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The Complexity of the Supertall Residential Skyscraper Phenomenon: an Enhanced Type-Morphological Analysis

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ABSTRACT

This PhD Thesis explores in depth the phenomenon of supertall residential skyscrapers (SRS), by combining perspectives of their historic development, theoretical foundations and practical considerations. Our research establishes and documents the case, and develops an argument starting from an intersection between two indications: (1) that the architecture of residential skyscrapers, one of the symbols of Modernist dynamism, has not changed in paradigm since the early modernist towers in the post-war period (Koolhaas, 1978), with only iterative deviations through progression of technology and construction methods and (2) the possibility of supertall residential skyscrapers, in their very Bigness (Koolhaas, 1995a), instigated the new regime of complexity which amounts to paradigm shift

This Thesis confirms that supertall residential skyscrapers do not represent simple growth in size of an already established architectural type but, when that type with highest residential density reached the capacity to accommodate practically unlimited numbers of lives and social situations, it has also approached the moment of possible transformation into an urban multiplicity – thus leaving the constrains of an object and capitalising upon the potentials of an urban settlement – of an entirely new type.

With Bigness and the sustainability imperative of our era, the reality and the need for complexity associated with complex sets of issues – that range from dwelling to urbanity – become an unavoidable ingredient of spatial quality as quality of life. That awareness, arising from research into the complexity of broader living systems, has informed our approach to SRS - as an assemblage (DeLanda, 2006, 2016) of discrete methods which deal with already complex constituting parts investigation, which provide the basis for synthesis that pulls together all disciplinary analyses into the holistic discussion of the particular complex phenomenon in our focus.

A number of secondary and tertiary, sectorial research questions have been investigated, using methods which include case study investigations (the key component); participant and non-participant observation; observation-based analysis; creation of an original database, and inquiry method; data analysis and experiments such as a geospatial computational wind analysis; and questionnaires and interviews with stakeholders across three continents. In this project such, particular investigations are equally important as broad generalisations which they trigger, enable and justify. They are also equally needed to address the issue of paradigm shift. The overall, composite method developed and applied in this Thesis - the Four Sphere Model for Analysis of Complex Socio-Environmental Systems – is one of our key contributions. Its segments have the capacity to deal not only with the foci of this Thesis but also other phenomena which aim at complexity of life.

Our research of the complexity of Supertall residential buildings was framed by Type-morphology (Giancarlo Cataldi, 2018; Giancarlo Cataldi, Luigi Maffei, & Vaccaro, 2002) which provides the key tool for the overall synthesis, within which it acts as a segment of assemblage theory. The most important aspect is the rejection of both radical particularisation of results (present in current research of the Supertall), and broad generalisations (at the expense of particular, expert- and discipline-specific aspects of quality and improvement). The Four Sphere Model for Analysis of Complex Socio-Environmental Systems enable discussion based on tensions between the disciplines/approaches/value systems/interests involved in production of space, where every element enters the system by acquiring new properties in the way in which the paradigm-changing ideas, devoid of the binding power of precedents, need to interact.

The usefulness of this thesis and its results is spread across the pillars of history, theory and practice upon which the research was positioned, providing new knowledge for concrete advancement of

planning, design and governance practices of residential skyscrapers, within their actual, concrete socio-cultural and environmental contexts.

Key words: supertall residential skyscrapers, urban integration, sustainability paradigm

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1 INTRODUCTION

1.1 THESIS BACKGROUND

This research explores in depth the phenomenon of high residential highrise buildings, by combining perspectives of its historic development, theoretical foundations and practical considerations. Our project establishes and documents the case, and develops an argument based on a strong indication by one of the most competent authorities of the 20th century, Dutch architect Rem Koolhaas, who claimed that within that architectural type since 1951 - nothing has changed (*Delirious New York: A Retroactive Manifesto for Manhattan*, 1978) Paradoxically, this paradigmatic symbol of Modernism, an era which was all about advancement, change and radical innovation, in terms of architectural design and spatial quality across scales, has not evolved since construction of Ludwig Mies van der Rohe's Lake Shore Drive (1949-51) project.

With Mies' search for the most functional layout achieved with minimal expressive means, at 860-880 Lake Shore Drive has ended, and the history of residential highrise buildings halted. In historic terms, once the Miesian simplicity took over, the complex scientific and technological methods continued to simplify both the process of making, and the highrise buildings as products. The theory of residential highrise has degenerated into history and criticism (Tafuri, 1980), mainly following and only rarely leading towards new insights, leaving innovation limited to the practical, pragmatic domains of economy and technology.

The impetus for this Doctoral Thesis, and the precise definition of its focus came from the researcher's personal lived, educational and professional experiences with residential highrise buildings. Concrete questions that led to opening of the project have been shaped over nine years that preceded its commencement in 2017, during which he was involved in planning and architectural design, specialist consultancy, and governance related to complex projects, witnessing

both *the conceptual stalemate* of the type and the emergence of *a particular moment* which highlight the need for critical reconsideration of architectural and urban aspects and repercussions of high residential highrise developments.

The stalemate and inertia, best represented in reduction of the progress of this type to technological advancement and globally accepted economic dogmas, are based on both the actual need to accommodate growing urban population while achieving sustainable densities without overcrowding, and the parallel pressures from wealthy elites in their search for luxury and new expressions of power.

But that critical moment came with an advent of residential *Supertall* skyscrapers. In 1999 the first building that meets definition of the Supertall was conceived and constructed in 2006, making the phenomena a uniquely 21st century typology. Since then, up to the opening of this research project (2018) another fourteen (14) supertall residential skyscrapers were built in Surfer Paradise (Australia, 2005), Dubai (UAE, 2010, 2011, 2012, 2013), Moscow (Russia, 2010), Abu Dhabi (UAE, 2011, 2014), Shenzen (China, 2011) and New York (USA, 2015).

Our detailed analysis and synthesis of information compiled from a broad variety of sources indicates that between 15 and 21 new residential Supertall projects are in various stages of development, across all continents barring South America and Africa (Figure 1).

REGION	EAST ASIA	ASIAN SUBCONTINENT	EUROPE	OCEANIA	NTH. AM	STH. AM	MIDDLE EAST
TOTAL	6	6	3	3	5	0	17
2005				●			
2006				●			
2007							
2008							
2009							
2010			●				●●
2011	●						●●
2012							●●●
2013	●						●
2014							●
2015					●		

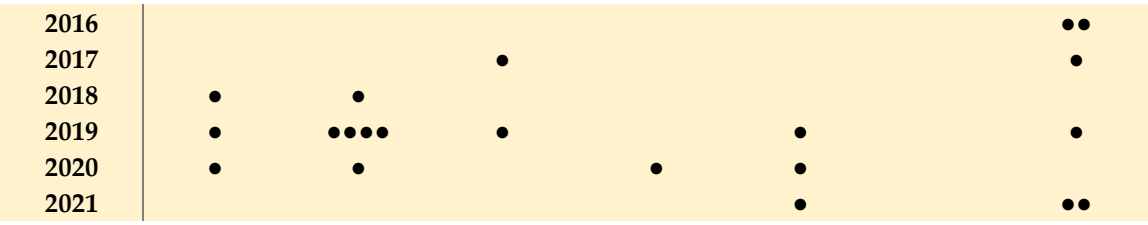


Figure 1 - Current and future projections of supertall residential skyscrapers (CTBUH, 2019) – 2016 onwards considered under construction for the purposes of this research (Radović, 2020a)

For clarity and completeness of this research, a point in time was selected to limit the set of buildings to not only constructed examples, as is the case with a number larger than the fifteen (analysed), but to building constructed *and already occupied*, thus allowing for a broader comprehension of the post-construction and post-occupancy statistics.

What as critical in that moment of emergence of this type has been hinted at in another of Rem Koolhaas' provocative discussions of architectural Modernism and an under-defined era that followed. In his essay entitled "Bigness, or the problem of the Large" (Small, medium, large, extra-large : Office for Metropolitan Architecture, Rem Koolhaas, and Bruce Mau, 1995a), he introduced the term that was going to mark the ensuing era, and provide another potent hint for our investigation of the residential highrise phenomenon. "It seems incredible", Koolhaas wrote, "that the size of a building alone embodies an ideological program, independent of the will of its architects. Of all possible categories, Bigness does not seem to deserve a manifesto; discredited as an intellectual problem, it is apparently on its way to extinction - like the dinosaur-through clumsiness, slowness, inflexibility, difficulty. But in fact, only *Bigness* instigates the regime of complexity that mobilizes the full intelligence of architecture and its related fields" (ibid, p. 500). In the case of residential Supertall, that new regime gets even more complex with inclusion of innumerable expressions of private, family and community lives of their inhabitants, enabling qualitative transition that is central to our inquiry and the key findings of this Thesis.

The technological advancements have enabled qualitative jump, dramatic transition of what was a large architectural object towards a previously non-existent and, thus, unexplored quality – Extra – Large or, in our case, Supertall. When that scale, from symbolic and business buildings entered the

realm of residential buildings, the paradigmatic consequences, ranging from concepts of dwelling to urbanity emerged – but within the reality which does not have direct continuities what we have already seen.

When an architectural type with highest residential density, the skyscraper reached the capacity to accommodate practically unlimited numbers of lives and social situations, it has also approached the moment of possible transformation into an urban multiplicity – thus leaving the constrains of an object and capitalising upon the potentials of an urban settlement, of an entirely new type.

That is the ultimate challenge that this research project chose to address.

1.2 Hypothesis and Research Questions

From the above described challenge which residential Supertall pose to history (as a moment of radical discontinuity), theory (as an uncharted opening of the new paradigm), and practice (which needs the return of architectural and urban design innovation, in creative dialogue with other aspects of conceptualisation and making of skyscrapers and urban settlements) of architecture and urbanism, the need for new knowledge and new practices, ready for a progressive path towards future, arise. The possibility of operationalisation of such knowledge becomes the opening Hypothesis of this work.

Consequently, these needs frame an overarching question of this thesis: What kind of research and governance method can address the complexity of issues introduced to architectural and urban practice by residential Supertall?

The research methodology resulting from definition of the key constituting aspects of that question – architecture, urbanism, practice – themselves need to be complex. The residential skyscrapers have experienced an end of their own history, which was caused by reduction of their processes and realities to the strictures of combined economic, technical and spatial efficiency. With Bigness and the sustainability imperative of our era, *the reality and the need for complexity* associated with

complex sets of issues – that range from dwelling to urbanity – came in as an unavoidable ingredient of spatial quality as quality of life.

That requirement is not utopian. In other disciplines which deal with complexity such methods already exist. In *Unsimple Truths: Science, Complexity and Policy* (2009) Sandra Mitchell reminds how "the world is indeed complex; so, too, should be our representations and analyses of it. Yet science has traditionally sought to reduce the "blooming, buzzing confusion" to simple, universal and timeless underlying laws to explain what there is and how it behaves" (p. 11). With the advent of Supertall, the scale, the numbers and densities bring into residential highrise precisely such "blooming, buzzing confusion" that human and urban life are all about. Mitchel explains how research in life sciences, from which one certainly cannot exclude human lives, "requires, in many cases, a more explicit and detailed analysis of the many roles context plays in shaping natural phenomena. It means that conditions often relegated to the status of 'accidents' or 'boundary conditions' be elevated to the subject of scientific study" (p. 13).

That awareness, arising from research into the complexity of *living* systems, has informed our approach to residential Supertall. That approach was established as an assemblage of discrete methods which deal with already complex constituting parts investigation, which provide the basis for synthesis that pulls together all disciplinary analyses into the holistic discussion of the particular complex phenomenon in our focus (See 1.4 Thesis Structure, below).

According to that structure, a number of concrete secondary and tertiary, sectorial research questions have been established, investigate and generated corresponding sets of findings, across relevant conceptual and practical levels.

Sectorial research questions covered a number of particular themes. Research methods applied to these questions included case study investigations (the key component); participant and non-participant observation (Section 3.3); observation-based analysis (Subsection 3.5.2); creation of an original database (Section 3.4) and inquiry method; data analysis and experiments such as a

geospatial computational wind analysis (Section 3.5.3) and implementation of questionnaires and interviews with various architects and professionals related to the industry in Australia, Japan, United State and Malaysia (Section 6.1). In various segments of the project these methods have interacted in case- and situation- specific manner. Those particular and stand-alone investigations are equally important as the broadest of generalisations, which they trigger, enable and justify. They will also be equally needed as a way to navigate through the uncharted territories of the paradigm shift. The overall, composite method which was developed for, and applied in this Thesis is, in itself, one of our key contributions to knowledge, as it has the capacity to deal not only with what is in the focus of this particular Thesis (residential highrise, Supertall skyscrapers, urbanism) but with other phenomena which aim at complexity of life – the *Four Sphere Model for Analysis of Complex Socio-Environmental Systems*,

In this case, our entry into that complexity of residential Supertall buildings was framed by urban morphology (Subsection 5.1) and, in particular, by Type-morphology (and its well established capacity to help understanding of future (Figure 53 – Saverio Muratori's famous 4-phase diagram as the cover of Il pensiero e l'opera (though and work) an anthology of his work (G Cataldi, 1984). In this Thesis, Muratori-Cataldi based Type-morphology approach provides both the tool for the analysis of one the three constitutive themes and clusters of analysis (Section 3.3) and for the overall synthesis, within which it acts as a segment of assemblage theory (Chapter 4 and 4.1).

The most important aspect of that approach is in an explicit rejection of two possible and common paths: (1) radical particularisation of results (as present in current research of the Supertall, efforts which remain discipline-specific, generating an aggregate, but unable for the qualitative leap of synthesis), or (2) generalisation of results (at the expense of particular, precious, expert- and discipline-specific nuances of quality and improvement). One culturalist analogy, from Dževad Karahasan's exegesis of multicultural urbanity (Karahasan & Drakulić, 1994) provides a summary of the resulting quality of such, in his terms "dramatic" (as opposed to "dialectical") systems. He

explains how “the fundamental relationship between elements of the (dramatic) system is oppositional tension, which means that its elements are poised against one another, and mutually bound by that opposition, wherein they define each other. These elements enter the system - which is the totality of a higher order - without losing their primordial nature or relinquishing any of the properties they possess independently of the system to which they belong. Every element enters the system by acquiring new properties, instead of losing any of those it possessed from the beginning. Every one of these elements is itself a complex whole, composed of two parts, mutually connected by their oppositional relationship. The fundamental property of this kind of cultural system is pluralism, which is what makes it directly contrary to monistic cultural systems, which can also be defined as dialectical (see Section 2.2.3**Error! Reference source not found.**).

The *Four Sphere Model for Analysis of Complex Socio-Environmental Systems* introduced in this Thesis enable discussion based on tension between the disciplines/approaches/value systems/interests involved in production of space, where every element enters the system by acquiring new properties precisely in the way in which the paradigm-changing ideas, devoid of the binding power of precedents, need to interact.

Development of this approach was largely possible due to the above mentioned unusual background of the author, his first-hand involvement in architectural and urban practice, as well as that of governance as an architect, urbanist and expert consultant, a participant and observer, and fruitful interaction with experts of various profiles in diverse projects (including this research project).

Such experiences, combined with the refined capacity of Type-morphology to help understanding future, have enabled an overall, “dramatic” method to emerge, the approach that can both inform discussions and make critically important distinctions between the likely (econo- and techno-driven) and desirable (holistic) futures. That enables an openness to comprehension of “the qualitative leap” within an overall sustainability imperative (Subsection 5.2.2) the capacity for which is contained in residential Supertall.

1.3 Purpose, Aims and Objectives

The main aim of this Thesis was to respond to the unique moment in history of residential architecture and urban development, which came about with the advent of Supertall residential skyscrapers and, thus, an introduction of Bigness with all of its paradigm-changing potential.

In order to address that complex and vast set of issues, the set of objectives has been established, with an intention to both treasure and advance an overall interdisciplinarity in various processes engaged in the making of Supertall residential skyscrapers, and reach beyond their mechanical aggregate. Those included steps based in investigations of (a) the historic development of the type, from its origins to the moment of paradigmatic transition from architectural singularity to urban multiplicity (Subsection 5.1); (b) establishment of strong theoretical foundations, capable to support both quantitative and qualitative investigations of all 15 cases which have qualified for this project (Section 2.2); and (c) detailed analysis of actual practices of conception, development, realisation and inhabitation of Supertall residential skyscrapers (Sections 3.3 to 3.5.3).

The usefulness of this thesis and its results is spread accordingly, across the three pillars upon which the research was positioned. The key usefulness corresponds closely to the initial motivation of the researcher to undertake this project – to help advance planning, design and governance practices of in production and use of residential skyscrapers. That has been achieved by combining (1) deep understanding of the past developments in residential skyscrapers (history) with (2) their diverse socio-cultural and environmental aspects (theory), from where the method of inquiry emerged, to help extend and trace the timelines of inquiry of supertall into the future (practice of planning and design), thus facilitating innovative processes of translation of an architectural type into an urban phenomenon (practices of governance).

1.4 Thesis Structure

The structure of this Thesis was built upon two sets of theoretico-practical ideas:

- *Conceptual Framework* (Section 2) which operationalises definitions and etymological trajectories of the phenomena to be explored, introducing *Theoretical background*, which summarises the history of the skyscraper and its evolution into contemporary type. That provides first set of three research questions and corresponding three research approaches, based on (a) Heideggerian comparative analysis of the idea of Dwelling), (b) Hegelian (Universal Space) analysis of foundations established by practice of Mies van der Rohe, and (c) the synthesizing Type-morphological approach (Skyscrapers and their urban contexts). All of these segments provide particular findings, discussion and conclusions.

and

- *Methodological framework* (Section 3.1) which structures the *Practical background* of the project, staring with an in-depth analysis of a concrete, paradigmatic case (Eureka Building in Melbourne, Australia), and provides a set of conclusions on Process Driven Approach. That leads into Quantitative comparative analysis of all fifteen (15) existing Supertall residential skyscraper globally, and analytical core of the project, an *Architectural analysis of skyscrapers at three scales*. The second set of three research questions and corresponding three research approaches address (a) *The Micro Scale* deals with façades and modularization analysis, pointing out at the complexity of and within the Small (subsection 3.5.1); (b) The Meso Scale deals with multifactorial analysis of apartments (Subsection 3.5.2) while (c) The Macro Scale reaches the level of contextual and urban analysis (Subsection 3.5.3). And again, each segment provides specific findings, discussion and conclusions.

These, themselves complex, parallel lines of inquiry intertwine, forming an assemblage of themes, crucial and lateral questions, and thematic/sectorial and overall findings.

Due to the character of the topic of this research project, methodology designed to address its complexities and the main aim to help advance practice of residential Supertall, in a somewhat unorthodox way Conclusions chapter precedes that of Discussion. Following the sets of previously elaborated conclusions which end theme-specific chapters, Conclusions chapter wraps up the

predominantly analytical body of this Thesis, while Discussion chapter consolidates future-orientated findings, and elaborates upon the ways of their concrete implementation.

Overall Conclusions (Chapter 4) are derived from application of synthetic assemblage theory to the previous sectorial findings and elements of synthesis – and a novel take at spatial, architectural aspects across all cases studied within this project. The key driver in definition of these conclusions is its Type-morphological component. Type-morphological analysis is an example of concrete application (Subsection 5.1) of assemblage theory – which, often justifiably, gets accused for fuzziness. In this Thesis, even at the Micro scales of inquiry where the windows of the Supertall get examined in detail as veritable "assemblage of assemblages", it proves capable to relate the finest (and the "driest") of technical aspects of construction to materiality to politics via (Section 3.4) "*expressive*" and Zaera-Polo's definition of their "*political* role". That is an example of application of qualitative and quantitative analysis of space as equal keeps the "fuzziness" of culture at the same level as the exactitude of the finest of architectural detailing. The novelty of insights generated by application of such, *Four Sphere Model* justifies its use.

Discussion (Chapter 5) expands on the most important findings and focuses at future of (1) residential Supertall buildings and (2) implementation of the *Four Sphere Model* for those *and other* complex systems. It is the claim of this thesis (Chapter 4.1) that if the Four-Sphere Model is to be effectively applied to a pre-existing condition it must be contextualized, and thus the political sphere must be considered within its own current context. Within the new conceptual model proposed henceforth, the political stops being an arbiter and impartial policymaker, but forms the "ecosystem" within which contextualized examples take form.

Discussion stresses the importance of a tripartite system of sustainability and establishes the need for a new profile of expert in strategic thinking, holistic analysis of complex systems based on contextualization of the tripartite system of sustainability.

2 CONCEPTUAL FRAMEWORK AND THEORETICAL BACKGROUND

2.1 CONCEPTUAL FRAMEWORK

2.1.1 Definitions

There is precious little agreement in professional and academic architectural discourse to define what a 'skyscraper' is and almost as importantly, what it is not. A 'tall building' is not inherently a skyscraper by definition; other requirements need to be met. In the engineering professions there is a somewhat more coherent definition of what a 'tall building' is, albeit a very exact one in nature; a building upon which lateral loads (horizontal atmospheric, or wind) are of higher concern than static vertical loads. This statement can therefore be taken metaphorically as that for a building to be a 'tall building' it shares more in common with the air that surrounds it and attempts to blow it over than the earth it sits on. Another metric used to quantify tall buildings is that the buildings height must be taller than its length (L) by a factor of five, or that its total floor area is 25:1 of its site area. Therefore, a square based building with the length/width of 50m must be at least 250m tall to satisfy these requirements. Moreover a 'building' is a an occupied structure, while a 'tower', like the Eiffel Tower for example, which is predominantly unoccupied, and thus is not a skyscraper nor a tall building. Equally unclear is what could be considered the first, or even the archetypal 'tall-building'.

Typology	**Definition**
Tower	An un-occupied object that exhibits all the attributes of tall-buildings, however without occupants.
Tall-Building	A permanently occupiable object.

Table 1 - Definition of tower and building

The Council for Tall Building and Urban Habitat (CTBUH), has developed the international standards for measuring and defining tall buildings, and is the recognized arbiter for bestowing designations

such as ‘World’s Tallest Building’, refrains from using the word ‘skyscraper’ at all, preferring to define buildings in the categories of ‘tall’, ‘supertall’ and ‘megatall’[1].

They define ‘tall’ buildings in reference their urban context, where a building’s tallness is a function of the character and height of the surrounding city of town. What might be tall in a rural village would not be tall in Dubai or New York. Secondarily slenderness of a building is important in the appearance of height; therefore a shorter yet slender building might meet the requirements of a tall building, whilst a wide yet physically tall building might not. Of tertiary concern, is the presence of technologies that are attributed to the notion of tall buildings; such as elevators and wind bracing solutions (referring to the aforementioned importance for horizontal wind loads in engineering structure).

Supertall and Megatall have a very specific definition; any building above the height of 300m is considered supertall and any building above the height of 600m is considered megatall2. Furthermore the exact heights point of measurement is also contentious when evaluating the total height of the building, however within the context of this research the tip or the highest point of the building irrespective of function is considered its penultimate height.

[1] Council for Tall Buildings and Urban Habitat; CTBUH Height Criteria for Measuring & Defining Tall Buildings. Available from: http://www.ctbuh.org/LinkClick.aspx?fileticket=zbw8MY6N98s%3d&tabid=446&language=en-GB (accessed 16 January 2018)

[2] Currently (April 2020) the only three *megatalls* built are the Burj Khalifa (828m) in Dubai, the Shanghai Tower (632m) and the Makkah Royal Clock Tower (601m) in Mecca, Saudi Arabia. The architecture practice Skidmore Owings Merrill (SOM), who were the design architects on the Burj Khalifa, are currently in charge of designing the Kingdom Tower in Jeddah, Saudi Arabia which is planned to be over 1000m in height.

Typology	Definition
Tall	1. Required to be physically taller than the surrounding urban context. 2. Required to exhibit the aesthetic attribute of *slenderness.*
*Super*tall	1. Fulfill the requirements of 'tall' 2. Be of 300m or more in height
*Mega*tall	1. Fulfill the requirements of 'tall' 2. Be of 600m or more in height

Table 2 Definition of tall, supertall and megatall buildings, as per CTBUH

An important secondary terminology within this research relates to the definition of multi-residential buildings, particularly within the context of tall-buildings. There is an important differentiation made within the typology of residential buildings between what is considered a single dwelling building and a multi-dwelling building. In certain countries such definitions are even legally defined, and as such require different building codes and standards for each. The Building Code of Australia (BCA) for example differentiates these two typologies as Class 1 buildings and Class 2 buildings respectively (Australian Building Codes Board., 2009, p. 37). Class 1 buildings within the context of the BCA can be summarized as either free-standing houses or row, villa, town and terrace houses (separated by fire resistant walls). Class 2 buildings, of which all tall buildings are inherently a part of, are defined as containing two or more sole-occupancy units. A simple differentiation of the two classes, and one that we will adopt for this specific research, is that dwellings, attached or detached, forming a horizontal row are Class 1 and dwellings forming a vertical row are Class 2.

CTBUH has a further definition on what attributes a multi-residential building must exhibit. They recommend that for a tall building to be considered residential, at least 85% of the total floor area of any given building must be solely devoted to long-term residential use. Therefore hotels, aged care facilities, student housing and other types are not considered 'residential' within the context of

multi-residential buildings. If tall buildings contain these facilities and do not satisfy the 85% residential provision, they are considered mixed-use buildings[3].

Typology	Definition
Multi-residential	1. Two or more separate sole-dwellings. 2. Organised in a vertical row ensemble 3. At least %85 of total floor area must be solely long-term residential use

Table 3: Definition of multi-residential building typology used within the context of this research

[3] Council for Tall Buildings and Urban Habitat; CTBUH Height Criteria for Measuring & Defining Tall Buildings. Available from: http://www.ctbuh.org/LinkClick.aspx?fileticket=zbw8MY6N98s%3d&tabid=446&language=en-GB (accessed 16 January 2018)

As elucidated previously, in order for a building to fall within the category of Supertall Multi-residential Skyscraper (SMrS) it must exhibit the attributes of a supertall building and a multi-residential building in unison. These attributes have been tabulated below, with reference to specific calculable metrics as well as more ephemeral aesthetic qualities.

Metric Qualities of SRS				
Association	Definition	Attribute	Type	Value
Supertall	Metric	Height	To tip	x>300m
		Ratio	Height/Length	5:1
		Ratio	Plot Ratio	25:1
Multi-residential	Metric	Alignment	Vertical	Dwelling
	Metric	Percentage	Dwelling area	x>85%

Table 4: Definition of supertall in relation to metric qualities required.

Aesthetic Qualities of SRS				
Association	Definition	Attribute	Type	Appearance
Supertall	Aesthetic	Slenderness	Height/Length	Must appear slender
	Aesthetic	Tallness	Height	Contextually must be tall

Table 5: Definition of supertall in relation aesthetic qualities required.

2.1.2 Etymology

Within this research we will refer to tall buildings interchangeably as tall buildings or skyscrapers, as the very word skyscraper has historical significants in society. Supertall and Megatall will remain as defined by CTBUH.

In order to understand how we arrived at the definitions that we did in the previous section of the chapter, historical references must be understood. These historical references are shown through the literary works of architectural historians, and although it is not the main purpose of this research to elucidate or judge upon the questions of which skyscraper came first, or what context specifically provided it, a brief overview must be presented.

Perhaps firstly to understand the symbolism of the work 'skyscraper' we should refer to the Second Edition of the Oxford English Dictionary which, succinctly explains the origin of the word.

"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)."

A skysail being the smallest and highest of the sails on the middle mast alternatively referred to as equally poetic moonraker, hope-in heaven or hopesail Therefore, the first references to man-made objects as skyscrapers were maritime in nature; however even the later examples referring to a singular object differentiated due to its immense height compared to its surroundings. This definition offered by the Oxford Dictionary also further strengthens the argument for the initial attribute offered by CTBUH as to what constitutes a tall building (refer to Chapter 1) as an object that is tall within its context and not to an absolute scale.

The Encyclopaedia Britannica[4] offers that in contemporary, architectural contexts, skyscrapers first came in to use in the 1880's America shortly after the construction of the first examples; and explains that initially the word was associated with building of "10 to 20 stories" and only later in the 20th century tended to refer to buildings of unusual height. The encyclopedia offers alternatives to

[4] Although obviously not a technical document per se, the encyclopaedia presents an interesting overview of the skyscraper, as it details what would be of most use to a non-expert audience.

what it suggests were some of the technology developments, which allowed for these early examples, namely:

1. 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),
2. The installation of the first safe passenger elevator in Haughton Department Store, New York City (1857),
3. The later development of steel prefabrication as a replacement of iron for external frameworking as found in William Le Baron Jenney's Home Insurance Building in Chicago (1884-85)

Therefore it can be summated that origin of the word in the English language in non-architectural contexts can be traced back to the late 18th century and the use within architectural contexts to the late 19th century, logically with the first examples of such examples being built in the United States. The importance of these findings is centered around the notion that the first skyscrapers are inherently different to other tall buildings, due to the virtue of the specific attribute of height[5].

W. A. Starrett in his book *Skyscrapers and the Men that Built Them* (1928) 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*

[5] As first presented in Section 2.1.1, and is further elucidated in the critical analysis of the Rem Koolhaas' essay *Bigness and the Question of Tall* (1995b) in Section 2.2.1

such admiration and awe and pride, our everlasting pride in our completely American creation." (Starrett, 1928, p. 1)

Importantly Starrett identifies four architects, William Le Baron Jenney, Daniel H. Burnham, John W. Root, and William Holabird in that order (incidentally all lived 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 1884-85.

What both the Encyclopedia Brittanica 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 there is an alternative definition of skyscrapers that must also be examined, that of the social context of the terms.

Although the first use of the word skyscraper itself is unclear, but perhaps the first direct translation to English came from the Italian word grattacielo, or literally something that scratches the heavens; *gratta* being to scratch or scrape and *cielo* being 'heaven'. However, the first uses of grattacielo, were used in the early middle ages to describe a 'tall-man', rather than a structure (Peet, 2011) Seemingly over time the word was adopted across Europe as a direct translation such as *небоскреб* (skyscratch) in Russian, *neboder* (skyripper) in SerboCroatian, *wolkenkratzer* (cloudscratcher) in German, or *gratte-ciel* (sky-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.

According to Gerard Peet in his paper *The Origin of the Skyscraper* (2011) an important way of understanding the history of skyscrapers to focus on the first adoptions of the word skyscraper within the common lexicon, albeit firstly English. This is a very interesting notion as it links the first skyscrapers as a function of their perception within the public sphere. Fundamentally what he attempts to suggest is that skyscrapers defined themselves from other tall structures at the exact

moment that society began to associate height for the sake of height as a valid typology. Through this criterion Peet suggests that one of the first people to refer to skyscrapers in their contemporary architectural form was New York journalist and critic Montgomery Schuyler in his article entitled *The Evolution of the Skyscraper* (published in 1909). Peet describes the Schulyer article as having given several candidates for the honor of the first skyscraper. His 'candidates' for the first true skyscraper were the Equitable Life Assurance Building (1870), the Tribune Building and the Western Union Building both in New York (1875) or the Home Insurance Building in Chicago (1885). However by modern standards all these early examples would be dwarfed by most buildings in every modern major city centre around the world. Height in the context of buildings has always been relative.

Another early adopter of the phrase skyscraper, according to Peet, was the Peruvian architect Francisco Mujica in his book *The History of the Skyscraper*, yet he went further than Schulyer by categorising the building in to three discreet typologies, which lead him to proclaim that Chicago's Randy McNally Building was the first skyscraper built in the world. The categories he suggested at the time were:

- Pre-Skyscrapers or buildings with elevators
- Embryo Skyscrapers or buildings with elevators and a metal frame
- Modern Skyscrapers or buildings of 'great height' with high-speed elevators and a steel skeleton.

This was an early attempt at differentiating what is simply a 'tall-building', in the sense of an existing building typology such as a town hall, a commercial building or, which was enlarged and therefore reached a great size from building whose main purpose is height. True skyscrapers, unlike 'just any' tall-buildings, one could argue, have no historical architectural precedent. Towers, as defined previously in the Definitions section of this chapter, on the other hand do and have simply been enlarged and scaled to the height of today's monuments. Peet coffers a myriad of examples, all of which to certain degrees exhibit some of the attributes required to be skyscraper, but fail in others. Some of these, such as ancient Rome's *Insulae Felicula* were examples of multi-level residential

buildings but were long, wide structures with not much in common with 'slenderness' associated with the first requirement of what constitutes a tall building. Others such as religious monuments with their spires, although sometimes monumentally tall rarely accommodated people, so fall within the 'tower' subsection of tall-buildings; but do not make skyscrapers. Perhaps the most convincing, albeit also incorrect example of potential predecessors of skyscraper cities, was the town of Shibam in Yemen, which visually seems to exhibit the all the requirements defined as prerequisites for skyscrapers. The town is fundamentally a walled city, in the tradition of ancient fortified cities, and therefore its height was a function of its defensiveness.

Taking in to consideration the points put forth in this section of the chapter, two theories have been offered to the reader.

1. The etymology of the word *skyscraper* may be much older than its contextual use within the sphere of architecture, yet the contemporary use of the word is fundamentally linked to the phenomena of tall-buildings, and a specific kind of tall building.. The prefix of residential, commercial or mixed-use is almost unnecessary to the concept of skyscraper as the skyscraper has become a typology on to itself; thus height has become a defining feature of an architectural object irrespective of its contents.
2. Albeit historians disagree on the exact origin of the first skyscrapers, all examples reviewed specify mid-to-late 19th century United States as the birthplace; and the cities of New York and Chicago as their contextual locations. Thus it can be assumed that through historical review of these two locales a comprehensive understanding of the phenomena of skyscrapers can be achieved.

As such, to continue our understanding of the phenomenological birth of the skyscraper this research focuses on those two exact places, New York city (or more precisely Manhattan) and Chicago (or more precisely the Loop) as important points in the history of skyscrapers. The following segments in Chapter 3.3 focus specifically on Manhattan and Chicago and the birth of the skyscraper

2.2 THEORETICAL BACKGROUND: THE IDEA OF THE SKYSCRAPER AND BIRTH OF CONTEMPORARY TYPE

The role of this segment of Section 2.2 is to contextualise the advent of the pre-modern and modern skyscrapers as fundamentally American invention; albeit with major influences from European

architects. It is easy to conflate the roles of Manhattan and Chicago in the birth of skyscrapers and to simply assume that by the fact that they are both American cities that developed the typology on skyscrapers almost in unison that their roles were entwined. By comparing literature on both Manhattan and Chicago, with a particular focus from mid-19th to mid 20th century skyscraper advancements, this chapter attempts to pursued the reader that although both cities had major roles to play in the birth of the typology, their roles were very much separate.

New York city is reviewed through the works of Rem Koolhaas (1978) which gives us a fundamental understanding of the first conceptual inklings of skyscrapers in their infant form. Koolhaas establishes that the first design concepts of skyscrapers, in the minds of their Manhattan visionaries, were far removed from the first built examples, and were fundamentally conceived as a utopian vision of life within the context of the New World and within the confines of a predetermined urbanistic decisions, the street grid. Moreover Koolhaas introduces us to Hugh FerriSs (1986) and his early visions of proto-skyscrapers, buildings which are imagined as colossal objects, entirely conceived without a purpose, and whose only defining feature is their great height.

Whilst Koolhaas explains the initial conceptual births of the Manhattan skyscraper Carl Condit in his two books on the late 19th and early 20th century New York and Chicago (Condit, 1973; Landau & Condit, 1996), provides a comprehensive understanding on the social, technological and economic levers that facilitated their ultimate construction. His books provide an invaluable insight as they describe chronologically the transition of skyscrapers from their initial styles, namely beaux-arts in Manhattan and neo-gothicism in Chicago, to their most recognisible modern forms; that of *modernism* in the style of Mies van der Rohe (amongst others).

The final part of section 3.3 focuses on modernism in early skyscrapers by analysing two of the most important examples in Chicago; that of 860-880 Lake Shore Drive apartments (Mies van der Rohe) and Lake Point Tower condominiums (George Schiporeitt). By focusing on architectural sections, specifically those of architectural facades, a fundamentally important point about modernism is

presented; that through modernism skyscrapers achieved their ultimate architectural expression. It is argued that through this expression, namely that of the famous Mies quote *"less is more"*, all subsequent skyscrapers, particularly of the residential typology, are fundamentally derivatives of Lake Shore Drive apartments and Lake Point Tower. Architectural theory seizes to evolve within the contexts of American skyscrapers and is replaced by engineering, technology and material advancements.

In architectural history there is much debate on what constitutes a skyscraper, where the first one or ones originated, and what is a valid metric for skyscrapers in general. What is beyond conjecture however is that the concept of the modern skyscrapers is intrinsically linked to America and a particular set of circumstances both social and economic that allowed them to occur. This chapter focus particularly on Manhattan and the beginnings of what might today be considered the 'modern skyscraper'.

To better understand the history of skyscrapers we must better understand how and why they were formed in the first place. What were the social, environmental and economic underpinnings that lay the foundations for this building typology? Rem Koolhaas in his book *Delirious New York; A Retrospective Manifesto for Manhattan* (1978) ties the phenomenon of the skyscraper as a fundamentally New York type of building. This view differs from other researchers such as Condit and Walker in *The Chicago School of Architecture* (1964) and Thomas Lesie in *Chicago skyscrapers, 1871-1934* (2013), who contend that in fact the initial form of the skyscraper is in fact a Chicago invention, albeit different to the Manhattan version. Koolhaas's manifesto on New York is set out chronologically, from the earliest colonisation of the east coast of America until the arrival of Salvador Dali and LeCorbusier in the 1930's, prior to the great American depression. In a later chapter I will focus further on the developments in Chicago during the era, however this chapter will solely focus on Manhattan and the first set of circumstances that proved fertile ground for this new building typology.

The idea of a *retrospective* manifesto is explained by Koolhaas as a post-facto attempt at coherence of a city, and the skyscraper as a building typology. Fundamentally tied to the experience of New York as a *"mythical island where invention and testing of a metropolitan lifestyle and its architecture could be pursued as a collective experiment in which the entire city became a factory of man-made experiences, where the real and the natural ceased to exist"* (Koolhaas, 1978, p. 10). He goes on to say that New York, even modern New York, is still in search of a theory, and all encompassing logic, which on one hand would free the city of the *"shameless architecture"* and any some way also destroy it.

The book begins by explaining the *prehistory* of New York, or more precisely the lack-thereof. From its discovery by Henry Hudson on behalf of the Dutch East India Company, to the first waves of western explorers and migrants in the 16th century left no trace of the original inhabitants of the island. No vernacular architecture, no local social structures, not even the population itself was left behind, in order to contribute to what Koolhaas describes as a *"theatre of progress"*. The project of New York, or at that time little more than an outpost in the new world named New Amsterdam, from its very first appearance in the conscious of the European populace was through engravings and paintings sent back with the early explorers. They showed a city that yet did not exist, but rather an idealised European medieval city of fairy tales transplanted onto the east coast of America. This type of idealisation, misrepresentation and otherworldliness is an undercurrent throughout the book, and I would go on to argue within the skyscraper typology as an extension of New York. At its beginnings New York's first representations were quite literally conceived from a blank canvas, completely removed from its physical and cultural settings. These first painting and engravings showed a *"church, a stock market, a city hall, a place of justice, a prison and, outside the wall, a hospital complete the apparatus of the mother civilization"* (Koolhaas, 1978, p. 15), but of course none were there in reality. Koolhaas explains this depiction as *"project Manhattan: an urban science fiction"*, and as the precursor for the development of New York going forward through history.

At its beginning the colony of Manhattan is little more than a pentagonal fort, but with the "purchase" of Manhattan island as whole from the native Indians in 1807, a planning exercise is undertaken to allot the land, both known and still unknown to the Europeans, for future development. In 1811 the future city is divided into "*12 avenues running north-south and 155 streets running east-west"* (ibid, p. 10). This simple action provides the island with its iconic grid of 2,028 blocks which remains relatively unchanged to this day. Of course this primitive grid was laid for horseback and horse-drawn carriage travel, but it also was the foundation for the *culture of congestion* which is another key concept picked up on by Koolhaas later in the text.

This subdivision is an integral component of the skyscrapers that would be built over the course of the next few centuries in Manhattan. They provide the first environmental restrictions on a *tabula rasa*, the blank canvas that is Manhattan, for these towers of the future. Koolhaas describes is at as *"...the most courageous act of prediction in Western Civilization; the land it divides, unoccupied; the population it describes, conjectural; the buildings it locates, phantoms; the activities it frames, nonexistent."* (ibid, p. 19). He goes on to explain that although at first glance one might see this initial stroke of urban planning as neutral, perhaps even democratic in its allotment of future parcels, in fact it completely negates all existing context and allows for all of the building that is to succeed it. The Grid, he continues, is makes all previous urbanisms irrelevant, and that the orthodoxy of the plan in 2D dimensions leaves the only avenue for creativity to architects and designers to be upwards. The uniformity of the ground plane allows for anarchy vertically. The totality and completeness of the Grid from its first concept to its fulfilment provides that *"Manhattan is forever immunised against any (further) totalitarian intervention.* Any and all future"s of Manhattan must forever be contained within the 80x275m grid. However, of course the lot between 5th and 8th avenues and 59th and 104th streets, is retained as outside the Grid, and becomes what is now Central Park; also an entirely human intervention which replaces all native foliage with handpicked varieties, complete with a man made lake. *"Central Park is a synthetic Arcadian Carpet."* (ibid, p. 23)

Koolhaas sees London's Crystal Palace as the precursor for Manhattan's ambition towards innovative buildings. Some argue (Starrett, 1928)that in fact Crystal Palace is the world's first glass tower, however Koolhaas uses its progressive nature, rather than it's size and height as the catalyst for Manhattan's surge upwards. He suggests that the Latting Observatory, which was built in response to the London International Exhibition of 1851 and it's Crystal Palace, as the first true skyscraper. It allows for the first time that New Yorker's be able to inspect their realm from above, and see that land that they have and its limits within the Manhattan Island.

With the creation Manhattan's Crystal Palace an equally important aspect of the skyscraper, as the grid was to its 2D nature, is created and exhibited. Elisha Otis, the inventor of the first lift, exhibits his invention in part as spectacle and circus performance and in part as an alternative to walking upwards between floors. These two events, the planar grid and the means to travel vertically, as the inklings to all future skyscrapers. Koolhaas describes this moment in detail, showing the reader that in Manhattan in that era, even the humble lift becomes a course for celebration and extravagance.

If the Manhattan Grid and the Otis lift provided skyscrapers with the initial possibilities for verticality, then Koolhaas firmly believes that the neighbouring region of Coney Island, brought New York it's extravagance. Coney Island is an appendage to the archipelago that is modern day New York city. A peninsula on the Atlantic ocean, and the cauldron for New York's excesses. Conceived as a holiday destination for Manhattanites of the era, it provided, amongst other interests the first Luna Park. One of the attractions is the Centennial Tower which serves as an observatory, similarly to what the earlier Latting Observatory did in Manhattan. Koolhaas describes it yet another catalyst for Manhattan and that *"it also offers an additional direction of escape; mass ascension."* (ibid, p. 33). This idea of ascension and escapism features heavily throughout the text as a means of showing that, in many ways like the Otis lift, height becomes a performance in itself and a celebration of architecture breaking out of the orthodoxy of its planar circumstances at ground.

The different types of amusement parks in Coney Island are all relatively alike, all offer an otherworldliness to the visitors. They contain oddities and transplants from around the world, however their inauthenticity lies in the fact that only the visual is replicated, the social and cultural remains nonexistent. Like Disneyland or Las Vegas of today they try to mimic what has already been seen globally, except of a grander scale and completely dislocated from its natural environment. To Koolhaas, Coney Island is *"the laboratory of the fantastic"*, where all manners of inventions are created to amuse the visitors, but eventually through mutations and adjustments become the very essence of building in Manhattan, and in turn the essential components of Manhattan's skyscrapers of the future. One such invention is an artificial cooling mechanism for an exhibit of 'Switzerland' in one of the amusement parks, which takes what we now know as air-conditioning and makes a spectacle out of it, just like the lift. Koolhaas describes this as *"... potential of technology for the support and production of fantasy, of technology as an instrument and extension of the human imagination."* (ibid, p. 55)

If the Grid gave Manhattan the *need* to ascend, the Otis lif gave it the *means* to ascend, then Coney Island and its technology of the fantastic gave it the *desire* to ascend.

This idea of the technology of the fantastic, is the first of three defining characteristic of Manhattan to Koolhaas. It lays the *foundations* on which the possibility of Manhattan lays. To him the combination of the technological inventiveness of the era and the capacity of its inventors to exhibit it in a theatrical manner provide the cultural, economic and public support it required to be made, initially from a fantastical amusement park setting, into something tangible and authentic in Manhattan. It describes that Manhattanism was a specific moment in time which allowed for the city to happen it's current form, and rather than a singular moment of genius from a single visionary, it was a multitude of coincidences, visions and potentials that created it. Had any of these initial inventions been delayed or not invented at all, Manhattan and its iconic symbol of the skyscraper would have perhaps been entirely different or perhaps non-existent.

"The Manhattan Skyscraper is born in instalments between 1900 and 1910. It represents the fortuitous meeting of three distinct urbanistic breakthroughs that, after relatively independent lives, converge to form a single mechanism:

The reproduction of the World

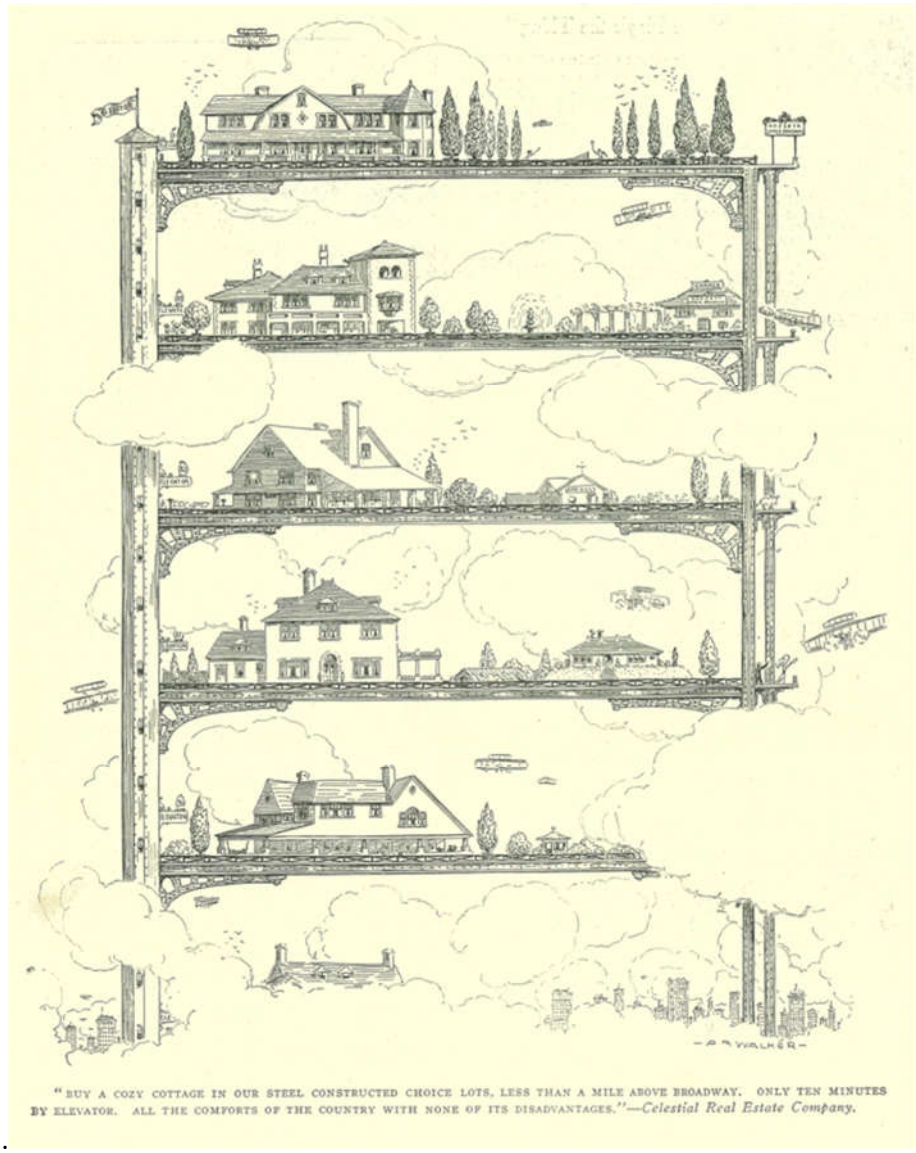
The annexation of the Tower

The block alone."

- (Koolhaas, 1978, p. 82)

The reproduction of the world within the text refers to the endless possibility of vertical repetition of floorplates, which is possible amongst other things by the lift, which becomes widely available by the 1870's. The lift shaft, as a perfect vertical steel extrusion allows for maximisation of floorspace. To Koolhaas the repetition and ascension of floors is not only a financial decision, where suddenly higher floors, which prior to the elevator were considered suboptimal due to stairs, were now prime real estate; but also allow for glimpses of nature in what had become a crowded city by this era. Furthermore the lift allowed for seamless transition from ground floor to any other floor which he describes as *"aesthetic based on the absence of articulation"* (pg.82). Secondarily technological advancements in steel construction allow that through *"...these two breakthroughs, any given site*

can now be multiplied ad infinitum to produce the proliferation of floor space called Skyscraper."



(pg.82).

Figure 2- An early visualisation of the concept of a skyscraper, as famously illustrated by A.B. White in the 1909 Real Estate issue of LIFE magazine explains the origins of the idea of modern vertical settlement (White, 1909 as cited in Koolhaas, 1978)

An early 1909 image of this utopian dream from *Life* magazine, shows a shelf like structure where the external columns contain a slab like floor upon which sit a series of idealised moments from rural life. Two and three floor mansions, fully grown trees as well as images of clouds and farm animals are superimposed over the gargantuan structure which provides for *"...unlimited number of virgin sites on a single metropolitan location."* (pg.83). This image perhaps best exemplifies what Koolhaas calls the pre-history of the skyscraper, which one could some up as a yearning for a misplaced

European country life of a bygone era, devoid of any natural context and with the only imperative being that it must fit within the man-made Grid. Furthermore he suggests the fact that this early architectural 'diagram', having been shown in a non-architectural magazine of the era, somewhat subverts the idea of the architect being the custodian of this new typology of building. The true custodian are in fact the people, the Manhattanites where *"...there exists a subterranean collective dialogue about the new form from which the official architect is excluded"* (pg.85). Therefore some of the initial Manhattan ideas about what the skyscraper of the future would be was not an architectural project, nor a developer's requirement, but rather a potential for a new type of urbanism. This new urbanism was three dimensional in nature, where even the caption accompanying the initial diagram sells that land according to its vertical proximity to the street below. This is perhaps the first example of a truly Manhattan type of vertical housing proposal; one that is completely void of architecture and architects themselves. Koolhaas calls this new typology *unknown urbanism* where the potential for unlimited unknown futures is possible and where the *"1909 Skyscraper holds out the promise that all this business is only a phase, a provisional occupation that anticipates the Skyscraper's conquest by other forms of culture, floor by floor if necessary."* (pg.87). Within the same decade as the 1909 Skyscraper concept, several buildings following the same logic of vertical multiplication are constructed. Koolhaas notes that by 1910 *"...the only area not occupied by enormous buildings in Lower Manhattan would be the streets."* (pg.89), and that they are all designed seemingly with no architectural input or discourse, simply as vertical extrusions of the site repeated floor by floor to their maximum potential. However, unlike the 1909 Skyscraper, these are entirely housed within a single building, with a differentiated interior and exterior. The Flatiron Building is an early example of this, as are many others, that conceals a number of different functions behind an ornamental facade. The separation of the interior program and the exterior concealer.

Koolhaas introduces the concept of architectural *Lobotomy* to explain this disconnect between the program and the facade. He argues that in western architecture up to this point, the interior spaces

and the exterior envelope had a mutual relationship, where an *honest* facade would speak about what was occurring on the inside, and vice-versa. Manhattan's skyscrapers of the era, due to the fact that the ratio of cubed increments increase of internal volume to the squared increments of the external facade, cause a *break* between what is shown externally and what is housed within. Architectural lobotomy to him is precisely this disconnect, the idea of the facade not being a representation of what it holds within but rather that *"it hides everyday life."* Fundamentally the position Koolhaas holds in his argument, that the separation of the inside and outside, or the skull and the brain if you will in the lobotomy analogy, also divides the role of the architect between interior designer and 'exterior designer'.

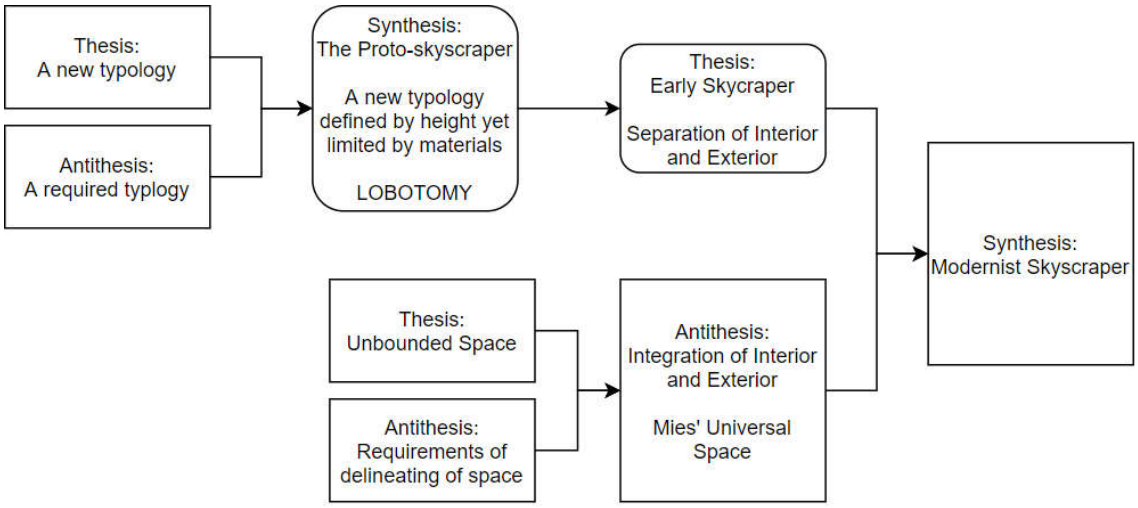
Since skyscrapers from their initial built form do not have a singular origin, that is to say if the predecessor to the theatre or stadium typology was the Roman colosseum, or that to a detached dwelling the predecessor was a nomadic hut, then the skyscraper does not have a direct ancestor. In the book Residential Tower (Gigon, Guyer, & Jerusalem, 2016) the editors allude to medieval Italian towers in the city of San Gimignano being one of the original typologies for high-rise living, however their existence was directly linked to the need for city defence. They were above all else used as a type of secondary fortification within the city walls, separating the peasantry within the walls from the nobility within the towers. These medieval towers were more akin to an extension of the city walls then a true dwelling typology. With no direct ancestor Manhattan's towers were therefore a new typology onto themselves, and were 'free' to adopt this visual separation between the inside and out. The first truly modern skyscrapers were indeed as Koolhaas describes them, lobotomised.

