

## Article

# Density through the Prism of Supertall Residential Skyscrapers: Urbo-Architectural Type in Global Megacities

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Received: 28 December 2019; Accepted: 10 February 2020; Published: 11 February 2020



**Abstract:** Since their inauguration in 2005, supertall residential skyscrapers have established themselves as a truly new, 21st century phenomenon. Their uniqueness spans the spectrum of critically important issues, ranging from discrete ways of conceptualization, production, and delivery, introduction of latest technologies, strict organizational and spatial rules and practices, all the way to various socio-cultural impacts, which include the peculiar, often invisible ways of cultural accommodation. This paper presents parts of a larger research project into this urbo-architectural type, focusing on the capacity of these skyscrapers to address numerous issues related to residential density, especially in fast-growing megacities. While a substantial number of research projects explore economic, architectural, engineering, and environmental attributes of these buildings by focusing on measurable aspects of their production and use, the holistic comparisons and qualitative elaboration of the significance of the residential supertall phenomenon are still lacking. This paper attempts to fill that gap and open a new approach into investigations of supertall residential skyscrapers. The starting position is that these are not simply bigger and taller, but fundamentally different urban artefacts, which have an untapped capacity to reach another kind of quality. Definition and recognition of that difference will enable us to better capitalize upon the qualities which it brings and help avoid the problems which it generates.

**Keywords:** Supertall residential skyscrapers; megacities; density; radical globalism

## 1. Introduction

Cities have experienced the pressures of population growth globally, in a variety of ways. In some, the growth has taken the form of suburban sprawl, whilst others, often due to specific geographic or historic morphological conditions, have adopted a strategy of densification through intensification. Urban compactness is a form of density which requires more than simple aggregation of a large number of objects within a limited area. Mathematics defines compactness using the rules defined in Euclidian geometry, as a finite number of sets or collections [1]. A defined boundary makes all sets referential to one another. If we apply that fundamental logic to urban analysis, we can define compactness as the density of objects within a defined area of the urban realm. Urban morphology commonly defines the urban realm as of the architectural scale, the tissue/fabric scale, the urban scale, and the network scale [2]. An analysis of these scales indicates that the highest that some of the world's densest spaces are, actually, at the smallest scale, that of architectural objects [3]. The most extreme examples of this densification are manifested in very particular circumstances of residential buildings, the supertall residential skyscraper.

While the exact definitions of this typology will be elucidated later in the text, it is necessary to point out here that these extremely tall residential buildings have proliferated across the world

in the 21st century. Their genesis has been widely discussed within both architectural practice and theory, most often in pejorative terms, focusing on their excesses and, most notably, their seeming incompatibility with immediate surroundings and, evermore so, on their reputation as physical manifestations of an unwanted, radical globalism [4]. Radical globalism is by no means limited to the supertall residential skyscrapers, as there are innumerable developments of much smaller proportion that exhibit equally inappropriate scale, albeit not to the same vertical height. This paper, however, focuses specifically on the supertall phenomena in part due to the novelty of the development (strictly 21st century) and the limited number of examples, which allows for a holistic overview of the entirety of the group. These, amongst other perceived problems, have taken the discussion of supertall residential building typology away from serious architectural investigation [5], making it an almost exclusive domain of experimentation and the advancement within technological, scientific, and technical agendas. The fertile ground for these types of agendas stems from the very first mid-20th century modernist towers, such as the Mies van der Rohe's Lake Shore Drive apartments in Chicago, and the "less is more" doctrine exhibited in their minimalism—the redefinition of the façade into a thoroughly ornament-less paneled glass wall, the minimization of the primary and secondary structure to its core purpose of holding the building and the units upright, and the flexibility of internal spaces [6]. Subsequent towers, particularly the Lake Point Tower by van der Rohe's associates John Heinrich and George Schippleit, retained many of the Lake Shore Drive apartments' ideas but contributed in planar reorganization of the floorplate, by allowing each apartment to attain a view of Lake Michigan [7]. With this subtle rearrangement, the architect embraced the role of curator of the internal spaces and aesthetic designer of the envelope, while material and technical advancements gained their own trajectory in the façade, structural, and mechanical design. This separation of the technical and artistic professions can be observed through a plethora of specialist journals that are endowed with much analysis of the means of keeping the buildings upright, due to tremendous static and wind pressures on the primary and secondary structures. Mechanical engineering has sought to advance cooling and heating mechanisms, which were objectively impossible only a decade ago, to almost ubiquity with the supertall genre [8]. Material scientists have opined about the potential for achieving positive environmental impacts that e-coated glazing and double/triple curtain wall skins have been able to achieve in terms of both safety during construction and the longevity of waterproofing to the interiors [9,10], while the economists have variously marveled at not only the financial yield of the buildings themselves, but also at the secondary and tertiary effects which these buildings often tend to have as drivers of tourism [11]. Yet, the architectural profession and, by extension, urbanism, have been almost universally scathing in their assessments of the buildings from a contextual standpoint unless, of course, referencing the above technical attributes. This fragmentation of the study of skyscrapers, and in many ways serious study of all complex buildings, can be attributed to the separation of professions [12] from what was historically strictly the domain of architects (in their true meaning or *arhi-tekton*, or chief-builder) into the role of project managers, whose duty is to facilitate the synthesis of vastly different specialist professions. The contemporary history of supertall residential skyscrapers is thus a history of the technical advancement of assemblages which, when combined, constitute the building as a whole.

Thus, no serious comparative spatial analysis has addressed the similarities and dissimilarities of the currently built residential supertall stock, beyond that cursory observation of their aesthetic sameness and lack of contextual integration. While architectural similarity is a given, this paper, drawing upon broader research relating to this urbo-architectural type, attempts to reach beyond the skin-deep opinion and provide a holistic empirical architectural analysis of these buildings, as related to one another. The paper will first focus on establishing a set of definitions, so as to limit the discussion to the exact foci of our key arguments; secondly, it will concentrate on the locations of currently constructed and proposed supertall residential buildings, highlighting the diverse cultural, regional, and economic realities within which these buildings thrive; thirdly, an original set of data will be presented to further focus the discussion specifically on the architectural realm, which is so sorely absent in the current discourse; and lastly, a hypothesis will be presented, to challenge the

preconception of “sameness” attributed to the typology, by providing examples of cultural phenomena both within and without the buildings which point at an actual a diversity of outcomes, irrespective of the undeniable globally uniform economic pressures for homogeneity, which these structures, almost uniquely in the architectural world, require.

