INVESTIGATING THE IMPACT OF ULTRA-TALL BUILDING ORDINANCES ON THE FUTURE OF MAJOR CITIES

Abstract

The key aim of this study is to investigate the development of Tall Building Ordinances (TBOs) and their interactions with the development of ultra-tall buildings, in order to better understand the role and dynamics of different municipal policies in the urban morphology, and how they could be improved to help better shape the future of the city. The study seeks answers to the following question: How can cities regulate ultra-tall buildings, as a well-defined catalyst, in anticipation of future challenges and uncertainty?

This study hypothesizes that some elements of the current Tall Building Ordinances are obsolete, or may lack the flexibility to embrace ultra-tall buildings and address future challenges and emerging technologies. The research conducts a survey of the history and principles of building ordinance policy-making in general and the history of TBOs and Height Limitation Ordinances (HLOs) in particular. Then it will ultimately analyze the forces and dynamics behind the emergence of ultra-tall buildings using primary, secondary, and tertiary sources, in addition to statistics, surveys, and interviews with different stockholders. This study aims to develop an approach to establish universal criteria for evaluating the existing set of TBOs in different cities and to help policy-makers improve the regulatory framework/guidelines for ultra-tall constructions to implement a more indigenous, flexible, and responsive approach toward the emerging human needs and technologies.

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Keywords

Autonomous vehicles, building ordinances, codes, digital twins, drones, mega-structures, skybridge, soft infrastructure, vertical communities, ultra-tall buildings, urban morphology, urban farming, zoning

Introduction

By the turn of the 20th century, "Tall Buildings" had become a new urban catalyst to be admitted into the hard and soft infrastructures of Chicago, New York, and other major cities in the US. In Chicago, time and effort were invested through public, juridical, and business debates before the existing sets of municipal ordinances were developed. Studies today show that more than 60 percent of the world's population is anticipated to live in urban centers by 2060 and ultra-tall buildings (buildings of 1,000 feet or more) have emerged as a new catalyst to answer some of the questions related to the future "dense-cities."

Ultra-tall structures as a built-form are widespread in cities around the world. Nevertheless, existing municipal policies and Tall Building Ordinances (TBOs) were developed to mainly consider buildings up to a given height in most of these cities, and only limited sections of the existing city ordinances have addressed ultra-tall, yet within the same "old" definition of high-rise and not as a genre by itself. The main question this study is trying to answer is: How can cities define and regulate ultra-tall buildings in anticipation of future challenges and uncertainty? In order to answer this question, key future challenges will be plotted, explored, and investigated.

Tall and Ultra-Tall Building Ordinances

Building restrictions were found centuries BC, and capping the height of buildings is as old as cities, early forms of "legislative order" that suppressed heights can be traced back to the Roman Emperor Augustus who restricted the height of buildings in Rome to 70 Roman Feet (around 20m). After the great fire of AD 64, the maximum permitted height of structures was reduced by Nero, then again by Trajan to 60 Roman Feet (17m) (Storey, 2003).

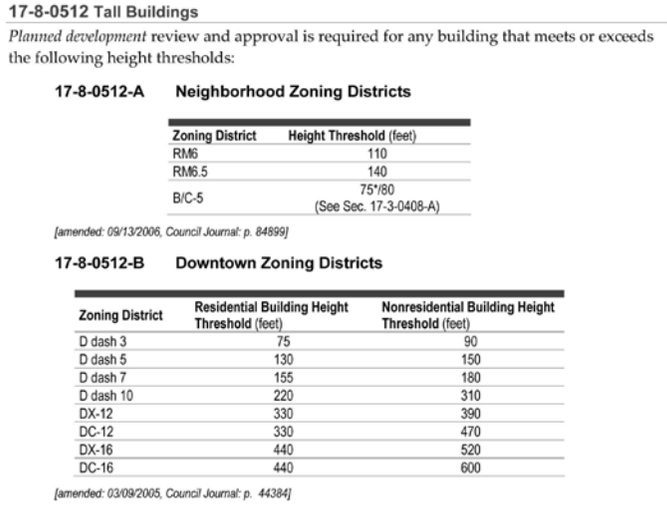
In America, uncontrolled development and noxious land-use have resulted in the increase of city populations during the 19th century. This has encouraged cities and municipalities to establish the earliest measures of regulations to control growth and avoid the worst outcomes, and above all, to protect public health, safety, and welfare. In parallel, city planning of major cities was based on the need of individual patrons to respond to local economics, and political and social pressures in addition to the need for development control. After the emergence of tall buildings, providing access to sunlight, available firefighting equipment, and incompatibility of land use were the main dictators of early height limitations ordinances, regulations, and policies.

