten, a school, a cinema, and underground parking. Connectivity is a key concept for the design team of Steven Holl Architects. The design aims to create an open complex that ensures maximum assimilation with the surrounding urban fabric. skybridges and ground passages link the 66m/ 216 ft high structures. The sky and base loops aspire to form a random relation between levels and spaces, generating a unique city experience. Sustainably, the complex was awarded the Golden LEED certification for the ecological innovations applied in the design. ***(Steven Holl) (CTBUH) (Arch-Daily 9 Sep 2009)***

In Singapore, Marina Bay Sands set an example of one-of-a-kind design innovation, a concept evolving around connectivity. The form is visually permeable, linking views through the giant voids between the hotel masses. The atrium turns into an extension of the city's pedestrian web. The 57th and last floor sit on top of the three towers, creating an extraordinary park for recreational activities along with a public observation deck. At a height of 200m/ 656 ft, the sky-park of 2.5 acres is the most expansive connecting slab ever built, with a 66m cantilever public observation deck. The genius of the design is the result of the collab between the architecture team and urban planners. According to Safdie Architects, the concept was developed in alignment with URA's planning of the Marina Bay ring, resulting in a well-integrated architectural experience, and considering the future development of the Bay. ***(Safdie architects) (CTBUH) (Arch-Daily 26 July 2010)***



2. Linked Hybrid, Beijing, China, Steven Holl Architects, 2009. Program: Residential & Mixed-use. Height: 66m/216.5 ft, Stories: 21 floors. Client: Modern Green Development Co., Ltd. Beijing, Structure Mat: Concrete.



A design by OMA, Rem Koolhaas exceeded the normal perception of height race. CCTV sets a new definition of skyscraper typology. The building is an innovative three-dimensional high-rise shaped like a loop, taking its inspiration from the Television office function. He takes the typical two towers and turns them into continuous interlinked activities connected by a 75m/ 246 ft cantilever, replacing the previous scattered version in various sites across the city. The collaboration between Chinese and European engineers made it possible to realize the structural engineering of the structure. An innovative structural façade of an external continuous tube system developed to resist lateral and gravitational loads as an essential structural element to enable the desired design. The tubes are shaped according to their structural function, where they become denser or lighter according to the stress loads. ***(CTBUH) (Arch-Daily 12 May 2012)***

4. CCTV Headquarters, Beijing, China, OMA, 2012. Program: Offices. Height: 234m/768 ft, Stories: 54 above ground & 3 underground. Owner: China Central Television, Structure Mat: Composite; Steel, Concrete Encased Steel, Steel.

3. Bay Sands, Singapore, Safdie Architects, 2010. Program: Hotel, Park, Restaurants. Height: 206.9m/679 ft, Stories: 57 above ground & 3 underground. Client: Marina Bay Sands Pte Ltd.; Las Vegas Sands Corporation, Structure Mat: RC & Concrete Encased Steel.

## 2.0.2. Sustainability Typologies

By the end of the 20th century, sustainability became a focal point for the construction industry, from material selection to building form. In the twenty-first century, tall building design is influenced by sustainability standards. Skyscrapers aim to become self-sufficient in energy production, the concept revolves around saving and generating energy and maximizing the benefits of natural resources. Therefore, high-rises develop into forms that differ from the air-conditioned box model of the former century. Tall buildings developed pioneering concepts such as green facades, sky gardens, and innovative gathering spaces.

The 21st century marks the birth of a new generation of high-rises. In the heart of London, 30 St Mary Axe represents a modern evolution of the world's oldest financial center. The building reached completion in 2004. With high environmental considerations in mind, the shape of the building was designed to increase natural sunlight and ventilation. The chosen model significantly lessens the energy consumption of the building with up to 50% less energy when compared with artificially ventilated skyscrapers. Technologies are developed to reach exceptional designs and environmental architectural masses that define the new century's vision. The realization of the envelope was made possible with the 3D parametric technology, used to design and produce the complex structural envelope. The smooth form proved ideal with wind loads, with the creative fluidity of the exterior directing air movement around the building while diminishing wind movement at ground level for the comfort of pedestrians. (Arch-Daily 12 Nov 2019) (CTBUH)

Innovative designs continue to be the focal point of the 21st century's skyscraper. In the case of One Central Park the design of the

5. 30 St Mary Axe, London, Foster + Partners, 2004. Program: Offices. Height: 179.8m/590 ft, Stories: 40 above ground & 1 underground. Developer: Swiss Re, Structure Mat: Steed.

6. One Central Park, Sydney, Australia, Ateliers Jean Nouvel, 2014. Program: Apartments, Retail. Height: 117.8m/384 ft, Stories: 34 above ground & 4 underground. Owner/Developer: Frasers Property Limited; Sekisui House Australia, Structure Mat: Concrete & Steel.



fresidential towers entirely evolves around sustainability. The design consists of two towers that differ in height and with intermediate space between them. The height difference is made to apply sustainable factors via extraordinary technologies of hydroponics and heliostats, where the higher tower has an 80m cantilever holding 320 reflectors that are then redirected by 42 heliostats placed on the roof of the lower tower. This made possible to lighten the central zone of the building and control the sunlight all year long depending on the weather, it is an automatic system that changes every hour and season depending on the needed temperature for the construction. The greenery element in the project took another step in high-rise advancement. Aside from the base park, the building itself take the park up to sky, a 64,000 sqm park along the structure facades. These 5 kilometer of planetary perform as organic shading system of the building significantly reducing the energy needed for cooling. The greenery façade enhances the aesthetics of the city with high environmental standards setting a new scale of exceptional advancements of tell buildings and urban environment. (Arch-Daily 25 Sep 2014) (Arch-Daily 10 Nov 2014) (CTBUH)

Bosco Verticale in Milan, Italy, is a remarkable example of a vertical forest. The project was nominated as the most innovative and beautiful tall building worldwide in 2014. It consists of two residential towers, standing at 112m and 80m above the ground, representing a new model of high-rise design. The structure employs a rigorous greenery façade that accommodates 480 large trees, 300 smaller trees, 11.000 shading plants, and 5.000 shrubs. It is a new approach for a high-rise model where people and trees co-exist. "*Along with creating a beautiful appearance, the living green façade concurrently stimulates interaction with the surrounding environment while also protecting against it, in fact enhancing the sustainability of the project*"1 according to CTBUH.

7. Bosco Verticale, Milan, Italy, Boeri Studio, 2014. Program: Residential Complex. Height: 115.9m/380 ft, Stories: 27 above ground & 3 underground. Developer: COIMA; Hines Italia, Structure Mat: Concrete.

## 2.0.3. Mega-Tall Structures

The skyscraper race took diverse forms in the 21st century, nevertheless, it remains dominant. On the contrary, the advancements in materials and engineering technologies alternated what was thought possible in this arena. The 21st century is the era of Mega-tall structures. In the first decade, CTBUH developed the international classification of high-rises into three categories; tall buildings of up to 300m in height, supertall for buildings standing between 300 and 600m, and mega-tall for structures that exceed 600m in height

In 2010, the world was astonished by the unprecedented height of Burj Khalifa. The record-breaking tower invades the sky of Dubai for 828m/ 2.723 ft above the ground. The mega-tall building was made possible thanks to its shape and engineering technologies. The super-structure adopted a simple footprint of a Y-shaped plan to reduce wind forces. A buttressed core structural system is designed to support the three wings. Inspired by the ingenious engineering of Willis Tower in Chicago, the wings of Burj Khalifa go through a series of setbacks as they increase in height. The design concept is influenced by its structural performance against lateral and gravitational loads to confuse the wind. It redefined what is possible for supertall structures. A regional desert flower, Islamic architecture, and modern architecture shaped the geometrical design of the skyscraper. Burj Khalifa is a 162-story of mixed-use program, at the heart of Dubai's new downtown, varying from business to leisure. Lower floors are dedicated to retail spaces and an Armani Hotel. Above them are residential units going up to floor 124th. Elite corporate offices occupy the top 37 floors of the high-rise. Two observation decks on 124th and 148th floors are open to the public, offering astonishing views of Dubai. Ultimately, a steel pipe of 136m/ 446 ft

9. Burj Khalifa, Dubai, UAE, SOM, 2010. Program: Mixed-use; Office, Residential, Hotel, Commercial. Height: 829.8m/2,723 ft, Stories: 163 above ground & 1 underground. Owner/Developer: Emaar Properties, Structure Mat: Steel & Concrete.



was assembled into place at the pinnacle of the tower. ***(SOM) (CTBUH) (Skyscraper Museum) (Arch-Daily 27 Oct 2017)***

Shanghai Tower arrives as the highest high-rise building in Asia and the world's second tallest structure after Burj Khalifa. An outstanding 632m/ 2.073 ft. high structure. It is the third high-rise of the symbolic trio in the Finance and Trade zone in Shanghai. The skyscraper innovation goes beyond its remarkable height. The unique twisting form of the tower significantly reduces wind loads on the superstructure by 24 percent, according to the wind tunnel testing results. Using parametric software, Gensler developed three strategies to reduce wind loads by creating: asymmetrical forms, curved corners, and tapering profiles. The result is an unmatched light structure that withstands wind forces while saving approximately 58$ million in construction costs compared with a rectilinear shape of the same height. Designed as a self-contained city of vertical urbanism, the tower is a unique mixed-use program of shops, offices, hotels, restaurants, and gathering areas. The skyscraper's 128 floors are divided into nine vertical sections. Each represents a vertical neighborhood rising from a sky garden. A new vision of integrated vertical urbanism is made possible with the generous space between the double-skin envelope of the skyscraper. The void between the first and second curtain walls creates an air buffer that isolates the building from the outside weather while providing natural ventilation and maximizing daylight. The sky lobbies offer gathering spaces, a simulation of a city's squares and plazas that visually connect the 14 floors of each vertical neighborhood. With interconnected public spaces, Shanghai Tower delivers an exceptional experience for living in a megastructure. ***(CTBUH) (Skyscraper Museum) (Arch-Daily 06 Mar 2016) (Arch-Daily 04 Nov 2016)***

10. Shanghai Tower, Shanghai, China, Gensler, 2015. Program: Mixed-use. Height: 632m/2,073 ft, Stories: 128 above ground & 5 underground. Owner/Developer: Shanghai Tower Construction & Development, Structure Mat: composite; Reinforced Concrete, Concrete Encased Steel, Steel.

## 2.0.4. Educational Tall Buildings

Mode Gakuen Cocoon Tower is an innovative high-rise in Tokyo, Japan. Constructed in 2008, the elliptical tower poses a new typology of skyscrapers. Distinct from the horizontal approach of educational facilities design, the project provides a place for 10.000 students in a vertical composition. The unparalleled function of the tower redefines the vision of the future campus. Located between the busy Shinjuku Station and Shinjuku Central Business District, the school aims to revive the connection between the two areas with young students. The limited site area inspired the pioneer vertical development of a campus. It is a true example of urban and architectural collaborative solutions. The building hosts three different schools. With a simple floor plan, three rectangular classrooms take place around the inner core of the skyscraper. Three stories high atriums are placed between the classrooms, offering exceptional city views and comfortable social spaces. They stimulate the student's lounges and corridors in a horizontal campus. The Cocoon Tower's program opens the door to an essential question, what could be the function of the skyscraper of the future? ***(CTBUH) (Arch-Daily 02 Jun 2011)***

11. Mode Gakuen Cocoon Tower, Tokyo, Japan, Tange Associates, 2008. Program: Higher Education. Height: 203.7m/668 ft, Stories: 50 above ground & 4 underground. Owner/Developer: Mode Gakuen, Structure Mat.: Concrete filled steel, Steel columns and floor spanning

## 2.0.5. Under-construction & Visionary Skyscrapers

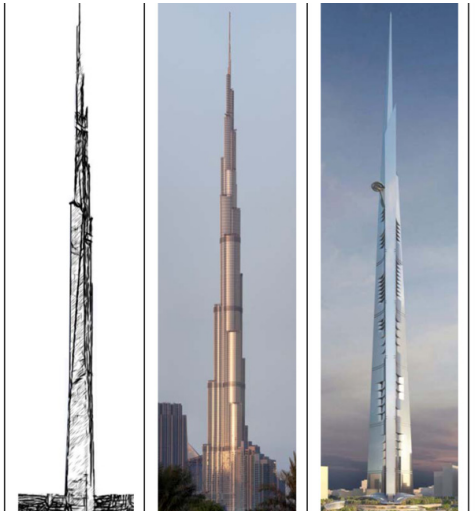
The skyscraper model of the near and far future redefines the limits of what was thought possible. In a robust competitive environment, the proposed high-rises smash conceptual heights more than ever imagined. Radical forms and advanced structural technologies are developing to achieve unparalleled heights. With lavishly exceeding 1000m heights, giga-structures evolve into a new form of a city within the city. The expansive floor areas they offer, turn the mixed-use program into a partially or totally independent city. In Japan, some quixotic projects provide the utmost scientific fiction of futuristic architecture. From the X-Seed, 4000m high -that envisions a city of 1 million inhabitants, to the Tokyo Tower of Babel 10.000m, to the Space Elevator that goes 100.000 kilometers into space. How far height can go? "*Is Sky the Limit*?" 2 ***(Kheir Al-Kodmany, 2011)***



Jeddah Tower is the tallest building that is currently under construction. Soaring over 1000m/3.281 ft into the sky, it anticipates being the world's new tallest skyscraper. The initial design aimed to reach twice the height of Burj Khalifa at 1.6 km/1 miles. It is the first structure that provokes breaking the conceptual height of one kilometer. With a 530.000 sqm floor area, the mega-structure (or giga-structure) offers spacious spaces for business, leisure, residential, the highest observation deck, and amenities for a luxurious lifestyle. It aims not only to hold the title of the world's loftiest structure but, to become a focal point of interest to the surrounding region. The record-breaking height redefines the concept of the vertical city. The design of the tower is simple. Extrusion of a Y-shaped plan with a smooth envelope of three wings concluding at different heights as the building grows upwards. This strategy eliminates the need for complicated structural transfers, thus reducing the structural loads of the traditional setback approach. The needle-like design is observed also in Burj Khalifa, interestingly the first visionary needle design was anticipated in Illinois Tower by Frank Lloyd Wright in 1956. ***(CTBUH) (JEC) (Arch-Daily 18 Apr 2022) (Kheir Al-Kodmany, 2011)***

"*The Tower was envisioned by Frank Lloyd Wright in 1956 to be built in Chicago. It was meant to provide an alternative to the increasing urban sprawl by building a 528-story structure, with a gross area of 18,460,000 square feet (1,715,000m2). Had it been built, it would have been nearly twice as tall as the world's current tallest building, the Burj Khalifa.*" 3 ***(K. Al-Kodmany, 2011)***

12. Jeddah Tower, Jeddah, Saudi Arabia, Adrian Smith + Gordon Gill Architecture / Dar al-Handasah Shair & Partners, Construction Started: 2013, Expected Completion: NA. Program: Residential. Height: 1,000+ m/3,281+ ft, Stories: 167 above ground & 2 underground. Owner/Developer: Shanghai Tower Construction & Development, Structure Mat.: All-Concrete.



13. Illinois Tower, Frank Lloyd Wright, Visionary design in 1956, Left side. Drawing by K. Al-Kodmany.
Burj Khalifa, SOM, 2010, Center.
Jeddah Tower, Adrian Smith, Under construction in 2022, Right side.

14. Sky Mile Tower, Tokyo, Japan, Kohn Pedersen Fox Associates, Conceptual Design, Expected Start: 2030, Expected Completion: 2045. Program: Residential Complex. Height: 1,700m/5,577 ft, Stories: -. Owner/Developer: -, Structure Mat.: Composite.

In the vision of Tokyo 2045, Sky Mile Tower comes as a part of the rising "Next Tokyo" megacity. It is a conceptual design of an eco-district located in Tokyo Bay. The project was developed by Kohn Pedersen Fox Associates and Leslie E. Robertson Associates as an urban research project for the low coastal city. The design is conceived to adapt to climate change projected for the year 2045. Next Tokyo is a 12.5 sqm of the man-made enclave, made to protect the low-coastal area against floods, hurricanes, and earthquakes. Resilient infrastructures were designed to increase the city's ability to withstand climate change and as a defense mechanism for the bay against natural disasters. Scattered hexagonal isles of 150m to 1500m width are designed to reduce wave impact and draw ship paths across the district. The transportation network is operated by a vacuum-tunnels system presently under development by Elon Musk. The city features an unprecedented mile-high skyscraper, housing half a million inhabitants. Soaring 1.700m/5.577 ft high, the Sky Mile Tower, will be double the height of the prevailing world's tallest structure Burj Khalifa. The building was designed to make it possible to realize its height. Hexagonal-shaped-base demonstrated the most wind resistance. The hexagon extrudes 320 meters into three solids (legs) and three voids. A series of five interlinked legs intersect along the vertical axis of the structure, allowing the optimal wind flow. Each two-leg set is attached by forceful steel trusses at points of intersection. Sky lobbies are shaped at overlapping notches of the building structure, and host public amenities, restaurants, gyms, clinics, commercial areas, and libraries. With 1.365 million sqm the tower redefines the concept of a vertical city. Much like the Next Tokyo district applies advanced technologies for horizontal circulation, Sky Mile Tower will feature the technology of ThyssenKrupp's MULTI magnetic levitation for vertical transport. One of the concerns that faced the architectural team was the issue of pumping water a mile into the sky. The research proposed that the height of the skyscraper could enable cloud harvesting as a resource of water, using an articulated façade. The system will rely on gravity for distributing water instead of pumping. The futuristic superstructure wreck down all the limits imagined for what is possible for vertical architecture. ***(CTBUH) (AD 03 Feb 2016) (Design Build 17 Feb 2016)***

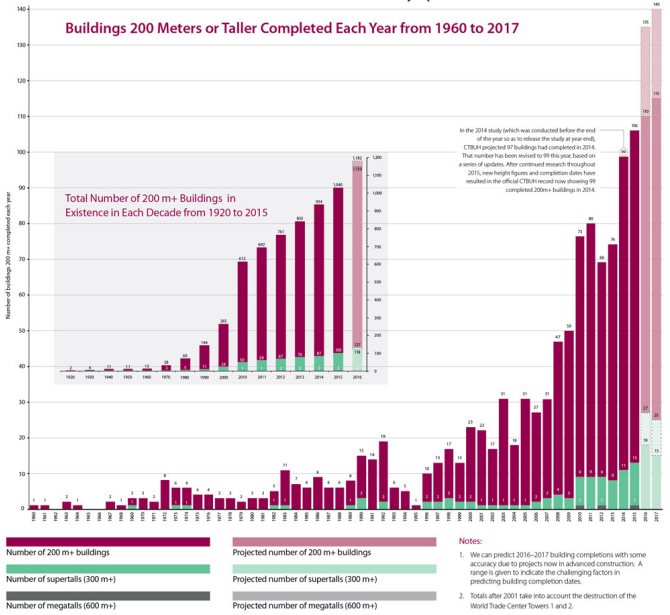
Table 4. Tall Building Function in the 21st Century

| 21st Century | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Project | Year | Height | Stories | Location | Function | Status |
| | Taipei 101 Tower | 2004 | 508m/1.666 ft | 101 | Taipei | offices & commercial | Present |
| | Linked Hybrid | 2009 | 66m/216.5 ft | 21 | Beijing | Residential & Mixed-use | Present |
| | Bay Sands | 2010 | 206.9m/679 ft | 57 | Singapore | Hotel, Park, Restaurants | Present |
| | CCTV Headquarters | 2012 | 234m/768 ft | 54 | Beijing | Business | Present |
| | 30 St Mary Axe | 2004 | | 40 | London | Business | Present |
| | One Central Park | 2014 | 117.8m/384 ft | 34 | Sydney | Apartments, Retail | Present |
| | Bosco Verticale | 2014 | 115.9m/380 ft | 27 | Milan | Residential Complex | Present |
| | Oasia Hotel Downtown | 2016 | 190.9m/626 ft | 27 | Singapore | Hotels, Mixed-use | Present |
| | Burj Khalifa, Dubai | 2010 | 829.8m/2,723 ft | 163 | Dubai | Mixed-use | Present |
| | Shanghai Tower | 2015 | 632m/2,073 ft | 128 | Shanghai | Mixed-use | Present |
| | Mode Gakuen Cocoon Tower | 2009 | 203.7m/668 ft | 50 | Tokyo | Higher Education | Present |
| | Jeddah Tower | NA | 1,000+ m/3,281+ ft | 167 | Jeddah | Residential | Under Construction |
| | Sky Mile Tower | 2045 | 1,700m/5,577 ft | - | Tokyo | Residential Complex | Conceptual |

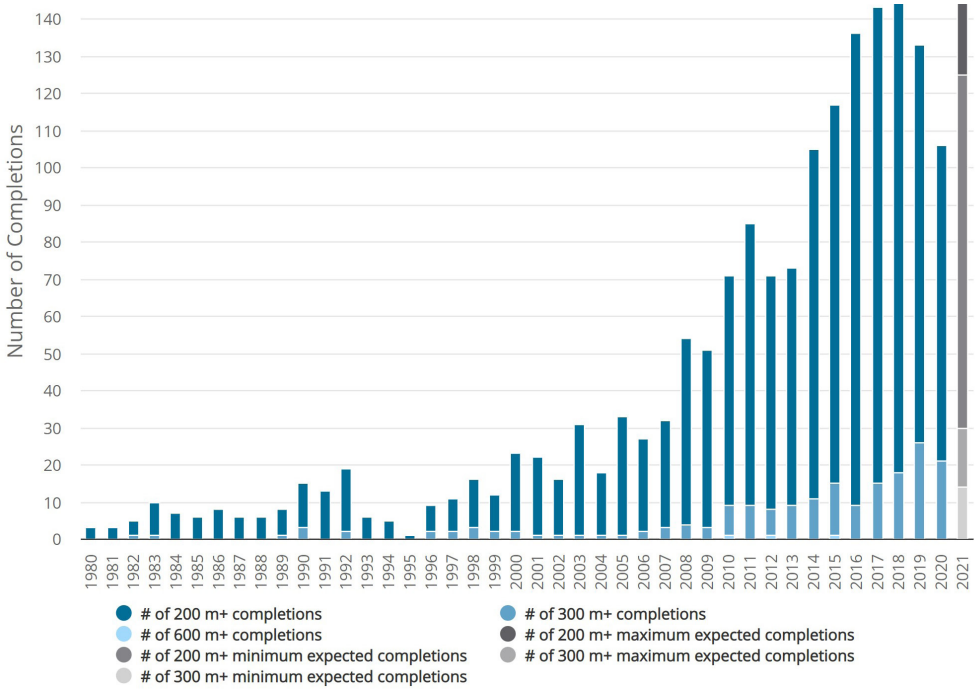
## 2.1. Why Tall Buildings in the 21st Century

According to statistics, skyscrapers have been built throughout the 21st century more than any time before. While 2008 was a "bumper year for skyscrapers" despite the global great economic depression. The high-rise boom continued in 2009, then 2010 was marked as the most active year in tall building history, and 2011 was even more vigorous than 2010. Afterward, in the 2015 Year in Review report by the CTBUH "*It's clear that 2015 was a banner year for skyscrapers: Across the globe in that year alone, 106 tall buildings (above 200 meters or 656 feet in height) were finished, surpassing 2014's previous record of 99*"4 In the 2016 CTBUH's Year in Review Report "*136 buildings of 200 meters' height or greater were completed around the world in 2016*" 5

In 2017, 143 buildings of height 200 m+ were built, and 15 buildings in the 300m+ categories were built. 2018 is the fifth year in a row with an increasing number of tall structures completed and marks the year with the highest skyscrapers boom in history with 148 buildings in the 200m+ categories and 18 buildings in the 300m+ category. After a rigorous history in tall buildings, European cities completed and are increasingly building tall buildings in the 21st century.*"By 2013, skyscrapers had been constructed in over 100 European cities located in 30 different countries, and the trend towards the expansion of high-rise construction continues."*6 CTBUH indicates the growth in tall building numbers by stating that it took 80 years between 1930 and 2010 to complete the 50-first supertall structures, while it only took five years between 2010-2015 to build the following 50 supertalls. ***(CTBUH, 2015 report) (K. Al-Kodmany, 2018) (Mir M. Ali and K. Al-Kodmany, 2012)***




15.CTBUH Data Base, 2015 Year in Review report. The graph poses the built skyscrapers number from 1960 to 2015, the chart characterizes the tall buildings in three categories: 200 meter+ height, 300 m+ height, 600 m+ height. The smaller graph displays the number of skyscrapers of height 200m+ evolving every decade since the year 1920 to 2015.