### Definitions

The term supertall (multi)-residential skyscraper has a specific set of requirements, which can be summarized as presented in Table 1.

**Table 1.** Definitions of supertall residential skyscrapers.

Association	Definition	Attribute	Type	Appearance
Skyscraper	Qualitative	Slenderness	Height/Length	Must appear slender
	Qualitative	Tallness	Height	Contextual tallness
Association	Definition	Attribute	Type	Value
Supertall	Quantitative	Height	To tip	X > 300 m
	Quantitative	Ratio	Height/Length	5:1
	Quantitative	Ratio	Plot Ratio	25:1
Multi-residential	Quantitative	Alignment	Vertical	Dwelling
	Quantitative	Percentage	Dwelling area	X > 85%

Universally accepted definition of supertall residential skyscraper [13].

For a tall building to be considered a skyscraper, it must be (a) slender within the context of its height to length ratio and (b) taller than its immediate surrounding context. Within the context of this paper, we can summarize that a skyscraper is a unique typology where the height of the object provides a specific attribute otherwise lacking in simply tall buildings. This attribute, most eloquently described with a neologism—bigness [14]—is time-specific. The exact point where a building might be named as such is hard to pinpoint, but Koolhaas suggests that that occurs when the object transcends the architectural narrative and becomes a phenomenon unto itself, without a simple maximization of smaller buildings. Thus, the point being posited here is that “tall buildings” are fundamentally juxtaposed with “small buildings”, a larger version of a known typology, whilst bigness, in this context the skyscraper, is decontextualized in comparison to all other typologies. Moreover, what separates a mere building from a tower is the fact that it is habitable, either in the sense of residential apartments or commercial offices. For a skyscraper to be defined as supertall, it must (a) be taller than 300 m to its architectural tip; (b) have at least a 5:1 height to length ratio (a stricter requirement than the simple slenderness requirement for a skyscraper); and (c) have a plot ratio of 25:1. Lastly, for this supertall skyscraper to be considered a residential type, 80% of its floorplate must be dedicated solely to long-term dwelling, to the exclusion of hotels or serviced apartments. A building can only be considered a supertall residential skyscraper if all the above requirements are met. As of 2017, only 14 such buildings existed in the world (see Figures 1 and 2).





**Figure 1.** Supertall residential skyscrapers 1–7 (in order of construction). Q1 Tower (Australia), Eureka Tower (Australia), HHR (UAE), Ocean Heights (UAE), Capital City Moscow (Russia), The Torch (UAE), and Etihad T2 Tower (UAE).



**Figure 2.** Supertall residential skyscrapers 8–14 (in order of construction). Doosan Haeundae, We've the Zenith Tower (South Korea), Princess Tower (UAE), Marina Tower (UAE), Elite Residence (UAE), Cayen Tower (UAE), East Pacific Centre T1 (China), Abu Dhabi WC (UAE), 432 Park Avenue (USA).

To further refine these definitions, we need to seek the etymological foundations of the term “skyscraper”. Both the literary and architectural historical investigations point at its highly dubious origins. To first understand the symbolism implied in the word skyscraper in architecture and urbanism,

we should refer to the, for this theme, early, Second Edition of the Oxford English Dictionary [15], which succinctly explains how:

*“Before skyscraper was used for buildings with an exciting height, the word was already in use for things sticking into the air, such as a triangular sky-sail (first recorded use in 1794), a high-standing horse (1788), a very tall man (1857), a rider on one of the very high cycles formerly in use (1892) or an tall hat or bonnet, (1800).”* (Oxford English Dictionary, 1933)

A skysail being the smallest and the highest of sails on the middle mast was, alternatively, also referred to as the equally poetic moonraker, hope-in heaven, or hope sail. Therefore, the first references to man-made objects as skyscrapers were maritime. However, even the later examples refer to a singular object differentiated due to its immense height compared to its surroundings. This definition also strengthens the argument for the initial attribute, as required by Council for Tall Buildings and Urban Habitat classification (Table 1), as an object that is tall within its context (our emphasis) and not to an absolute scale. The Encyclopedia Britannica brings that into contemporary, architectural context. The term skyscraper first came in to use in architecture in 1880s America, shortly after the construction of the first examples. The word was initially associated with buildings of “10 to 20 stories”, and only later in the 20th century did it start to refer to buildings of unusual height. The encyclopedia offers alternatives, related to what it suggests were some of the relevant technological developments, which allowed for these early examples, such as:

- the use of cast-iron and wrought-iron framework in lieu of thick masonry foundations, first used in James Bogardus’ Cast Iron Building, also in New York City (1848);
- the installation of the first safe passenger elevator in Haughton Department Store, New York City (1857);
- the later development of steel prefabrication as a replacement for iron for external frame working, as found in William Le Baron Jenney’s Home Insurance Building in Chicago (1884–1885).

Although the first use of the word skyscraper itself remains unclear, perhaps the first direct translation to English came from the Italian word grattacielo, or literally something that scratches the heavens (gratta—to scratch or scrape, and cielo being “sky”, or “heaven”). The first uses of grattacielo in the early middle ages described a tall man, rather than a structure [16]. Over time, the word was adopted across Europe as a direct translation, such as небоскре́б (skyscratsh) in Russian, небодер or neboder (sky-ripper) in Serbo-Croatian, wolkenkratzer (cloudscratcher) in German, or gratte-ciel (heaven-scratcher) in French, all of which have the notion of the skies or the heavens above being ripped, scratched, torn, or otherwise disturbed by man, seemingly in defiance of the laws of nature. It can, therefore, be summated that origin of the word skyscraper in the English language in non-architectural contexts can be traced back to the late 18th century, and the use within architectural contexts reaches back to the late 19th century, logically with the first examples of such examples being built in the United States. The key is in the notion that the first skyscrapers were inherently different to other tall buildings, due to the simple virtue of height.