In 1892, the first American Height Limitation Ordinance was released in Chicago, just two years after the city had become the second largest city in the US and around seven years from when the US Height of Buildings Act of 1899 was levied. The 1892 Chicago Ordinance set up the height limit to 150 feet at that time and was conceived by the city as a "principal instrument to prevent the negative impact of tall buildings on public health and safety" by controlling building heights and shapes (Nichols, 1923).

Ordinances in American cities started as part of a larger policy to manage development and improve housing conditions (Fischler, 2018), then the basic structure of zoning largely remained unchanged ever since; however, continuous adjustments to the building height ordinances and heights limitations took place in Chicago and other major cities in the US (Figure 1).

Nichols (1923) argued that height regulations were not only meant to limit the height of new buildings but also to ensure a fair division of light and air among lot owners. "The erection of unnecessary skyscrapers is not a sign of city progress but city ignorance," he stated. Tall buildings' policies are not limited to stipulating maximum height for a designated area; it is rather more about the architecture, volume, functions, slenderness, ground-floor use, and other factors. Fischler (2018) suggests that there is a difference between theory and practice of regulatory tools in general, where in theory it implements the community's vision of the future, but in practice it is deal-making with developers (Chicago Zoning Ordinance, 2004).

"North-American zoning was the brainchild of real-estate developers and conservatives much more than of good-government reformers or radicals; its primary aim was to protect the property owner and the taxpayer" (Fischler, 2018).



17-8-0512 Tall Buildings

Planned development review and approval is required for any building that meets or exceeds the following height thresholds:

17-8-0512-A Neighborhood Zoning Districts

Zoning District	Height Threshold (feet)
RM6	110
RM6.5	140
B/C-5	75*/80 (See Sec. 17-3-0408-A)

[amended: 09/13/2006, Council Journal: p. 84899]

17-8-0512-B Downtown Zoning Districts

Zoning District	Residential Building Height Threshold (feet)	Nonresidential Building Height Threshold (feet)
D dash 3	75	90
D dash 5	130	150
D dash 7	155	180
D dash 10	220	310
DX-12	330	390
DC-12	330	470
DX-16	440	520
DC-16	440	600

[amended: 03/09/2005, Council Journal: p. 44384]

Figure 1: Chicago heights threshold in downtown (D Zone). (Source: Chicago Zoning Ordinance, 2004.)

Theory	History	Practice
Planning before zoning	Zoning before Planning	Zoning and Planning together
Zoning for health, safety & welfare	Zoning for social & economic capital.	Zoning for taxes & Public Benefits
Fixed rules with exceptions	The growth of discretionary rules	Zoning as deal-making
The city zone, developers build	Developers zone and build	Many stakeholders zone

Table 1: The theory, history, and practice of zoning. (Source: Fischler, 2018.)

The actual role of municipal regulations has changed along the course of the 20th century, municipal regulations in the early life of American cities, according to Fischler, were meant to perform certain tasks including the control of health and safety threats by regulating human activities and introducing buildings that help to minimize fire threat; and managing streets' qualities and sunlight access; and consolidating social distinctions in physical spaces by keeping 'social inferiors' out of areas where they presumably did not belong; and finally increasing municipal efficiency and reliability. All four elements seem to help keep property values high and taxes low" (Fischler, 2018).

This last element has significantly changed today, and taxes became the main source of sustaining the four other elements; American cities nowadays are counting on increased taxes from the private sector along with vendors' revenues to repay investments in transit, infrastructure, and other areas of public interest and welfare.

In this vein, financial factors now are guiding the growth and shapes of cities, and hence the shapes and purposes of their soft infrastructure (Kiefer, 2017). Current "urban revival" in American cities is happening with no policy framework, but through market forces:

"The current urban revival happened with no master plan and no national urban policy framework, but mostly through the 'invisible hand' of market forces. An amalgam of development approvals, incentives, and exactions has arisen in the past several decades, largely in place of planning" (Kiefer, 2017).