16.CTBUH Database, 2020 Year in Review report. Graph of number of completed skyscrapers from the year 1980-2020, the chart characterizes the tall buildings in three categories: 200 meter+ height, 300 m+ height, 600 m+ height.

In fact, most cities added tall structures to their urban fabric in the twenty-first century, according to a study by Kheir Al-Kodmany, 2018 (Table 5) showcasing the cities with the highest activity in the high-rise building in the first two decades of the century. Also, megacities are numerously rising "*The number of megacities with a population of 10 million or more has climbed from 1 in 1950 to 5 in 1975 to 14 in 1995, and to 23 in 2015.*"7 In 2020, the world reached 36 megacities and they increased to 44 megacities in 2022.

Aside from the concept of verticality and the human instinct to reach the sky and observe from above. The skyscraper in the 21st century is essentially an urban question. The global urban form is rapidly and intensively altering. Cities are exploding with inhabitants, and the migration from rural to urban causes increased demand for space. Lands in the metropolis' downtown become scarce and extremely expensive. The suburbs are occupied by sprawling urbanization of megacities. The uneven and poorly planned urban sprawl results in a radical increase in travel time and congestion. Carol Willis, an urban theorist, explains the rise of megacities is that cities only have three options to face overpopulation: 1-urban sprawl. 2-horizontal overcrowding. 3-vertical expansion. Consequently, a fundamental question evolves: Can the city afford to constantly expand laterally without affecting their social well-being, surrounding farmlands, and suburbs?

The tall building develops into the city's tool of vertical transformation. Nonetheless, sustainable developments render the high-rise



Table 5. Skyscrapers in 2000 and 2020

| | City | Number of skyscrapers in 2000 | Number of Skyscrapers Built between 2000 and 2020 | Number of Skyscrapers in 2020 | Percentage of Increase |
|---|---|---|---|---|---|
| 1 | Dubai | 25 | 322 | 347 | 1288 |
| 2 | New York | 590 | 305 | 895 | 52 |
| 3 | Shenzhen | 20 | 173 | 193 | 865 |
| 4 | Shanghai | 69 | 157 | 226 | 228 |
| 5 | Moscow | 31 | 151 | 182 | 487 |
| 6 | Chicago | 207 | 127 | 334 | 61 |
| 7 | Melbourne | 36 | 116 | 152 | 322 |
| 8 | Bangkok | 27 | 96 | 123 | 356 |
| 9 | Miami | 27 | 92 | 119 | 341 |
| 10 | London | 23 | 80 | 103 | 348 |
| 11 | Sao Paulo | 17 | 70 | 87 | 412 |
| 12 | Panama City | 7 | 63 | 70 | 900 |
| 13 | Sydney | 83 | 61 | 144 | 74 |
| 14 | Beijing | 10 | 60 | 70 | 600 |
| 15 | Mexico City | 27 | 53 | 80 | 196 |
| 16 | Doha | 1 | 48 | 49 | 4800 |
| 17 | Riyadh | 3 | 43 | 46 | 1433 |
| 18 | Tel Aviv | 11 | 42 | 53 | 382 |
| 19 | San Francisco | 67 | 29 | 96 | 42 |
| 20 | Nairobi | 4 | 6 | 10 | 150 |

model and dense living more environmentally friendly than the horizontal expansion of the urban as they cut carbon emissions produced from travel time. Skyscrapers stand as an icon of the nation and the image of the city; therefore, they are viewed by many as a product of capitalism. In the 21st century, vertical structures are needed to save lands, suburbs, and energy, and reduce carbon emissions. In the twenty-first century, the skyscraper is a habitable space more than an icon. ***(K. Al-Kodmany, 2018)***

Any posed solution to the urban question in light of overpopulation has its benefits and drawbacks. We aim to weigh the advantages and disadvantages of the city's vertical expansion to determine the viability of the scheme.

**Downsides of Tall Buildings:**

I- High cost

Skyscrapers are indeed costly. Tall buildings require robust structures to withstand gravity, strong winds, and earthquake forces. The complexity of the building increases with its height and raises the cost of the building.

II- Ecological Influence

They produce vast shadows and cause wind turbulence, which requires multiple tests to decrease these impacts as much as possible.

III- Municipal Infrastructure

Superstructures pose an extra load on existing infrastructure systems and transportation networks.

IV- Sociocultural Aspects

The majority of high-rises act like isolation islands in the urban grid from nature and social networks.

V- Safety Concerns

Fire and evacuation operations should opt for the most efficient scenario. Safety stands as a complex challenge in tall buildings.

**Benefits of Tall Building:**

I- Overpopulation

Tall buildings are a sustainable scheme to accommodate the increasing number of inhabitants in the city.

II- Urban Regeneration

The vertical expansion makes it possible to recreate the land in desirable locations in the city.

III- Agglomeration

Dense living enhances social networks, cut down travel time, and creates dynamic communities.

IV- Land Conservation

Tall buildings save open space and improve access to nature, which are primary objectives for sustainable living. Saving lands will leave free future needed projects while increasing the parklands and quality of public space in the city.

V- High Land Prices

Skyscrapers are costly, but land prices in megacities are too pricy as well. Sometimes multiplying the lands vertically is more profitable. Quoting Cass Gilbert in 1900, "A skyscraper is a machine that makes the land pay" 8

VI- Transportation and Infrastructure Models

Tall buildings are a compact type of development and thus create efficient infrastructures. They require fewer roads, energy lines, sewage systems, etc. relative to horizontal modules, as they allow dense infrastructure systems.

VII- Reduced Energy Consumption & Environmental Impacts

According to Doster et al.'s tall building saves energy when compared to an equivalent low-rise module: "Manhattan can be considered the greenest place in America, if measured by energy use per inhabitant. If New York City were a state, it would be 12th in population and last in energy consumption" 9 Further research is carried out on turning skyscrapers into energy-self-sustained structures and energy batteries where that also supply the surrounding city with energy.

VIII- Global Competition

Iconic skyscrapers put the country on the global map of advancement.

IX- Technological Development

The relentless competition resulted in enormous innovations. Technological innovations portrayed a vital role in developing the skyscraper and vice versa.

X- Aspiration Influence

High-rises create interesting skylines and stand as a representation of power while resembling human potential.

***(Mir M. Ali and K. Al-Kodmany, 2012)***



## 2.1.1. The Function/ Program

As discussed in the first chapter of this dissertation, in the 19th and 20th centuries, tall buildings hosted the following programs: offices, residentials, hotels, and mixed-use high-rises. The recreational skyscraper emerged by the turn of centuries and no longer exists.

Are there functional changes in the 21st century for tall buildings?

Based on the review by K. Al-Kodmany, 2018 "Skyscrapers in the Twenty-First Century City: A Global Snapshot" He analyzed the skyscrapers' functionality in three height categories from 2000 to 2020. He divides the function of high-rises into five categories: Office, Residential, Mixed-use, Hotel, and others. The study summary is in the following (Table 6).

Table 6. Functional use of skyscrapers changes in 2000 and 2020.

| Function | 100m+ Skyscrapers | | 200m+ Skyscrapers | | 300+m Skyscrapers | |
|---|---|---|---|---|---|---|
| Year | 2000 | 2020 | 2000 | 2020 | 2000 | 2020 |
| Office | 71% | 32% | 40% | 40% | 75% | 32% |
| Residential | 13% | 44% | 3% | 28% | 0% | 13% |
| Mixed-use | 9% | 19% | 12% | 27% | 12% | 50% |
| Hotel | 4% | 4% | 3% | 3% | 13% | 5% |
| Others | 3% | 1% | 0% | 1% | 0% | 0% |

As shown in the table, office space significantly decreased, while residential and mixed-use typologies steadily increased in the three height categories. The hotel remains the same for 100m+ and 200+ but it decreased in the 300+ category.

From the previous analysis, it is clear that the tall building functionality hasn't evolved in new programs/usage for the vertical space in the undergoing century. Perhaps with few exceptions like the case of Mode Cocoon Tower vertical educational campus in Tokyo, Japan.

Here we may think about all the urban spaces that can expand vertically instead of eating up the valuable city lands. Building typologies such as educational facilities, hospitals, and governmental institutions require central locations in metropolises, swallowing up vast portions of land in the most feasible and dynamic urban zones. If tall buildings don't develop in a program-driven scheme, they will eventually create an unbalanced urban fabric. ***(K. Al-Kodmany, 2018)***

## 2.1.2. How Can the High-rise Program Develop In the 21st Century?

Much like the glass air-conditioned box model of high-rises, the inherited functions of the tall buildings -office, residential, and mixed-use- need to be investigated and developed. Perhaps one of the reasons that skyscrapers are not well integrated within their urban fabric is a result of their fixed functionality. What could be the benefits of smashing the box of the fixed skyscraper program? Designers of tall buildings should develop a futuristic vision of urban quality. The high-rise model should no longer be a stand-alone icon, but it ought to be well-integrated with the city layers and the environmental cycle. Architects and urban planners need to create functions that never correlate with skyscrapers and add them to the vertical expansion plan of the metropolis. When tall buildings evolve into urban elements more than architectural icons, they should be able to accommodate any space program in the city, which results in a new urban fabric in the third dimension

"*The forces which are shaping cities worldwide, related to the effects of population growth and urbanization, are compelling and unavoidable. In the near term, we should continue to see an expanding role for tall buildings in our urban fabric*"10 This should additionally involve the 'program' role the tall building plays in the urban fabric. Sustainability, functionality, and technology should be the driving engine of the following skyscraper generation. The fifth generation shall develop the program of the tall building as much as the sustainable and technological aspects are explored. Although I hardly found any theoretical research focused on developing the functionality of tall buildings, there are empirical studies through the platform of the e-Volo magazine. The magazine focuses on developing the high-rise realm in all directions, including the functions the skyscrapers contain. ***(Mir M. Ali and K. Al-Kodmany, 2012) (K. Al-Kodmany, 2018) (CTBUH)***

## 2.2. e-Volo Magazine

**What is e-Volo magazine?**
According to the magazine's website, "*It is an architecture and design journal focused on technological advances, sustainability, and innovative design for the 21st century. Our objective is to promote and discuss the most avant-garde ideas generated in schools and professional studios around the world. It is a medium to explore the reality and future of design with up-to-date news, events, and projects.*"11
Established in 2006 by Carlo Aiello in which he is the Creative Director and Editor-in-Chief. Aiello graduated in 2004 from Columbia University in New York. The magazine is based in New York and was later expanded to Los Angeles in 2013 when he founded Carlo Aiello Design studio there.
The magazine pursues to participate in the empirical research of skyscrapers and the development of conceptual ideas for tall structures. The proposals are published through the magazine's website, digital & printed magazine editions, and social media. The magazine performs as a medium for high-rise architectural advancement through an annual competition held since 2009. e-Volo became one of the most prestigious magazines in the high-rise architecture field for its massive contributions to the development of a conceptual typology for the 21st century. ***(e-Volo website)***

### 2.2.1. e-Volo Competition

In 2009, e-Volo initiated an annual competition that investigates the role of high-rises in the 21st century. The magazine invites designers, architects, intellectuals, students, and engineers to contribute to the evolution of the skyscraper typology. The competition recognizes the projects that aim to develop the relationship between the skyscraper and its context; the city, society, environment, and economy. It is an avenue to think and rethink the skyscraper application of materials, spatial assembly, programs, technologies, flexibility, compliance, aesthetics, and digitalization.
The competition aspires to create new dynamics in the vertical community. It is a call to investigate the nexus amidst man and nature, individual and community, building and city. The magazine is a forum for a new high-rise architectural discourse that develops a conscious vertical community with the city, environment, economy, inhabitants, and global threats in mind. The applicants should seek to redefine the skyscraper role in the 21st century while taking into consideration the present and anticipated problems facing our cities. The contemporary skyscraper's model endeavors to be economically and socially responsible, it's designed with awareness of overpopulation, scarce resources, pollution, and uneven urban spread

Official sponsors of the competition are Archinect, Bustler, Architecture Competitions Yearbook ACY, ARCHITIME., Competitions Archi, e-architect, Global Design Awards Lab, and Skyscraper City.com. The magazine is the channel where the participants, jury committee, sponsors, editors, and readers gather to form this influential platform. ***(e-Volo website)***

## 2.2.2. The Brief of the Competition

Hence the competition is held on an annual basis with one objective, to redefine the role of the skyscraper to engage with a conscious urban model suitable for the 21st century, The competition's brief is fixed aside from the schedule and the jury committee. What is remarkable to note here is that the first-place winners of the previous year become part of the jury team for the following year. The brief's five fixed terms are as following: program, submission requirements, registration, and awards. (e-Volo website)

PROGRAM
In the magazine's approach, there is no sort of limitations for any aspect of the envisioned skyscraper, in design, site, materials, ideas, height, shape, or function. Offering the participants maximum freedom in their approach to define "What is a skyscraper in the 21st century?"

SUBMISSION REQUIREMENTS
-Two boards with the project information including plans, sections, and perspectives. boards should be 24(h) X 48(w) in horizontal format, The boards resolution must be 150 dpi, in RGB mode, and JPG files format
-A DOC file including the design statement (600 words max)

REGISTRATION
The magazine invites Architects, engineers, designers, and students to participate in the competition.

REGULATIONS
The competition language is English. There are no restrictions on the number of people per group. Individuals and groups are the same, as the competition is anonymous, and the jurors are only acknowledged with the registration number of the submitted proposal.

AWARDS
It is an $8000 USD awarded competition.
1st place – $5000 USD
2nd place – $2000 USD
3rd place – $1000 USD
The number of Honorable Mentions vary.
Winners, honorable mentions, and special mentions are published in the magazine's editions. Moreover, the results are issued by the most influential architectural platforms in addition to general media.

Schedule and Jurors of the 2023 edition of the competition:
SCHEDULE
August 29, 2022 -Competition announcement and registration opens.
December 6, 2022 -Early registration deadline
February 7, 2023 -Late registration deadline
February 21, 2023 -Submission deadline (23:59 hours US Eastern Time, UTC-5h)
May 9, 2023 -Winners' announcement

JURY
Kim Gyeong Jeung, Yu Sang Gu, Min Yeong Gi [First Place Winners of 2022 e-Volo Competition]
Dr. Sina Mostafavi [CEO SETUParchitecture studio, Associate Professor Texas Tech University College of Architecture]
Skylar Tibbits [Co-Director, Self-Assembly Lab, MIT]
Kathy Velikov [Principal rvtr, Vice-President ACADIA, Associate Dean for Research and Creative Practice Taubman College of Architecture and Urban Planning]
Lu Yun [Principal, MUDA Architects]



## 2.3. New Typologies & Functions

About the debate e-Volo magazine's competition imposes, "What is a skyscraper in the 21st century?". This part aspires to portray innovative programs and concepts of high-rises through 24 e-Volo competition proposals. It explores the possible programs that high-rises can encompass and investigate the conceptual role of skyscrapers. It is a step towards developing the high-rise functionality for the forthcoming skyscraper generations.

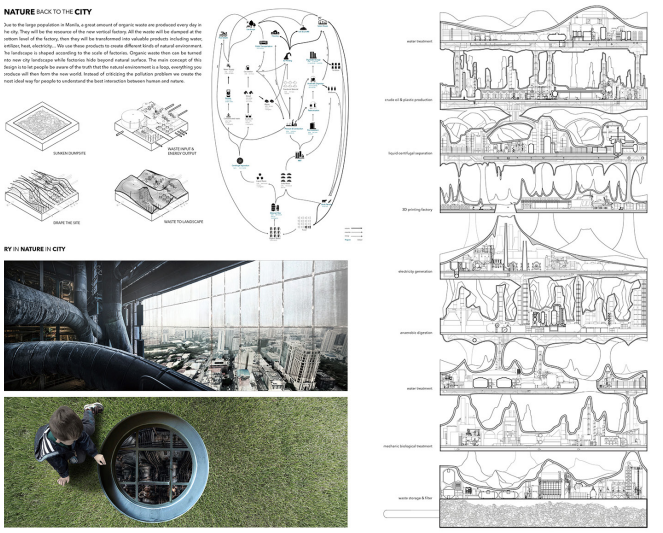
## 2.3.1. Factory Skyscraper

**Vertical Factories in Megacities**

Factory in Nature in City, this proposal hosts three functions in a high-rise: factory, nature, and waste management. It redefines not only how we perceive skyscrapers, but furthermore, it replans the city. Inspired by the growth of megacities and increasing urban population, along with the industries they attract and develop. The project is a development plan for the Metropolis of Manila, Philippines. The region contains 14 cities, with an annual population increase of 4 percent. Traditionally, factories take place on the city's edges. Vertical urban factories advocate bringing factories to the metropolis. Unlike the horizontally blueprinted factory, industries intended to be stacked in vertical structures amidst the city. By dissolving industrial zones into the urban fabric, the project aims to shorten the travel distance of the employees from and to work and upsurge its network with suppliers, workers, and research centers. Planning factories within the urban grid will help them reach zero CO2 emissions. Bring nature back to the city, is a proposal that calls for the need for coexistence between natural and artificial features in our modern cities. As shown in the renders, landscape spaces and factories will go through a series of overlaps throughout the vertical structure. At the same time, they will use the collected garbage from Metro Manila's dumpsite as a resource of heat, electricity, and fertilizers for the vertical factory. At the bottom of the structure, rubble is to be transformed to feed the different activities of the skyscraper. It is a loop model of cohabitation of humans, nature, waste, and industries. ***(e-Volo Comp. 2017 Winners)***

1. Vertical Factories in Megacities, Site: Metropolitan Manila, Philippines, Project by: Tianshu Liu, Linshen Xie, Conceptual Design, Second Place Winner in e-Volo Comp. 2017. Program: Factory, Waste Management, Natural Public Space. Height: -, Stories: -., Structure Mat.: Not Specified.


1.a. Vertical Factories in Megacities, Competition delivery 1.



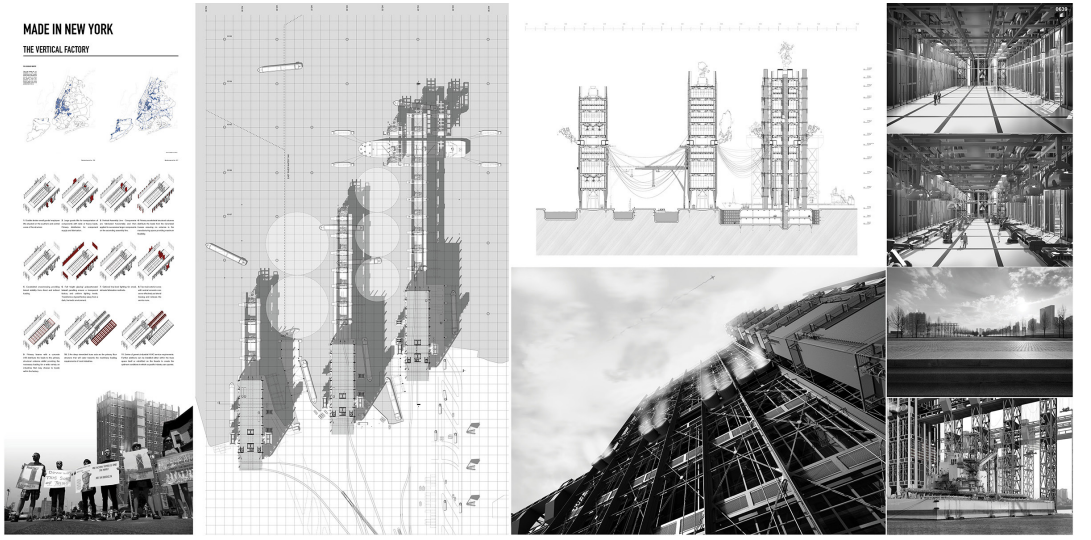

1.b. Vertical Factories in Megacities, Competition delivery 2.

**Made In New York: Vertical Urban Industry**

Industrial forces have been shifting to the far east -like China and India- over the past decades just for economic competence. In New York, the population growth rate versus declining industries will leave the city with no choice but to rely on imports. The designer manifests the importance of bringing factories to the cities and calls for an investigation into the uneven manufacturing urban sprawl. The project proposes to bring factories in former areas of industrial function. Located in Newtown Creek, Queens, the new industrial hub will consist of three vertical structures standing 158 meters above the ground. The concept is to provide flexible spaces for small to large-scale industries with a limited footprint. Made In New York cluster makes it possible to revive direct relations with manufacturers and bring businesses closer to their consumers. The scheme presents a new paradigm for industrial urbanism in the city grid. (e-Volo Comp. 2014 Honorable Mention)

2. Made In New York: Vertical Urban Industry, Site: New York, Project by: Stuart Beattie, Conceptual Design, Honorable Mention in e-Volo Comp. 2014. Program: Factory. Height: 158m/518 ft, Stories: 10-/+, Structure Mat.: Not Specified.


2.a. Made In New York: Vertical Urban Industry, Competition delivery 1.



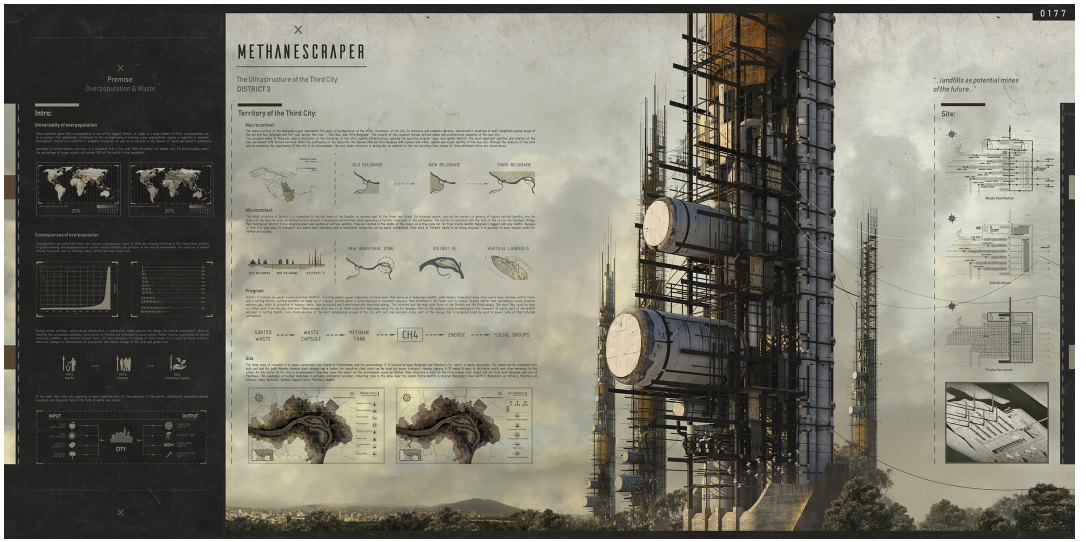

2.b. Made In New York: Vertical Urban Industry, Competition delivery 2.