W.A. Starrett, in his book *Skyscrapers and the Men that Built Them* [17], goes further and gives us a technical starting point on what attributes a building must exhibit in order to be considered a skyscraper, which somewhat mirrors that of the *Encyclopedia Britannica* earlier in the chapter: “For the skyscraper, to be a skyscraper, must be constructed on a skeleton frame, now almost universally of steel, but with the signal characteristic of having columns in the outside walls, thus rendering the exterior we see simply a continuous curtain of masonry penetrated by windows; we call it a curtain wall. This seemingly continuous exterior is supported at each floor by the beams or girders of that floor, with the loads carried to the columns embedded in that same masonry curtain, unseen but nevertheless absolutely essential to the towering heights upon which we gaze with such admiration and awe and pride, our everlasting pride in our completely American creation.” [17]

Importantly, Starrett here identifies four architects, William Le Baron Jenney, Daniel H. Burnham, John W. Root, and William Holabird (in that order and, incidentally, all Chicagoans) as the pioneers

of skyscraper construction. W.L.B. Jenney's first skyscraper, and therefore, according to Starrett, the first skyscraper in the world, was the Home Insurance Building in Chicago, built in 1884–1885. What both the *Encyclopedia Britannica* and Starrett consider to be of paramount importance when identifying skyscrapers are technical, engineering attributes, such as means of construction, materials used, or machinery. However, an alternative definition of skyscrapers must also be examined, the one that puts this architectural type into the social context.

Later in this text we will return to this duality of skyscrapers, being at once a technical phenomenon where the genesis is attributed to technical specifications and attributes irrespective of cultural context. Regardless of whether it is in Chicago or Manhattan, what makes one structure a skyscraper is its physical properties.

On the other hand, we will develop a parallel between the etymology of the word skyscraper itself and its subversive global proliferation, where the concept behind them was globalized, yet the word itself was transliterated (an object puncturing the heavens). In the following section we will focus on the above-mentioned technical aspects of a selected list of few skyscrapers, and then on this cultural loss of context implied in the simultaneous retention of meaning, as a means of understanding the global adoption of this architectural form.

Fourteen current supertall residential skyscrapers that exist in 2017 are all seemingly unrelated to the cities, cultures, and geographies within which they were erected. The uniform term skyscraper itself implies a homogenous universalism, where the type remains insensitive to differences between cultures, contexts, and climates, an adoption of the form akin to a superficial transliteration of the term. The spread in supertall residential skyscraper typologies can be roughly divided into three periods: (a) the pre-global financial crisis era where the first examples were constructed in Australia (prior to 2008), on the Gold Coast and in Melbourne, (b) the global era, where the typology proliferated in Europe, Asia, and the Middle East (2010–2015), (c) the pencil-skyscraper era of intense development in Manhattan (2015–2018) [18]. The Gold Coast and Melbourne (Australia), Moscow (Russia), Dubai and Abu Dhabi (United Arab Emirates), and Busan (South Korea) are classified as emerging Global Cities [19]. New York City, the location of the latest supertall residential skyscraper, is by all metrics considered a tier-1 Global City. The projection of the future of supertall residential skyscrapers, which focuses on approved, soon to be approved, and/or under construction projects, points at the new settings, particularly in India. The sub-continent expects the construction of six towers in Mumbai, which is, according to the Index, yet another on the list of emerging Global Cities (see Table 2).

**Table 2.** Current and future projections of supertall residential skyscrapers [20] from 2016 onwards, considered under construction for the purposes of this paper.

Region	East Asia	Asian Subcontinent	Europe	Oceania	North America	South America	Middle East
Total	6	6	3	3	5	0	17
2005				•			
2006				•			
2007							
2008							
2009							
2010			•				••
2011	•						••
2012							•••
2013	•						•
2014							•
2015					•		
2016							••
2017			•				•
2018	•	•					
2019	•	••••	•		•		•
2020	•	•		•	•		
2021					•		••



## 2. Materials and Methods

This paper focused on the comparison of all the currently constructed (2017) supertall residential skyscrapers through their numerical, architectural, and urban similarities and dissimilarities. The broader body of work which underpins this specific research focused on hundreds of variables relating to the selected buildings, however the foci presented here relate to five specific categories, which highlight the sometimes paradoxical integration of a global architectural typology, which is, at first glance, devoid of regional, cultural, climatic, or financial integration to their environment, with a set of local rooted expectations. These five categories are (i) region, context, and climate (Table 3), (ii) structure and cladding (Table 4), (iii) empirical measurements (Tables 5 and 6), (iv) construction, consulting and design companies, and ownership structures (Table 7), (v) apartment sizes, sale costs, and rental costs (Tables 8–10). These specific categories highlight the similarities between the buildings (where the aesthetic “sameness” has often been the primary focus) but also point at some of the stark dissimilarities, which are less obvious without a holistic analysis of each example in their singularity, as well as cross examining against the field.