In this interest, Chicago city development was historically stimulated by private interests in exchange of profitable return on their investments. The city offered developers, and still does, an encouraging larger build-up area (FAR bonus) to compensate for public welfare facilities, such as accessible outdoor areas, green roofs, upper-level set-backs, underground parking, winter gardens, and through-block connections, etc. (Chicago, 2004). All have been offered as an attempt to balance the developer's interests and public benefit. The introduction of the concept of FAR (Floor Area Ratio which is a factor that is multiplied by the plot area to determine the total quantity of built development permitted on a plot) as a replacement of the height capping concept, was a practical move toward such intention. The concept has also played a significant role in the emergence of ultra-tall buildings. FAR was first introduced to the Zoning Policy in New York City in 1961, and later became one of the most popular Heights & Density controllers in large American cities and around the world, and it enhanced the efficiency of other height controllers realized in municipal ordinances: Setbacks, Maximum Height, Building-to-Street Proportions, Building Lines, and Coverage.

Today's Chicago zoning ordinance promotes tall buildings through incentives offered to developers, super-tall buildings (or buildings taller than a given threshold set by the city) are not recognized as a genre by themselves, but are permitted only under the "Planning Developments" zoning regulations (Chicago, Chicago Zoning Ordinance 2004).

The zoning picture in Dubai looks more complex. The city is a polycentric entity formed by interconnected developments or "miniature cities," which are largely independent in their zoning ordinances and height limitation. The first development plan of Dubai did not come to realization until 1960, more than half a century after the 1909 Burnham Plan of Chicago. The actual urbanization of the city was later administrated by giant governmental, semi-governmental, and private real-estate companies. Dubai Municipality defines its role as "the leading driver of growth and evolution of the Emirate of Dubai."

Tall Building Economics

"The ultimate test of a value of a building is its earning capacity, not its cost" (Cecil, 1914).

Architecture historians and city planners believe that because of urbanization and the increase in populations, and the change in the urban life of cities, a switch to tall buildings and higher density structures has occurred, and this will eventually lead to the inevitable domination of tall buildings in the urban fabric of major cities. However, additional factors played a significant role in the emergence of tall and ultra-tall buildings and have been realized by economists, legislators, and developers. Such interpretation needs to be acknowledged to better define ultra-tall buildings as a new built form in the predicted urban morphology of future cities.

Architecture historians also suggest that skyscrapers are primarily signifiers of cultural values and symbolic importance, and skyscrapers collectively generate skylines that advertise the economic power of the city. Obviously, finance plays an important role in the emergence of skyscrapers and vice-versa. Willis (1995) argued that the most important factor and force behind the value of a skyscraper is the economic determination, including its height, overall massing, and fenestration and facade treatment. He argued that skyscrapers should be understood as businesses themselves.

Barr (2010) acknowledges that building heights are motivated by land value. He also believes that building higher is stimulated by economic competition between cities to attract investors, and in order to prove his proposal he compares and contrasts the market of skyscrapers in two cities, Chicago and New York, and suggested that the cities respond differently to the same economic fundamentals. He presents evidence for interaction effects across the two cities where New York's height decisions have impacted Chicago's height decisions and vice versa. Barr concludes that skyscrapers embody two types of competition: 1) regional competition for employment and industry growth, and 2) competition among builders to have a place within a "height hierarchy." High land prices and the need of space are reasonable arguments; however, the actual purpose of skyscrapers can't be backed-up when land is value-based on the zoning and code-allowed building volume, i.e., ground lease of government-owned land (Klerks, 2009).

Helsley and Strange (2008) suggest that tall buildings have never been about economy alone but also about building height in and of itself. They propose that there is an important force influencing skyscraper development construction which is the inherent value of being the tallest. They discuss the implications of this factor for the nature and efficiency of urban development, and for the operation of urban real-estate markets. Similar to Barr, they propose that contests between cities pushed the height limit up, from New York World Trade Center to Sears Tower in Chicago to Petronas Towers in Kuala Lumpur to Taipei Tower, and even locally: "A tendency to overbuild in order to win a skyscraper contest pushes the city to a more centralized spatial structure" (Helsley and Strange, 2008).

Thus, there is always another payoff for the builder when they develop the tallest structure in their market! They also think that skyscrapers result in surrounding development stimulation for three reasons: 1) they allow the concentrations of great numbers of workers and businesses in very close proximity; 2) they create tendency toward a centralized urban spatial structure rather than decentralization; and 3) they create a tendency toward overbuilding in real estate markets (Helsley & Strange, 2008).