## 2.3.2. Vertical Landfill

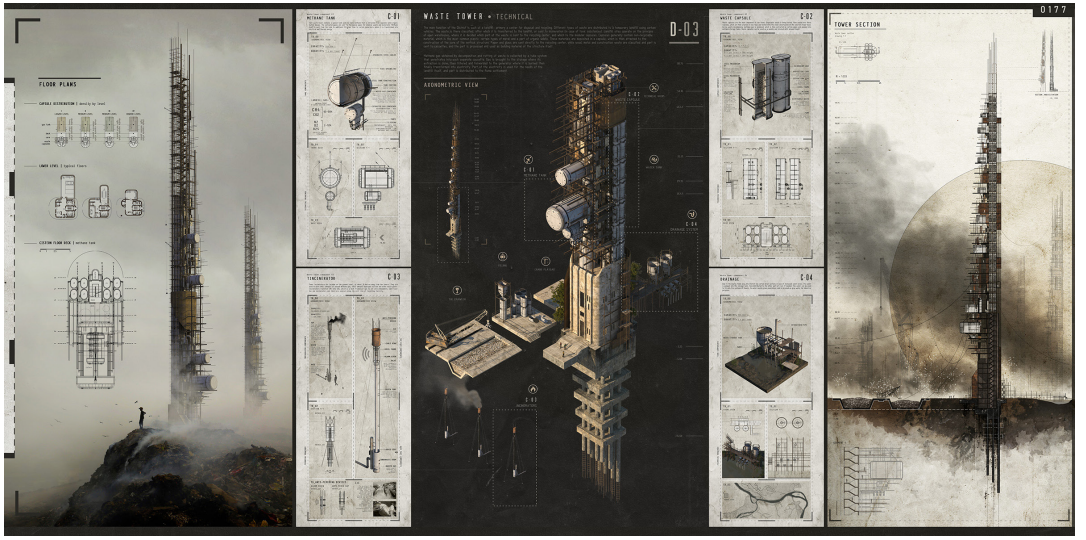
**Methane-scraper**

The project evolves in response to emerging urban and environmental issues. Overpopulation, mass urbanization, growing disposable waste, and shortage of resources and free space are acute problems calling for action. The proposal states two questions: "*What makes the future city different from the present one? What kind of new components would be needed for a city decades from now?*"12. Enormous research efforts attempt to improve the living quality. Sociologists, engineers, and architects address that with the continuous growth of the population, space is becoming especially valuable. The new urban, District 3, is a concept of a vertical landfill forming in a new urban model. It suggests that instead of taking the waste to the conventional landfill, where it gets buried in the ground, the structure will be the new landfill. The ingenious of this alternative is that it doesn't only intend to save valuable space, furthermore, it can protect the environment from toxic gases that form while organic matters rot. Methane-scraper is a module-based tower that contains waste capsules. The capsules are the storage space for organic and disposable waste. When they are rotting, methane gas forms. The gas is panted to the tanks through pipelines, and later will be transformed into energy. This method of waste depot safeguards the ground, air, and water from toxins, while effectively diminishing the space for waste storage. ***(e-Volo Comp. 2019 Winners)***


3. Methane-scraper, Site: Belgrade, Serbia, Project by: Marko Dragicevic, Conceptual Design, First Place Winner in e-Volo Comp. 2019. Program: Landfill System. Height: -, Stories: -, Structure Mat.: Not Specified




3.a. Methane-scraper, Competition delivery 1.



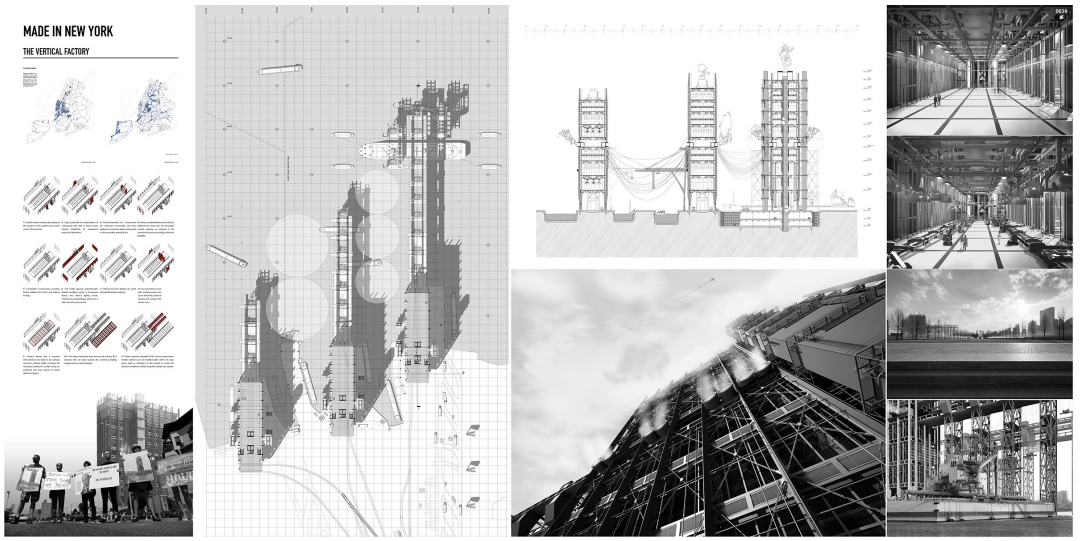

3.b. Methane-scraper, Competition delivery 2.

**Monument to Civilization: Vertical Landfill for Metropolis**

Skyscrapers are the icon of modernity. Our arrogance justifies the need for high-rises with the demand for compact mixed-use living spaces. In most situations, the truth is, towers are built just for the sake of owning one, aiming to represent affluence, development, and power. With this vision, the designer calls to redefine what is impressive. Vertical space should tackle urban problems by providing space with a meaningful use for the citizens. Inherited means of waste management in the metropolis are obsolete and require major reconsideration. As cities expand, waste increases and free space is limited, landfills are fleeting to keep up with the rapid transformation. The proposal calls for a new vertical typology of landfill amidst the city, redefining what is 'Spectacular.' In New York, the annual garbage the city generates would fill a 1.300m tower, which is three times the height of The Empire State Building "isn't that spectacular?"1
A concept of "an ever-growing Monument" in which the tower stands as a symbol of civilization. Shorter towers mean less waste and a more environmentally friendly city, a 'Civilized City'. The structure vertically stores the trash, and beneath the tower, there is a water recycling facility, dump water tank, gas tank, and power points. The skyscraper is a source of clean energy from emitted gases and recycled waste. ***(e-Volo Comp. 2012 Winners)***

4. Monument to Civilization: Vertical Landfill for Metropolis, Site: New York, Project by: Lin Yu-Ta & Anne Schmidt, Conceptual Design, Third Place Winner in e-Volo Comp. 2012. Program: Landfill System. Height: 1.300m/ 4.265 ft, Stories: -, Structure Mat.: Not Specified.


4.a. Monument to Civilization: Vertical Landfill for Metropolis, Competition delivery 1.




4.b. Monument to Civilization: Vertical Landfill for Metropolis, Competition delivery 2.

## 2.3.3. Emergency Skyscraper

**Skyshelter.zip: Foldable Skyscraper for Disaster Zones**

The proposal implies an innovative solution for catastrophic times. The concept is to provide temporary shelter and needed aid following a natural disaster. The design is a foldable structure that is possible to transport by helicopters to affected areas. The base gets anchored to the ground, and afterward, the skeleton unfolds effortlessly using a giant helium balloon placed inside. Lightweight 3D-printed slabs are attached to the balloon and are lifted by the connecting structural steel wires. The wires also resist lateral wind loads on the tower. The vertical form requires a small footprint when compared with tents and containers while providing similar floor areas. It also stands as as a landmark for people from far away to recognize the aid points. The high-rise contains shelters, a first aid floor, storage, a vertical farm, and a hollow central core used to store and cleanse rainwater. It is a multi-purpose hub for emergency uses. The envelope and walls are made of nanomaterial fabric and based on ETFE foil which contains a network of solar cells. The material takes advantage of the external surface in order to produce clean energy that is particularly needed in isolated areas. ***(e-Volo Comp. 2018 Winners)***

5. Skyshelter.zip: Foldable Skyscraper for Disaster Zones, Site: Non, Project by: Damian Granosik, Jakub Kulisa, Piotr Pańczyk, Conceptual Design, First Place Winner in e-Volo Comp. 2018. Program: Foldable Emergency Shelter. Height: -, Stories: -, Structure Mat.: nanomaterial ETFE foil & infused with perovskite solar cells.


5.a. Skyshelter.zip: Foldable Skyscraper for Disaster Zones, Competition delivery 1.

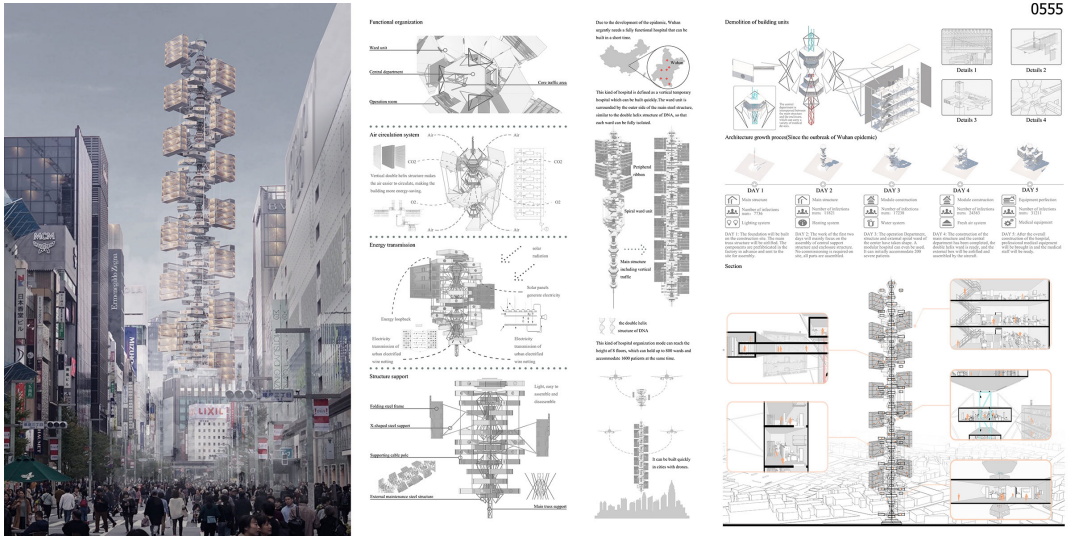

5.b. Skyshelter.zip: Foldable Skyscraper for Disaster Zones, Competition delivery 2.

**Epidemic Babel: Healthcare Emergency Skyscraper**

The tragic shortage of hospital space during the Coronavirus pandemic resulted in thousands of people dying. The vast outbreak of the virus left no time for a proper response to the disaster. Our healthcare infrastructure was proven insufficient for similar cases. The proposal comes as a possible solution for the development of alternative healthcare facilities. A temporary vertical structure is suggested for a rapid-deployment hospital. Epidemic Babel is a simple emergency hospital that is fast to assemble and easy to transport. Inspired by the double helix structure of DNA, the high rise is composed of the main truss structure. Isolated spiral ward units and lightweight external boxes attach to the core structure. Services and vertical movement take place in the center. The construction design is to be assembled in five days. The skyscraper goes eight floors high, providing space for approximately 1600 patients, with a small footprint. At the end of an epidemic, the hospital modules are unassembled and transported for alternative usage. Thus, we don't develop buildings that will be abandoned and occupy valuable lands. (e-Volo Comp. 2020 Winners)

6. Epidemic Babel: Healthcare Emergency Skyscraper, Site: Non, Project by: D Lee, Gavin Shen, Weiyuan Xu, Xinhao Yuan, Conceptual Design, First Place Winner in e-Volo Comp. 2020. Program: Portable Emergency Hospital. Height: -, Stories: -, Structure Mat.: Steel.


6.a. Epidemic Babel: Healthcare Emergency Skyscraper, Competition delivery 1.



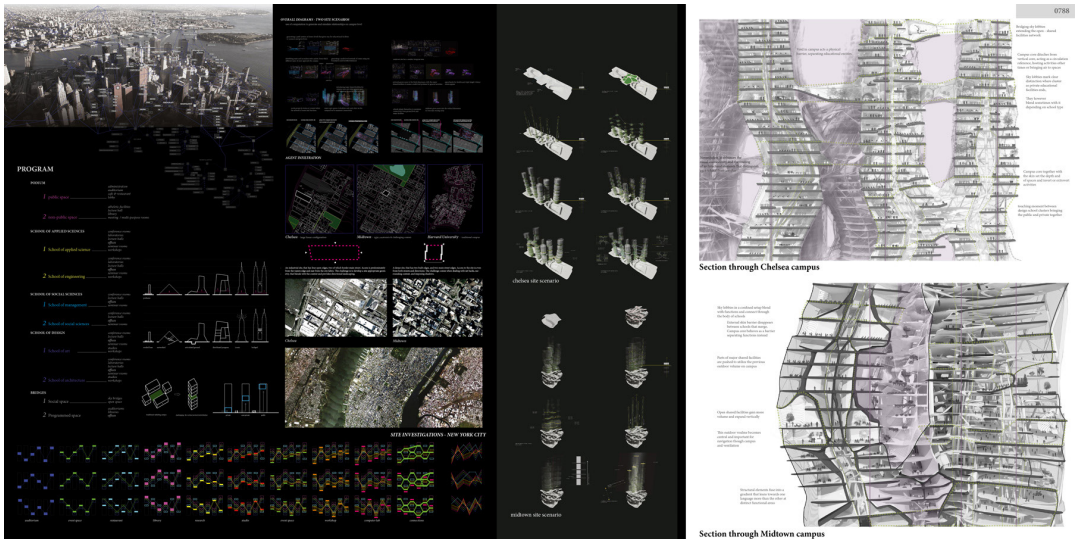

6.b. Epidemic Babel: Healthcare Emergency Skyscraper, Competition delivery 2.

## 2.3.4. Educational Superstructures

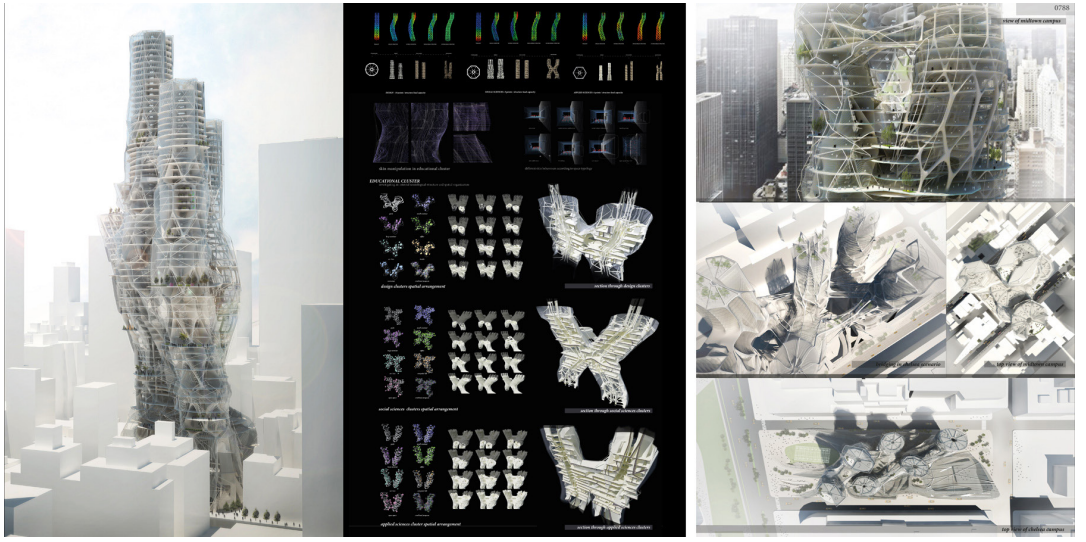
**Vertical Ground**

Vertical Grounds is a high-rise facility for higher education. In this scheme, designers are reconsidering the “norm” in vertical architecture. The proposal is a college complex for Manhattan in which the typical horizontal campus develops into a vertically oriented superstructure on a superblock. The campus complex is composed of multiple towers interconnected with sky bridges on variable levels. The skyscraper consists of clustered departments with shared gathering public spaces amongst them. The concept was employed on two sites -Chelsea and Midtown- to test the site’s effect on the out coming design. The two projects are distinctly different due to variable building regulations and maximum height allowance. In the midtown scenario, the towers are high and with a compact footprint. In the case of the Chelsea site, towers were inferior to the Midtown model and with a more relaxed layout. Vertical Grounds is an inventive intertwined structure that provides space for 20.000 students. The scheme can be deemed as an elaboration of the foretasted Cocoon Tower campus in Tokyo, Japan. (e-Volo Comp. 2012 Honorable Mention)

7. Vertical Ground, Site: Manhattan, New York, Project by: George Kontalonis, Jared Ramsdell, Nassim Es-Haghi, Rana Zureikat, Conceptual Design, Honorable Mention in e-Volo Comp. 2012. Program: Educational Campus. Height: -, Stories: -, Structure Mat.: Not Specified.




7.a. Vertical Ground, Competition delivery 1.

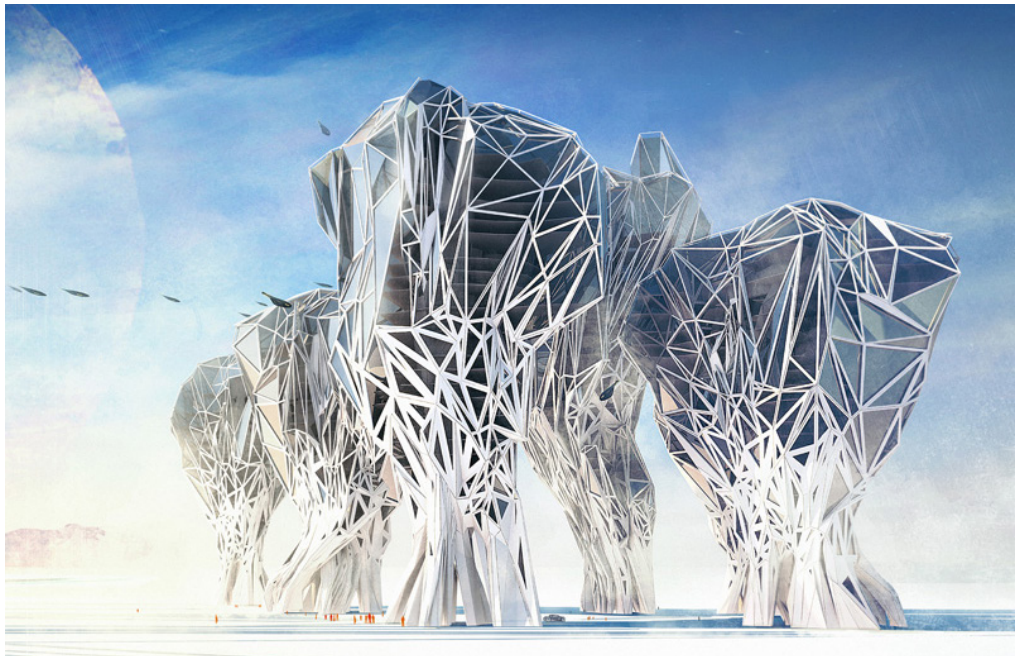


7.b. Vertical Ground, Competition delivery 2.

**Quantum Skyscraper**

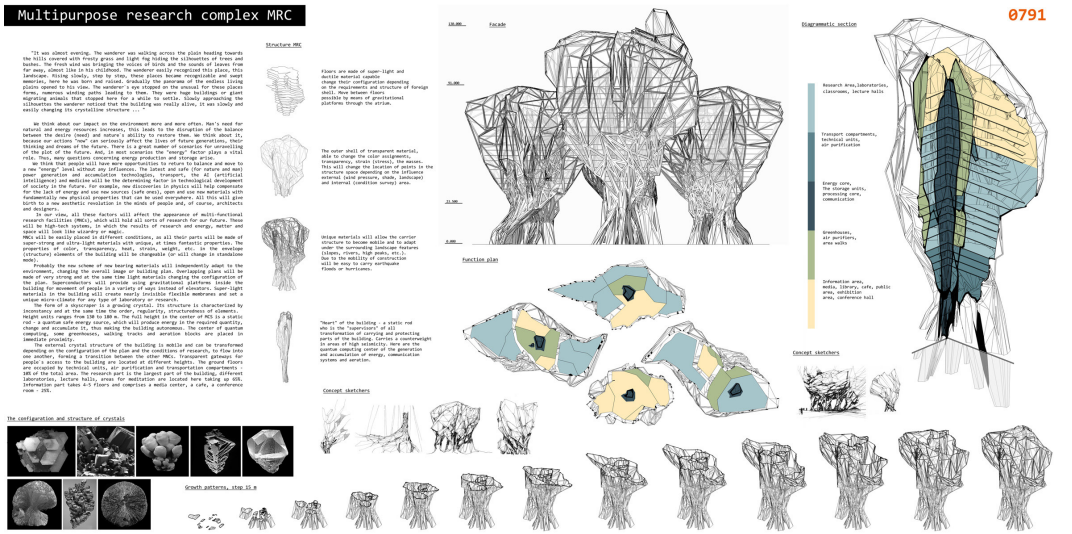
The designers anticipate that in the search for new clean energy sources, environmental problems, and technological development, research institutions will evolve new typologies in the future. The proposal imagines a Multipurpose Research Complex (MNC) consisting of multiple structures with height variations between 130m and 180m. The high-rise is an irregular crystal-shaped form. The external skeleton of the crystal is transparently supported with a lightweight structure and is designed to follow the shape of the shell. The envelope encloses irregularly shaped floors made of lightweight and ductile material.

The program is split into five sections; two functions take place in the center, and the remaining three surround them and are stacked above each other. The atrium composes of quantum computing, greenhouses, and air purifiers. In the lower section are the technical units and transport compartments, and they occupy 10% of the building floor area. In intermediate levels are research offices, laboratories, and lecture halls, and fill 65% of the total building area. The upper part hosts an exhibition, conference hall, library, cafes, and gathering areas. The project exemplifies a new prototype for research facilities. (e-Volo Comp. 2013 Honorable Mention)



8. Quantum Skyscraper, Site: Non, Project by: Ivan Maltsev, Artem Melnik, Conceptual Design, Honorable Mention e-Volo Comp. 2013. Program: Multipurpose Research Complex, Height: 180m+/590 ft+, Stories: -, Structure Mat.: Not Specified.


8.a. Quantum Skyscraper, Competition delivery 1.

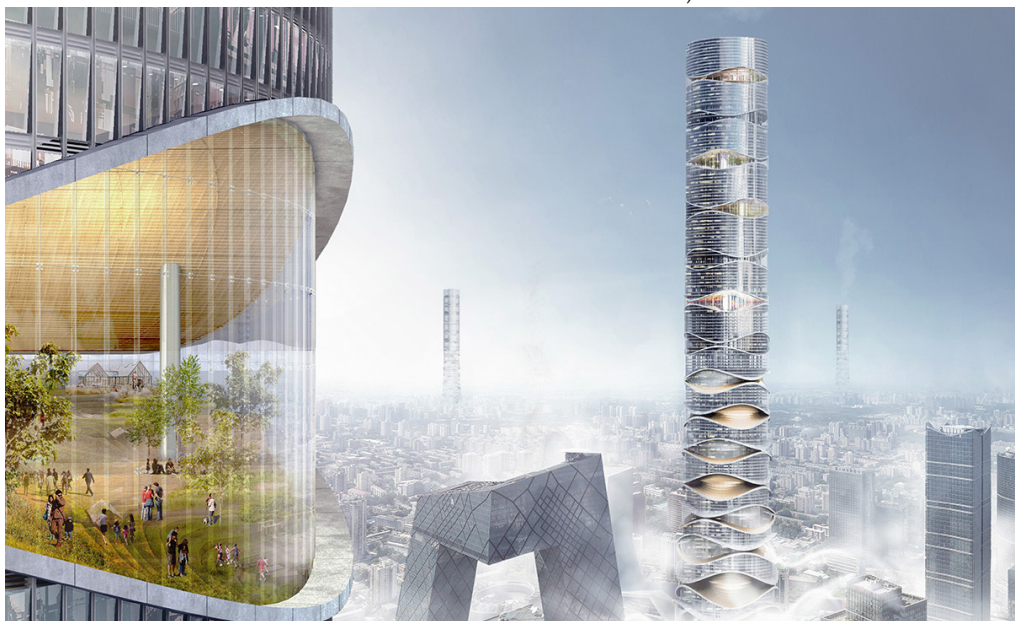



8.b. Quantum Skyscraper, Competition delivery 2.