**Table 3.** Region, context, and climate comparison [22]. Sorted by completion date.

Name			Region		Context		Koeppen Climate
	Start	Completion	Name	Population	GDP/capita (USD) 2014	Urban Population (UN Data)	Classification
Q1 Tower	2002	2005	Aust	24,309,000	\$62,290.00	89.40%	Warm, temperate, fully humid, hot summer.
Eureka Tower	2001	2006	Aust	24,309,000	\$62,290.00	89.40%	Warm, temperate, fully humid, warm summer,
HHHR Tower	2006	2010	UAE	9,267,000	\$43,962.70	85.50%	Arid desert, hot arid.
Ocean Heights	2007	2010	UAE	9,267,000	\$43,962.70	85.50%	Arid desert, hot arid.
Capital City Moscow	2005	2010	Russia	143,440,000	\$12,897.90	74.00%	Snow, fully humid, warm summer.
The Torch	2005	2011	UAE	9,267,000	\$43,962.70	85.50%	Arid desert, hot arid.
Etihad Towers T2	2007	2011	UAE	9,267,000	\$43,962.70	85.50%	Arid desert, hot arid.
Doosan Haeundae	2007	2011	South Korea	50,504,000	\$28,165.80	82.50%	Warm, temperate, fully humid, hot summer.
Princess Tower	2006	2012	UAE	9,267,000	\$43,962.70	85.50%	Arid desert, hot arid.
23 Marina	2006	2012	UAE	9,267,000	\$43,962.70	85.50%	Arid desert, hot arid.
Elite Residence	2007	2012	UAE	9,267,000	\$43,962.70	85.50%	Arid desert, hot arid.
Cayan Tower	2006	2013	UAE	9,267,000	\$43,962.70	85.50%	Arid desert, hot arid.
East Pacific Centre Tower	2008	2013	China	1,382,323,000	\$7616.70	55.60%	Warm, temperate, fully humid, hot summer.
WTC Abu Dhabi	2007	2014	UAE	9,267,000	\$43,962.70	85.50%	Arid desert, hot arid.
432 Park Avenue	2011	2015	USA	324,119,000	\$54,306.30	81.60%	Snow, fully humid, warm summer.

**Table 4.** Engineering type (structure, cladding, glazing percentage) and urban form (development style, tower typology, crowing design, and development type). Sorted alphabetically.

Name	Structure	Cladding	Typology					
	Slabs	Column	Balcony	Material	Installation	Type	Tower	Dev.
23 Marina	Concrete	Blade	Entire tower	Concrete, glass, aluminum	Curtain wall	Cluster	Pure extrusion	Single tower
432 Park Avenue	Concrete	Tube	None	Concrete, glass, aluminum	Window wall	Landmark	Pure extrusion	Single tower
Wtc Abu Dhabi	Concrete	Blade	None	Glass, aluminum	Curtain wall	Landmark	Pure extrusion	Complex
Capital City Moscow	Concrete	Rigid frame	None	Glass	Curtain wall	Cluster	Dual tower	Complex
Cayan Tower	Concrete		Entire tower	Glass, aluminum	Curtain wall	Cluster	Podium/twisting	Single tower
Doosan Haeundae	Concrete		None	Glass	Curtain wall	Cluster	Flower extrusion	Complex
East Pacific Centre Tower	Concrete		Entire tower	Concrete, glass, aluminum	Curtain wall	Landmark	Linked tower	Complex
Elite Residence	Concrete	Tube	Entire tower	Concrete, glass, aluminum	Curtain wall	Cluster	Podium/tower	Single tower
Etihad Towers T2	Concrete	Blade	None	Glass	Curtain wall	Cluster	Twisting	Complex
Eureka Tower	Concrete	Blade	Entire tower	Glass, aluminum	Curtain wall	Landmark	Podium/stalagmite	Single tower
Hhhr Tower	Concrete		Unknown	Unknown	Unknown	Canyon	Dual tower	Unknown
Ocean Heights	Concrete	Blade	Entire tower	Glass, aluminum	Curtain wall	Cluster	Twisting	Single tower
Princess Tower	Steel/ Concrete	Tube	Entire tower	Concrete, glass, aluminum	Curtain wall	Cluster	Podium/tower	Single tower
Q1 Tower	Concrete	Blade	Entire tower	Glass, aluminum	Curtain wall	Landmark	Pure extrusion	Single tower
The Torch	Concrete	Tube	Entire tower	Glass, aluminum	Curtain wall	Cluster	Podium/tower	Single tower



**Table 5.** Building height, global rankings, and floor levels. Sorted by global ranking.

Name	Height				Global Rank	Res. Rank	Floors		
	Tip	Architectural	Occupied	Observatory			Total	Above G	Below G
432 Park Avenue	425.5	425.5	392.1	n/a	17	1	88	85	3
Princess Tower	414	413.4	356.9	356.9	20	2	107	101	6
23 Marina	392.4	392.4	313.5	n/a	23	3	66	62	4
Burj Mohammed Bin Rashid	381.2	381.2	352.3	n/a	28	4	93	88	5
Elite Residence	381	380.5	314.5	n/a	29	5	91	87	4
The Torch	352	352	300.1	300.1	40	6	90	86	4
Q1 Tower	322.5	322.5	235	235	70	7	80	78	2
HHHR Tower	317.6	317.6	267	n/a	82	8	72	72	0
Ocean Heights	310	310	288.6	n/a	89	9	86	83	3
Cayan Tower	306.4	306.4	263.1	n/a	97	10	78	73	5
East Pacific Centre Tower	306	306	278	n/a	99	11	89	85	4
Etihad Towers T2	305.3	305.3	281.6	281.6	102	12	87	80	7
Capital City Moscow	309.8	301.8	295.2	n/a	117	13	82	76	6
Doosan Haeundae	300	300	276.8		119	14	86	80	6
Eureka Tower	301.3	297.3	292.3	285	129	15	92	91	1

**Table 6.** Goss floor area (GFA), apartment information, and parking provisions. Sorted by global ranking.

Name	GFA			Number of App.	Park	Park/App
	Total	Dev	%			
432 Park Avenue	65,497	74,322	88.1	104	n/a	n/a
Princess Tower	171,175	171,175	100	763	957	125.43%
23 Marina	139,596	139,596	100	289	586	202.77%
Burj Mohammed Bin Rashid	Unknown					
Elite Residence	140,013	140,013	100	697	788	113.06%
The Torch	94,306	135,475	69.6	676	686	101.48%
Q1 Tower	107,510	107,510	100	527	730	138.52%
Hhhr Tower	Unknown			454	0	0.00%
Ocean Heights	113,416	113,416	100	519	582	112.14%
Cayan Tower	111,000	111,000	100	495	623	125.86%
East Pacific Centre Tower	170,000	170,000	100			
Etihad Towers T2	83,738	529,987	15.80	387		0.00%
Capital City Moscow	Unknown					
Doosan Haeundae Tower A	128,595	572,000	22.50	1384	4474	323.27%
Eureka Tower	301.3	297.3	79.35	285	92	91