Some of the first Manhattan planning restrictions were introduced as the 1916 Zoning Law, which unlike the Chicago zoning laws of the era which had a prescribed maximum building height, were more complex allowing for a maximum site extrusion to a certain height followed by an unlimited height for a quarter of the sites surface area (pg.107). This law therefore not only limited the volume of the potential for high-rise development, but also directly influenced the design of the typology.

The motivation between this law was fundamentally designed to allow better external amenity to the city and observed that "(i)t became increasingly evident that the large project was a concern not only of an individual, but of the community, and that some form of restriction must be adopted…" (pg.107) After the Grid, perhaps this setback zoning law was the other most important planning influence on the now iconographic stepped architectural aesthetic of the Manhattan skyscraper, and by extension introduced the first examples of the podium-tower typology globally.

If the Grid forced the developers hand to build vertically, and the elevator allowed for this development to flourish then the Zoning Law was the first non-technological limitation to the Manhattan skyscraper. What resulted was a push by the building owners to maximise every possible inch of area of the newly mandated envelope.

2.2.1 Analysis of Evolution of the Type - From proto to modern Skyscrapers, and beyond



The world is becoming more globalized and urbanized. More people live in cities than in the countryside for the first time ever, and with this the rate of people living in apartments in increasing at over 300% compared to traditional housing. It is the claim of this paper that within the sphere of apartment construction capitalist globalization has been profoundly successful in globalizing economic, ecological and cultural modes of operation – and asks whether this success has

marginalized traditional culturally specific means of dwelling. The basis of analysis focuses on perhaps the most globalized and technologically advanced residential typology, the residential apartment complex, in its most extreme form, the *supertall* residential tower. By focusing on the interplay of technological advancement and the proliferation of global capital this paper will provide a novel

Much conjecture exists in architectural discourse relating to which building was the first proto-skyscraper, how to define what made them unique compared to other buildings of comparable height and which city gave provided them with their genesis. What is clear however is that proto-skyscrapers emerged in the United States at the turn of the 20th century – in either Manhattan or Chicago. The architect Rem Koolhaas has argued that the conceptual backdrop to the emergence of what was to become the skyscraper began in Coney Island, New York with faux-lighthouses of the early Luna Parks which were placemakers for a nation, and indeed for the whole New World, as competition to the established European cities such as London and Venice. He argues that, in a type of inversion of architectural existentialism, essence preceded existence and thus the yearning for building objects of great height preceded their technical possibility. Only later did these possibilities become available through invention, namely the Otis lift invented in 1852 and the air-conditioning unit first invented as a gimmick to make festival goers attend a "Switzerland" exhibit in the Coney Island Luna Park (Koolhaas, 1978), which fundamentally changed the desirability of living at height. No longer did the arduous drudge up floors condemn the upper levels of buildings, like had been the case in older European cities, to lower desirability but catapulted them to the highest echelons of attractiveness by providing early skyscrapers with uninterrupted views. Other historians focused less on the ephemeral, conceptual underpinnings of skyscrapers to proclaim that indeed it was Chicago that produced the first proto-skyscraper. In a cataclysmic event, the great Chicago fire of 1871 provided a type of tabula rasa to a city about to undergo profound change. The dual shock to Chicagoans of the era was that architecture had to change to accommodate an unprecedented influx of population from other regions, both within the United States and from abroad, whilst ensuring

that shanty towns which had burned so easily were replaced by regulated contemporary buildings. From 1870 to 1900 Chicago grew from a town of less than 300,000 persons to nearly 1.7million – and with the wealth that this increase in populace brought the rise of the first skyscrapers which combined two important attributes needed for the era, a) resilience, in the case of Chicago against the imminent threat of another fire and b) rising land prices due to population growth. Thus the first constructed skyscraper is often attributed to the Home Insurance Building (1884-1931) which at the time stood at an imposing ten stories and beyond adhering to stricter regulations also utilized a non-loadbearing outer skin – a pre-cursor to all skyscrapers of the future. Moreover, an often-overlooked fact is that the programme of the building, as insurance company headquarters which possessed huge amounts of papers relating to deeds of ownership of ever expanding land acquisition in the area provided the need for a vertical storage solution in a growing metropolis.

It is not the object of this paper to solve the question of which preceded which, the idealised want of the people of the era to stamp their place on the then global map or a more pragmatic necessity of everchanging material circumstances, but rather to posit a symbiotic relationship reading between designers and technologists, architects and inventors, wants and needs in the ever shifting interplay of the typology of skyscrapers. This interplay can perhaps best be illustrated through the stylistic changes that early skyscrapers which mirrored society at large. Architects followed trends of other building typologies endowing an incredible variety to early-skyscrapers – such as the neo-Gothic commercial towers of downtown Chicago, the slender art-deco spire of Manhattan's Chrysler building or the Renaissance-revival Flatiron building overlooking Broadway. Koolhaas described this phenomenon as 'lobotomisation' of the typology, a profound disconnect between the exteriority and the projection of the building with its interiority. Perhaps aptly the idea of the curtain-wall which intended to signal the hanging structural properties of these facades also functioned to hide the emptiness, both literal and metaphorical, behind the curtains.

As important as the rise of the early skyscrapers on the contemporary 21st century skyscraper is the paradigm shift that occurred in Chicago in mid 20th century and the arrival of modernism and in turn the international style. The post war period, much like several other epochs in America which experienced mass immigration, brought new ways of thinking about, how contemporary society should live and dwell. At the avant garde of this cultural shift was the architect Mies van der Rohe and his work stemming from the German Bauhaus movement. In order to illustrate the aforementioned paradigm shift this essay will focus on Mies' own 860-880 Lake Shore Drive apartments[6] (1949) and the subsequently constructed Lake Point Tower (1968) by Mies' students and colleagues John Heinrich and George Schipporeit who were highly respected Chicagoan architects in their own right.

Although not the first apartment building designed by Mies van der Rohe in Chicago, the Lake Shore Drive apartments are the first buildings constructed by the master in his now famous "less is more" modernist style – focusing on the interplay of glass and steel absent of any decoration. It has been called both the beginning of the architect's American odyssey, and the final result of a revolutionary evolution within architecture of the façade, interior spaces and spatial arrangement (Neumann, 2015). The building was to become a physical representation of Mies' and the modernist movement's philosophy of the era. The three key aspects which remained unchallenged I their purity were what was to become the three defining elements of all subsequent glass residential towers. Namely, a) the use of glass as the primary material in the two façade modules on the entire shaft (Mies van der Rohe & Puente, 2008, p. 13), only interrupted where required by metal mullions, transoms and spandrels (佐野潤一, 2000); b) highly open internal planning with little to no internal

[6] It is important to note that in the American real-estate jargon the difference between apartments and condominiums is fundamentally in the ownership structure. Apartments in an apartment building generally denote a single building owner leasing single apartment to tenants. Condominiums, or condos, are also apartments in the sense that they occupy an apartment building, however, are owned privately as single units. Lake Shore Drive Apartments are neither, but rather a function as a cooperative trust. A complete understanding of the building ownership structure can found at: http://860880lakeshoredrive.com/ownership-structure/

structural elements interrupting the flexible interior spaces; and c) the acontextuality of the building to the environment surrounding it. The dogmatism of Mies van der Rohe's design ethos within this building became somewhat folkloric in its purity, with early residents complaining to the architect about the heat experienced inside the sun facing apartments in summer and the freezing conditions in winter due to the architects unwillingness to break the aesthetic symmetry of the façade with the introduction of air-conditioning units and addition of sun-shading beyond the uniform grey curtains on the inside face of the window frames (Roth, 2001). The interior planning, or lack thereof, is also as legendary as the initial concepts of the apartments were of spaces entirely devoid partitioning walls – even between the bathrooms and the living spaces. In perhaps the first critique of the burgeoning modernist movement, these spaces were not universally adopted as pleasant to live in at the time, with critics referring to them as unlivable glass cubes and vertical glasshouses (Gordon, 1953). Much of this criticism stemmed from the protracted legal battle Mies had with the owners of one his previous works, the iconic Farnsworth House (constructed from 1945-1951) which famously also became unlivable during the summer months, albeit for a very different reason to Lake Shore Drive apartments – the fact that the architect refused to install mosquito nets on the property, which was situated in a forest outside of humid Chicago (Vandenberg, 2003, p. 15). Although not fully realized in this project, Mies' idea of 'universal space' (Randall & Randall, 1999, p. 40), obvious in several of his other smaller built and unbuilt works, also sets the blueprint for many subsequent buildings and is the precursor for the contemporary 'open plan living'. Mies himself articulated universal space through the power inherent in glass, which can delineate space without obstructing it. He called this the *"space topping"* power of glass, steel and concrete (van der Rohe, 1986 in Neuman, 2015). However, universal space extended beyond the confines of single units and allowed

for the potential for consolidation of several apartments into single units, and several units have subsequently been amalgamated to double in size[7].

2.2.2 Heidegger and Mies': Comparative analysis of the idea of dwelling

This essay presents an investigation of Ludwig Mies van der Rohe's unbuilt Resor House project, the ways in which that project informed his later residential highrise projects, as an alternative position against that of Martin Heidegger's thoughts, concepts and fears related to dwelling and technology in the time of modernity. That theme could be approached in two ways, starting from an analysis of Mies' architecture and reaching out, towards broader frameworks of thinking, or conversely, from historical and philosophical contexts down, towards concrete acts of making. Our decision to start with Heideggerian philosophy was in order to stress the importance of a dramatic moment in history which made Mies and Heidegger simultaneously face a fork in the road of their lives and work - where they chose diametrically opposite ways. In order to explain the synergies between the two great thinkers of XX c. as expressed in the media of philosophy (thinking) and architecture (making), we will first introduce and then juxtapose their core ideas. Firstly, we will introduce Heidegger's work on the concept of mankind's dwelling in nature and expand on what is meant by the idea of building within his philosophical world. His ideas will be illustrated through his own idyllic cottage in Southern Germany's Black Forest, where the philosopher used to retreat in order to think. Then, we will proceed to his critique of modernity, technology and the means of production of objects. The synthesis of these two key concepts within Heidegger's phenomenological corpus will establish a basis for the analysis of specific architectural projects. To concretize Heidegger's concepts in the first two sections, the work of his contemporary and countryman the architect Ludwig Mies van der Rohe will be introduced. A direct response to Heidegger's famous metaphor of bridge building and the cottage in the countryside will be elucidated within Mies' early architectural theory (as defined upon his arrival to the United

[7] The website www.860880lakeshoredrive.com which is run by the 860-880 Lake Shore Drive apartments co-operative provides a wonderful database of not only the original design intent of the architect, but also current real-estate listings, resident stories, innovations adopted post-construction and a gallery of the apartments in their original and current state.

States) and followed in his later built work in the form of mid-20th century skyscraper designs in Chicago, Illinois. The basis of this comparison is structured upon not only the objective differences between the two buildings, but also upon their choice at that fork on the road, their divergent responses to Nazism and thinking about the future.

German philosopher Martin Heidegger opens his seminal work on the nature of domesticity in *Building, Dwelling, Thinking* (public as a part of the book *Poetry, Language, Thought*, (1971) with two simple questions: what is it to dwell, and how does the building belong to dwelling? From the very beginning, the question he raises relates to the building/dwelling relationship: does a building guarantee dwelling and, vice versa, does dwelling demand a building[8]? He indeed concludes that dwelling requires building (in the form of structure), yet with a caveat that 'only if we are capable of dwelling, only then can we build'. Although seemingly paradoxical in turn of phrase, Heidegger there provides a fundamental stepping stone from which we can analyze dwelling within a building. A requirement to *capability* to dwell needs to be established first, that for the commencement of dwelling. The question is: hat is that capability in the contemporary sense?

For Heidegger, this capability to dwell is a type of demarcation by a subject upon land, which precisely through this human intervention becomes a place. However, not all building is dwelling. There indeed are buildings, such as 'bridges and hangars, stadiums and power stations' which are buildings but do not allow for dwelling. Etymologically Heidegger draws upon the root word of *building*, relating it to Old English and High German *bauen*, which meant *to dwell*. Thus, historically, building indeed was dwelling, but the original meaning has been lost. Buildings that are *not* dwellings, for Heidegger, take a secondary role to buildings that *are* dwellings, insofar as that they only exist as a result of mankind's dwelling upon land. Heidegger provides us with a direct example of a bridge. He claims that two banks of a river only emerge as banks once a bridge spans the

[8] And furthermore, he raises this specific question through the rubric of housing shortages of his era which, interestingly, albeit in a slightly different mode, are a fundamental anxiety which frames the question of vertical urbanism in the contemporary epoch.

stream; that only through the building of the bridge do the two banks emerge as places and not simply any two pieces of non-descript land. Only through the bridge building do the banks become neighbouring banks of the river. The bridge is also never simply an objective thing. For example, a stacking of rocks and grout of a certain width and height but is firstly symbolical insofar that it is a connection between two predetermined, and only actualized through the building of the bridge itself. However both the symbolic and the objective must be actualized for the bridge to be a bridge, for the building to be built and for the building to be a dwelling. To be overly simplistic but useful here, we could say that the only reason that a bridge exists between two banks of a river is because of mankind's ability to dwell and thus have a need to cross the river from one dwelling to another in a specific location.

Dwelling to Heidegger is always related to a specific place which derives its specificity from the cultural context of its location. In its objective form, to Heidegger, the physical place of dwelling must be steeped in not only local materials but built through traditional means of production of that specific locus. Thus, any place of dwelling is fundamentally *rooted* within not only the physical environment, but also within the traditions of the place. The idea of rootedness, as the antithesis of *uprootedness*, to Heidegger can be observed in his own cottage in Todtnauberg in the *Schwarzwald*. That simple hut was financed by a young Heidegger in 1922, as a place of retreat in the location where he formulated much of his latter thought which will be explored within this essay (Sharr & Unwin, 2001). Within this context, retreat can be understood both as literal withdrawal to the countryside and a metaphorical retreat from his own flirtations with National Socialism and his eventual disillusionment with modernism and technology[9]. Sharr in his thesis *Heidegger's Hut* (2006) observes that to the philosopher the agrarian countryside was more than a simple escape from

[9] Much has been written about Nazism and Heidegger (and indeed Mies van der Rohe and Nazism), but this dark period falls well outside the bounds of this research. An excellent resource for understanding both men's link to National Socialism can be found in *Building, Thinking, and Politics: Mies, Heidegger, and the Nazis* (Snyder, 1993) and an alternative account that paints Mies in much more favourable lighting (Dyckhoff, 2002).

suburban life into the wilderness, but a fundamental change in his own approach to thinking/dwelling. It suffices to say that to Heidegger *dwelling* was inherently tied to a type of *völkisch* interpretation of true living. This idea is in stark contrast to his interpretation of *technicity*.

Pertinently, Heidegger also provides us with a second mode of understanding of the building/dwelling concept via his essay on technology, and where he conceptualizes *technicity* or the *essence* of technology (Heidegger, 1977, pp. 3-36)[10]. Heidegger does not think of the essence of technology as *technical*. No, the essence of technology, or *technicity*, is its ability to reveal nature to humans through *Enframing*. What is meant by the term *Revealing* within the context of technicity is founded on the principle that through modern technology the earth itself stops being viewed by humans as, for example, in the case of the pre-modern farmer something to sustain his crops and *vis à vis* provides him and his family with nourishment and perhaps earning through sales at markets, to the contemporary view of land being something to be exploited for its natural minerals. Heidegger does not see *Revealing* as something within the human, but rather that the earth itself changes through its perception as a resource. Thus, within the Heideggerian lexicon, nature is *Enframed* through technicity as something to be exploited. Nature reveals itself to humans via technology as something external to be mastered which, fundamentally, uproots the human from the Earth. The logic which Heidegger uses to justify his conclusions rests upon the Aristotelean ideas of causation[11].Heidegger explains the causal sequence as *occasioning* and, most importantly, introduces the concept of *revealing.* To give a banal, yet useful example, which is perhaps easier to grasp than the tedious original silver chalice analogy, could be a simple tea cup. The material cause there is the porcelain of the cup. The formal cause is the physical shape of the cup. The final cause is the cup's ability to hold liquid. And, ultimately, the efficient cause is the maker of the cup himself. That is where Heidegger makes one of his major contributions – the concept of *concealment*. What

[10] It should be noted here that *essence* in Heidegger's writing has a direct lineage with Aristotelean ontological realist ideas that claim that these objects have their essences, or something primary at their core.
[11] For a basic understanding of these concepts refer to *Aristotle on Causality* in Stanford Encyclopedia of Philosophy (Falcon, 2015)

he would now claim is that the cup is brought out of concealment, into unconcealment via the application of the four causes. Heidegger triumphantly claims that the essence of technology has everything to do with revealing, as all productive manufacturing lies exactly there.

To Heidegger, modern technology is not a successive iteration of pre-modern technology, but rather something entirely different. As he sees it, pre-modern technology was perhaps based on cultural developments and successive minor changes and adjustments over time, with an aim to produce better tools. Essentially, as explained earlier, over time a simple rock became a hammer and so on, whilst modern technology relies on modern physics, modern apparatus and the building of these apparatuses. Former was based on trial-and-error practices, whilst the latter builds upon the increase in precision through science; the former advances through what Heidegger calls *poetry*, and the latter through *bringing forth* or *ordering*. The explanation for this specificity is framed as technicity *challenging* a piece of land to be seen as a mineral deposit, whilst previously it would have been seen as something to be maintained by a peasant. This point is key for understanding the rest of this paper.. To further elucidate this point, Heidegger compares the hydroelectric plant on the Rheine to a wooden bridge. While the former reveals the Rhine as dammed up energy, the latter does that through poetry. Lastly on this point, Heidegger introduces the concept of *standing reserve* where, using the example of coal. The coal itself is not necessarily burned to produce heat where it is mined, but is rather stored, transported and, most importantly, to be *ordered*, to be available as *standing reserve*. Thus the River Rhine, via the turbines in the dam, becomes the sortable quantity of energy to be transferred elsewhere and lose all connectedness with the poetic River Rhine; thus the River Rhine is *Enframed* as an energy source to be sorted and ready at hand for use. As a result, it gets entirely uprooted from its place.

Thus, Heidegger claims that the essence of technology is *Enframing*, and that *Enframing* reveals nature as standing-reserve and loses its objectivity and placement within the world. The warning that emerges out of this points that if the human related through nature only through the

technological revealing of nature as standing-reserve, and the human is only the ordered of this objectless standing-reserve, then the human itself could become a part of the standing-reserve; as human is of course a part of nature. Therein lies the crux of Heidegger's thinking on technology: human faith gazed at through the revealing of technology shows humans to be nothing more than then energy to be ordered and stored in standing-reserve.

Martin Heidegger wrote this essay in 1954, concerned with thoroughly contemporary issues of that era. The text was penned down in the shadows of the world wars, with a rapidly changing Western world that began to question the core principles of modernity. Throughout the essay Heidegger refers to a loss of a certain characteristics of Germany to the steady march of technological progress; be it the subjugation of the Rhine to mankind's biding, or the changing landscape of Schwarzwald. To link the two concepts, Heidegger sees the steady progress of industrial society[12] as an *Enframing* of nature in the form of the capacity to produce energy and leads to a loss of *poesis* or craftsmanship.

In order to link the first sections of this paper which summarize and problematize Heidegger's work on dwelling, building and modern technology, we will return to his analogy of the bridge, which can also be applied to his understanding of his own hut in the Black Forest. As elaborated in comparative analysis of those two essays, to Heidegger dwelling is intrinsically linked to groundedness. He has shown that only through dwelling, building is possible. Fundamentally to this idea, as building requires dwelling it also requires a space, such as a location next to the creek for a bridge to be built. This space, through mankind's ability to dwell and thus to build, becomes a place. To use terminology as defined in Heidegger's essay on technology, the river only reveals itself as a space to build a bridge via *poesis* (in the sense of craftsmanship). Thus, to provide a comprehensive

[12] Here it is important to differentiate the ideas of 'modernism' and 'postmodernism' within the contexts of architecture, social sciences and philosophy. I will refer to 'modernism' and 'postmodernism' strictly in the architectural sense aware that, in the case of social sciences, the corresponding terms are 'industrial society' and 'postindustrial society', while in philosophy the same ideas would be referred to as 'structuralist' and 'poststructuralist' (Smith, 1991, p. 371)

understanding of the bridge in tune with phenomenology of Heidegger's thinking, one should approach the concept step-by-step:

1) the bridge (building) only exists due to the mankind's ability to dwell (dwelling),

2) the river reveals itself as a potential for building (bridge) through craftsmanship (*poesis*), and

3) space (nondescript land) only becomes place (specific banks of a specific river) with both the symbolic and objective possibility of bridge (building) being actualized.

Heidegger's critique of technology within the context of this research focuses on mankind's inability to dwell; and by this inability to dwell manifests itself in the process of building without poesis, or craftsmanship. Therein lies a major component of Heidegger's work that will be explored further in the following section relating to the architectural process of building.

The philosophical underpinnings of Mies van der Rohe's architectural work can be compared to Heidegger's disillusionment with the prevailing ideology of his era. While Heidegger's hut was commissioned in 1922, the Resor house, the first of Mies' foreign commissions, was conceptualized in the pre-War 1937. While Heidegger's hut, as a physical manifestation of his own though and apprehension of modernity, was a retreat to agrarian typologies, Mies' Resor House was a radical integration of the exact *technicity* Heidegger so feared. Due to Mies' leftist leanings (Champan, 2017), his response to dwelling was an antithesis to that of Heidegger. Freed (or deprived) from context and (his own) cultural baggage, in America, Mies perpetually sought universalist, libertarian expression - as best understood in the concept of the *'international style'*. In architectural terms, *Enframing* is a technique used by Mies van der Rohe, among others of his contemporaries, in many of his projects. Capturing the particular view of nature, or the outside, turning architectural interior outwards, was achieved through window *frames*, which quite literally enframe the outside from the privileged inside. Mies' first use of this technique dates back to the unbuilt Resor House project, that was a rural Wisconsin property, where he proposed a modernist extension to two preexisting

structures which sat at two opposite sides of a narrow creek on Snake River Ranch. The house was commissioned in 1937, and was to be the first of the architect's projects in America. Although it was never completed, Resor House provides architects with a truly unique insight into the Mies' understanding of the relationship between inside and outside spaces, as conceived in his post-German period (Goto, 2011; Kim, Jeon, & Kim, 2018; Levine, 1998). Luckily, this is also one of his most meticulously documented unbuilt projects and thus open to detailed investigations.

The initial design was conceived as clad in locally sourced fieldstone on the lower floors and cypress pine on the upper floor. If developed, that would have been the first and only use of cladding in one of Mies van der Rohe's buildings. Two separate structures at ground level were envisioned as garage and entrance in the east section, and several domestic rooms in the west, whilst the upper floors were divided into sleeping quarters in the east, domestic food preparation in the west, and the focus area of this research - the central, glazed living area.

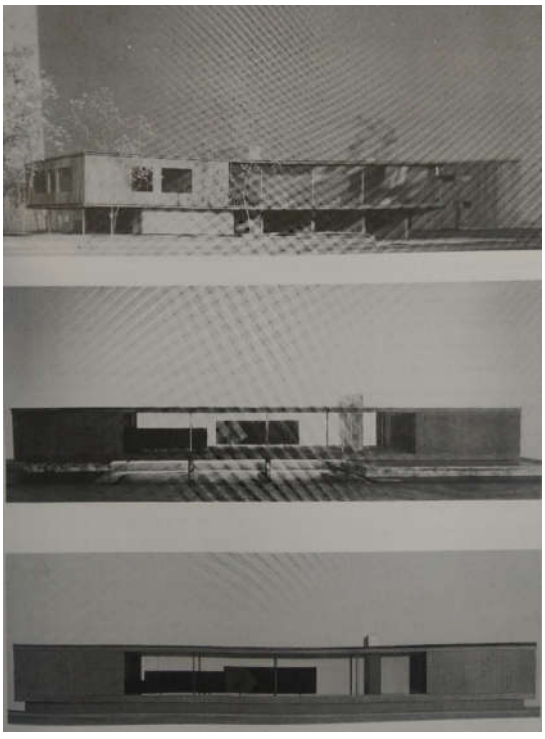


Figure 3 - Resor House project (1937-41, unbuilt) physical models, Jackson Hole, Wyoming (Initial proposal, reduced scope proposal, final unbuilt proposal) Source: (Mies van der Rohe, Drexler, Schulze, & Mies van der Rohe Archive., 1986, pp. 5,)

Mies van der Rohe's Resor House can be seen as the perfect manifestation of Heidegger's thoughts, concepts and fears. Two separate structures sit on the two sides of a small creek, precisely as per his

analogy in the essay on dwelling. They are only made into 'neighbouring' banks of a river with the construction of a bridge. These pre-existing structures were already present on the site prior to Mies' proposed intervention, were placed there as a beginning to another architect's unfinished vision. Partially due to financial concerns the owners of the Resor site required Mies' to incorporate them into his own design which he, at first begrudgingly and later enthusiastically, accepted. The above photograph of three physical models which Mies' on separate occasions presented to the owners in 1937-41 show design process, progress from a purely theoretical design unto a pragmatic, austere, contextless and ultimately compromised final reality.

The initial model (Figure 3) shows a two-level structure straddling the creek and providing the types of views identical to those which Mies explored in his contemporary collages. The central model (Fig.1, middle) is much more austere than the original. The building continues to span the creek, albeit in reduced height. Finally, the third model (Fig.1, bottom) shows a minimalist, container-like single-storey structure no longer sitting atop the creek, but rather laying on a pedestal, entirely devoid of the context (Mies van der Rohe et al., 1986). The initial design, conceived as a two-floor structure bridging the small stream, differed from both stages that followed in two significant ways: firstly, the building was intended to use timber as structure (which would have made it the only Mies' building built out of the natural materials) and the major glazed living room would have provided a higher vantage point for the occupants. The second, scaled down version, reimagines the building as a sleek single level rectangle, sitting on a podium which spans the creek. The result is a much 'heavier', horizontal building which barely allows for any clearance from the water surface. Lastly, it's final iteration decontextualizes the now container-like volume, places it on a podium, presumably on the flat ground further away from the steam. On the basis of the thought process captured in these three models of Resor House, we can hypothesize that in this project Mies van der Rohe appropriated the practice of (en)framing and, by making it his own made the evolution towards his trademark minimalist but profoundly rich interiors with panoramic view possible.

Figure 4 - Resor House project (unbuilt), Jackson Hole, Wyoming (Interior perspective of living room) [view through north glass wall], 1937-1941. Source: (3800.809, Mies van der Rohe et al., 1986)

Figure 5 - Resor House project (unbuilt), Jackson Hole, Wyoming (Perspective and view of site from interior), 1937-1938. Source: (3800.808, Mies van der Rohe et al., 1986)

The perspective (Figure 4) which Mies used in his graphical/architectural explorations of (en)framing is taken from a hypothetical point in the centre of the living room, which straddles the creek. Instead of providing what could be seen as a realistic view, Mies opts for abstraction, extending the space into depth, as the compositional verticality of columns and window mullions would imply, provides a 'depthless void' (Levine, 1998, p. 79). The horizontality of the overall frame is divided into five sections which invert the background/foreground relationship by dematerializing the interior of which the viewer is a part, and radically reinterprets the exterior. The perceived subject of the composition is the outside whilst the objective interior is posited as a negative space, a mere delineation and capturing of the unknown. The interior, thus, provides a sense of shelter, or

dwelling, through subjugation of the inside to the sublime outside while, at the same time, providing a sense of freedom (Tegethoff et al, 1985).

What is intriguing here is the treatment of interior architectural space by Mies. The thoroughly modernist sleek, cruciform, steel, slender and, most importantly, manufactured columns dematerialize to an almost complete non-existence against the monumentality of the landscape. Here Heidegger's *poiesis* is non-existent, in more ways than one way. The artisan's or the craftsman's handwork, had it even existed in the alienated form of the manufactured column or mullion, is reduced to composition. While dwelling, as described earlier in the essay, should be understood as rootedness of mankind in their surroundings, Mies' example radically uproots the observer. Heidegger sees the 'world as picture' as a thoroughly modern concept. The modern age, as exemplified by the Mies' collage (Fig. 2), is of the 'Age of World Picture', where everything indeed is an object grounded by a subject (Heidegger & Grene, 1976, p. 350).

What was important in the above analysis is to understand the theoretical shift of the perspectival collage in Resor House. Mies, through his architectural models, establishes a 'sacred' view from the central position in the living room, which depicts the nature of the context as described by Heidegger. Initially, through the utilization of local wood, he attempts to link modernism back to *poiesis* or craftsmanship, while preserving the specific location between the two banks. By the time he has reached the final resolution, the building has become entirely technological. That is further stressed by removal of the building from the creek and placing upon a nondescript podium, a major move done without the alteration of the perspective collages. The *Enframing* of nature changes from one of curating the external to the observer to one of a background to a space.

To surmise, the evolution of Resor House exemplifies a trajectory of rigorous (architectural) thinking, which has unfolded in three specific design steps and was captured in three physical models provided (Figure 3:

1. The initial design consisted of a two level structure, envisioned to be materialized in locally sourced products and, one assumes, detailed and constructed by artisanal labour. The living room, with its large sheets of glass, stood proudly above the water, as the only element of visual connection. For a view from the interior outwards, a sublime sight was promised (Figures 2 & 3)
2. The second design reduces the height of the volume, dropping a level and raising above the water level by only few hundred centimeters.
3. Lastly, the final design, radically departs from the previous two models. One assumes that this version was designed for use of mass produced materials. The location of the structure becomes entirely arbitrary, with its actual context undisclosed. Yet, what remains – and thus captures the essence of the project - is the picturesque setting of the living room.
4. Therefore the only context that remains through is the long distance view into nature.

Mies' notion of placeless dwelling which he, as we are suggesting here, might have discovered while seeking how to make the Resor House fit the ever-diminishing budget, is further explored in his later, built works, most notably via the apartment buildings of Chicago. As argued above, if the final design of Resor House focused on placeless dwelling, then his move towards residential skyscraper design marks the culmination of this same thought process. Dwelling in skyscraper apartments is, by definition, displaced and decontextualized. Modernist skyscrapers, pioneered by Mies, are not only displaced from the land, by the virtue of their skywardness. They are thoroughly technological through their peculiar production process. One might as to what extent these apartments are indeed still dwellings at all?

Here we claim that the roots of some of the key aspects of modernist apartments can be found in the latter form of Resor House, in its up-rootedness from the context, while strongly referenced to radical rethinking of the contemporary Heideggerian idea of dwelling. Due to reality of having neighbours on all sides, within the overall form of the skyscraper the dwelling gets reduced to the glass box - of the Resor House type. The specific and particular landscape and scenery of Wyoming is now replaced by that of a non-descript metropolis; simply through the photo montage-like framing of actual views.

Figure 6 - Mies' sketch of the interior of a Lake Shore Drive apartment[13]

Mies continued to use collages as exterior scenes in his work on his first multi-residential skyscraper, Lake Shore Drive apartments, his second multi-residential skyscraper in Chicago and, perhaps, the first ever radically modernist residential skyscraper. Here we find the highly stylised Resor House perspective reimagined. A two-point perspective is introduced, along with furnishings, detailed articulation of not only the tectonic elements of the columns and mullions, but the ebbs and flows of the curtains, a particularly non-rectilinear plant in the corner and, of course, the seminal Barcelona chairs. The outside is treated differently as well. The sublimeness of the natural world is replaced with a rather believable introduction of a Chicago skyline. The structure of the image is such that the foreground is truly in the foreground, the background in the background and the architectural middle-ground rather than framing views almost shily attempts to not impose itself. The realm of the subject, the interior, is a place from where to enjoy the view, perhaps even to master it. To use Heideggerian imagery, the framing of the nature is now a furnishing of the interior space; merely a picture to be appreciated. The only objects within the composition are furnishings; chairs, tables, stools, plants and of course the skyscrapers of Chicago, which too became a decoration. There are no traces of inhabitation, of dwelling, life. Mies' architecture of 'less is more' applies to the object.

[13] Refer to Architecture Forum magazine ("Modernization", 1950, p. 76) where the collage was first published under the headline: *"The all-steel and glass tower, the crystal cage for humans"*.

Everything else that is ‘more’, and it becomes the toy for the also generic occupant. Perhaps, if one gets tires of the view, (s)he can simply draw the curtain.

One could argue that architectural career of Ludwig Mies van der Rohe started twice, once in his native Germany and then again, in exile in the United States of America. Becoming world-known for his stark minimalism and perfection of execution. His first project in the US could be seen as the moment of crossing the threshold between those two lives of one architect, leaving one universe of ideas and entering another. With his architecture mimicking his own uprootedness (in both the physical sense of expatriating across the Atlantic as well as a moral sense of rejecting what Germany had become in the 1930’s), Mies van der Rohe’s American journey began with a ‘failure’, the inability to build the Resor House. His triumph only came with the acceptance and dedication to uprootedness as a form of dwelling; that of the modernist apartment.

Through his way of living and thinking, that with the advent of modernity, at the height and collapse of Nazi Germany, Martin Heidegger chose his rural retreat; a place of history and a place where time itself changes backwards, from the ticking of the industrial clock to the cycles of nature (Sharr, 2006). He thought that mankind was doomed to uprootedness, placelessness. To him, without place mankind could not dwell and, in a sense, without dwelling even mankind itself was to become a product of technology, something to be organized, reorganized and placed in the realm of the standing reserve. On the other hand, Mies van der Rohe, facing his own upheaval during the Nazi period, losing the intellectual haven of Bauhaus and commissions in his homeland, was forced to emigrate to America. At that exact point, where the philosopher retreated to the primitive hut, Mies discarded his homeland and approached his forced exile as a moment to embrace universality. If dwelling to Heidegger was culturally defined, to Mies the cultural became universal and global. The simple hut was literally placed within its context and surrounded by it. Within the architecture of Mies the context gets enframed as a part of the interior, like a painting on the wall, meticulously crafted for a privileged view. Ultimately Heidegger was secluded in nature far from the idea of the city, technology and allowed to be free in

thought. Mies' architecture was mastering nature, making it a part of the artificial interior irrespective, regardless if that nature was a mountain stream or as yet unbuilt planes of Chicago.

2.2.3 Hegelian dialectical method and Mies': "Universal Space"

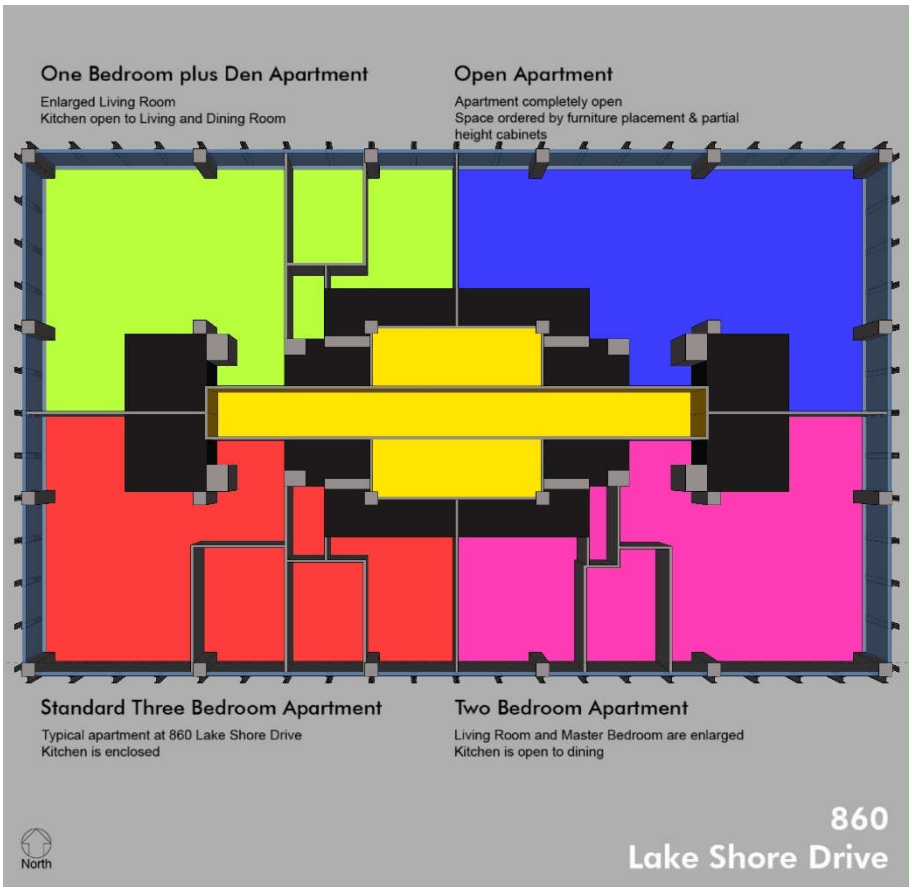


Figure 7 - 860-880 Lake Shore Drive Apartments typical apartment layouts as understanding of 'universal space'

Each floor in 860 Lake Shore Drive apartments is divided into symmetrical quadrants. The footprint of each apartment in each quadrant does not change, nor does the location of the wet cupboards and electrical cupboards and therefore subsequently the bathrooms and kitchens retain their precise location from top to bottom of the building. There are nominally four options possible through arrangement of interior walls with the three-bedroom apartment (lower left quadrant) being the original built design. The other options possible, aside from consolidation of apartments, are two two-bedroom options which differ in the execution of the kitchen arrangement and a one-bedroom apartment (top-right quadrant) which is perhaps most closely resembling Mies's Universal space concept, which has been described as functional homogeneity (Haraguchi, 1989, as cited in

Yim, 1996). In 880 Lake Shore Drive apartments, 860's perpendicular sister building, the rationalization of the floorplate is into eights or more precisely four apartments per length. If unconsolidated each apartment in 880 is therefore a one-bedroom apartment.

The one-bedroom apartment in 860 offers an uninterrupted space from external façade to neighboring apartment wall with only a tall shelving unit separating the belly of the living room with the semi-private bedroom area. It is this thoroughly modernist re-envisioning of living that drew the ire of many contemporaries and subsequently provided the blue-print for much of today's architectural inertia relating to open-space living. But, much like much else in this seminal building the idea of universal space is absolute in in theoretical underpinning – that is to say that when the goal is complete uninterrupted free area the only alteration to this concept is addition. If we take the idea of *universality* inherent in notion of universal space to the Platonic idea of theory of forms. To Plato, ideal forms exist outside the human realm, the outward form, and therefore only *appear* to us as objects (see Kraut, 2017, Section 1: Plato's central doctrines). In the same way Mies' universal space exists bifurcated outside of the human realm and once it enters physical space it is fundamentally no longer essentially perfect but enters the human world of appearances. Other scholars have approached Mies' architecture through the prism of Hegelian Philosophy of Spirit and Dialectic remarking that 'For the first time in aesthetic theory, the space within, enclosed by an architectural boundary, was recognised and identified as the necessary content. Space within, made visible by concrete form, became the embodiment of Spirit' (van de Ven, 1980, p. 73). The notion of Spirit in Hegelian philosophy reaches far beyond the scope of this writing; however, it is important to note that the idea of *zeitgeist* (translated from German as spirit-of-the-time) is fundamental to understanding Mies' modernist work. The zeitgeist of the milieu Mies occupied was one of technological progress and general disillusionment towards the German regime which forced himself and many of his compatriots to leave German for America. Mies saw technology as 'a world in itself' and a 'real historical movement – one of the great movements which shape are represent their epoch' (van der Rohe, 1950). This technological progress was intrinsically connected to Universal

space where the Hegelian notion of the 'death of art' found itself materialized in spaces that were entirely devoid of ornament (Sola-Morales Rubio, 1994). A second important Hegelian notion is that of *dialectics* or the process that opposites undertake from thesis, to anti-thesis and finally synthesis to merge into one (see Maybee, 2019 for a comprehensive understanding of Hegel's dialectics). In order to give a superficial understanding of the idea, without confusing the topic beyond the necessary, we can replace the thesis-antithesis-synthesis pattern as being-nothing-becoming – which leads the way to Mies's universal space. *Being* in this case can be understood as Subjective spirit of consciousness, the *nothing* can be understood as the Objective spirit governed by (external) laws, morality and ethics (Yim, 1996), and finally the *becoming* is the Absolute spirit where Subjective spirit and Objective spirit are identical where the two realms merge to 'become' the world (in the sense of *zeitgeist* or the spirit-of-the-time). One can see how this concept gave the required intellectual platform for Mies to build his ideas of Universal space upon. Conceptually space for Mies is firstly boundless Subjective and free of requirements of the World (the thesis), however to be built and enter the realm of architecture as object it must conform to external 'Worldly' requirement, such as being enclosed, so the result, the Universal space is at once boundless (in the sense that it is open and free) and yet bounded (by materials and structures). This synthesis of the two finds form in Mies architecture in the use of materials such as glass, which to the viewer are transparent (and therefore metaphorically non-existent) yet nonetheless delineating space to conform to requirements. Space is at once closed yet simultaneously not-enclosed. Herein lies the metaphysical challenge inherent in Mies's and modernist thought at large. With the physical construction of space, the space itself becomes real and occupiable by objects. The paradox is in the presupposition and at the core of the idea of universal space. Mies, and all architects after him who follow the doctrine of less is more a therefore fighting a losing battle, since and change is ultimately a battle in futility – absolute space will never be reached. For readers interested in more in depth understanding of Universal space and appearance are recommended to read Jean Baudrillard seminal work on the Pompidou Centre in Simulacra and Simulation (Baudrillard, 1994) where the

French sociologist describes Richard Roger's and Renzo Piano's building through a lens of appearance of unobstructed space and post-modernism.

Architecture however by being a practice in creating space resigns itself by dealing with this paradox by limiting objects in universal space by reducing them to their required minimum. Required minimum conceptually can be understood through a variety of ways; to a structural engineer the required minimum of structure may be the least amount of material required to keep a building safely upright or to a façade engineer the required minimum could be seen as the least amount of material needed to achieve the desired waterproofing or windproofing of a façade module. Inherent to commercial construction from a financial standpoint the required minimum is the least investment in the highest yield, and in a laissez-faire environment this minimum would be entirely regulated by the, in this case residential apartment, market. Less is more adopts a much more complex meaning then the aesthetic conceptual meaning Mies envisioned; less is less of everything until that less is becomes so low that it falls below the required minimum – in all its aspect. I claim that it is precisely this mantra of required minimum that drives rationalization of subsequent high-rise residential buildings. Rationalization takes many forms in commercial residential building[14] industry and a key tenet of this is the separation of industries from a singular discipline of 'architecture' as in Mies's milieu (where Mies had almost complete control of spaces created, from the materials used to the appearance of the interior spaces) to a multitude of primary, secondary and tertiary consulting roles (refer to 3.3 Process Driven Approach to Skyscraper Design: Case Study 1 (Melbourne, Australia)).

At the scale of the city block, Mies' rejection of urbanity crystalized itself in the utter contempt of the architect towards the most important vista the site offers, towards Lake Michigan. Mies approach to *enframing* of views will be discussed on a theoretical level later (Subsection 2.2.2) but at

[14] 'Commercial residential buildings' might seem like a paradox as commercial buildings are thought of as office buildings, however I use this term to delineate residential buildings which are built for profit as opposed to something like public housing apartment buildings.

this point it suffices to say that to Mies this apartment was an object sitting in universal space, and much like the conceptual universality of the façade module at the micro scale and the apartment interior at the meso scale, the building itself at the mega scale was theory objectified. In a famous anecdote it is said that Mies' modernist contemporary, the architect and urbanist LeCorbusier when photographing his completed buildings for publication would 'air-brush' out shadows that sunlight would cast. This retouching of photographs perfectly illustrates the modernist anxiety of universality with reality, where even a built object would be so decontextualized that natural light would have no place in the form (see Piotrowski, 2016). It is the claim of this paper that this orthodoxy towards pure theory objectified as exhibited by Mies (and his contemporaries), immortalized in the minimalist sentiment, forced the hand of subsequent architects to only be able to approach the theory of modernity through referential derivative buildings. As Alfred North Whitehead characterized all of Western philosophy as footnotes to Plato (Whitehead, 2010, p. 39) one could posit that all contemporary residential skyscrapers are footnotes to Mies and 860-880 Lake Shore Drive apartments.

An important footnote to Mies, to continue the metaphor, was established by John Heinrich and George Schipporeit in their Lake Point Tower development[15] a few hundred meters and few decades later away from the site of Lake Shore Drive apartments. Since Mies left no room for theoretical advancement of his concept the two younger architects approached their design in perhaps the most important aspect available to them – the *aspect* (in its Latin orgin of the word) itself, or the positioning of the tower towards its surrounding. Where Lake Shore Drive apartments triumphantly rejected Lake Michigan, Lake Point Tower radically accepted its position within the urban landscape. Due to the peninsular setting of the site, at the easternmost point of Chicago downtown, the tower appeared surrounded by water. Schipporeit and Heinrich embraced the location through the design

[15] The reason I use the word 'development' rather than 'apartments' is due to the aforementioned difference in ownership structure between apartment buildings/condiminums/co-opperatives. Recently the Lake Point Tower was proposed to be converted from condominiums to apartments, and the external bid seems to have been rejected. ((Freund, 2019))

of the tower, by adopting a three-fingered panopticon design, with the core at the center, they ensured that each apartment has unobstructed if sometimes only partial views of the lake. Their design logic has been wonderfully immortalized in a 1969 film which describes the process they used to finally arrive at their desired outcome (Unknown, 1969). Such was the importance of this aesthetic move, the requirement of privileged views of the lake, that it is said that the developer of the site William F. Harnett was convinced by the architects to sacrifice a whole wing, reducing the overall shape from an "X" plan to a "Y" shaped plan, forfeiting huge income from the larger gross sellable area (Lepik, 2004, pp. 84-87). At the base of the tower, where Mies chose to 'levitate' the building by placing it on slender *piloti* with floor to ceiling unobstructed glass Schipporeit and Heinrich added a heavy, solid, impenetrable podium and elevated the ground plane several stories vertically. Although seemingly antithetical to Mies' own concept the podium serves a similar purpose. The maneuver employed by Mies was to "empty" the ground floor and frame the towers over a glass lobby, Lake Point Tower those something similar, but eschews the transparency with monolithic opaqueness – yet both nonetheless detach the tower from the ground. On the upper face of the podium the architects introduced a green park in an almost literal raising of the ground plane from what could have been a public space, in the sense that the space surrounding 860-880 Lake Shore Drive apartments is public (Radović, 2020d), to a private garden. The centre of this newly created oasis is a lightwell which provides the innards of podium with natural light from above.

The second opening for innovation left by Mies was in the materiality of the building. Major advancements in fabrication and material sciences occurred in the immediate postwar period. Where Lake Shore Drive apartments utilized steel of poor thermal properties for the window assemblages and simple single glazed units with primitive non-silicone binding, Lake Point Tower adopted state of the art tinted double-glazed units with aluminum extrusions and structural silicone.

3 METHODOLOGICAL FRAMEWORK AND ANALYSIS

3.1 METHODOLOGICAL FRAMEWORK

The method utilized in this thesis is derived directly from the literature review presented in the previous chapter as well as from years of professional experience. The chapter is divided into five discreet sections which all utilize a different mode of analysis as required by the multidisciplinary approach to this research. Moreover, throughout the analysis a loosely chronological approach to the life of a supertall residential skyscraper is adopted.

a) The pre-construction of such a skyscraper by studying the process undertaken from the point of purchase of a site by an individual or group (Client) to the commencement of construction by a developer group (Builder). This section of the chapter is therefore focused on the design disciplines involved in the pre-construction phases of the building project, and the sub-sections of the chapter reflect such phasing, The aim of this part of the analysis is to highlight the homogeneity and the strict prescriptiveness from an authority standpoint which all residential skyscrapers must undertaken within a specific environment;
b) The immediate post-construction of skyscrapers by collating and comparatively analyzing all currently constructed supertall residential skyscrapers globally through statistical groupings. The groupings are intended to provide a holistic overview of non-strictly architectural metrics that define the skyscrapers.
c) An architectural analysis of the building elements that define the skyscraper object by focusing on the three key impacts architects have most control over, as defined in the previous chapter on the work of the modernist Mies van der Rohe and the post-modernist work of George Shipporeit. The three analyies in this section focus on three scales of architectural intervention.
    a. The micro scale of the façade modularization.
    b. The meso scale of the apartment interiors and inhabitable spaces
    c. The urban scale of the *skyscraper city* phenomenon.

This multidisciplinary approach, varying scales and adherence to architectural timelines provides this research a novel dimension yet unexplored on such a large scale as provided here.

Lastly each section listed above from a-to-c is further divided into the typical Introduction-Method-Conclusion process so as to be both discreet in their totality as standalone papers for publishing in

peer reviewed journal[16] and as a interlinked whole which provides a holistic understanding as a snapshot in time of the residential skyscraper phenomenon.

3.2 Practical Background

The choice and execution of the method utilized in this thesis in part also stems from the authors practical experience as an architect, urban designer and skyscraper specialist over a decade long period from his completion of undergraduate studies in Australia until the commencement of his doctoral thesis at Keio University. Certain experiences, particularly in the field of skyscraper design, consciously enter the analysis process and provide the thesis with a much-needed grounding in the profession. Moreover, these practical capabilities, drawing from experiences working in the field in Australia, Japan and Europe have provided the author with the technical skill to reconstruct and analyze buildings in a novel way.

3.3 Process Driven Approach to Skyscraper Design: Case Study 1 (Melbourne, Australia)

3.3.1 Aim

The process of architectural design in highly regulated and segmented, often even prescribed by architectural bodies as a mandatory prerequisite to commencement of a building project. Through globalization of the industry a fairly standardized process has emerged which divides the pre-construction tasks into four discreet phases:

- Concept Design
- Schematic Design
- Design Development
- Construction Documentation

[16] The process which has been undertaken at the time of submission of this thesis.

Abbreviated to CD, SD, DD and Shop[17] this methodology has become the modus operandi for other industries associated with construction beyond architecture. In buildings of extreme complexity such as supertall skyscrapers specialist consultants join the design process during specific phases of this chronological process.

In certain circumstances a further stage precedes the CD phase, the Competition Phase, which as the name suggests is designed for competing architecture firms to exhibit and in a sense bid on a potential project that a potential client published. It can take the form of an 'open' competition where any architecture firm that satisfies the criterion a client has set or a 'closed' or 'invited' competition where a select few architecture firms are invited to bid for a project.

Beyond the construction documentation phase lies the 'tender process' which operates as the final phase of the pre-construction methodology and provides a close to finished set of architectural drawings and consultant reports upon which interested developer companies assess the cost of the works required and bid for the said work. In a sense both the genesis of the process begins with a bidding process, that of the architectural tender (be it through competition or otherwise) and finishes with a building tender.

It would be impossible to undertake the analysis of the process driven pre-construction approach on all supertall residential skyscrapers – and it is doubtful that it would provide much illumination beyond proving that indeed the architecture process is highly compartmentalized in chronology and highly homogenized on a case-by-case basis. Thus, in this research the axiom that the process is highly homogenized and indeed compartmentalized is taken as a starting point, with the focus shifting towards a particular context highlighting a much less explored aspect of the design process. In highly regulated, transparent industries, such as the construction industry in Australia, State Governments are the custodians of the regulatory levers required for the approval of buildings of

[17] Referring to 'shop drawing' a process where fabricators and construction subsidiaries provide independent details for architectural proofing and synthesis into the architectural object.

'state significants' (DPCD, 2009) which in the case of the State of Victoria (the State encompassing Australia's second most populace city, Melbourne) in practice means all structures above 20,000sqm in floor area – of which all tall skyscraper fall within.

The aim of this analysis is to provide the reader with a holistic understanding of the design process required within a specific jurisdiction in the infancy of the tall and supertall residential skyscraper phenomenon. From the years 2000 until 2018 there have been 5 towers constructed that fall within the category of *tall* residential skyscraper and one *supertall*. In order provide a more expanded overview all residential skyscraper above the height of 220 have been included.

Name	Height	Completion Date	Architect
Eureka Tower	297m	2006	Fender Katsalidis[18]
Prima Pearl	254m	2014	Disegno Australia
Victoria One	246.5m	2018	Elengberg Fraser[19]
Vision Apartments	229m	2016	Brady Group
Lighthouse Melbourne	220m	2017	Elenberg Fraser

Table 6 - Residential towers included in this section of the thesis.

The case study of Melbourne's skyscrapers has been chosen for a number of reasons, including the transparency methodology required by the State government planning department (DELWP or Department of Environment, Land, Water and Planning) for all approvals, the relatively high number of newly-constructed tall residential towers within a short radius of the Melbourne Central Business District (CBD) and the willingness of DELWP to provide this research with

[18] A transcript of the interview with Karl Fender of Fender Katsalidis can be found in Appendix of this document.

[19] The author of this thesis spent six months in 2016 as an architecture working for Elenberg Fraser, albeit on different projects, and therefore some of the information provided is from personal conversations with architects involved in the design process of the specific towers themselves.

unobstructed access to archival documents of all approved and rejected proposals fitting the scope of the research[20].

Due to confidentiality relating to any construction industry there has been little comparative analysis undertaken to understand which core consultancies are present in each stage of the design process and the procedural checks and balances adopted through governmental approvement at each phase.

3.3.2 Source and Data Collection

The source of the data provided in this section of thesis was collected from confidential planning documents submitted by architects, engineers and other professions in the form of drawing packages and reports directly to DELWP authorities. In agreement with DELWP only non-specific analysis could be undertaken and therefore the flow-chart presented are an amalgamation of 5 skyscrapers fitting the scope of the research without reference to specific examples. The documents reviewed as a part of this research were examined under supervision at the DELWP headquarters in Melbourne and were not taken off site.

The format of the data varies with the requirements at the time of submission. Certain documents were provided to the government authority in physical printed reports whilst others were only required in digital format. As a rule, all architectural drawings were required in both physical and digital format.

[20] The source collection for this research was completed in-situ at the Department of Environment, Land, Water and Planning under the direct supervision of Mrs. Jane Homewood (Director of Planning) and under the funding of the Keio University SFC Global Environmental System Leadership program over a three month period (Oct-17 until Jan-19). Due to a data failure at DELWP in 2015 a certain number of documents were corrupted at therefore only the meta data of the files was accessible for analysis within this research.

