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Tall Buildings: View From Six Regions

Edificios Altos: Visión Desde Seis Regiones

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Abstract

This article aims to identify different terms and concepts regarding tall buildings and evaluate the presence and hierarchy these buildings have on a global level. The methodology used considered the global database of tall buildings published by the Council on Tall Buildings and Urban Habitat. Six essential regions of the world were analyzed and classified as clusters. Forty-eight buildings were quantitatively described. As a result, thirteen terms and eighteen different concepts were found. The spatial configurations in terms of height and year of construction of each building, defined the population trends in the cities that make up each cluster. This research confirms a significant diversity of criteria for naming buildings in height. Tall buildings occupied by offices predominate in the clusters evaluated. Residential usage is not the most common occupation.

Keywords: Population; height; tall buildings; regions; cluster

Resumen

Este artículo tiene como objetivo identificar diferentes términos y conceptos relacionados con los edificios altos, así como evaluar la presencia y jerarquía que estos edificios tienen a nivel global. La metodología utilizada consideró la base de datos global de edificios altos publicada por el Council on Tall Buildings and Urban Habitat. Seis importantes regiones del mundo fueron analizadas y clasificadas como clusters. Cuarenta y ocho edificios fueron descritos cuantitativamente. Como resultado se encontraron trece términos y dieciocho conceptos diferentes. Se definió la diversidad global de las configuraciones espaciales en cuanto a alturas y año de construcción de cada edificio, así como las tendencias poblacionales en las ciudades que conforman cada cluster. Esta investigación confirma una gran diversidad de criterios para nombrar edificios en altura. Los edificios altos ocupados por oficinas predominan en los conglomerados evaluados. El uso residencial no es la ocupación representativa.

Palabras clave: Población; altura; edificios altos; regiones; conglomerado

Introduction

Cities today face complex social and ecological challenges around the world. These are caused by the increase in population, intensive construction activity, and the effects of climate change. To tackle these challenges, the governments of large cities are increasingly concerned with generating new materials and technologies aimed at innovating sustainable solutions that harmonize with the environment. Currently, it is being considered to design efficient cities with the use of resources and solutions that promote an increase in the inhabitants' quality of life.

The presence of tall buildings is on the rise every day in various locations around the world. Its development is conditioned by urban, industrial, and tourist growth factors. According to scientific literature, tall buildings are often named. Since the 20th century, most of its cities have rised their real estate boom. The continuous growth of the construction sector is evident, which is reflected in the projects and continued urbanization of modern buildings that every day compete in height and levels of floors. Some of these tall buildings are still in the preliminary design phase, others have just started the construction stage, nonetheless each stage has a relevant role in the process of creating tall buildings.

In the blueprint stage, the building begins its flowering, namely, the soil studies, schedule, and execution budget start in the design stage, and those are related to purchasing lots or large plots of land. In this stage, the real estate managers compete in the sale and search for potential clients, and the final schedule of the work is adjusted.

When more than 50% of the tall building is sold, the construction of this is a fact. In the construction stage of the building, the property begins to take shape and completes its physical form. The current stage constitutes a period that ranges from the beginning of construction to the completion of the internal and external structure. The last step comprises the poorly known "dead labor" or "finishing stage," in which tall buildings are installed in the networks. The execution of the work is concluded by painting, decoration of interior and exterior areas, and equipment furnished of the same.

Each of the stages described forms the path for constructing a tall building, and they do not vary much from nation to nation. An essential approach before making these buildings is that they must have the capacity to satisfy the needs for which they have been built. It must also facilitate access to a more significant number of the population in privileged places, causing the quality of life of the communities to be better and better.

In the present article, an empirical analysis is conducted on the global composition of tall buildings in six clusters of some of the main cities in the world. The research is based on the following hypothesis: The presence of tall buildings in the analyzed clusters is proportional to the increase of the urban population.

The database published by the Council on Tall Buildings and Urban Habitat-CTBUH is used. This site called The Skyscraper Center: Global tall building database of the CTBUH (2020) is the most important database on tall buildings globally. Considering the same, the authors characterize the altimetric-spatial composition of tall buildings on a world scale. Twenty-two representative cities and a total of forty-eight buildings were selected. International scientific literature and database were reviewed to detect the terminological contradictions in naming tall buildings (Ghosh & Sil, 2022; CTBUH, 2020; Pinchart, 2017; Burgos & Garrido, 2005; Abbott, 2000; Vergara, 2017; Sullivan, 1896; Capurso, 2020; Koolhaas, 1994; Al-Kodmany, Ali & Zhang, 2013).

Methodology

The methodology used in this article considers the global database of tall buildings published by the CTBUH (www.ctbuh.org). According to data from this site, six important regions were studied, such as Asia, Africa, Europe, South America, North America, and Oceania, which were identified and classified by the authors as clusters.

The correspondence between tall buildings and the global phenomenon of accelerated population growth and increased urbanization is determined for each cluster. The present research empirically examines 22 cities distributed within six clusters.

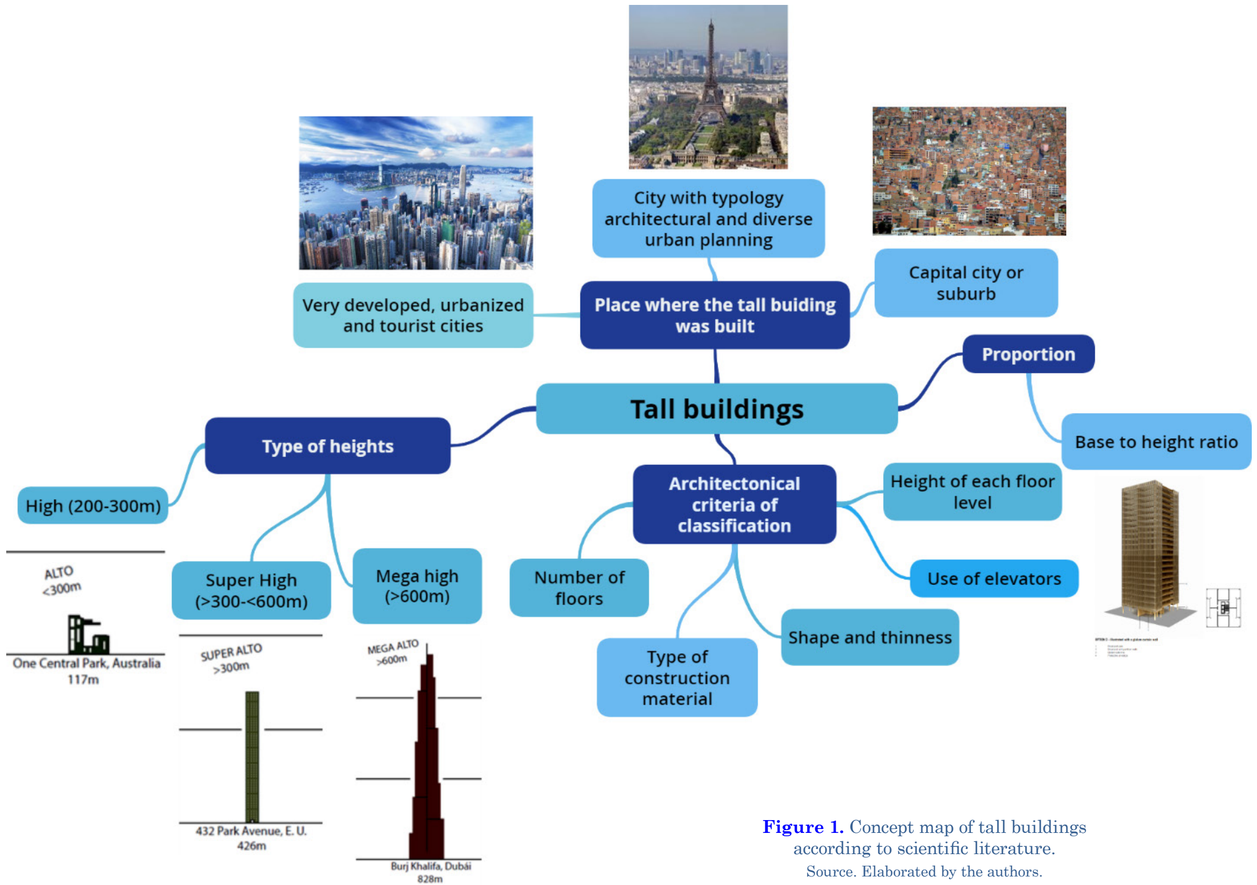

Figure 1. Concept map of tall buildings according to scientific literature.
Source. Elaborated by the authors.