**Table 7.** Ownership structures, developer, and consultant details. Sorted in alphabetical order.

Building Owner		Developer/Builder		Consultants			
Name	Owner	Name	Origin	Date Est.	Arch.	Loc.	Type
432 Park Avenue	56th and Park (NY) Owner, LLC	CIM Group; Macklowe Properties	Los Angeles, USA; New York, USA	1994; 1965	Rafael Vinoly Architects PC	New York City, USA	Stararchitect
Princess Tower	Tameer Holding Investment	Tameer Holding Investment	Dubai, UAE	1991	Eng. Adnan Saffarini	Dubai, UAE	Multi
23 Marina	Hircon International	Emaar Properties PJSC	Dubai, UAE	1997	Hafeez Contractor; KEO International Consultants	Mumbai, India; Kuwait City, Kuwait	Multi
Burj Mohammed Bin Rashid	Aldar Properties (sold to Gov. 2011)	Aldar Properties	Abu Dhabi, UAE	2004	Foster + Partners	London, UK	Stararchitect
Elite Residence	Tameer Holding Investment	Tameer Holding Investment	Dubai, UAE	1991	Eng. Adnan Saffarini	Dubai, UAE	Multi
The Torch	Select Group	Select Group	Dubai, UAE	2002	National Engineering Bureau	Dubai, UAE	Skyscraper Specialist
Q1 Tower	Sunland Group/Multiple Owners (strata-titling)	Sunland Group	Brisbane, Australia	1983	Innovarchi; Sunland Group	Sydney, Australia	Local
Hhhr Tower	Dubai International Real Estate	Dubai International Real Estate Group	Dubai, UAE	1994	Al Hasemi; Farayand Architectural Engineering Consultancy	Dubai, UAE	Local
Ocean Heights	DAMAC Gulf Properties L.L.C.	DAMAC Gulf Properties L.L.C.	Dubai, UAE	unknown	Aedas; ECG Engineering Consultants Group	Hong Kong, China	Global Giant
Cayan Tower	Cayan Group - Real Estate Investment & Development	Cayan Group - Real Estate Investment & Development	Dubai, UAE	2004	Skidmore, Owings & Merrill LLP	Chicago, USA	Giant, Skyscraper Specialist
East Pacific Centre Tower	unknown	-	-	-	Wong & Ouyang (HK) Ltd.	Hong Kong, China	Large Scale
Etihad Towers T2	H.H Sheikh Suroor Bin Mohammed Al Nahyan (Government owned)	Sheikh Suroor Projects Department	Abu Dhabi, UAE	n/a	AECOM	Los Angeles, USA	Global Giant
Capital City Moscow	Capital Group	Capital Group	Moscow, Russia	1993	NBBJ	New York City, USA	Multi
Doosan Haeundae	Daewon Plus Construction	Daewon Plus Construction	Busan, South Korea	1999	DeStefano + Partners	Chicago, USA	Multi
Eureka Tower	Multiple Owners (strata titling)	Eureka Tower	Melbourne, Australia	1999	Fender Katsalidis Architects	Melbourne, Australia	Local, Skyscraper Specialist

**Table 8.** Apartment sizes (sqm) by number of bedrooms. Sorted in alphabetical order (data sourced from: cityrealty.com (USA), Propertyfinder.ae, purehome.ae (UAE), Realestate.com.au, Domain.com.au (Aus), themoscowcity.com (Rus), joeunrealty.ty (Kor)). (East Pacific Centre and Etihad T2 tower removed due to data unavailability).

Name	Apartment Sizes Range (Min Sqm)							Date Collected
	Studio	1-Bedroom	2-Bedroom	3-Bedroom	4-Bedroom	5-Bedroom	Penthouse	
432 Park Avenue	56	132	166	205	504		765	18-Oct-2017
Princess Tower	0	80	110	185	297		570	19-Oct-2017
23 Marina	0		150	200			524	18-Oct-2017
Burj Mohammed Bin Rashid	0	98	150	220	268			18-Oct-2017
Elite Residence	0	68.5	120.5		297	1160	1393	19-Oct-2017
The Torch	0	82.2	118.45	159.2	563.5			19-Oct-2017
Q1 Tower	0	97	160	205			414	19-Oct-2017
HHHR Tower								
Ocean Heights	0	81.6	128.3	161.1	204.4	269	1022	19-Oct-2017
Cayan Tower	0	72.1	116.6	168.4	236.9		509.9	19-Oct-2017
Capital City Moscow	0	106	220				876	20-Oct-2017
Doosan Haeundae	0		145	184.8	324.4			19-Oct-2017
Eureka Tower	0	77	116	180				19-Oct-2017

**Table 9.** Apartment sales by apartment size (2017) in \$USD. Sorted in alphabetical order (Burj Mohammed Bin Rashid, HHHR Tower, East Pacific Tower, Etihad Tower T2, and Doosan Haeundae not listed due to unavailability of data).

Name	Apartment Sale Range (Min Sqm, USD)						
	1-Bedroom	2-Bedroom	3-Bedroom	4-Bedroom	5-Bedroom	Penthouse	Price/sqm
432 Park Avenue	\$5,071,000	\$17,791,000	\$28,985,000	\$32,990,000		\$84,607,000	\$93,730
Princess Tower	\$379,000	\$533,000	\$786,000	\$1,123,000		\$3,230,000	\$4874
23 Marina		\$519,000	\$590,000			\$2,246,000	\$3840
Elite Residence	\$286,000	\$421,476		\$983,000	\$15,454,000	\$13,487,000	\$16,302
The Torch	\$280,000	\$365,000	\$871,000	\$3,371,000			\$5294
Q1 Tower	\$421,000	\$750,000	\$971,000			\$2,756,000	\$5593
Ocean Heights	\$351,000	\$463,000	\$709,000	\$1,095,000	\$2,191,000	\$5,057,000	\$6178
Cayan Tower	\$407,000	\$533,000	\$955,000	\$1,208,000		\$2,809,000	\$5358
Capital City Moscow	\$1,897,000	\$2,722,000				\$13,552,000	\$15,000
Eureka Tower	\$530,000	\$891,000	\$1,175,000				\$6964

**Table 10.** Apartment rent by apartment size (2017) in \$USD/month. Sorted in alphabetical order. (Q1 Tower, HHHR Tower, and East Pacific Tower not listed due to unavailability of data).