Nichols (1923) stated that economic reasons would sooner or later prevent people from building skyscrapers. In the same vein, Andrew Lawrence, the originator of the skyscraper index, associates skyscrapers to bigger economic cycles; however, he believes this correlation is an unhealthy sense that skyscrapers start with a large economic boom and end with a large recession. According to his index, the completion of the world's tallest buildings is inevitably a marker of economic crisis (Lawrence, 2011).

The skyscraper index was disputed, as it predicted only severe changes in the economy and ignored many downfalls (Thornton, 2012).

Super-tall buildings tend to stimulate adjacent development, and this could be observed in the city of Dubai, and explained by the CEO of one of the largest development enterprises globally, Emaar Properties, Mohamed Alabbar, who considered super-tall as a strategic decision for introducing new urban developments and as a premeditated cause of surrounding real-estate investment value growth. As an example, today's tallest building in the world, Burj Khalifa, was planned as an icon to attract and serve to develop the entire surrounding downtown district. Alabbar also explained that same strategy has resulted in the decision to build the new Dubai Creek Tower (under construction) to be the next tallest in the world, which is now helping to better promote the Creek Development larger masterplan of attracting investors and increasing the land value regardless of the actual profit expected to be generated by the tower on its own.

Ultra-Tall and Future Challenges

"The forces of the past and present are losing ground to the forces of the future," Mahjoub Elnimeiri.

Ultra-tall buildings are urban nodes, vertical communities, and miso-cities. They put forward a considerable increase in density and place enormous demands on transportation, infrastructure, connectivity, and supplies, and interact with the change in human activities and behavioral patterns.

On-Demand Economy, Transportation as a Future Alternative

By the year 2030, or within 10 years of regulatory approval of autonomous vehicles (AVs), 95% of US passenger miles traveled will be served by on-demand autonomous electric vehicles owned by fleets, not individuals, and this "transport-as-a-service (TaaS)" business model is inevitable (Arbib & Saba, 2017).

While autonomous vehicles and on-demand fleets are already in place, the on-demand aviation era is approaching.

"Just as skyscrapers allowed cities to use limited land more efficiently, urban air transportation will use three-dimensional airspace to alleviate transportation congestion on the ground" (Uber elevate, 2016).

A network of on-demand small electrical aircraft could soon become a reality. Many companies are working hard on Vertical Tack-off and Landing (VTOL) technology (Uber, A3 XTI aircraft co. Aurora Flight Sciences). Were it made available, it would radically revolutionize urban mobility with a network of small flying electric vehicles. To accommodate this inevitable change, a sophisticated system for hard and soft infrastructure should be made ready, including take-off and landing hubs, probably with multiple take-off and landing pads, and electrical charging stations. The city should be ready for this coming change, and the necessary laws, codes, and ordinances that are required to regulate this change.

Parking Garages

One aspect of change in major cities emanates from the new and future alternative means of transportation, including autonomous vehicle, rideshare, bike-share, car-share, and on-demand ground fleets and aviation. A transformation to a car-free future has become more likely. Hence, today's design considerations should be revisited, such as the case of parking garages, which must be designed to be repurposed in the future.

Today, additional build-up area (BUA) is necessary to fulfill municipalities' parking requirements, the areas which will become absolute in most of existing tall and ultra-tall buildings, not to mention the associated structural and ecologic burdens. Cities in the future cannot afford the allocation of precious spaces for empty parked cars.

Chicago Zoning Ordinance offers floor area bonuses if parking garages are considered at underground level (Chicago, Chicago Zoning Ordinance, 2004). This encourages developers and designers to consider underground parking, and design visually accepted, well-lit, occupiable floors at street level, and eventually contribute to a less polluted micro-urbanism. However, a serious controversy is presented in the city offer, considering that buildings should survive 100 years or more. With a car-free possible future, underground parking, above-ground sloped parking, and parking designed with minimum floor heights are not always changeable to different uses, and designers should address this concern from the start by looking at column location, floor heights, envelopes, and building services.

Architecture firms have started looking into this issue. SOM is considering parking garages in the design of some future tall buildings to adopt a change in use. LMN Architects, a Seattle-based architecture firm, in turn, is designing the 1029-foot mixed-used "Vertical Village" in the heart of Seattle's financial district and considered four levels of above-grade parking to take on alternative functions in the future, mainly apartments and offices (Marshall, 2016). Gensler, in partnership with the city of Cincinnati, is similarly designing a corporate headquarters in the heart the downtown with three above-ground floors of parking that could be converted into offices.