The variations in the heights of 48 buildings in the cities examined are quantitatively described. The GoConqr tool (www.goconqr.com/es) was used to design the mental or conceptual map, as they are also often called interchangeably. four categories for analyzing the term and concept of tall buildings were selected: 1) Place where the tall building was built 2) Proportion 3) Architectonical criteria of classification and 4) Type of heights (Figure 1).

Some articles published in Scopus and Web of Science were consulted to determine terminological and conceptual differences regarding tall buildings. The results of this process are shown in section III Results and Discussion.

Results and discussion

Terminological and conceptual differences between tall buildings

It is essential to understand what is considered a tall building. Over time, the concept and its different terms have gained strength in global construction. In 1885, the so-called Home Insurance Building was built by the architect William Le Baron Jenney in Chicago, Illinois, U.S.A., considered by the theorists (Peet, 2011; Mujica, 1977) the first tall building in the city.

History, with ten floors and a height of 42 meters. At present, the height of buildings has increased by more than 100 stories. An example of these new tall buildings is the Burj Khalifa in Dubai. It is considered the tallest building, with 828 meters and 163 floors above the ground. As can be seen, the concept of what we consider "high" has evolved.

"The height of tall buildings, also named by some authors as skyscrapers, is a relative term" (Quintana, 2006, p. 1). "During Communism, the word 'skyscraper' became taboo for the countries under the regime —as it was considered an American concept that referred directly to North-American capitalism" (Pinchart, 2017, p. 117). About the term skyscraper, there is a disagreement regarding the origin. According to Schleier (1986) and Condit (1968), the word skyscraper was used for the first time in 1780 to "characterize a particularly tall horse" (p. 1). The term skyscraper was applied to the buildings that stood out from the environment in the nineteenth century and were noted for their vertical grandeur. In 1883, according to Landau and Condit (1996), the word was also used to "describe great public monuments" (p. 1). And in 1889, it was used as a "nickname for high-rise office blocks" (Landau & Condit, 1996).

A visitor perception study conducted by Bagaeen (2007), and Wu (2000), found because of the processing of the surveys applied in the cities of Dubai and Shanghai, that the local population and architects are not satisfied with the new "western" environments, which include high-rise buildings. According to Kodmany, "it is necessary to adopt policies that make skyscraper buildings respect local tradition, culture, and heritage" (Al-Kodmany et al., 2013, p. 1).

To attract foreigners to the city, Dubai seems to have cut its solid cultural roots and opted for a cosmopolitan city with a political open the outside cultures. According to Kodmany, "the city's gleaming, the laid-back nightlife is reminiscent of Las Vegas more than any other regional city" (Al-Kodmany et al., 2013). The first skyscrapers were tall commercial buildings with iron or steel frames and emerged in the late 19th and early 20th centuries. With its ten stories high, the first skyscraper in Chicago started the boom in the construction of taller buildings every day, a trend that was possible to maintain thanks to a series of architectural and engineering innovations, including the invention of the first process for mass produce steel. Today, the tallest skyscrapers worldwide are over 100 stories tall and approaching and exceeding 800 meters (Bellis, 2020).

Schuyler (1909) and Mujica (1977) were among the first to discuss which building deserved the world's first skyscraper title. According to Peet (2011), "an alternative to using technical criteria to define skyscrapers is to observe how the first tall buildings were perceived and analyze the characteristics that inspired their development" (p. 19). Bradford and Condit (1997) establish some criteria to determine the importance of the first vertical building in the world.

Consequently, each standard points to a different building in the United States. Among the evaluated criteria is the use of elevators, metal construction, and all-steel building. Other decisive factors enunciated by the authors are a certain minimum height (which is not specified by the mentioned authors), the shape and thinness of a building, in which case, these new criteria would produce other candidates to define the first skyscraper in the world (Peet, 2011).

As the construction processes progress, the "limit" of the height of buildings increasingly ceases to be an obstacle. When asked what is considered a tall building? Various opinions are issued, ranging from the differences in height measurements to the number of floors these buildings have. The CTBUH (2020) developed international standards for measuring and defining tall buildings, commonly referred to by them as skyscrapers. The council is the database and primary source for accurate and reliable information on current tall building data. This group is recognized as the judge for awarding designations as the "tallest building globally". Table 1 shows the differences in naming tall buildings and considers the terms used in this site and the review of the international scientific literature in the English and Spanish languages. Table 1 shows all the conceptual terms found due to the state of the arts regarding the tall building.

Table 1.
Terminological and conceptual differences found in tall buildings.

No.	Terms	Concept	Author
1		High-rise habitable tower. The building has many floors or plants and stands out, due to its size, from the neighboring buildings.	(Pérez & Gardey 2013).
2	Skyscraper	Building in which the vertical has superlative consideration over any other of its parameters and the context in which it is implanted.	(CTBUH, 2020).
3		They are building taller than the rest of the buildings around it. It is one of the great conquests of modern structural design.	(www.ecured.cu/Rascacielos).
4	Pre-skyscraper	Tall masonry buildings that have passenger elevators.	(Mujica 1977).
5	Embryo skyscrapers	Tall buildings with elevators and a metal frame.	(Mujica 1977).
6	Modern skyscrapers	High-rise buildings are built on a steel skeleton that has high-speed electric elevators.	(Mujica 1977).
7	Horizontal skyscraper	Horizontalizing a skyscraper consists in denying its vertical condition.	(Pinchart, 2017).
8		The horizontal variant of the North American skyscraper.	(Burgos y Garrido, 2005; Pinchart, 2017).
9	Tall Building	Buildings ranging between 200 and 300 meters.	Ghosh & Sil, 2022; CTBUH, 2020; Capurso, 2020).
10	Super tall buildings	Buildings that exceed a height of 300 meters.	(World Ometers Information Database, 2022).
11	Mega tall buildings	Buildings that exceed a height of 600 meters.	(World Ometers Information Database, 2022).
12	Vertical Building	Buildings that exceed 20 levels and range from 100 to 600 m^2, covering 700 m^2, with an average of 200 m^2.	(Ruiz, 2005).
13		Vertical properties that develop from the surface upwards.	(www.definicion.de).
14	Tall building	The building that arose due to sociotechnical conditions allowed its "invention," highlighting the structure of reinforced concrete, steel, and elevators.	(Abbott, 2000; Vergara, 2017; Sullivan, 1896; Koolhaas, 1994).
15		Cultural artifact, the object of value and sign. Space system.	(Goss, 1988).
16	Urban giants	Large buildings constitute "urban giants" whose consequence of their wholesale "import" has been the loss of architectural tradition.	(Al-Kodmany et al., 2013).
17	High-rise construction	Buildings that are not limited only to the construction techniques used to construct their skeleton. The use of the structure in the architectural language and the adoption of elegant structural solutions also characterize these works.	(Capurso, 2020).
18	Freestanding Towers (Telecom towers)	Independent towers destined only for telecommunications.	(CTBUH, 2020).