3.3.3 Analysis

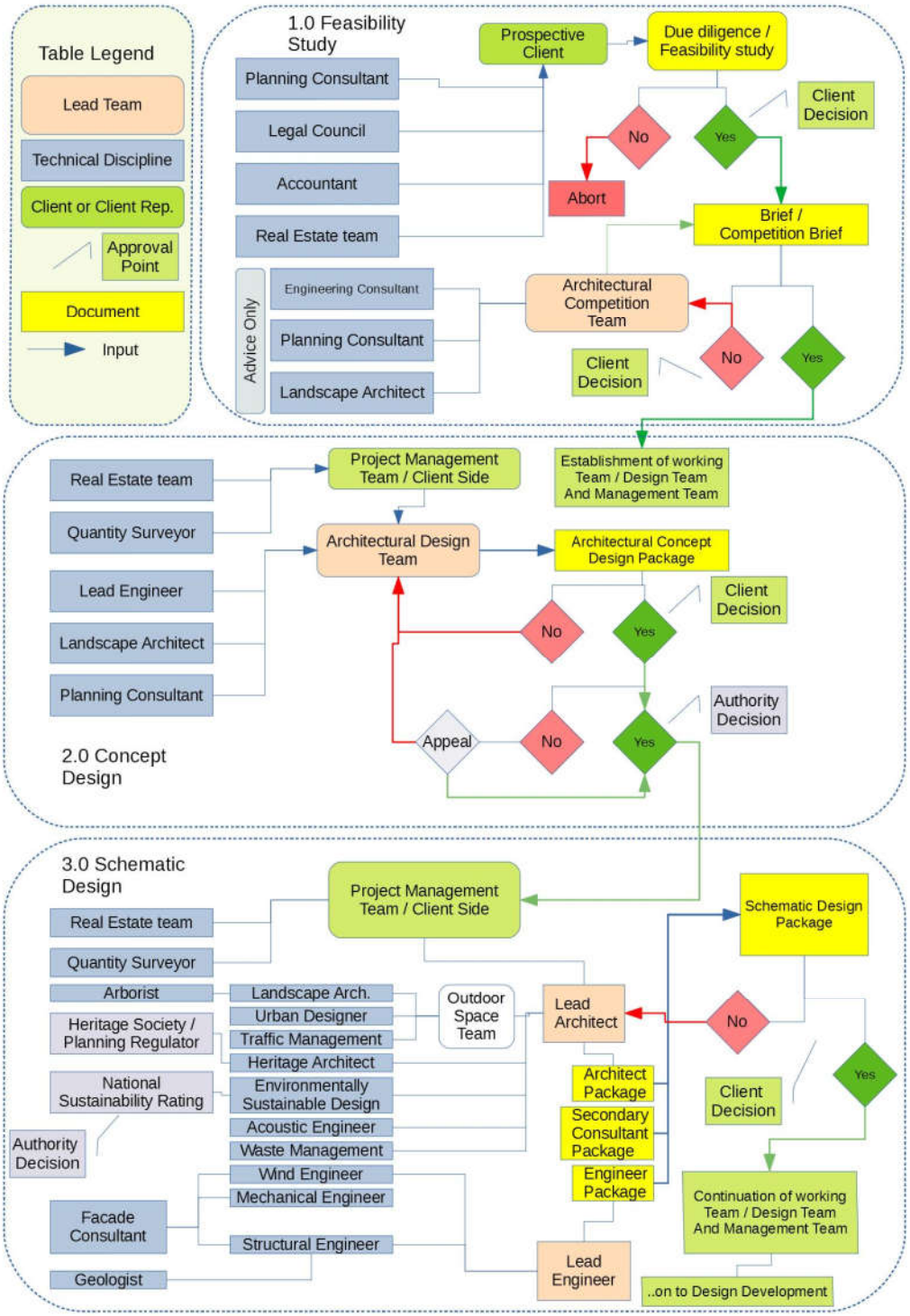


Figure 8 The process flow chart encompassing the 1) Feasibility Study, 2) Concept Design, 3) Schematic Design phases of the architectural construction process

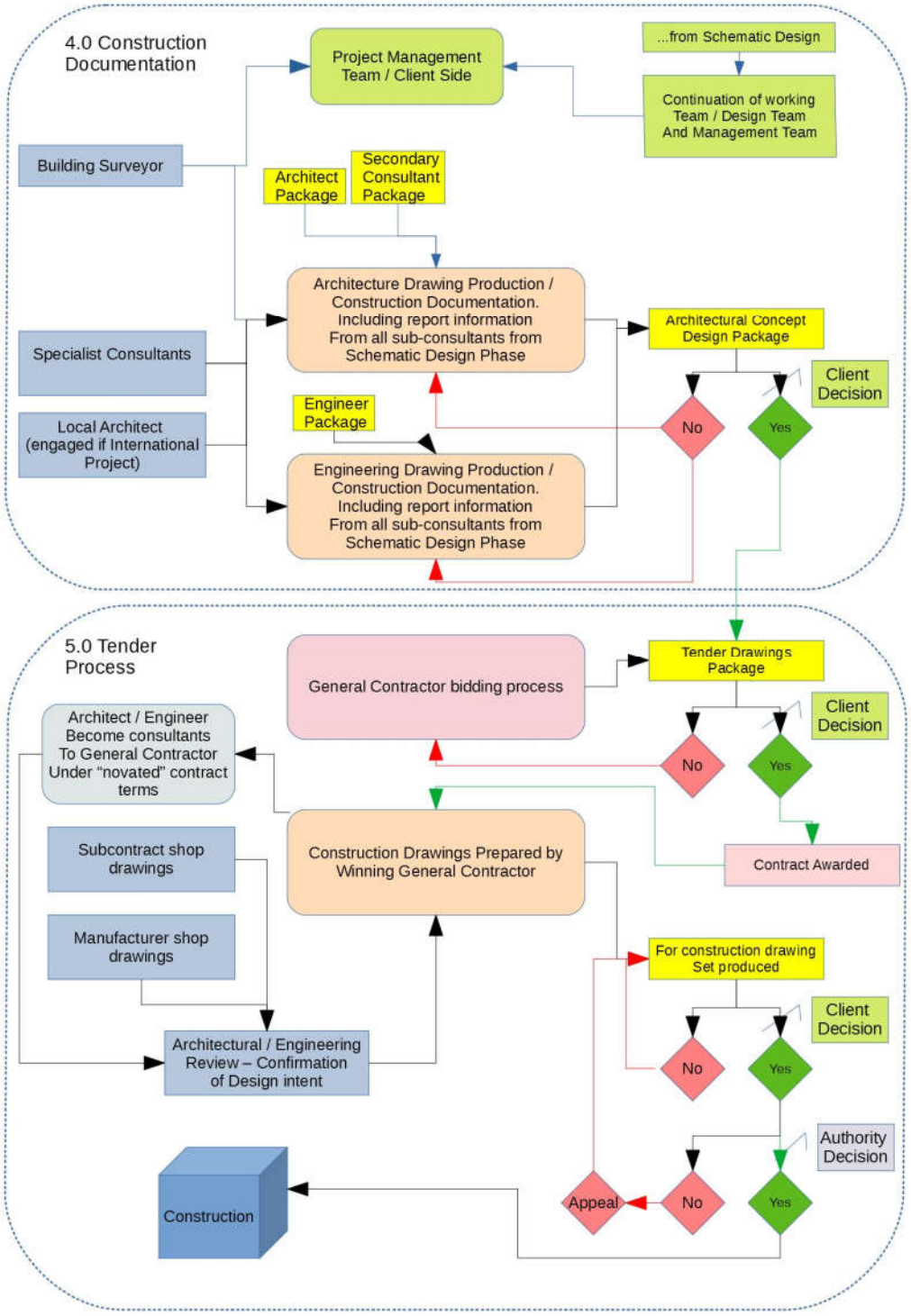


Figure 9 The process flow chart encompassing 4) Construction Documentation and the 5) Tender Process stages

There are seven major milestones achieved through the design process in the form of approval documents by the client, two of which are also approved by the government. Aside from the 'due diligence' and 'brief' documents, which are approved prior to engagement of the architect, the following five each align with the aforementioned CD-SD-DD-Shop phasing trajectory. The lead architect and the lead engineer have concurrent roles throughout the process, with the exception of the competition (Comp) phase and the concept design (CD) phase where the engineer is a consultant to the architect, are the two primary design disciplines.

During the competition phase where the architecture practice is bidding for the work secondary consultants (in this case the structural engineer, the statutory planning consultant and the landscape architect/urban design firm) only occupy an advisory role, focusing on descriptive rather than prescriptive advice[21]. Upon commencement of the architectural contract the client team is represented by a Project Manager (PM) who liaises between the design teams and the client team.

At the Concept Design (2.0 CD) phase there is an initial bifurcation in duties – a project management team and a design team are established, each with discreet roles. The process is always coordinated so as to have a set of architectural drawings, diagrams, renders etc. with input from secondary consultants being costed by the quantity surveyor and the real-estate agent forming a Concept Design package. The package is generally only indicative of the envelope of the tower and the basic structure. This package is firstly approved or rejected by the client, followed by the approval or rejection of the authority. The authority approval is considered the issuing of the Planning Permit (DELWP, 2020)

Out of the five towers reviewed in this research four had their initial CD package either rejected on the first authority review or applied for change later in the design process. This discovery has shown that the Planning Permit issued by the authority is relatively hard to attain. One tower had their

[21] Descriptive/prescriptive advice can be divided as descriptive being advice which tells, for example, the architect how a object should operate whilst prescriptive advice being how an object must operate.

package rejected on the explicit grounds of not providing enough direct sunlight to certain bedrooms in the tower (Office of the Victorian Government Architect, 2016; State of Victoria, 2015), whilst the other four had generic "re-application required" tags afforded to them. Of course, since the client approval precedes the authority approval, there was no way to see if there were further re-submissions prior to the planning permit application.

Once planning approval was granted, the SD 3.0 phase commenced with a bifurcation of duties in the design team, which up to that point was led by the lead architect. The SD phase is the largest phase of the design process in terms of the work produced by the secondary consultants, which in some instances swelled to nine reporting to the lead architect and five to the lead engineer. In the case of single project a heritage architect was appointed who reports to both the lead architect team and a secondary government authority, Heritage Victoria[22]. The approval from Heritage Victoria was granted however it was unclear on which attempt. The schematic design package is essentially three coordinated documents; a) the architectural package, consisting of architectural drawings, b) the engineering package which consists of civil and mechanical engineering drawings and c) the secondary consultant reports in which the format varied greatly from project to project. DELWP was provided the SD package for reference, however not for approval.

The Construction Documentation phase commences upon client approval of the SD package. The package provided at the end of this phase is quite like the SD package from the architect, however providing much higher detail in certain aspects. The package unlike the previous ones is meant to describe the building from a technical standpoint and to provide a detail overview of material elements of the structure to the developer team.

The final phase constitutes of two discreet packages, one the tender drawings from the winning developer for review by the architect and the engineer (with oversight from the client) and a second package provided by the developer to the authority for cross reference with the initial planning

[22] https://www.heritage.vic.gov.au/

permit application. From the documents reviewed at DELWP this process is much more immersive and collaborative between the government authority and the developer, who at this stage is the lead designer and the lead architect and lead engineer become in a sense consultants to the developer.

3.3.4 Results

What this analysis has shown is the sheer segregation of disciplines which are used in the design process. There are two main lead teams, the architect and the engineer, who essentially run two simultaneous yet coordinated design trajectories. The drawing packages provided for approval of one kind or another are really the only consolidated documents. The lead architect in many ways adopts the role of a design project-manager – collating, consolidating and appropriating secondary disciplines input. In the case of the façade modularisation, a key aspect highlighted in the literature review the façade consultant ultimately designs the façade basing their work on the loose aesthetic guidelines given by the lead architect. The colour of the glass, the shape and size of the elements and even the possibility of opening or closing of the windows is strictly advised by the secondary consultant. The shape, size and arrangement of the interior spaces is as much governed by the retail sales market provided by the real estate agent as it is the aesthetic or functional requirement of the architect. Lastly the urban realm beyond the confines of the tower envelope falls within the domain of the landscape architect, who in turn is confined to the requirements of the statutory planner and any city ordinances that may or may not exist in the towers specific contextual location.

The architectural process has become an intricate network of specialist disciplines all involved in production of what is ultimately a building that must adhere to the government guidelines and the financial bottom line of the client. Each project has two fundamental lock-in points, the Planning Permit document and the final Construction Document – each is heavily scrutinised by the responsible authority.

3.4 Quantitative Comparative Analysis of All Supertall Residential Skyscrapers: Case Study 2 (Global)

3.4.1 Aim

Cities have experienced globally the pressures of population growth, in a variety of ways. In some, the growth took 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 Euclidian geometry, as a finite number of sets or collections ("Compactness," 2012). A defined boundary makes all sets referential to one another. If we apply that fundamental logic to urban analysis, we can define compactness as a density of objects within a defined area of the urban realm. Urban morphology commonly defines urban realm as of the architectural scale, the tissue/fabric scale, the urban scale and the network scale (Giancarlo Cataldi, 2018).An analysis of these scales, indicates that the highest that some the world's densest spaces are, actually, at the smallest scale, that of architectural objects (Radović, 2020c). 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 at their excesses and, most notably, their seeming incompatibility with immediate surroundings and, evermore so, at their reputation as physical manifestations of an unwanted, radical globalism (Yeang, 2002). 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 numbers of specimens which allows for a holistic overview of the entirety of group. These, amongst other indictments, have relegated the discussion of supertall residential building typology away from serious architectural investigation, making it an almost exclusive domain of experimentation and the advancement within technological, scientific and technical agendas. A plethora of specialist journals 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. Material scientists have opined about the potential for achieving positive environmental impacts e-coated glazing , 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 (American Society of Heating Refrigerating and Air-Conditioning Engineers., 1981, 2018), 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 tend to often have as drivers of tourism (Radović, 2019). 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 (Spencer, 2016) from what was historically strictly the domain of architects (in their true meaning or *arhi*-tekton, or chief-builder) into a role of project managers, whose duty is to facilitate synthesis of vastly different specialist professions. The contemporary history of supertall residential skyscrapers is thus a history of technical advancement of assemblages which when combined constitute the building as a whole.

Thus, no serious comparative spatial analysis has addressed the similarities and dis-similarities of the currently built residential supertall stock, beyond that cursory observation of their aesthetic

sameness and lack of contextual integration. While architectural similarity is 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, 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 at specifically architectural realm, which 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.

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>300m
	Quantitative	Ratio	Height/Length	5:1
	Quantitative	Ratio	Plot Ratio	25:1
Multi-residential	Quantitative	Alignment	Vertical	Dwelling
	Quantitative	Percentage	Dwelling area	x>85%

Figure 10 Universally accepted definition of supertall residential skyscraper (CTBUH, 2018).

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 an neologism - *bigness* (Koolhaas, 1995a) 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 a 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 a residential apartments or commercial offices. For a skyscraper to be defined as a supertall, it must (A) be taller than 300m to its architectural tip, (B) be at least 5:1 height to length ratio (a stricter requirement that the simple ‘slenderness’ requirement for a skyscraper) and (C) to 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 fourteen (14) such buildings existed in the world.

Figure 11. Supertall residential skyscrapers 1-7 (in order of construction). Q1 Tower (Australia), Eureka Tower (Australia), HHHR (UAE), Ocean Heights (UAE), Capital City Moscow (Russia), The Torch (UAE) and Etihad T2 Tower (UAE).

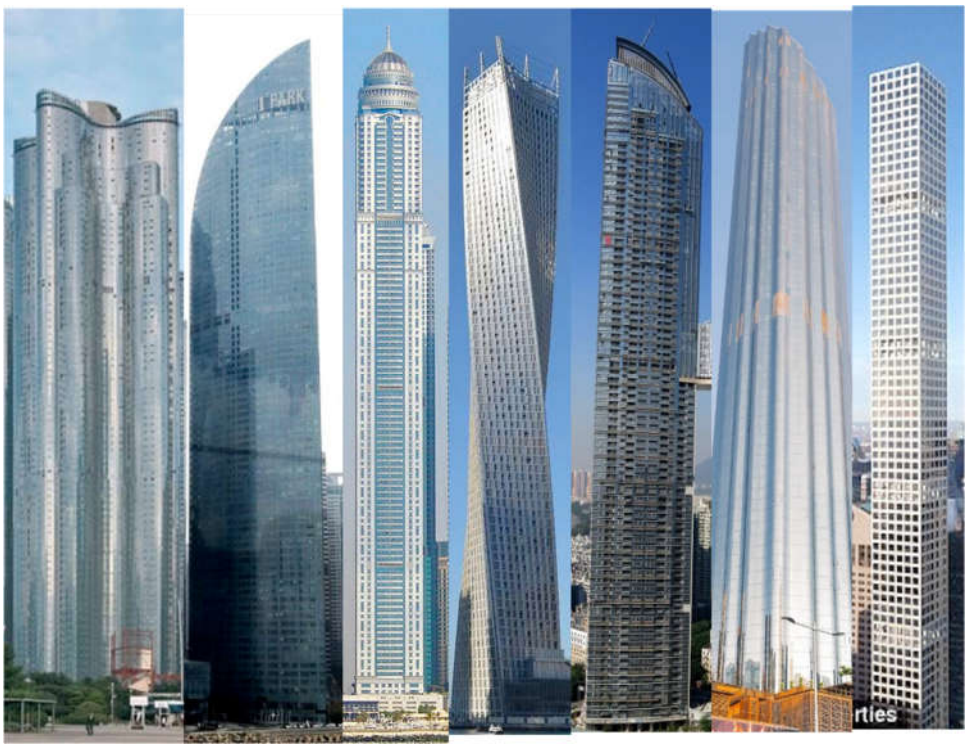


Figure 12 - Supertall residential skyscrapers 8-14 (in order of construction). Doosan Haeundae, We've the Zenith Tower (South Korea), Princess Tower (UAE), Marina Tower (UAE), Elite Residence (UAE), Cayan Tower (UAE), East Pacific Centre T1 (China), Abu Dhabi WC (UAE), 432 Park Avenue (USA)

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 if 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.

Fifteen (15) current supertall residential skyscrapers that exist in 2017[23] are all seemingly unrelated to cities, cultures and geographies within which they were erected. The uniform term 'skyscraper'

[23] Refer to Chapter 0 for reasoning on limiting the research to the time-frame up to 2017

itself implies a homogenous universalism, where the type remained insensitive to difference between cultures, contexts and climates, an adopted 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), Gold Coast and Melbourne respectively, 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) (Wainwright, 2019). The Gold Coast and Melbourne (Australia), Moscow (Russia), Dubai and Abu Dhabi (United Arab Emirates), Busan (South Korea) are classified as emerging Global Cities (Peterson, Hales, & Pena Mendoza, 2018). The New York City, 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 at 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.

Region	East Asia	Asian Subcontinent	Europe	Oceania	Nth America	Sth 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					●		●●

Table 7 Current and future projections of supertall residential skyscrapers (CTBUH, 2019) – 2016 onwards considered under construction for the purposes of this paper.

This segment focuses at 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 (as presented above, In …), however the foci presented here relate to five (5) specific categories which highlight the sometimes paradoxical integration of a global architectural typology which is, at the 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 [Table 5a and 5b], (iv) construction, consulting and design companies and ownership structures [Table 6], (v) apartment sizes, sale costs and rental costs [Table 7a, 7b and 7c]. These specific categories highlight the similarities between the buildings (where the aesthetic 'sameness' has often been the primary focus) but also to 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.

3.4.2 Source and Data Collection

The data collection method can be divided into collection from primary and secondary sources. The primary data has been in part sourced through a) interviews with prominent architects (Radović, 2020b), 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 has been 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.

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

3.4.3 Analysis

3.4.3.1 Region, context and climate

Table 8 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 coincides 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 have been 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 relating to each city or even district population growths, but such micro-scale assessment remains beyond the scope of this paper. Similarly, to population growths each of the countries on the list are highly urbanised, 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 this data gets cross-referenced with the construction methods and, importantly, the façade design, the dissimilarity of climates will be starkly juxtaposed to the similarity of façade glazing, installation and systems.

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	$7,616.70	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 8 - Region, context and climate comparison (Arnfield, 2019). Sorted by completion date.

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

Table 9 - Engineering Type (structure, cladding, glazing percentage) and urban form (development style, tower typology, crowing design and development type). Sorted alphabetically

3.4.3.2 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 get defined by this primary morphological requirement. Built on singular sites, often within an already dense urban fabric and their footprints get maximized by covering as much as possible area, 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 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 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 aa 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 in the economic realities and availability of land.

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 10 - Building height, global rankings and floor levels. 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%
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 11 - Goss floor area, apartment information and parking provisions. Sorted by global ranking.

3.4.3.3 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 300m 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 currently tallest building in the world is the iconic Burj Khalifa tower (2009) in Dubai. at 830m. That makes it the only megatall (towers above 600m) 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 1,000m.

The gross floor area (GFA) of each of the fourteen supertall residentials varies widely. That is, in part due to the shape, with some being particularly 'pencil'-like, whilst others girthier. Calculation for GFA also varies from country to country. In certain regions, the entire interior of the tower gets 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 neighbours in Jumeirah.

	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	Starachitect
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	Starachitect
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 12 - Ownership structures, developer and consultant details. Sorted in alphabetical order.

3.4.3.4 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 get 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. That 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 (SA) s 5*, 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 off 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 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 realisation. This multiplicity of expertise tends to "democratise" design, often limiting radical design thinking by favouring '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 a major influence over what can and cannot be constructed.

The homogenous interior programs of these high buildings are primarily residential apartments. 80% of total floor plate to qualify as supertall residential towers and often 100% in practice, mandate 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.

Name	Apartment Sizes Range (Min Sqm)							
	Studio	1-Bedroom	2-Bedroom	3-Bedroom	4-Bedroom	5-Bedroom	Penthouse	Date Collected
432 Park Avenue	56	132	166	205	504		765	18-Oct-17
Princess Tower	0	80	110	185	297		570	19-Oct-17
23 Marina	0		150	200			524	18-Oct-17
Burj Mohammed Bin Rashid	0	98	150	220	268			18-Oct-17
Elite Residence	0	68.5	120.5		297	1160	1393	19-Oct-17
The Torch	0	82.2	118.45	159.2	563.5			19-Oct-17
Q1 Tower	0	97	160	205			414	19-Oct-17
Hhhr Tower								
Ocean Heights	0	81.6	128.3	161.1	204.4	269	1022	19-Oct-17
Cayan Tower	0	72.1	116.6	168.4	236.9		509.9	19-Oct-17
Capital City Moscow	0	106	220				876	20-Oct-17
Doosan Haeundae	0		145	184.8	324.4			19-Oct-17
Eureka Tower	0	77	116	180				19-Oct-17

Table 13 - Apartment sizes (sqm) by number of bedrooms. Sorted in alphabetical order (data sourced form: 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).

3.4.3.5 Apartment dimensions, sale and rental information

Other nuance or the unintended, but very present "regionalism" at which this analysis hints are related to occupancy and various (un)availability of data related to that aspect of this extravagant residential type. For instance, it is important to notice that internal arrangements of three of the towers listed above are - unknown. There are no published plans of the buildings, neither 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 HRRR 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 publicised 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 publicises only sale prices, without any rental details. That tower is a very specific case, as many of the apartments are short term rented via corporation such as Airbnb.

An important design feature of the supertall residential towers is the compartmentalisation 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 ques 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 (100m from ground level) due to water pressurisation 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 1-bedroom apartments and relatively commonly sized 2-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.

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	$4,874
23 Marina		$519,000	$590,000			$2,246,000	$3,840
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			$5,294
Q1 Tower	$421,000	$750,000	$971,000			$2,756,000	$5,593
Ocean Heights	$351,000	$463,000	$709,000	$1,095,000	$2,191,000	$5,057,000	$6,178
Cayan Tower	$407,000	$533,000	$955,000	$1,208,000		$2,809,000	$5,358
Capital City Moscow	$1,897,000	$2,722,000				$13,552,000	$15,000
Eureka Tower	$530,000	$891,000	$1175,000				$6,964

Table 14 - 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 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

Table 15 - Apartment rent by apartment size (2017) in $USD/year. Sorted in alphabetical order. (Q1 Tower, HHHR Tower and East Pacific Tower not listed due to unavailability of data).

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. Table 7b and 7c 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 3-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 6 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 is has been highly publicized in newspapers in both the US [13] and the UK (Bernstein, 2015; Neate, 2016; Owen, 2015) whilst defended by the architects and the developers (Macklowe, 2015). In an interesting coincidence the median annual New York salary could by 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 ~$4,800 per sqm and the average 3-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 3-bedroom apartment for slightly less than 50% of their annual income.

In the example above, 432 Park Avenue is targeted specifically at the ultrarich of Manhattan or indeed of the world, as many apartments are simply vanity investment for the world's rich (Fernholz, 2014), whilst in Dubai many of the towers are targeted at workers working in the Emirates.

3.4.4 Results

This segment of the Thesis presented a 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 of investigations, which tend to favor measurable aspects of 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 have exposed a number of situations of unexpected difference.

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

At that level, our multifactorial, relational analysis extends not only beyond purely architectural, engineer 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 (Radović, 2020c). 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 contextualisations of supertall residential skyscrapers and fine, locally attunes expressions of place and moments in its history.

3.5 Architectural Analysis of Skyscrapers and Three Scales

3.5.1 The micro scale – façade, modularisation analysis

In contemporary architectural discourse the topic of skyscrapers, and more specifically residential skyscrapers, are often portrait as having an innate ability to become something '*more'* than simply buildings. Recently this '*more'* has tended to be discussed within the context of vertical cities (King & Wong, 2015), sustainable skyscrapers (Yeang, 1999, 2002; Yeang & Richards, 2007), vertical urbanism[24] or vertical villages (MVRDV (Firm), Why Factory., & Museum of Tomorrow (Taipei Taiwan), 2012); all of which explicitly place the future of skyscraper architecture at the nexus of urbanity and sustainability. This future possibility is characterized by attempts from architects, engineers and planner to 'design' a solution to a hypothetical future urban skyscraper; without attempting to analyze the foundational principles of what urbanity is, and how it could be applied to skyscrapers.

Thus it is the argument of this chapter that the fundamental conceptual change of skyscrapers from perceived architectural singularities in to urbanistic multiplicities requires a novel theoretical analysis based on established social theory. It cannot be assumed that a requalification of a building in to an urban expression only requires architectural design for it to succeed; which far too often is the case in literature on the subject. The most appropriate social theory to utilize for this task is what has commonly been referred to as *assemblage theory*, a highly differentiated reading of a philosophy first introduced by Gilles Deleuze and Felix Gauttari in *A Thousand Plateaus* (1987) and its companion volume *Anti-Odepus (1977)*. The reading of assemblage theory in this research is not meant to be presented as holistic, but rather disparate components of a much larger theory are appropriated as necessary to make them relevant to the reader in the context of architecture, skyscraperism and specific moment in time. The main body of work thus rests on the comprehensive work of Manuel DeLanda on the assemblage theory (DeLanda, 2011, 2016) and his interpretation of

[24] In the case of CTBUH's conference Polycentric Cities: The Future of Vertical Urbanism (October 2018).

Deleuze and Gauttari. The research also touches upon topics and lexicon of Bruno Latour (2005) and his actor-network theory, however only to critically contextualize certain aspects of assemblage theory which seem to be lacking clarity. Assemblage theory is a complex system of thought and has been used by different scholars of social sciences differently, yet at its core (as a theory, rather than a wider philosophy) it tends to be utilized to explain complex networks.

Firstly, as an introduction, we will attempt to elucidate basic understanding of assemblage theory through identification of what theory claims to be in relation to other of sociological theories; establish a lexicon of terminology through which we will be able to place the concepts at hand within the larger body of knowledge relating to the field and finally prove the emergence of skyscraper understanding within the wider understanding of urban social theory.

Secondarily we will focus on the specific capacity of the theory to provide unique insight in to the existing capacity of skyscraper, by focusing on scale of assemblages; from the micro assemblages which constitute the interiors of the rooms to the macro assemblages that can be city district scaled.

Thirdly by providing a temporal dimension to the scalar assemblages introduced previously, we will offer an understanding of skyscrapers as necessarily organic concept; an assemblage that due to interior and exterior forces provides a capability for reimaging that has not thus far been captured.

Lastly through the introduction of a complimentary *sustainability theory* the main temporal component of assemblage theory will be provided a necessary cause for change to be the catalyst for a rethinking of the architectural object into an urban multiplicity.

3.5.1.1 Aim

It is important to stress that assemblage theory as used in the context of this research is not the only theory to commence from the same beginnings in Deleuzian philosophy. Both sociologist Bruno Latour *(ANT) actor-network theory* (2005) and Christopher Alexander's *pattern language* (Alexander, Ishikawa, & Silverstein, 1977) stem from a similar starting point, yet establish their own independent

theories and subsets of understanding which, although similar, are nonetheless not explored in this particular research. *Assemblage theory* as formulated by Manuel DeLanda in *A new philosophy of society : assemblage theory and social complexity* (2006) and further expanded on in his latest book simply titled *Assemblage Theory* (2016) is the basis of understanding presented in this research. The applicability of this specific strand of assemblage theory is particularly pertinent to the topic in hand for a multitude of factors; however the two most important concept which are dealt with are the a) implicit notion of temporality embedded within the theory and b) the explicit concept of scale within assemblages.

Perhaps it is best to firstly present two critiques of DeLanda's specific strand of assemblage theory prior to commencing its application to skyscraperism.

Firstly, DeLanda's theory is conspicuously devoid of ideology and treats all the '*actors'*, to borrow a term from Latour, within assemblages as fundamentally self-serving interests and rational beings (Spencer, 2016) which are devoid of an overarching ideology or ecosystem; something that was not the case in the original Deleuzean theory. Secondarily, DeLanda is accused of crafting an entire philosophy out of what was a relatively small component of a larger Deleuzean concept, where Bueger (2014, p. 59) argues that the best role for *assemblage theory* should thus neither be one of simplification to a metaphor for a process of assembling and dis-assembling without a coherent reference to the original theory; nor an overly philosophical project, where its application becomes overly theoretical. The research presented here heeds Bueger's assessment and attempts to utilize assemblage theory firstly as an empirical tool to establish a foundation of understanding relating to a defined assemblage undertaking a profound conceptual redefinition. It is this use of the word 'concept' rather than 'theory' that is particularly useful within the context of this research, as the application of the theory as a concept allows for concrete analysis of specific skyscrapers. Ong (Acuto & Curtis, 2014, p. 23) characterizes this 'withdrawal' from theory and into conceptual territory by asserting '(o)ne could actually mobilize the *concept* of assemblage theory to look at the

past and that would provide a much more penetrating understanding of certain discussions of the past'.

An assemblage is a grouping of more than one heterogeneous, disparate and identifiable elements in discussion with one another. They are thus in a single discernible formation which in not confined to a single scale nor a distinct order and exhibit at least on of four core characteristics; multiplicity, relations & practices, material and symbolic expressivity and (de)territoriality as offered by Bueger (2014, p. 61).

Multiplicity as understood within the context of assemblage theory must be approached as an alternative to the false dichotomy of singularist/pluralist understanding of a whole (ibid, p. 61). Latour (as cited in Bousquet, 2014, p. 93) explains the idea of dualism to a 'modernist settlement' with rigid demarcations between subject/object, human/non-human and social technical. This lends itself within research on objects, such as buildings, as neither being a coherent singularity, a perfectly defined whole; nor an atomized system of autonomous singulars, a mixture of elements and objects. Thus it should not be defined as a singular system which is bound by, for example, the edges of its physical envelope (such as a typical glass curtain wall façade); nor should it be thought of as an atomized ecosystem of parts, for example, the discernable componentry within the abovementioned envelope (the glass panels, the aluminium mullions, silicone seals and so on which form the façade). Multiplicity within assemblage theory should thus be thought of as an alternative to organic totalities with an implicit temporality; with a potentiality for change over time.

Therefore, multiplicity within this research refers to a concept which is defined as a potential for an assemblage to be both under the influence of, or the pressure to become, a singularity and a plurality. This specific concept will be further analyzed in respect to the potentiality of skyscrapers to redistribute themselves over time whilst remaining fundamentally the same assemblages albeit with different ratios of component dominance.

Assemblages necessarily offer relations between the abovementioned heterogeneous, disparate and identifiable parts, as at its core an assemblage is an assembly of *parts* in connection to one another. These relations in practice, that is to say in any specific assemblage, can be assumed to be either expressive through materiality or symbolism and territorializing or de-territorializing. Thus, the material and symbolic can be imagined as two extremes on a vertical scale, whilst territorializing/de-territorializing on the horizontal.

Since assemblages can be constituted out of all sorts of parts (be it humans, machines, technologies or concepts; or indeed other assemblages) it is important to understand that any of these elements are both material and symbolic; that is to say any element exerts both a material and symbolic roll on any given assemblage at any one time (De Landa, 2006, p. 12). Bueger highlights this concept through an analogy to an office document, where the document exists within an assemblage as its material self that could be distributed physically to a group of people and also symbolically through its contents (Bueger, 2014, p. 63). To relate this to our topic of skyscrapers, an alternative understanding to the same gradient polarity of material/symbolic could be the role that the previously associated glass façade has within the assemblage of residential occupancy. At once it is the material differentiator between inside/outside whilst also being the symbolic in-between of the private/public; operating at potentially different extremes within the spectrum.

Furthermore, the material – symbolic role of an assemblage can be either territorializing or de-territorializing. Territorialization can be described as the process that can 'either stabilize the identity of an assemblage, by increasing its degree of internal homogeneity or the degree of sharpness of its boundaries, or destabilize it' (De Landa, 2006, p. 12). This stabilizing effect itself must ultimately be approached through both materiality and expressivity. Firstly, territorialization must be approached through the spatial boundaries of an actual material territory or object. Bueger (2014, p. 64) provides a parable to a UNESCO world heritage site being adopted on to the list, which at once being placed within the 'heritage site' symbolic assemblage is afforded symbolic

territorialization through its acceptance on the expressive list, also undertakes material territorialization through a sharpening of physical boundaries; thus increasing internal homogeneity of both. Essentially through expressive territorialization, that of the acceptance into a reified list, the objective also undergoes a process of territorialization. It is important to understand this concept as it allows capacity for the necessity of change of one aspect of the multiplicity to facilitate and necessitate the change in the other; thus a (de)territorializing force of expressivity can also (de)territorialize the objective.

This symbiotic relationship could be further interrogated through my previous example of the skyscraper envelope, via asserting that materially the territorialization of the building occurs at its already strictly defined edge condition; the façade. Thus, the symbolic private/public also necessarily occurs in that example at that edge within the context of coherent assemblage within the material and expressive vertices. Therefore a skyscraper, in its architectural singularity, is territorialized firstly through its material form, that of a sealed building with sharp edges, which allows for symbolic territorialization, that of private/public. However, following on from the UNESCO world heritage site example, a de-territorialization would commence firstly through its symbolic territorialization, followed by its material de-territorialization.

In contrast to territorializing the concept of coding is simpler to explain through the expressive form of it's being. 'Coding' is a process, akin to a corporation or governmental bureaucracy, that has rigidly outline operations rules and regulations through a centralized planning and issuing of commands. Alternatively 'de-coding' is the opposite process, one where the there is no central authority governing the performance. DeLanda gives the example of governmental organizations as being highly coded (through a set of rules and regulations) whilst merchants operating within these highly coded spaces act as de-coding forces; by adhering to market prices and the movement of goods (which are implied not to have a top-down pressure placed on them (DeLanda, 2016, p. 43).

Moreover, a highly territorialized and highly coded assemblage, within the work of Deleuze and Gauttari is called a *molar* assemblage; whilst the opposite, highly de-territorialized/highly de-coded is referred to a *molecular* assemblage. To be even more precise they are referred to as molar/molecular *lines*; with the concept of lines identified as a *potentiality* of an assemblage. An example given to elucidate a historical case is that at the largest human scale of a culture, or nation, in the case of the Roman Empire their military apparatus focused on organization; through their institutions, their military, within the military the hierarchical structure of the command, within it the rigid phalanx formations; all of which are denoted with *molar lines*. Alternatively the barbarian tribes which arrived with their mobile armies (of men on horseback), the nomadic tradition and their migrations are assigned *molecular lines*. Lastly a *line of flight* or a change from molar to molecular can be understood as the potentiality, in opposition to *actuality*, of an assemblage to change. The example given by DeLanda is that of an army returning from a victory refusing to demobilize; thus, destabilizing the entire state apparatus (DeLanda, 2016, p. 129; Deleuze & Guattari, 1987, pp. 222-223).

3.5.1.2 Analysis

It can be safely assumed that assemblage theory, by extension of it being a network theory and necessarily a pluralist view of ontology, attributing a scale to an assemblage is a futile task. At its core the theory is reductionist, where ever smaller assemblages can be elucidated in one direction, whilst entire societies can be linked in to other. To circumvent this particular lack of scale provided within the theory three precise assemblages at three varying scale, in relation to one another, will be examined within skyscrapers to provide a bedrock upon which to build the latter sections of the chapter. As described previously objective properties of assemblages, such as the size of a window compared to the size of a floor slab are obvious, the difficulty arises when comparing the expressive scale of components. Thus we will delineate scale firstly objectively and then provide clarity on its secondary and tertiary multiplicities. The three assemblages selected are the building a) the building

façade at a unitized micro level; b) the interior of an apartment at the meso scale and c) the skyscraper object itself at the macro scale.

Initially to provide an example of the type of thinking required to conduct this analysis we will unpack a historically relevant example provided by DeLanda (2016, pp. 34-36), who perhaps most concretely relates assemblage theory to the phenomena of cities and buildings. To him cities posses' varieties of material and expressive components, some of which are actively territorializing cities (such as pubs, churches and public squares) which keep populaces in place. The example he gives of an objective deterritorializing force is the locomotive which due to its physical features, such as needing to accelerate and decelerate to pick-up/drop-off passengers can effect city design; train stations ultimately are forced to be at a certain distance apart to function properly. On the expressive side, and importantly for this research, DeLanda sees skyscraper skylines as themselves assemblages; through historically being associated with churches and government buildings, thus providing particular cities with particular identities (one can only think of the silhouette of the Eiffel Tower, the palace at Westminster or the Sydney Opera House to think of an identity of an entire city to be encapsulated expressively within an object). What is ultimately the point of this argument within the text is that objective (de)territorialization should be viewed not only in terms of how 'tight-knit' or impermeable the object is itself, but rather what types of (de)territorializing effect it has on its populace (in the case of cities, towns and buildings). DeLanda offers an explanation of this at the historical macro scale of ancient Greek villages in comparison to medieval central-European walled cities. Many Greeks of the era had holiday houses and villas on the Greek coast and island, and thus were moving backward and forward from cities to the countryside periodically; and even living in large Greek cities in neighborhoods relating to their ancestral homes in the countryside. This permeability of the Greek populace was a deterritorializing effect on the city, therefore providing a much more heterogenous expression of urbanism. In contrast the strict bound, delineated non-permeability of a walled city provided a tremendously objectively territorializing effect on the expressive mode of the populace. DeLanda even alludes that the physical walled cities ultimately

were the first bastions of European patriotism and understanding of land ownership. Thus a tangential concept, from the relatively micro-scale of walled medieval cities and their sense of local patriotism can be established over time to have provided the first nation-state ideas of 'sovereignty' (DeLanda, 2016, p. 35). Historically the idea of the façade of the skyscraper as an autonomous element truly begins with the separation of structure and envelope. The concept was ultimately a practical one, the structure was able to rise independently of the envelope, and thus a separation of workforce was possible on site and in the architects office. Architecturally the separation meant a 'freedom' of expression of architectural intent devoid of the necessity to replicate the interior. To sum this had meant a practical solution to an engineering problem, to others, this fundamental separation of interior/exterior with a 'film' or envelope was akin to 'lobotomizing' the skyscraper (Koolhaas, 1978). The buildings external, or expressive form, stopped conveying its internal order; and thus, began the separation of architecture into two, that of the inside and the outside via an intermediary skin. This initial obfuscating of the internal by the external was entirely reversed to the extreme with the advent of modernism in architecture.

The role of the 'skin' as a physical separator of the private inside and public outside gained traction in the previously established modernist era, highlighted by the Lake Shore Drive apartments. Here the skin began materializing as a technology with machine like properties; devoid of embellishment, visceral and dematerialized in its translucency. This mechanization of the façade was in part due to the process of assembling of the façade firstly on-site with steel and glass (such as the aforementioned Lake Shore Drive apartments), through to partial off-site manufacturing and a move to thermally more efficient aluminium, glass and silicone curtain wall facades in the Lake Shore Drive apartments (Windhorst, Harrington, & Chicago Architecture Foundation., 2009) and its most technologically advanced manifestation in the supertall residential skyscrapers of the contemporary era.

This seemingly continuous temporal flow from one advancement to another has led researchers to observe, or perhaps more pertinently to 'assess', facades as simple objective extensions of technological necessities, capacities and capabilities across time. Objectively viewed contemporary facades are a simple affair, in fact critics have argued that they only consists of the glass/aluminium/silicone materiality; with all other additions superfluous or aesthetic (see Yeomans, 1998). We in this analysis are however not necessarily interested in historicizing the curtain walls in a manner which attempts to declare a 'winner' to the first, or oldest curtain wall façade; what is of interest here is the assemblage of the curtain wall façade.

Through a detail analysis of the architectural façade of the building, the outermost skin of a skyscraper, this section of the work will attempt to show the paradoxical complexity of the simplest set within the contemporary building as a perfect example of an *assemblage of assemblages*. Firstly what we will define as the architectural façade of the skyscraper is the rudimentary composition of glass/aluminium/silicone assemblage; as observed across all supertall residential skyscrapers. The physical composition of this assemblage is such that in all instances, from a structural perspective, the glass is held in place by silicone which in turn is held in place by the aluminium which attached to another discreet assemblage; that of the primary slab. The façade assemblage is therefore at once homogenous, in the sense that the addition of any further elements within the objective assemblage would be superfluous from a purely structural vantage point. The glass/aluminium/silicone (GAS) assemblage is highly territorially defined; on the vertical edges of the glass panel by the aluminum mullion, the horizontal edges by the aluminum sill at the base and the aluminum head at the top, with potentially transoms at intermediary points. The single GAS assemblage physically attaches to its neighbouring GAS assemblage (on all four sides), who in turn do the same to their neighbours, and so on; achieving a pure *assemblage of assemblages*, or a recursive application of the part to whole relation (DeLanda, 2016, p. 70).

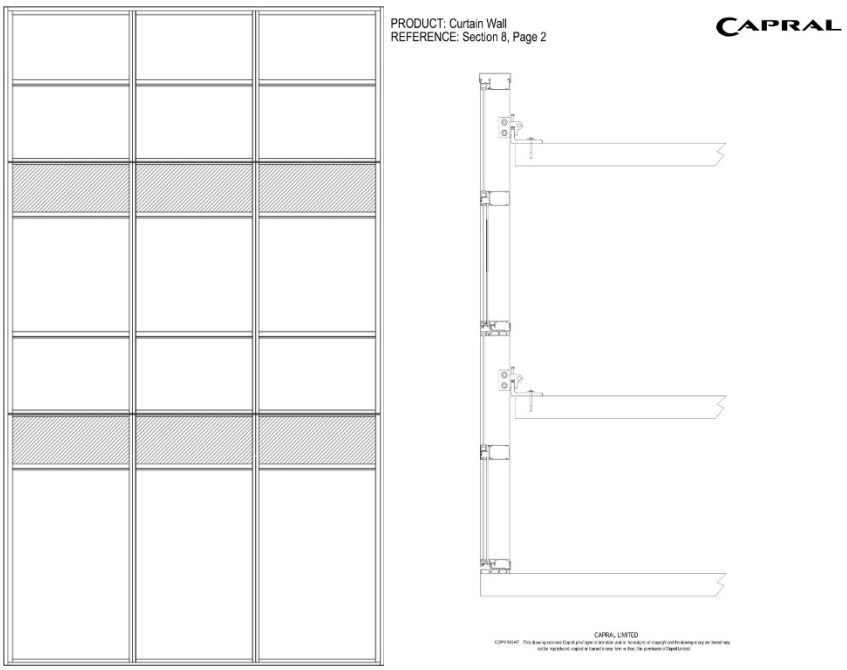


Figure 13 - Typical curtain wall 'GAS' detail as provided by the Australian manufacturer Capral

The glass/aluminium/silicone components can thus be described as *nested* assemblages within the 'GAS' assemblage which is a nested assemblage within the 'skyscraper skin' assemblage. The nested parts are irreducible, as the glass without the silicone or the aluminium, would no longer form the assemblage of GAS nor would the other two be able to form it. Moreover, if the GAS assemblage had a decorative fin added to it for example, the assemblage would become a glass/aluminium/silicone + fin assemblage, but the nested elements relationship would change; there would be superfluous element. However, in the case that fin was in fact a necessary sun shade, for example, then the GAS+F assemblage would be nested with all it components, as the removal of the '+F' would reduce the assemblage to 'GAS' (which no longer served the same purpose as GAS+F, that of GAS that also shades from the sun).

The above is important to be understood as it illustrates the second point within the GAS assemblage, that of bottom-up/top-down effect of parts to the whole. In assemblage theory causality always operates bidirectionally; the effect of the part on the whole and the effect of the whole on the parts (ibid., pp. 71-72). The capacity of the GAS assemblage to be an effective wind and rain mitigation screen, whilst allowing light in, as opposed to a brick wall for example, is due to its

component's casual interactions; it's bottom-up effects. The top-down effects of the GAS assemblage on its constituent parts those of G, A and S is that of the requirement of it to be a good wind and rain mitigation screen, whilst allowing light in, as it forms the outermost skin of a bedroom. Thus, one can see that the relationship of GAS being a constituent part of the 'skyscraper skin' assemblage; and being constituted from G, A and S means that the 'skyscraper skin' assemblage necessarily provides top-down requirements for G, A and S via GAS. If we take this a logical step further and assume that the 'skyscraper skin' assemblage forms a constituent part of a larger assemblage itself (this larger assemblage could for example be an expressive one, a list assemblage of 'environmentally friendly' skyscrapers) then that requirement might be to have shade on certain percentage of the glass on the North facing façade. Thus the 'environmentally friendly' assemblage necessitates that the 'skyscraper skin' assemblage has a sun shade component, which in turn 'passes' this requirement on to the 'GAS' assemblage, which due to the necessity of the top-down pressure, is required to be 'GAS+F'; which previously was not necessitated but due to the expressive assemblage of 'environmentally friendly' now does.

But how does this top-down requirement work in everyday circumstances, when we are discussing physical objects, skyscrapers, that might have a need for change; due to let's say the impending requirement for all skyscrapers in a given city to have a mandatory sun shade? Or perhaps, like in the case of the Melbourne, where a non-compliant material was found within a residential skyscraper, a requirement has been made to remove all instances of this specific material from all high-rise buildings; a momentous task due to its prevalence as cheap and effective screening material. The logical conclusion would be to simply 'install', by a human worker on site via some sort of building maintenance unit or crane, the required prosthesis (sun shade) or to replace the specified material (screening). The complexity in this seemingly simple task can be found in what DeLanda poetically denotes as *commands frozen in metal* (ibid, pp. 82-83).

3.5.1.3 Results

The concept posited above is a secondary process of bottom-up/top-down management within the assemblage of assemblages, that which I will refer to as *residual* aspects. A bottom-up process of construction would be a pre-Miesian one where a skilled artisan would roll steel for the window frame, or perhaps carve wood, place a type of putty in the crevice created and place the glass window pane. The process would most likely be done in a workshop which not only specialized in window framing, but also other crafts involving the abovementioned materials (perhaps wooden doors etc.) and thus the top-down process of making was not highly territorialized (homogenized) nor highly coded (routine). Thus the *residual* of the manufacturing process would form a component of the assemblage of assemblages which would be a non-identical, non-'perfect' and non-unitized outcome; the outcome being a de-territorialized façade which allows for other de-territorializing effects to influence it, such as perhaps the aforementioned worker on a ladder installing a fin.

Alternatively, a contemporary glass/aluminium/silicone assemblage is more often then not constructed in a highly specialized ~~manu~~factory, where each component elements are sourced as finished products from a varied field of manufacturers that specialize in glass, or aluminium or silicone; and often even further specialized for the construction industry. Thus the product produced is a highly territorialized and coded article; unitized, homogenized, mechanical perfection and in its residual attributes. Thus the output, GAS, is also necessarily highly territorialized and coded; and as described previously it takes a large de-territorializing force to effect such a homogenous, well defined assemblage.[25]

Thirdly the GAS assemblage of assemblages can be further elucidated via the same line of enquiry as the workshop/manufactory or artisan/machine allegory; that of the creative process or design. The

[25] It is a well-known fact within the construction industry that the topic of de-construction of curtain wall clad skyscrapers has not be researched sufficiently. There is simply not a cost effective, safe and technically feasible de-construction method for a failed curtain wall façade on a skyscraper; let alone a supertall example. Thus, to use the logic established in the main text, the territorializing force is so strong within the GAS example, that even de-territorializing through destruction would seem to difficult; such is the objective homogeneity and residual effect on this element.

highly territorialized and coded nature of GAS is partially due to the manufacturing process, but equally so it is a product of the nature of its conception. With the complexity of skyscrapers ever increasing the design process of the façade module is rapidly transforming into a concert of varied disciplines rather than a product of the watchful eye of a single designer.

Specifically relating to supertall residential skyscrapers, the façade 'package' (to use a term derived from construction logistics, which denotes a separate on-site specialist requirement) is the most aesthetically pronounced of all the architectural building components. As can be seen in the examples provided the largest surface area of any of the towers is a simple GAS assemblage. However, the disciplines involved in a typical procurement process of one such unitized, non-loadbearing, curtain-wall façade are numerous; and specifically territorialize and homogenize its boundaries. To provide an example, assuming the façade module is a typical 3.0m tall, 1.5m wide, double glazed unit façade with mullions, transoms and guttering as per standard; the disciplines involved would be divided into:

(POSSIBLE TO USE SAME COLOURS AS IN DIAGRAMS 3.1.4? if yes, that would be helpful)

Profession	Role
Architects	Provide the aesthetic requirements, such as color selections of the glass and metal; and any particular type of window frame extrusion types
Structural Engineers	Estimate the wind loads and weight of the unit; and also provide calculations on how to connect the façade to the primary structure
Environmental Engineers	Assess any ecological requirements necessary, such as adhering to LEED
Acoustic Engineers	Assess the noise requirements for the inside/outside of the building, as well as between floors
Mechanical Engineers	Provide any air-conditioning intake and outtake requirements via the spandrel panels
Fire Engineers	Provide guidance relating to evacuation requirements, emergency services coordination and any external sprinklers
Build Surveyors	Sign off the fabrication and construction as relating to any governmental and statutory building requirements
Specialist Façade Consultants	Correlate all the above information in specific products on the market
Logistics Consultants	Provide information on suitable fabricators and if necessary methods of procurement of materials.
Quantity Surveyors	Calculate the final costs as correlated by the façade consultants and logistics consultants
Other Specialists	Such as fabricators, consultants and artisans that may have a role to play within the system.

Table 16 – Primary, secondary, tertirary and specialist consultants involved in the façade assemblage manufacturing and design

The role of the disciplines listed above is specific, delineated, compartmentalized, distinct and measurable. (possible “guns”)There is little to no overlap, except to of course inform one another to the requirements of each, and to conform to the aesthetic requirements of the architect whilst remaining within the scope of the budget. The outcome is a highly territorialized divisions of expertise providing recommendations for GAS assemblage which have a distinct finality to them.

So to return to the previously mentioned top-down causality of ‘environmentally friendly list’ assemblage -> GAS -> G.A.S, the bottom up, or constituent assemblages of Glass, Aluminium and Silicone are not some atomic divisions of each; but rather the bottom-up requirements of the specific disciplines listed above, in the form of embedded technical processes employed to design the G, A and S. One can imagine this bottom-up autonomous development of the G, A and S respectively as being part of the larger assemblage of assemblages and to operate independently; perhaps an environmental engineer going above and beyond what is required due to sense of pride in their work, or a self-imposed requirement for the most advanced of environmental requirements. Therefore, in this bidirectional feedback loop the top-down effects all constituent parts and the bottom-up likewise. In an alternative example, which was previously posited in the chapter describing coding and de-coding a Roman army returning home after a victory refuses to demobilize and thus threatens the *molar* existence of the whole Roman governmental apparatus; the same logic is at play. A decoding effect on the bottom-up process, that of a single unit refusing to de-mobilise, has an effect of the top-down assemblage, that of the Roman Empire.

Further yet, if we take an architectural practice, which has a role to design the G within GAS, then we must look at the organizational structure within that office. For example, the office of Skidmore Owing Merrill[26] on their project of Cayan Tower in Dubai, had a highly delineated team of architects and structural engineers working on the project. There was a lead-architect and a lead-engineer, and

[26] SOM was interviewed for this research in regards to the Cayan Tower in Dubai, and the following corporate structure was noted during the visit on January 2018 at SOM’s Chicago Office.

although of course they communicated on the project, their role were top-down defined and each had a 'package', to use the logistics term, to deliver. These packages, although intersecting in the sense of where the structure and the architecture had to be in concert, were highly codified. In fact, the codified process penetrates all levels of the architectural design process which ultimately delivers the aesthetic requirements for the GAS assemblage; of course realizing that the ultimate output of an architect is a set of drawings and a performance specification, rather than the literal making of the window system itself. In fact the only level where the highly coded process of design, which could be said as the assemblage to design, is de-coded, is at the level of the individuals as people within the process. However, if one can put it this way, as soon as the 'person' becomes the 'architect' the process of coding commences. Thus the question can be posited; if the top-down process commences as de-coding and de-territorializing, or as the *flight line of molecularisation* to use the correct terminology, on the assemblage of assemblages at the largest scale; then what would this de-coding and de-territorializing look like at the bottom end of the GAS assemblage of assemblage, that of the architect?

We will approach this possibility as described above towards the end of the chapter, when all three scales discussed have been thoroughly examined through the rubric of assemblage theory.