Name	Apartment Rental Range (Min Sqm, USD)					Statistical Data
	1-Bedroom	2-Bedroom	3-Bedroom	4-Bedroom	Penthouse	Salary Data/year in \$ (gross)
432 Park Avenue	Unknown	Unknown	\$606,000	\$804,000		Manhattan/\$93,282
Princess Tower	\$22,000	\$29,000	\$43,000	\$84,000		Dubai/\$53,518
23 Marina		\$38,000	\$43,000	\$101,000		Dubai/\$53,518
Burj Mohammed Bin Rashid	\$19,000	\$32,000	\$56,000	\$58,000		Abu Dhabi/\$52,112
Elite Residence	\$22,000	\$28,000	\$49,000	\$65,000		Dubai/\$53,518
The Torch	\$18,000	\$25,000	\$38,000			Dubai/\$53,518
Ocean Heights	\$24,000	\$32,000	\$43,000	\$56,000	\$280,000	Dubai/\$53,518
Cayan Tower	\$30,000	\$38,000	\$48,000	\$76,000		Dubai/\$53,518
Etihad Towers T2	\$27,000	\$39,000	\$46,000	\$67,000		Dubai/\$53,518
Capital City Moscow	\$75,000	\$97,000	Unknown	Unknown		Moscow/\$34,090
Doosan Tower A		\$22,000	\$29,000	\$76,000		Busan/\$47,000
Eureka Tower	\$27,000	\$38,000	\$50,000	Unknown		Melbourne/\$70,000

The data collection method could be divided into collection from primary and secondary sources. The primary data were, in part, sourced through (a) interviews with prominent architects [21], designers, and public officials directly linked to the construction of select supertall residential skyscrapers, (b) extensive field-work to all relevant sites (Melbourne 2016 and 2017, Manhattan 2017 and 2018, Chicago 2018, Tokyo 2016–2019, Queensland 2016, Moscow 2017, Hong Kong 2019), and (c) through a three-month placement at the Illinois Institute of Technology (USA) with access to the CTBUH Library in Chicago (2017–2018). Secondary data were gathered through a variety of online and offline sources, such as (a) regional, city, and climate data via the UN Data website, (b) rental/sales yields from local real-estate websites in the region focusing on the latest date of lease/sale (as of 2017), and (c) literature review in both academic and popular journals relating to the construction of supertall residential skyscrapers. The set of data presented in this paper is a small portion of a much larger private dataset which formulates the basis of a doctoral thesis on the subject of supertall residential skyscrapers.

Organization of data has facilitated various classifications aimed at enriching discussion and opening avenues for new interpretations and qualitative analysis.

### *2.1. Region, Context, And Climate*

Table 3 sorts the cases by construction date. It firstly shows the noticeable gap between the construction of the two Australian examples and a several-years-long gap prior to further construction across the globe. That gap coincided with the global financial crisis and it can be safely assumed that indeed the global calamity was the primary driver for the lull in construction. The regions where the structures were constructed are regionally very diverse, ranging from the Far East, Europe, North America, Oceania, and, of course, the Middle East. Each country, although vastly different in terms of its size and population, tends to have positive population growth, although perhaps not so large as to require such extreme residential densities. Further analysis could relate to each city or even district population growths, but such micro-scale assessment remains beyond the scope of this paper. Similarly, for population growths each of the countries on the list is highly urbanized, with the exception of China, which still has a significant rural population (approx. 44%). Lastly, and most importantly, the Koeppen Climate index shows an incredible diversity in biomes within which the samples have been constructed. Once these data are cross-referenced with the construction methods and, importantly, the façade design, the dissimilarity of climates will be starkly juxtaposed to the similarity in façade glazing, installation, and systems.

### *2.2. Structure, Cladding, and Building Typology*

If we relate the above table to the geographical location of each building and the diversity in settings where each occurs, we can see an almost complete arbitrariness of their materiality and irrelevance to their climatic context. All examples within Dubai feature balconies throughout the shaft of the tower, as does the Eureka Tower in Melbourne and Q1 tower in the Gold Coast. The Burj Mohammed Bin Rashid/World Trade Centre Abu Dhabi, only a few hours' drive from Dubai, does not have any balconies and neither do the examples in Busan, Moscow, nor Manhattan. What the table does not show is that the balconies can be found on each face of the symmetrical towers and on two of the four faces of the blade-like Eureka Tower.

The compositional relationship between their own forms and those of other structures in their immediate vicinity point at two distinct configurations. The towers are either singular landmark buildings, usually within an established urban district—such as the vicinity of Central Park in Manhattan, Melbourne's Central Business District (CBD), Queensland's famous tourist destination Surfers Paradise, or the World Trade Centre shopping district in Abu Dhabi. These skyscrapers function as place-makers and symbols to be observed from afar. Their overall aesthetic concepts are defined by this primary morphological requirement. Built on singular sites, often within an already dense urban fabric, their footprints are maximized by covering as much area as possible, as defined by local regulations. The other type is that of the cluster development, where the dominant tower in question



forms a part of a set of other towers of similar height, which are typically built by the same developer or government agency. In visual terms, they conform to the design of the other towers, as they are intended to be seen as a part of a larger compositional whole—a sort of tree within a forest view. There are, of course, some significant outliers, such as the Moscow tower and the Cayan tower in Dubai. The Russian example consists of clustered towers intentionally designed to suggest an eclecticism and non-homogeneous aesthetics. Furthermore, the Moscow tower is the singular residential object within a cluster of otherwise commercial buildings. The Cayan tower in Dubai, surrounded by other supertall residential skyscrapers, was designed to stand out, which was a major requirement of the Skidmore Owings Merrill (SOM) brief. SOM confirmed as much to me during a 2017 interview in their headquarters in Chicago, where they explained that their “feminine twisting form” was a direct counterpart to the orthogonal neighbors. Lastly, the tower clusters always get developed on unused, underused, or reclaimed sites. That provides the developers with areas of land larger than what the landmark typology could afford.