Source. Elaborated by the authors.

Table 1 made it possible to compile a total of thirteen terms and eighteen concepts, defined by consulting more than fourteen authors and organizations that have written on the subject. A mind map constructed by understanding the variables used in identifying tall buildings is provided in Figure 1. This image shows an interpretation by the authors of the four elements that define a high-rise building. This aspect is according to 1) the environment where a high-rise building is built and developed, 2) the high-rise of the building concerning its height in meters, 3) architectural classification criteria, and 4) height according to proportions.

There are diverse cultural, socioeconomic, demographic, and political conditions in cities' urban and morphological-spatial configurations with tall buildings. At the same time, there is a variety in the construction of these types of buildings due to their architectural and constructive typologies and differences in heights. Finally, we detected those tall buildings occupied by offices are predominant. In contrast, residential use not being the usual occupation.

In general, it is detected that there is no absolute definition of what constitutes a "tall building." These concepts are based on the subjective variables that each author determines relevant to be able to define a building as "high".

Figure 2. a) Building in a poorly developed province. b) Building in an urbanized city
Source. Elaborated by the authors.

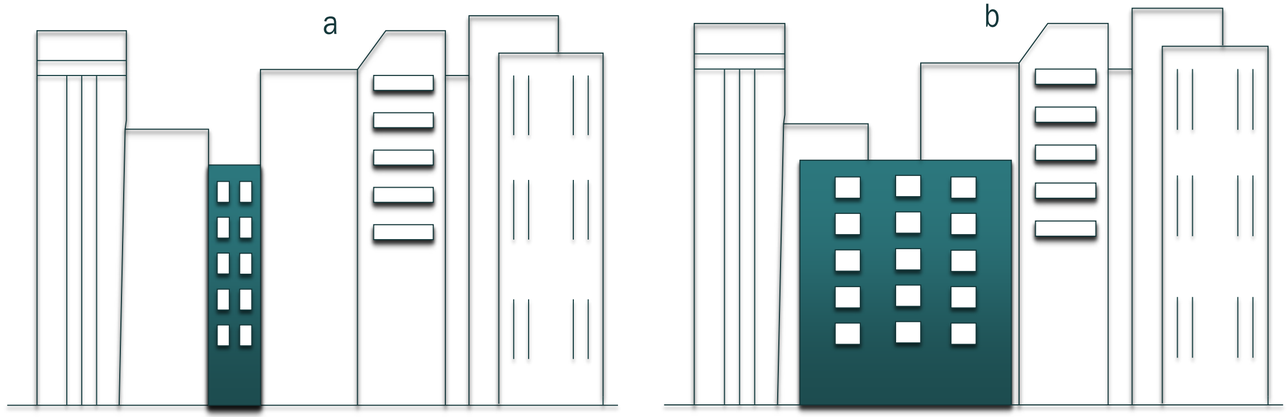

Figure 3. a) Slim building. b) Wide building.
Source. Prepared by the authors.

One of these elements is the environment where the building is developed. The location of a fourteen-story building, which can be considered tall in a small city where one-and two-story dwellings predominate (Figure 2a), is not the same as a building located in larger cities such as Chicago or Hong Kong. Kong, where buildings over 100 meters high, predominate (Figure 2b). Both figures represent what a tall building can mean, depending on the locality or settlement where it is located.

Another element that intervenes in the definition of a tall building and that is part of the conceptual map generated in Figure 1 is the proportion of the building. Depending on the most notable characteristics, we could find properties that are not particularly tall, but being thin enough, they give the appearance of being tall (Figure 3a). At

the same time, we can find buildings that grow in height, but their most significant characteristic is being robust. These would no longer be considered tall because the main feature is that their base is as broad as it is tall (Figure 3b).

The last variable is the number of floors. Depending on the number of floors a building has, however, this is an incorrect indicator in the definition of a tall building because the height from floor to floor, between different buildings, sometimes changes due to their functions. For example, the props are often variable when a tall building is dedicated to offices versus residential use. A building of fourteen or more floors and more than 50 meters in height could be used as a threshold to be classified as a "tall building."

Tall buildings in the world

According to Condit (1968), "the first skyscrapers emerged in the United States due to economic growth, the financial organization of American companies, and the intensive use of developable land" (p. 1). Currently, some buildings exceed the limits of the imagination of the builders of the 19th and 20th centuries since. At that time, it was unthinkable to overcome the obstacles related to heights. The help of technology and the evolution that it has had today allows for the construction of these enormous buildings. The most remarkable examples built and completed to date can be seen worldwide. The presence of the three classifications of tall buildings at a global level, established by the CTBUH (tall, super tall, and mega-tall) and the behavior of the three tallest buildings for each of these categories are represented in Table 2.

When reviewing the information from the CTBUH (2020), which lists the 500 tallest buildings and their rankings, it is detected that, among the 100 tallest buildings in the world, the height ranges are around 327.3 meters. The described corresponds to the Baoneng Center building in China with the position number 100, up to the Burj Kalifa building, which has all the prominence for being the tallest building of those built to date with a height of 828 meters (CTBUH, 2020).

When analyzing the 500 tallest buildings in the world, it is seen that 333, which represent 97% of the total buildings included in this list, are *tall buildings*. It is followed by *super-tall buildings*, with 66.6% representativeness and a worldwide existence of 164 buildings. Only three buildings belonging to the *mega-tall* category, with three buildings in the world which are located on the Asian Continent (Figure 4).

TABLE 2.
Location of the three tallest buildings in each category.

Building category	Regions	Countries	Building name	Height to peak	Architectural height	Occupied height
Mega-high	Asia	Arab Emirates	Burj Khalifa	829.8 m	828 m	585.4 m
		China	Shangahai Tower	632 m	632 m	583.4 m
		Saudi Arabia	Makkah Royal-Clocktower	601 m	601 m	494.4 m
Super highs	Asia	China	Ping An Finance Center	599.1 m	599.1 m	562.2 m
		South Korea	Lotte World Tower	555.7 m	554.5 m	497.6 m
	America	E.E. U.U.	One World Trade Center	546.2 m	541.3	386.5 m
High	Asia	Bangkok	Four Seasons Private Residence	299 m	299 m	299 m
	America	Canada	First Canadian Place	355 m	298 m	287.1 m
		Panama	J.W Marriott	284 m	284 m	277 m

Source. Elaborated by the authors.