Lastly, what needs to be examined to provide a holistic view of the architectural façade as an *assemblage of assemblages* is the expressive; which thus far has not been discussed. The complexity of the seemingly rudimentary glass/aluminium/silicone assemblage must be further juxtaposed with the initial complexity of what the façade is expressively. Architect Alejdandro Zaera-Polo describes the contemporary façade, or building skin, as precise location where representative and materialistic adopt a political or expressive form. Although the contemporary façade is a simply enough a unit, consisting often of glass, aluminium, silicone and perhaps an ancillary ornament (in defiance of Mies' mantra (or "dictum"?) of less is more); the expressive role it plays is that of inside and outside, public and private, warm and cold, observer and the observed. This expressive role of the façade, or as

Zaera Polo would have it, *politicised* role of the façade, is exactly its importance to architecture; and something that has the potential for change. To use his own words; 'mobilizing a political critique of the envelope to address its multiple attachments may enable us to frame architecture not merely as a representation of the interests of a client, of a certain political ideology, or an image of utopia, but as an all-too-real, concrete, and effective political agency able to assemble and mediate the interests of the multiple stakeholders that converge on the architectural project today' (Zaera-Polo, 2008, p. 197). Thus, as Zaera-Polo would have it, the expressive role of the façade is the very political actor; more than a sum of its parts, in the same framing as the material GAS assemblage spoken about previously is an assemblage of assemblage of G, A, S; so is the expressive role of the same assemblage. Moreover, he suggests that indeed the aesthetic role of the façade is the last bastion of architectural design within the context of buildings; and one can only assume even more so when relating to skyscrapers due to the abundance of façade surface area at the very least.

The façade, considered as the differentiator between inside and out, has two entirely different expressive forms towards interiority and exteriority. Although materialistically fundamentally the same assemblage; glass held in place by silicone, held in place by aluminium, the role of the façade to the interior is that of a hinderance to pure unadulterated vistas outwards, a thoroughly de-territorializing agency; letting light in, letting the 'view' in and curating the interaction between the outside and inside. Alternatively from the outside the form is entirely different; preventing surveillance from the street level in to the living spaces through light reflection, forming an impenetrable wall between the out and in and territorializing the building by providing a rigid edge (the fact that glass is the main element rarely means transparency). Moreover, as Mies' drawing of the façade assemblage on the Lake Shore Drive apartments shows, the intent from the inside looking out is for the objective elements to completely disappear; and only the political to remain. The entire architecture, as Zaera-Polo explained previously, is reduced to a hinderance to the uninterrupted views of Chicago by providing vertical interferences. From the outside looking in

however the entire theory of architecture compiled by Mies is exactly displayed in the, from the inside almost invisible, façade modularisation.

Figure 14 - Mies' sketch of the interior of a Lake Shore Drive apartment, and an outside photograph of the apartments

Thus the Lake Shore Drive apartments, and by extension any of the supertall residential skyscrapers reviewed, must be observed from two vantage points; that of interiority and exteriority. The politics of the façade have an entirely different mode of representation depending on the observers position, and thus which assemblage they belong to; that of private interiority or public exteriority.

The analysis of this duality of perspective will be further examined in the following sections relating to the Meso and Macro scales of assemblages.

3.5.2 The meso scale – apartment, multifunctional analysis

3.5.2.1 Aim

As posited in Chapter 3.1 where the segmentation and regulation of the architectural profession was highlighted, that happens through the process-driven approach to skyscraper design - from the architectural competition phase of the process until the commencement of construction, and the homogenisation of the final product – the architectural object itself. In this Section of the Thesis the second of the three scales of architectural intervention (Chapter 2.3 through Chapter 2.7) will be explored. Here meso scale addresses the apartment interiors. To briefly revisit the critical period from Mies' Lake Shore Drive apartments to Schipporeit and Heinrich's Lake Point Tower, we must

return to the three key concepts developed by these architects. Firstly, universal space in Miesian terms was the concept of as unobstructed vantage from the interiors of apartments outwards, which was taken to its absolute within the Lake Point Tower, and the unobstructed private views of Lake Michigan from every single apartment; secondly the "amorphous" partitioning of interiors and vague delineations between fully-private (bedroom) and semi-private (bathrooms, kitchens) and universal (living rooms, dining rooms)[27] spaces; and lastly, the minimisation of structural elements to allow for abovementioned "amorphous" character of universal space and for the potential for future re-arrangement and consolidation of apartments.

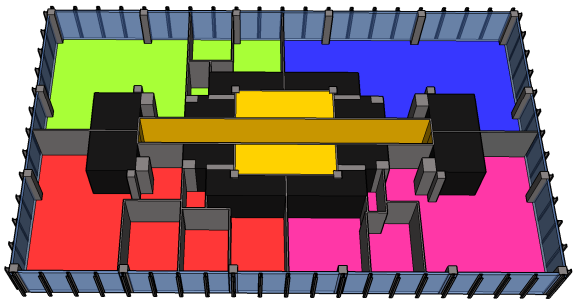


Figure 15 - Lake Shore Drive apartments with colour coded variations of internal spaces. Green as one bedroom apartment, purple as two bedroom apartment, red as thee bedroom and blue as 'pure' universal space as conceptualised by Mies van der Rohe)

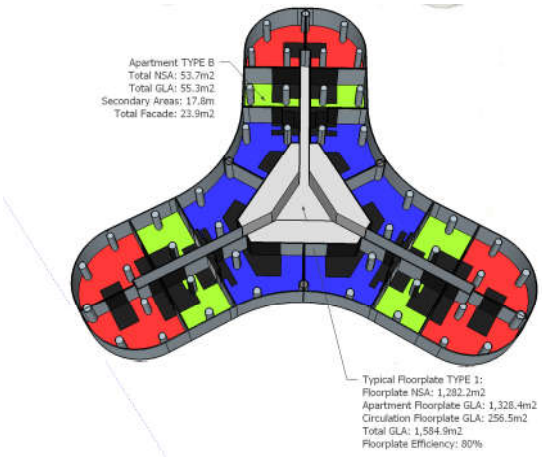


Figure 16 – Lake Point Tower with apartments colour coded with accent on symmetry of internal plans. Each coloured apartment is a single bedroom apartment allowing for consolidation of spaces to form larger single entities.

Much has been written in architectural literature of ideal proportions of living space and in fact most undergraduate architecture schools provide courses on these exact parameters. Canonical design guidelines lists of od ideal sizes of each conceivable dimensions within residential apartments have been written and re-written, with updated guides to providing the perfect ambience within which one is to dwell. At the architects disposal are books that elaborate upon perfect dimensions of internal space such as the, now in its fifth re-printing and first printed in 1979, *Architecture: Form,*

[27] In the sense of areas that are intended to entered by guests yet nonetheless private and areas which are occupied by numbers of people if guests are present.

Space and Order, and re-printed triennially *Building Codes Illustrated: A guide to understanding the (2000-2018) International Building Code*, all by Francis D. K. Ching (Ching, 2015; Ching, Winkel, & International Code Council., 2018), amongst dozens of others. Government institutions, as highlighted in Chapter 3.1 offer universal requirements for the safety of skyscraper occupants, often through building codes and offer direction through design guidelines within their specific context.

The primary aim of the analysis presented in the following section of this Thesis is to provide a definitive quantitative comparison of all supertall residential skyscrapers through their typical floorplate arrangements, focusing on the built result rather than on architectural concepts, of which there are countless numbers. In order to provide a like-for-like specimens, a typical floorplate has been selected covering the largest possible number of permutations of internal arrangements. Often this has meant that 1, 2 and 3-bedroom apartments are of most interest, albeit in cases where either no small apartments exist or have not been published larger examples are analysed. By focusing on a comparative analysis of supertall residential skyscrapers a yet un-researched direction opens to this Thesis – the direct understanding of what is , and what is non-universal or particular in each assemblage set of functionally and structurally defined towers.

Rather than dwelling on particular aspects of universality that these towers possess (such as similarity in height, use etc., as established in the previous Chapters), the assumed physical and behavioural similarity of occupants[28] and certain constants (such as the requirement for internal spaces to be lit, waterproof and breathable) our focus is on the particularity of each.

The secondary aim of the analysis is to provide a blueprint for the process of collecting and itemizing future research of supertall residential skyscraper, by focusing on novel ways of collecting and interpreting data. Within some scientific fields, and in particular those dealing with big-data, in recent times much credence has been given to so-called “citizen scientists”, individuals and groups which are often little more than private enthusiasts who, out of their own volition, collect and share

[28] Refer to the concept of ‘human scale’ within architecture.

data at a massive scale. These volunteers, often through internet-based means, such as esoteric specialist blogs and message boards, and, more recently, directly through social media provide an abundance of information. While that has been highly valued by ecology and environmental sciences (Bonney et al., 2014; Silvertown, 2009), the field of architecture has not been so quick to accept these new trends. That is partially due to possible inaccuracies and biases in such research, such as the well-documented cases of citizen scientist within the field of bird watching, understandably, preferring weekend data collection on sunny days to workday collection on rainy days (Courter, Johnson, Stuyck, Lang, & Kaiser, 2013). Similar biases are evident in architectural enthusiast data as well, often taking the shape of 'fans' of certain buildings or structures, heaping praise whilst detractors highlighting the inadequacies. This research proposes a fail-safe approach to this problem, by segregating the collected data into a three-tiered system of what could be described as primary source data; secondary source data; and tertiary (enthusiast) based data. The first two sources are preferred for obvious reasons. However, when those are unavailable or in short supply (as it happens with information about residential supertall in a number of the examined cultures), the tier-3, *citizen enthusiast* data have proven to be invaluable.

3.5.2.2 Source, Data Collection and Processing

The key source of data collected for this analysis stems from 2D interior architectural drawings of the set of towers in question. The data collected for this analysis, albeit far too large to mention individually for each example, stem from three types of sources:

Tier-1 - Published architectural and engineering drawings, sourced either through publications or directly from the architects/engineers.

Tier-2 - Real-estate brochures and websites, which provide a simplified interior arrangement plan, often of a single apartment and, on occasions, complete floorplates detailing measurements.

Tier-3 - Images of drawings taken by the (a) owners of the apartments themselves (often obtained through social networking websites), (b) enthusiasts of supertall residential towers. post on their

public messaging boards and (c) secondary literature collected by citizen enthusiasts focusing on specific elements within the apartments.

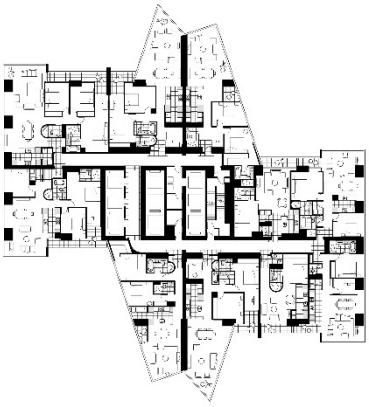
		
Example Tier-1 Data	Example Tier-2 Data	Example Tier-3 Data
Eureka Tower architectural plan provided architects with accompanying dimensions spreadsheet	Q1 Tower short term let real-estate brochure image with key plan of general arrangement	HHR Tower in Dubai as imagined and rendered by a private enthusiast for the PC game Cities Skylines (a successor to the popular 1990s computer game Sim City)
Source: Fender Katsalidis Architects	Source: Q1 Resort and Spa	Source: Steam workshop website / user: LUMINOU

Figure 17 - Three tiers of data quality used in the analysis

The highest quality data is undoubtedly sourced directly from the architects and the engineers in charge of the design of the structures, and their collections of drawings to publications. This type of data provides for a comprehensive, scaled and annotated drawing, which requires the least interpretation on behalf of the researcher.

Where such, high accuracy sources are unavailable, the secondary quality of data comes from real-estate brochures. They often legally must provide accurate dimensioning of apartments for potential

buyers and renters in m². Moreover, through the aforementioned standardisation of design a very accurate estimation of certain aspects of the interior space can be derived; such are the ubiquitous 900mm widths of apartment doors, the standardised 150mm dimensions of the partition wall and the minimum 200mm separation between the outer pane of a glass façade and the interior depth of the standard mullion. When extrapolated across these standards, and with the help of the total footprint of the apartments in question, a highly accurate dimensioned model can be created. In the case where single apartments are the only source of information, image processing tools are utilised to 'collate' single apartments into a cohesive whole.

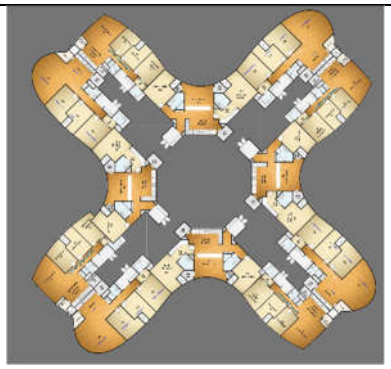
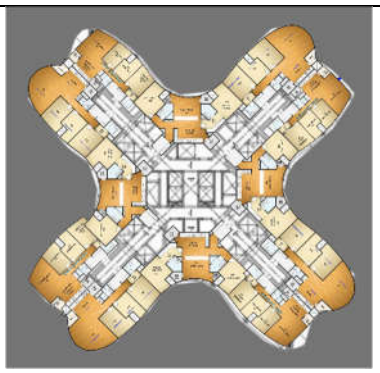
		
Disconnected Tier-2 images sourced from real-estate website.	Images collated to provide a cohesive whole.	Tier-3 image introduced to provide location of elements missing from Tier-2 sources.
Sourced directly from website	Processed via photomanipulation	Cross checked via engineering image from enthusiast website.

Figure 18 – Typical process of data processing of lower tier images into a workable whole

The example of We've the Zenith tower in Busan, South Korea (Figure 18) is emblematic of the process utilised from lower tier data sources. An incoherent number of disparate real-estate plans from singular sources are assembled and dimensioned to fit approximately within the general shape of the tower, which more often than not is observed from satellite imagery. Secondly the apartments are scaled in accordance to one another and placed in space virtual space as to form a

coherent whole. A tertiary low-quality Tier-3 image is then underlapped, as a proof of dimensions. The final image is ready for scaling and architectural re-drawing.

The lowest tier of data, Tier-3, while in off itself of very little use (as it often takes the shape of images from unverifiable sources which cannot be trusted individually), often provide invaluable information which might be obscured in the higher quality sources. Tier 3 is most often found in enthusiast websites where local populations scan images of towers from local newspapers, advertisements etc. for the benefit of the wider community, or from residents and local publishing images on websites such as Facebook, Twitter or Instagram. This enthusiast work can vary highly, from staggeringly accurate to completely inaccurate.

The process of selecting data is based on simple reductionist principles. If a building is documented in all three tiers of quality, the highest tier is used and the other tiers are provided for checking of inconsistencies. If a sample only has tier-2 and tier-3, both tiers are used in conjunction (refer Figure 18). If a building only has the lowest quality tier-3 data, then it is excluded from the analysis, as the variance in two high and could be misleading.

Further discussion on the implications of this tier-3 only category will be provided in the Discussion Chapter. Lastly the extent of data refers to the quality of the data across the whole tower, rather than a singular floor, which has a secondary impact on the study. If a tower has, for example, Tier-1 data on a single typical floor, yet lacks that level of data on the whole of the tower but still satisfies Tier-2 requirements on other atypical floors, the extent of data is considered whole and further analysis can be undertaken (refer to Figure 19 – Columns 3 & 4).

Tower Name	Tier – 1	Tier – 2	Tier – 3	Comments	Extent of data

Q1 Tower				Lower quality real estate brochure requiring collating in photographic software and cross-referencing with tier-3 images	
Eureka Tower				Drawings sourced direct from architect with real-estate brochures	Whole
HHHR Tower				Unpublished building	
Ocean Heights				Drawings sourced from publication and real-estate brochures	
Capital City Moscow				Highly published in architecture publications with real estate brochures	Whole
The Torch				Several real estate brochures available	Whole
Etihad Towers T2				Real estate brochure with key plan and enthusiast imaging	
Doosan Haeundae				Lower quality real estate brochure requiring collating in photographic software and cross-referencing with tier-3 images	
Princess Tower				Drawings sourced from publication and real-estate brochures	
23 Marina				Drawings sourced from publication and real-estate brochures	Whole
Elite Residence				Real estate brochure with key plan and enthusiast imaging	Whole
Cayan Tower				Drawings sourced direct from architect with real-estate brochures	Whole

East Pacific Centre Tower				Unpublished building	
WTC Abu Dhabi				Lower quality real estate brochure requiring collating in photographic software and cross-referencing with tier-3 images	
432 Park Avenue				Highly published in architecture publications with real estate brochures	Whole

Table 17 - Tower data tier level breakdown with comments and extent of data

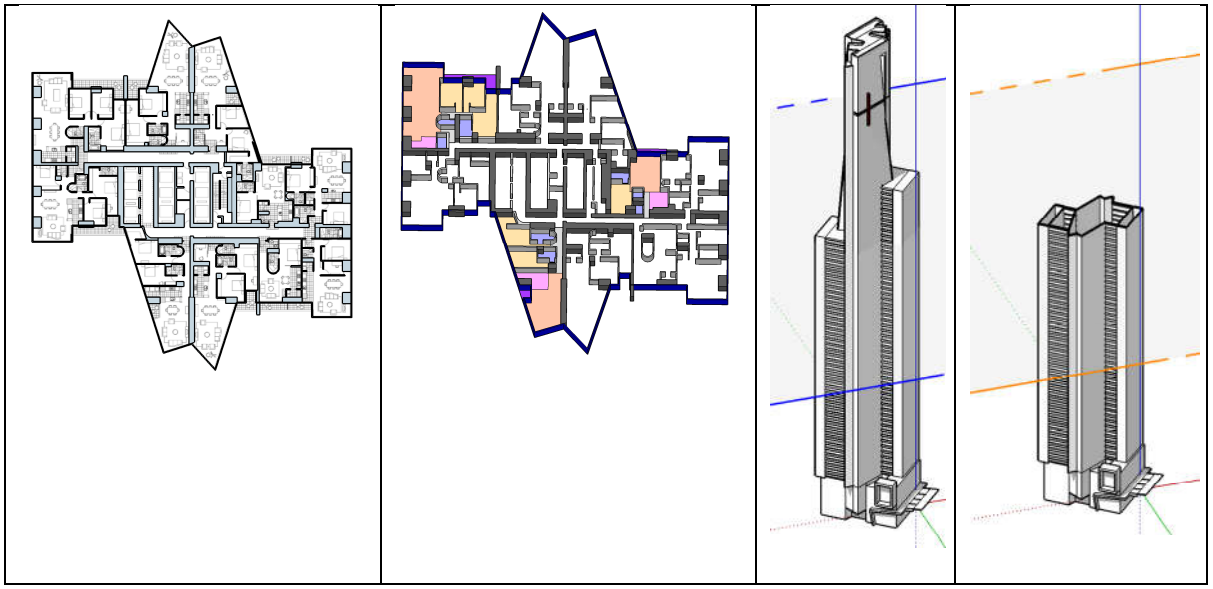
In summation seven towers have had the highest form of data, Tier-1 information available, six have had Tier-2 as the highest form of data, supported with Tier-3 or higher supplementation, and for two towers only Tier-3 data was available, which resulted with their exclusion from this research[29].

Once the data is sourced and processed (Figure 18), the apartment is re-drawn using Google Sketchup into a 3D dimensional scaled object, with a set of hierarchical layers. The primary elements of interest for the analysis can be observed via the layer naming convention and focus on primary structure, partition walls, room spaces, façade elements and textual elements. Each of the above elements provides the model with a unique attribute which helps overall dimensioning. Primary structure is differentiated from other walls, in order to provide for an understanding of the elements that puncture the building vertically from the lowest to the highest floors and these include the static elements such as columns and sheer walls, and dynamic, such as lift and stair shafts, and wet and dry cupboards. Partition walls and room spaces provide for an understanding of the definition of space and the potentiality for space consolidation with respect to the primary structures. Façade elements allow for the calculation of glazing to spandrel ratios, the general shape of the externality

[29] Surprisingly the HRRR Tower in Dubai and the East Pacific Centre Tower in Shenzen are entirety unpublished outside of unverified tier-3 quality, meaning that there is no record of their interior planning anywhere of note.

of the building and any external spaces such as balconies or wintergartens. Lastly the model itself is imbedded with a linked output of the room areas within the model.

Once a typical floor is detailed to the level presented below (Figure 19), any eccentricities to that typical drawing are modelled at a lower resolution to provide a holistic understanding of the tower as a whole. The comparison of the towers on a typological scale enables the analysis with broader understanding where the tower shifts from one internal typology to another, where any lateral transfer and services floors appear, and any changes in the surface of the tower. This holistic 3D modelling of the tower is only possible where the tier levels of data allow it and where sufficient number of typical floors is available (Refer to Table 17 – Column 6). The whole tower modelling is completed in two phases, firstly the detail typical floor and the atypical floors are superimposed to give an understanding of the floorplate variation, and secondly they are cross referenced with Tier-3 data (ideally from other 3D sources, such as private enthusiast modelling). The final result can be seen below (Figure 19).



Typical Tier-1 sourced plan processed for 3D modelling	High detail 3D model differentiating primary elements for analysis	Whole tower model at lower resolution	Horizontal sectional cut at the appropriate level of the typical floorplate used

Figure 19 - Typical 3D process of Tier-1 level data sourced tower (Example: Eureka Tower)

The process of data collection to data analysis is undertaken within this research is described below (Figure 20).

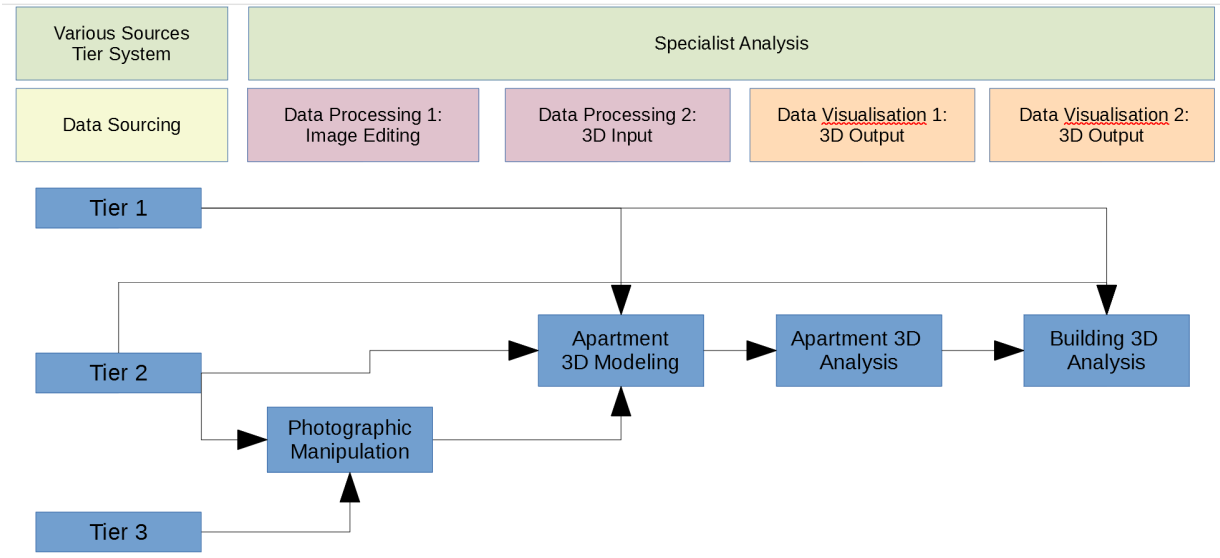


Figure 20 - Method diagram

3.5.2.3 Analysis

As described in the previous section (3.5.2.2) thirteen of the fifteen total supertall residential skyscrapers were analysed using the process presented in Figure 17Figure 20.

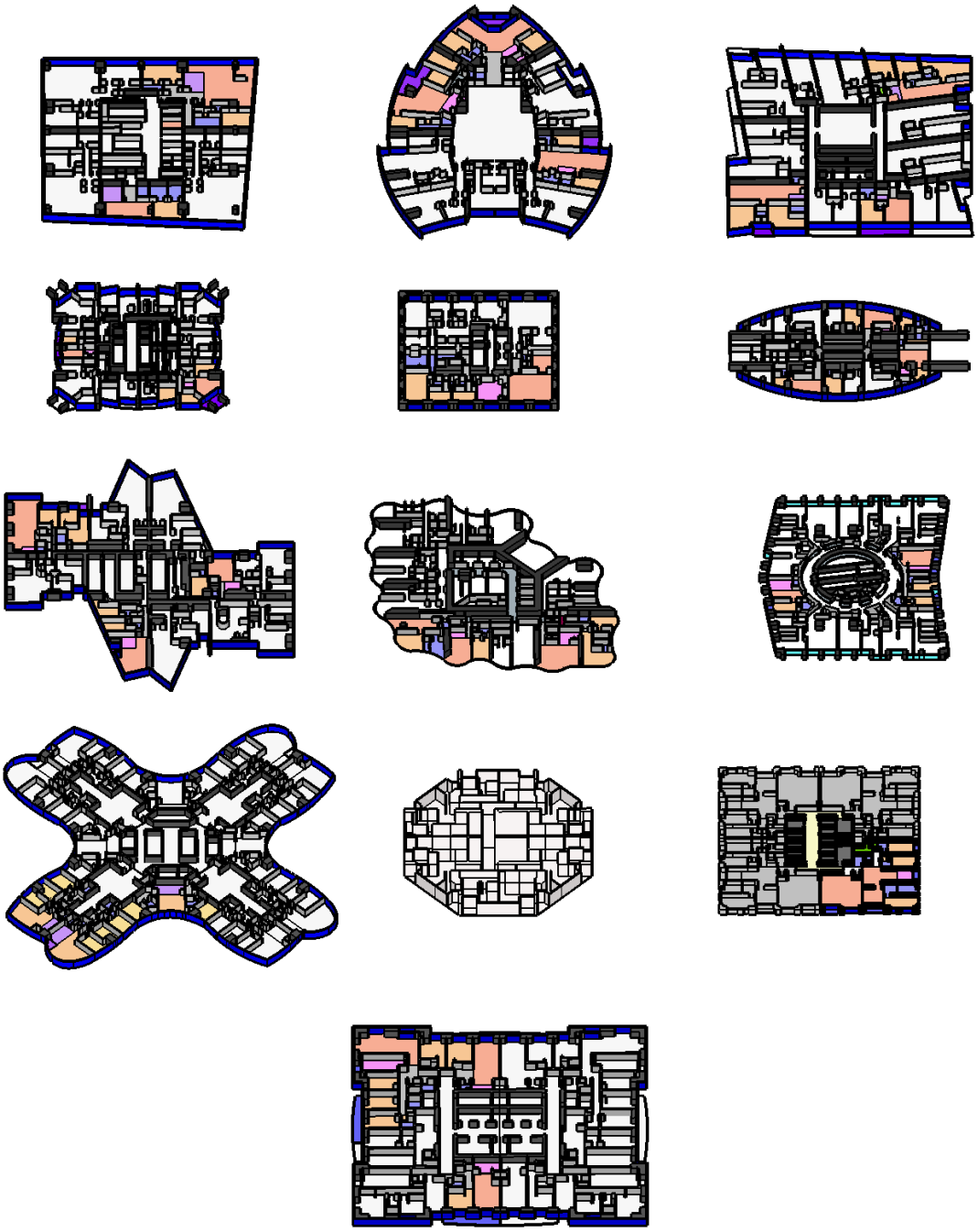


Figure 21 - All thirteen tower floorplates visualised in parallel projection at same scale in a single visual space. Consisting of (from left to right); 1. Capital City Tower, 2. Q1 Tower, Ocean Heights, The Torch, 432 Park Avenue, Etihad 2 Tower, Eureka Tower, Burj Mohamed bin Rashid, Cayan Tower, We've the Zenith Tower, 23 Marina Tower[30], Elite Residence and Princess Tower[31]

[30] The visualisation of 23 Marina Tower is slightly different stylistically compared to the other towers in the set due to a change in software at the early stages of analysis. However, the methods are in accordance with the complete set.

[31] For a complete overview of each tower with accompanying measurements

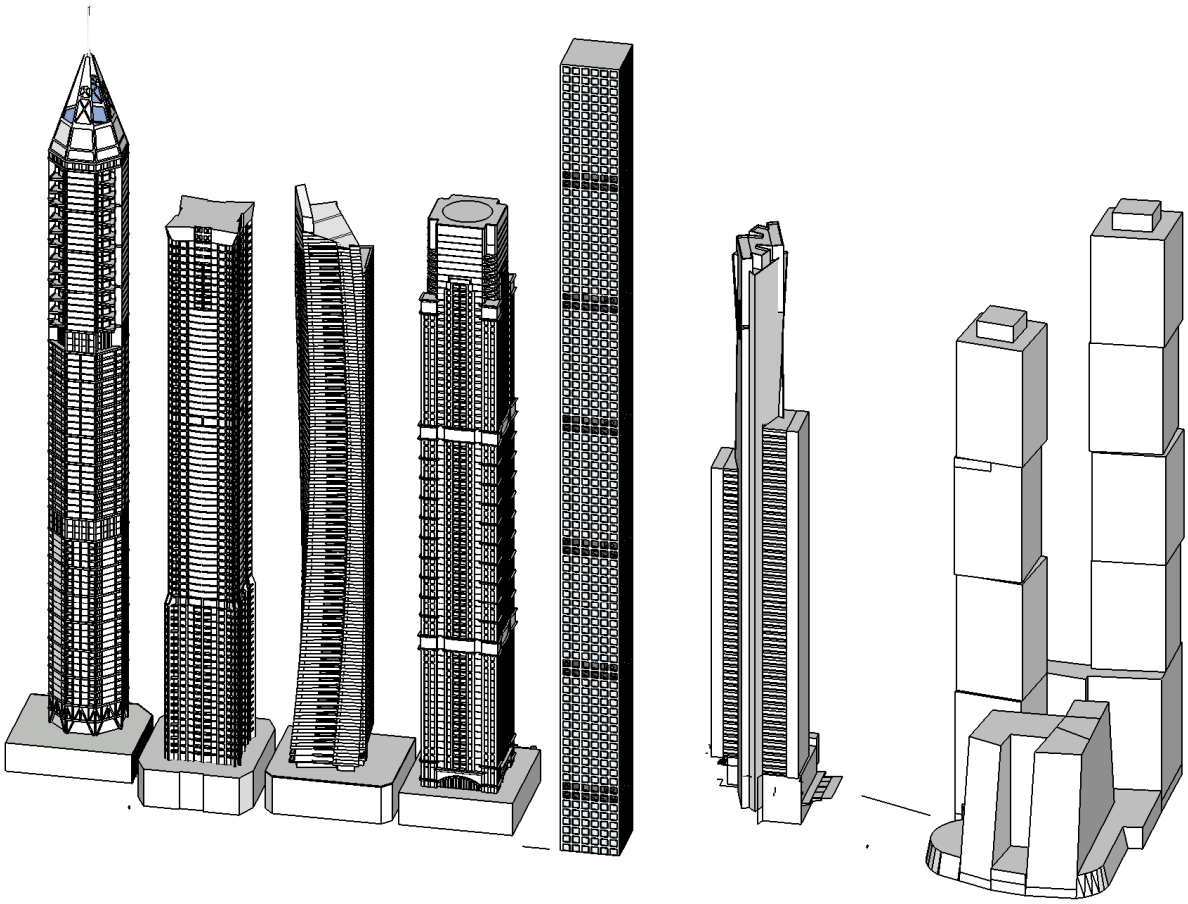


Figure 22 – Seven towers as highlighted in Table 17 with the required quality of information for 3D tower assessment. Consisting of (from left to right) 23 Marina Tower, The Torch, Ocean Heights Marina, Elite Residence, 432 Park Avenue, Eureka Tower and Capital City Moscow[32].

[32] Capital City Moscow tower seems less developed then the other towers in the set, however the visualization is correct as the software used is different to the other towers and there are no balconies or façade modularization beyond the large rectangular step-backs and thus the shadows do not pick up the same level of complexity. This lack of complexity does not affect the accuracy of the modelling or the result collected.

Below in Table 18 is an outline of all values related to the buildings in question.

			Apartment Types		Apartment Breakdown																		
Name	Typical Floor	Floor Type	1	2	3	Type	Rooms Types																
							Master Bedroom	Master Bathroom	Master Closet	Bedroom 1	Bathroom 1	Bedroom 2	Bathroom 2	Living/Dining	Kitchen	WC	Maid Quarters	Balcony 1	Balcony 2	Balcony 3	Balcony 4	Other	Total	Total Usable	Percentage Usable
23 Marina	8 - 31	Quandrant	0	2	4	2-bedroom	12.77 m²	3.64 m²	3.1 m²	9.5 m²	3.62 m²			27.05 m²	7.2 m²	1.9 m²	5.41 m²	4.03 m²	4 m²			10.1 m²	92.25 m²	82.15 m²	89.05%
						3-bedroom	15.2 m²	4.33 m²	4.4 m²	9.6 m²	3.52 m²	9.5 m²	3.12 m²	33 m²	6.6 m²	1.6 m²	5.65 m²	3.36 m²	3.01 m²	3.44 m²		8.58 m²	115 m²	106.4 m²	92.54%
432 Park Avenue	91-95	Symmetrical	0	0	2	3-bedroom	36.5 m²	17.2 m²	12 m²	15.5 m²	6 m²	16 m²	5.5 m²	82.5 m²	29 m²	3.9 m²						29.45 m²	253.3 m²	223.82 m²	88.37%
Burj Mohamed Bin Rashid	Unknown	Asymmetical	5	4	0	1-bedroom	16 m²	4 m²						26 m²	4 m²	4 m²						6.5 m²	60.5 m²	54 m²	89.26%
						1-bedroom	17 m²	8 m²	8 m²					27 m²	3 m²	5 m²						5.57 m²	73.57 m²	68 m²	92.43%
						2-bedroom	27 m²	5 m²		18 m²	5 m²			41 m²	13 m²	5 m²	13 m²					13.7 m²	140.7 m²	127 m²	90.26%
City of Capitals Moscow	64-73	Asymmetical	1	4	0	1-bedroom	28.7 m²	12.57 m²	10.1 m²					46.5 m²	15 m²	8.6 m²						9.7 m²	131.3 m²	121.57 m²	92.61%
						2-bedroom	32 m²	17.3 m²	5.2 m²	34.3 m²	9 m²			113.9 m²	18 m²	3.3 m²						42.5 m²	275.6 m²	233.1 m²	84.58%
Cayan Tower	Unknown	Asymmetical	4	5	0	1-bedroom	16.1 m²	5.41 m²						18.08 m²	11 m²	4 m²		2.94 m²				0 m²	57.76 m²	57.76 m²	100.00%
						2-bedroom	14.88 m²	5.36 m²	2.62 m²	15.67 m²	5.99 m²			24.55 m²	9.7 m²	2.5 m²		2.85 m²	2.95 m²	2.86 m²		11.65 m²	101.6 m²	89.93 m²	88.53%
Elite Residence	71-75	Quandrant	0	0	4	3-bedroom	22 m²	10.94 m²	7.7 m²	18.23 m²	4.46 m²	17.1 m²	4.05 m²	109.5 m²	9.1 m²	6.8 m²	9.9 m²	2.67 m²	3.33 m²	3.68 m²	2.34 m²	13.6 m²	245.4 m²	231.8 m²	94.46%
Etihad 2			1	4	0	1-bedrom	16.73 m²	5.41 m²						26.56 m²	7.2 m²	1.4 m²						6.86 m²	64.15 m²	57.29 m²	89.31%
						2-bedroom	16.73 m²	5.41 m²		9.23 m²	4.8 m²			26.56 m²	7.2 m²	1.4 m²						6.86 m²	78.18 m²	71.32 m²	91.23%
						2-bedroom	10.15 m²	6.38 m²	1.94 m²	10.44 m²	4.76 m²			24.71 m²	6.4 m²	1.5 m²						0.99 m²	67.25 m²	66.26 m²	98.53%
Eureka Tower	26-52	Symmetrical	4	4	2	1-bedroom	15.68 m²	4.96 m²						27.66 m²	10 m²	4.6 m²		5.46 m²				3.79 m²	72.3 m²	68.51 m²	94.76%
						2-bedroom	25.02 m²	6.5 m²		16.85 m²				41.44 m²	12 m²	4.6 m²		2.97 m²				10.77 m²	119.7 m²	108.95 m²	91.00%
						3-bedroom	24.15 m²	7.38 m²		15.16 m²	4.49 m²	16.58 m²		65.99 m²	9.6 m²	3.8 m²		12.91 m²				13.6 m²	173.6 m²	159.98 m²	92.16%
Ocean Heights Marina	Unknown	Assymetrical	5	4	1	1-bedroom	27.2 m²	7.65 m²						33.3 m²	6.2 m²	3.5 m²		15.48 m²				3.79 m²	97.16 m²	93.37 m²	96.10%
						2-bedroom	39.22 m²	8.36 m²		34.96 m²	5.39 m²			57.86 m²	8.4 m²	4.6 m²		6.44 m²				8.36 m²	173.7 m²	165.29 m²	95.19%

						3-bedroom	38.35 m²	4.99 m²		20.37 m²	6.34 m²	25.9 m²		52.57 m²	6.5 m²	5.4 m²	4.35 m²	4.14 m²				9.54 m²	178.4 m²	168.9 m²	94.65%
Princess Tower	25-50	Symmetrical	4	2	2	1-bedroom	25.19 m²							42.78 m²	14 m²	7.2 m²		17.77 m²				10.16 m²	116.9 m²	106.77 m²	91.31%
						2-bedroom	28.6 m²	6.46 m²		28.59 m²				47.76 m²	9.7 m²	4.6 m²		17.17 m²				14.57 m²	157.5 m²	142.92 m²	90.75%
						3-bedroom	30.12 m²	6.8 m²		26.41 m²	7.02 m²	26.41 m²		64.54 m²	30 m²	11 m²	4.35 m²	3.1 m²	18.33 m²			30.35 m²	259.1 m²	228.71 m²	88.28%
Q1 Apartments	42-54	Symmetrical	0	3	4	2-bedroom	21.04 m²	9.33 m²	5.96 m²	21.17 m²	6.38 m²			68.42 m²	9.5 m²	2 m²		13.33 m²				1.56 m²	158.7 m²	157.11 m²	99.02%
						2-bedroom	25.63 m²	7.25 m²	6.16 m²	23.26 m²				67.83 m²	19 m²	1.7 m²		16.46 m²				27.06 m²	194.3 m²	167.2 m²	86.07%
						3-bedroom	27.03 m²	10.2 m²	7.02 m²	18.17 m²	5.74 m²	24.72 m²	2.71 m²	56.65 m²	14 m²	3.2 m²		21.52 m²				17.93 m²	209 m²	191.09 m²	91.42%
The Torch	66-73	Quadrant	4	0	4	1-bedroom	13.12 m²	5.41 m²	2.62 m²					19.86 m²	6.9 m²	3.7 m²		9 m²	9 m²			5.71 m²	75.28 m²	69.57 m²	92.41%
						3-bedroom	18.78 m²	6.74 m²		19.95 m²		21.63 m²	8.05 m²	33.38 m²	9 m²	3.7 m²		14.81 m²				11.6 m²	147.6 m²	136.04 m²	92.14%
We've the Zenith	52 - 75	Quadrant	0	4	8	2-bedroom	18.6 m²	5 m²		17.6 m²	6 m²			27.4 m²	14 m²	3.4 m²						22.34 m²	114.6 m²	92.3 m²	80.51%
						3-bedroom	18.2 m²	4.9 m²	2.9 m²	13.5 m²		17.5 m²		42.26 m²	11 m²	6.3 m²		3 m²				14.86 m²	134.2 m²	119.36 m²	88.93%
						3-bedroom	16.2 m²	4.9 m²	2.9 m²	12.9 m²		13.9 m²		33.9 m²	11 m²	6.1 m²		2.5 m²				14.85 m²	118.9 m²	104.08 m²	87.51%

Table 18 - Numerical values of all three skyscrapers analysed.

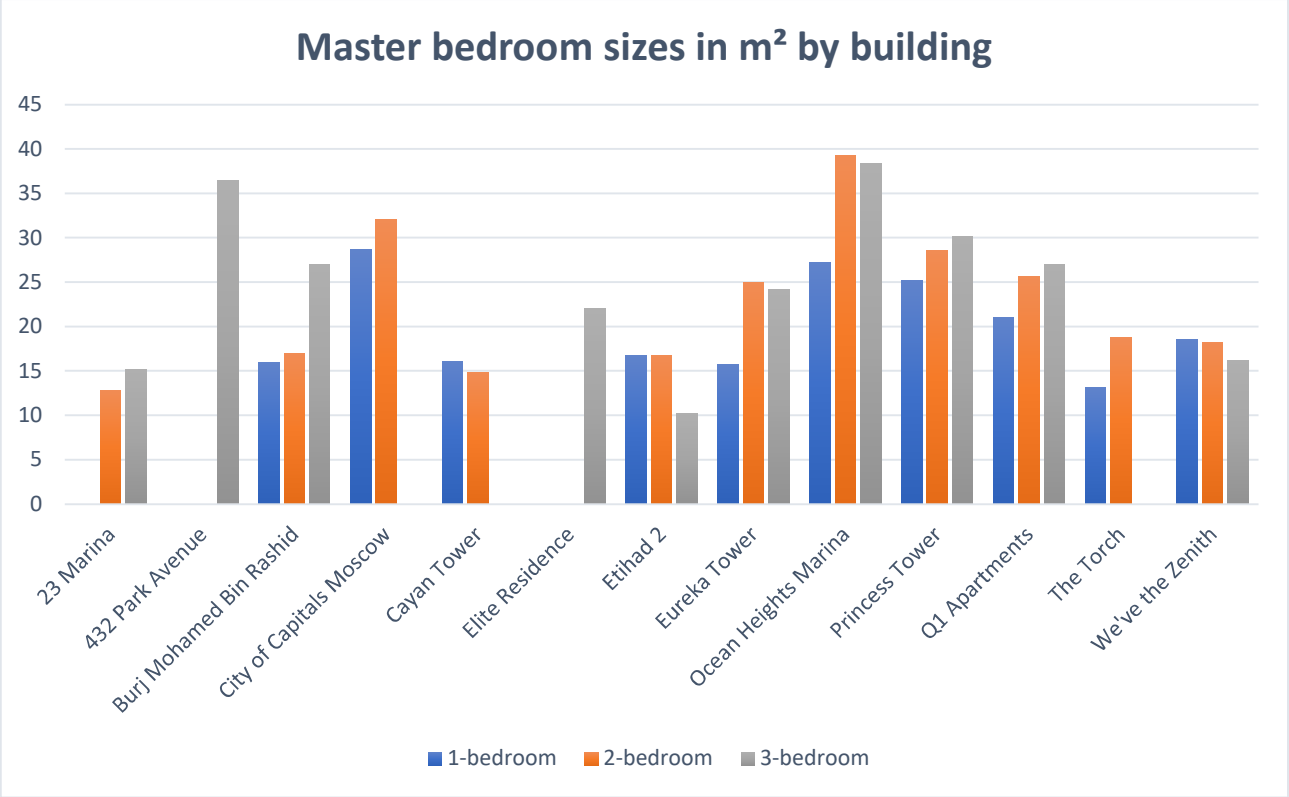


Figure 23 - Master bedroom size in m² by building type

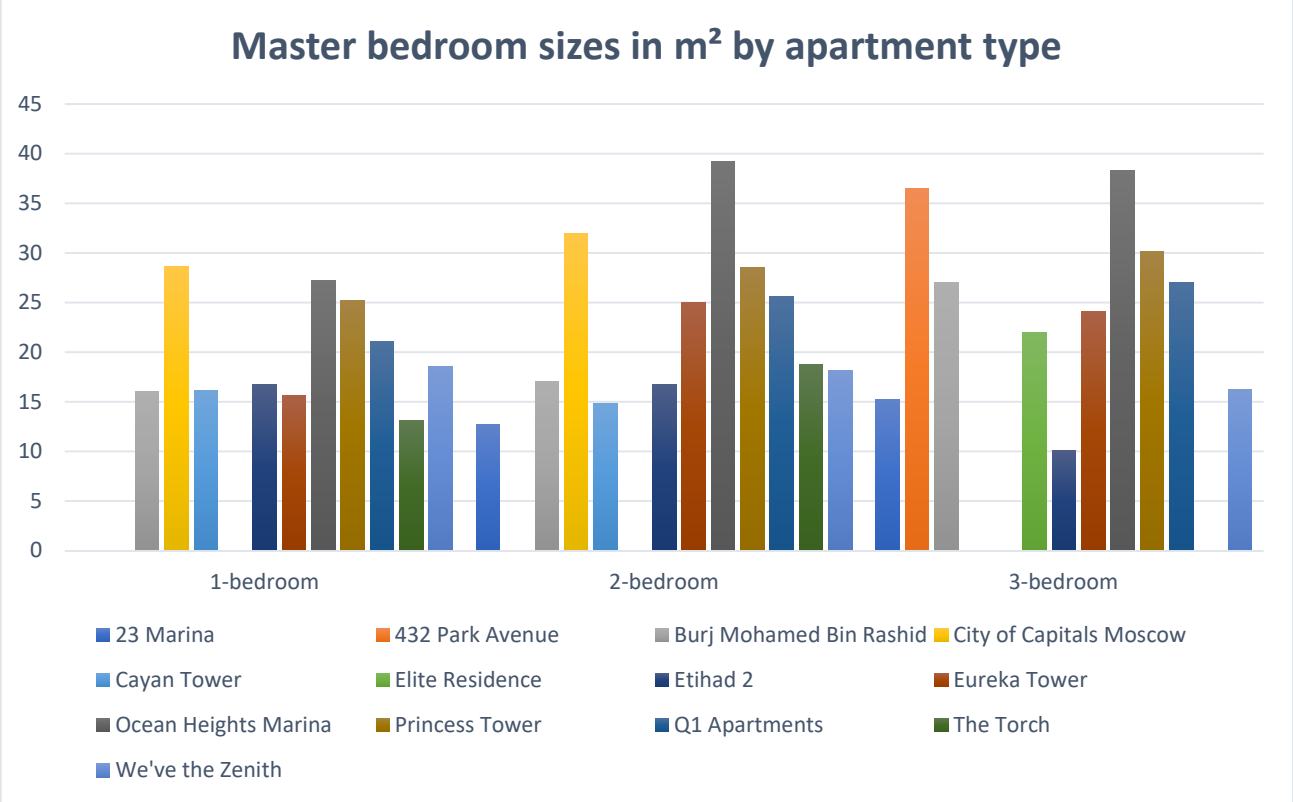


Figure 24 - Master bedroom size in m² by apartment type

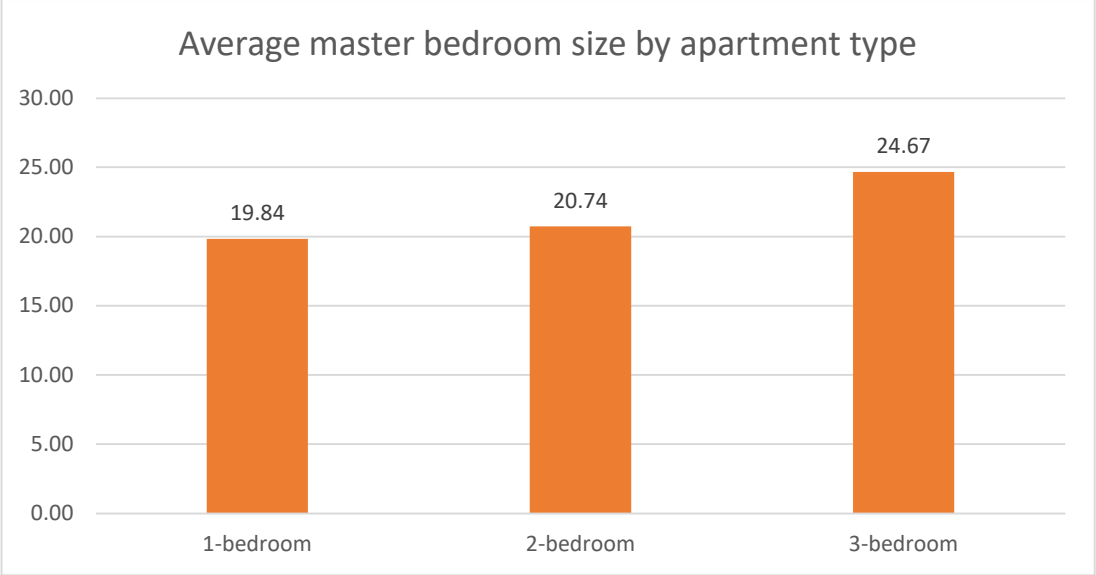


Figure 25 - Average master bedroom size by apartment type

The first zone of interest within the set of data provided in Table 18 focuses on the 'master bedroom' area within any give apartment. The terminology of 'master' -bedroom references back to older housing typologies which could have a bedroom for the master of the house, bedrooms for children and often bedrooms or sleeping quarters for servants. The use of the term has become widely recognised in contemporary jargon to mean the bedroom for the occupant of the house, whilst the other bedrooms could be re-purposed for other activities or visiting guests. For clarity, in this work the master bedroom is the only bedroom within a 1-bedroom apartment[33], and either the largest bedroom in a multi-bedroom apartment or, in the case of City of Capitals Moscow, The Torch and Ocean Heights Marina (where the master bedroom is not the largest bedroom by surface area) by the room with a direct, unshared access to a private 'master closet' and/or 'master bathroom.

The smallest master bedroom was observed in the Etihad 2 Tower measuring at just 10m², whilst the largest was a staggering 39.2m² in the large 2-bedroom apartment. What the data shows us (Figure 23 and Figure 24, page …) is that there is little standardisation of master bedroom sizes in the set beyond the minimum requirements of placing a double bed with the ancillary storage around. Moreover, all master bedroom, bar the 1-bedroom at Princess Tower, have direct access to a private master bathroom with the rest of the apartment having access to

[33] It is relevant to note that none of the apartments within the towers analysed offer 'studio' apartments which have a combined bedroom-living-dining area, although the Eureka Tower comes closest with an arrangement termed a 'borrowed-light' apartment which will be referred to in the Chapter discussion.

a separate WC (water closet) area. On average (

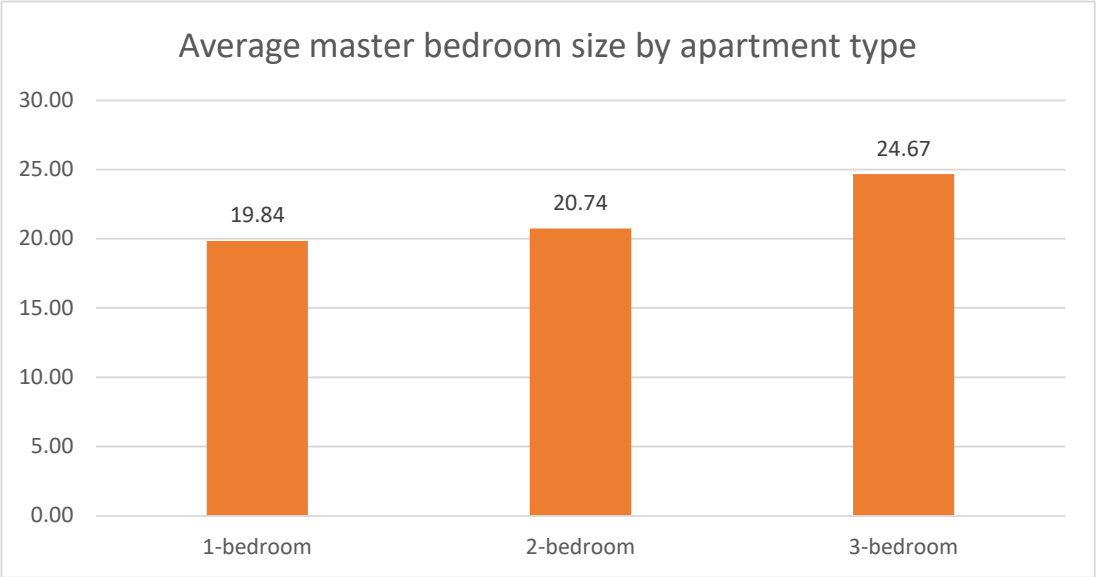


Figure 25, page …) the size of the master bedroom grows in size as the apartment types rises in size from 1-bedroom to 3-bedroom, albeit with only minimal gains from the 1-bedroom to the 2-bedroom variant.

Nonetheless the master bedroom, as the antithesis of Mies's universal space, in all the examples reviewed is a highly private space as shown by the strict separation of sleeping and hygiene areas from the primary guest and secondary bedroom areas.