If the landmark type acts as a signpost to an already established district, then the cluster establishes a new, supertall district. This can be seen in Moscow, where the cluster was constructed on the brownfield ex-Soviet era factory site on the river Moskva; in Busan, where the cluster was built on the land reclaimed from water on the base of Mt. Jang; and in the Jumeirah district in Dubai, where the clear water of the Persian Gulf were reclaimed for this development. Once again, the typological features of the towers are unrelated to the cultural or environmental contexts of their locations, but based solely on the economic realities and availability of land.

### *2.3. Structure, Cladding, and Building Typology*

As previously described, in order for the skyscrapers to be considered supertall, their architectural tip must reach above 300m in height. Each of the above presented towers satisfies this requirement, with all but the Eureka Tower reaching the 300 m point with their architectural height. The towers often provide an observation deck or lookout at their peak. Commercial and multipurpose skyscrapers are still of much greater height than residential buildings. The current tallest building in the world is the iconic Burj Khalifa tower (2009) in Dubai, at 830 m. That makes it the only megatall (towers above 600 m) currently in existence, with the highest occupied floor just shy of the megatall mark. The tallest tower under construction is the Jeddah Tower (constructed started in 2013) in Saudi Arabia, which is planned to top-out at 1000 m.

The gross floor area (GFA) of each of the 14 supertall residencials varies widely. This is, in part, due to the shape, with some being particularly pencil-like, whilst others are girthier. Calculation for GFA also varies from country to country. In certain regions, the entire interior of the tower is considered in GFA calculations (including the lift shafts and mechanical voids), whilst others only calculate the net sellable area (NSA). What is of interest to us here is that the skyscrapers often occupy 100% of their allotment ground area, which makes them essentially extrusions of the full legal title. The stark examples of that approach are the Doosan Tower A in Busan, a part of a development of several towers and much open space, and the Etihad Tower T2, which sits in a monumental position away from its neighbors in Jumeirah.

### *2.4. Ownership Structures, Developer, and Consultant Details*

The often-overlooked aspect of these towers are the ownership arrangements. Several ownership models reflect the real estate realities of the country in which the towers exist. The most common model is that of a single entity, be it private or publicly-owned, which funds the construction of the tower until completion date. At that point, the completed apartments are sold-on to private individuals or investment companies to be either owner-occupied or rented. The second model, prevalent in Australia, is the “off-the-plan” sale of pre-constructed apartments. The essence of this approach is that, prior to construction, architectural plans of apartments are directly sold to private individuals or investment companies. This is done on a percentage-based deposit upon which, if the total pre-sale of

apartments reaches an economic viability threshold, the building of the skyscraper begins. Off-the-plan sales are a direct remnant of the individual household mode of ownership, which was historically prevalent in Australia, where land gets divided into strata-titles, which in the case of skyscrapers translates into airspace which will at a future date, upon completion of the tower, be occupied by an apartment (*Strata Titles Act (South Australia)*; 1988.).

The developer companies charged with the building of the structures are always local, whilst the base of architectural companies varies. The type of architects engaged ranges from the world-famous global firms, starchitects with rich portfolios, global awards, and accolades (such as Norman Foster's Pritzker prized firm), via specialist skyscraper companies of global renown (such as Skidmore Owings Merrill), to mainly local skyscraper specialists (e.g., Fender Katsalidis in Melbourne). Finally, as best exemplified in UAE, a large portion of the architects are local, with associated engineering specialist firms from abroad.

The above set of data suggests that the ownership and developer/builder companies are generally related to the city or region within which the structure is being constructed. The former tends to be related to the ownership structures in place, which are already in a specific location, such as the builder-owner model or the strata-titling model. The developers and builders are also preferably local, due to their knowledge of the building regulations and customs in the specific context. The difference between the types of architects engaged varies across the entire spectrum of possibilities—from local to global, from relative obscurity to starchitects, from 'purely' engineering firms to large multidisciplinary alliances. This diversity, ostensibly welcome due to the variety of experiences and backgrounds each company could bring into a project, paradoxically results in buildings of staggering aesthetical similarity. That poses a question: why does this variety in designers not produce a corresponding difference in architectural expressions?

Skyscrapers are inherently complex buildings, often requiring dozens of specialist firms, simultaneously working on diverse design packages. Overseen by a management firm, their product has to be a coordinated building design and, ultimately, an efficient realization. This multiplicity of expertise tends to "democratize" design, often limiting radical design thinking by favoring "world's best practice", which can alternatively be cynically described as "already seen practice". Within the complexity of the undertaking the risks of experimentation tend to be seen as an unnecessary risk. The awesome heights of supertall towers further limits architects by the specialist requirements of engineering, which exert major influence over what can and cannot be constructed.

The homogenous interior programs of these high buildings are primarily residential apartments. To qualify as supertall residential towers, 80% of the total floor plate, and often 100% in practice, mandates a minimum set of requirements of light provisions, shading, operable windows, and in some cases, balconies on all sides of the building. Perhaps most pertinently, supertall residential skyscrapers are sold or rented to individuals, unlike large office spaces in commercial buildings, and therefore have an added economic pressure associated—reducing the cost whilst remaining appealing to a specific market, retaining value, and offering safety.

## 2.5. Apartment Dimensions, Sale, and Rental Information

Other nuances of the unintended, but very present, "regionalism" at which this essay tries to hint are related to occupancy and the various (un)availability of data related to that aspect of this extravagant residential type. For instance, it is important to notice that the internal arrangements of three of the towers listed above are unknown. There are no published plans of the buildings, either online or in physical publications. They are also not available from the architectural firms, which have been contacted to no avail. Moreover, the East Pacific Centre tower in Shenzhen, China and the HHRH Tower in Dubai, UAE offer no information relating to sales or rental opportunities for the towers (which was the reason for not having them included in the above-presented analysis). Burj Mohammed Bin Rashid in Abu Dhabi, UAE is highly publicized on the internet, however seemingly no real-estate company handles the sale of apartments—although the rental pricing is available. Inversely, the Q1

tower in Surfers Paradise, Australia publicizes only sale prices, without any rental details. That tower is a very specific case, as many of the apartments are short-term rented via corporations such as Airbnb.