## 2.3.5. Redefining the Mixed-use

**Air-scraper**

The designer implies a climate-conscious super-structure model for megacities. In Beijing, the dense population is projected to grow to 30% in the upcoming fifteen years, with an average of 2200 inhabitants/km2. At the same time, the city is facing high levels of CO2 emissions and air pollution crises. Air-scraper designed to provide vertical compact living spaces and assist in relieving air pollution. It is a mega-structure of 800m/ ft high and 60m/ ft in diameter. The sky-scraper contains an innovative concept of air filtering. A round tube 'chimney' atrium along the height of the building and 30m/ ft wide sucks the polluted air from the bottom of the scraper, filters it, and produces clean air. The chimney contains three modules for take module with a filtering system that sucks polluted air while the filters collect TSP, PM10, and PM2.5 particles. In the mid-section of the structure is a solar-gain module, equipped with mirrors to reflect sunrays on the chimney's black stone surface for natural upward air movement. Afterward, the green-garden module follows at a height of 400m/ ft and above the pollution fog level. The greenery feeds on CO2 and emits clean air for the skyscraper and the surrounding city. Around the atrium, a mixed-use program of residential, educational, commercial, and recreational facilities takes place. Air scrapers can host 7500 people and help clean the air with an efficiency of up to 80 percent. It stands as a healthy vertical city model that serves the need of the city, its occupants, and our planet Earth. (e-Volo Comp. 2019 Winners)



9. Airscraper, Site: Beijing, China, Project by: Klaudia Gołaszewska, Marek Grodzicki, Conceptual Design, Second Place Winner in e-Volo Comp. 2019. Program: Pollution Cleanser, Residential, Recreational, Educational, Commercial. Height: 800m/2,625 ft, Stories: -, Structure Mat.: Not Specified.


9.a. Airscraper, Competition delivery 1.


9.b. Airscraper, Competition delivery 2.

**Times Squared 3015**

Time Square 3015 is a superstructure resembling an actual vertical expansion of the city. In Times Square, New York, the structure presents a new height to the metropolis. The concept evolves in response to overpopulation and land scarcity. The tower hosts twelve module blocks, replicating the horizontal city grid. Modules are stacked on top of each other, hovering over the city with a more than mile-high structure. Open spaces are carved out of each module, where they function as gathering and entertainment places in forests, mountain hills, and lakes. The program consists of daily life sectors: housing, offices, vertical farms, and gathering open spaces of natural environments.

Vertical farms and open natural spaces are positioned on the southern façade to benefit from solar energy. Energetic vibes of Time Square are transmitted to the vertical city through entertainment sky malls placed on both above and below residential modules. The tower's pinnacle is a 4000 ft high observation deck, offering a dazzling view of the city. Vertical circulation is divided into two categories; a primary subway that only stops at each block, and a secondary core of elevators and stairs within each section. This method significantly cuts down vertical transport duration, where travel time from the podium to the peak is 3 minutes. The skyscraper aspires to draw new boundaries of a mixed-use typology. (e-Volo Comp. 2015 Honorable Mention)


10. Times Squared 3015, Site: New York, Project by: Blake Freitas, Grace Chen, Alexi Kararavokiris, Conceptual Design, Honorable Mention e-Volo Comp. 2015. Program: Innovative Mixed-use. Height: 1700m+/5,687 ft, Stories: -, Structure Mat.: Not Specified.


10.a. Times Squared 3015, Competition delivery 1.


10.b. Times Squared 3015, Competition delivery 2.

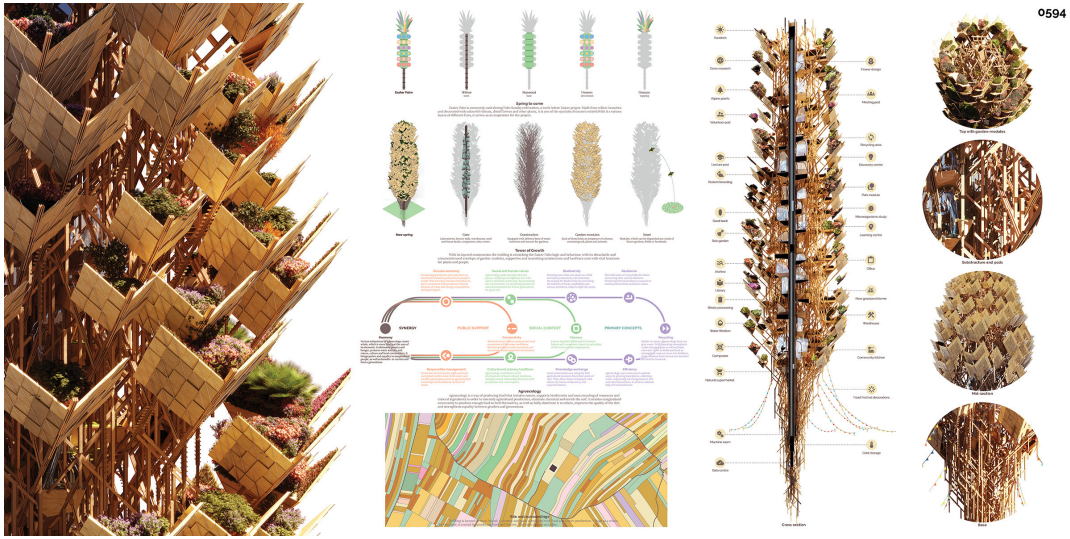
## 2.3.6. Radical Vertical Farming

**New Spring: Agro-ecological Skyscraper**

The proposed skyscraper is a machine that connects nature and science to contribute to global food production. The designers highlight the hunger problem and the anticipated world food shortage. Distinct from the Mashambas tower, the New Spring high-rise function as biodiverse farmland, bringing together plants that naturally never intersect. The concept is to create a floating garden/field that can be utilized anywhere in cities or farms to increase fertile land worldwide. The construction is composed of two parts; an envelope of modular pods surrounds the supporting core. Farm pods are constructed outdoors to provide the plants with direct sunlight and fresh air. Pod modules are made from cross-laminated timber and designed to be easily assembled, dissembled, and shipped. The supporting core is made of timber and contains hardware functions. The tower hosts various programs besides the farm. Behind the pod branches, there are laboratories, plant tissue banks, data centers, lecture halls, warehouses, meetings, and event spaces. The ingenious scheme is it develops the imagined vertical farm. It is much more than a farm as it brings more functions to the concept, uses sustainable materials, and creates a circular design. (e-Volo Comp. 2022 Honorable Mention)

11. New Spring: Agro-ecological Skyscraper, Site: Poland, Project by: Michał Spólnik, Marcin Kitala, Second Place Winner in e-Volo Comp. 2022. Program: Reservation of Future Farming. Height: -, Stories: -, Structure Mat.: Timber.


11.a. New Spring: Agro-ecological Skyscraper, Competition delivery 1.



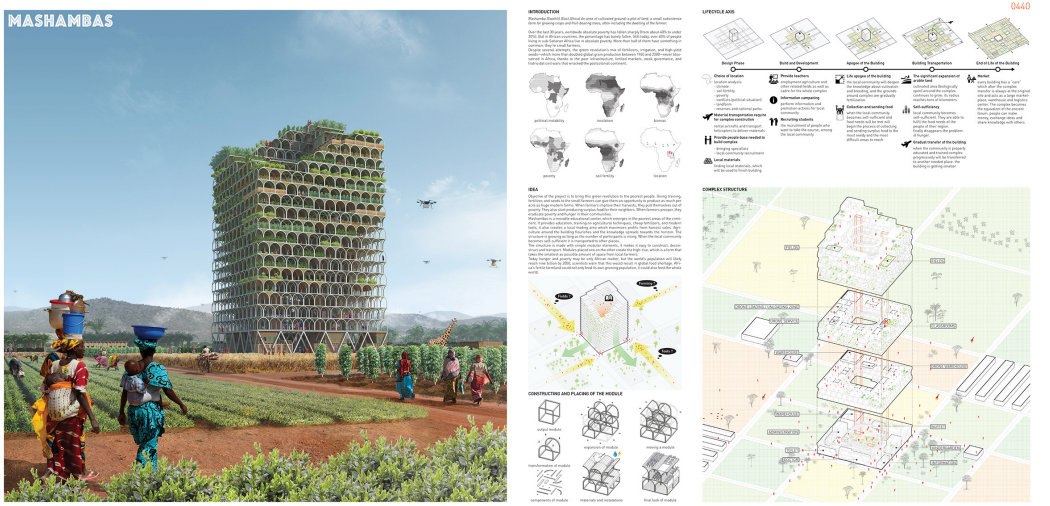

11.b. New Spring: Agro-ecological Skyscraper, Competition delivery 2.

**Mashambas Skyscraper**

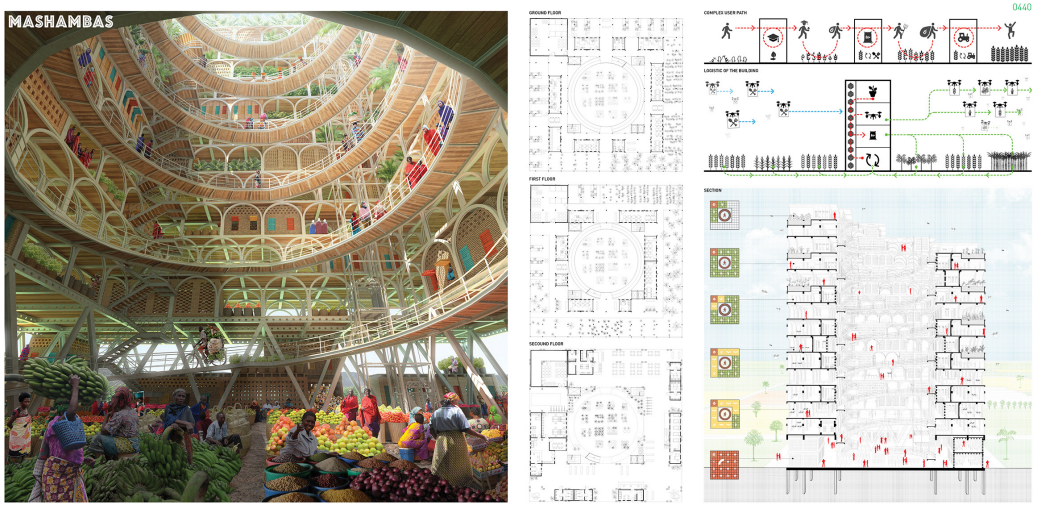
The designers are introducing a tower model for African farmers. The project objective is to accentuate the poverty issue in African countries and the possible potential the region owns. Mashambas high-rise is a portable center for farming education. The fertile farmlands in Africa constitute a great resource that is not only able to reduce deprivation in the continent, but also it can supply food to the world.

Therefore, the proposal pursues to provide a place to educate farmers about agricultural techniques, provide them with fertilizers and seeds, and train them to benefit from their lands. The form constitutes a simple module, repetitive vertically and horizontally. The construction grows or shrinks depending on the space needed. The vertical expansion of the structure saves the land for agricultural usage. When local farmers are trained and competent, modular sections are easily dispersed and shipped to a new community. (e-Volo Comp. 2017 Winners

12. Mashambas Skyscraper, Site: Swahili, East Africa, Project by: Pawel Lipiński, Mateusz Frankowski, Conceptual Design, First Place Winner in e-Volo Comp. 2017. Program: Educational movable farming center. Height: Variable, Stories: Variable, Structure Mat.: Not Specified.




12.a. Mashambas Skyscraper, Competition delivery 1.




12.b. Mashambas Skyscraper, Competition delivery 2.

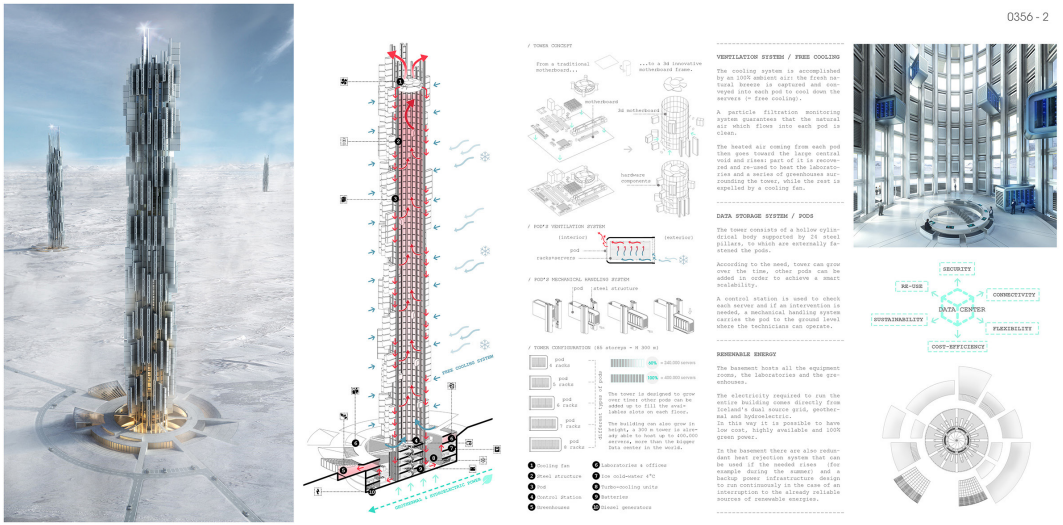
## 2.3.7. Technological Skyscraper

**Data Skyscraper: Sustainable Data Center in Iceland**

A Data skyscraper is an innovative vertical structure designed to store data. The annual global IP traffic passed 2 Zettabytes per year in 2019 and 278.1 Exabytes per month in 2021, up from 96.1 Exabytes per month in 2016. Data centers are the physical place where servers are stored. Companies build data centers as huge industrial containers that have no architectural identity. Almost no proper urban or architectural analysis is carried out on the new building typology; thus, they occupy large portions of land, consume plenty of energy, and produce a large carbon footprint. The project is a morphological model for a green data center in Iceland. The chosen site provides several benefits; it is an intermediate location between the U.S. and Europe, it is a naturally cold region, and it's filled with green energy resources. Animated as a gigantic 3D motherboard, the high-rise consists of two elements. The envelope of data hardware modules is attached to a cylindrical structure and an empty core for the internal cooling system, where an enormous cooling fan takes place on top of the atrium. Pods benefit from the outside natural cold breeze and release warm air internally, then exit from the top of the tower. The proposal aims to emphasize the complexity and importance of the building. (e-Volo Comp. 2016 Winners)

13. Data Skyscraper: Sustainable Data Center in Iceland, Site: Iceland, Project by: Valeria Mercuri, Marco Merletti, Conceptual Design, Third Place Winner in e-Volo Comp. 2016. Program: Data Storage. Height: -, Stories: -, Structure Mat.: Not Specified.


13.a. Data Skyscraper: Sustainable Data Center in Iceland, Competition delivery 1.




13.b. Data Skyscraper: Sustainable Data Center in Iceland, Competition delivery 2.

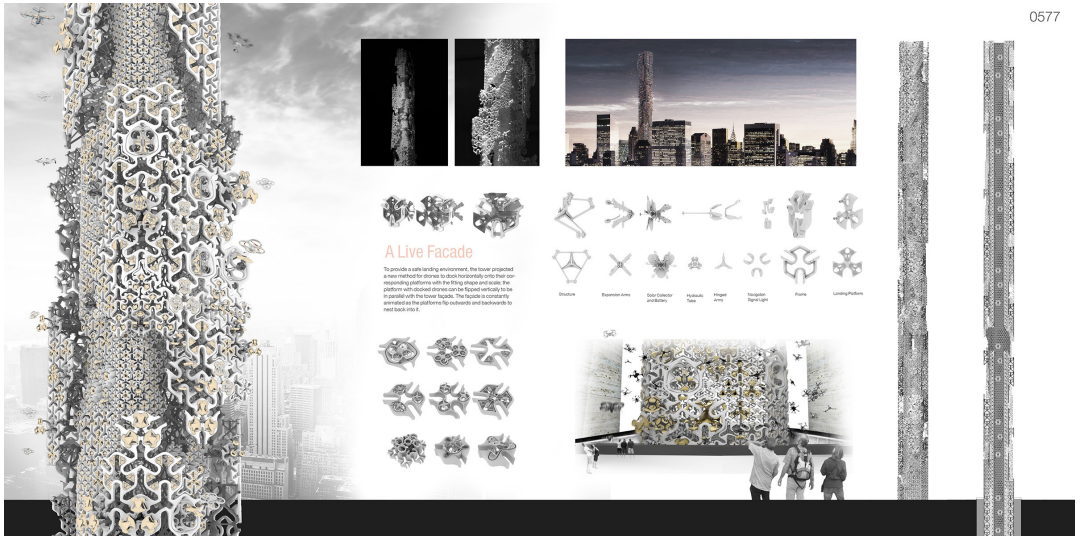
**The Hive: Drone Skyscraper**

The Designers imagine an inventive skyscraper that controls drone traffic. Drone technology is projected to be the new mean of high-speed delivery services. The structure is a terminal where drones land and charge. The Hive is envisioned as an infrastructure scheme to regulate drone traffic and obeys the current legislative concerns. The design is a vertical live façade composed of nine different-sized modules. The modules feature a new technology to enable drones to land horizontally into their equivalent geometry.

Afterward, the landed drones are vertically rotated parallel to the structure to maintain a homogeneous surface. The high-rise is a two-layer envelope where the inner layer hosts the smaller drone modules, and the outer layer contains the larger modules. This way increases the usable surface area of the tower. A central location in Manhattan is to host the new high-rise typology, at 432 Park Avenue. The ingenious of this project is the developed geometries of different drones' sizes and shapes where they will be placed vertically on a new building typology that can significantly help relieve congestion. And provide a green method of product delivery. (e-Volo Comp. 2016 Winners)

14. The Hive: Drone Skyscraper, Site: New York, Project by: Hadeel Ayed Mohammad, Yifeng Zhao, Chengda Zhu, Conceptual Design, Second Place Winner in e-Volo Comp. 2016. Program: Live Facade. Height: -, Stories: -, Structure Mat.: Not Specified.


14.a. The Hive: Drone Skyscraper, Competition delivery 1.




14.b. The Hive: Drone Skyscraper, Competition delivery 2.

## 2.3.8. New Generation of Environmental Skyscraper

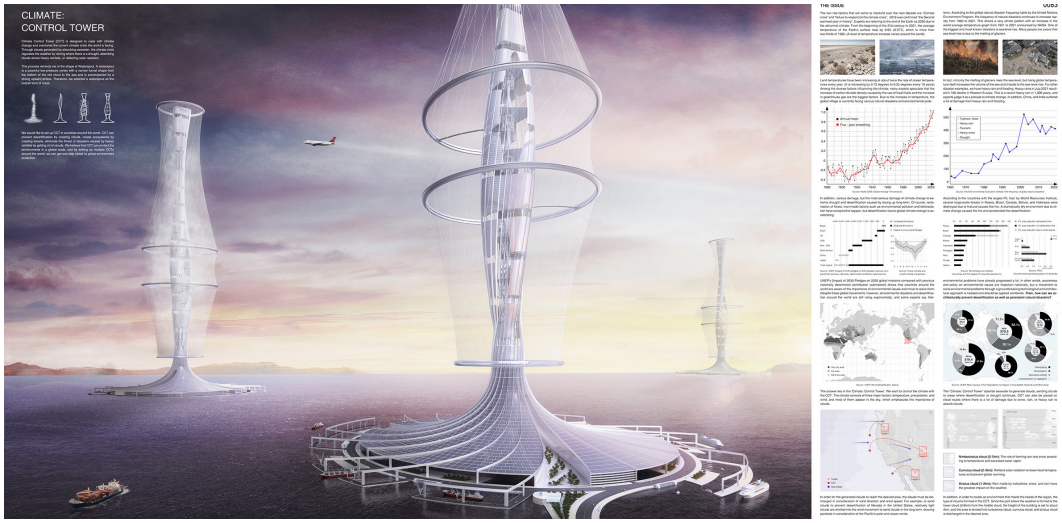
**Climate Control Skyscraper**

The world is facing severe climate and environmental crises. Desertification and floods are acute issues facing our planet. Excess and scarce rain are the main factors for these phenomena. It is essential to state that despite the efforts to regulate the situation, 2050 is expected to be the end of the world if we don't take an action. Can we control rain to fight desertification and floods? The design team proposes a solution to overcome desertification via architecture, the Climate Control Tower CCT. The concept is to create structures that produce clouds, they are then carried by the wind to bring rain to drained regions.

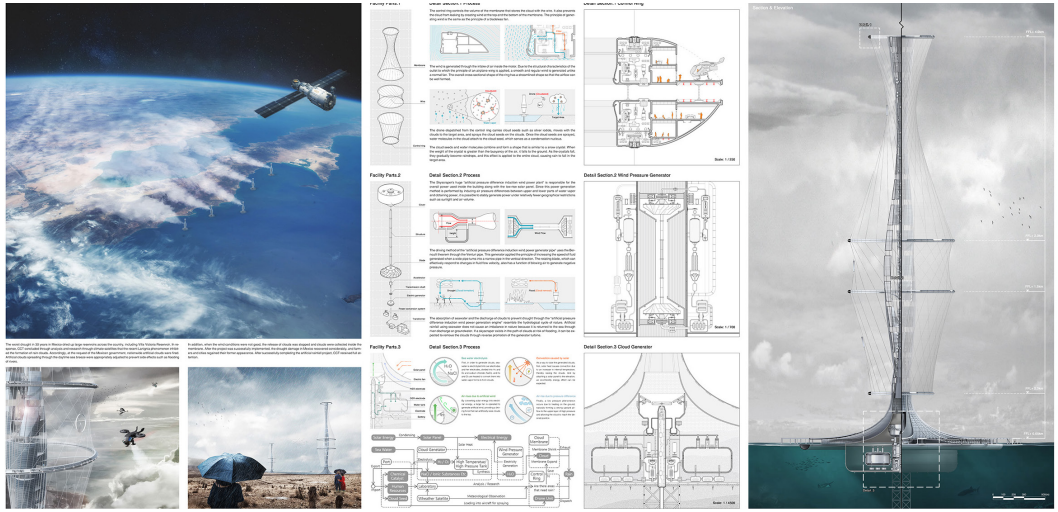
How does it work? The skyscrapers are placed above water, seawater is used to produce the clouds. The structures are anchored to trusses under sea level. The height of the tower corresponds to the desired clouds in different regions, low, medium, or high types of clouds. The structure generates the power it needs from a solar panel roof and wind pressure generator at the base of the building. Solar energy generates heat that is transmitted to the cloud's generator in a high-pressure and temperature tank that transforms seawater into pure water. Water vapors move upwards where they get sprayed along the height of the skyscraper forming clouds, the clouds are contained in the skyscraper by the membrane and control rings. On their way up water, vapors pass through a wind pressure generator to produce electricity using the pressure difference concept. CCT is connected to a space weather satellite that measures wind direction and distance between the tower and the targeted region. As the cloud is ready it gets discharged through an outlet in the membrane according to the information obtained from the satellite base. Drones are dispatched with the clouds; they carry cloud seeds such as silver iodide when the cloud arrives at the targeted area the drones spray the seeds into the cloud. The seeds and water molecules form snow crystals that are heavier than air, so it falls in form of raindrops, thus generating rain where it is needed. CCTs work also as cloud suctions, they are placed in areas with excess clouds to prevent floods.

The objective is to distribute CCTs around the world to protect the environment on a global scale. The Climate Control Tower system can prevent desertification and turn drained regions into forests, preventing disasters caused by floods. (e-Volo Comp. 2022 Winners)

15. Climate Control Skyscraper, Site: Non, Project by: Kim Gyeong Jeung, Min Yeong Gi, Yu Sang Gu, Conceptual Design, First Place Winner in e-Volo Comp. 2022. Program: Climate Control, Height: 4km+/13.123 ft+, Stories: -, Structure Mat.: Not Specified.




15.a. Climate Control Skyscraper, Competition delivery 1.