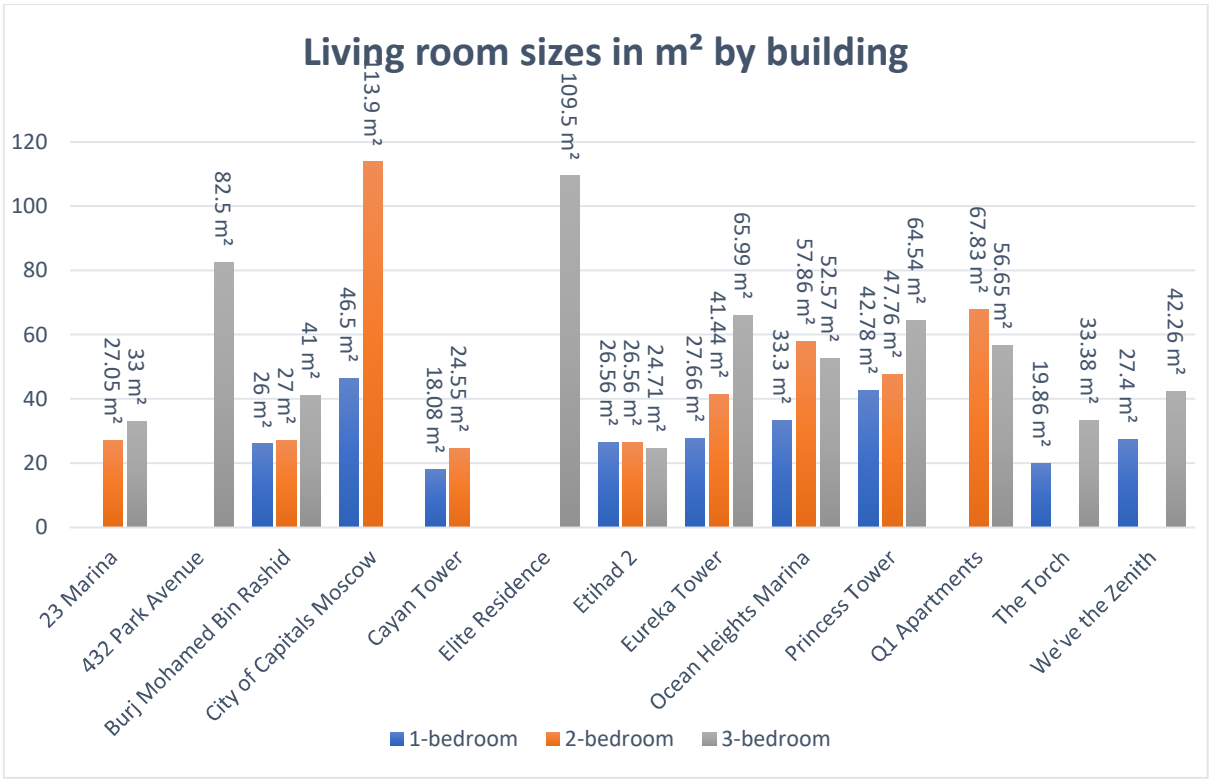


Figure 26 - Living room sizes in m² by building

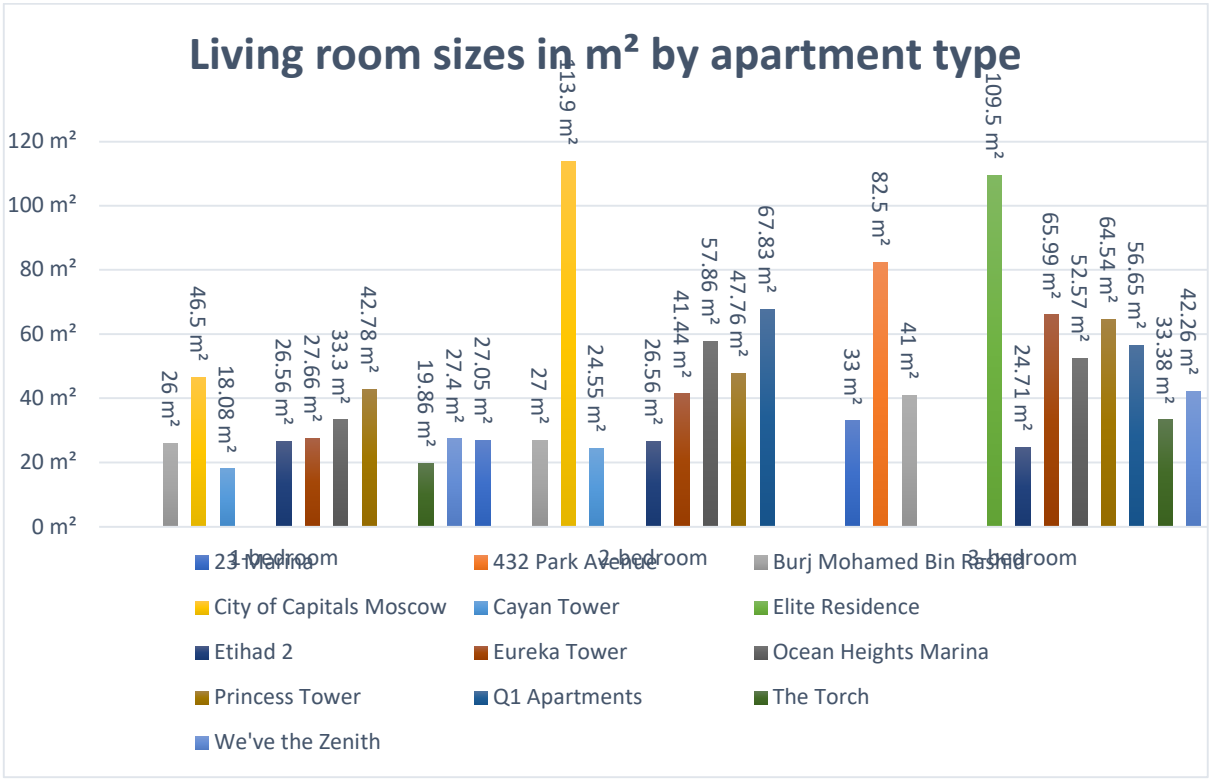


Figure 27 - Living room sizes in m² by apartment type

The second zone of interest is the living/dining room ensemble present in all examples. For the sake of clarity, we will refer to the living/dining room as simply living room unless specifically differentiated zonally or by partition walls. The role of the living room in the entirety of the apartment differs from one to the other specific context. There are two prevalent arrangements observable in 2- and 3-bedroom apartments. In order to differentiate the two typologies, we will refer to the first as the 'dumbbell' arrangement[34] and the second as the 'edge' arrangement.

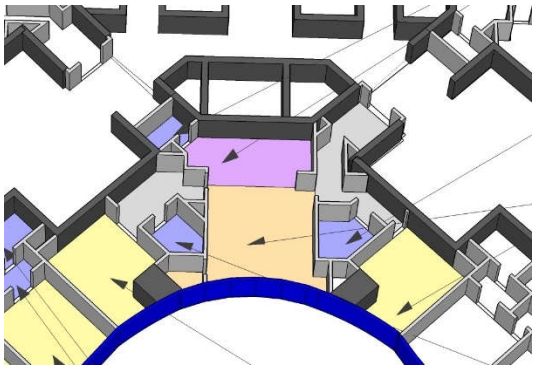


Figure 28 - We've the Zenith tower, 2B apartment exhibiting the typical 'dumbbell' arrangement (orange is living room, yellow is bedroom)

Figure 29 – Princess Tower, 2B and 3B arrangement exhibiting the typical 'edge' arrangement (orange is living room, yellow is bedroom). 2B apartment highlighted in yellow.

In the above examples (Figure 28 and Figure 29) the differences are highlighted. In the dumbbell arrangement the open space living/dining/kitchen area is skirted by bedrooms and their ancillary bathrooms, thus dividing the apartment into three discreet parts following the logic of bedroom-living-bedroom arrangement. The replication of this model from apartment to apartment allows for the desirable condition of two bedrooms, which can be considered night-time areas, to press back to back. If we imagine that the example is not in its unique clover-leaf design, the following design can be seen:

$$[bedroom - \boldsymbol{living\ room} - bedroom][bedroom - \boldsymbol{living\ room} - bedroom]$$

[34] A borrowed term from the design of shopping centres where either side of a central space is defined by two major outlets.

Day-time areas, or the living room area is contained within two night-time areas, and thus noise is reduced to a minimum from apartment to apartment. In the 'edge' arrangement we can see that the case is not the same. The living room of the 3B apartment butts up against the master bedroom of the 2B apartment (highlighted in yellow). Therefore, the desired outcome of the dumbbell arrangement is lost and day-time and night-time rooms from separate apartments meet in proximity. To follow the liner logic of the dumbbell layout we can see that (clockwise from bottom left bedroom in the 3B apartment) the following pattern is established:

$$[bedroom - bedroom - bedroom - \boldsymbol{living\ room}][bedroom - bedroom - \boldsymbol{living\ room}]$$

From a purely self-contained dwelling vantage point the dumbbell arrangement is superior, however the edge condition of the living space provides an interesting potential for consolidation of apartments with minimal internal works.

Figure 30 – We've the Zenith 3B and 2B apartment form

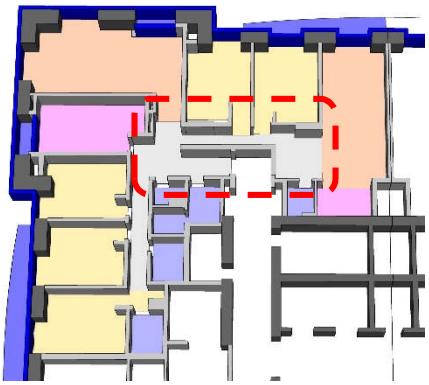


Figure 31 – Hypothetical consolidated 5B (or 6B) apartment model

In the above scenario the removal of the master-bedroom ensuite in apartment 2B (Figure 30) allows for the continuation of the internal hallway to provide a centralized circulation space whilst maintaining the integrity of the apartment shape. Of course further changes could be made but on the most simple of interventions one large apartment, or perhaps two integrated yet discreet apartments, is achievable.

3.5.3 The macro scale – contextual and urban analysis

The notion that skyscrapers should ideally be built in grouping is not a new one in architectural discourse. The idea was perhaps firstly and most dramatically introduced by the mid-20th century French architect and urbanist Le Corbusier (Corbusier, 1933) where he proposed the demolition of central Paris and its reconstruction in his *Plan Voisin*. The founding principle behind his utopia was that cities of the era, exemplified by Paris, were crowded and lacking green space; his solution was to construct skyscrapers in the place of the historical centre of Paris, and thus free the land for parks and greenery whilst submerging roads and public transport. This theory gave birth to the idea of the ideal city being one dominated by living at height, whilst retaining open space at foot. Although never realized at the scale or ambition that Le Corbusier proposed, large-scale urban re-developments primarily focusing on high-rise vertical housing have become a common city in cities around the world.

3.5.3.1 Introduction

Melbourne, Australia is one such city, which through a variety of factors experienced a housing boom unseen in generations. Fueled in part by excessive land prices, relatively lax planning laws and government eagerness for construction the city has gone through considerable change over the last twenty years; resulting in one of the densest urban centres in the world (Hodyl, 2015). The rate of development seen in Melbourne, and mirrored my many other Australian urban centres, has seen a degradation of certain livability factors; exemplified in new large scale inner city land releases. Two such releases in central Melbourne (Southbank in the early 1990's and Docklands in the 2000's) have been accused of providing a subpar level of public amenity within the districts. Southbank has been accused of not providing enough sunlight (Dovey & Symons, 2014) whilst Docklands has seen unacceptable wind speeds.

The newest land release in inner Melbourne is the Fishermans Bend district. Through consultation with stakeholders at different levels of government in Australia, it has been established that, in order to prevent mistakes carrying over from previous developments, Fishermans Bend requires a holistic overview of environmental factors prior to commencement of wholesale construction with a simulation of the same region post complete construction.

This research focuses on two environmental factors directly related to the ground level comfort and amenity of the people in the precinct of Lorimer, within the larger district of Fishermans Bend. Through large-eddy simulation coupled with three-dimensional radiative transfer model of the precinct in its current undeveloped state and its post development state 1) wind speeds and 2) wind temperatures are simulated and visualized to provide a clear understanding of the impacts large scale skyscraper development will have within this region.

As the world's megalopolises continue to attract large increases in populations certain affected cities and regions have adopted policies of inner city urban renewal that comprises of redeveloping post-industrial brownfield sites from their previous uses into residential districts.

Figure 32 - Melbourne's Docklands and Fisherman's Bend urban renewal districts 1940's and 2010's Source: The Age newspaper

Often this urban requalification and redevelopment takes the form of high-rise 'skyscraper cities'[35], areas that are dominated by a building typology predominantly focusing on height as the solution for specific urban malaise (refer to Fig.1). Historically cities relied on tall buildings to 'cure' different social and urban problems of the specific era; from the required reconstruction of cities destroyed through war (Tokyo, Japan), ghetto clearing and social engineering (Chicago, USA) or post-war migrations (Melbourne, Australia).

Many contemporary examples of skyscraper cities, particularly those developed on either reclaimed or post-industrial land (Refer to Fig. 2) are constructed in a very short period of time and tend to use similar materials.[36]

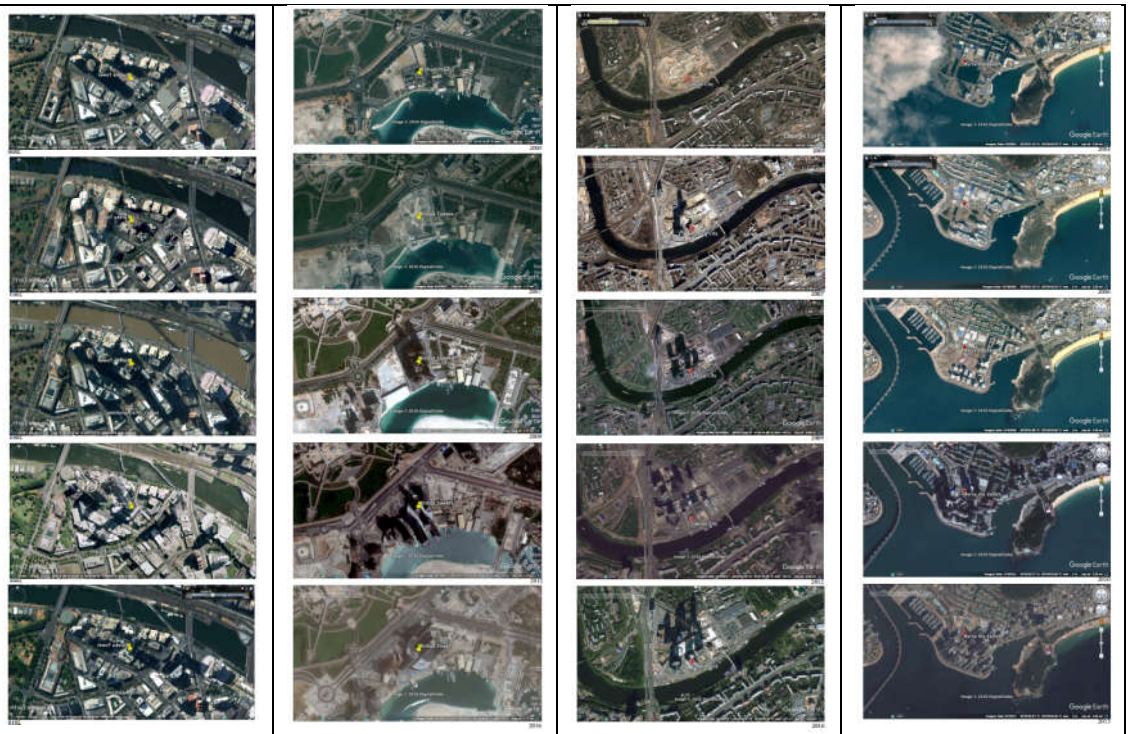
The four districts in the figure 2 (from left to right; Melbourne, Australia; Dubai, UAE; Moscow, Russia and Busan, South Korea) all share a set of commonalities that are more linked to their impressive clusters of skyscrapers than anything specific in their urban contexts. Namely, the predominant materials used are glass, silicone and steel on the exterior, and either concrete, steel or concrete-steel composite structure.

In the case of Melbourne, Australia the district highlighted is Southbank, and was the first example of new skyscraper city growth on what was previously rail related post-industrial land within the city (Dovey & Symons, 2014). The development began in the late 80's and early 90's. Soon after, and partially due to the success of Southbank, the Docklands area of western Melbourne (Fig.1) began a similar process of re-development; this time from underused dockyards to residential and commercial areas in the early 2000s' (Ray, 2013;

[35] The emergence of skyscaper cities, sometimes referred to as the neologism "Manhattanisation" of an area, refers to quick replacement of traditional urban fabric (whatever it may be) with tall nondescript skyscrapers. The root of the word comes from the mid-1960's San Francisco or early 2000's Miami, where there was a groundswell of opposition to neighbourhood character being altered through erection of skyscrapers.

[36] For further reading on this specific topic, regarding reclamation of land and development of skyscaper cities; please refer to the Major Project presentation by Radovic, Vuk

Shaw, 2013). The newest, and perhaps final, urban renewal development project within Melbourne, and the focus of this research, is the Fishermans Bend urban renewal project, immediately south of Docklands.



Southbank Melbourne (AUS)	Corniche Dubai (UAE)	City of Capitals Moscow (RUS)	Haeundae Busan (Kor)
Images from 2000 until 2015			

Figure 33 - Satellite imaging relating to four districts exhibiting 'manhattanisation' in a very short period of time. Source: Google Earth

Melbourne is the capital city of the State of Victoria and is Australia's second most populous city. The city was first founded in 1847 with the discovery of gold in Victoria and quickly grew from a small settlement to over 40,000 inhabitant in a matter of months in the 1850's. The population of Melbourne has grown steadily every since, and currently houses over 4.7million inhabitants (up from 3.7 in 2006) with a year-to-year increase of approximately 2.0% or around 100,000 people per annum[37].

[37] Australian Bureau of Statistics: http://www.abs.gov.au/ausstats/abs@.nsf/mf/3218.0

Historically Melbourne, and many other large Australian cities, has adopted the suburban model of development for housing. This model, which has its roots in the late 19th century British idea of Garden Cities or satellite cities shrouded in greenery (conjuring images of semi-rural life, albeit at a reasonable distance to the city centre) dominated and in many ways still dominates Melbourne's planning logic (Rahnam, Wyatt, & Heydari, 2015). This adherence to 'wide' cities, has meant that Melbourne covers an area of approximately 9,900sqkm, or that of over four and a half times the area of metropolitan Tokyo (2,200sqkm), with a fraction of the population.

In the early 1990's a concerted push towards limiting the outwards sprawl of metropolitan Melbourne was first introduced through a planning mechanism called Postcode 3000[38]. The logic of this planning policy was to introduce residential populations into the city centre, then still referred to as the Central Business District (CBD), through re-zoning of commercial and industrial land into mixed-use and residential zoning.

In many ways Fishermans Bend, almost thirty years later, is a direct descendent of the planning policies set out in Postcode 3000, albeit slightly away from the now highly residential Melbourne city center[39].

Fishermans Bend urban renewal project began in the early 2010's with a large land release by the then Premier of Victoria Hon. Matthew Guy, which took the form of a quick change in

[38] This planning policy was primarily the work of Prof. Rob Adams of the City of Melbourne, and put in to practice by the then Premier of Victoria, Jeff Kennett.

http://www.melbourne.vic.gov.au/arts-and-culture/city-gallery/exhibition-archive/Pages/Postcode-3000---A-city-transformed.aspx

[39] For further reading relating to Melbourne's incredible growth, particularly in the city centre, refer to: https://www.churchilltrust.com.au/media/fellows/Hodyl_L_2014_Social_outcomes_in_hyper-dense_high-rise_residential_environments_1.pdf

planning zoning from industrial land to mixed-use. The rezoning was not received well[40] in certain circles of the architecture and ubran design communities of Melbourne. The result has been that one specific area of the much larger Fishermans Bend district, the precinct of Lorimer (Fig. 3) having had a number of large scale developments submitted to the government for approval (Fig. 4).

As figure 4 shows, all the developments, irrespective of the phase they are currently in (applied for approval or approved) have been registered in a five (5) year period from the year 2013. Furthermore, since the developments have been proposed by different developer companies, due to secrecy involved around the governmental construction approval process it is possible to assume that these development had no clear indication of what was being constructed on the neighbouring sites.

Figure 34 - Fishermans Bend urban renewal district, with Lorimer precinct in the north-eastern corner. Source: Author

[40] The attacks on the original plan have been particularly vicious since the change of government at state level. Refer to: https://www.premier.vic.gov.au/fixing-matthew-guys-mess-at-fishermans-bend/ and https://www.theage.com.au/national/victoria/fishermans-bend-anatomy-of-a-highrise-ghetto-20141101-11ekr2.html

Thus each of these developments, without the benefit of knowing exactly what was being proposed on each other site within the district was ultimately designed 'in the dark'.

3.5.3.2 Source and Data Collection

With the advent of skyscrapers being the predominant housing typology in inner-Melbourne, a set of rules and regulations have been developed to specifically address their materialization within the wider context of the city. Namely a robust wind engineering analysis has been required by the approval authorities to prove that the construction of each specific building being applied for does not negatively impact its surroundings. Within the established district of Melbourne city centre, which has seen high-rise development since the late 70's, this approach of requiring each development to provide a wind engineering report specific to their site seemed to have been sufficient to prevent unwanted wind tunnel effects. However, the developments in Docklands, which were basically built on a *tabula rasa* were plagued by wind intensification due to skyscraper construction[41]. Fishermans Bend, partially due to its location immediately south of the Docklands, and partially due to the fact that it is following a similar development schedule as Docklands has the potential to have comparable wind issues.

[41] See https://www.domain.com.au/news/docklands-the-once-unliveable-suburb-that-people-now-wont-leave-20161012-grzg4e/

No	Name	Type	Status	Date	Floors	Dwellings	Office (sqm)	Industrial (sqm)	Retail (sqm)	Car Parks
162-188	Turner	Residential	Applied	2015	40	344				147
162-188	Turner	Residential	Applied	2015	36	265				184
162-188	Turner	Residential/Commercial	Applied	2015	40	311	3390			
162-188	Turner	Residential/Commercial	Applied	2015	28	215	5467			
162-188	Turner	Residential	Applied	2015	40	348				235
150-160	Turner	Residential	Approved	2013	31	361				252
351-387	Ingles	Residential	Applied	2013	35	263				278
351-387	Ingles	Residential/Commercial	Applied	2013	45	312	3762			
351-387	Ingles	Residential	Applied	2013	39	505				394
351-387	Ingles	Residential	Applied	2013	30	375				316
351-387	Ingles	Residential	Applied	2013	25	460				397
310-324	Ingles	Mixed Use	Approved	2015	9		6865	4100		
850-868	Lorimer	Residential	Applied	2014	43	366				227
850-868	Lorimer	Residential	Applied	2014	45	401				308

850-868	Lorimer	Residential	Applied	2014	29	367				425
172-179	Lorimer	Residential	Applied	2018	4	18				43
172-192	Lorimer	Residential	Approved	2015	43	316				400
111	Lorimer	Street	Applied	2018	40	396				497
85-93	Lorimer	Street	Approved	2014	43	393				375
85-93	Lorimer	Street	Approved	2014	57	501				347
13-33	Hartley	Street	Applied	2016	40	352				341
13-33	Hartley	Street	Applied	2016	34	256			60	

Figure 35 - Lorimer precinct breakdown of new developments Source: Author

Through conversations with relevant building authorities, architects working on specific buildings within the area, and wind engineering experts locally and internationally; [42] it has been made clear that district wide wind analysis must be undertaken to understand the implications skyscraper cities have on their immediate environment. This type of analysis, which traditionally would have been undertaken in physical wind tunnel testing, has proven to be of too large a scale to utilize this method.

Figure 36 - Fishermans Bend looking North highlighting the proposed developments within the Lorimer precinct. Source: CoM

The method of simulating district wide wind patterns prior and post major architectural development can be understood as a tripartite system.

1. data relating to the current and future conditions of the site need to be collected from various Australian government sources (Fig. 6)
2. that collected data needs to be transferred in to binary format to be used for numerical simulations by the Earth Simulator of the Japan Agency for Marine-Earth Science and Technology Centre (JAMSTEC). The Earth Simulator is a highly parallel vector super-computer system funded by the Japanese government and primarily used for global climate models.
3. and finally, two numerical studies were performed utilizing the data collected and compared to highlight the differences in wind direction in the pre and post construction scenarios.

The results of the analysis can be found in Chapter 4.0 Results.

[42] The author spent three months working with the Department of Energy, Land, Water and Planning at the State Government of Victoria from October '17 – January '18 as a part of the GESL International Training and has spent three years prior to commencing the GESL program working as an architect on projects within the zone of Fishermans Bend.

Australia as a part of their National Innovation and Science Agenda[43] has strived to provide open source data collected through national agencies online. The data although readily available is accessed via a number of different portals, domains and agencies. Federal and state based data is most readily found on the website data.gov.au; however local data (relating to local municipalities) is most likely found via specific local municipal councils, which in some cases have extensive GEOSpatial archives, and in others very limited. Figure 6 explains what data was collected from Australian sources to be used within this specific research.

Type of data	Source	Use
3D Development Model	City of Melbourne (Local Municipality)	3D model of existing, applied and approved construction
3D Tree Canopies	Department of Forestry (State Gov.)	City wide map of foliage with size, species, area and position.
2D Cadastral	Department of Energy, Land, Water and Planning	Zoning strata allotments pertaining to the development of City of Port Phillip and City of Melbourne.
2D Contours	Department of Energy, Land, Water and Planning	Topographic data at 1m intervals (not used due to the relative flatness of the site).
2D Waterways	Department of Energy, Land, Water and Planning	Basic mapping of the Port Phillip bay body of water, the Yarra and Marribyrnong Rivers and the dockyards

Figure 37 - GEOSpatial data collected from a variety of Australian data sources

The data collected, although of relatively high quality and accuracy was difficult to collect due to the disparate nature of the file locations. Moreover, the specific physical location of Fishermans Bend sits between two different municipal councils, City of Melbourne and City of Port Phillip, yet is managed by a specific governing body directly reporting to the State Government of Victoria. This separation caused major complications in the delineation between data sets, and meant that certain zones were not covered by the data from either municipality. In the case that data was not available in either data set assumptions were made. These assumptions were primarily focused on:

1. the height of buildings that were unavailable in the 3D development model data set

[43] See *Government as an Exemplar* section of the National Innovation and Science Agenda at https://www.innovation.gov.au/page/national-innovation-and-science-agenda-report

    a. heights were estimated through complex, iterative referencing between the cadastral data set, satellite imaging and through the use of Google Streetview, and
2. the discrepancies in land-use data sets
    a. which were once again supplemented with the above method in case of data unavailability.

3.5.3.3 Analysis

Through the utilization of Geographic Information System (GIS) software the data collected (Fig 6.) was transferred in to a specific format that was required for the simulation via the JAMSTEC Earth Simulator. The simulation parameters followed closely the precedent set in the study *Tree-crown-resolving large-eddy simulation coupled with three-dimensional radiative transfer mode* (Matsuda, Onishi, & Takahashi, 2018). For specific computational methods and the coupling of the large-eddy simulation (LES) and three-dimensional radiative transfer (3DRT) please refer to the abovementioned paper.

Large-eddy simulation (LES) is a numerical technique for integrating spatially filtered equations of motion that describe high Reynolds number time-evolving, three-dimensional turbulence (Yung, Wong, & Gaidos, 2015). In order to run an LES for the analysis of urban thermal environments it needs to be coupled with an efficient three dimensional radiative transfer (3DRT) model.

The computational domain of the simulation was 8000m x 8000m in horizontal area with the centre of the domain placed at the Lorimer Street precinct. The vertical height of the domain was set at 2500m. The vertical grid spacing below the height of 400m was set at 5m and above 400m was extended continuously until it became 15m.

Four days and specific times were selected for the simulation when wind directions varied most. These days were taken from meteorological data from the previous year (2017). In the below table the top two dates and times were used for the simulation, with the secondary dates used as backups.

Southerly Wind		Northerly Wind	
Date	Time	Date	Time
January 2nd 2017	**12.00pm**	**August 10th 2017**	**12.00pm**
February 12th 2017	06.00am	July 1st 2017	12.00am

Figure 38 - Meta data

The simulation required the data to be in three discreet types[44] (Ashie, 2012):

a) Elevation and building heights – where the physical perimeters of buildings were assumed to be predominantly glass and aluminium in the future case scenario, and aluminium in the current case (Fig 7).

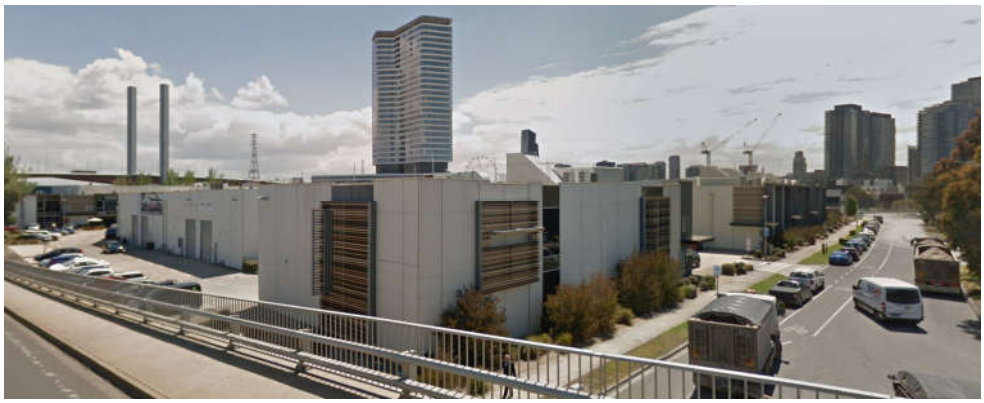


Figure 39 - Typical existing condition in Fishermans Bend, highlighting the uniformity of existing building stock punctuated by new residential high-rise. Source: Google Streetview

b) Trees / Foliage – where the tree heights were set at 15m, tree crown bottom height at 5m and the location of each tree was collected via the Urban Forestry dataset (Fig 6.)

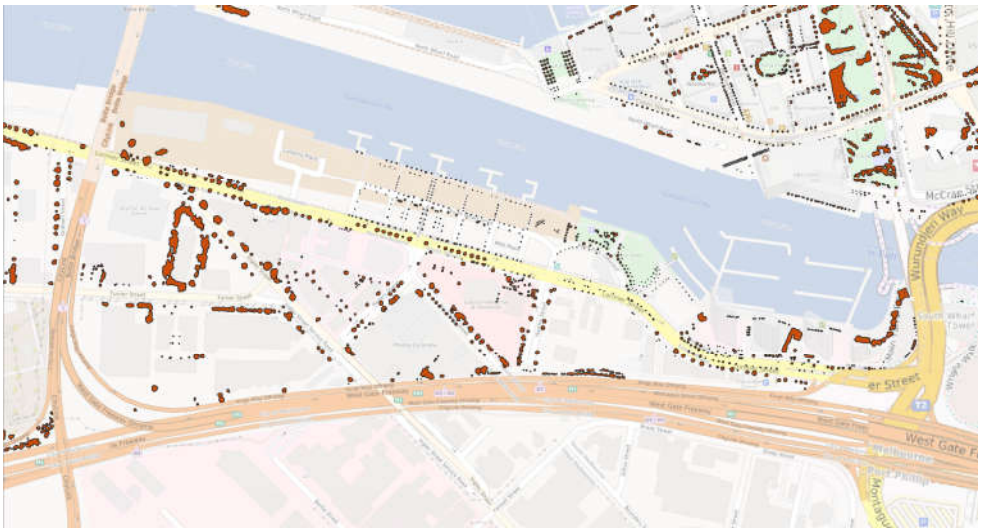


Figure 40 – 2015 tree distribution in the Lorimer precinct. Source: Urban Forest

c) Horizontal distribution of land-use indexes;
   a. Buildings – The physical outlines of structures.
   b. Building site – cadastral zoning of private buildings cross referenced with aerial photography

[44] Note that due to the district of Fishermans Bend being on partially reclaimed land, the topography of the whole site is very flat; therefore due to the grid being utilized at 5m intervals the area was assumed to be flat.

c. Road area – bituminous areas
d. Grassed areas – such as parks, reserves of sports fields (household front and back yards were excluded from the study)
e. Waterways – such as the large southern body of water (Port Phillip Bay), and the Yarra and Maribyrnong Rivers and the Moonee Ponds Creek.

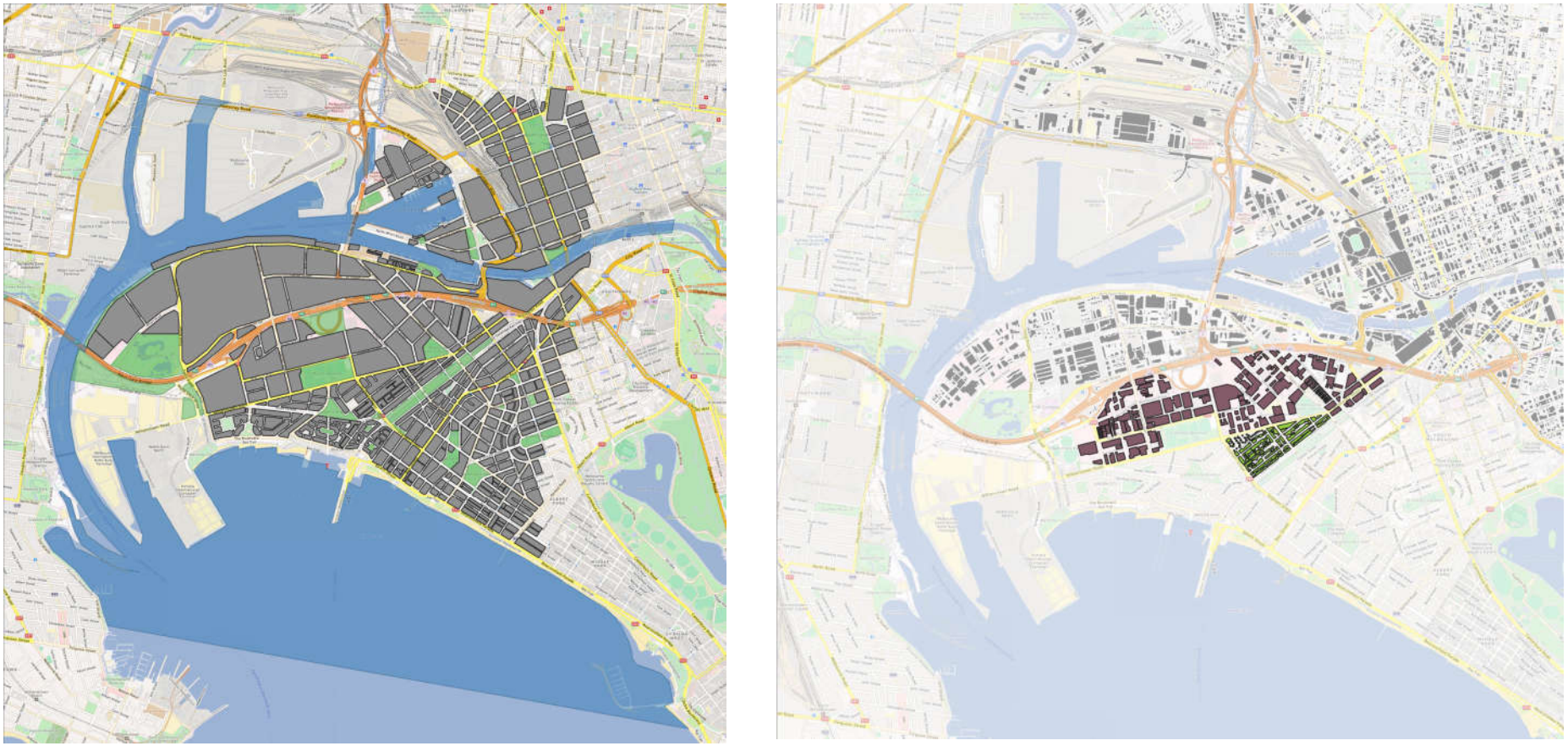


Figure 41 – Horizontal distribution of land-use indexes as visualized with GIS software.

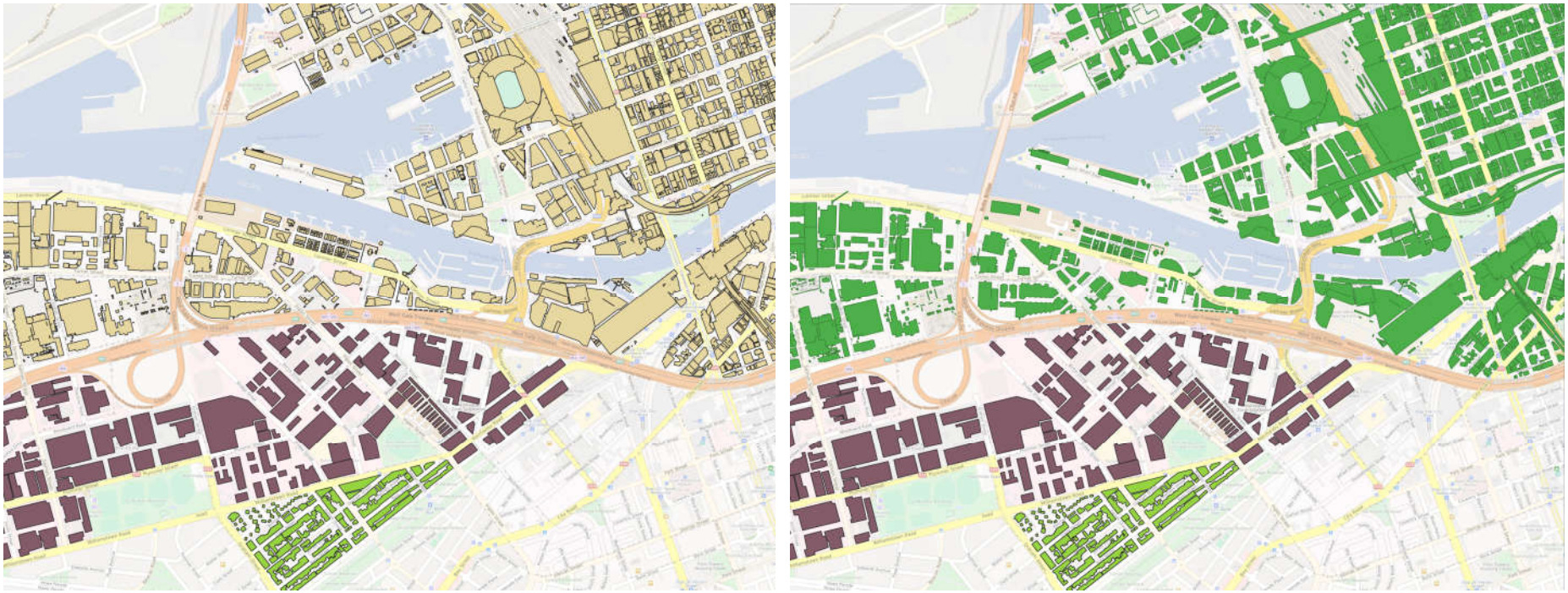


Figure 42 - Lorimer precinct current and future building footprints

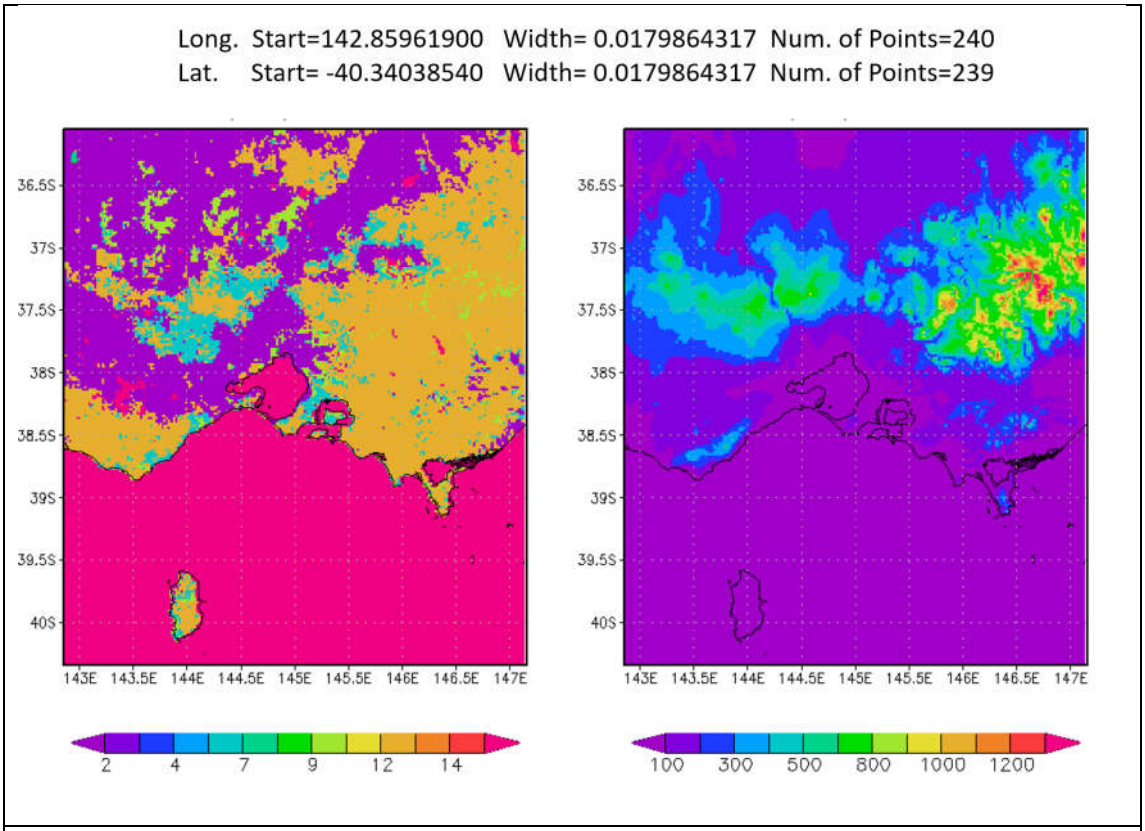


Figure 43 – Landcover and topographic map of the State of Victoria[45]

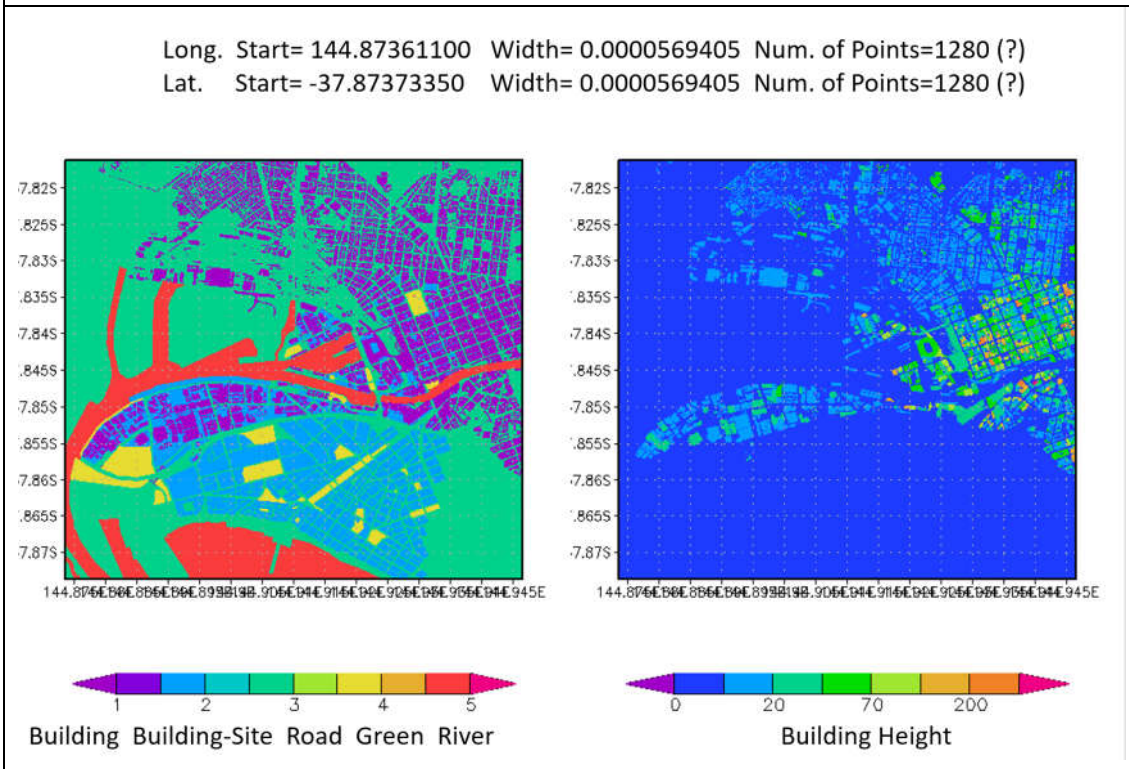


Figure 44 – Land-use and building heights of the area of interest (approx. 6km x 6km)

[45] Note that these are the visualization that were directly used for the simulation in Chapter 4.

3.5.3.4 Results

The results are divided as follows:

Scenario	Date of Simulation	Wind Direction	Vertical Height of Simulation (above sea level)	Type of calculation
Unbuilt (Current)	January 2017	Southerly	7.5m (z=3)	Wind velocity
	January 2017	Southerly	47.5m (z=3)	Wind velocity
	August 2017	Northerly	7.5m (z=3)	Air Temp.
	August 2017	Northerly	47.5m (z=3)	Air Temp.
Built (Proposed)	January 2017	Southerly	7.5m (z=3)	Wind velocity
	January 2017	Southerly	47.5m (z=3)	Wind velocity
	August 2017	Northerly	47.5m (z=3)	Air Temp.
	August 2017	Northerly	7.5m (z=3)	Air Temp.

Figure 45 - Simulation result overview

Simulation of result for January 2nd January 2017

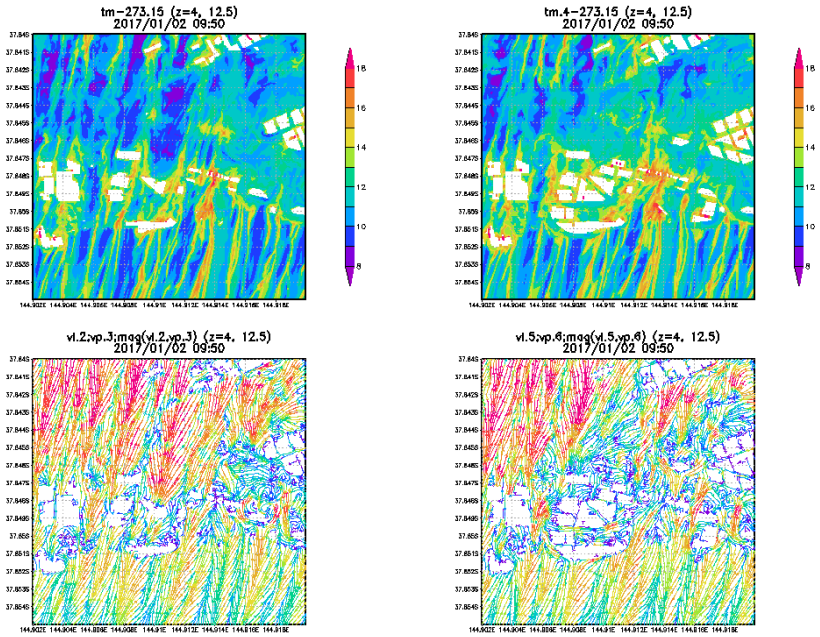


Figure 46 – a) Current and b) Proposed wind speeds and air temperatures at ground level

The above figures relate to the wind direction and air temperature in the January examples, where the predominant wind is a southerly. The images in Fig.13 relate to a ground level scenario. What can be observed in the visualizations provided is that:

a) There is a major increase in air temperatures within the centre of the precinct, where the largest concentration of new development is occurring.
b) Wind velocity in the proposed scenario changes from a previously relatively direction to turbulent and spiral, with an overall reduction in speed.

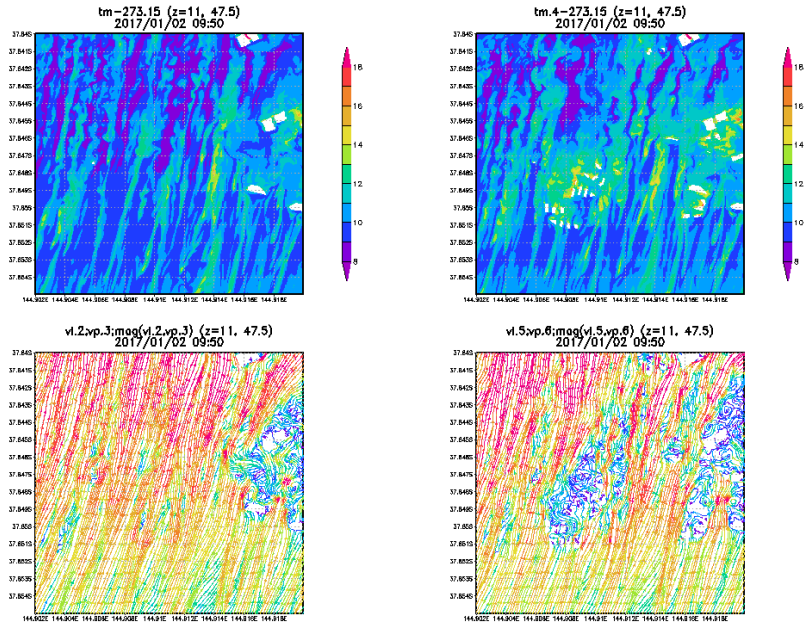
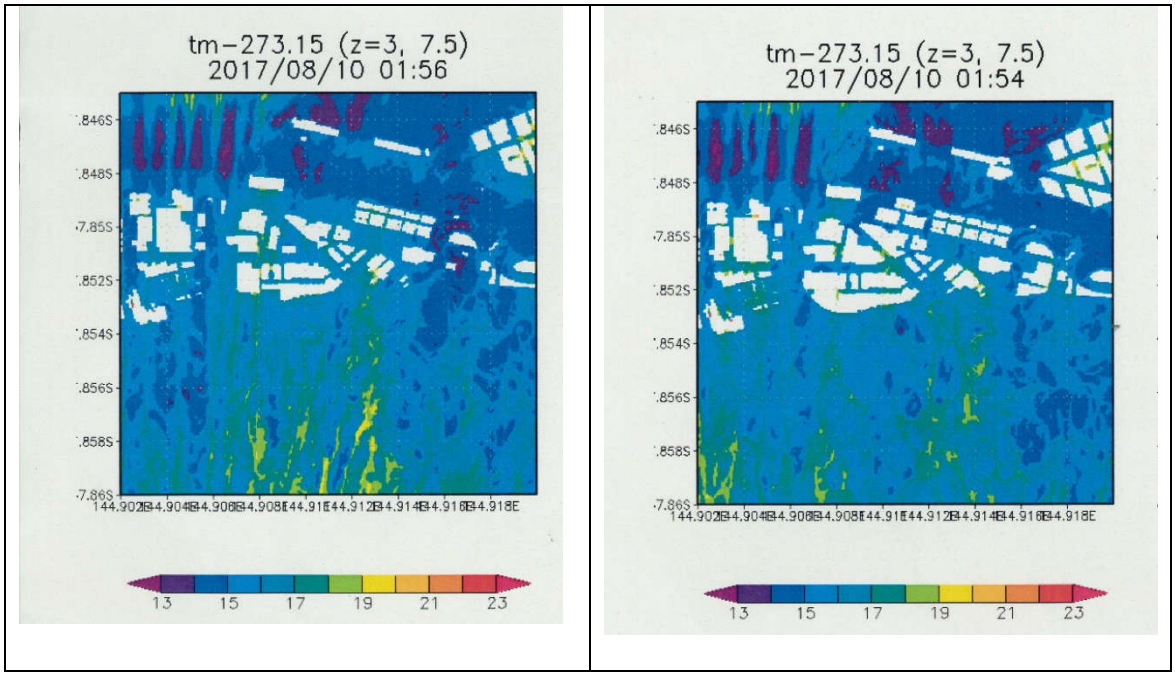


Figure 47 – a) Current and b) Proposed wind speeds and air temperatures at building rooftop level

c) There is minor increase in air temperature at the roof of the buildings.
d) There is major turbulence in wind velocity and direction in the proposed scenario.

Simulation of results for August 10th 2017



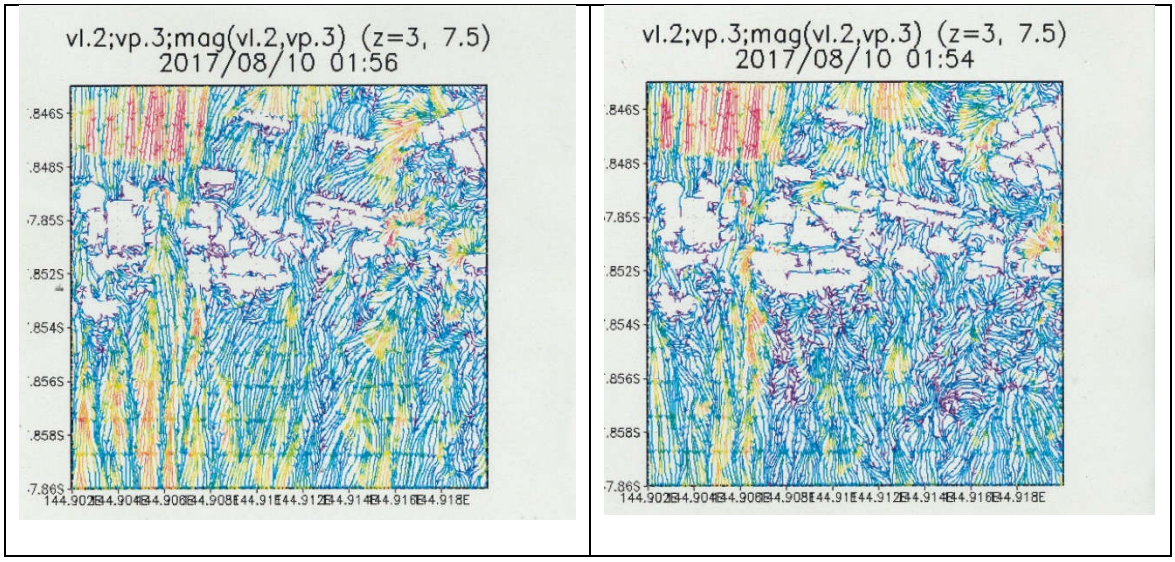


Figure 48 - a) Current and b) Proposed wind speeds and air temperatures at ground level

The above figures relate to the wind direction and air temperature in the August examples, where the predominant wind is a northerly. The images in Fig.15 relate to a ground level scenario. What can be observed in the visualizations provided is that:

a) There is no significant increase in air temperatures within the centre of the precinct.
b) There is major disturbance directly south of the major development.

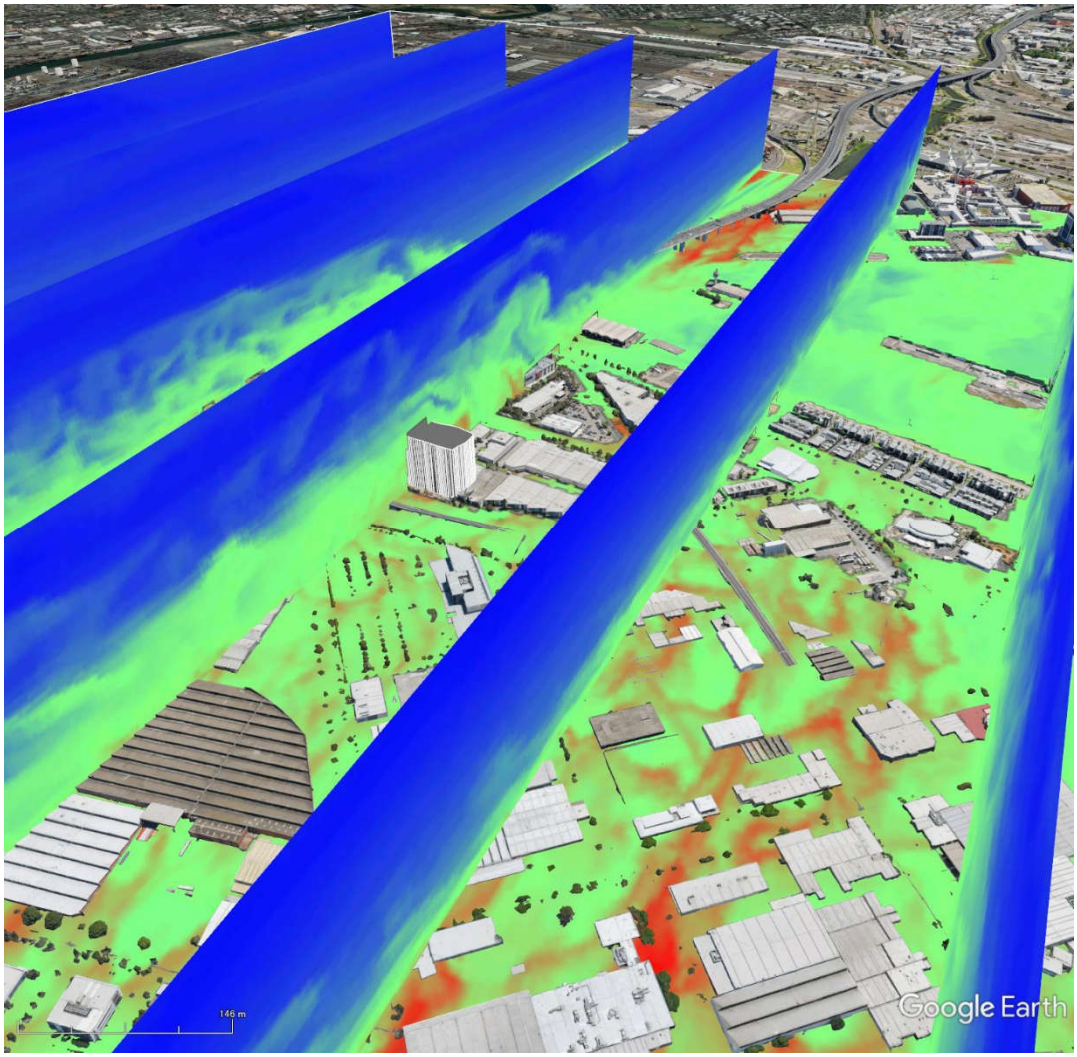


Figure 49 – Still from video - refer to Appendix 1 (separate file) for visualization over time in video format

As has been described in the background section, the skyscraper city typology has developed quickly as a global phenomenon. In metropolises, particularly those growing in population, limited either geographically or through planning regulations to expand outwards or those experiencing gentrification of post-industrial land; the logical solution in many cases has been to expand upwards. With this increase in upwards growth, many municipal, local government, state government and even national governments are struggling to follow with planning policy. In the case of Australia, this planning policy still lags behind by focusing on singular towers within skyscraper cities as the single units, rather than focusing on district wide policies. The example highlighted in this paper focuses on wind turbulence in proposed districts; but fundamentally other similar examples must also be studied. As can be seen in this study there are major implications on wind velocity and air temperature in new skyscraper city developments when compared to the existing condition. These changes can only be observed when simulated on district wide example, such as the one provided here for Fishermans Bend in Melbourne.