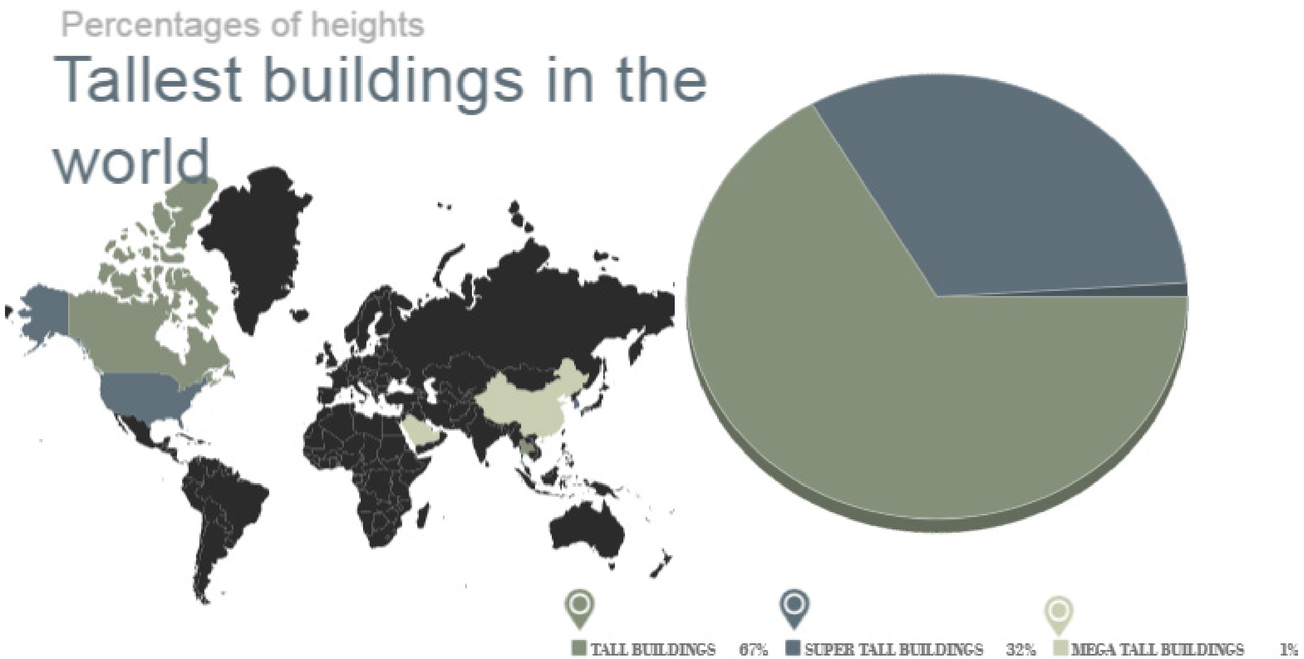

Figure 4. Percentages of heights based on the 500 tallest buildings in the world
Source. Elaborated by the authors..

Super-tall buildings

A significant curiosity detected in this database is that to evaluate the height of the buildings, the CTBUH (2020) offers three diverse ranges: height to the peak, architectural height, and occupied height. This detailed information allows a much better understanding of the valuable area of each building.

Cluster analysis

The trend for many years in large cities around the world was horizontal urbanization. As large tracts of land were available, creating increasingly tiny homes from the metropolises was decided. This model of urban growth is still being developed today, however, one of the problems it generates is the profound impact it produces on the environment. Having a larger and more branched city makes it necessary to build roads with increasing capacity, which often means using green areas for construction purposes. In addition, the poor organization and distribution of services and commercial areas in cities sometimes cause their inhabitants to spend more time moving from one place to another. On the other hand, travel time by car from home to work is greater, generating more significant expenditure on fuel and economic resources. Therefore, engineers, architects, and urban planners support the new concentrated or vertical cities model.

The world's population is growing faster and faster is, undeniable at an exponential rate. According to the United Nations-UN (ONU, 2018), cities will continue to grow faster in developed countries. This same organization confirms that in 1950 there was a population of approximately 2.6 billion inhabitants worldwide. Thirty-seven years later, this figure doubles, reaching about 5 billion people (UN, 2020). According to the Worldometer website (www.worldometers.info), the world population is currently around 7.8 billion people. This growth increases by the minute. The world population by 2050 is forecast to be 9.7 billion people, and this increasing trend can be observed in Figure 5, which represents the behavior of the population growth curve from middle age to the current era and the trend projection for the next few years (World Ometers Information Database, 2022).

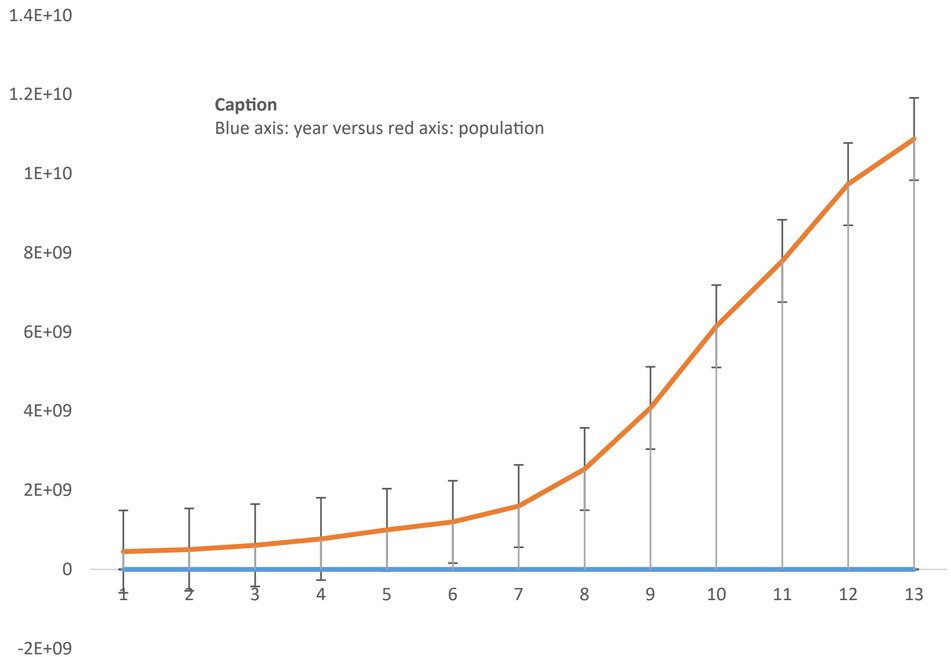

Figure 5. Graph of the trend of increase in world population in the last 500 years.
Source. Elaborated by the authors based on World Meter Data (2022).

The data shown represents a challenge for future generations since there will be an increase in the demand for human consumption resources such as water, food, and housing with a rise in the population. In vertical cities, the problem will be accentuated. According to Khalid and Meng (2020), "the growth of the urbanization rate is also increasing, and the United Nations projected that 68% of the world's population will live in densely urbanized areas by 2050 (p. 1), in response to this problem, there are several aspects.

In this section, we focus on determining whether the development of vertical cities is a viable solution to the challenge presented by overpopulation and the future accumulation of people in the most important cities in the world.

According to Luna (2019), "tall buildings are one of the most viable solutions to cope with the global phenomenon of rapid population growth and urbanization" (p. 1). It is impossible to speak of tall or vertical cities without referring to tall buildings. Every day we try to create buildings that can house more people inside and facilitate the use of space, which according to Montejano-Castillo, Moreno-Villanueva and Espinosa-Jiménez (2020), "it is expected that, with the densification of the city and its vertical growth, there may be a decrease in travel, energy savings, more organized mobility, and better use of urban land and infrastructure" (p. 1).

The planners of urban areas have the great challenge of finding the balance between the number of inhabitants of a city and its services. Much of this responsibility falls on governments, which must regulate the correct distribution of housing and commercial spaces. In the same way, proper allocation of recreational spaces must be found, emphasizing green areas.

Promoting sustainable activities such as bicycles or green technologies such as solar heaters and photoelectric cells can contribute a lot to constructing a sustainable city.