An important design feature of the supertall residential towers is the compartmentalization of apartment sizes into specific segments across the tower. It is well known that the very top of the towers is usually reserved for penthouses, which either occupy the entire floorplate or, in certain cases, half the floorplate. The lower floors often offer a mix of smaller apartments, while in terms of sizes the middle is essentially mixed. This stratification can visually impact the shape of the building, such as in the case of the Moscow Capital city tower, or be entirely absent in the final elevations, such as in the case of 432 Park Avenue tower, which offers no external cues to the internal division of apartments. Mechanical service floors, or in some cases structural transfer floors, occur at regular intervals. In the case of mechanical services, that is commonly at approximately level 30 (100 m from ground level) due to water pressurization requirements. In the case of the world's tallest building, the Burj Khalifa, the mechanical floors can be found within that range, on levels 17, 41, 73, 109, and so on.

Relating to apartment sizes within the supertall residential cohort, only the Manhattan example offers studio apartments—single room dwellings with no internal separation between living and bedroom spaces. In fact, 432 Park Avenue is an outlier in that the differentiation between extremely large one-bedroom apartments and relatively commonly-sized two-bedroom apartments is quite small. As can be expected, the Dubai supertalls have very similarly sized apartments across the range. Most of the apartments across the towers, in general, fall within a standardised unit size.

This comparison is important in illustrating the point that although supertall residential skyscrapers are objectively expensive buildings to inhabit, there are stark differences in their exact availability to their local populace. Tables 9 and 10 when read in tandem reveal the huge discrepancy in sale prices and rental yields of 432 Park Avenue compared to its global colleagues. For instance, the cost of the median three-bedroom apartment in this particular building (~\$28,000,000) is approximately 290 times the price of the median annual Manhattan salary (~\$95,000). The rent for the same apartment would require six-times the median annual Manhattan salary. The incredible discrepancy between what average New Yorkers can afford and what super-luxury residential towers in New York demand for occupancy has been highly publicized in newspapers in both the US [13] and the UK [23–25], whilst defended by the architects and the developers [26]. In an interesting coincidence, the median annual New York salary could buy a New Yorker almost exactly 1sqm of floorplate of a median apartment within the tower.

On the other end of the spectrum, the Princess Tower in Dubai costs only ~\$4800 per sqm and the average three-bedroom apartment cost is \$786,000. With a median Dubai salary sitting at approximately \$53,000, a no interest loan could be repaid in 17 years. A Dabawi family with two equal salaries could therefore rent a three-bedroom apartment for slightly less than 50% of their annual income.

In the example above, 432 Park Avenue is targeted specifically at the ultra-rich of Manhattan, or indeed of the world, as many apartments are simply vanity investment for the world's rich [27], whilst in Dubai many of the towers are targeted at workers working in the Emirates.

### 3. Discussion

This paper presented a segment of broader research into the phenomenon of supertall residential skyscrapers. Our primary aim was to explain their proverbial “sameness”. The research method was designed specifically to address an imbalance in investigations, which tend to favor the measurable aspects of the production and use of these buildings, by enabling multifaceted comparisons of all existing examples and facilitating qualitative elaboration. Drawing from large sets of data (compiled towards the end of 2017), that approach has yielded results which both confirm and explain the almost total similarity among those skyscrapers, while our multiple juxtapositions exposed a number of situations of unexpected difference.

Our juxtapositions confirmed that, irrespective of location, supertall skyscrapers show a startling number of similarities, both internally (apartment layouts; unit sizes; costs per square meter) and

externally (general use of materials, most notably glazing percentages; primary and secondary structures), and in interaction with, or isolation from, the ground plane. These juxtapositions explain those similarities as consequences of strict planning, design procedures, and rigorous execution of projects.

On the other hand, the dissimilarities discovered during our analysis tended to be unintended, and even unwanted, byproducts in those strictly controlled processes. These seemingly insignificant nuances of difference enable qualitative interpretations, which expose them as fine expressions of cultural specificity, even regionalism, of a kind. That unintended but significant form of expression points at qualitative differentiation, not (necessarily) in formal and aesthetic terms, but in the socio-cultural substance of supertall skyscrapers. In direct response to these findings, our research now encompasses a number of themes related to the specific problems arising from local circumstances—to which the novel characteristics of the supertall could provide some equally novel responses.

In order to illustrate that possibility, we will use the example of Tokyo and its unique combination of high density and the dramatic ageing of Japanese population at large. As a new take on the old dream of vertical urbanism, supertall could be able to turn an otherwise undesirable level of social control into new and desirable forms of community care. Carefully designed and managed, such an approach to supertall could make up for dramatic loss of social bonds at the level of traditional streets, hotengai shopping lanes, and neighborhoods, and create new forms of bonding specific to the extremely ageing society and the associated need for care.

At that level, our multifactorial, relational analysis extends not only beyond purely architectural, engineering, or economic starting points, but also beyond the physical confines of singular supertall structures. It points at the need for their new understanding and radical redefinition—from unsustainable architectural singularities towards true urban multiplicities [3]. Such redefinition has the capacity to address new horizons of place-specific urban life. In the briefly described case of Tokyo, that was in response to a precise situation of ageing within the concrete context of dense urban fabric. Other high-density places and other cultures would point at different, equally challenging, place-specific orientations and tasks for vertical urbanism. Such new understanding opens rich potential for productive, creative, and critical contextualization of supertall residential skyscrapers and fine, locally attuned expressions of a place and moments in its history.

**Funding:** This research received no external funding.

**Conflicts of Interest:** The author declares no conflict of interest.

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