Transit-Oriented Developments

Locating ultra-tall buildings at transit nodes is one of the solutions that could solve the increased traffic loads resulting from such mass-developments. Early precedence of a Tall Building-Transit Oriented Development (TB-TOD) was found in New York City in 1930, according to Georges Binder, with the erection of the Chrysler Building with direct underground access to New York's terminal.

In Chicago, transit station improvement projects are ineligible for floor area bonuses (Chicago Zoning Ordinance, 2004), and this kind of incentive convinces developers to invest in TOD and could be the basis of future change.

Food and Vertical Farming

The rapid growth of cities will eventually place an additional enormous demand for urban food supply. Today, 800 million people worldwide are growing fruits or vegetables or raising animals in cities (UN Food and Agriculture Organization Report, 2016), producing 15–20 percent of the world's food. With the increase of city population, food supply has become crucial and challenging. We will have to cultivate more land and use more freshwater for irrigation and devour more fuel and energy on farming, cultivation, and transportation.

Finding alternative farming methods has become a necessity, and studies confirm that growing food vertically reduces the use of water and energy, saves land, and cuts emissions (Despommier, 2009). Urban Planners are now considering prototypical vertical farms in order to solve this issue. The multi-story greenhouse rooftops are a successful way to produce food year-round using less water and energy, and producing less waste.

Despommier (2009) advocates vertical farming as a reliable source of food supply for coming generations; however, vertical farming faces two main issues that are preventing its acceptance amongst developers and investors: First, the economic viability when looking at the land values. And second, the economics of supplying energy and water to a large vertical farm.

As a solution, vertical farms can be integrated with mixed-used ultra-tall developments. However, cities and municipalities should be active in this process, and ordinances should encourage and facilitate the developer's choice to integrate urban farming with tall and ultra-tall buildings by providing incentives.

"Urban farming in Chicago in 10 years looks to be an important element of economic development, and important in terms of how communities come together," Chris Wheat.

Urban farming today is becoming more popular and is being promoted and realized by many cities around the world. The city of Chicago started addressing this need by offering area bonuses for buildings with green roofs (Chicago Zoning Ordinance, 2004).

Chicago, with the aid of a federal grant, started the "Growing for Chicago" initiative to promote urban farming (Trotter, 2016).

Skybridges and Horizontal Links

Another possible future of cities' connectivity is the multi-level linkage to serve pedestrians and other means of transit. For pedestrians, different names have been given to the grade-separated systems, including sky-bridges, skyways, skywalks, pedways, and footbridges, and the development of such above-grade connection routes could be attractive to developers for the potential to concentrate transit, commercial, and real-estate values (Yoos & James, 2016).

Such a system eventually enhances, besides connectivity, the safety and security aspect of movements between different buildings. In addition, such links will provide alternative evacuation routes, and comfort and climate control in harsh weather conditions.

The city of Chicago has recognized such importance for both developers and the public, and offered floor area bonuses to developers for indoor and outdoor through-block connections unobstructed and open to the sky, given that the latter must be open to the public (Chicago, 2004).

However, the city considers the floor area of a connecting link constructed to serve as a passageway between two or more buildings, as a portion of the total floor area of that connected building which represents the most superior type of construction and discourages developers from investing in skybridges. Elevated transit routes are not limited to pedestrian use. Many examples of elevated streets, railways, and rapid-transit could be seen in different cities.

Ultra-tall buildings will eventually play a significant role in determining such solutions in the future. The need for increased safety and security measures in ultra-tall buildings is becoming more challenging, and this might call for enhancement of connectivity between tall buildings via high-level circulation nodes to provide additional means of egress and evacuation routes, especially in cities with dense business centers that have clustered tall buildings in close proximity to each other (Wood, et al., 2003).

In the same interest, elevated route intersections can become nodes that potentially provide centralized activities, including recreational, leisure, and commercial. Generally, the need for sky-bridging might become essential.

Conclusions

Tall Building Ordinances (TBOs), along with other municipal laws, codes, policies, and soft infrastructure are key instruments that physically and figuratively shape our cities, control demography, form, space, and skylines, and determine the quality of lives, well-being, health, and comfort of people. TBOs also control the development of tall buildings, as distinctive actors in the built environment of major cities today, and influence the urban identities, structures, and characters. However with more need to develop ultra-tall buildings, (i.e., buildings above 1000 feet high) UTBOs need to allow for flexibility, adaptability, and responsiveness to the dynamic nature of needs, technological potentials, and achievements within the structure of the existing set of regulations.

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