Many of the largest cities around the world have already started to implement this development model with encouraging results. For example, Tokyo currently has about 126 million inhabitants in Japan, a figure like that of Mexico of approximately 129 million inhabitants. Let's consider the territorial extensions of both countries. Japan owns less than a fifth of the territory of Mexico, which raises the following question: can population growth be linked to the increase in the construction of tall buildings and thereby satisfy the demand for housing?

By analyzing the population increase in the different continental regions of the planet in the last 70 years and the tallest buildings for each decade and region, it could be possible to visualize the correspondence between the phenomenon of population increase and its relationship with the construction of tall

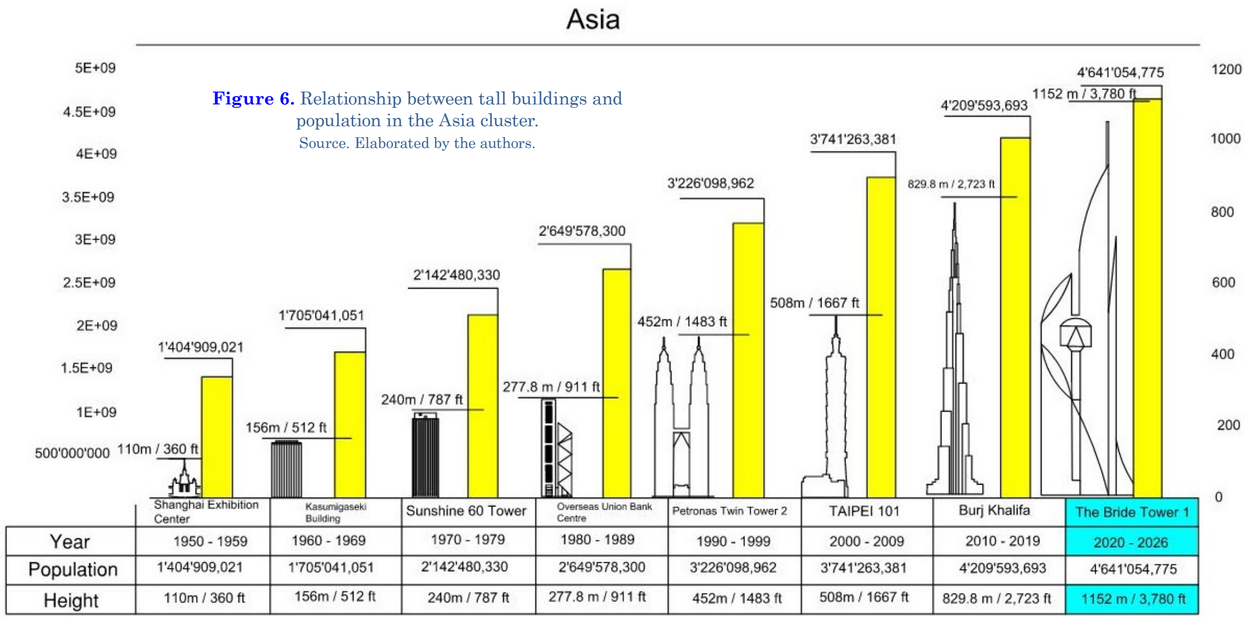

Figure 6. Relationship between tall buildings and population in the Asia cluster.
Source. Elaborated by the authors.

buildings. This type of analysis of groupings by regions and cities is conducted according to altimetric, geographical, and cultural expression. These groupings were called clusters and were created considering six significant regions of the world —Asia, Africa, Europe, South America, North America, and Oceania. The study conducted in each cluster is detailed below.

- *Cluster Asia*

This region extends over the eastern half of the Northern Hemisphere. It borders the Arctic Ocean, the Indian Ocean, the Ural Mountains, and the Pacific Ocean. Not only in terms of the number of inhabitants, but it also houses the tallest building built by human beings to date (Figure 6 and Table 3).

TABLE 3.
Tallest buildings identified for each decade in the countries and cities that make up the cluster.

Asia							
Decade	Building	Peak Height	Country	City	Type of Occupation	Start of Construction	End of Construction
1950 - 1959	Shanghai Exhibition Center	110 m / 360 ft	China	Shanghai	Exposición	1955	1959
1960 - 1969	Kasumigaseki Building	156 m / 512 ft	Japon	Tokyo	Offices	1965	1968
1970 - 1979	Sunshine 60 Tower	240 m / 787 ft	Japon	Tokyo	Offices	1973	1978
1980 - 1989	Overseas Union Bank Centre	277.8 m / 911 ft	Singapur	Singapur	Offices	1982	1986
1990 - 1999	Petronas Twin Tower 2	451.9 m / 1,483 ft	Malaysia	Kuala Lumpur	Offices	1992	1998
2000 - 2009	TAIPEI 101	508 m / 1 667 ft	Taiwan	Taipei	Offices	1999	2004
2010 - 2019	Burj Khalifa	829.8 m / 2 723 ft	Emiratos Árabes Unidos	Dubai	Multiple uses	2004	2010
2020 - 2026	The Bride Tower 1	1 152 m / 3 780 ft	Irak	Basra	Multiple uses	This building is in the design stage, and it is planned to be finished in 2025 approx.	

Source. Elaborated by the authors.

Figure 6 shows the continuous ascent of the population in this region. This growth has intensified since the 1950s. When observing the diversity of constructions, it is detected that each decade. There is an increase in tall buildings that break records in terms of height. Table 3 contains the seven countries and cities with tall representative buildings in this cluster. The city of Tokyo stands out as the most relevant, having two flagship buildings in two consecutive decades. At the same time, it is recognized that office buildings are the most widespread representative use of tall buildings in this cluster. It is confirmed that residential activity is not the priority in these significant Asian construction works.

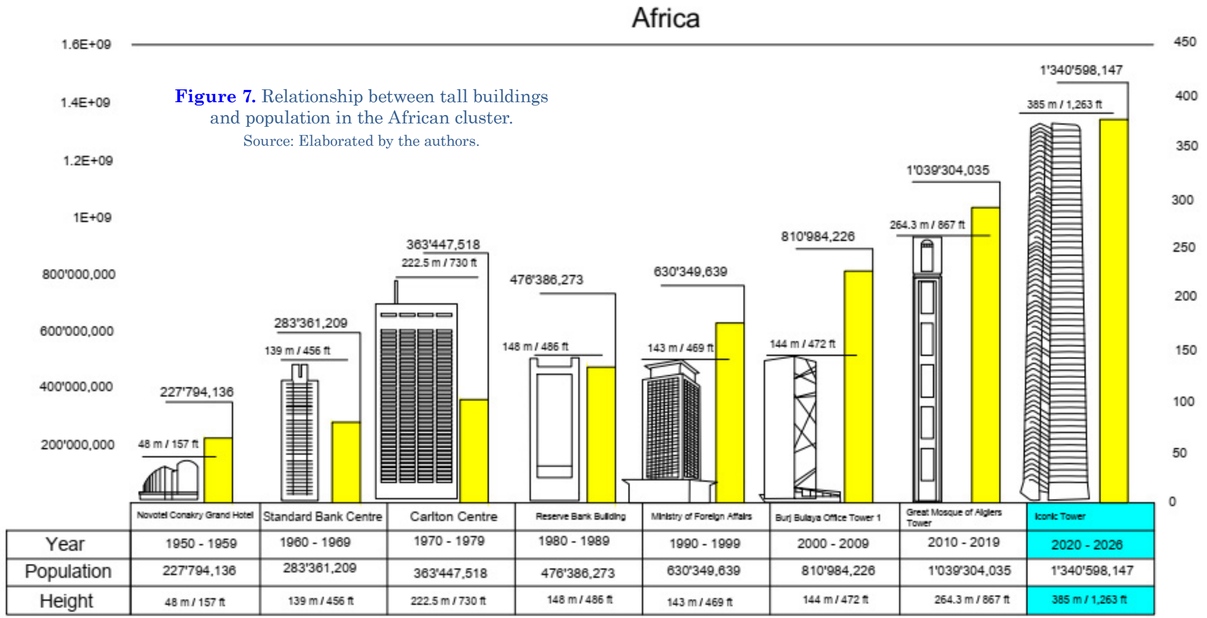

Figure 7. Relationship between tall buildings and population in the African cluster.
Source: Elaborated by the authors.