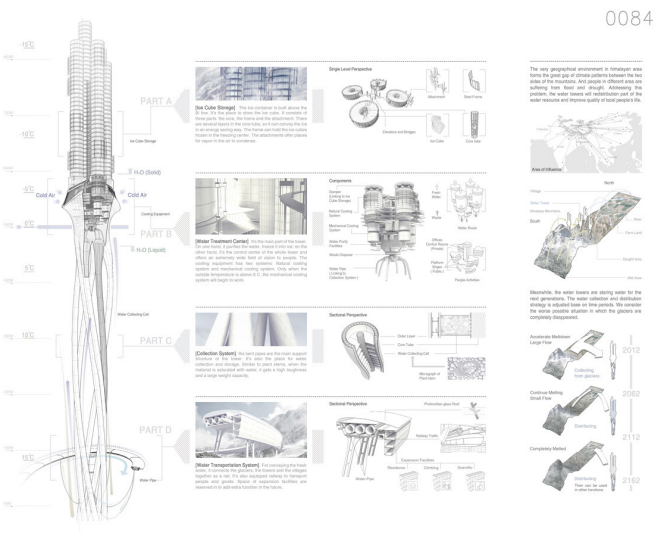
15.b. Climate Control Skyscraper, Competition delivery 2.

**Himalaya Water Tower**

Up to 40% of the Earth's freshwater is in the Himalayan Mountains. Global warming is causing the mountain's ice to melt at an alarming pace. Sea levels are increasing, putting Asia and the rest of the world under threat. The design team proposes an architectural approach for the imminent disaster. Himalaya Water Tower is a high-rise complex to be located in the Mountains. The super-structures aim to store excess water during the rainy season, then the water will be filtered and frozen for future usage. The structure provides a means to control water distribution for surrounding villages while saving enormous water supply for upcoming generations. The skyscraper is composed of three divisions. The lower section is six spinning water pipes designed to expand or diminish relative to the stored water amount. The upper part consists of four cylindrical containers where frozen water is stored. The intermediate section is dedicated to the operating system that regulates the functions of the construction. It is where mechanical operations of water purification, freezing, and distribution control are located. On the ground level, a transport system surrounds the tower's tubes and distributes water to towns. (e-Volo Comp. 2012 Winners)

16. Himalaya Water Tower, Site: Himalaya Mountains, Project by: Zhi Zheng, Hongchuan Zhao, Dongbai Song, Conceptual Design, First Place Winner in e-Volo Comp. 2012. Program: Water Storage, Height: 850m+/2.788 ft+, Stories: -, Structure Mat.: Not Specified.


16.a. Himalaya Water Tower, Competition delivery 1.

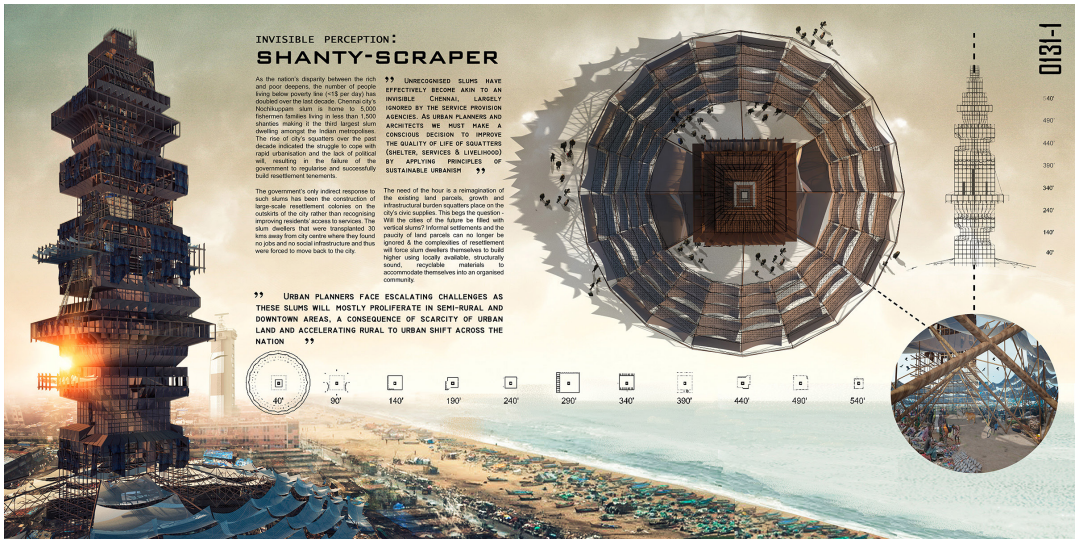

16.b. Himalaya Water Tower, Competition delivery 2.

## 2.3.9. Vertical Housing Solutions

**Invisible Perception: Shanty-Scraper**

The proposal brings attention to the slum settlement issues and the fast-base shift from rural to urban caused by their horizontal expansion. In the case of Chennai city, which contains India's third-largest slum dwelling, the Nochikuppam slum houses around 5.000 fishermen families in 1.500 shanties. The government responded to the issue by offering remote settlements on the city's borders, far away from the inhabitants' jobs and social infrastructure. It is reported that 20% of the provided residences are abandoned, and 50% are no longer occupied by the original residents. At the same time, the resettlements require an overly long time to build, they swallow enormous valuable lands and are incredibly high in cost. As the gap between rich and poor broaden, the population below the poverty line escalates, and informal settlements are growing. On the other hand, the lands are scarcer. Nochikuppam slums have two choices, to expand towards downtown or the surrounding rural areas. The designers propose Shanty-Scraper as a solution for Nochikuppam.
The project is a self-built high-rise, made with low-tech, low-cost materials. Post-construction waste, pipes, and reinforcement bars are used for structural stability. The supporting structure is made of circular brace timber and roped to the ground. The envelope is realized with local brace timber, recycled metal sheets, and hay bale. Vertical movement is divided into several timber lifts that operate with a simple mechanical device. The podium is a double-height semi-open space that hosts the fish market and gathering spaces. The structure pinnacle allows future expansion. (e-Volo Comp. 2015 Winners)

17. Invisible Perception: Shanty-Scraper, Site: India, Project by: Suraksha Bhatla, Sharan Sundar, Conceptual Design, Second Place Winner in e-Volo Comp. 2015. Program: Vertical Slum, Height: 165m+/540 ft+, Stories: -, Structure Mat.: Timber and metal sheets.




17.a. Invisible Perception: Shanty-Scraper, Competition delivery 1.

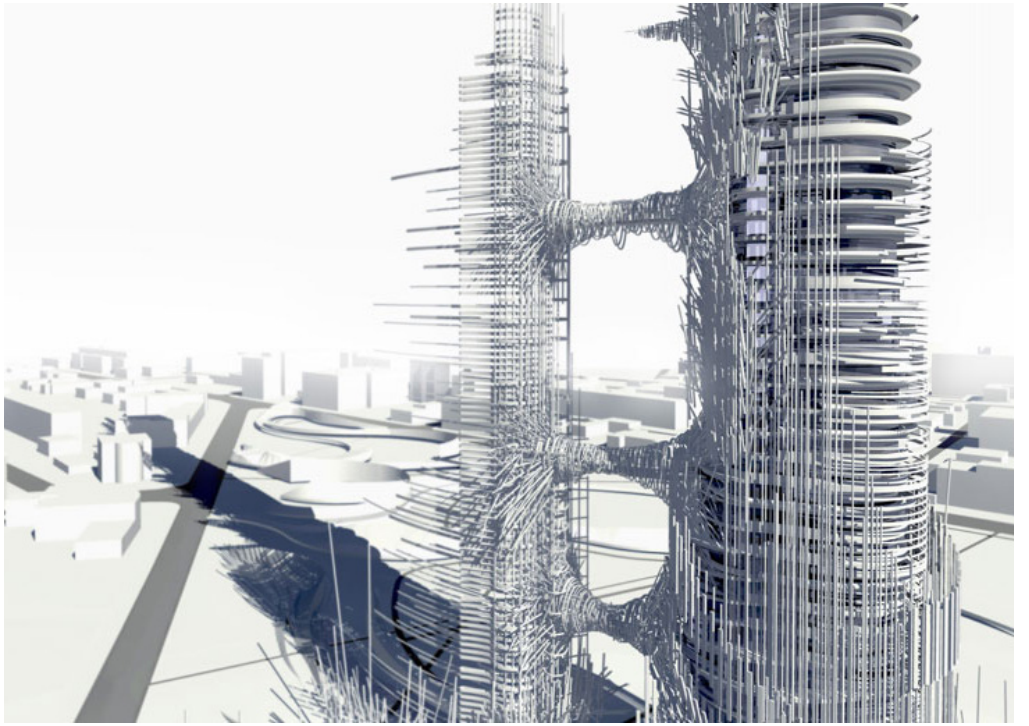

17.b. Invisible Perception: Shanty-Scraper, Competition delivery 2.

## 2.3.10. Medical Superstructure

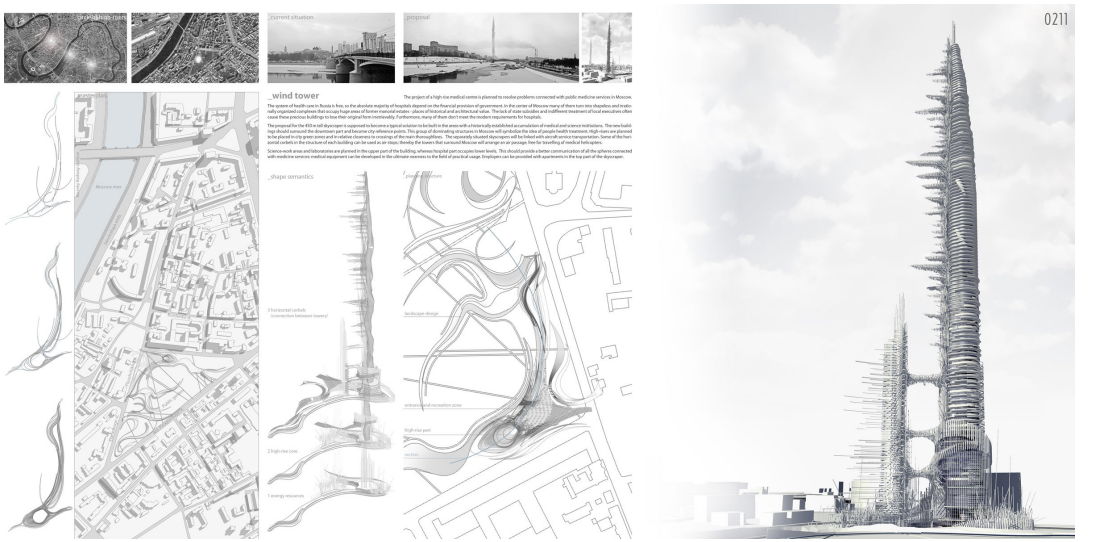
**Wind Tower**

The project proposes a high-rise hospital typology for Moscow city. The skyscraper's model follows the principle of form follows function. The structure of 450m/ 1476 ft high provides the city with the needed medical space. The envelope's design offers a self-sufficient energy system. Cantilever trusses are used as an air stop linking the hospital with the city while avoiding traffic for critical cases. Research laboratories and science workspaces occupy the tower's upper floors. The structure is topped with shared apartments for health workers.

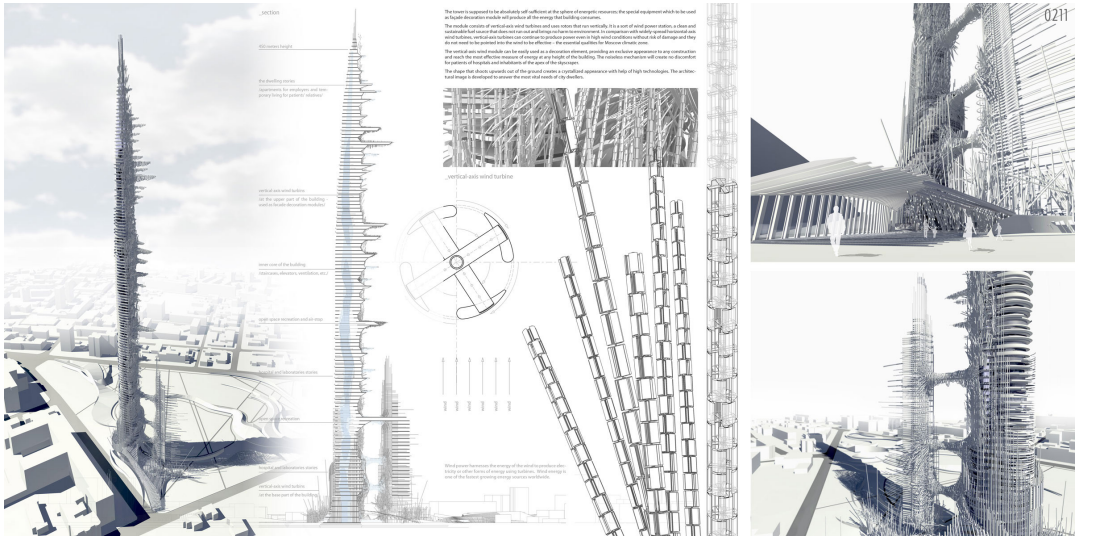
The designer applies a creative decorative module for the façade which functions as a green electric power producer for the entire structure. Vertical wind turbines are placed inside the modules, which transforms the decorative modules into a power station. The vertical placement of wind turbines enables energy production in high wind conditions like those found in Moscow. Instead, the mechanism turns the high wind speed into a benefit for continuous energy production. The noiseless system provides enough energy for the entire building. (e-Volo Comp. 2010 Special Mention)



18. Wind Tower, Site: Moscow, Russia, Project by: Elena Batueva, Conceptual Design, Special Mention e-Volo Comp. 2010. Program: Medical Center and Wind Tower. Height: 450m+/1,476 ft, Stories: -, Structure Mat.: Not Specified.




18.a. Wind Tower, Competition delivery 1.




18.b. Wind Tower, Competition delivery 2.

## 2.3.11. Vertical Airport

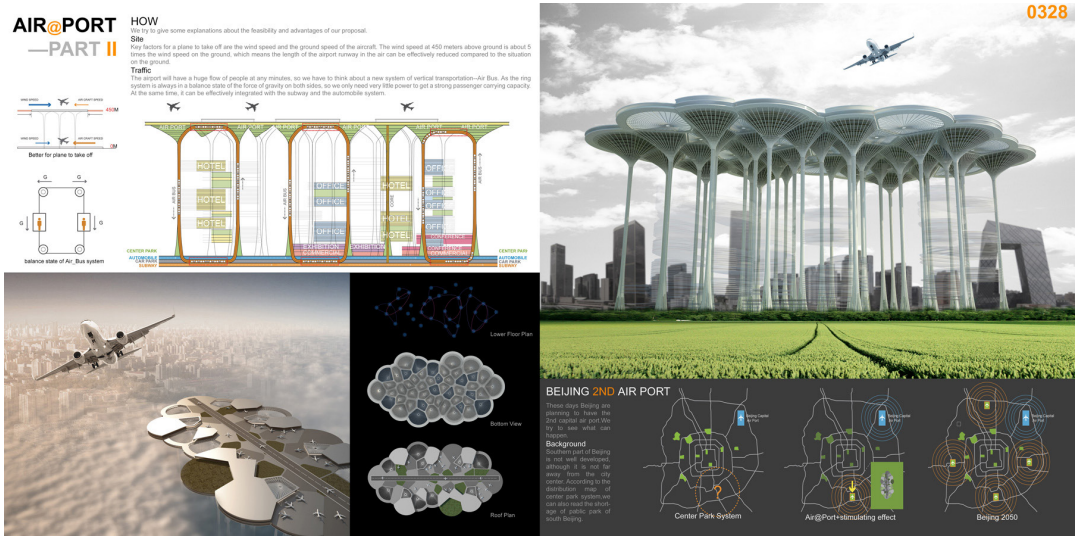
**Airport Skyscraper**

The project designers propose elevating airports 450 meters above the ground and placing them within the urban fabric. Why? Airports are land-consuming not only do they require a massive plot of land, and they change building height regulations for a vast surrounding area which results in reducing land value. The project also cuts travel time and distance to airports when placed close to or within the city, which decreases congestion

Elevated airports can save the scarce valuable lands in megacities like Beijing, a city that is increasing its air transportation flow early. The project aims to integrate vertical architecture for urban problem solutions and save lands. The Air@Port stands on thin towers that grow mushroom-like at the pinnacle providing wide spaces for airport runways. The supporting spires contain vertical circulation and are linked with variable functions of; hotel, office, commercial, and recreational spaces. (e-Volo Comp. 2012 Honorable Mention)

19. Airport Skyscraper, Site: Beijing, China, Project by: ZhiYong Hong, XueTing Zhang, Conceptual Design, Honorable Mention e-Volo Comp. 2012. Program: Airport. Height: 450m+/1.476 ft+, Stories: -, Structure Mat.: Not Specified.


19.a. Airport Skyscraper, Competition delivery 1.



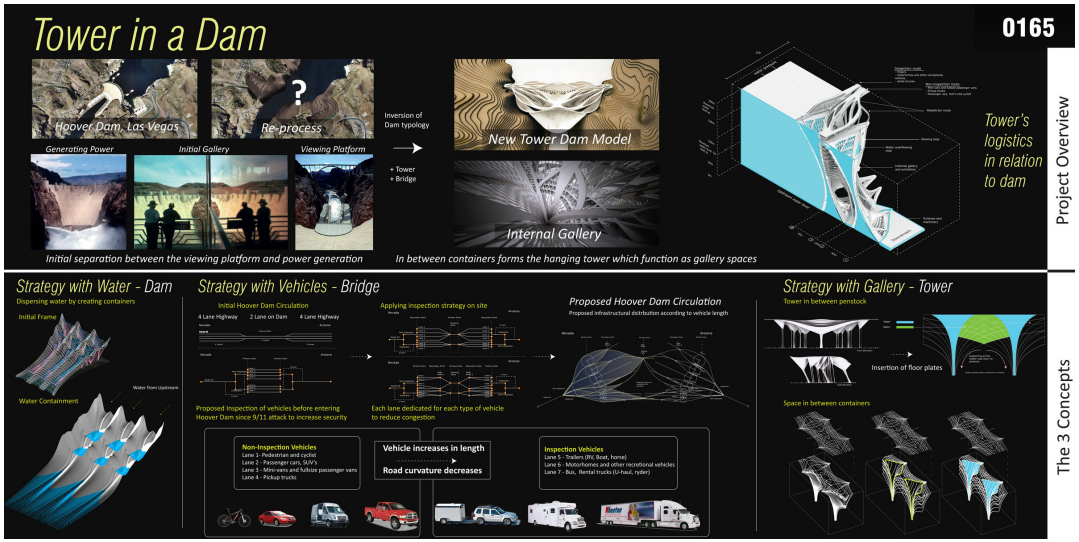

19.b. Airport Skyscraper, Competition delivery 2.

## 2.3.12. Vertical Amenities

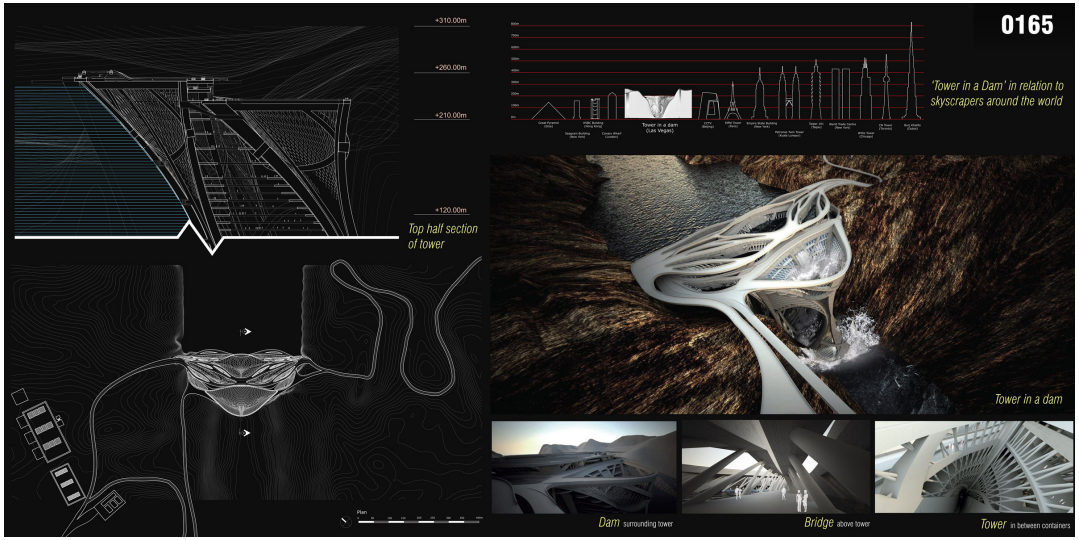
**Re-imagining the Hoover Dam**

The scheme is a rehabilitation for The Hoover Dam in the U.S. It is a 250-meter-high inverted skyscraper. The designer aims to gather the existing scattered amenities of; the gallery, viewing platform, and bridge and place them in a vertical structure that replaces the initial layout The project replaces the initial frame of the water barrier with a water containment frame. The Tower in Dam stands amid the penstocks, forming an internal gallery that is in direct contact with the river's vertical aquarium. The structure provides a homogeneous space for viewing platforms, galleries, and other needed services. The hanging high-rise creates a more engaging experience with the surroundings while improving the spatial quality of the original functions. (e-Volo Comp. 2011 Winners)

20. Re-imagining the Hoover Dam, Site: Hoover Dam, Las Vegas, Project by: Yheu-Shen Chua, Conceptual Design, Third Place Winner in e-Volo Comp. 2011. Program: Vertical Amenities. Height: 310m/ 1.017 ft, Stories: -, Structure Mat.: Not Specified.




20.a. Re-imagining the Hoover Dam, Competition delivery 1.



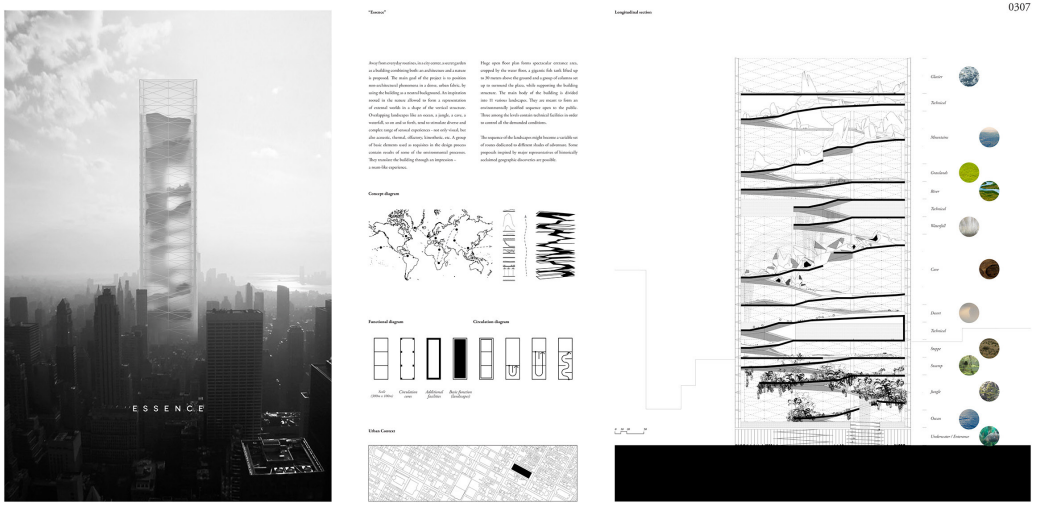

20.b. Re-imagining the Hoover Dam, Competition delivery 2.