It is understandable that questions relating to the appropriateness of utilizing the Earth Simulator super computer for calculating district wide wind patterns as it is impossible to be used in all cases; as the time required is prohibitively long and the cost excessive. What this paper attempts to prove is not that in this specific case this specific tool would provide governments with the visualized data to inform future planning decisions. What it attempts to highlight is that traditionally planning regulations, which focus on antiquated ideas of cities slowly changing shape and predominantly doing so horizontally must be questioned. Cities, globally, have proven that with influx of capital they have the chance to change entirely in the matter of years, and not decades. These physical changes to cities must be viewed as a process of change, rather than simply addition and subtraction of building stock. Moreover it is the opinion of the author that steps must be taken to hold developers accountable for the changes they are imposing on cities. Much like when environmental requirements became mandatory or when in the case of Melbourne city wide controls were introduced in 2014, there was an outcry from building lobby groups, vested interests and developers

suggesting that such controls would stifle innovation, decrease profits and drive development elsewhere. The bottom line is, which has been highlighted by this research, is that more needs to be done to assess the environmental impacts new build has on existing cities, particularly in the cases when skyscraper cities grow.

4 CONCLUSION

4.1 CONDENSED RESULTS

This thesis was conceived as having minor conclusions present at the end of each of the sections and subsections within the *Theoretical Background: The idea of the skyscraper and birth of contemporary type* (Section 2.2) and Methodological Framework and Analysis (Chapter 3). The role of this section (Chapter 4) is to provide a synthesis of the minor conclusions and to provide the reader with a full understanding of the contributions this thesis provides to theory and practice of architecture and urban design in the context of supertall residential skyscrapers

Literature review and theoretical underpinning, as elaborated in Section 2.2, clearly defines two key aspects evident in the evolution of skyscrapers from their beginnings, described as:

a) proto-skyscrapers (Subsection 2.2.1), through to their maturation as,
b) modernist towers, and the introduction of 'universal space' as the first truly residential skyscraper-specific architectural theory (Subsection 2.2.3).

These sections can be understood as an elaboration of chronological developments beyond the realm of architectural practice, encompassing larger geo-political forces of the era. What has been gained from such theoretical investigations is the definition of three distinct, yet temporally fuzzy epochs through which residential skyscrapers, and later supertall residential skyscrapers (SRS) evolved. The first epoch proto-skyscrapers were stylistically and aesthetically vastly different. Depending on the preferences of their designers, some were adorned by neo-gothic facades reminiscent of European cathedrals, others with elements of Art-Deco. In concrete terms there was a cornucopia of styles yet a limit to their distribution. Almost all examples of this period were situated in either Manhattan or Chicago, two locations which were experiencing major socio-cultural changes related to mass immigration to the New World and its wealth (Section 2.2.1). The second epoch in development of skyscrapers was characterized by the introduction of Modernism as the antithesis to the first epoch. Traditional architectural styles were abandoned, in a way that was

perfectly summarized by Mies van der Rohe' succinct phrase 'less is more'. In that period, skyscrapers have for the first time entered architectural theory. That was particularly the case with residential skyscrapers and introduction of the concepts of 'enflaming' (Section 2.2.2) and 'universal space' (Section 2.2.3). The second epoch was a time of maturation of this typology, and dissolution of styles and historic references into a 'non-style' of Modernism. Two specific building examples which we used to explain this epoch, each representing a bookend of that significant era, were the 860-880 Lake Shore Drive apartments (Mies van der Rohe, 1949-1950) and Lake Point Tower apartments (Schipporeit and Heinrich, 1965-1968). Much like the case of the first epoch, the second epoch was also strongly influenced by events beyond the realm of architecture. In both cases mass migrations to the United States coincided with the end of the Word Wars period and a development of new construction methods and techniques particular to development of skyscrapers (Section 2.2.3). The third epoch, that of our era, has been characterized by the latest in technological developments, which resulted in global dissemination of the now ubiquitous glass tower typology and its most extreme manifestation, the supertall residential tower in the 21st century.

Thus, the major finding of 2.2 *Theoretical Background: The idea of the skyscraper and birth of contemporary type* section is that on both of the preceding occasions two prerequisites for a paradigm shift to occur, for an epoch to formally turn over, were required:

a. **technological and structural advancement to facilitate a new typology to be formed,**
b. **right socio-economic circumstances, in both cases simultaneously at a local and global level.**

The theoretical background section provides the foundations for the novel analysis of the third epoch, our era what can be called the globalized epoch, by establishing a knowledge-base upon which new residential towers can be analyzed, which is a focus of this Thesis and the bulk of analyses undertaken in Chapter 3 - Methodological Framework and Analysis.

In the second epoch, by showing that the method of construction was replaced stylistic difference, the first mode of analysis revealed itself. By not having a pre-determined style to follow, i.e. neo-

gothic or art-deco, the aesthetics of tall buildings became reduced to expression of 'function, while, through their technological development, they became the arena in which various disciplines and authorities had to contribute to the design process (Section 3.3). This complex process is elucidated in the thesis by focusing on a particular case study, within a particular context (Melbourne, Australia) – as is required in the universal-to-global-to-local process manifestation of the third epoch. That is to say that the form is universal, the typology is global, yet the context is local. The other reason for focus on this study was in full availability of Tier-1 data and possibility to conduct an interview with the architect.

That full exegesis was followed by an equivalent analysis of further five (5) examples, listed in Subsection 3.3.2.

The major finding of Subsection 3.3.2 was that the homogenization of design is underpinned by two major external pressures;

a. **disciplinary fragmentation into very narrow focused expert consultant relying on best practice (more precisely, previously seen examples 'managed' by architects and engineers rather than 'led' by architects and engineers),**
b. **the numerous sign-offs by clients and authorities led by economic pragmatism in the former and the public interest by the latter. Evidence of this process is extensively supported by literature (Spencer, 2016; Zaera-Polo, 2008)] yet has never been focused on residential skyscrapers in a particular context.**

If the first mode of analysis undertaken is that of the process-driven approach to designing a skyscraper (Section 3.3), which fundamentally focuses on the architectural and technological apparatus, the second mode of analysis follows on from the hypothesis posited earlier – that for a paradigm shift to occur a set of global conditions must be met, which makes it also feed into Chapter 5 Discussion.

Section 3.4 *Quantitative Comparative Analysis of All Supertall Residential Skyscrapers: Case Study 2 (Global)* commences from an axiom derived from the previous Section 3.3. The axiom is that any specific local context adorned with supertall residential skyscrapers meets a criterion of universal-

global-local phenomenon. Therefore, by focusing on a local example, elucidated through the Melbourne case study, and knowing that the process is global, one can assume that by focusing on the example of the SRS in Melbourne, the Eureka Tower a global process can also be assumed. We hypothesized that the process is going to be similar, if not the same, for all global examples which satisfy the strict SRS requirements (for definitions refer to Subsection 2.1.1). In Section 3.4, the second analysis of this thesis and a discrete research into *Density through the Prism of Supertall Residential Skyscrapers: Urbo-Architectural Type in Global Megacities* conducted by the author (Radović, 2020a), several important conclusions were obtained and can be found in Subsection 3.4.4.

The overarching conclusion relevant to understanding the thesis as a whole are numerous, yet the most important points are:

a. **all fifteen (15) towers are remarkably similar in their final architectural objectivity,**
b. **major differences can be seen only in their specific contexts – namely resulting from their climatic and social setting,**

To illustrate the first point, one only needs to refer to Table 9 - Table 11, which highlight the similarities in materials, dimensions and internal areas of the towers examined. The second point is highlighted in Table 14 and Table 15, where rental and sales rates to apartments are tabulated. Although the example of the Eureka Tower (Melbourne, Australia), Q1 Tower (Queensland, Australia), We've the Zenith (Busan, South Korea) and 432 Park Avenue (Manhattan, USA) are typologically and architecturally remarkably similar, their occupancy is vastly different. The Eureka Tower is aimed at local Australian families on relatively average incomes (refer to 6.1 *Skyscraper development in Asian Pacific Rim – Interviews with Prof. Ken Yeang and Karl Fender*. and journal paper *High-rise high-density: A Pacific rim hypothesis* (Radović, 2020b) for details), Q1 Tower is primarily short term rental for holidaymakers, We've the Zenith 2-bedroom apartment is only a 5^{th} of the average salary (assuming a two earner household) whilst 432 Park Avenue penthouse apartment is 1000% of an average Manhattanites salary (Subsection 3.4.3.5 *Apartment dimensions, sale and rental information* and Table 15).

These finding are supported by Section 3.3 *Process Driven Approach to Skyscraper Design: Case Study 1 (Melbourne, Australia)* in the sense that ultimately the local context provides a certain requirement on each of the towers irrespective of their similarities in architectural style, the non-style described in 2.2 *Theoretical Background: The idea of the skyscraper and birth of contemporary type*, yet with a major difference which is explored in more detail in the subsequent section 3.5 *Architectural Analysis of Skyscrapers and Three Scales*.

Lastly, Section 3.5 is divided into three components and undertakes the architectural analysis discovered in Section 2.2.2 and 2.2.3, which focuses on three elements of architecture of the Modernist movement, and more precisely of Mies van der Rohe focused on in his own architecture. These three elements of varying scales focus on the façade at the micro scale (3.5.1), the apartment and its multifunctional analysis (Section 3.5.2) and lastly the urban context (3.5.3). Each section was approached with different, customised method, as it adheres to different principles elucidated in the Theoretical Background.

At the micro scale, a theoretical understanding of the complex relationship of the façade, or the skin of the building, and the interior was established expanding on the theoretical work posited in Section 2.2.2 *Heidegger and Mies': Comparative analysis of the idea of dwelling* by introducing a contemporary social-science based method of analysis based on *assemblage theory* (DeLanda, 2006, 2016).

The major conclusion of this section was to highlight the complex network nature of the façade elements as a microcosm of the entire design process of towers. If Section 3.3 *Process Driven Approach to Skyscraper Design: Case Study 1 (Melbourne, Australia)* **provided insights into the varied disciplines involved in the design process of the towers, then this section mirrored those findings by illustrating the complex interwoven outcome with a physical object, the façade module, as a representation of those disciplines.** At the most fundamental level it has shown that the aesthetic architectural element most visible to the public, its exteriority, is no longer the domain

of the single architect, as was the case of the towers during the second epoch, but rather a collective outcome.

At the meso scale, a practical approach to understanding the internal space of supertall residential skyscrapers was undertaken, by comparing typical floorplates of all relevant towers. The method undertaken is novel in itself, as it focuses on three tiers of data quality to facilitate a holistic reading of the floorplates (for whole set of floorplate refer to 6.2). Data sourcing focused on architectural and engineering data as tier-1 highest quality data, real-estate brochures as tier-2 medium quality data and tier-3 citizen scientist sourced data as supporting evidence.

The major conclusions of this section underpin the similarities identified on a numerical level in Section 3.4 *Quantitative Comparative Analysis of All Supertall Residential Skyscrapers: Case Study 2 (Global)* **however with a much finer grain of detail. The critical quality added by the fact that at this level certain cultural nuances find their way into the sameness of the towers, and that they were not previously documented in literature. That supports the hypothesis that cultural norms permeate the buildings in unexpected ways, and identifies specific ways in which that process happens.** This conclusion is highlighted in the tower's approach to the contentious issue of hired maids, or live-in help. Separate dormitories within large apartments that house hired help occur only within the UAE examples, Dubai and Abu Dhabi, and only in towers that seem to be targeted at the local wealthy populace. Within the Manhattan example of 432 Park Avenue, entire mid-level floors are dedicated to studio-like apartments housing hired help and maids. In the Moscow example smaller structures are erected on site, but external to the SRS themselves. Whilst in the Australian example commercial services of the same kind are afforded but do not have a permanent residence on-site.

Lastly at the macro scale (Section 3.5.3) a contextual and urban analysis of 'skyscraper city' phenomena is explored by focusing on the case study of Fishermans Bend, Australia which is an example of government land consolidation into a single 'land release' facilitating the potential for a

whole district to become a hub for SRS. By utilizing advanced computer simulations, a wind assessment is undertaken focusing on the broader city wide impacts of SRS clusters.

The major conclusion arrived at in this section focuses on the quantitative measurable impacts which high-density SRS scenarios may have on their host cities, and how global city governments are preparing for a new typology to emerge – the skyscraper city. The idea of skyscraper city is the most contemporary form SRS has seen in certain locales, such as the Busan Haeundae marina district, where a dozen towers were erected on reclaimed land in a short period of time, Dubai Jumeirah district which houses several SRS in extremely close proximity and Moscow, which was first to establish a new commercial and residential district on brownfield site on the Moscow river.

What this thesis thus far has concluded is that **global supertall residential skyscrapers seem at the precipice of a paradigm shift, where technological, architectural and socio-economic forces have the capacity to reinvent the skyscraper yet again**, from its now dated third epoch international style towards a radically new form. Firstly, what was established in this thesis was the social climate required for a paradigm to shift, namely large population migrations. Secondly a new external pressure on technology and material sciences is necessary. Thirdly the evolution of residential skyscrapers seem to follow a discernable logic – varied styles crystalize into a singular style (or non-style), which gets globally disseminated as a universality, yet through local particularities gains a level of contextualization which is difficult to analyze without the comprehensive and novel method such as the one appropriated in this thesis. Fourthly, it is well established that the next iteration in construction must follow the sustainability imperative. Lastly through literature review and further discussion **in the subsequent Chapter 5 we will posit a thoroughly novel reading of this sustainability imperative, as the impetus to commence the fourth epoch of SRS**.

4.2 VISUALIZATION OF THE CONCEPT OF THE SKYSCRAPER EPOCH MODEL

Approximate Time Period	Epoch No#	Epoch Name	Location	Architectural Role	Genesis	Typology / Morphology	Basis
Post- great Chicago fire (1880's) until the Great Recession (Late 1930's)	First	Proto skyscrapers	Globalised (in the sense that they are mimicking European counterparts yet based in USA)	Non-expert architect or no- architect (described by Koolhaas as lobotomy of architecture)	Mass migration from the Old-World (Europe)	Variety of styles; neo-gothic, Art-deco, neo-classical etc. in particular context (USA)	Practical
World War period (mid-1940's) until the later 1960's	Second	Modernist skyscrapers	Contextualised (Chicago, Manhattan)	Specialist Architect with holistic control of the process	Mass migration from Europe in the post-war period	Homogenisation of style in particular context (USA)	Theoretical
1970's until Present	Third	International style / Post-modern	Globalised	What is the architectural role in SRS?	What mechanisms globalized the typology?	What (dis)similarities are observable in the typology?	Is there a theoretical basis to the typology?

Figure 50 – Visualisation of the concept of the skyscraper epoch model

To visualize the steps undertaken from the Conceptual Framework and Theoretical Background (Chapter 2) to Methodological Framework and Analysis (Chapter 3) we have provide Figure 50 – Visualisation of the concept of the skyscraper epoch model (above) that summarises the initial conclusions and findings which lead to the method of analysis.

Approximate Time Period	Epoch No#	Epoch Name	Location	Architectural Role	Genesis	Typology / Morphology	Basis
Post- great Chicago fire (1880's) until the Great Recession (Late 1930's)	**First**	Proto skyscrapers	Globalised (in the sense that they are mimicking European counterparts yet based in USA)	Non-expert architect or no-architect (described by Koolhaas as lobotomy of architecture)	Mass migration from the Old-World (Europe)	Variety of styles; neo-gothic, Art-deco, neo-classical etc. in particular context (USA)	Practical
World War period (mid-1940's) until the later 1960's	**Second**	Modernist skyscrapers	Contextualised (Chicago, Manhattan)	Specialist Architect with holistic control of the process	Mass migration from Europe in the post-war period	Homogenisation of style in particular context (USA)	Theoretical
1970's until Present	**Third**	International style / Post-modern	Globalised	**Analysis 1**	**Analysis 2**	**Analysis 3** 1. Micro 2. Meso 3. Macro	**Method Conclusion/ Discussion**

Figure 51- Visualisation of the relevance of the method (analysis) to the epoch model.

Approximate Time Period	Epoch No#	Epoch Name	Location	Architectural Role	Genesis	Typology / Morphology	Basis
Post- great Chicago fire (1880's) until the Great Recession (Late 1930's)	First	Proto skyscrapers	Globalised (in the sense that they are mimicking European counterparts yet based in USA)	Non-expert architect or no- architect (described by Koolhaas as lobotomy of architecture)	Mass migration from the Old-World (Europe)	Variety of styles; neo-gothic, Art-deco, neo-classical etc. in particular context (USA)	Practical
World War period (mid-1940's) until the later 1960's	Second	Modernist skyscrapers	Contextualised (Chicago, Manhattan)	Specialist Architect with holistic control of the process	Mass migration from Europe in the post-war period	Homogenisation of style in particular context (USA)	Theoretical
1970's until Present	Third	International style / Post-modern	Globalised	**Finding 1:** Architect as design manager,	**Finding 2:** Globalisation of capital and trend	**Finding 3:** Homogenisation of dwelling	Practical
Future	Fourth	Sustainable Skyscrapers	Contextualised (derived from conclusion)	Discussion 1: What is the role of the architect in this new epoch?	Discussion 2: What is the social change required?	Discussion 3: What changes are required to integrate culture into typ/morph?	Theory (derived from requirement of sustainability)

Figure 52 - Visualisation of the questions raised out for the Discussion Chapter

5 DISCUSSION

Before introducing Type-Morphological and Assemblage Theory methods, Future Directions in SRS and the Homogenizing Nature of SRS Ownership, which are going to elevate discussion and findings to the level of synthesis and elucidation of likely and desirable futures of Supertall Residential Skyscrapers, we will provide a succinct, literally executive summary of the essence of seven answers to our research questions, which were listed in Chapter 4, Conclusions:

- The preceding occasions two prerequisites for a paradigm shift to occur are that (a) technological and structural advancement to facilitate a new typology are ready, and (b) socio-economic circumstances, at a local and global level are ripe.
- The identified homogenization of design is underpinned by two external pressures: (a) disciplinary fragmentation into very narrow focused expert consultant fields, and (b) numerous sign-offs by clients and authorities, in the name of economic and public interest respectively.
- All fifteen investigate towers are remarkably similar in their final architectural objectivity, while the only identifiable differences come from their contexts, specific climatic and social settings.
- The network character of the façade elements act as a veritable microcosm of the entire design, showing how that fundamentally aesthetic architectural element is no longer the domain of an architect, but a product of collective creativity and decision-making.
- At a discreet level certain cultural nuances erode the sameness of the towers, supporting our hypothesis that cultural norms permeate the buildings in unexpected ways
- High-density SRS scenarios can have major environmental impacts on their host cities, and global city governments are preparing for a new typology – the skyscraper city – to emerge.
- Global supertall residential skyscrapers seem to be at the precipice of a paradigm shift.

These findings have been the stepping stones towards this Discussion, to which they will also be the ingredients.

5.1 TYPE-MORPHOLOGICAL APPROACH: SKYSCRAPERS AND THEIR URBAN CONTEXTS

Urban morphology has proven to be one of the potent tools for better analysis of evolution of urban form and possible trajectories of development of human settlements. Most often it is utilized as a historical tool for analysis of pre-existing urban forms yet has the capacity for understanding potential future forms. While types of urban form evolve, at certain points in history the new also emerge. By focusing at one such moment, which has occurred when quantitative growth of high residential

buildings developed into extra high (supertall) residential buildings at the turn of the 21st century. That transition has announced a potential paradigms shift, translation of quantity into the potential new quality. This thesis explores the capacity of thinking the emerging new time to advance Type-Morphological Theory of urban morphology, so that it can embrace, explain and help project into the future transition from *architecture-of-dwellings* into *a village-of-architectures*.

At its essence, the study of urban morphology is focused at the transformation of urban settlements over time. The key concepts at work there relate to the *urban*, or the scale of multiplicity of dwellings which form a coherent and physically defined whole. The idea of *morphology* was first proposed by Johann Wolfgang Von Goethe at the end of the eighteenth century, as the 'science that deals with the study of forms'. The combination of the terms *morphology* and *urban* only became widely used towards the end of the nineteenth century, as relating to the study of human settlements (Oliveira, 2018). The development of the concept went through many iterations. After the initial emphasis on *form*, modernist architects concentrated their efforts on *function*[46]. Later still, in the mid-twentieth century, a group of Italian architects introduced the notion of *process* into the field. Additional schools of morphological thinking were developed by French and English counterparts (Whitehand, 2001) which, eventually, all developed their discrete ways and, eventually, their *schools*. The work presented in this paper was based the *Italian school*, or the *Muratorian approach* as it is often named after the founder of the school of thought Saverio Muratori (Giancarlo Cataldi, Maffei, & Vaccaro, 2002). In his essay *Towards a General Theory of Urban Morphology: The Type-Morphological Theory* (2018), Giancarlo Cataldi provides a solid basis for understanding of the Italian school's *process*-driven approach. Cataldi set out to do was to provide a general theory which obviously, yet not explicitly, refers to Einstein's famous general theory of relativity. What, however, was stated explicitly is that that the general theory developed there was not aiming to achieve a 'scientific truth', but that it rather forms a basis for a philosophical understanding of the

[46] In the idea of 'form follows function', as the early champion of modernist architecture, Louis Sullivan was famously quoted as saying.

morphological process (Giancarlo Cataldi, 2018, p. 66). What makes a general theory relevant is that it formulates *a proposition* wide enough in scope to provide further additions within the theory itself.

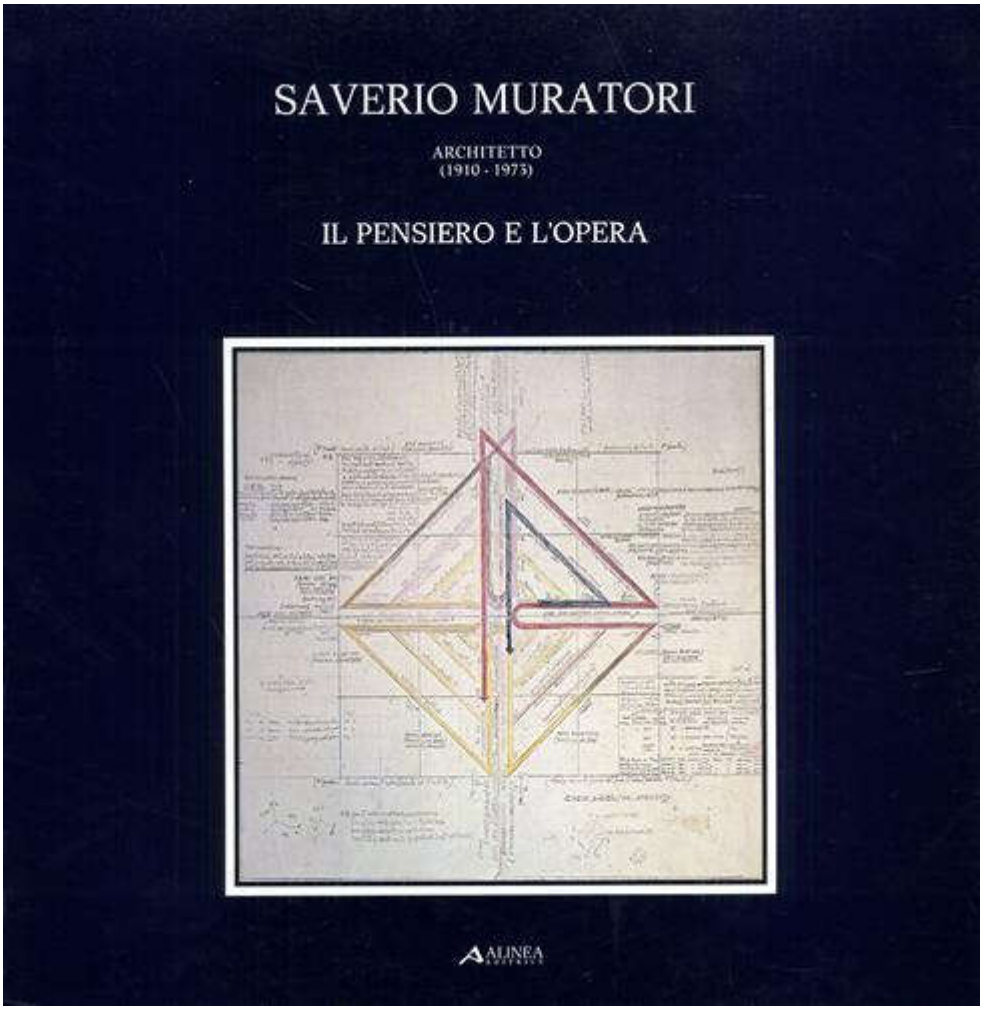


Figure 53 – Saverio Muratori's famous 4-phase diagram as the cover of Il pensiero e l'opera (though and work) an anthology of his work (G Cataldi, 1984)

This research intends to do exactly that: to describe and advance the theory relevant to the subject at hand whilst testing its own limits through radical interpretation of its founding principle, the causal relationship and qualitative shift from architecture at the scale of shelter to humanity, to architecture as building block of society.

Firstly, when approaching urban morphology in that way, it is important to understand a key concept - that of temporality. Urban forms are inherently, always evolving, adapting and becoming

new forms, both on an objective, physical level and through numerous subjective processes. Once an object exists in the physical realm, it is easy to conceive of a process over time; for instance, a building falls into ruin, a city grows, or a new roof gets built to replace an old one. However, the *process* approach to urban morphology divides temporality into four interrelated conceptual quadrants. The temporality mentioned above constitutes only half the process as conceived by the Italian school, that of objective reality attributed to the physical world. The other half is of the process is a subjective one, within the mind of the concrete person. Thus, the primary dialectic within this method relates not only to the urban realm once construction [Building] commences and occupation [Dwelling] begins. It also to the collective idea of living [Reading] and the concept of dwelling [Projecting] (Giancarlo Cataldi, 2018, p. 65). This scalar development Reading-Projecting-Building-Dwelling is the central idea of the Italian school of urban morphology. Its complexity was the main reason for choosing it here to understand, describe and analyze the cases within the following research.

Within the philosophy of Aristotle's metaphysics, from which the Italian school derives its theory, there are four stages of causality: a) *causa materialis*, the matter of which an object is made, or its material, b) *causa formalis*, the shape of the object, or the form of the object, c) *causa finalis*, the final form, and d) *causa efficiens*, which translates to English as 'that which gives rise to something' or, in this case, the subject.

German philosopher Martin Heidegger, a contemporary of Muratori who also approached Aristotle's metaphysics through application of his causes, uses an analogy of a silver chalice to describe the process. The material cause of the silver chalice is, of course, the silver it is made of. The formal cause of the silver chalice is the physical shape of the chalice which allows it to hold liquid, as opposed to, for example, hammering a nail in. The final cause is its ability to hold a liquid, as opposed to simply having the shape that allows it to hold a liquid but perhaps having holes in. Ultimately, the efficient cause of the silver chalice is the maker himself. That is where Heidegger

makes one of his major contributions to thinking – the concept of *concealment*. What he would now claim is that the cup is brought out of *concealment*, into *unconcealment*, via the application of the Aristotelean four causes (Heidegger, 1977). We will continue with the concept of *concealment* later in the paper, but until now it is important to understand simply that the maker is as much a cause of something as the material, the shape and the ability for it to perform the correct task. A more linear advancement through the causes of the silver chalice, to align with Cataldi's Reading-Projecting-Building-Dwelling method, would require a division between a priori and a-posteriori. Thus, the Reading of the chalice would be the maker's a priori knowledge of what a cup is (without necessarily conceiving of the concept for his specific chalice), the Projecting of the chalice would be that of the maker conceptualizing this specific chalice, the Building of the chalice would be the leap from the mind into reality through making the cup (in this case from silver) and finally Dwelling would be final shape which the cup undertakes.

At the larger, environmental scale, to Heidegger, this capability to dwell is a type of demarcation by a subject upon land, upon the space which, through this human intervention, becomes a place (Heidegger, 1971). However not all building is dwelling. There are indeed buildings such as 'bridges and hangars, stadiums and power stations' which are all buildings, but do not allow for dwelling. Thus, historically building was indeed dwellings. But, that original meaning has been lost to contemporary audiences and buildings that are not dwellings take a secondary role to Heidegger, as compared to buildings that are dwellings - insofar as that they only exist as a result of mankind's dwelling upon land. Heidegger provides us with a direct example through an analogy of a bridge. He claims that two banks of a river only emerge as banks once a bridge crosses the stream; that only through the building of the bridge do the two banks emerge as places and not simply any two pieces of non-descript land. Only through the bridge building do the banks become neighbouring banks of the river. The bridge is also never simply an objective thing. For example, a stacking of rocks and grout of a certain width and height is firstly symbolical insofar that it is a connection between two predetermined ends, and only actualized through the building of the bridge itself. However, both the

symbolic and the objective must be actualized for the bridge to be a bridge, for the building to be built and for the building to be a dwelling. To be overly simplistic, the only reasoning that a bridge exists over two banks of a river is because of mankind's ability to dwell and thus have a need to cross the river from one dwelling to another in a specific location.

To Muratori and Cataldi, the building process of a house follows the same exact logic, albeit at a different scale. A builder has an *a priori* understanding of what a house is, he conceptualizes in his mind the specific house he wants to build, then commences building it via a material until it is built and thus becoming *a posteriori* knowledge. What is very interesting, however, is that Cataldi imagines this not as a linear cradle-to-grave type of operation but rather as a loop. The Italian theory of morphology understands that there is an inherent link from the physical Dwelling back to Reading. An analogy I can provide to illustrate this particular point here would be the gradual change of dwelling over time. Our core Reading level is always in flux. This can be seen through the advancement of building typologies around the world, otherwise there would be no ingenuity in design, since we would simply follow with the same process producing the same outcomes. This changing of the Reading is inherently altered over time by our Dwelling. For instance, in the late 19th century skyscrapers were often designed in the neo-gothic style, yet over the last century they have been universally replaced by glass towers. Contemporary architects do not have an understanding of skyscrapers as a priori examples of neo-gothic architecture but glass towers, and therefore their Projecting cause, which conceptualizes their *specific* skyscraper, commences from the idea of what a contemporary skyscraper should look like.

Urban morphology however is not only interested in buildings in the sense of objective architecture, but also of larger scales. Cataldi defines these built objects as: a) tool ($\sqrt{t}$), b) garment ($\sqrt{c}$), c) furniture ($\sqrt{f}$), d) building ($\sqrt{a} + A$), all within the architectural scale and e) village ($\sqrt{B}$), f) city ($\sqrt{U}$) and g) region ($\sqrt{T}$) within larger scales. These can be divided into domestic (small) and territorial (large) scales (refer to Fig. 1). Thus, it can be summarized that within the subjective constellation the

tool is held by the subject, the garment rests atop the subject, furniture allows the subject to rest, whilst lastly the building houses the subject. Each of which can be seen as subject-orientated.

As can be seen in Cataldi's diagram the architectural scale $\sqrt{a} + A$ is positioned centrally and thus exhibits a duality of roles; that of the overarching meta-scale of the domestic grouping and the smallest of the territorial scale. Moreover $\sqrt{a}$ inhabits the constructive domain, that of objects (i.e. the silver chalice analogy $\sqrt{t}$ and the building $\sqrt{a}$) whilst $\sqrt{A}$ inhabits that of territoriality. Thus, $\sqrt{a}$ is summarized as 'the object is a complex built organism supporting, containing, and protecting spatially people and things, allowing them to conduct their indoor activities, among which, in the dwellings, sleeping is paramount', whilst $\sqrt{A}$ at the environmental scale 'in which the building organism is considered for its quality of minimal territorial dwelling, the characteristics of which depend on the form of the place, chosen on the basis of a set of domestic and extra-domestic activities, the latter mainly related to production' (Giancarlo Cataldi, 2018, p. 77).

This placement of architecture at the tipping point between the objective and the territorial provides an important distinction from the four causes model. Heidegger's silver chalice analogy has provided us with a basis of examination of the $\sqrt{t}$ scale, the a priori is that of the subject in its Cartesian sense. The Reading is that of a specific subject, who is ultimately the Projector. This can translate relatively seamlessly to the $\sqrt{a}$ scale and the architect[47], however *the scalar jump from* $\sqrt{a}$ *to* $\sqrt{A}$ *requires a paradigm shift*. Within the process-driven urban morphology theory there is a necessary 'jump' from building to human societies (Giancarlo Cataldi, 2018, p. 65), and this jump seems to decentralize the human subject within the meta-scale of territory. The 'building block', quite literally, of the territorial scale is the architectural scale.

To conclude the theoretical component as described by Cataldi, the scalar jump to the environmental scale sees a) the architectural scale (the largest of the objective scale) as the setting

[47] In the sense of the Greek origin of the work *arkhi* + *tektōn*, or *chief* + *builder*.

block where the subject is housed, b) the tissue scale being a grouping of similar residential buildings, c) the urban scale where the tissue scale is connected via a network and defined by an edge condition, and d) the territorial scale in which all other scalar objects necessarily exist (Giancarlo Cataldi, 2018, p. 77). What is important is that the scale of each component within the $\sqrt{a}$ scale is defined by the subject, in the sense of *human scale*[48]. The hand held tool has an implicit maximal scale attributed to it (i.e. something that can be held by a human) and vice versa with the building (i.e. something that can house a human), the tool one could argue has no minimal scale and the building has no maximal scale, but both have a set of parameters they must adhere to. *The scalar leap from $\sqrt{a}$ to $\sqrt{A}$ loses that human scale, and the scale that is referred to is that of the building*. No maximum is provided by the tissue scale, and one can reasonably imagine a repetition of buildings forming a coherent whole of the same building typology ad infinitum. This clear distinction between the human scale, or of the $\sqrt{a}$, or the scale of the subject in comparison to the scale of the building, or the $\sqrt{A}$, or the object is not all encompassing. There are typologies that can be imagined which occur at a point between the two and thus require to exhibit one or more of the attributes of both.

Within the social sciences the initial scale $\sqrt{a}$, from tool to house, with its causal relationship can be viewed as technological determinism. The iterative process of continuous advancement in the craftsmen's' work as described previously, from *a priori* concept of a house which, through the specific design within a particular craftsmen's mind and the material process undertaken becomes the objective house. The loop is thus finished on this ontological scale by that specific house. Through its specific technological advancements, that forms a part of a future craftsmen's *a priori* concept of a house. The advancement of tools used in this process, from an antiquated hammer and chisel to contemporary methods of forming concrete, the iterative process is determined by technology itself rather than a conscious decision by the craftsman. This advancement is technology

[48] Which can be traced back to Leonardo DaVinci's *Vitruvian Man* and his understanding of Vitruvius' understanding of architecture, human proportions and geometry.

can be understood as self-determinative and independent of the subject (Khong, 2003). All scales within the micro universe of the human scale $\sqrt{a}$ follow this same process. Advancements in tool making has provided mankind to produce ever more efficient tools, and these tools have consequently made more and more advanced objects possible.

The macro scale of $\sqrt{A}$ within the logic of the general theory follows a different doctrine. The centre point of the model, the architectural scale of the house, forms a component piece of the tissue scale, which through perhaps conurbation of previously physically separate developments forms the urban scale of the city which, through different networks, forms the territorial meta scale. The qualitative leap the general theory presents here is a theoretically substantial one, as it posits a fundamental shift from physical objects to social concepts. A grouping of standalone buildings does not physically form the village as an object, as a village is conceptual in nature, immaterial and governed by a set of immaterial principles. To use the concept of *assemblages* as described in the work by architect and sociologist Manuel DeLanda (2006, 2016), the buildings within a village are assemblage parts of a larger assemblage. These parts can be physically connected by road networks, or mail routes, postcodes etc. but they nonetheless remain independent from an object perspective. A single house is still a single house irrespective of it being a component of village when observed at the scale of the object. A village however cannot exist in the traditional sense without a number of houses forming its assemblage. Ultimately at the scale of the territory, be it a nation state or a loosely linked network of 'world's most livable' cities, its territorializing effect is produced not through the strength of its physical connection of cities, but rather through entirely social mechanisms. This type of understanding of networks as at once physical entities and a set of socially constructed mechanisms is often referred to as the social constructivist approach.

In opposition to the technological determinist standpoint, the premise of social constructivist doctrine relies on the understanding that it is not the tool in the sense of material that defines technology but rather social, ergo non-material, factors. Sociologist Bruno Latour offers an example

of the materialist view through the gun reform slogan of 'guns kill people', where he argues that the gun itself doesn't kill the person but rather people kill people through the means of the object of the gun. Alternatively, the concept of 'people kill people' and the gun itself is simply a material used to achieve the result would be considered the sociological viewpoint (Latour, 1999, p. 177). If we replace the 'gun' with a tool as a means of production of a building within the general theory of morphology, we can apply Latour's social constructivist position as being that *the tool itself is simply the material component of a socially defined act of the craftsmen utilizing the tool* to complete his intention of building a house. A Latourian response to the binary division of the Cartesian subject and object relationship as synthesized in the type-morphological theory of urban morphology is a valid experiment to be undertaken. It does not form part of this research; the theme is followed in another essay by the author (Radović, 2020c)

The technological determinist viewpoint falters at the qualitative redefinition of architecture at the micro scale, to architecture at the macro scale. No determinist causal evidence within the ontological concept of the village, city or territory can be observed. Groupings of houses, no matter the physical scale mandate the formation of a village in the sense of a community of buildings. The existence of villages is entirely constructed through social means. Cities are also not determined in the scalar relationship to villages, as certain examples of cities can be much smaller in scale than certain villages. The causal determinist relationship from architecture to village is not of a singular maker designing the village itself, although it has been tried through such attempts as *new urbanism*, gated communities and retirement villages. The general theory of urban morphology, thus, bears a theoretical schism at its very core, in the sense of the architectural object being the central point of the model, and therefore occupying the physical objective realm as well as the subjective societal realm. To follow the causal mechanisms that allow the concept to be physically built, we would arrive at quite a different form of urban environment, one that is autocratic in the

sense that it is predetermined by the technological means *of* its singular maker, the *arkhitekton*[49] as city builder.

As stated at the beginning of this chapter the role of a general theory is to provide a basis for analysis of specific, more particular examples which bring the theory itself into question. The qualitative redefinition of architecture, at once the largest of the objective scales, yet the smallest of the territorial scales is theoretically sound - within the conceptual framework posited by the authors where the morphological process occurs within the same cultural area (Giancarlo Cataldi, 2018, p. 65), and clearly demarcated scalar relationships. The scalar relationship between $\sqrt{A}$ and $\sqrt{B}$ (tissue scale)[50] in contemporary global megalopolises, where many factors including land prices, scarcity of suitable allotments or simple surging population growths have mandated an incredible vertical increase in residential buildings. The relationship at the smaller scale, from tool to architectural dwelling, remains relatively unchanged yet the scale of dwelling to tissue is fundamentally altered. A new amalgamation of building as vessel to building emerges, placing strain on the concept of $\sqrt{A}$ as direct assemblage component of $\sqrt{B}$, without a tertiary intermediary which at once is the logical endpoint to the object scale, whilst also a physical manifestation of the territorial scale. Within the logic of the Type-Morphological theory the division between architecture as the largest end to the human scale and the smallest end to the territorial scale the building occupies a position where it is either an end point or the beginning point.

Thus, if we consider the Reading-Projecting-Building-Dwelling causal mechanism concluding at the dwelling-as-architecture node, then this newly described building as vessel to building could be described as *architecture-of-dwellings*. The understanding of residential skyscrapers as exactly that can be seen in their mode of production, where the *arkitekton* easily accommodates into the larger scale of territory. After all, most skyscrapers are designed by a singular subject (of course

[49] As derived from the Greek words *arki* (chief) and *tekton* (builder).
[50] Defined within the theory as primarily individual residential buildings set within the same urban context.

understanding that subject here is implied to be an architectural office or suchlike). A singular architectural object housing a population akin to a population of a large village. Following the logic of architecture-of-dwellings, then, the inverse case could also be posited: at the smallest scale of the territorial assemblage we now have *a precinct-of-architectures*.

Therefore, a second set of suppositions can be placed on the architecture as vessel concept. If indeed it is not only the nodal point of the two scales but rather encompasses both scales at the nodal point, then the object must also internalize the territorial aspects of the larger social scale. Latour has said as much in his writing of the division between subject/object as not being a philosophical one but rather a political one (Latour, 1999, p. 13). Regardless how big, *architecture-of-dwellings* remains an object and, as such, it complies with the timeless Vitruvian definition of architecture – *utilitas, firmitas, venustas.* The transition of an object into a *precinct-of-architectures* amounts to qualitative translation into higher levels of complexity, and the capacity of a social urban entity.

5.2 FUTURE DIRECTIONS IN SUPERTALL RESIDENTIAL SKYSCRAPERS – THE SUSTAINABILITY IMPERATIVE

5.2.1 Sustainability – from triple-bottom line, via three-pillars, to four-spheres theory

In contemporary theory related to human culture and development, the term sustainability has taken a tripartite form since its first conceptualization in the early 1980's, when the concept of environmental sustainability was first introduced as equal to the traditional economic and social objectives. Since its inception, the concept of interconnected Economy/People/Planet, initially formulated by John Elkington (1998) as the triple bottom line (3BL) principle, has taken many guises. Although not the first to touch upon the subject, the novelty introduced by Elkington was *the addition of the 'planet' component*. That has provided a new level of awareness, and facilitated better understanding and acceptance of the concept. By the late 1990's and early 2000's, that

terminology became widely accepted as a blueprint for sustainable design. It was even adopted by the United Nations, albeit with a different terminology. The metaphor of the horizontal bottom line was abandoned, in favour of the foundational concept of 'three-pillars of sustainability'.

Although both of those terms have certain qualities, neither of them is appropriate when applied to the topic of sustainable high-rise design. The 'bottom-line' alluded to accounting jargon, where it has traditionally been viewed as the sum in monetary equations. Introducing the third bottom line into an equation gave impression that mathematical equation could not be balanced if either social or environmental parameters were not met. The idiom failed to explain what and where these bottom lines were to be drawn; it lacked definition of the relative importance of elements in the equation.

The United Nations re-phrasing took direct monetary connotations away, leaning towards more tectonic and structural language. That was more in line with broader discussions the UN were about to commence. Instead of an accounting discourse, the new concept preferred foundations, and thus 'pillars' of ideas. The newly adopted term suggested that all three concepts need to be simultaneously applied and work in unison, upholding an ideal equally. Removal of any pillar would make the whole structure not falter, but fall. There was no ambiguity of the importance and properties of each of the pillars. In order to lay a solid foundations for the suprastructure, they all had to be of the same height and, metaphorically, of the same importance.

However, regardless how ell intended, the language used in the three-pillars strategy turned out to be too rigid, even authoritarian. Besides being strong, the pillars are also autonomous objects, set equidistantly from on another (imagining a three-legged stool). Thay all work in unison yet, except in their basic ability to hold something up, they do not impact on one another. The concept also suggested the solid ground upon which these pillars sit, which can be inferred to mean a set of 'truths' upon which they must sit. That was an already outdated, modernist concept which advocates universal, unalienable truths upon which any new system must be founded. Furthermore, within that system, each pillar, be it economy, society or ecology, must focus only on its own third of

the overall load, and let the other two worry about their equal share. The only possibility of contact between the pillars was via an intermediary, either the set of solid foundations they sit upon or a lofty goal they uphold. Thus, unwittingly, a silo effect between the disciplines and top-down power were promoted, from the very conceptualization of the new term.

5.2.2 Four-spheres of sustainability.

More recently, the international community has begun discussing normative changes that would move away from the dominant three-pillar/triple bottom line jargon towards an introduction of the critical, fourth component. Albeit a limited consensus has been achieved so far on what this fourth component (from here on referred to as 'sphere') should be (Sala, Farioli, & Zamagni, 2012), three distinct possibilities emerged:

a) **institutional**, or the introduction of a political sphere as an impartial referee acting upon the three pre-established spheres

b) **cultural**, as an effort to place sustainability within broader frameworks of human existence and expression and

c) **technological**, a push to see sustainability within the currently dominant techno discourse. (O'Connor, 2007).

5.2.3 Institutional four-sphere of sustainability theory

The four-sphere theory of sustainability (O'Connor, 2007) reimagines and builds upon the three established, independent categories of PEOPLE, PLANET and PROFIT through the edition of a fourth component, that of an institutional actor or POLITICS. This quaternary 'sphere' forms a tetrahedral lattice where each sphere is independent yet linked to each other. What is claimed, for the first time compared to the previous two theories, is that *the interlinkages between the now identified spheres are of paramount interest*. O'Connor builds upon the thesis by René Passet who first introduced the concept of understanding sustainability through a rubric of 'systems theory' (Passet, 1979).

O'Connor describes the tetrahedrally arranged system of spheres within his model as being:

Components	Elements of Characterization
The three spheres	**The 'three-spheres'**
Economic	Economic self-organisation
Social	Social self-organisation
Environmental	Environmental self-organisation
The fourth sphere	**… and the institutional arrangements for their governance…**
Political	The governance dimension of organisation is constituted through the emergence of conventions and procedures for the regulation of each sphere in relation to the others
Policy Domains (interlinkages)	**The three domains of governance/regulation**
Political <-> Economic	**Political -> Economic:** Supply of ''economic policy'' or ''governance'' of the economic domain **Economic -> Political:** Demands (with accompanying arguments, reasons, principles) made on government by economic actors concerning ''the economy''
Political <-> Environmental	**Political -> Environmental** Supply of ''environmental policy'' **Environmental -> Political** Not-applicable
Political <-> Social	**Political -> Social** Supply of ''social policy'' **Social -> Political** Demands made of government concerning civil society.
System Interfaces	**Characterization of the interfaces of the three spheres**
Environmental <-> Economic	The economic sphere seeks the ''services'' of ''natural capital'' to economic welfare as a factor of production; this engenders ''environmental pressures'' and ''impacts'' on environmental functioning and (future) services
Economic <-> Social	The economic sphere seeks the ''services'' of ''human capital'' (and also of ''social capital'') to economic welfare; this signifies, on the one hand (sought-after) opportunities for wealth, revenues, goods and services but, on the other hand, exploitation and perturbation of existing community forms. For the Social sphere, the economic is a means and not an end, and the question is whether ''opportunities'' provided by the economic are nourishing or perturbing of the affirmed values and forms of community
Social <-> Environmental	This is the domain of environmental values and the matrix of ''culture'' that determines the ''meanings of nature'' or the spectrum of ''environmental functions'' identified by/for a society, e.g., nature as a cosmology, roles as a ''source'' of well being or wealth, perceived quality of landscape. This is therefore the material-symbolic space of meanings that (among other things) permits members of society to articulate ''risks'' and to affirm values: sustainability of what, why and for whom (e.g., productive land uses, biodiversity conservation, reverence for nature; rights and duties of the current generation to consume natural capital relative to rights/duties of respect towards future generations…)

Table 19 - The tetrahedral model for sustainability studies (O'Connor, 2007) pp. 288

As described above, this model illustrates how the three initial spheres adopt silo-like definition, that of independent components, presented in both the triple-bottom line and three-pillar model. It

explains how, by introduction of the fourth, political sphere this independence gets undermined, as the political realm can only exist through its effect upon one of the three pre-established spheres. That challenges the hegemonic nature of the spheres from the offset. The political sphere, simply through its insertion in the equation, mandates that links be formed between the now interdependent entities. In itself, the role of the political sphere is non existent. It emerges only as a function of its application; it can be summarized that the applied politics becomes *governance*. An asymmetric independence between the spheres ultimately emerges, with economic sphere inevitably in the focus.

In the context of the O'Connor four-sphere model the role of governance is relatively simple. The political influences other spheres by supplying policies via a feedback loop with each of the constituent spheres. For example, environmental policy[51] gets supplied by the political class (Political → Environmental) through demands made by the social, environmental and economic (Social + Economic → Political). Therefore, the political sphere is devoid of any demands within itself, and is only considered as a vehicle for aggregating the demands of other spheres and providing policy to the corresponding areas.

5.2.4 Requalification of the four-sphere sustainability model in the context of SRS; the new tripartite system

Building upon the above-summarised analysis of the strengths and weaknesses of previous and current conceptualisations of sustainability and their operationalisation, this research proposed the renewed focus on a tripartite system of sustainability, but one which is more organic and less rigid then what was previously proposed and explored. Each part of the proposed system in itself does not hold up anything, nor it underwrites any grand equation. Each part is holistic in itself. It has no

[51] It is worth noting that in the Environment -> Politics vector nature itself cannot 'demand' anything from the political sphere, as the demand in O'Connor's model is mute; or to say that nature cannot voice demands directly in to the political sphere. An alternative idea understanding of the 'nature' sphere could be thought of as not being literally nature as in or geo

requirement to be mathematically measured against any of the other participants, thus providing false numerical regime upon all three; nor does it have to hold up a larger ideal, and therefore gets measured within its rigidity. While this system clearly draws inspiration from the aforementioned four-sphere of sustainability model (O'Connor, 2007), it fundamentally realigns the axis upon which the previous modelling is based.

The four-sphere model relies on the fundamental notion that the political sphere is an impartial arbiter, and, therefore, that through simple exchange of demands from one actor it provides a just policy for another. Such concept works only at the conceptual level. When applied in practice, to concrete examples within specific locations, any *a priori* statement that the political entity functions devoid of ideological pressures prove to be naïve.

The claim of this Thesis is that, if the four-sphere model is to be effectively applied to a pre-existing condition, it must be variously contextualized and, thus, the political sphere must be considered within its own, current context. Within the new conceptual model proposed henceforth, the political stops being an arbiter and impartial policymaker, and it forms the (metaphorical) 'ecosystem' of values and ideals within which particular, contextualized examples take form.

5.2.5 The Ecosystem

In practice, each of the three components works within one of such ecosystems. In the case of skyscrapers, the ecosystem could be a city or, perhaps, even a nation. They all exude a pull towards their own private nuclei where, in order to achieve its totality, each of them mercilessly tugs on the other two nodes. If the pull of any of these nodes is too strong and too constant, it fundamentally alters the composition of the whole.

If the way to visualize the early concept of the triple bottom line system was that of a long scroll filled with hieroglyphs, symbols and numbers (which at the end either equate to a positive answer, or do not); and the three-pillars system that of a sturdy three-legged stool (able to hold weight only if each leg is equally strong) - then the tripartite system is more akin to three soap bubbles,

precariously forming a trigonal planar object. If one of the bubbles pops, the other two will not necessarily follow suit, but the fundamental composition of this new molecule will be altered. *The context within which this molecule takes form is the ecosystem, the governance mode*.

Above all else, what this model provides, is *the area of profound tension* - that in the slices between two discreet bubbles. Such areas of tension are neither wholly one, nor wholly the other, but rather *a volumetric gradient of being* which can only exist in equilibrium.

The infinitely small nucleus of all three is the exact point of *sustainability*.

This exact in-between-ness is the topic of the following chapter. However, to comprehend these important slices in-between, a basic understanding of the system in relation to the topic at hand is required.