- *Cluster Africa*

This cluster is located between the Atlantic and Indian Oceans. The Mediterranean Sea separates it from the European continent; The Red Sea separates it from the Arabian Peninsula. The region is linked to Asia through the Isthmus of Suez. Africa is the second continent with the most significant number of populations. It has a total of approximately 1 345 000 inhabitants. However, unlike the Asian continent, this is one of the poorest regions in the world. Although buildings are also breaking height records, their growth has not been as constant as in the Asian region (Figure 7 and Table 4).

TABLE 4.
The tallest buildings are identified for each decade in the countries and cities that make up the cluster.

Africa							
Decade	Building	Peak Height	Country	City	Type of Occupation	Start of Construction	End of Construction
1950 - 1959	Novotel Conakry Grand Hotel	48 m / 157 ft	Guinea	Conakry	Hotel	Not specify	1954
1960 - 1969	Standard Bank Centre	139 m / 456 ft	South Africa	Johannesburg	Offices	1966	1968
1970 - 1979	Carlton Centre	222.5 m / 730 ft	South Africa	Johannesburg	Offices	1967	1973
1980 - 1989	Reserve Bank Building	148 m / 486 ft	South Africa	Pretoria	Offices	1986	1988
1990 - 1999	Ministry of Foreign Affairs	143 m / 469 ft	Egypt	Cairo	Offices	Not specify	1994
2000 - 2009	Burj Bulaya Office Tower 1	144 m / 472 ft	Libya	Tripoli	Offices	Not specify	2007
2010 - 2019	Great Mosque of Algiers Tower	264.3 m / 867 ft	Algeria	Argel	Religion	2012	2019
2020 - 2026	Iconic Tower	385 m / 1 263 ft	Egipto	Cairo	Offices	Construction began in 2019 and is planned to be completed by 2023.	

Source. Prepared by the authors.

Table 4 shows the list of tall buildings present in this cluster. Unlike the previous cluster, only six cities in five different countries feature tall representative buildings. South Africa stands out with three buildings, two of them located in Johannesburg and one in Pretoria. This country stands out by having the leadership of tall buildings for three consecutive decades. It is succeeded by the city of Cairo located in Egypt. As in the previous cluster, the most representative use of these buildings is for offices (6 buildings). The first tall building of the 1950s was destined for tourist activity. Currently, the tallest building has religious use in this cluster, and residential activity is not the priority.

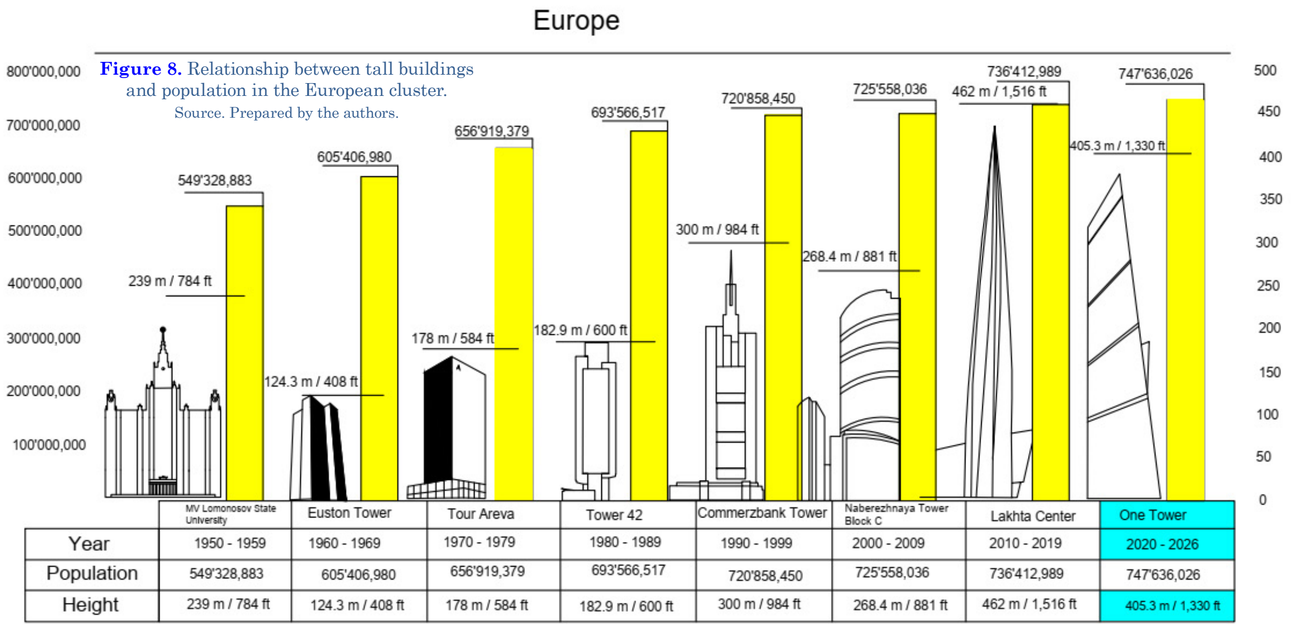

Figure 8. Relationship between tall buildings and population in the European cluster.
Source. Prepared by the authors.

- *Cluster Europe*

The European continent has the third place of regions with the most significant number of populations nowadays. As shown in Figure 8, this region presents the most stable population growth of all the clusters. Its population growth curve is relatively flat. Compared to previous areas, its population has remained constant in recent decades. However, despite Europe being one of the most prosperous regions on the planet in terms of economy, the cluster is not known for its super tall buildings. Currently, the tallest building in this region is 462 meters (Figure 8 and Table 5).

TABLE 5.
Tallest buildings identified for each decade in the countries and cities that make up the cluster.

Europe							
Decade	Building	Peak Height	Country	City	Type of Occupation	Start of Construction	End of Construction
1950 - 1959	MV Lomonosov State University	239 m / 784 ft	Russia	Moscow	Educacion	1949	1953
1960 - 1969	Euston Tower	124.3 m / 408 ft	United Kingdom	London	Offices	Not specify	1968
1970 - 1979	Tour Areva	178 m / 584 ft	Francia	Courbevoie	Offices	Not specify	1974
1980 - 1989	Tower 42	182.9 m / 600 ft	United Kingdom	London s	Offices	1971	1980
1990 - 1999	Commerzbank Tower	300 m / 984 ft	Germany	Frankfurt am Main	Offices	1994	1997
2000 - 2009	Naberezhnaya Tower Block C	268.4 m / 881 ft	Russia	Moscow	Offices	2005	2007
2010 - 2019	Lakhta Center	462 m / 1,516 ft	Russia	St. Petersburg	Offices	2012	2019
2020 - 2026	One Tower	405.3 m / 1,330 ft	Russia	Moscow	Residential	Construction began in 2019 and is planned to be completed by 2024.	

Source. Elaborated by the authors.