## 2.3.13. Vertical Public Spaces

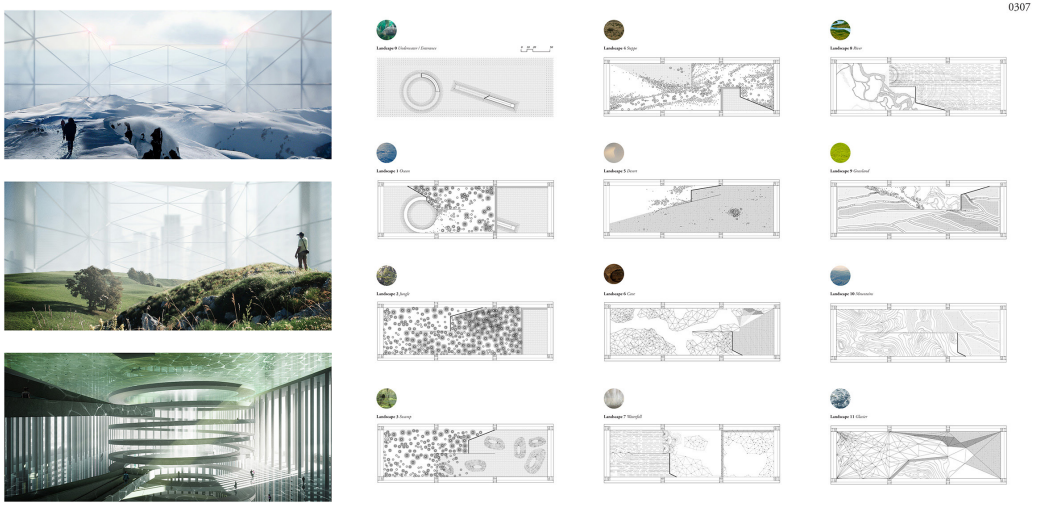
**Essence Skyscraper**

The project is a vertical structure that introduces a new model of public space to the urban fabric. It is a radical redefinition of bringing nature to the city. Much like Coney Island Parks concept, the designers propose an escape point from the fast pace of living in urban areas back to the Essence of Nature. The high-rise places non-architectural aspects within the city grid. It is a recreation of the world's nature in a vertical sequence, in a series of eleven overlapping landscapes hidden from their surroundings. Multiple scenarios of nature start with an underwater path, jungle, desert, caves, waterfall, mountains, and topped with glaciers. The program stimulates diverse experiences aided by visual, acoustic, and thermal effects. It is an adventure open to the public in the heart of the city. (e-Volo Comp. 2015 Winners)


21. Essence Skyscraper, Site: Non, Project by: Ewa Odyjas, Agnieszka Morga, Konrad Basan, Jakub Pudo, Conceptual Design, First Place Winner in e-Volo Comp. 2015. Program: Public Space, Height: 550m+/1,805 ft+, Stories: 11 levels, Structure Mat.: Not Specified.




21.a. Essence Skyscraper, Competition delivery 1.




21.b. Essence Skyscraper, Competition delivery 2

**Egalitarian Nature: Vertical Green Park for Urban Areas**

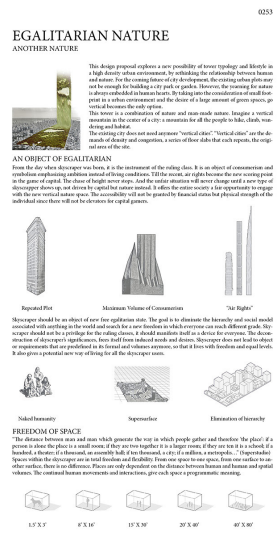
The designers deem the current vertical buildings as a requirement for congestion, representing the consumer society and reflecting wealth and power. The height race never stops, and the vision for skyscrapers will never change till we allow new typologies to exist. Typologies that integrate with the entire population and are built for living conditions, not ambitions.

In New York City -not far from Coney Island and its former entertainment parks and towers- the designers propose a recreational high-rise within the city's grid. The Egalitarian Tower is a new high-rise typology. "Imagine a vertical mountain in the center of a city: a mountain for all the people to hike, climb, wander and habitat."13

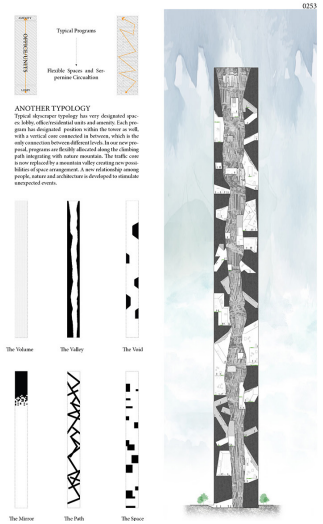
The project not only dismantles the typical typology of a high-rise or redefines the public space in the city, but it is entirely a radical intervention to what is known for skyscraper design. The atrium replicates a mountain's crevice with a zigzag path for climbing. Programs are distributed vertically around the core, creating a flexible interface between nature, architecture, and human activities. In the Egalitarian tower, access to the city's mountain will be granted according to physical strength, not financial status. The proposal aspires to achieve social equality, where skyscrapers are not monopolists by certain classes, instead they are tools standing to serve society. Only with this type of freedom for vertical structures, it is possible to develop new potentials for the way of living in the city. (e-Volo Comp. 2020 Winners)

22. Egalitarian Nature: Vertical Green Park for Urban Areas, Site: New York, Project by: Yutian Tang, Yuntao Xu, Conceptual Design, Second Place Winner in e-Volo Comp. 2020. Program: Public Space of Vertical Mountain. Height: -, Stories: -, Structure Mat.: Not Specified






22.a. Egalitarian Nature: Vertical Green Park for Urban Areas, Competition delivery 1.




22.b. Egalitarian Nature: Vertical Green Park for Urban Areas, Competition delivery 2.

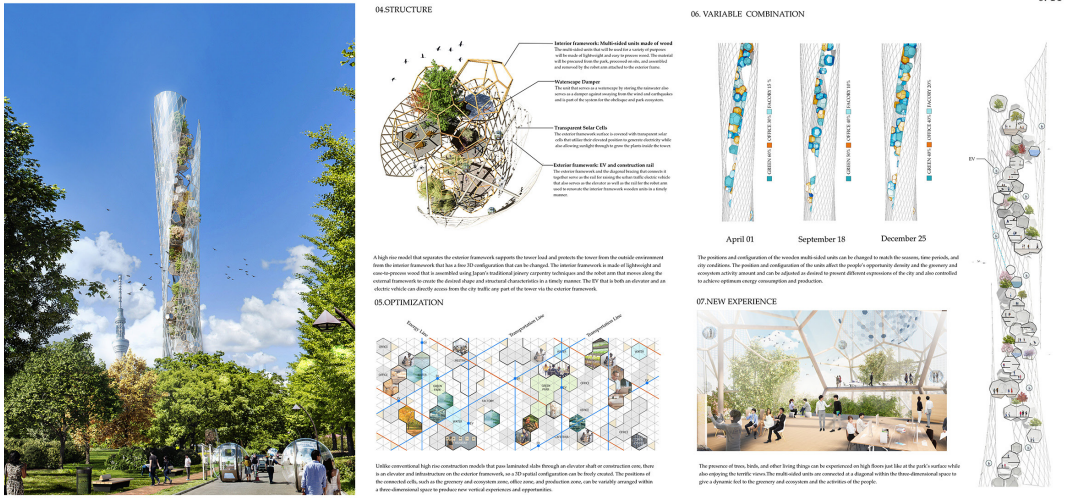
**Smart Obelisk Skyscraper: A Vertical Non-Linear Park**

The proposal highlights the importance of developing the city's parks to fit the model of a smart city. The designers propose three-dimensionalized parks by employing a vertical structure to existing gardens. Smart Oblisque is a new high-rise typology for public space to improve its functionality. The tower deploys artificial and natural elements to create variable spaces and opportunities. As cities evolve in the 21st century, finding a balance between natural, technological, and urban elements become a complex subject. The tower develops the parks by mixing recreational activities with technology applications that turn the park into a device of energy production and become a part of the cycle of a smart city. The skyscraper deploys an innovative concept of an accountable exoskeleton and endoskeleton. In Smart Oblisque the typical multi-layer slabs permeated by the vertical circulation and services are replaced by continuous flexible space across the vertical access, referred to as the inner skeleton. The exoskeleton functions as a shield from the outside environment made of transparent solar cells producing electricity for the construction while permitting natural daylight to the plants. The diagonal framework holds the solar panels and utilizes vertical circulation developed similarly to the electric vehicle (EV). Endoskeleton is therefore freed from the vertical core allowing a 3D spatial configuration to form. It composes of multisided flexible cells varying in program and location in the endoskeleton web. The cells function as green areas, offices, meeting zones, museums, water tanks, gathering areas, and services. (e-Volo Comp. 2020 Editor's Choice)

23. Smart Obelisk Skyscraper: A Vertical Non-Linear Park, Site: Non, Project by: Masaaki Matsuoka, Yuuki Murakami, Fumito Tamamura, Ryo Watada, Hiroki Kanto, Conceptual Design, Editor's Choice e-Volo Comp. 2020. Program: Smart Vertical Park. Height: -, Stories: -, Structure Mat.: Forest wood




23.a. Smart Obelisk Skyscraper: A Vertical Non-Linear Park, Competition delivery 1.




23.b. Smart Obelisk Skyscraper: A Vertical Non-Linear Park, Competition delivery 2.

## 2.4. New Programs: Towards The Fifth Generation of High-rise

In the above proposals, we find examples of skyscrapers with innovative programs. They undoubtedly present a radical definition of what a tall building can be.

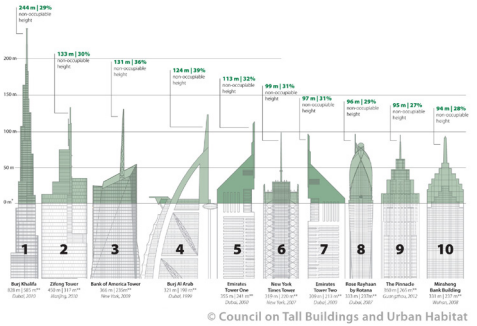
**How can skyscrapers save the city?**
The tall building can turn into a game changer in urban design. Variable functions of vertical structures reinvent the meaning of High-rises and their role within the urban fabric. Similar to any low-rise building that accommodates every program, also the skyscraper can. The urban fabric will grow into low, medium, and high rises, developing a new dynamic of the urban module. The future module will include a mix between all heights in all city districts, with new programs.

As observed in Figures 15 &16, the 21st century is the era of verticality, and indications support that the high-rise is increasingly a main building typology of the future. The challenging scale of tall buildings makes a significant impact on any improvement to them, there is still a lot to investigate and improve. For instance, the height race resulted in what is known as 'vanity height.' It is a term developed by CTBUH to refer to the non-occupiable space in the pinnacle of high-rises. In UAE vanity ratio is 19% of high-rise space, the country was titled with the vainest high-rises. "*The Burj Khalifa's vanity height is 244 m (800 ft), which qualifies to be a skyscraper on its own.*" 15

The height race can alter to a new notion as seen in the project "Monument of Civilization: Vertical Landfill for Metropolis", where nations aim to reach less height, which reflects how environmental the city is. If the technology enables us to build a Sky Mile Tower, we ought to question the need for exceptional height and if it is justified or needed. This is not a call against Mega or 'Giga' structures, but a call to a conscious approach to tall buildings perception in the twenty-first century.

When tall building functionality emerges as a topic of research, the vertical expansion of the city can take different forms and positions, unlike any existing urban model. The goal is to enable cities to grow while maintaining a great potential to improve the quality of urban life and social well-being. Freeing the tall building from inherited envelopes paves the way for architecture to engage with the urban model beyond city boundaries. **The world becomes a small village when tall buildings can develop into not just a solution for overpopulation in megacities but for the globe's well-being.** With the increasing need for the vertical dimension in the twenty-first century,

"*Skyscrapers will have a significant international role in the global village.*" 16 Therefore, the fifth generation of tall buildings is necessarily a conscious development of City-ness. ***(e-Volo Competition) (CTBUH) (K. Al-Kodmany, 2011) (K. Al-Kodmany, 2018)***



17. CTBUH, Vanity Height Article.

0.3.

# Vision of Fifth Generation of High-rises **Methodology:** Case of Public Space Skyscraper in Hong Kong

## 3.0. The Methodology

The concept is to challenge the inherited perception of the high-rise program and tackle the city's challenges with a new perspective aiming to provide the lack of a function in the city in a vertical form and integrate it into the existing urban grid. The increasingly dense communities of the 21st century urge us to develop a way to tackle the present urban problems. A primary concern of dense cities is the lack of land relative to the growing population. These inquiries are met by building vertical housing, business, and mixed-use spaces to pair the needs of the increasing inhabitants. While these are essential requirements, alternative functions of the city should escalate simultaneously.

Urban spaces such as public spaces, educational buildings, factories, health institutions, and other city spaces often do not receive sufficient expansion procedures to offer efficient services that match the increasing housing, business, and retail spaces in the city. The dilemma is always the lack of land to house the needed expansions. The other part of the problem is that these functions aren't naturally associated with vertical solutions to provide these required spaces. How various functions can find their way into the vertical dimension of the city? can a vertical university, park, factory, institution, etc. be an expansion/alternative to their horizontal forms?

This chapter proposes that high-rises stand with the potential to develop the social well-being of cities when considering the shortage of different functions in the urban fabric. The purpose is to diminish the lack of spaces dedicated to certain uses due to land scarcity in dense modern cities. The city of Hong Kong is selected, and research on how new program typologies of vertical structure can help improve the urban challenges. Hong Kong is a great candidate for studying the possible programs for the vertical dimension as it is almost an entirely vertical city.

## 3.0.1. The City

Hong Kong is one of the densest cities in the world, with current inhabitants in Hong Kong 7,489,270 according to the latest world population review. And an average density of 7,135/km2 ranking 4th on the world density level.

1. Hong Kong City

2. Hong Kong Residential Dense Skyscrapers.

## 3.0.2. Why Vertical Public Space In Hong Kong

3. Hong Kong City

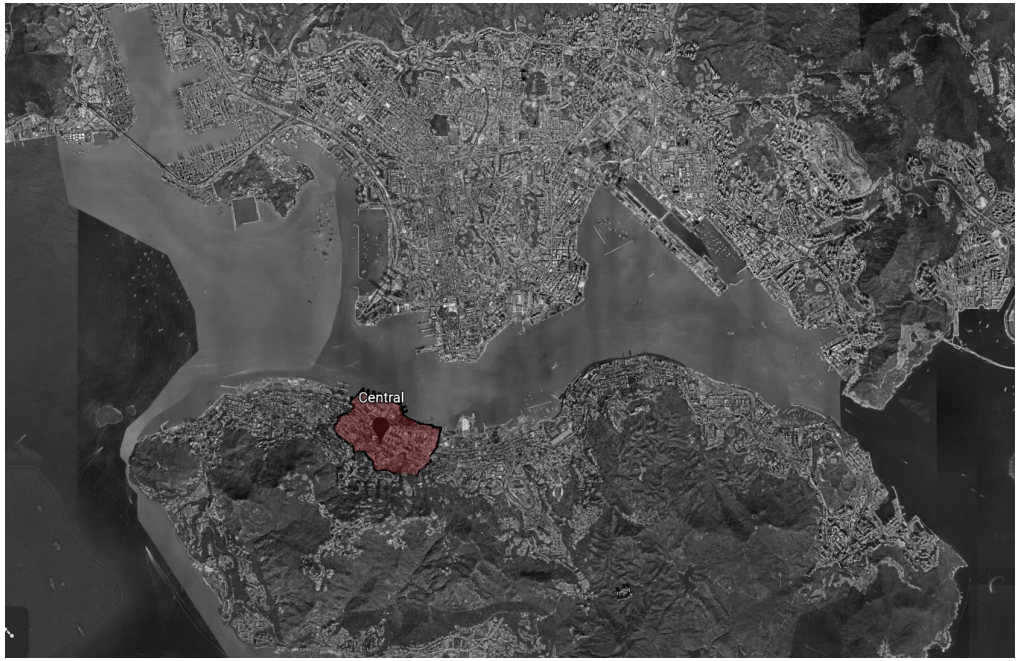
4. A gathering of domestic workers in the Centrsl District of Hong Kong in the weekend.

The topic of public spaces in Hong Kong is complex, at the first glance Hong Kong seems to be surrounded by greenery. Around 40% of Hong Kong's land is green spaces. However, the placement of large parks away from the dense districts of Hong Kong results in a long travel distance that is usually avoided by residents. On the other hand, there is a significant public space shortage within the urban fabric of the city and its busy streets.

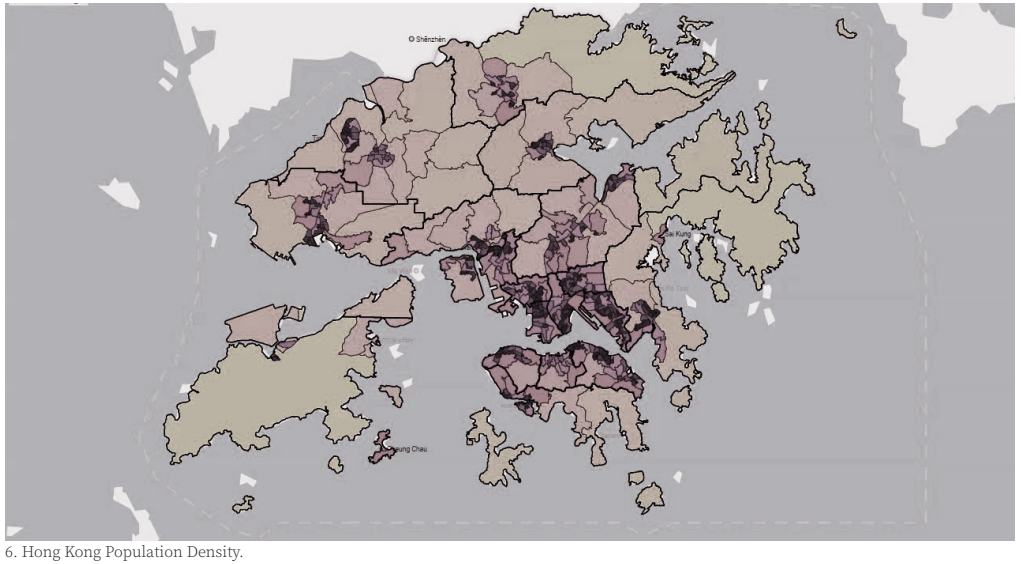
According to BBC Worklife "Compared to other cities, Hong Kong's urban public space – outdoor recreational space that is accessible to the public – is particularly small. Residents have only 2.7 square meters (29 square feet) per person, slightly larger than a coffin or a toilet cubicle, while Singapore at half of the size of Hong Kong has 7.4 square meters (79.6 square feet) of urban public space per capita, according to a 2017 study from Civic Exchange. New York, also known for its high land price, has over 10 square meters (107.6 square feet) of public space per capita." 1

The very limited space a person has at home urge the need to spend time outside. but, with the British colonial government's interest in land sale taxes over providing sufficient public spaces. They dedicated very limited lands for public use. After the colonial government, Hong Kong's government developed policies for privately owned public spaces, resulting in a 'shopping paradise' for tourists and challenges for the residents. Another major problem for HongKonger is the lack of activity in a green spaces.
*(BBC Worklife)*

## 3.0.3. The District




5. Central Hong Kong District.



6. Hong Kong Population Density.

Hong Kong is divided into 18 districts. The chosen district for the proposal is the Central and Western district for its central location among the area with the highest population density in Hong Kong to serve the largest possible population within the urban fabric. The average population density in the Central and Western districts is 19,048/km2 in 2021. With a peak of 147,061/km2 in the Belcher area. ***(Council Districts and Constituency Areas)***

## 3.0.4. Proposal Location

The proposal is to take place on Victoria harbor in the Central district. The area is a public space with a fascinating location by the harbor. It consists of The Hong Kong Observations Wheel, Central Harbourfront Event Space, Cultural Plaza, Tamar Park, and a walkable seaside. It is one of the busiest public spaces in Hong Kong for its divert activities.

7. The land is a part of public space zone on Victoria's Harbor


8. Victoria's Harbor Public Space complex.

## 3.0.5. The Site

Central Harbourfront is a 36,000 sq.m flexible event place located on Victoria Harbor front of Hong Kong Island.

According to Central Venue Management -the current site managers- "*Government's open tender for the "Central Harbourfront Event Space" was issued in September 2013. The tender was awarded to Central Venue Management (CVM) in March 2014. CVM was again awarded the tenancy in an open tender for the next 3 years*"2

The Events Place is a free-entry open-air public space. How does it work? event organizers should place a booking request from the website of the CVM to organize different events. The managing organization offers high flexibility in terms of the area needed for the events and provides essential services such as; electricity, water supply, fences, and gates to regulate entries.

The event place hosts variable entertianment activities and functions like;
. Exhibitions
. Music Festivals
. Free entry park and community events
. International Carnival
. Free sporting demonestration
. Art fair
. International car race

The CVM reflect on the imbact of the events taking place on the Central Harbor:
. The events increased the public entertainment in the city.
. It represents a successful modul of public engaegment.
. And most importantly for Hong konger's that it provided variable activities and events to the public.