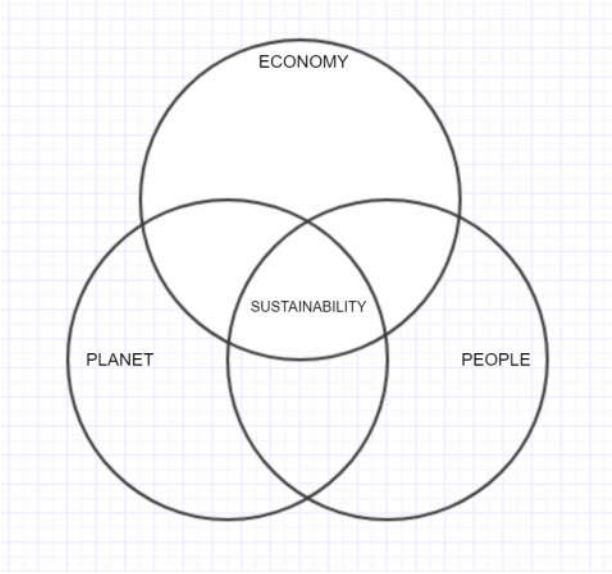


Figure 54 - Sustainability spheres visualisation

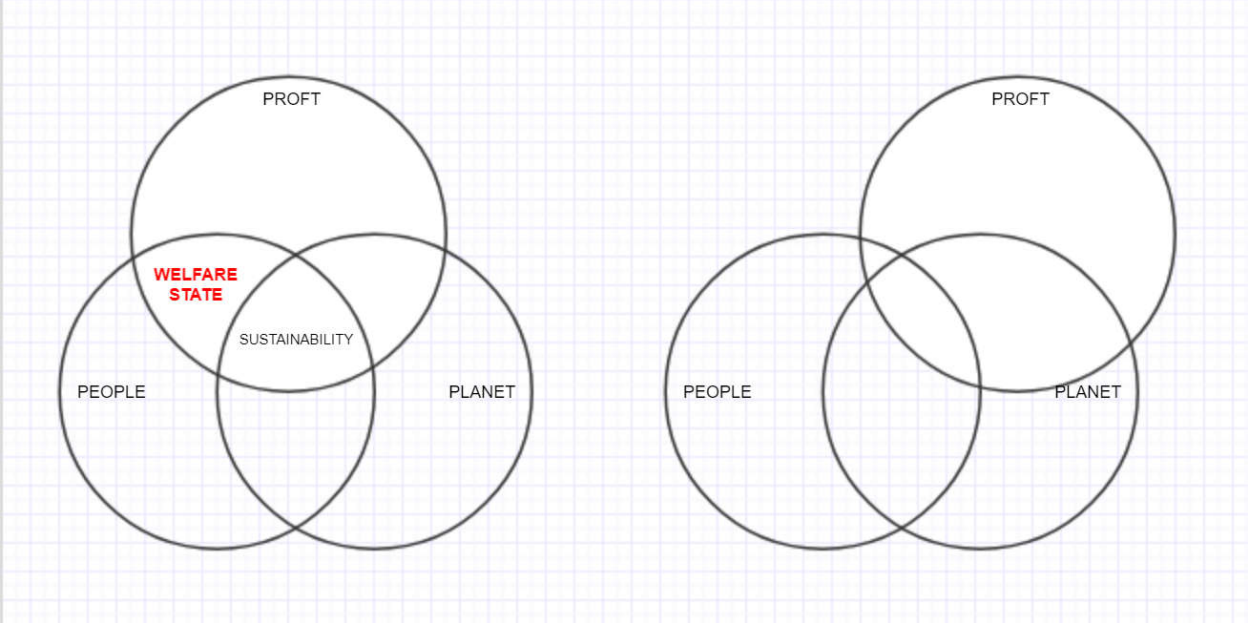
The ecosystem within which the tripartite system of residential skyscraper sustainability exists is both physical and temporal. This ecosystem, for the lack of a better word, can be called *the political atmosphere* of any given location within which a skyscraper takes form. Different forces, with their different objectives, act simultaneously upon this ecosystem. When the vectorial pulls on the ecosystem are overwhelming in a singular direction, the system not only reacts by shifting in that

particular direction, but it either collapses entirely (and, thus, no longer remains sustainable), or it violently shifts back towards the centre, in opposite direction. The following chapter argues that precisely this violent pull towards a singular direction is currently being performed in the tripartite ecosystem of 'sustainable' residential skyscrapers. Two of the three interacting bubbles (refer to the soap bubble metaphor again) are exerting a disproportional force in a single direction, leaving third bubble underrepresented in the system.

In simple, traditional understanding of ecosystems where specific groups represented separate segments, these groups were relatively strictly defined. The democratically elected officials, in the cases where the nation is a democracy (worth mentioning due to United Arab Emirates, and therefore Dubai being an outlier), should fundamentally represent the public, or the PEOPLE bubble. The economic interests, or the PROFIT, are represented by private individuals, companies or suchlike who are, fundamentally, the antithesis of public interest. The third environmental or PLANET component was traditionally represented by academia, professional and expert fields. Simplistically, in this scenario each component is specifically managed or looked after by a discreet group.

In the age of neoliberal capitalism distinct roles have been assigned to political classes, which vastly differ to those of previous regimes. As the Greek economist Yannis Varoufakis explains, the role of classical liberalism, the era which directly preceded that of neoliberalism in the West, was exemplified by the doctrine of minimalisation of governmental interventions in financial markets. Simply, the role of government was previously precisely to not have a role in economic affairs of the free market system; other than, of course, to uphold the law. Neoliberalism, particularly under the influence of Reagan in the United States and Thatcher in the United Kingdom through the 1980's changed the requirement of the political class from that of the law enforcing observer to the economy, the one which only steps in on a national level to prevent monopolies, fraud or suchlike, to that of the global economy apostle of free market, which is required to spread the free market reform and open (sometime forcefully) new markets. Thus politicians, firstly those in the Anglo-

speaking West, followed quickly by most of the western world, and most recently truly globally, have been coerced to represent the interests of the economy and profit above those of ecology or cultural society. Evidence of this subservience of ecological concerns to those of the economy are perhaps best highlighted in the messy withdrawal of the United States from the tokenistic Paris agreement. The message was clear, ecological concerns are not the concerns of the political class if they impede the primary role of politics, that of upholding the free market ideology.



If we once again imagine the bubble diagram from the previous section, the sliver between the PROFIT and PEOPLE was traditionally occupied by what was referred to the as the welfare state. The welfare state was a mechanism where the government invested in the welfare of the public. This intervention had many forms, such as investment in education, health and housing. Often this last type of investment took the form of high-rise social housing, which in the cases of the United Kingdom and Australia formed the first attempt at high-rise living.

With the advent of neoliberal divestment from all things social, through the mantra of reducing the size of the governmental apparatus, rapid disassociation from any ideological stances other than

free-market competition and general promotion of private interests over public benefits, the sliver between PEOPLE and PROFIT shrunk.

It is the position of this piece of research that the contemporary skyscraper sits very much within this new neoliberal ecosystem, where the PROFIT and PEOPLE intersection is miniscule. To a large degree, it could be seen as the product of that system of power. However, with the qualitative change of skyscrapers from architectural singularities to urban multiplicities, a novel reimagining of the linkages between PEOPLE and PROFIT must be sought, and it should be possible.

5.2.6 Contemporary Skyscrapers and the profit/planet dichotomy

Repercussions of neoliberalism on architecture and urbanism were profound, from impacting the very workflow within architecture offices, to the scale of projects undertaken, to expediency required during the architectural process and, finally, to the globalized nature of work undertaken within 'starchitect' offices (see Spencer, 2016).

As our analysis of the fifteen supertalls has revealed, more often than not a truly international team of architects, consultants and engineers undertakes the initial design phases, with local contractors usually involved at the latter stages. Within the field of skyscraper architecture there has been a growing discontent from globally significant practices critiquing and subverting the abovementioned hegemony of current architectural profession. It is not uncommon to see some of the world's leading practices to dedicate, albeit only a portion and more often than not unbuilt, to 'eco-skyscrapers' or skyscrapers that in one way or another attempt to respond to the ecological concerns of contemporary critical design.

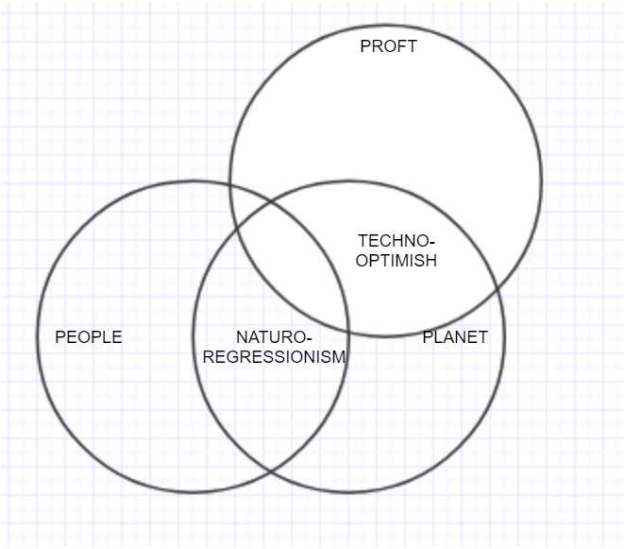
Thus, if the contemporary political class is mandated to uphold the *economic* merits of projects, the design professions have become the de facto custodians of the *ecological* movement through architecture. This new found license for design has meant a huge uptick in eco-futurism emboldened by a newfound avenue for creativity. Suddenly, a new requirement has been offered, that of ecologically sustainable design. That is not only subversive to the hegemony of the late 20th

centuries neoliberalism; but has also been seen by many to be the rallying cry for a new leading role for the profession of architecture within a shifting world order. The Council for Tall Buildings and Urban Habitat has dedicated five of its last ten conferences to the subject[52], the United Nations High Level Political Forum (UNHLPF) in 2018 focused on the Paris agreement Goal 11[53] and even CNN profiled skyscrapers as the future of ecological sustainability in its expose 'The City'. Further afield the renowned economist Jeremy Rifkin has released several influential texts (2011, 2014) imploring global governments to double down on environmental sustainability, which in part is seen through distributed energy production; such as photovoltaic cells on facades of buildings and private, off-the-grid, energy production through windfarms (which one assumes would be heavily utilized on skyscraper designs).

This excitement to design, create, subvert and question has taken shape within the architecture profession relating to residential skyscraper design through two very particular visions; a) techno-optimistic 'smart' design and a mantra of 'designing our way out of a problem', and b) a *return to nature* within the edifice of a building. In order to establish a working language within this thesis I will refer to them as *techno-optimism* and *naturo-regressionism.*

[52] CTBUH (2008) 8th World Congress: "Tall and Green: Typology for a Sustainable Urban Future", CTBUH 2009 Chicago Conference: "Evolution of the Skyscraper: New Challenges in a World of Global Warming and Recession", CTBUH 2010 World Conference: "Remaking Sustainable Cities in the Vertical Age", Seoul CTBUH 2011 World Conference: "Why Tall? Green, Safety & Humanity", Middle East CTBUH 2018 International Conference: "Polycentric Cities: The Future of Vertical Urbanism"

[53] UN Sustainable Development Goal (SDG) 11: Make cities and human settlements inclusive, safe, resilient and sustainable



5.2.7 Techno-optimism

The techno-optimist pantheon draws much of its inspiration from the mass communication era, bookended by data collection and data analysis. In its simplest form, this direction within the field of skyscrapers propagates that ecological sustainability can be achieved through digital monitoring, evaluating and analysing of not only the behaviour of buildings within the natural environment, but also that of the inhabitants within the said building. It fundamentally upholds that ecological salvation will be achieved through design and digitalization. Contemporary examples of this 'smart' movement are many, but perhaps are best exemplified through the huge advancements that have been realized in elevator design and manufacturing. Modern high-tech lifts, which unlike their predecessors do not rely on pulleys and ropes, but rather levitate via magnets, in supertall skyscrapers have become so efficient that their downwards fall via controlled gravitational pull is captures and stored as energy through such excellence that these lifts actually provide excess energy from a up/down journey,

In 2018 there has even been a dedicated techno-optimist summit entitled Smart Skyscrapers 2018 Summit in Dubai[54] which featured global architectural firms such as Adrian Smith and Gordon Gill Architects (US), UNStudio (Netherlands) and Skidmore Owings Merrill (USA). Each of those firms

[54] http://www.smartskyscrapers.com/

espoused the benefits of not only integrating smart skyscrapers into smart cities but, in many cases, making them the focal point of this brave new urbanity. Other Smart Skyscraper summits have been scheduled, which seems to point towards the global appetite for discussion relating to the subject; particularly in locations facing rapid residential verticalisation.

Perhaps the most successful, and definitely the largest exposition of this ideology has been held in the newly founded Kazakhstani capital Astana, where in 2017 the World Expo was held under the title *Future Energy* [55]. The expo's technical committee was chaired by Jeremy Rifkin, and the architecture firm chosen to design the campus style exhibition was Adrian Smith and Gordon Gill Architects; seeing off competition from their Smart Skyscraper 2018 Summit colleagues UNStudio (Netherlands), starchitect Zaha Hadid (UK) and Snøhetta (Norway) among others. Rifkin was quoted as saying that the winning scheme is "the most practical in terms of both sustainable development and architectural and artistic design". The New York times published an article at the time (Segal, 2017) praising the design, however not without mentioning that calling it Future Energy "may sound like a stab at humor given that oil, gas and metals are the lifeblood of the country". The World Expo was the perfect amalgamation of eco futurism and economic pragmatism.

Interestingly exactly 164 years after the famous World's Fair in New York in 1853 the, now renamed, World Expo once again wooed the audience with techno futurism of the elevator. Just as Elijah Otis revolutionized the world of skyscrapers with his invention and exhibition of one of the world's first commercial lifts in 1853 (Koolhaas, 1978), the world once again turned towards this marvel of effortless vertical ascension to perhaps welcome, yet again, a brave new world. This time the hollow centre of the giant globe, an all to obvious metaphor for planet Earth which at once was the main exhibition hall of the 2017 show and also a giant digital canvas, was punctuated by a collection of brightly lit elevators which rhythmically ascended and descended through what Koolhaas would have surely opined to be the contemporary version of his 'lobotomised' skyscraper of 20th century

[55] https://expo2017astana.com/en/

Manhattan (Refer to Chapter xx and Koolhaas (1978)). If the images of Otis in 1853 were set to the aesthetic of Hugh Ferriss (1929) , then their 2017 descendants were more akin to the film Tron[56].

The overriding ideology of the techno-optimist mantra is that of gradual advancement in disparate disciplines which when combined, through intelligent data integration, advance the common cause of ecology.

At its core the techno-optimist philosophy, by the fact that it is inherently entirely removed from the PEOPLE component of the tripartite system, attempts to continue operating in the exact economic and political system that currently dominates. Therefore the thought leaders of this specific ideology are more often than not leaders of professionals associations, market lobby groups, conscientious economists and 'enlightened' politicians.

5.2.8 Naturo-regressionism

Naturo-regressionism approaches the ecological imperative from a radically alternative perspective to that of PROFIT and PLANET. It purports that ecological sustainability should primarily rest on the shoulders of the human occupants of skyscrapers, but subverting the very conceptual foundation of skyscrapers as buildings into vertical urban and rural assemblages. These ideals usually manifest themselves in often banal ideas of vertical farming, where inhabitants 'green' their outdoor spaces to produce vegetables (thus seemingly amalgamating two major eco themes; urban farming and self-sufficient agriculture). Philosopher Slavoj Žižek refers to this phenomenon, albeit not specifically relating to architecture, as return to nature (Zizek, 2000, 2008), a phenomenon of assuming that nature itself was in a state of equilibrium prior to human intervention and that only human un-intervention or perhaps a more traditional humane approach to intervention is required. The nexus of this conceptual regression to a previous state of being, one that is in one way or another more

[56] Refer to the website Calvert Journal, for a first hand report of the Astana 2017 Expo; http://www.calvertjournal.com/features/show/8590/astana-expo-2017-kazakhstan-invites-world-step-into-future-energy; and a simple YouTube search for the keywords 'Astana, Expo, elevators' provides numerous videos of the aforementioned elevators in motion.

connected to ‘nature’ and thus absolved of not only the sins of modern architectural design but also free-market globalization, and its application to a thoroughly contemporary edifice, that of a skyscraper provides fertile ground for architectural design. More often than not this type of utopian thinking is almost entirely bereft of economic underpinnings; which is inherent in its conceptualisation, as it is entirely removed from the PROFIT component. Thus if the though leaders of the techno-optimist campaign are professionals, industries and politicians (backing private investment), then the custodians of the NATUROREGRESSIONIST mantra are the academic, environmental and conservationist groups.

5.3 PUBLIC-PRIVATE PARTNERSHIP

This segment focuses on the uneasy relationship between public space and contemporary skyscrapers. While equivalent to the quality of the truly publicly owned spaces, accessible and open to all, has often been promised by owners and developers of contemporary skyscrapers, in various forms such as gardens, plazas, lookouts and so on, the pseudo-public reality offered by the much-lauded Privately-Owned Public Spaces (POPS) falls short of expectations. Here we present an analysis of the idea of territoriality within the edifice of the skyscraper in several paradigmatic examples, which illustrate the origins of concept of POPS in skyscraper design, current trends, and the ideas about future. The emphasis is on positioning of Privately-Owned Public Spaces within skyscrapers themselves, where they are usually relegated to the periphery of the building. This periphery gets conceptualized as an externality to the building itself as internality to the site and externality to the structures in the form of public central courtyards or even internal to the structures (as in the case of the Rockefeller Centre, Manhattan), yet critically segregated by peripheral positioning at the ground floor (the Leadenhall Building, London) and the top floor (20 Fenchurch Street Tower, London). Common to all of these externalities is hard control over highly regulated, pseudo-, and semi-public space, which questions the use of the term public in describing them.

For discussion that follows it is important to emphasize the physical nature of public space, which is always an arena for diverse manifestations of the public discourse, the realm of free thought, expression, and association. From the foundational thought of the Greeks to Hannah Arendt, Jane Jacobs, Jürgen Habermas, Bill Hillier, and Judith Butler (to name a few), urban and political theorists of various orientations stress the constructed aspects of public space - as streets, squares, parks, spaces between buildings, spaces of buildings and functions etc. - in which the full richness of public life can unfold. Being simultaneously socially defined and defining, by being urban public spaces inevitably conform to concrete rules and regulations which keep the interests of the people firmly above and beyond any particular, private or corporate interests. Central to public life and public space remains the quality which Lefebvre, Kofman, and Lebas (Lefebvre et al, 1996, p. 147, sqq) postulated as *the right to the city* but, as Mitchell (2003) argued, "just what public space is - and who has the right to it - is rarely clear, and certainly cannot be established in the abstract…" (p. 5)

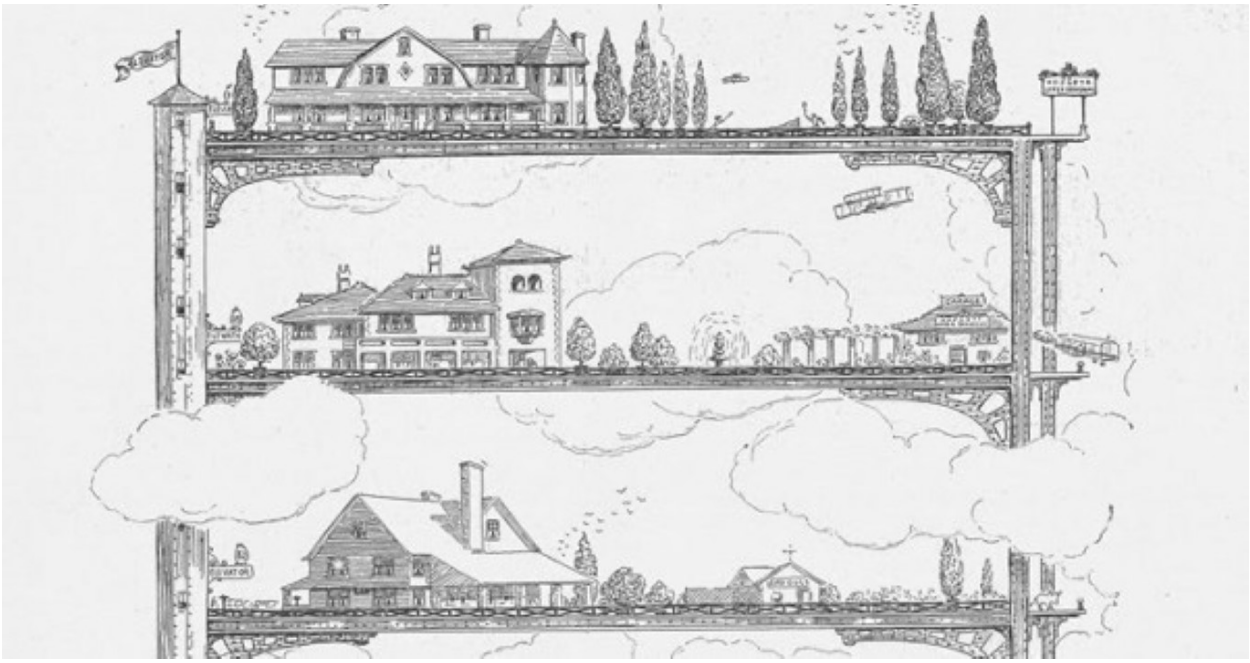
Public space enshrines the fundamental, ancient notion of public good. While that concept is an ideal, the experience of public quality has to be real, constantly re-defined and defended. Since 1970s, with rising awareness of an environmental crisis, definitions of public good started to include demands for environmental and cultural sustainability, which in 2015 became sanctioned as official United Nations Sustainable Development Goals.

What matters here are the physicality, vulnerability and that need for regular redefinition of the fundamental and intertwining values which underpin the concepts of what true public space is, and what it ultimately is not. The definition and expressions of those concepts have to be as alive as those concepts are, to account for fundamental continuity and perpetual change within forces shaping them. New forms of urban life seek new expressions, which need to be placed in positive relationship to the time-honored values of urbanity. That is why, rather than seeking a blueprint or some prescriptive advice about future of public space within already present and emerging urban realities, this essay attempts to elucidate the nexus of physical public space and the conceptual

framework of publicness by focusing on what is, perhaps, the most rapidly evolving architectural type of contemporary era, the skyscraper.

5.3.1 The precursor to the skyscraper

In order to understand the historically antithetical relationship between the ideal of public space and the skyscraper as development, we need to examine the role which public space has had in formation of that architectural type. An early visualisation of the concept of a skyscraper, as famously illustrated by A.B. White in the 1909 Real Estate issue of LIFE magazine explains the origins of the idea of modern vertical settlement (Koolhaas, 1978). White presented a structure of columns and platforms, repeating "land" subdivision, building types and form which were common at the time. That structure barely relates to what was to become a skyscraper.



Such conceptualisation of life above the ground was a direct response to the non-urban reality and the firm framework of values within which the developer strived to innovate. *The Commissioners' Plan* of 1811 was, simply, a subdivision of the island of Manhattan above Houston Street up to what is now the 155th Street. The grid here expressed colonisation of the New World through urban means, the appropriation by an imposed "neutrality" of the Cartesian urban form, making land

reducible to financial transactions, to money. In order to prevent chaotic expansion of the new wealth into the hinterland, a homogenous and rigid pattern of allotments was laid out over the island (even beyond the geographical limits of what has been known and mapped at that time). The subsequent Plan of 1818 was, again, the physical manifestation of values of European Enlightenment, thus relating to the ideals of democracy, private property and equality. Through its understanding of native land as *tabula rasa*, that plan is also the most abhorrent tool for colonial expansion (Highmore, 2006). In this concept of space, from the outset there was no place for the notion of "public good," and by extension that of "public space." Those values reserved for a select "public" only. One could argue that the exterritorial character of the skyscraper was an unavoidable and truly American projection of society, aimed exclusively at the entitled citizens only.

A.B. White's idea how to circumvent the orthodoxy of the ground plane, for profit, of course, was a vertical subdivision of the air above the grid, establishment of a rectilinear, shelf like structure which only replicated the idealised vision of the New World of his era. Rather than imaging the new type as an enclosed object more akin to traditional European towers, this new skyscraper was a multiplication of rural open space, with it all the trappings of an idealised rural life, such as meadows, orchards and homesteads. Although, predictably never constructed, this utopian concept provides an intriguing starting point for the analysis of tenuous relationship between what would be a thoroughly private object and the idea of open space, open yet not public domain in nature.

5.3.2 The reality of the skyscraper

The physical reality of skyscrapers as we know them today is one of territorial integrity of the object, with potential for added externalities. The examples of interactions between the two that follow will help open discussion about the dialectics between public and private interests in contemporary urbanism, within the limitations of our theme. They illustrate the evolving meaning associated with the syntagm "public space" in the context of skyscrapers and provide a starting point for discussion of the idea of public inside a decidedly architectural space. Not surprisingly, the examples which best

cater for that purpose are of Anglo-American provenance, as both the architectural type (skyscraper) and the ideological framework which introduced it and imposes it globally (neoliberal capitalism) have also originated there.

Historically, skyscraper developments have externalized public space. Such, externalized spaces, for which developers claim the public quality, tend to be privately owned. Although conceptually created much earlier, since the 2000's the acronym POPS, also coined in New York, was promoted and imposed as a "solution" to total commercialization, portrayed as an inevitable new urban condition as with a lack of publicness and a limit to public access (Kayden 2000). While in social terms, with some good will and positive spin, one could argue that these spaces still seek their socio-cultural definition, their physical positioning within the project challenges such attitude. POPS tend to be located at the periphery of architectural objects.

5.3.3 Rockefeller Centre

The Rockefeller Centre in Manhattan (designed by Raymond Hood, 1939) provides a paradigmatic example needed to open this story. Rather than developing the entirety of the site, the developer "donated" a portion of the buildable land towards public use and skirted the perimeter with skyscrapers. The whole of the site, which pans several of Manhattan's city blocks, has two main open spaces; a) a pedestrian thoroughfare which dissects the site east/west; and b) an open plaza underneath the 30 Rock Building. At the time, this type of urban addition within a purely commercial site was unique, unlike what could be seen elsewhere within Manhattan. However, this pedestrianized zone was firstly and foremostly intended as an extension of the shopping environment, with the promenade originally conceived as an artery to funnel pedestrians towards the interior of the site. The sunken plaza, originally intended to house the Metropolitan Opera Company building, was never constructed. The remaining gap between the buildings was retained primarily due to commercial considerations, and as a publicly accessible open space only later (Adams 1985). The Rockefeller Centre provided a much-copied model where public space is only a

means of bringing pedestrians in, towards shopfronts and offering resting areas, spaces for exercise and seating. The space labeled “public” is peripheral to the architectural objects. It is conceived to invite the public to the interiors of the ground plane, whilst acting as a barrier to the shield private structures.

5.3.4 Walkie-Talkie and Cheesegrater

A recent trend in newly constructed skyscrapers has been to place “semi-public” spaces and POPS within the physical boundaries of the architectural objects themselves, conforming to local public space laws whilst retaining as much of the possible building footprint for commercial area. Two exemplary cases can be found in London, only a few hundred meters apart. 20 Fenchurch Street Building and 122 Leadenhall Street Tower - colloquially, because of their respective silhouettes, referred to as the Walkie-Talkie and the Cheesegrater. The designers and developers of those skyscrapers approached the integration of public amenity within their physical boundaries, in two diametrically opposite ways.

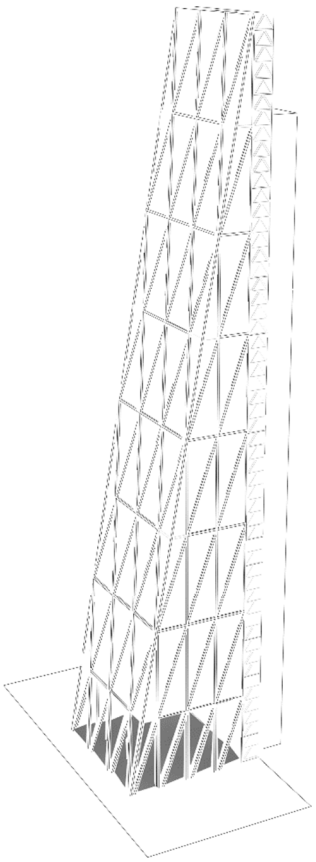


Figure 55 - 122 Leadenhall Street Tower (The Cheesgrater)

The Leandenhall (Cheesegrater) building, designed by Roger Stirk Harbour + Partners, had a large portion of the ground floor footprint entirely open, devoid of enclosed spaces with only several sets of escalators and large columns interfering with public thoroughfare. The lowest eight of the height of this building (see Figure 1 – darkened area) represents the forecourt area. The building itself is designed as an horizontally extruded right-angle triangle, with the top tapering so as to allow privileged (and, in public interest legally protected) views of St. Paul's cathedral (Wood, 2014). The frontage facing Leadenhall St. is minimal, with a cavernous overhang providing shelter to the forecourt.

Ultimately, this intervention is precisely that is what that external demarcation of a forecourt as public space is all about. The space itself contains an elongated stretch of concrete public seating to the perimeters of the site, with several trees planted around those benches, with a hard-surfaced

entry and bollards preventing vehicular access. Although seemingly generous by giving whole ground-floor away to public, this type of insertion of public space within a private structure still adheres to the principle of externality. However, morphing into an addition-by-subtraction by "sacrificing" an internal space provides open external space. The separation is still placed at the decidedly hard edge, segregating the outside from the inside and, consequently the private from the public. The formal authoritative structures of private interest dominate the public. The rules and regulations defined under the authority of the private and imposed over the public in the literal and functional sense.

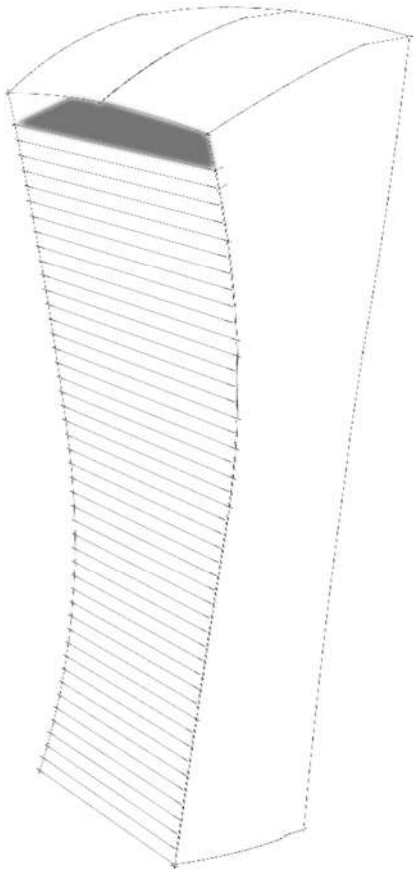


Figure 56 - 20 Fenchurch Street (The Walkie-Talkie)

The Walkie-Talkie in 20 Fenchurch Street was opened a few months prior to the Leandehall tower. In this case, the designer, Rafael Viñoly approaches the partial integration of public space within the objective space of the private by allowing a "public" viewing gallery, referred to as the Sky Garden in

promotional advertising of the skyscraper to the general public, at the summit of the commercial building (see Figure. 2 – darkened area). Due to the shape of the skyscraper, that of an unusual floorplate expanding from bottom to top, the volume also nominally allows the largest floorspace to be designated for the viewing gallery. While the platform is an enclosed space within the edifice of the building, it operates through its connection via a lift available to public. Thus, similarly to the Leandenhall Building, the publicly accessible space sits within the planar confines of the private space. It remains segregated with the private owner providing the rules and regulations governing its function, whatever they may be (Shenker, 2017) . The architects explain this inversion of public space from its rootedness to the urban fabric of the city as an innate desire for humans to ascend, and thus to provide the public a free of charge experience of otherwise privileged views or 'otherworldliness.' The interior of the 'Sky Garden' is an amalgamation of public seating areas, green planted zones, and publicly accessible spaces, such as restaurants. However, security reasons are cited for the need to pre-book place in the restaurant or the "public" space itself. While the justification for design concept came from a noble idea to challenge the socioeconomic stratification of cities, particularly the likes of London, by literally raising the public to the highest strata of the building, the actual quality has been reduced, predictably at the cost of truly public space (Viñoly et al, , 2015).

As usually, the final realization of the public space has differed drastically from the grand architectural vision. The Sky Garden upon completion was not free to the public, but rather required an entrance fee. That already happened to 30 Street Mary Axe (designed 2003 by Foster and Partners), affectionately known as the Gherkin, which now hosts a restaurant at its previously labelled public space (Reike, 2015). These ongoing controversies associated with Privately Owned "Public" Space show a clear pattern, where the idea of public accessibility dominates the concept and design, then gets pushed to periphery during the design development phase, to eventually become completely compromised through management based on restrictions. Those practices are by no means limited to London, although the examples listed above have a secondary concerning

attribute. The approval of these towers is contingent on the developers providing public space "back" to the city, and thus by ultimately requalifying public space to POPS, to semi-public, to potentially even private, should not be viewed as an act of kindness rescinded, but rather as a subtraction of required public space. A cynical view at reoccurrence of such practice suggests that it could well be the part of comprehensive business planning.

5.3.5 The Vessel

Figure 57 - The Vessel (Photograph: Ryan NG, Wikicommons)

The most recent of example of privately-owned public space within the context of skyscraper developments to be mentioned here can, yet again, be found in Manhattan. The newly constructed Hudson Yards complex (2019) has been described as the most expensive site in the world, houses a unique structure within its sprawling outdoors space. Named *the Vessel*, British designer Thomas Heatherwick designed a tower and lookout which is part sculpture, part public viewing gallery and,

supposedly, part public space. The initial concept was for a set of intertwined staircases leading upwards, to nowhere, particular with the act of climbing providing the general public a unique view of the Hudson River. Heatherwick described the structure as a "three-dimensional public space, like a park, but taller" in an attempt to infuse an architectural object with a public good (Schwab 2019). Initially the structure was to be completely public, in the sense that although owned by the developers could be scaled by all.

As has been the trend with most public offerings within private structures the end result is very different to that initial idea. Although free, an appointment must be made with the agency operating the structure prior to visiting and is subject to a lengthy terms of service agreement which stipulates that any photographs, videos or media collected of the project remains the property of ERY Vessel LLC (2019). This clause, a thoroughly contemporary incarnation reflective of the social media era where images are much more likely to be seen through mobile apps rather than printed media, is yet another form of soft power being exerted over the general public visiting a place that has been marketed as public, yet has a purely commercial role.

5.3.6 Likely futures and desirable futures

As frequently argued by David Harvey (Harvey, 2006, Harvey, 2005) the above examples and indeed most global examples featuring a public/private interface predictably favor the private over public interest, not only in terms of disproportionate share of the risks and profit, but in terms of the essence of the idea of public, Lefebvre's right to the city, the right to appropriation, which should not be confused with ownership.

Within our narrow focus on a specific type and its constraints, we have explained how all attempts towards integrating public space within the confines of the private object remain tokenistic at best, not only in terms of its spatial relegation to the periphery. That periphery can be the external ground plane, the undercroft, or the crown, yet nonetheless - the periphery. That limits the potential

impacts of “public” as the set of values on the object itself to an absolute minimum. As long as thinking continues to be within the existing paradigm, the primacy of private over public and banal tokenism in design and definitely in reality are the most likely outcomes.

But, future directions in the integration of public space within skyscrapers or any suitably sized residential buildings can challenge this false dichotomy, and the perceived inevitability of separation of the private object from the public realm. Several contemporary theorists and practitioners have focused specifically on this lack of integration, also powering their critique on the imperatives of environmental and cultural sustainability. These conceptual projects tend to refer to eco- or green-skyscrapers, or an integration of these buildings into broader, renewed garden city movement (Bingham-Hall and WOHA (Firm), 2016).

The theoretical basis for claims that skyscrapers need to be sustainable are based on the well-grounded proposition that in the contemporary world sustainability is more than simply ecological, but rather requires careful balancing of economic, cultural and ecological requirements (Elkington, 1998). Only when combined in a coordinated and locally adequate manner, those measures provide for whatever a “truly” sustainable outcome might be. The economic viability of skyscrapers is rarely questioned. The result of economic non-viability, particularly in the private, commercial sense, would result in the building simply not being constructed. Recently the secondary, ecological requirement has been successfully adopted. That was often in the form of technological and material advancements in the building fabric, under the moniker smart-buildings and smart-cities. However, the aspect of culturally inclusive design has been much harder to attain, as can be observed in the general “sameness” of skyscrapers, irrespective of their geographical location. In commercial skyscraper districts, be they in Canary Wharf in London, Lower Manhattan, Dubai or even tropical Asia, configurations and aesthetics have more in common with one another than their cultural surroundings.

If we assume that the quality public realm is inherently interwoven with the specific "public" of the urban, then the culturally sustainable buildings require an integration of the public realm within the skyscrapers themselves. If the right to the city is the right to that "public," then it includes the right to the complex of issues that frame the broadly understood sustainability. This is exactly the point Ken Yeang (2002) approaches when calling for the new typology of skyscrapers to be linked to urban design, rather than object based architecture, although his book could easily be described as suggesting insertion of public space as the solution to the cultural sustainability of skyscrapers. Yeang's major critique of the prevalent architectural design of modern skyscrapers is that the architects tend to design a floor-plate which yields the largest financial returns to the developer as a primary consideration, and they simply multiply this 'successful' floorplate indefinitely with little to no variance. He suggests that this type of design is not responsive to the requirements needed for the buildings inhabitants and therefore provides a suboptimal, inhuman solution. His radical questioning of the current trends in skyscraper design focus on several key observations related to public space; a) a need for continuity between and distinguishability of private and public space within skyscrapers, b) a legibility, both of identity and character of public space within skyscrapers and c) adaptability over time embedded in design (Yeang 2002) (ibid).

Yeang's approach demands redefinition, from architectural singularities towards urban multiplicities, and it is not limited to the insertion of public space within the towers. The separation of the inhabitants of high-rise residential skyscrapers from the ground plane, and thus the public realm of the city is of major concern, as their lives are also segregated into discrete public and private components more so than their compatriots living at lower levels, and thus more immersed in their surroundings. Sky-courts, plazas and streets-in-sky are among the proposed solutions to mitigate the alienation of the occupants from public life and each other. Integration of the city and skyscraper is conceived in the way that public spaces within these eco-skyscrapers are not intended as accessible only to the residents (and, thus only pseudo public), but rather as required components of a larger urban strategy of their home cities. One of Yeang's most radical ideas is the insertion of readapted

quality public space in major metropolises, such as New York's Central Park, as green 'lungs' of the towers, providing air circulation, pollution reduction and so on. His premise is that in vertical urbanism "urban design concepts meant for the horizontal plane will be flipped to a high-rise condition and reinterpreted as vertical propositions" (Yeang, 2002, p. 32). Similarities between Yeang's and A.B. White's imagining of a future skyscraper are inescapable. Both of them advocate a re-insertion of already seen possibilities within their newly conceived constructs.

Yeang, while providing some critical steps in the right direction, is not radical enough in this specific interpretation of what quality public space in skyscrapers could and should be. His theory remains fundamentally limited to an architectural top down vision, where an enlightened expert or singular designer manifests his/her own vision of an ideal public space which materializes as a 'solution' to vertical spaces. That does not take into consideration that true public space is never limited to grand gestures within cities but demands multiplicity of actions by active citizens. Central Park in New York does function as a reprieve for New Yorkers from the concrete jungle that surrounds it, but cities also need fine-grained, spontaneous, and irregular pockets of public space. Precisely those acts are never to be seen in skyscraper spaces designated as "public."

5.3.7 Desirable Outcomes

For true small-scale public space to be achieved a radical rethinking of skyscrapers is required. In order to achieve this spontaneity, of the public realm, an antithesis to traditional and conceptually conservative, unimaginative skyscrapers needs to be established. Under the rubric of vertical urbanism, the *urbanism* component must be promoted to equal footing as the *vertical* - which assumes an object. In quantitative terms skyscrapers, especially very large ones, have a potential which their smaller siblings do not possess. Long ago, architect Rem Koolhaas referred to this as the attribute of *bigness*, something that can be achieved only with scale (Koolhaas, Mau, and Office for Metropolitan Architecture 1995). This bigness provides skyscrapers beyond certain size to become conceptually "more" than just larger version of their smaller selves. The research which underpins

this essay suggests that bigness itself may also provide the ground for reinterpreting public realm, as the potential for true *urbanism* in the context of skyscrapers.

As suggested at the opening of this essay, in the way urban life itself does so the ideals of public space and sustainable development demand regular redefinition of underpinning values, balancing their fundamental continuity and perpetual change. Public space should not be considered as a welcome addition, or an excuse to otherwise unsustainable buildings, but rather an integral component and the new force that challenges their very being. Supertall residential skyscraper, buildings of immense height (official definition describes them as taller than 300 meters), that sometime house thousands of occupants, have the potential to transition from architectural singularity into public multiplicity. However, this can only be achieved through their conceptual re-interpretation as cities, towns, or communities. Successful cities are seldom top-down designed, never by a single designer. They have morphed over time to become what they are and what they might become. Self-governance, in the form of city councils and city ordinances, seems to hold be key aspect of this transformation, along with the thorny relationship between ownership and citizens' rights.

Further investigations into possibilities of such transition aims at re-evaluating skyscrapers above certain heights and numbers of occupants into discrete urban wholes within broader urban conglomerations. If we understand the scalar jumps of urban morphology within contemporary cities as being; a) building, b) village, c) city and d) region, then we can see how the *bigness* of skyscrapers places them between the scale of building and village (Cataldi 2018).

Perhaps a qualitative jump from understanding these skyscrapers as very large buildings towards treating them a parts of the *village* subtype hold potential for the emergence of true urbanism, including new manifestations of public space. That is where the right to the city could be established, precisely as "the right to the *oeuvre* (participation) and appropriation (not to be confused with property but use value) was implied in the right to the city" (Lefebvre et al, , 1996).

5.4 RESIDENTIAL MELBOURNE: FROM PROJECTION OF AUSTRALIAN LIFESTYLE TO AN INTERNATIONAL INVESTMENT TYPE

In the 21st century Australia, and more specifically Australia's large urban centres, have experienced a residential construction boom not seen in the country for generations. The commencement of this boom has been generally accepted as in the mid-2000's. Several commentators (Berry & Dalton, 2004; Birrell & McCloskey, 2016) have predicted its bust period towards at the beginning of the 2020's. The boom has visually manifested itself most apparently in the form of the emergence of tall residential skyscrapers. Driven, in part, by the broader commodities boom and the relative unaffectedness of the Australian market by the global financial crisis of 2008, Australia sat in a particularly interesting moment in time.

This section attempts to elucidate the phenomena of the Melbourne skyscraper as something at once extremely culturally acontextual in its international nature, yet particularly driven by Australian local factors and in many ways analogues to the Australian condition. Through robust comparisons of the only two supertall residential skyscrapers in the city of Melbourne, which bookend this construction period, a fascinating insight into the life of a city lend itself to observation and research. Supertall *Eureka Tower* (2006) and *Australia 108* (2020) share many commonalities but also exhibit some quite significant differences, which through architectural, urban and economic analysis allow for the essence of residential architecture, the microcosm of dwelling and the trends of apartment design as its physical frame to be evaluated.

Figure 58 - Australia 108 in the foreground (computer generated image) with Eureka Tower in the background. (source: domain.com.au)

Melbourne and the State of Victoria have been through boom and bust cycles since their very inception in 1835 by British colonist. These cycles began from the gilded gold rush era of the Eureka Rebellion in 1854, on to the Great Depression of the 1930's and the subsequent post-War immigration booms to the 1980's deregulation, the 1990's recession and the most recent mid-2010's commodities boom.

Throughout these epochs Melbourne, in many ways mimicking Australia at large, has seen a steady increase in population numbers; from a British colonial outpost of a few hundred people in the 1830's to the current population of approximately 4.75 million people and its planned population growth to almost 8 million by 2050 (*Plan Melbourne 2017-2050: A Global City of Opportunity and Choice*, 2017). Melbourne over this time period saw population approximately doubling every forty years, partly due to the steady birth rates amongst Australians (around two berths per family since the late 70's) and mass migration.

5.4.1 The tower in the park

The traditional dwelling typology in outer suburban Melbourne was the detached family home on the 'quarter-acre-block', which was colloquially referred to as the 'Australian Dream', which in many ways paralleled the suburban trends in North America. In the inner suburbs of Melbourne,

particularly in the districts of Fitzroy, Collingwood and Abbotsford, which are some of the oldest settled areas in the city, primarily housed day labourers and therefore were largely developed with 'workers' cottages', mimicking the working dwellings of Britain at the time. In both instances the dwellings were transplants from foreign cultures implanted into the Australian setting, which was discussed as length in Robin Boyd's book *Australian Ugliness* (1960). Boyd's thesis reflects heavily on the transplant of foreign, in his era British and American, typologies upon the Australian culture, albeit in a particularly gaudy and, in his words 'ugly' way. A part of this transplanting, he suggests, was not only of particular housing typologies for building trends, but also entire urban models. A specific urban model of interest to him was the tower in the park, which at the time of the first publishing of the book in 1960, was a new trend.

Following the Great Depression and the World Wars these inner suburbs experienced overcrowding and the Victorian Commission of Housing was established to provide low rent housing for low-income families and to clear the slum like ghettos that has formed within the area. By the 1960's the housing provided by the Housing Commission were bland concrete skyscrapers in the 'towers in the park' typology directly transplanted, once again, from British and American contexts, and were the first multi-residential buildings in Melbourne. The alternative to apartment living was the inception of "growth corridors' in previously rural areas which were based in the form of land releases and facilitated the growth of satellite cities, connected mostly via highways and in some cases rail to the city centre. The latter was adopted the as preferred living option by large sections of the population, which in turn made Melbourne the sprawling low density metropolis of today.

Due in part to the Commission Housing developments for low-income families being the first major multi-story dwellings in Melbourne, the initial association of high-rise living in the minds of the general populace had been that of poverty and erosion of the 'Australian Dream', rather than a valid alternative to overpopulation. The poor amenity of these early tall residential buildings further perpetuated the already established stereotype of cramped and unfit environments, particularly for

children, which persist in many quarters of today's modern Australian society. The pejorative term 'dog-box' or 'shoe-box' apartments was established during the era of the commission flats and is still used today to describe, almost exclusively, high-rise apartments.

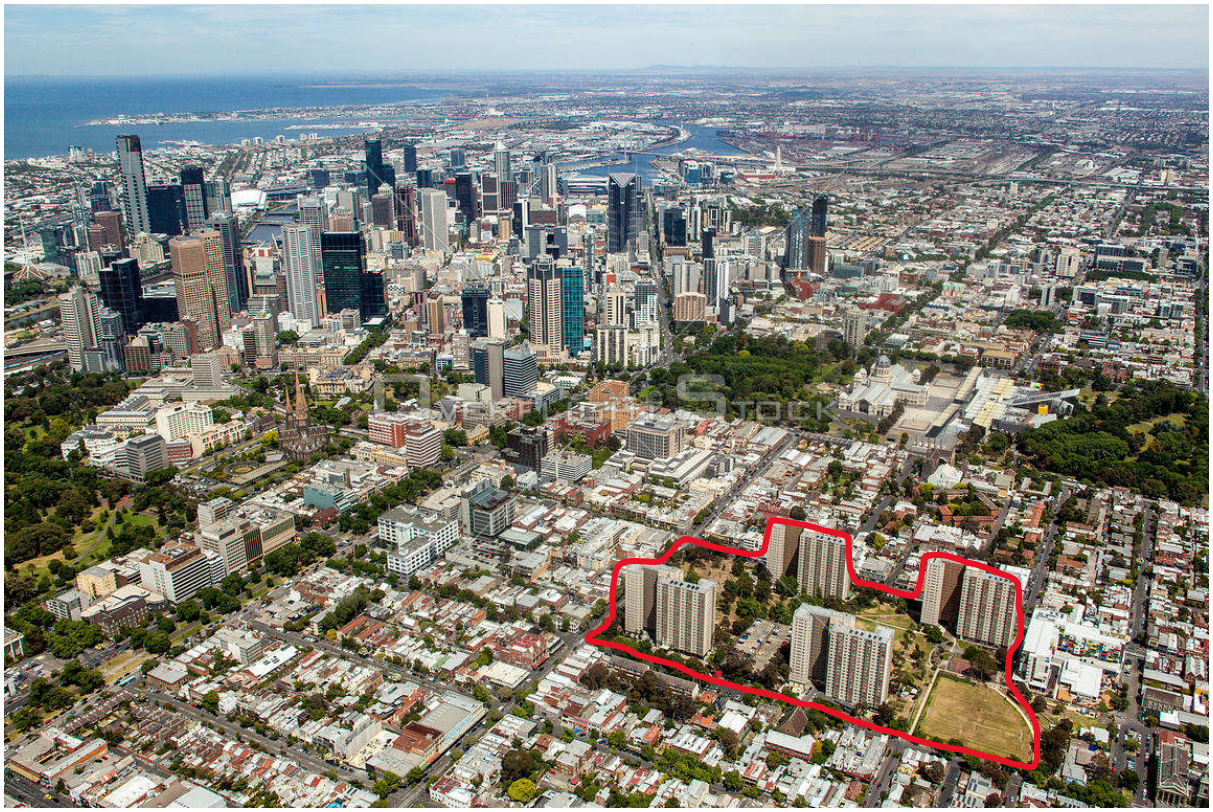


Figure 59 - Fitzroy public housing (foreground) in relation to the traditional urban fabric and CBD (background)

Figure 60 - Commission housing flats in various parts of Melbourne

5.4.2 Office towers and the international style

The second discreet development of skyscrapers in Melbourne focused on the office tower of the typology seen globally in financial districts, down-towns and central business districts.

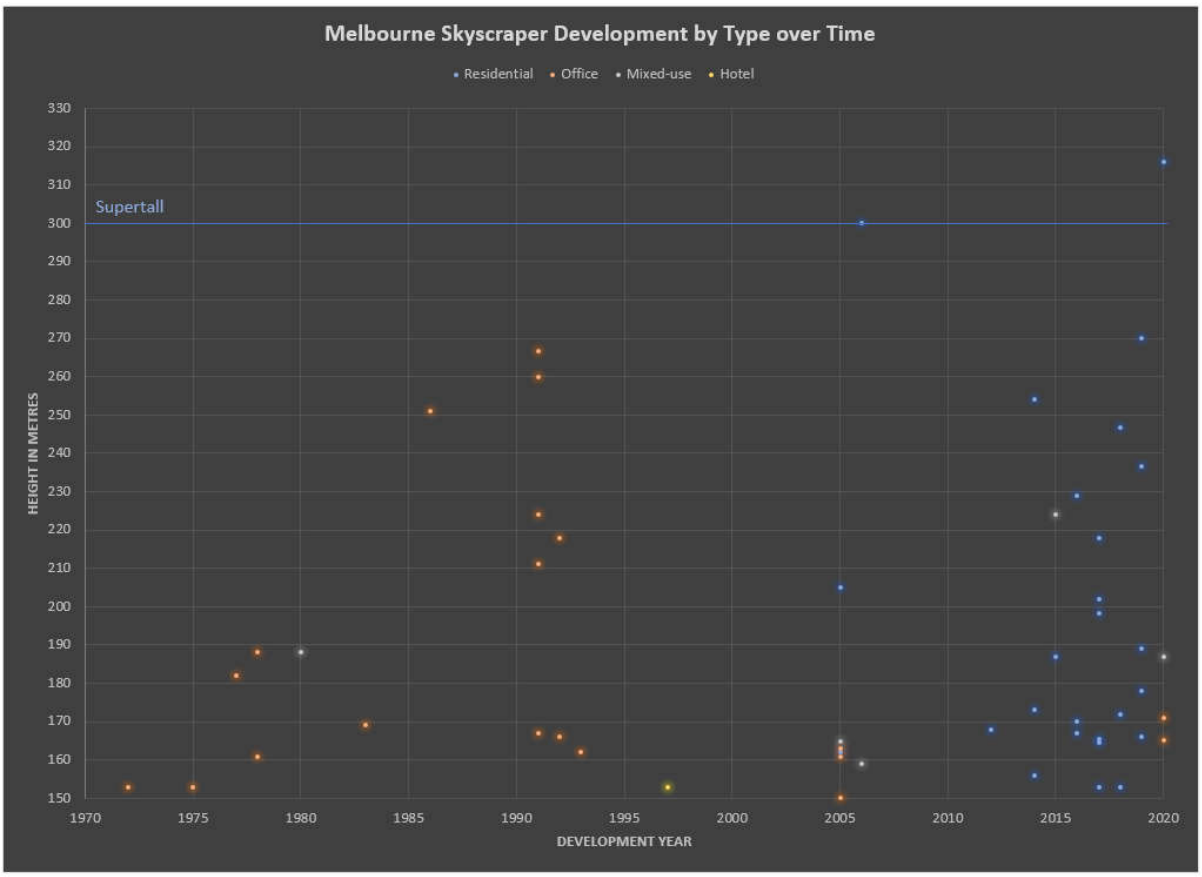


Figure 61 - Melbourne Skyscraper Development by type over time

In Figure 59 (above) we can see that this period of skyscraper development commenced at the beginning of the 1970's and formally ceased at the turn of the 21st century, with only a few development occurring thereafter. This era was marked by Australian companies, particularly in the field of commodities, becoming relevant global players and housing their headquarters in office style towers in Melbourne, Sydney and elsewhere in Australia.

Office towers per se are beyond the remits of this thesis, however it is important to highlight the residential-office-residential dynamic that has existed in Melbourne skyscraper typology over the last fifty years.

Figure 62 - Selected Melbourne office skyscrapers constructed between 1970 and 2000

5.4.3 The 21st century as the rise of SRS

Another important moment in the history of Melbourne high-rise was the introduction of 'Postcode 3000' in 1992, which was Melbourne City Council's strategy to re-populate the Central Business District from a strictly 'nine-to-five' arrangement to a 24-hour precinct via the introduction of mixed use and residential zones within the primarily commercial context. The resultant of this planning change was a huge upshift in CBD residential living and was perhaps the direct precursor to the residential apartment boom currently being experienced in Melbourne. The early stages of the Postcode 3000 plan were focused on refurbishing underused office towers, constructed in the phase described previously, into residential offerings. Only in the first part of the 21st century does Melbourne see a complete shift away from the previous office typology and into high-rise residential skyscrapers – punctuated by the two SRS currently built in Melbourne, the Eureka Tower (2005) and Australia 108 (under construction, to be completed 2021).

Along with this increase in population a visible rise in housing prices has been observed, particularly in the free-standing house typology, but also with the emergence of the apartment and condominium typologies. Just prior to the introduction of the SRS typology with *Eureka Tower* in 2005, the real-estate prices between apartments and houses were similar, after which the rise in the median house price continues to grow year on year, whilst apartment stagnate. By the year 2016

house prices have tripled from 2006 whilst apartments have gained only about 25% on their 2006 values. Some of the underlying reasons for this discrepancy will be examined later in the text.