Table 5 shows that Russia and the United Kingdom take the lead within the cluster due to tall buildings in cities such as Moscow and London in alternating decades. As in the two previous clusters, the most representative occupancy level of these buildings is that of offices (6 buildings). Of the eight tall buildings in the cluster, one has educational use. It is expected to build a tall building by 2024 for residential use.

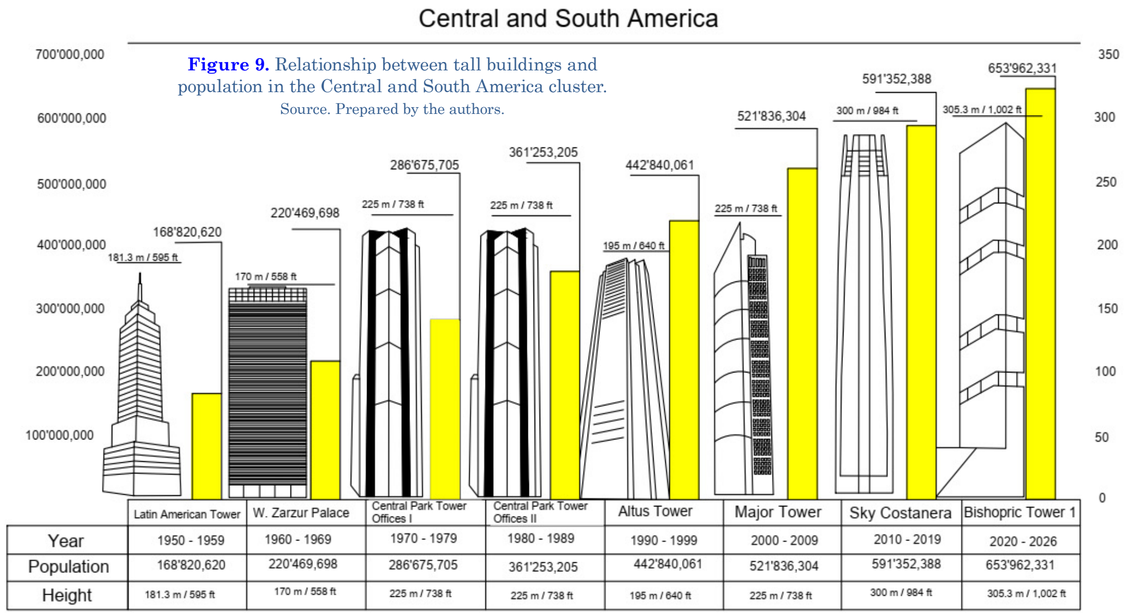

Figure 9. Relationship between tall buildings and population in the Central and South America cluster.
Source. Prepared by the authors.

- *Central and South America Cluster*

This cluster comprises the region of Central America, South America, and the Caribbean. As the region is interchangeably known, South America, South America, or South America is situated between the Atlantic and Pacific oceans. In the extreme east and west respectively, and between the Caribbean Sea and the Antarctic Ocean in its extreme south and north. Figure 9 and Table 6 show the information related to the population and tall buildings of the cluster.

TABLE 6.
Tallest buildings identified for each decade in the countries and cities that make up the cluster

Central and South America							
Decade	Building	Peak Height	Country	City	Type of Occupation	Start of Construction	End of Construction
1950 - 1959	Torre Latinoamerica	181.3 m / 595 ft	Mexico	Mexico City	Offices	1948	1956
1960 - 1969	Palácio W. Zarzur	170 m / 558 ft	Brasil	São Paulo	Offices	Not specify	1967
1970 - 1979	Parque Central Torre Officinas I	225 m / 738 ft	Venezuela	Caracas	Offices	Not specify	1979
1980 - 1989	Parque Central Torre Officinas II	225 m / 738 ft	Venezuela	Caracas	Offices	Not specify	1983
1990 - 1999	Torre Altus	195 m / 640 ft	Mexico	Mexico City	Residential	1994	1999
2000 - 2009	Torre Mayor	225 m / 738 ft	Mexico	Mexico City	Offices	1993	2003
2010 - 2019	Torre Costanera	300 m / 984 ft	Chile	Santiago	Multiple uses	2006	2014
2020 - 2026	T.Op Torre 1	305.3 m / 1 002 ft	Mexico	Monterrey	Multiple uses	Construction started in 2016 and finished in 2020	

Source. Prepared by the authors.

In this cluster, only four countries stand out with tall buildings. Mexico takes the lead as the country with the highest number of tall buildings (4 of them). Only Mexico City has three. The other is in the city of Monterrey. It is frequently followed by the city of Caracas in Venezuela, with two buildings that occupy primacy for consecutive decades. This cluster has diversity in terms of the level of occupation of its buildings with three diverse types of uses.

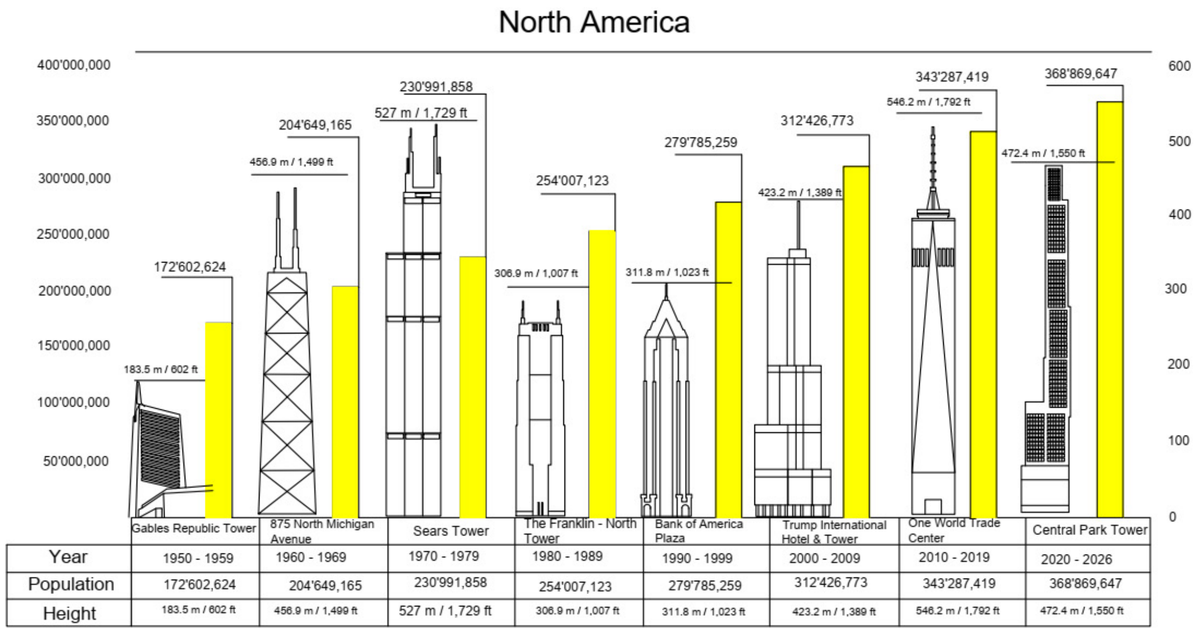

Figure 10. Relationship between tall buildings and population in the North American cluster
Source. Prepared by the authors, 2022.

- *North America Cluster*

North America presents a cultural and geological diversity. It is in the northern and western hemispheres. It borders the Arctic Ocean, Atlantic, and Northern Europe through Greenland, the Caribbean Sea, and the Pacific Ocean. It is also connected to South America. Figure 10 and Table 7 show the information for this cluster.