9. The Central Harbourfront Event Space land on Victoria Harbor.

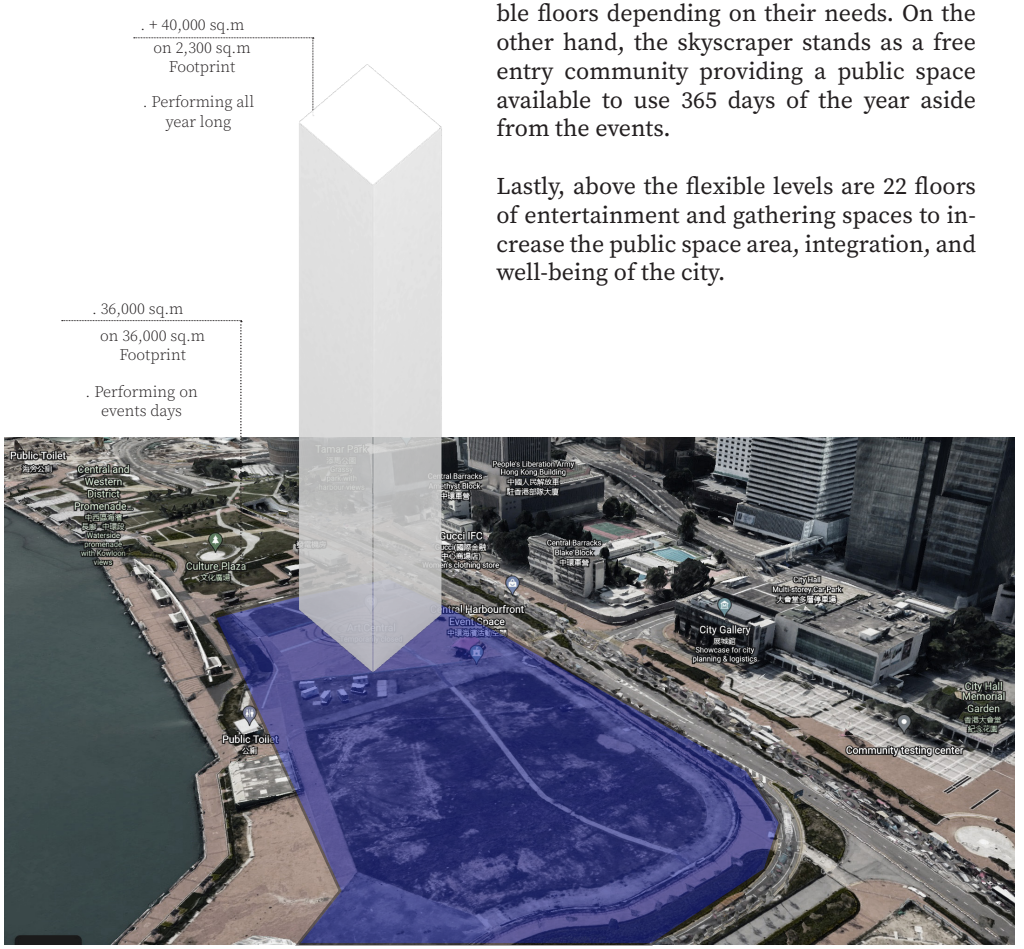

10. The Event Space land on Victoria Harbor.

## 3.1. The Scheme

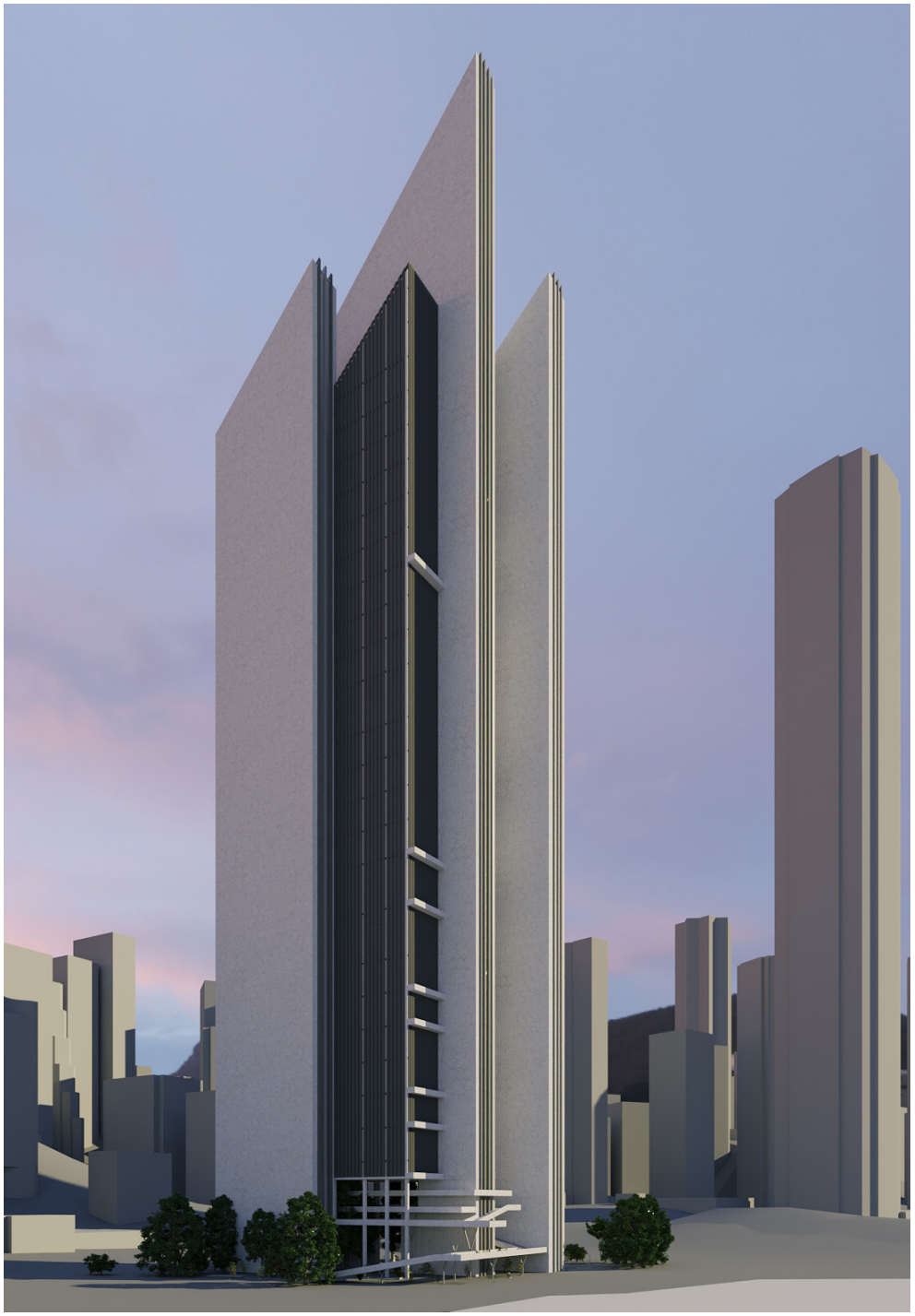
The project proposes a vertical elevation of the event site providing two factors; more than 40,000sq.m of vertical space with a footprint of 2,300sq.m for the structure and less than 8,000 sq.m for the surrounding landscape.

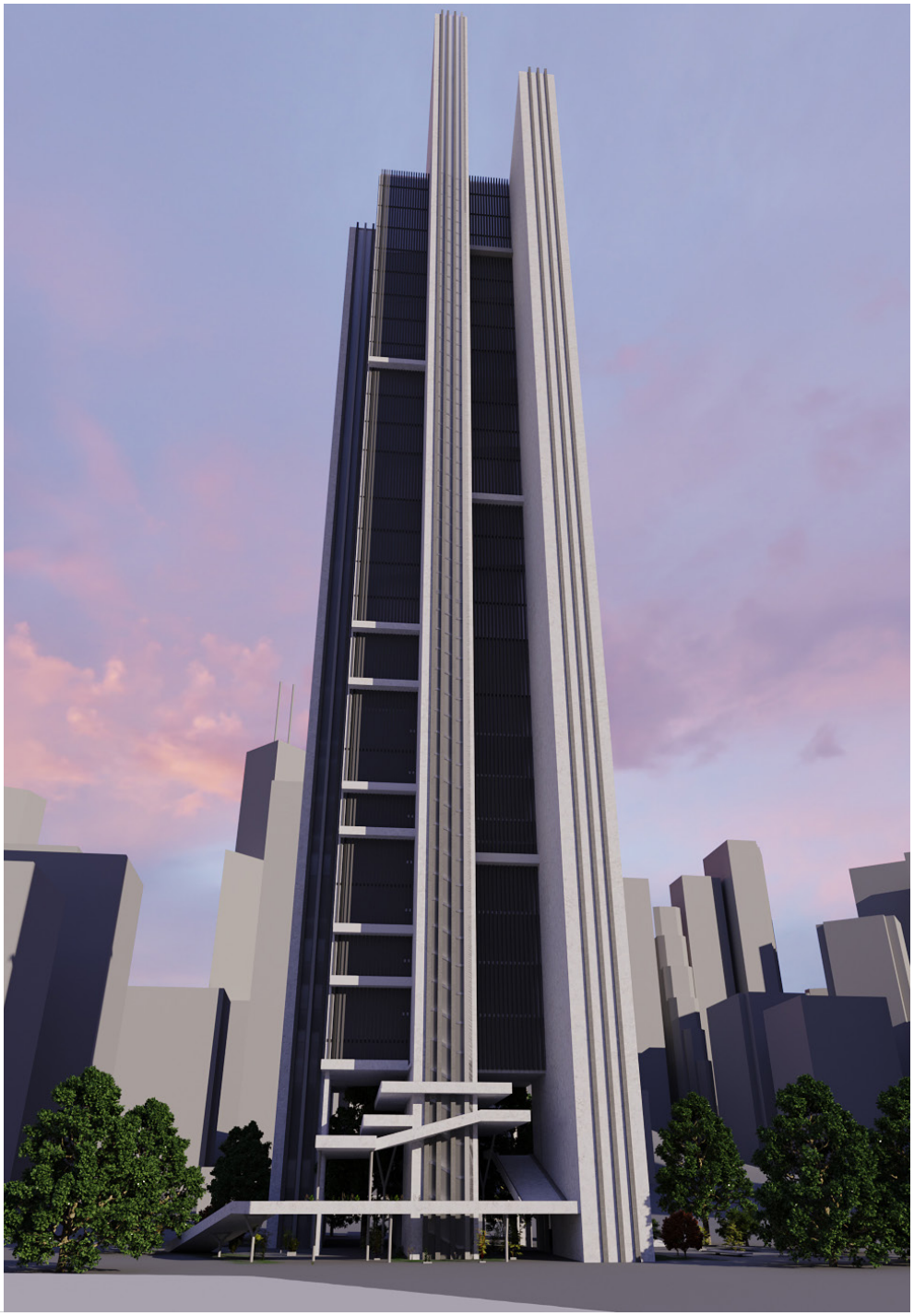
Two indoor floors and three outdoor levels are flexible to be used at the events, also in case of no events the managing organization of the building can alter the use of the flexible floors depending on their needs. On the other hand, the skyscraper stands as a free entry community providing a public space available to use 365 days of the year aside from the events.

Lastly, above the flexible levels are 22 floors of entertainment and gathering spaces to increase the public space area, integration, and well-being of the city.

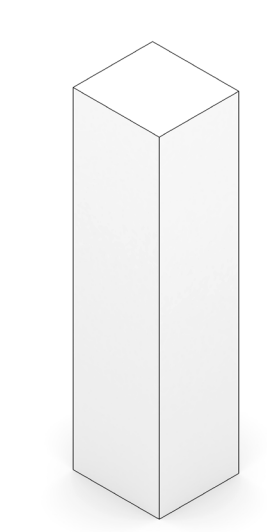



11. Concept of the vertical extension of the event space.

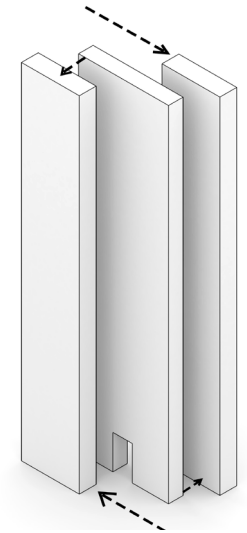




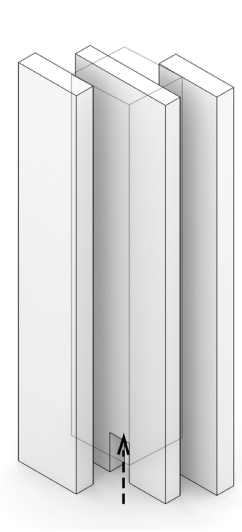
## 3.1.1.Concept



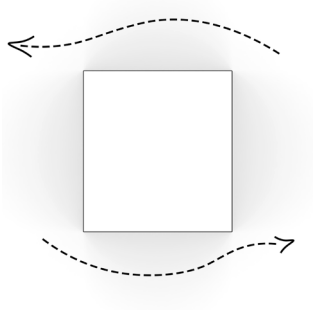
Typical Skyscraper Foot-print Force Circulation around

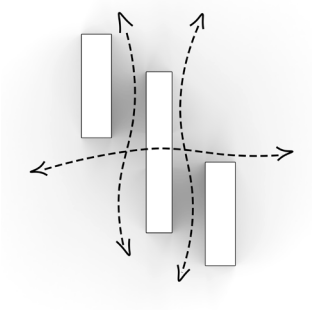


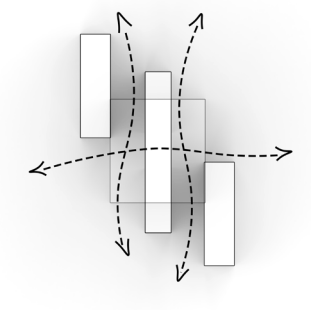
Free Circulation Pass-through Foot-print For Public Space



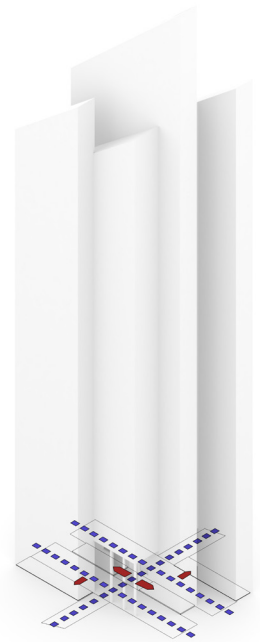
Main Elevated Mass of The Skyscraper



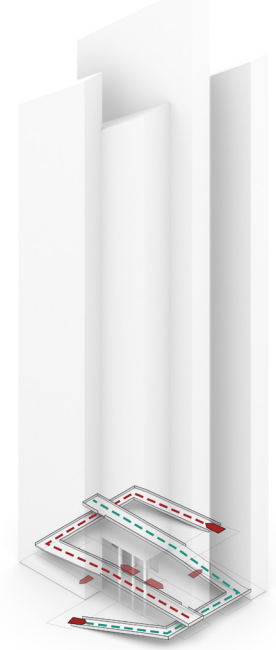




## 3.1.2. Ground-FLoor Circulation



Walk-Through
Building Entrances



Garden Ramp 1 Ent.
Garden Ramp 2 Ent.

The form is designed with the public space concept in mind. Unlike the typical skyscraper plan that forces a route around it, the proposal is designed as a walk-through concept. A new footprint is developed to create a flexible free entry to the building.

## 3.1.3. Program

Observation Levels

Roof Movie Garden

Restuants & Cafe Level

Holographic Themed Levels

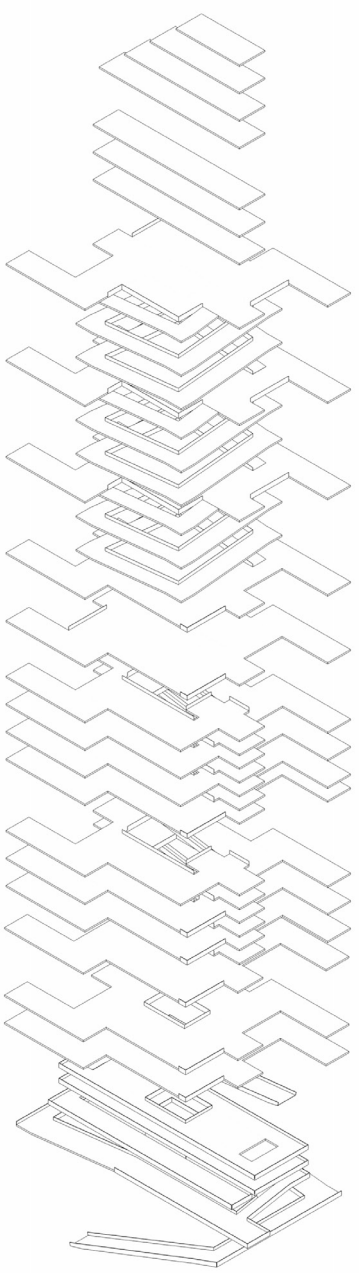
Virtual Illusion Level

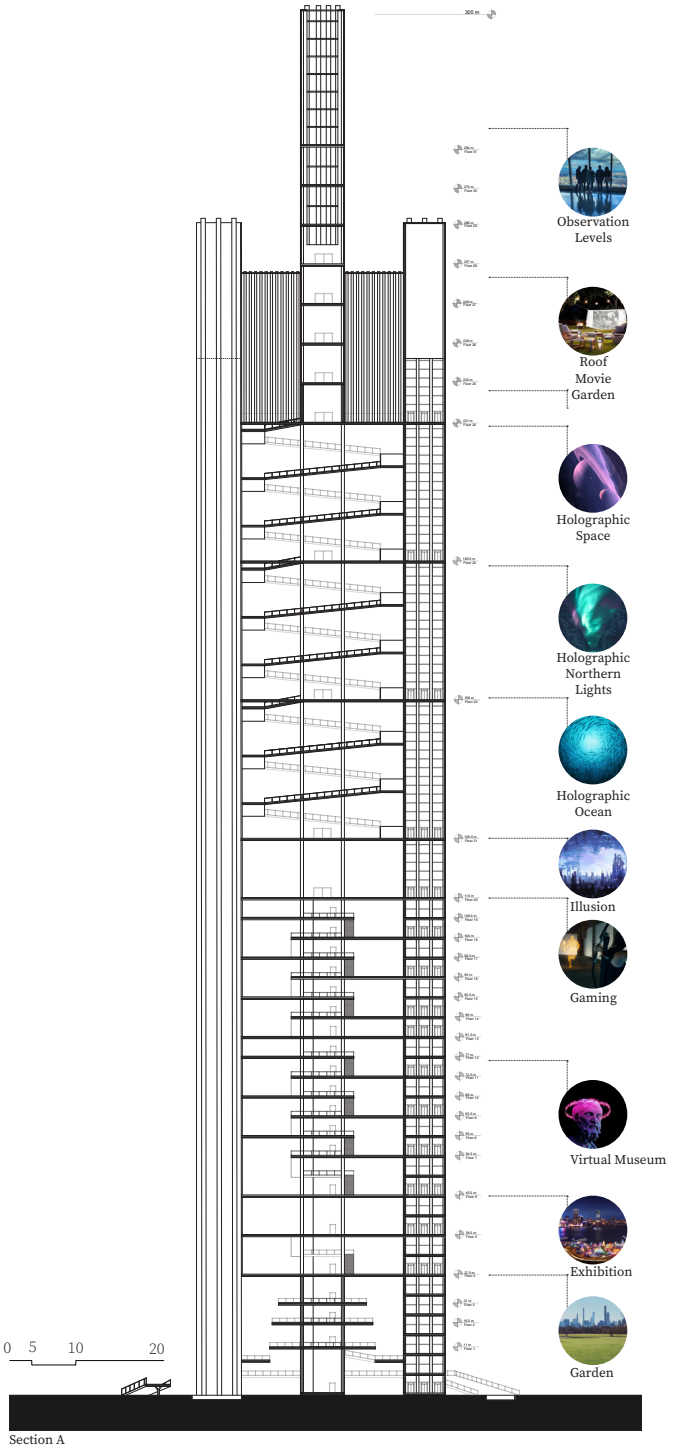
Virtual Gaming Levels

Virtual Museum Levels

Events Levels

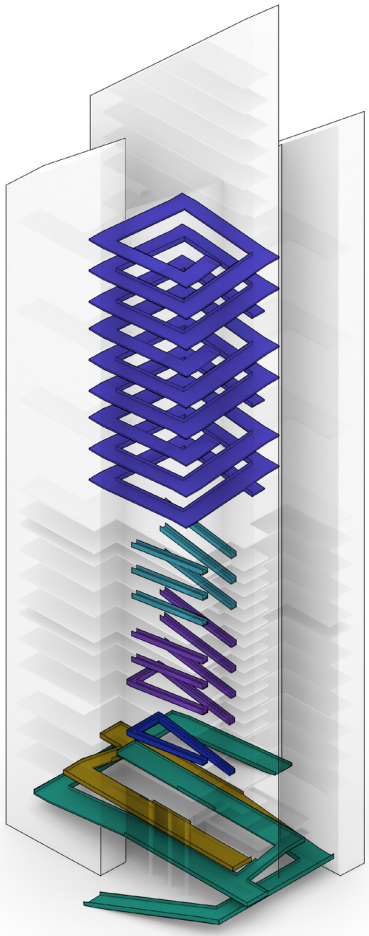
Garden Levels






Section A
Scale 1:200

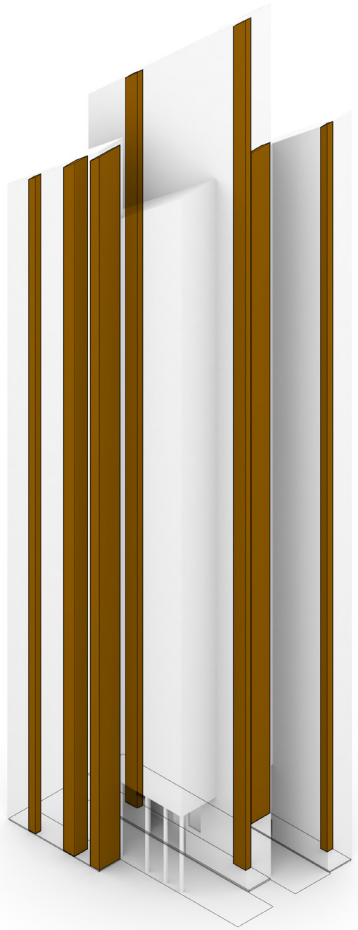
## 3.1.4. Vertical Circulation



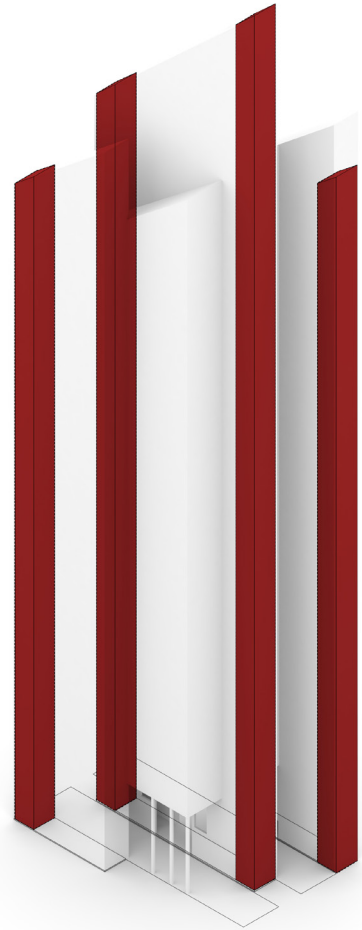
Garden Ramps
Event Floor Ramps
Virtual Museum Ramps
Gaming Floor Ramps
Holographic Themed Zone Ramps

Vertical circulation is divided into three Categories. The ramps as a means of vertical connection within a single activity, altering the elevator vertical travel within the same zone. They vary in their design and length in the different programs. In the garden levels, the ramps turn to a walkable street with seating areas. On the upper levels, they become a walking route through the holographic-themed levels.

The Building is equipped with 6 vertical batteries, consisting of 10 elevators for passengers and 2 elevators for staff use only. The fire escape is divided into 4 batteries of stairs, two of which contain fire escape elevators following the Hong Kong fire regulations.