TABLE 7.
Tallest buildings identified for each decade in the countries and cities that make up the cluster

North America							
Decade	Building	Peak Height	Country	City	Type of Occupation	Start of Construction	End of Construction
1950 - 1959	Gables Republic Tower	183.5 m / 602 ft	U.S.A.	Dallas	Residential	Not specific	1954
1960 - 1969	875 North Michigan Avenue	456.9 m / 1 499 ft	U.S.A.	Chicago	Multiple uses	1965	1969
1970 - 1979	Sears Tower	527 m / 1 729 ft	U.S.A.	Chicago	Offices	1970	1974
1980 - 1989	The Franklin - North Tower	306.9 m / 1 007 ft	U.S.A.	Chicago	Offices	1987	1989
1990 - 1999	Bank of America Plaza	311.8 m / 1 023 ft	U.S.A.	Atlanta	Offices	1991	1992
2000 - 2009	Trump International Tower	423.2 m / 1 389 ft	U.S.A.	Chicago	Multiple uses	2005	2009
2010 - 2019	One World Trade Center	546.2 m / 1 792 ft	U.S.A.	New York	Offices	2006	2014
2020 - 2026	Central Park Tower	472.4 m / 1 550 ft	U.S.A.	New York	Residential	Construction started in 2014 and finished in 2020	

Source. Prepared by the authors.

Table 7 shows that a single country (E.U.) takes the lead in owning the tallest buildings in the region in the eight decades analyzed. As for cities, Chicago stands out with four buildings, three of them built between the 60s and 80s. In the same way, this cluster also shows a diversity of occupation of the buildings with three different uses, one of them being residential use.

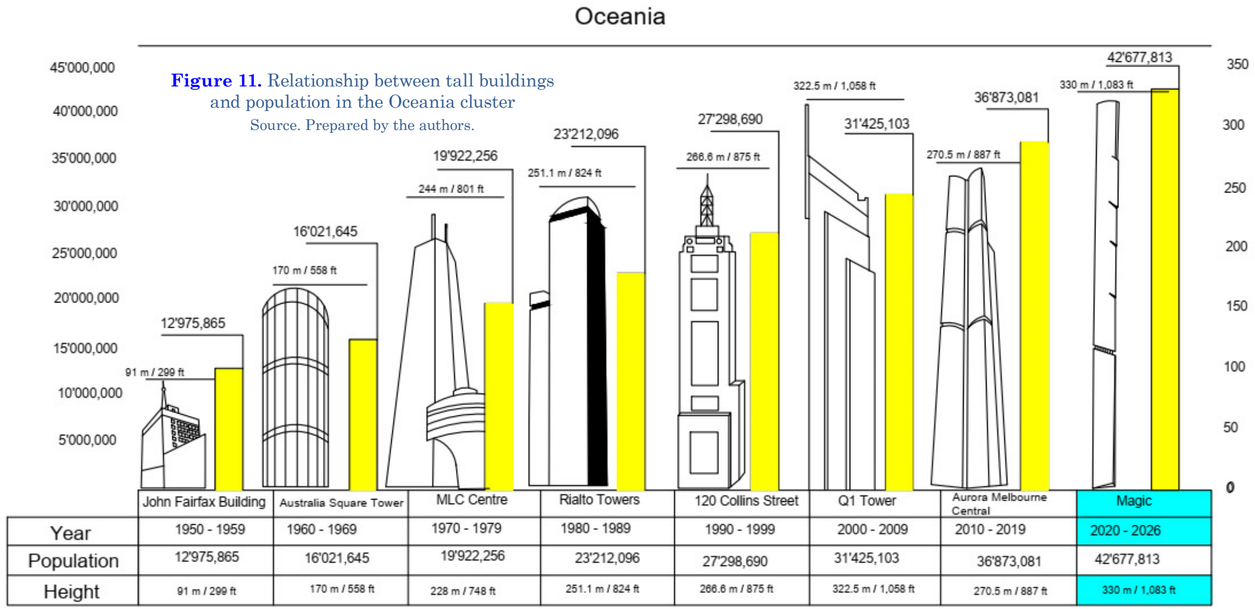

Figure 11. Relationship between tall buildings and population in the Oceania cluster
Source. Prepared by the authors.

Table 8.
Tallest buildings identified for each decade in the countries and cities that make up the cluster

Oceania							
Decade	Building	Peak Height	Country	City	Type of Occupation	Start of Construction	End of Construction
1950 - 1959	John Fairfax Building	91 m / 299 ft	Australia	Sydney	Multiple uses	1955	1957
1960 - 1969	Australia Square Tower	170 m / 558 ft	Australia	Sydney	Offices	1965	1967
1970 - 1979	M.L.C. Centre	244 m / 801 ft	Australia	Sydney	Offices	1972	1977
1980 - 1989	Rialto Towers	251.1 m / 824 ft	Australia	Melbourne	Offices	1982	1986
1990 - 1999	120 Collins Street	266.6 m / 875 ft	Australia	Melbourne	Offices	1986	1991
2000 - 2009	Q1 Tower	322.5 m / 1 058 ft	Australia	Gold Coast	Residential	2002	2005
2010 - 2019	Aurora Melbourne Central	270.5 m / 887 ft	Australia	Melbourne	Residential	2015	2019
2020 - 2026	Magic	330 m / 1 083 ft	Australia	Melbourne	Residential	Construction started in 2020 and is planned to be completed by 2023.	

Source. Prepared by the authors.

- *Oceania cluster*

Oceania is an island continent supported by the continental shelf of Australia. It comprises several islands (New Guinea, New Zealand) and several corals and volcanic archipelagos: Melanesia, Micronesia, and Polynesia. Figure 11 and Table 8 show the information of this cluster.

In this cluster, the cities of Sydney and Melbourne are the most representative, having three tall buildings each in consecutive decades. As in the two previous clusters, the most representative occupancy level of these buildings is that of offices (4 buildings).

After the analysis carried out in the six clusters, we can affirm that the growth of the population of a territory is linked to the increase in the construction of tall buildings. Nevertheless, this rise in the construction of tall buildings is not linked to meeting the demand for housing.

Of the 42 tall buildings currently built, only 4 have residential use today; 2 of them are in the Oceania cluster, 1 in North America, and the other in Central and South America, respectively. Of the six buildings that aspire to be built by 2026, three are designed for residential uses —integrated into these clusters in Europe, North America, and Oceania.

Conclusions

After the research, the hypothesis formulated is contrasted, and it is determined that the presence of buildings in height is proportional to the global urban population analyzed by region. It is found that the Asian cluster occupies the first place, both in the number of inhabitants and in the number of taller buildings built. The research confirms the diversity of criteria for naming buildings in height, finding 13 terms and 18 different concepts. It is concluded that there are diverse cultural, socioeconomic, demographic, and political conditions in the urban and morphological-spatial configurations of cities with tall buildings. There is also a variety in constructing these types of buildings due to their architectural and constructive typologies and differences in heights. Finally, it is detected that tall buildings occupied by offices predominate, with residential use not being the usual occupation.

The heights of tall buildings constructed range from 110 meters in the 1950s to 829.8 meters in the present decade. The cluster with a strategic vision plans to continue occupying world leadership by presenting the tallest building in the world in Asia. Nowadays in Basra, Iraq, the building that will be the largest on the planet to date is in the design phase, with a peak height of 1 152 meters. Tall buildings predominate in all clusters, occupied mainly by offices. On a smaller scale, these tall buildings in the six clusters analyzed have tourist (hotels), religious, residential, exhibition, and multiple uses.

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