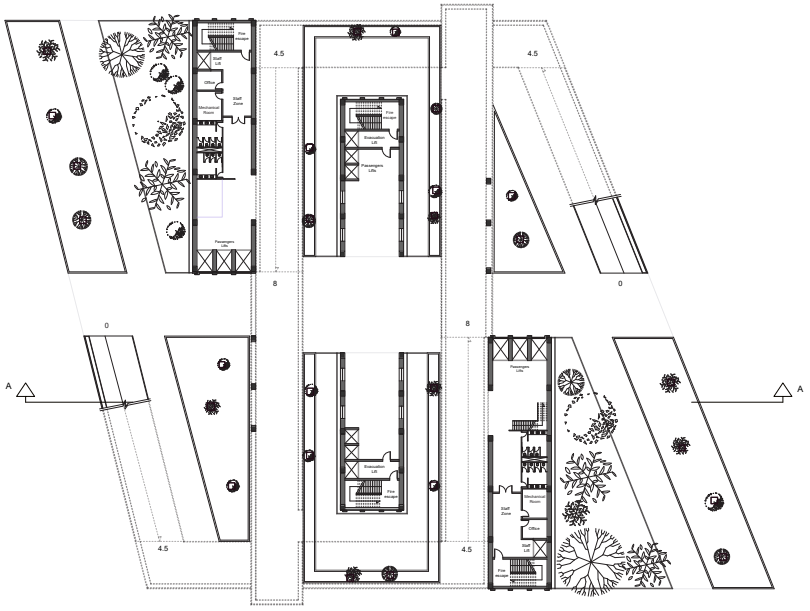


Vertical Circulation Batteries

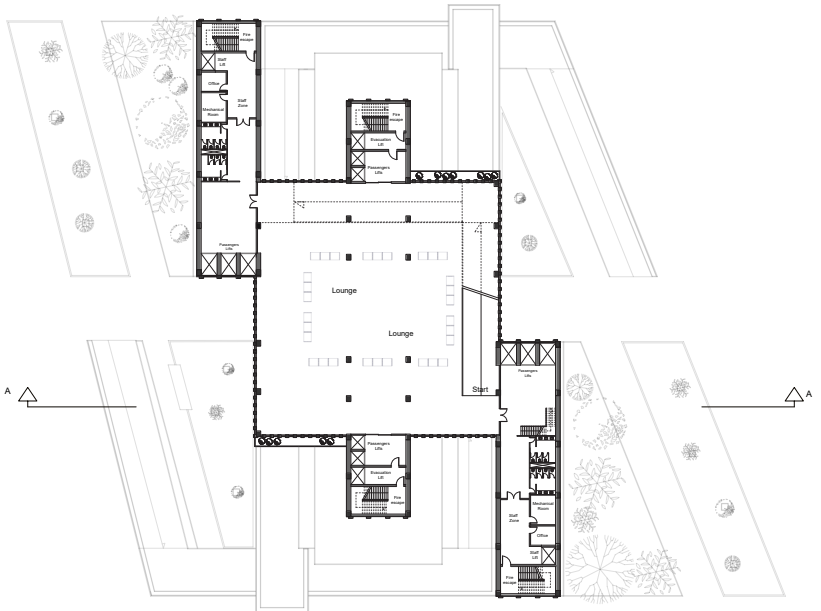


Fire-escape Batteries

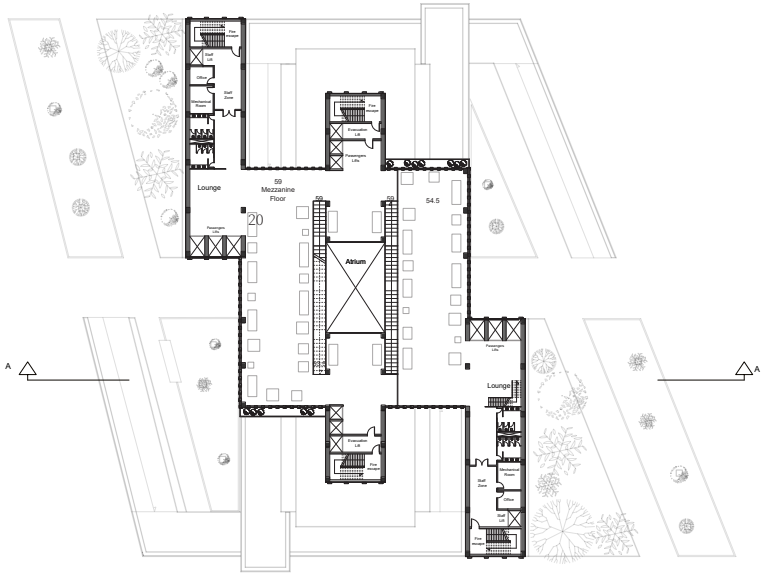
## 3.1.5. Technical Drawings



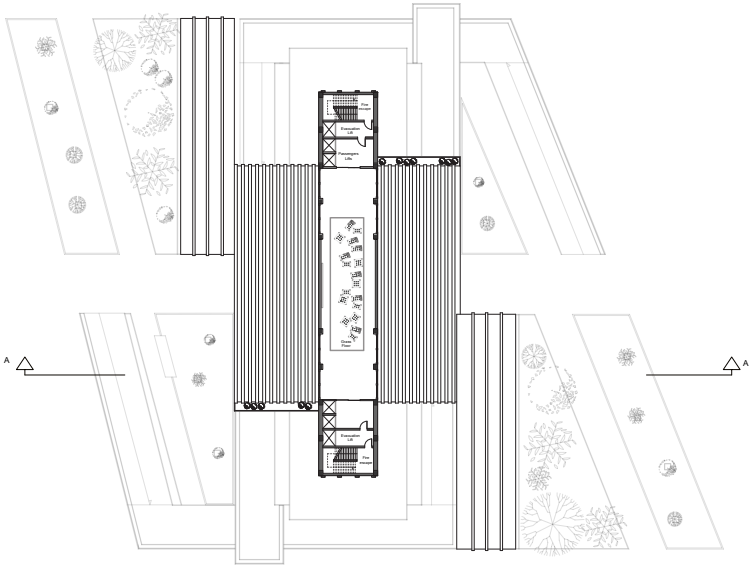

Ground Floor Plan
Scale 1:200




Holographic Themed Typical Floor Plan
Scale 1:200 - Level 21

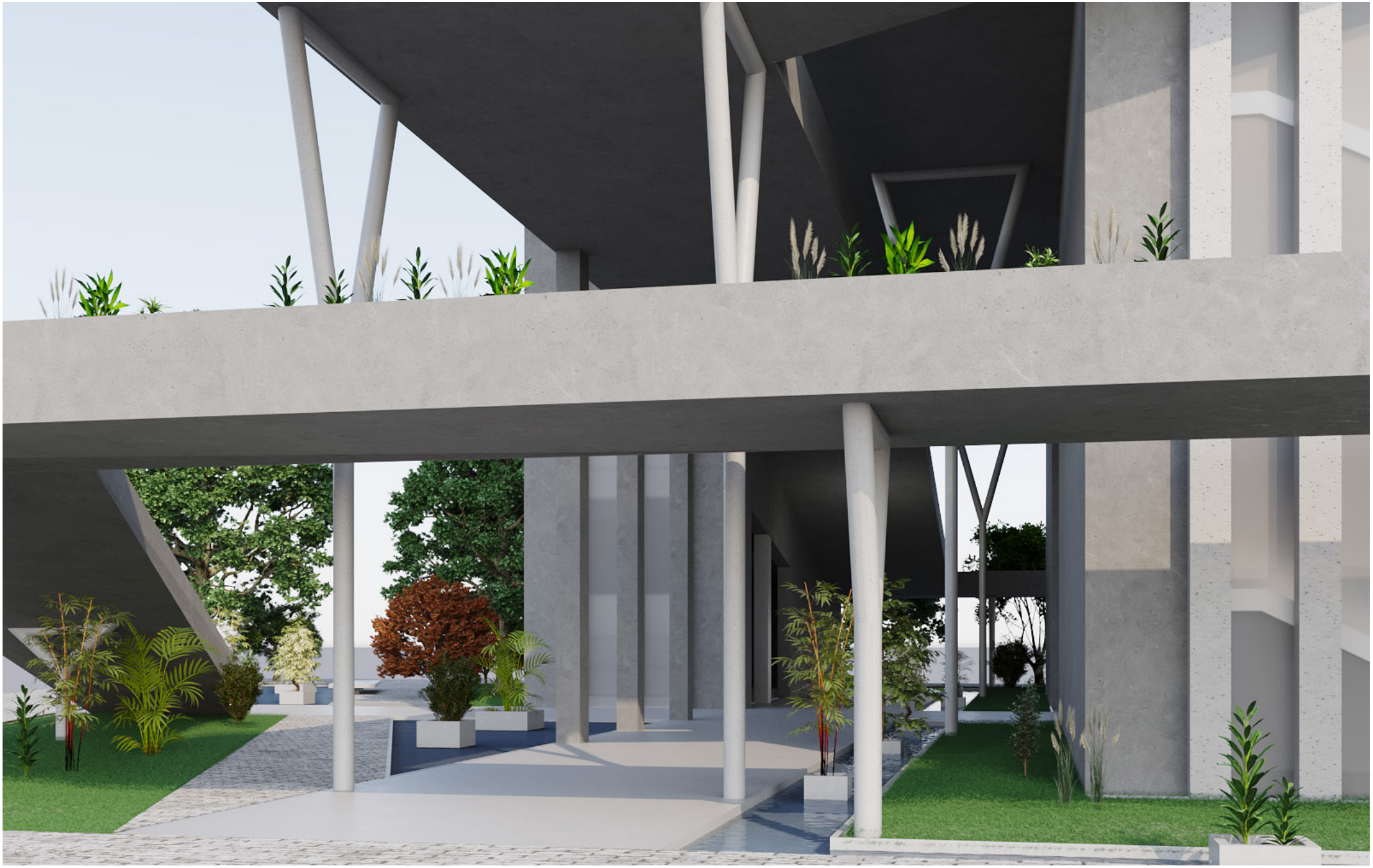


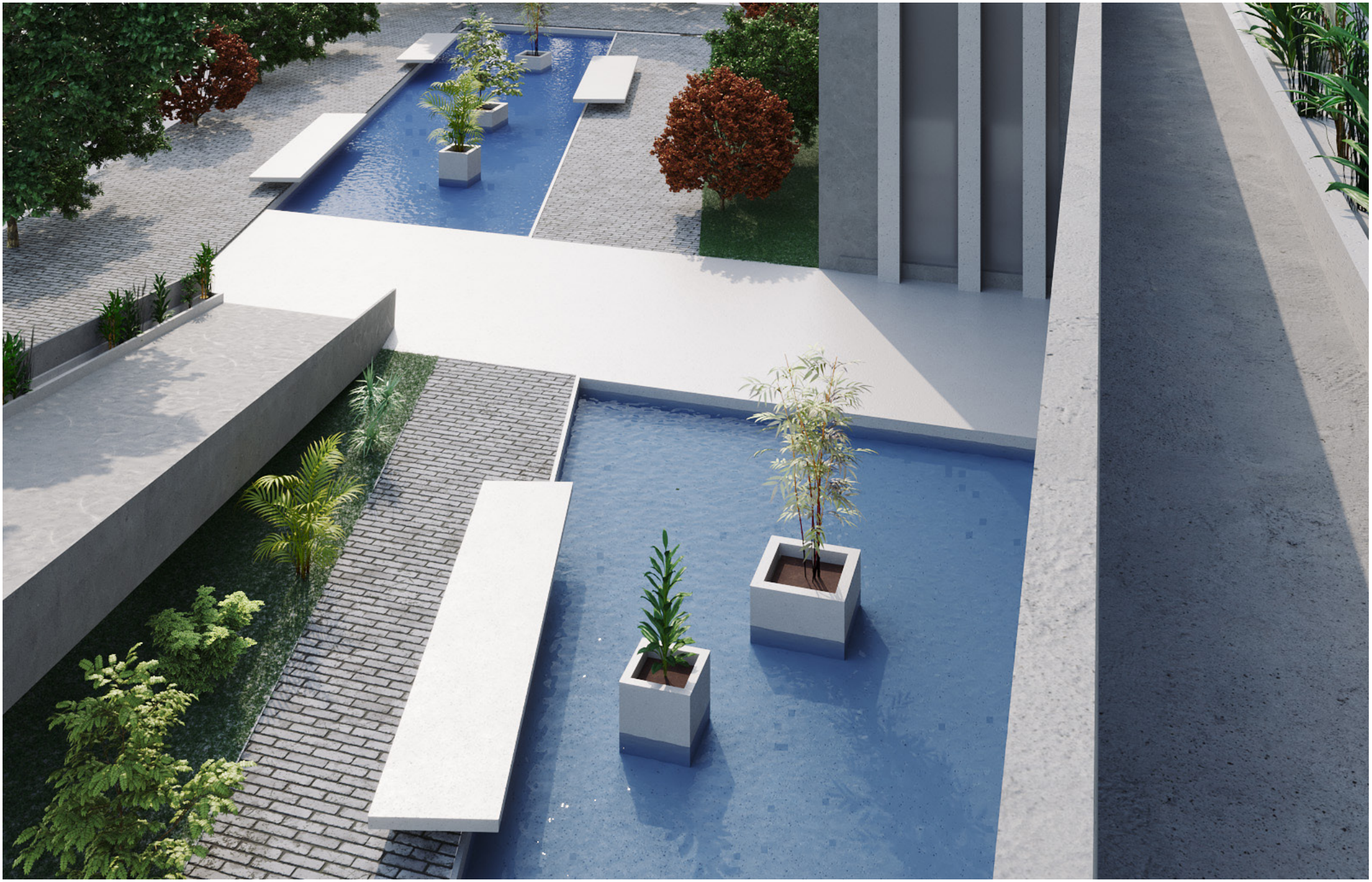

Virtual Museum Floor Plan
Scale 1:200 - Level 9

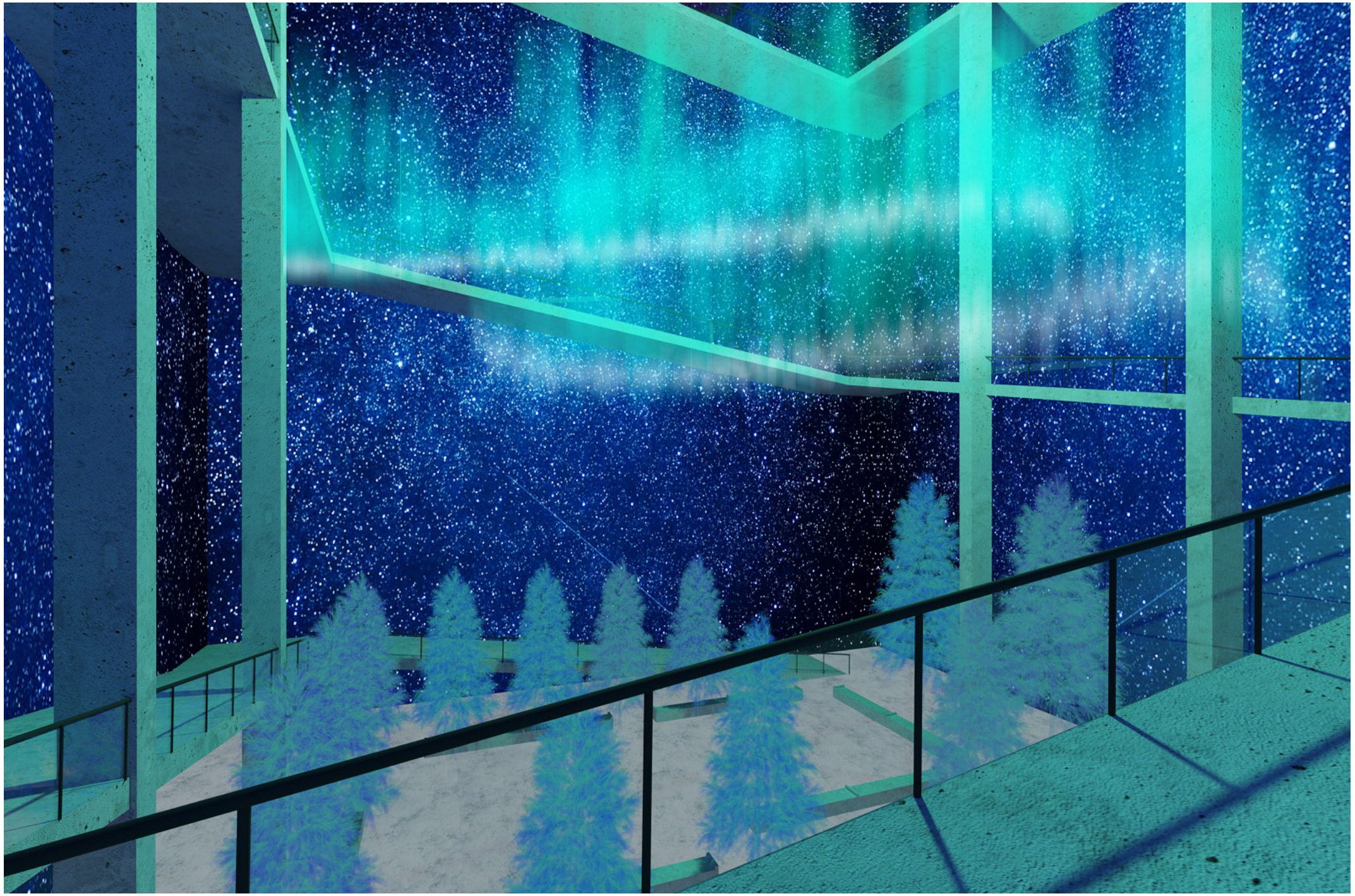


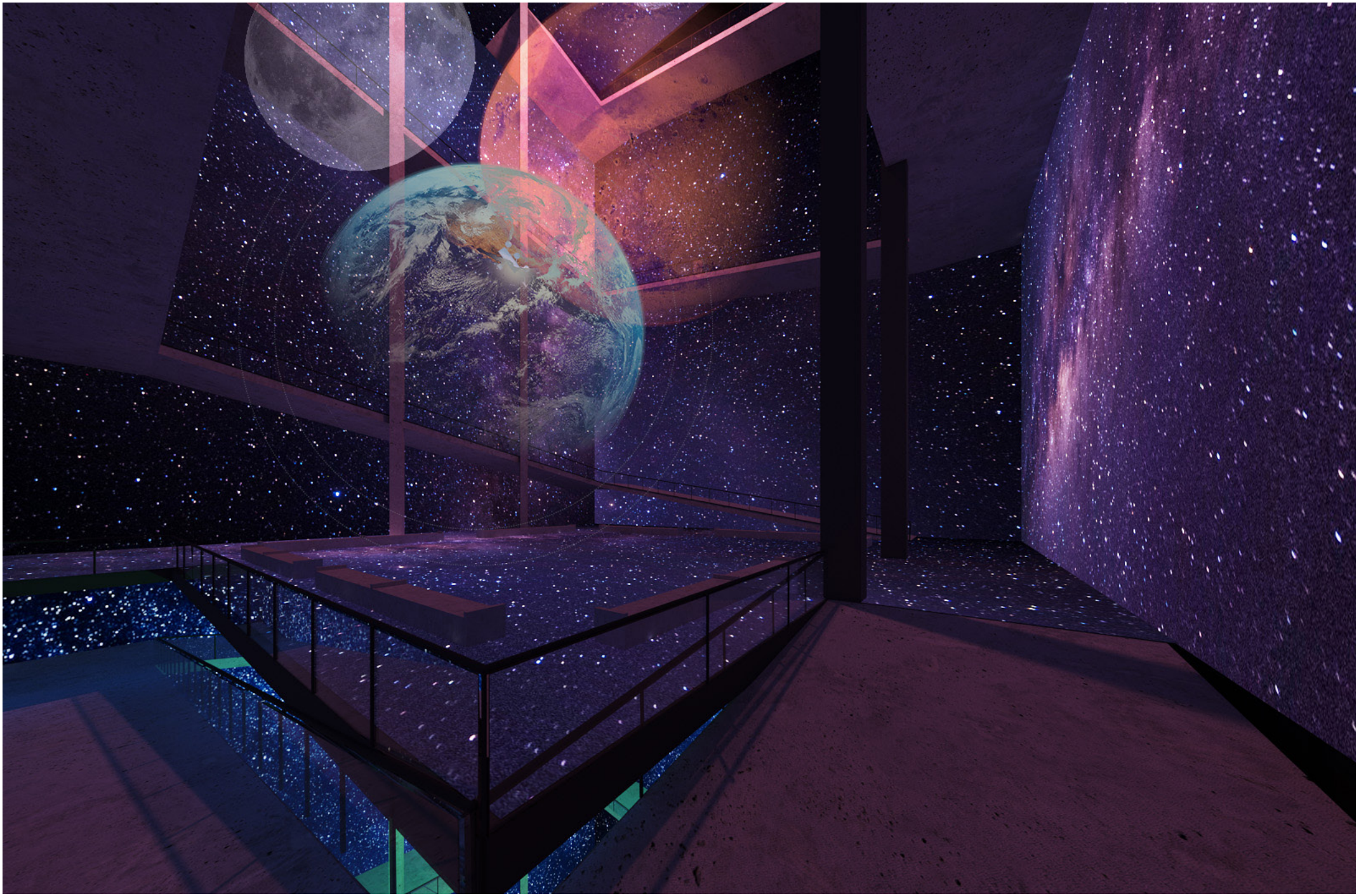

Roof Movie Garden Floor Plan
Scale 1:200 - Level 25

### 3.1.6. New Public Spaces

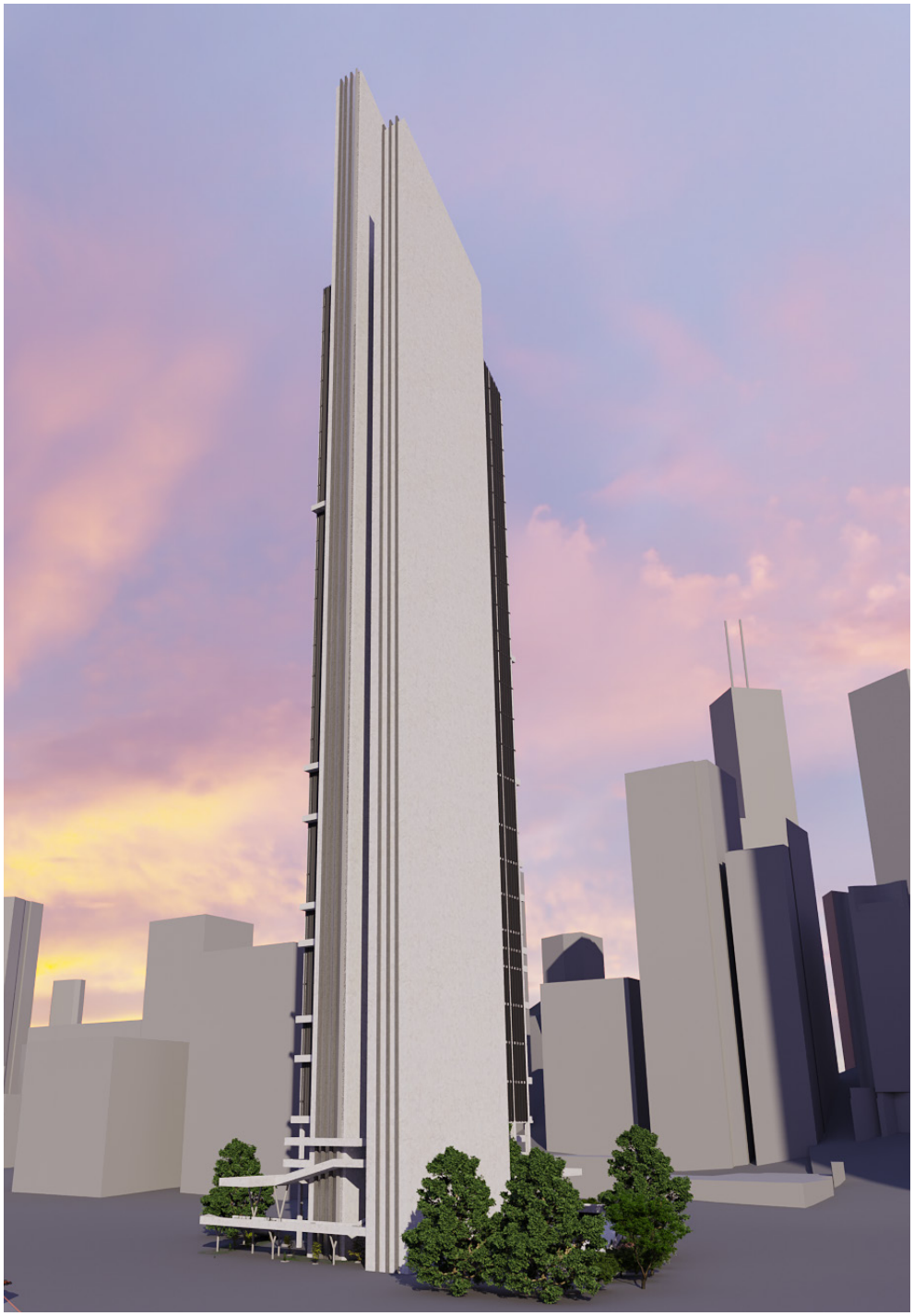









カラオケ館
90-45



0.4.

# Conclusion

This dissertation is dedicated to highlighting the importance of including the functionality of vertical structures as an essential element of research along with the technological and sustainable factors for the forthcoming generations of high-rises. The skyscraper journey dates to the mid-19th century when the symbolic structures of the city altered to business functions in America. The technological advancement of the elevator paved the way to reach higher into the sky. Developing the function of what a vertical structure can host formed what we today call "The Skyscraper."

The thesis carries on a profound study of the formation of the existing functions. The program of the vertical structures still undergoes what Rem Koolhaas refers to as unconscious urban and architectural development. On the other hand, creative platforms like the yearly e-Volo Magazine Competition for developing skyscrapers suitable for the twenty-first century give hope for more conscious approaches to the topic of 'High-rise Functionality.'

The 21st century is increasingly vertical, thus, the role the vertical structure play is essentially an urban question. The spectrum of the high-rise's functionality should urge to deliver skyscrapers that consider human needs in the process of arranging the cityscape, and not only providing business and residential units. Researchers should opt to integrate the vertical space with the city by including the distinct functions that exist in the urban fabric.

Lastly, A proposal is developed for the vertical city of Hong Kong. After researching the challenges facing the inhabitant, and urban and social well-being, it was found that the lack of public space and public space activities is one of the major concerns the dense population of the city is facing. The scheme developed is only an attempt to alter the notion of the possibility of applying scarce urban spaces in vertical forms and towards a more conscious approach to the functionality of skyscrapers.

Although the thesis applies the scheme of the new skyscraper program of public space in the city of Hong Kong, the aim is not limited to the functionality of public spaces or Hong Kong. The case study only aspires to deliver the conceptual potential of housing various functionalities into the high-rises and benefit the city with all the saved lands and new spatial spaces in the sky. In the end, it can be stated that; if altering the function of vertical elements from 'symbolic structures' of the city to 'businesses' altered the shape of our current world, what is the potential of developing alternative uses of the high-rises in developing the urban and the city-ness?

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