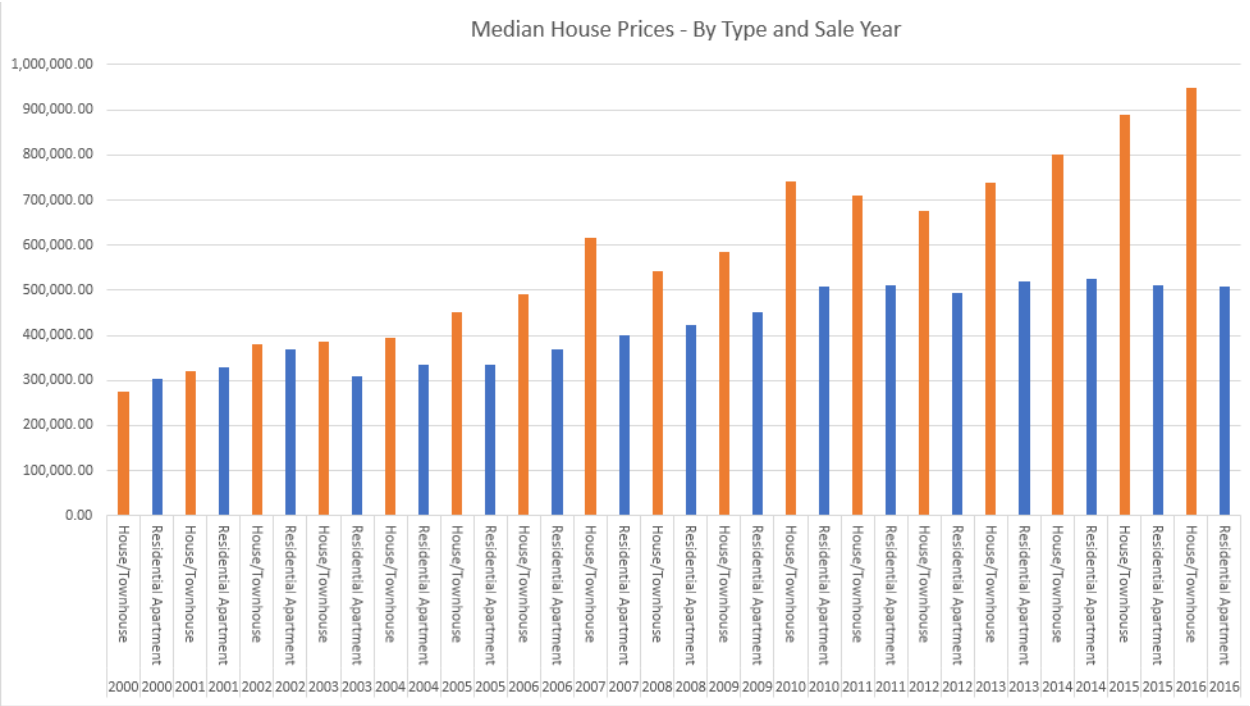


Table 20 - Median House Prices - By Type and Sale Year (Melbourne, Australia), Source:data.melbourne.vic.gov.au

Figure 63 - Selected Melbourne residential skyscrapers of the 21st cenury (first Eureka Tower, last Australia 108)

As described in detail in Section 3.5.2, the Eureka Tower is a 301m supertall residential skyscraper in Melbourne's inner district of Southbank, which falls within the municipality of City of Melbourne. Proposed in 1999, it began construction in 2001 and was completed in 2006. This period, from the buildings conception to its completion, was a particularly interesting period in Australia's property

market, as it somewhat straddled the ten years of low growth in the market sector (approximately from 1989 until 1999) and the boom period from 1999 to 2004 (Coates, 2017). The completion date preceded the global financial crash of 2008, and was the last supertall residential building built globally until 2010, and the last supertall built in Australia to date (Australia 108 is currently under construction).

The tower was designed by the architectural firm Fender Katsalidis (FK), as a direct response to what they perceive as a need for changing Melbourne demographics that were turning towards inner city living as a viable alternative to suburban life. Karl Fender's vision for the Eureka Tower from the onset was to produce a vehicle for this need, a valid alternative to the 'quarter-acre-block' house within the Melbourne socio-cultural context. The potential residents that this building was targeting were young professional families looking to live and work closer to their CBD offices, retirees looking to downsize as well as single and couples. Interestingly the very crown of the tower, which usually would be reserved for the most expensive penthouse apartments, was instead reserved for a viewing platform, open to the public.

What is important to understand in this early SRS is that although in many ways similar to its newer sibling Australia 108[57] the external economic rationale was vastly different. Whilst Eureka tower was novel as it was the first SRS within an established city environment (Q1, the first SRS, in Surfers Paradise is situated in a tourist strip of beach), Australia 108 was an iterative development of a residential typology aimed at a foreign investor class looking for secure investment rather than the owner-occupier type.

Herein lies the answer to the question posited at the beginning of this section: what factors other than urbo/techno/architectural (which has been the focus of this thesis) contribute to further homogenisation of the type?

[57] For a complete understanding of the relationship between Eureka Tower and Australia 108 refer to Appendix 6.1.2 for the full transcript from the interview with Karl Fender the architect of both towers.

5.4.4 Internationalisation of the housing market

The internationalisation of the Melbourne apartment takes many guises, but some of the key factors in that process have been:

1. The internationalization of student population at Melbourne universities and the follow-on effect of requirement for small, inexpensive student-focused apartment types, in the vicinity of the major inner-city universities.
2. Offshore investment in a stable Australian economy, which provides international buyers a safe-haven (refer to Section 3.4.3).
3. Speculation on property prices.

These three components, individually and combined, have had a homogenising effect on the typology of residential tall and supertall buildings in a variety of ways. But perhaps the most concise and the most accurate answer lies in the commodification of the apartment itself. Whereas in Australia, traditionally, houses were considered 'homes', in the sense of being occupied by families and utilised as dwellings (refer to Section 2.2.2), the novel *investment type* of housing is primarily an 'investment' and secondarily 'housing'. This type can be referred to as a tokenised exchangeable unit. There is no need for architectural and spatial variation when the underlying ideal is financial gain rather than the 'lived experience' of a place, as described previously.

If we observe the interior plans of Australia 108[58] and compare them to the set from Eureka Tower as examined in Chapter 3, we can see several design changes that have been adopted by the design team. Beyond the obvious aesthetic difference from jagged edges of Eureka Tower to the free-flowing form of Australia 108, we can see the size of the apartments varies greatly. The detail apartment breakdown of Australia 108 can be seen in Appendix 6.3 and Eureka Tower in Appendix 6.4. The total number of apartments in Australia 108 is 1103, with 3-bedroom comprising 14%, 2-bedroom 47.5% and 1-bedroom 37.9% (the rest being a total of three studio apartments and a penthouse). Conversely Eureka Tower, as has been explained earlier in 3.5.2, has 19% 3-bedroom, 50% 2-bedroom and 30% 1-bedroom. What can be seen in these two sets of data is that the number

[58] As provided by the architect Fender Katsalidis upon request.

of 1-bedroom apartments has significantly increased in Australia 108 (a rise of almost 8%, with the addition of several studio apartments).

Figure 64 - Typical Plan Australia 108, Source: Fender Katsalidis

This increase in the smallest sized apartments illustrates the changing nature of residential development in Melbourne at large – an ever-increasing number of small apartments in the inner city which do not cater for families and target mostly the leasing market. What is also evident is that the smallest of these apartment take the shape of saddle-back apartments with very limited light access (refer to 3.5.2 for definitions). These apartments, which also occur in Eureka Tower albeit in very limited numbers in the base of the tower, occur at a much larger scale in Australia 108 (refer to Figure 64. Green coloured apartments). Thus a clear hierarchy is established, two and three bedroom apartments received preferential positioning with smaller apartments 'filling in' the remaining floorplate areas.

By no means is the suggestion being made that from Eureka Tower to Australia 108 has this change occurred but rather the commercialisation of housing to property, from the 'quarter-acre-block' typology to the contemporary 'shoe-box' apartments, is a pathway that has wide-ranging outcomes.

Since the year 2016 the foreign investment property market has collapsed[59] with residential approvals across all sectors down to 2012 numbers (Scutt, 2018).

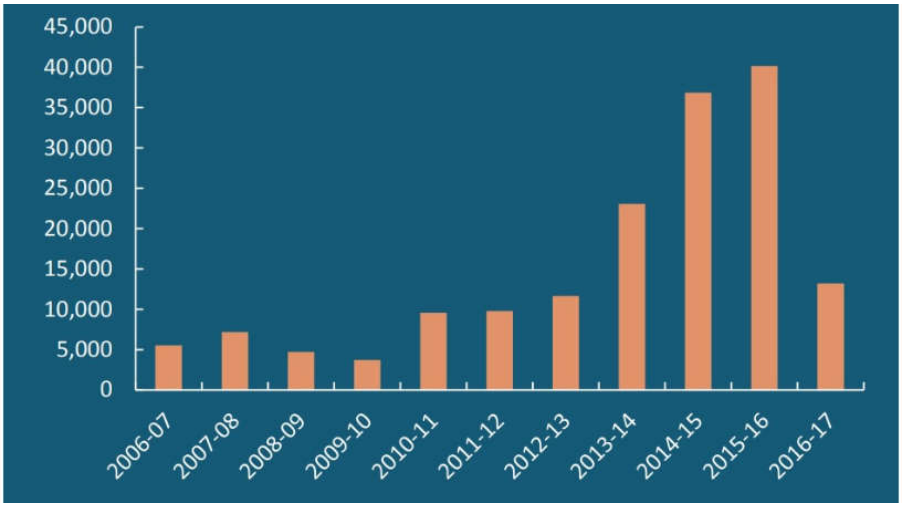


Figure 65 - Residential real estate approvals by year, source: AFIR Board

What this means for the future growth of residential skyscrapers and particularly SRS is unclear, however what is clear is that the Australian and more specifically Melbourne residential market can no longer rely on heavy foreign investment in the housing market to keep capital gains of residential stock rising at the rate it has so far.

[59] with the year 2020 seemingly even more dire for the sector, particularly in relation to the current pandemic, the loss of international student numbers and cooling trade between Australia and China – however which sits outside the scope of this thesis.

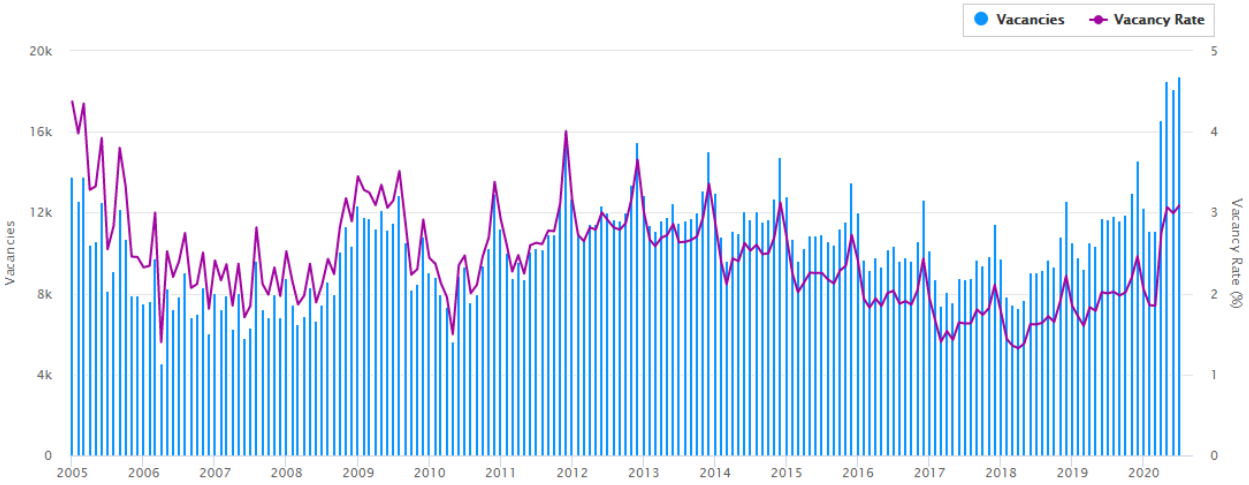


Figure 66 – Vacancies and vacancy rates in Melbourne over time, Source: https://sqmresearch.com.au/

The number of vacancies within Melbourne has also sharply risen in 2020, with further vacancies expected, particularly in the CBD of Melbourne where high rates of student accommodation are observable. The highest vacancy rate is exactly in the smaller 1-bedroom apartments with lower amenity, as per the Australia 108 example. These apartments will naturally have a difficult time being sold or rented in the economic crash observed in 2020 and their potential for consolidation into larger apartments is limited. Commodification of apartments and its flow on effect of providing housing stock in Melbourne has broadly been pushed by market forces and a major re-calibration of the future of this type of apartment must be sought to prevent mass vacancies occurring.

The outcome of this changing global outlook which has major implications for Melbourne and the housing market of the city in general. The solutions to this looming crisis are beyond the scope of this thesis which focuses on SRS up-to the year 2017 – however much further investigation into this field can be expected in the future.

6 APPENDIX.

6.1 SKYSCRAPER DEVELOPMENT IN ASIAN PACIFIC RIM – INTERVIEWS WITH PROF. KEN YEANG AND KARL FENDER.

6.1.1 A City in the Sky - from unsustainable architectural singularities towards true urban multiplicities

In Japan, living in high-rise residential buildings is an imported socio-cultural model, the example of blunt introduction of an urbo-morphological type without any attempt at contextualisation. What gets imported are the same urban and architectural layouts, the expression of the same kind of elitism that shapes similar developments in Moscow, Dubai or Melbourne with the same materials and construction methods proliferating through a vast global logistics network and the same dislocation of existing urban fabric and the new objects. Those symbols of status and lifestyle refer to the perceived quality of life purportedly existing elsewhere. In reality, the actual need for high rise residential development in a rapidly shrinking and ageing Japanese society is highly dubious – unless serious attempts at its contextualisation indicate ways in which it could contribute to mitigation of that, and other problems which are specific to Japanese society and this particular moment in its history. A brief overview of The concept of buildings as cities is not a new idea within the context of mitigation of density concerns in global metropolises. Interesting to our theme here are the ways in which Le Corbusier approached this typology through highly innovative investigations of how to adapt communal living, with ideas and lessons derived from already successful urban typologies. His housing type Unité d'habitation (1947-1952), of which the Marseille example is the first and perhaps the most successful, combines ideas of ideal living in duplex style apartments mixed with semi-public spaces previously relegated to separate buildings, such as galleries, a school and restaurant. One decade later, the John Hancock centre in Chicago (1960) was billed the first vertical city (Berger, 1973). This concept commenced from a radically different starting point to that of Le Corbusier. The

John Hancock Center was a commercial enterprise which deviated from the standard norm of the milieu by introducing semi-public space in what otherwise would have been yet another tall commercial office-space skyscraper. The tower housed apartments, offices, restaurants, bars, department stores, groceries, a bank, a barber shop, a drugstore and even an ice-skating rink. The American version of vertical urbanism did not focus on ideal living conditions, as espoused by Le Corbusier, but on commercial activities – a fundamentally different approach to what a city is and how it can be reinterpreted within an architectural edifice. Numerous other concepts and built structures have claimed to have achieved the elusive integration of the public sphere and life within a single building. However, only with the advent of the ecological imperative and, with it, a deeper understanding of the triple-bottom line prerequisites for sustainable design has the topic been reignited within architectural discourse.

For decades the modus operandi for dealing with population growth for many cities in developed nations, particularly in the UK, the US, Australia and Japan has been endless suburban sprawl, cannibalising rural and semi-rural land for carpets of low-density housing. This model, particularly due to the ecological concerns, has proved to be inadequate and high-rise high-density has re-entered the conversation relating to sustainable urban growth. The latest development in the field is introduction of residential supertall buildings. An investigation of that new type, which opens a number of new themes related to the question of bigness and its contribution to a veritable paradigm shift in thinking about highrise, asks entirely new questions and adds new dimension and realism to thinking about the radically new futures (Radović, 2020a)

Asia, and particularly its Pacific coast has seen unprecedented population growth and, with it, a radical rethinking of the vertical urbanism model – with a particular tropical sub-context of Monsoon Asia. While common perception of Hong Kong, Singapore or mainland Chinese cities are at the forefront of this change, the examples of extremely tall residential buildings became common across the region. In South Korea, Busan is the home of two of the world's tallest glass residential towers.

Kuala Lumpur (Malaysia), Bangkok (Thailand) and Manila (Philippines) have several more residential towers in the coveted 300m+ supertall range, either under construction, or under proposal. Yet none of these currently built or proposed towers even attempt to address density in anything other than simply stacking thousands of identical glass-clad, air-conditioned apartments ad nauseam into the sky. The architectural discourse in the profession and the construction are vastly apart. In this essay, we engage in discussion two architects who are at the forefront in this field: the Malaysian architect Ken Yeang and his theorizing on this discrepancy and, further afield, the Australian architect, the designer of two of the World's existing supertall residential skyscrapers, in Melbourne, Karl Fender of Fender Katsalidis, and his focus on reinterpreting local living conditions in thoroughly contemporary skyscrapers.

In the following extracts from discussions with Ken Yeang and Karl Fender, we will focus on the specificities of a South East Asian and Australian solutions to urban densification, the key themes associated with residential skyscrapers and on the above hinted capacity of these typologies to achieve qualitative leap from unsustainable architectural singularities towards true urban multiplicities. Our aim here is to suggest that such strategic, contextualised leap is necessary to meet the very peculiar needs of Tokyo.

6.1.2 A City in the Sky | Extracts from an interview with Ken Yeang, conducted on 27 June 2019

Ken Yeang (KY): The first proposition is that high-rise is not very ecological. It uses the third more of energy and materials. But my justification is that it is the building form that we cannot avoid. So, my proposition is that if it is big and it is going to be with us for a while, we should try and make it as green and ecological as possible. That is my premise. What I find is that most of the high-rises are basically vertical stratified spaces. That is unnatural, because when you move horizontally in a city, there is linked connectivity, with streets. Therefore, one of the first things we should do with high-rise is to increase connectivity, using staircases, secondary staircases, elevators and escalators and establishing new connectivity in the sky. The second thing is that high-rise should try to imitate the

city as much as possible. In the city, we have plazas, places for people. We need to make high-rise more like a city, with open spaces or community areas. The functions like a library or shop should not be all closed but open to the sky.

Vuk Radović: When we talk about vertical urbanism, with the practice of urbanism being in many ways synonymous to cities themselves, do you see a particular role for a government within these towers? Such as city councils, or community type of arrangements. Do you see these hypothetical urbanised towers large enough for a type of (self)government? Or, do they have to stay within an architectural, top-down managed type?

KY: The highrise of this type is, literally, an urban concentration, the city on a very small footprint. Therefore, even though those are micro concentrations, there needs to be some sort of security, management and organized control of the life in the high-rise. In 1975, James Graham Ballard wrote a book entitled High-Rise. He describes the development of an instant class structure, with rich living near the top, the middle class in-between and the working and aspirational classes in transitional spaces. The whole book is about these differences, hardship and fights in those in-between spaces. Therefore, if we are going to do the high-rise, we should try to make it like a city, and not with a stratification of the classes. We should try to mix them up vertically, as much as possible. But obviously, you would want to prevent quarrels, disputes or conflicts, which highlights the need for some sort of governmental control which you are alluding at. You need to have some sort of regulation of what one can and cannot do within the high-rise.

VR: At the very end of one of your books you talk about eco-skyscraper. You explain how to make them on the basis of dialectics between the public and the private interests. Most skyscrapers that I investigate in my research establish an interface between the public, which is usually external, and private, which is always internal. That interface is always at the physical edge of the building. The taller the building is, the larger its buffer zone, for real or perceived security needs, becomes. As a consequence, instead of having the tower more public, the city becomes privatized. How would you

redraw that critical line between public and private interests, if the public starts to enter private towers? Do you, or how do you separate them?

KY: I call that relationship the transitional zone, and I treat it as the zone which connects public and private, maybe as semi-public or semi-private areas, clustered zones to which the public can get access, while beyond those spaces the admission becomes progressively more defined and harder. I find such transitional zones are useful.

DR: Now that you have mentioned the public-private relationship, I would like to add something intriguing. I became interested in an impossibility to translate the word "public" into Japanese language. That absence suggests that the concept of "public" is untranslatable. In Japanese spatiality, transitional spaces are very important, in situations where stepping out form one space to another offers a sense of different quality, where something “public” that starts to feel like private until, at one moment, one starts to feel uncomfortable to continue, without any explicit prohibition. In traditional Japanese spaces (as elsewhere, in different ways) various hints and nuances mediate between those two poles, with no sharp edges between what is really private and what we would call "public".

KY: With public spaces, creating a community is important. With homes, privacy is important. There is always a need for balancing community and privacy. I actually wrote a book on it. But, I think we should look into the distance between community and privacy. If you shut the doors, there will be no communication between the neighbours. This is not just in a high-rise, the same applies to cities. In many cities, inhabitants don't even know the neighbours names. Thus, creating opportunities for people who live in a high-rise to interact, to create relationships and to form communities is important. That issue is deeply cultural. In some cultures, people do not like to mix with others; in other, we interact more. But, in any case within the stratification and the imposed separation of high-rise we need to find ways to help people interact.

DR: My second question is related to Vuk's emphasis on the Asian Pacific Rim. In China or Singapore, the population numbers are going up, and the pressure to concentrate on relatively small areas is real. On the other hand, in Japan residential high-rise is a status symbol. Here you see rich people opting to live in high-rise gated communities, while at the other end of the Pacific Rim, in Melbourne, high-rise became almost like social housings, providing mainly for the growing student population. That is an interesting theme in itself. You have explained a kind of filtering described by Ballard, with the rich living up and sedimentation of the poor down. What is your experience with that? In other words, how much the real public, rather than only community relationships and space would be part of vertical urbanism? Not offering spaces only for people whom one knows, but for anybody who wants to come in and behave in an urbane way.

KY: First of all, there is a cultural aspect. Some cultures are friendlier than others. For instance, I see the American culture as a very friendly one. People whom one does not know meet in the shops or restaurants and talk to each other, question each other. Asian cultures are a lot more inclusive. In order to encourage interaction, we have to think how to create comfort in transitional spaces. We always need to make people's lives comfortable. Then, it is very important is to help them live happy and pleasurable lives. That doesn't have to cost a lot, that is just a matter of good design. Therefore, one of the key tasks of design within the high-rise is to make people happy. That is the challenge of being an architect: how to make people happy, how to make them enjoy life.

[…]

VR: And, to conclude: we tend work with right angles and straight lines, expressing rational ideas. Maybe that rationality could be elevated, both metaphorically and literally, into something, leaving the ground to nature's own devices, as a restoration process.

KY: Yes, coming back to your question about governance, all we need to do is - a masterplan in the sky. In a traditional masterplan, you have the land use, building forms and plots. What happens if we flip that vertically and ask how to make a masterplan in the sky?

VR: So, that is almost like traditional urban regulation, again both metaphorically and literally, a 3-dimensional matrix where certain necessities may be positioned in space, on either a vertical or horizontal axis. This could mean that, if we look at desirable distances between the household and, let's say, a school or a care-space for ageing population, that facility may indeed be well above the ground-level, within an easy community reach?

KY: The future will be a 3-dimensional matrix of spaces to the sky. I think that is the proposition.

6.1.3 Highrise and Cultural Change | Extracts from an interview with Karl Fender (1 December 2017; Fender Katsalidis office, Melbourne, Australia)

Vuk Radović (VR): The Eureka Tower has really brought in the 'brave new world' to Melbourne, particularly in regards to challenging the established ways of life and typologies of residential architecture. What was the reasoning for Melbourne, in relation to New York, Tokyo or other global cities?

Karl Fender (KF): I don't think you need to consider these huge cities. Eureka Tower was a moment in time, in Melbourne. Various forces were driving the people towards wanting to live in the city. At Fender Katsalidis we were involved with higher density inner city apartments for some time, starting with Melbourne Terrace Apartments (1994), the Republic Tower (2000), Hero Apartments (2001) and 51 Spring Street (2001). So, there already was a demonstrated appetite for living in the city and enjoying all the benefits of urban life. In other words, people became a little bit more sophisticated in their thinking and a little more desperate about driving, driving, driving from suburbia to the city and back. And, of course, a lot of people were downsizing their homes. All of those factors combined drove a need for housing in the city. Eureka Tower came out of a set of particular drivers. Remember, all of our buildings up to then were medium in height, about thirty stories tall. Eureka

was developed from our studies of the particular site. That site was bought with a permit for two towers and from that point we analyzed and modeled the buildings. We noticed that: a) those would become just another two towers, drawing a horizontal line of built form on the south side of the Yarra river (South Bank), and b) they would perform like a wall, casting a large shadow, while also acting as a wind break. So, we thought, what would it be like if we put one tower on top of the other? That facilitated a quite remarkable train of thought. It gave us an option for housing at great heights. Living in something of such great imagery, stature and creating something new in the city that really become an international benchmark. It all finally started to gel. Nonetheless that proposal was an enormous commercial risk, as in those days 150 apartments in a release was the norm and, even if you had a site that took more, the approach was to stage its development.

VR: And, Eureka Tower was to be a single stage release for the 550 odd apartments?

KF: It was a single construction stage, with phased entry. Another key difference to other developments at that time was that we had a significant parcel of land and could offer a mixed-use development. It was possible to give back to the city a new public space. We were able to introduce an arcade through Palmer Court back to the City road. Urbanistically, that meant that we were building upon the idea of Melbourne as alleyways, with smaller section cross-connections. The key idea was also that the tallest building in Australia would have something important at the top of the building, that it wasn't for the richest man in Australia. Our concept was about bringing the public and international visitors to the top, to enjoy a view of Melbourne that has never been seen before. That is how the idea of a public viewing deck on the top floors came about. Everything that we did was risky. To give away some of the land, to put that facility up there – that was all expenses. But, it was amazing. The project was marketed around the year 2000 and it was incredibly successful. With almost 600 apartments, that was probably three times larger than any other development delivered in one contract. That was risky. To me, it showed that Melbourne had reached a level of cultural

development that accepts high-rise living and - high-rise living to the extreme. That had never been tested before. It was commercially very successful, it had instant take-up, everyone wanted to be in there and it pitched the apartments the right way at the right time. There was a dearth of smaller apartments, but these also provided for bigger apartments, which catered for the need of the marketplace. It was a considered building, in terms of its sculptural prowess and the way it introduced a bit of a legend in the “Eureka”, the gold rush, the idea of the “blood spilt”. It became part of the character and characterization of Melbourne. All of a sudden you saw the Eureka tower in the backdrop of many photographs, news bulletins television. It was always there in the background. During the first (political) elections, after Eureka Tower was built, it became the tower of power, with election voting being shown up the building. It became the essence of Melbourne. That is the power tall buildings do have. That stands for our obligation to be something, rather than just gray matter. Eureka seemed to work on all those fronts, and it filled a latent need.

Its engagement with the ground plane was very important. There is, certainly now, in Melbourne and through planning processes an acute awareness of the importance that these buildings need to integrate. How does a tall building integrate? It integrates where it touches people, at the ground. The uses, the connections, the scale making, the sculpturality, all these issues are important at the ground, while the tower above is important as a part of the skyline, defining the city from a distance.

VR: That is an entirely different approach to what is being built in Melbourne now. Why was that?

FK: In late 1999 we aimed at people that wanted to live in the city. All of them basically came from Melbourne. Buying there wasn't seen primarily as investment. A lot of the stuff you see in Melbourne today is about foreign purchase, getting money out of different countries and, definitely, about secure investment, rental yield and the market which demands as many apartments as possible. So, this is an entirely a different construct. In Eureka we had families. I myself moved in with my wife, my daughter, a dog and a cat, even some mice, there was a rabbit for a while, before he started eating the blinds. So it’s more of a family thing. It was very much the same with the

Republic Tower - absolutely about people wanting to live in the city, being near the market (VR: the tower located in close proximity to the Queen Victoria Market). A lot of those apartments are quite big and it was absolutely not about investment.

VR: You would think that also, within current market competitiveness, those sorts of things would tip it over the edge when speaking about skyscrapers in general. With 1100 apartments and, let's say, two people per apartment, the number of residents is similar to that of Cremorne near Richmond (VR: a historic inner-Melbourne suburb, 1,564 residents; Census, 2011). In academia there has been much talk about the idea of the 'vertical village' (Yeang, 2002), and bringing city life into towers. Almost all towers around the world are singular objects that sit among other towers. In which direction the evolutions of the skyscraper might go? Is that, simply, something to be defined by the market, or can the skyscrapers genuine entwine with the city?

FK: It has to. It has to. But as you know in some of the developing areas, even in Singapore which is very developed, there are land parcels big enough for the concept of a series of interconnected towers, their facilities and population. The connection is a huge opportunity. These interconnected towers do become communities and not just singular statements of vertical living. There is no doubt these buildings have to integrate, and they can integrate because they are very powerful economic drivers. They can afford programs that enable and enhance community and add another dimension to the city. They can also become very powerful sustainability drivers, through reduced water consumption, using facades to create power (VR: eg. recent research in combining photovoltaic cells within glazing panels). from light, and not just the sun.

Towers can be very sophisticated in the way that they give back resources to the city, rather than draining the city of its resources. But, that costs money. How do you do that? Well, you tell the developer that they have an obligation to make their building contribute to the city, and that that's going to cost them, so they will have to capitalize. But, will give you something back, in order to help you pay for it out of the marketplace. The government needs to allow you more density, more

height, whatever. Obviously, all this has to be done in a way that doesn't compromise the city in other ways, such as overviewing, overshadowing, wind or otherwise. "We give you this, and you give us that" approach becomes powerful driver for the sustainable future of the city. That is how it has to be.

VR: How a tower in Melbourne - let's take Eureka Tower as the example - in part due to its design, as a tower for Melbournians - differ from a tower in Dubai? Can a tower reflect the local culture? Do the skyscrapers, or tall buildings in general, have the capacity to represent the non-Western types of society?

KF: That is a really good question. There is a great tendency to do that superficially. Arches for example, or putting something in the façade, like a pattern that "reflects the culture". Contextualisation needs to be more about the culture within the building - how is it used, how does it identify with local patterns of living and customs. I remember when we were doing low-cost housing in Bangkok (VR: Maung Thong Thani, 1995). It was 22,000 units of low cost housing in 22 blocks at 1,000 people per block. Some would say "what does that have to do with Thailand?". Well, quite a lot actually. It doesn't have much to do with traditional Thai houses on stilts, but it has a lot to do with the way how people in those communities live. Thai's live in the street, they like to eat in their marketplaces, so those particular buildings, which were only about twenty stories high, had double loaded corridors and internal courtyards of forty meters by sixty meters. They were big. The bottom was landscaped like a forest and the whole base was dedicated to restaurants and related uses, with a couple of openings through to the community at the end. This forced the air currents, along with areas of ponds shaded by trees made the space five degrees cooler. All of the activity was around the base, so everyone came down to the new community space. That is how they live, how they want to live. The corridors were all open, because that culture is not about closed doors. It is about community. You have to build into it a pattern of living that is appropriate for where they are. It might be that in Dubai there would be a small prayer area, appropriate washing facilities and the

type of architecture inspired by subtle shapes to do with Arabic patterns; so there is an identifiable feeling. That is not simply about a tower with tessellation. If screening reduces the impact of the sun, like a veil - than that can legitimately be an Arabic pattern. In that case - what is wrong with that?

Vertical Urbanism

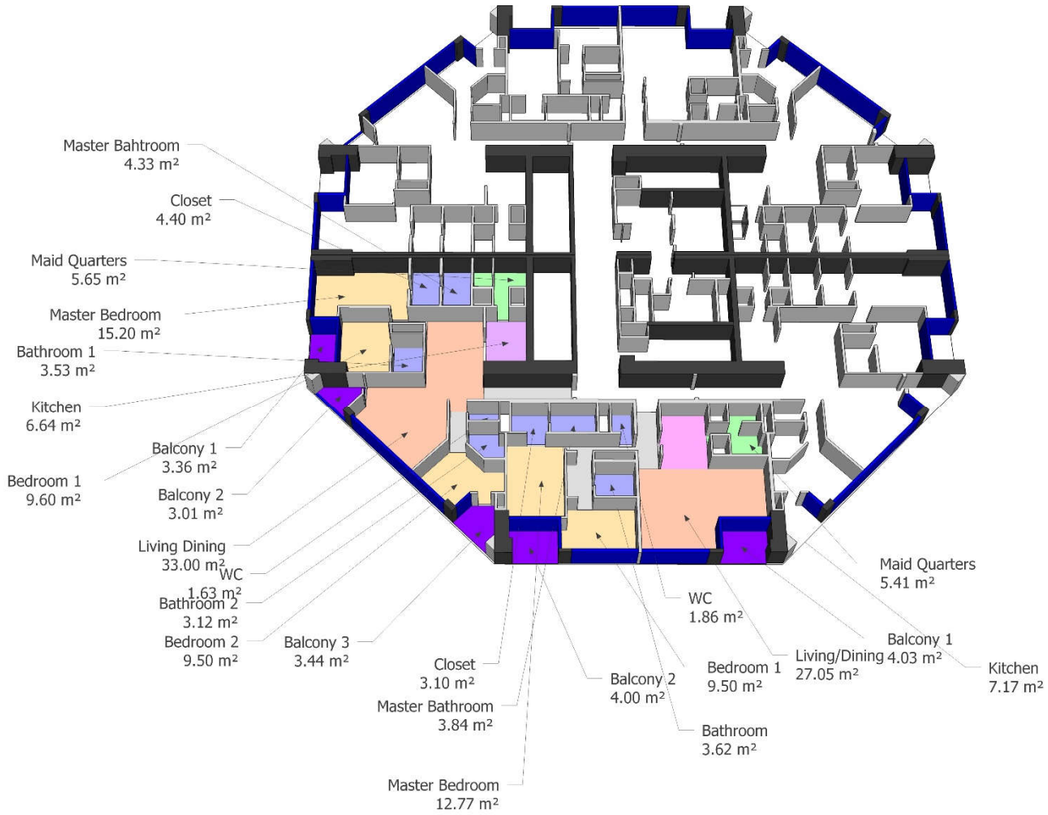
This section explores at the Right to the City and its future in Tokyo, we have focused at one residential type which is, gradually, entering Japanese major cities and their residential culture. High and extra high residential buildings have started to make their way to Tokyo not so long ago. After a decade or so of sporadic build-up, the breaking point came with construction of controversial Roppongi Hills (2000-2003). With all of its complexities aside, it is important to note that that project introduced strong association between living high and high-class living. As introduced in our brief opening of this text, Japanese elites and aspirational class tend to see highrise buildings in a positive light. That gets supported by evident technological advancements, which make these buildings earthquake resistant and increasingly environmentally sound. Without an unlikely, major shift of direction in which the global economic power evolves, that trend will continue. The Japanese financial and other elites tend to follow global trends, with a certain delay, whilst ex-pats arriving in Japan to high paying jobs often demand the same global trends.

Current practice opens a critical question – how to avoid the repetition of predictable, globally well-researched, multiple negative impacts of highrise concentrations (which range from a variety of environmental and bio-climatic hazards to, here most importantly, socio-cultural damage) towards positive contextual integration? Not surprisingly, the most promising efforts in that direction are happening in the parts of the world in which high density residential skyscrapers can satisfy an acute need (e.g. meeting the population growth requirements, stopping urban sprawl of fast-growing conglomerations etc.). Many of these experiments aim towards the renewed Vertical Urbanism, with some of the breakthroughs happening in a broader global region to which Japan also belongs – the

Asian Pacific Rim and, in particular, the monsoon Asia. If approached in a strategic way, focusing at local needs which are different from expressing the power of affluent and aspirational classes, high density residential high-rise could become the part of a solution for one the Japanese must acute problems. We believe that, if conceptualised, planned and designed in response to the actual needs of this country – and in particular those of Tokyo - Vertical Urbanism may have the capacity to support an ageing population, its special need for new, easier and more efficient forms of care, reduced distances, easy mobility, redefined social cohesion and support and novel functional combinations (such as care homes, hospitals, hospices within the Supertall).

6.2 3D Floor-plate Factsheets

6.2.1 23 Marina factsheet



3D model created of interior arrangement of bedrooms

Typical floorplate 8-31

Typical floorplate 35-58

Typical floorplate 62-85

3D model utilising typical floorplates

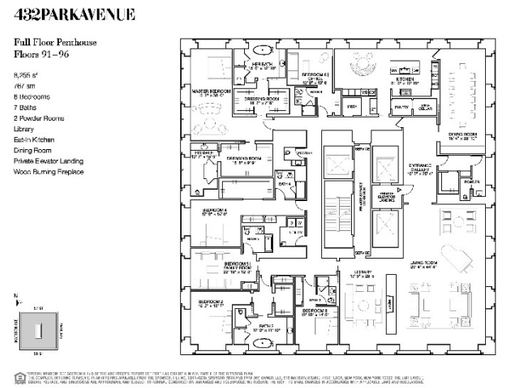
Source diagrams of floorplates and 3D model

Name	Typical Floor	Floor Type	No. of 1 bedroom	No. of 2 bedroom	No. of 3 bedroom	4	Type	Rooms Types																	
								Master Bedroom	Master Bathroom	Master Closet	Bedroom 1	Bathroom 1	Bedroom 2	Bathroom 2	Living/Dining	Kitchen	WC	Maid Quarters	Balcony 1	Balcony 2	Balcony 3	Balcony 4	Other	Total	Total Usable	Percentage Usable
23 Marina	8 - 31	Quandrant	0	2	4		2-bedroom	12.77 m²	3.64 m²	3.1 m²	9.5 m²	3.62 m²			27.05 m²	7.17 m²	1.86 m²	5.41 m²	4.03 m²	4 m²			10.1 m²	92.25 m²	82.15 m²	89.05%
							3-bedroom	15.2 m²	4.33 m²	4.4 m²	9.6 m²	3.52 m²	9.5 m²	3.12 m²	33 m²	6.64 m²	1.63 m²	5.65 m²	3.36 m²	3.01 m²	3.44 m²		8.58 m²	115 m²	106.4 m²	92.54%

6.2.2 432 Park Avenue factsheet

Typical apartment ‘residence a’ – foor 62-73

Typical apartment ‘residence b’ – foor 62-73



Floorplate reference – penthouse level 91-96

3D model utilising typical floorplates

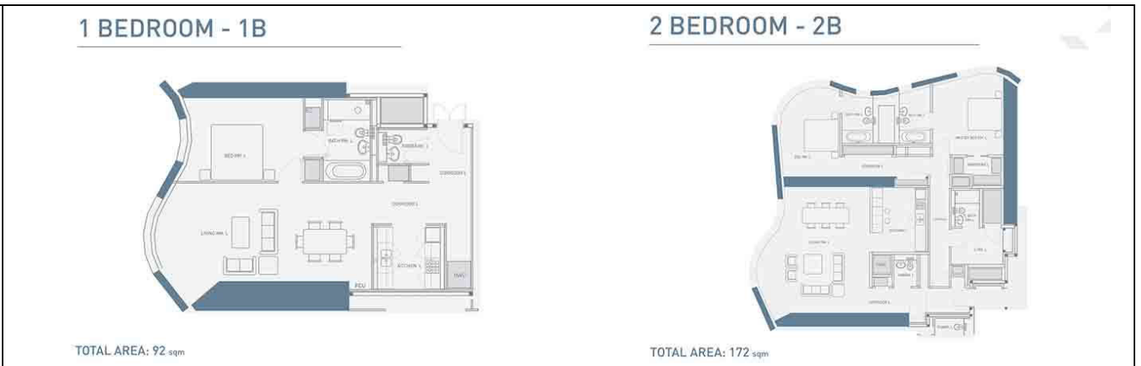
3D model created of interior arrangement of bedrooms

Source diagrams of floorplates and 3D model

Name	Typical Floor	Floor Type	No. of 1 bedroom	No. of 2 bedroom	No. of 3 bedroom	4	Type	Rooms Types																
								Master Bedroom	Master Bathroom	Master Closet	Bedroom 1	Bathroom 1	Bedroom 2	Bathroom 2	Living/Dining	Kitchen	WC	Maid Quarters	Balcony 1	Balcony 2	Balcony 3	Balcony 4	Other	Total	Total Usable	Percentage Usable
432 Park Avenue	62-73	Symmetrical	0	0	2		3-bedroom	36.5 m²	17.2 m²	12 m²	15.5 m²	6 m²	16 m²	5.5 m²	82.5 m²	28.7 m²	3.92 m²						29.45 m²	253.3 m²	223.8 m²	88.37%

6.2.3 Burj Mohammed bin Rashid factsheet

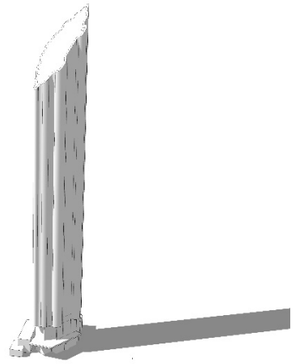
3D model created of interior arrangement of bedrooms



Typical apartment 1B

Typical apartment 2B

Floorplate reference – level unknown



3D model utilising typical floorplates

Source diagrams of floorplates and 3D model

Name	Typical Floor	Floor Type	No. of 1 bedroom	No. of 2 bedroom	No. of 3 bedroom	Type	Rooms Types																
							Master Bedroom	Master Bathroom	Master Closet	Bedroom 1	Bathroom 1	Bedroom 2	Bathroom 2	Living/Dining	Kitchen	WC	Maid Quarters	Balcony 1	Balcony 2	Balcony 3	Balcony 4	Other	Total	Total Usable	Percentage Usable
Burj Mohamed Bin Rashid	Unknown	Asymmetrical	5	4	0	1-bedroom	16 m²	4 m²						26 m²	4 m²	4 m²						6.5 m²	60.5 m²	54 m²	89.26%
						1-bedroom	17 m²	8 m²	8 m²					27 m²	3 m²	5 m²						5.57 m²	73.57 m²	68 m²	92.43%
						2-bedroom	27 m²	5 m²		18 m²	5 m²			41 m²	13 m²	5 m²	13 m²					13.7 m²	140.7 m²	127 m²	90.26%

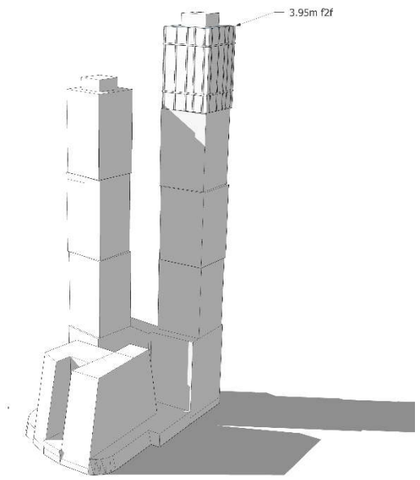
6.2.4 City of Capitals Moscow factsheet

3D model created of interior arrangement of bedrooms

Typical apartment 1B

Typical apartment 2B

Floorplate reference – level unknown

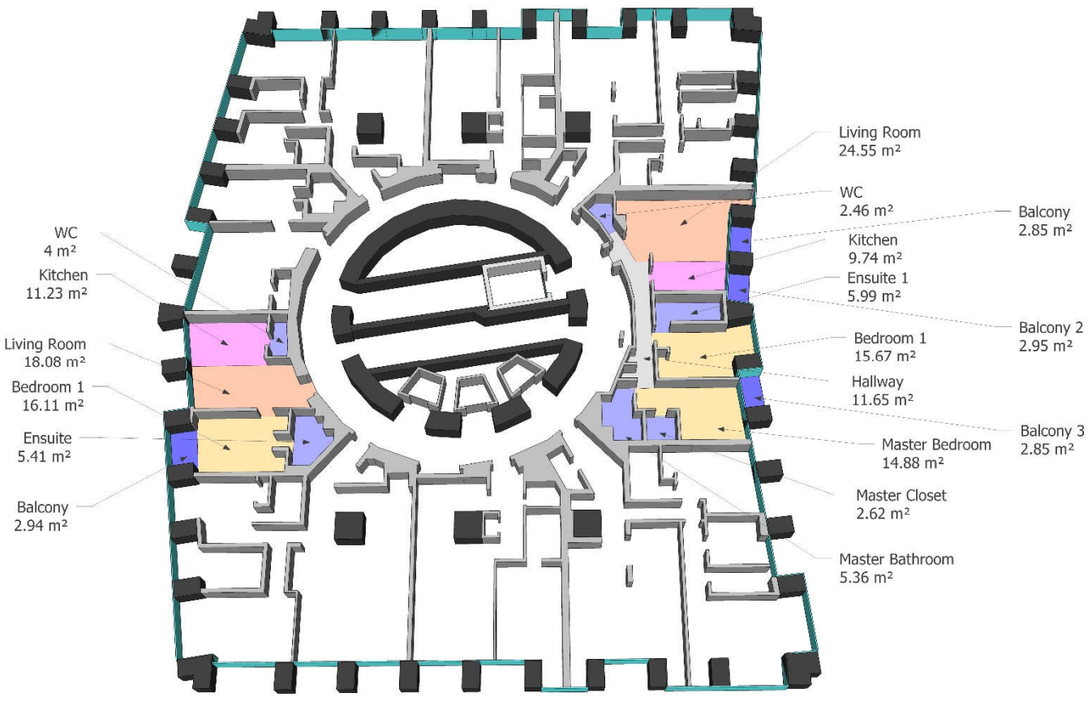


3D model utilising typical floorplates

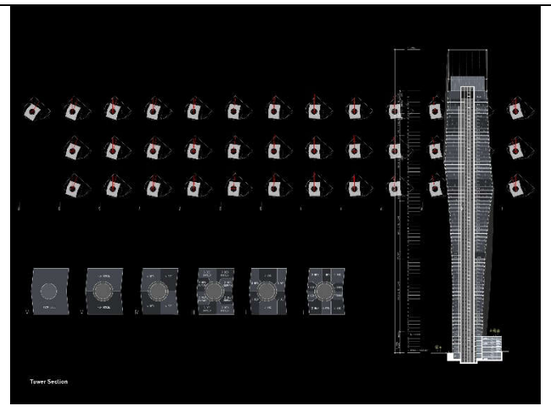
Source diagrams of floorplates and 3D model

Name	Typical Floor	Floor Type	No. of 1 bedroom	No. of 2 bedroom	No. of 3 bedroom	Type	Rooms Types																
							Master Bedroom	Master Bathroom	Master Closet	Bedroom 1	Bathroom 1	Bedroom 2	Bathroom 2	Living/Dining	Kitchen	WC	Maid Quarters	Balcony 1	Balcony 2	Balcony 3	Balcony 4	Other	Total	Total Usable	Percentage Usable
City of Capitals Moscow	64-73	Asymmetrical	1	4	0	1-bedroom	28.7 m²	12.57 m²	10.1 m²					46.5 m²	15.1 m²	8.6 m²						9.7 m²	131.3 m²	121.6 m²	92.61%
						2-bedroom	32 m²	17.3 m²	5.2 m²	34.3 m²	9 m²			113.9 m²	18.1 m²	3.3 m²						42.5 m²	275.6 m²	233.1 m²	84.58%

6.2.5 Cayan Tower factsheet

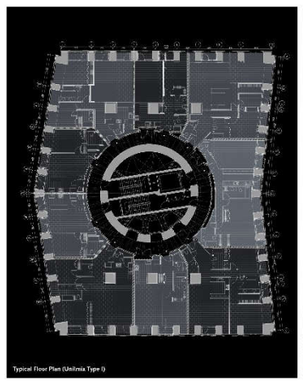


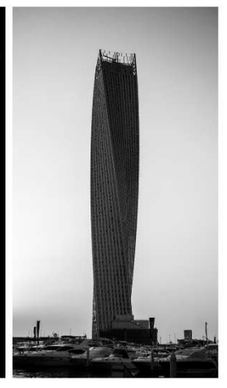
3D model created of interior arrangement of bedrooms



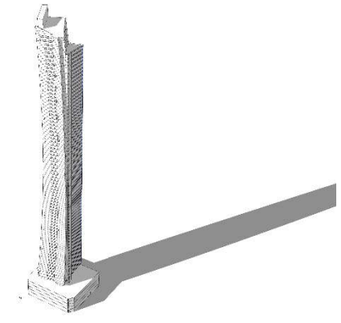
Typical Floorplates and sectional diagram

Typical apartment 2B





Floorplate reference – level unknown



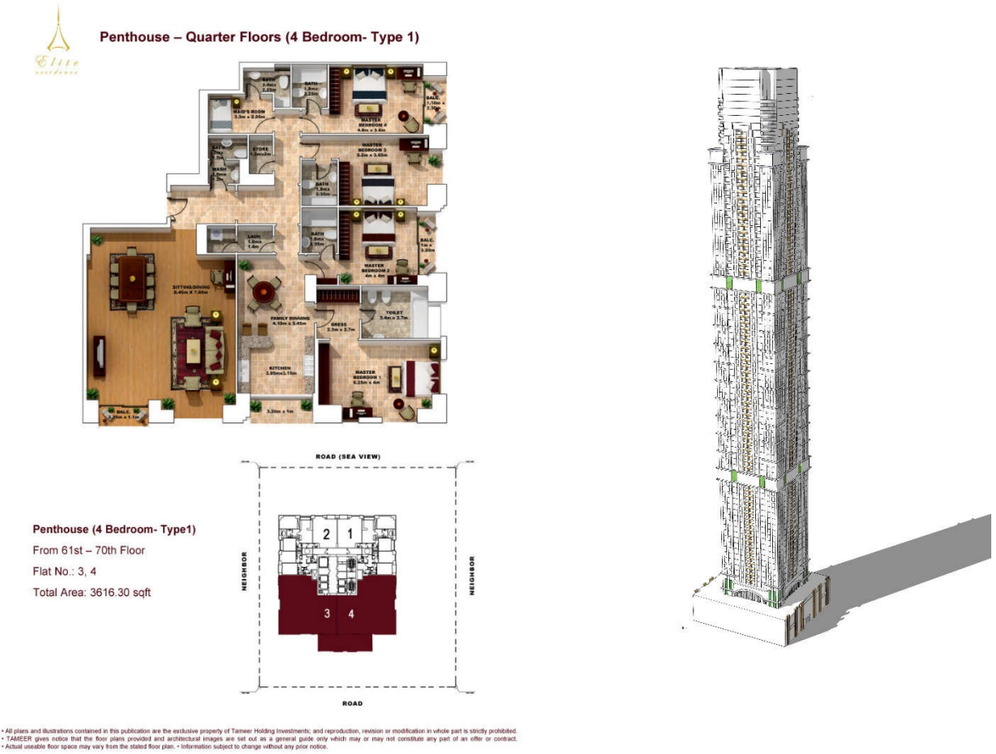
3D model utilising typical floorplates (Source: Architect)

Source diagrams of floorplates and 3D model

			Apartment Types			Apartment Breakdown																			
Name	Typical Floor	Floor Type	1	2	3	4	Type	Rooms Types																	
								Master Bedroom	Master Bathroom	Master Closet	Bedroom 1	Bathroom 1	Bedroom 2	Bathroom 2	Living/Dining	Kitchen	WC	Maid Quarters	Balcony 1	Balcony 2	Balcony 3	Balcony 4	Other	Total	Total Usable	Percentage Usable
Cayan Tower	Unknown	Asymmetical	4	5	0		1-bedroom	16.1 m²	5.41 m²						18.08 m²	11 m²	4 m²		2.94 m²				0 m²	57.76 m²	57.76 m²	100.00%
							2-bedroom	14.88 m²	5.36 m²	2.62 m²	15.67 m²	5.99 m²			24.55 m²	9.7 m²	2.5 m²		2.85 m²	2.95 m²	2.86 m²		11.65 m²	101.6 m²	89.93 m²	88.53%

6.2.6 Elite Residence factsheet

3D model created of interior arrangement of bedrooms (note difference visualisation style)



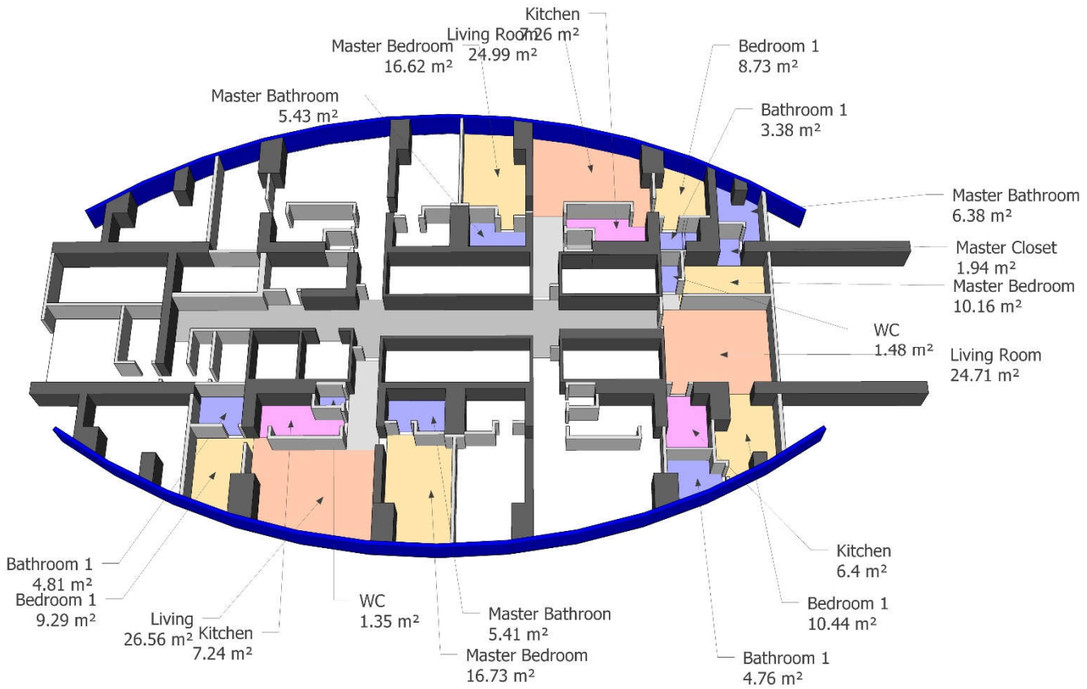
Typical apartment 3B with keyplan

3D model utilising typical floorplates

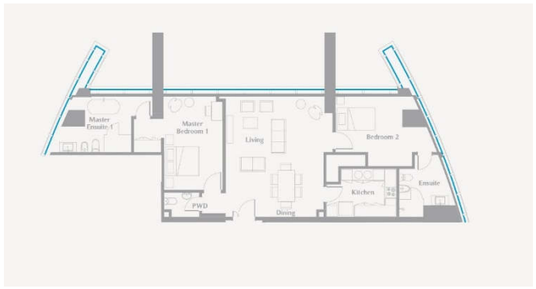
Source diagrams of floorplates and 3D model

			Apartment Types			Apartment Breakdown																		
Name	Typical Floor	Floor Type	1	2	3		Type	Rooms Types																
								Master Bedroom	Master Bathroom	Master Closet	Bedroom 1	Bathroom 1	Bedroom 2	Bathroom 2	Living/Dining	Kitchen	WC	Maid Quarters	Balcony 1	Balcony 2	Balcony 3	Balcony 4	Other	Total	Total Usable	Percentage Usable
Elite Residence	71-75	Quandrant	0	0	4		3-bedroom	22 m²	10.94 m²	7.7 m²	18.23 m²	4.46 m²	17.1 m²	4.05 m²	109.5 m²	9.1 m²	6.8 m²	9.9 m²	2.67 m²	3.33 m²	3.68 m²	2.34 m²	13.6 m²	245.4 m²	231.8 m²	94.46%

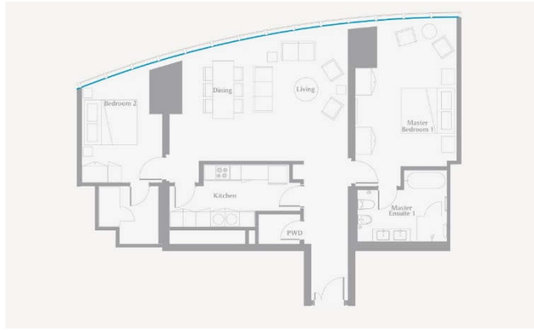
6.2.7 Etihad 2 factsheet



3D model created of interior arrangement of bedrooms



Typical apartment 2B (edge condition)



Typical apartment 2B

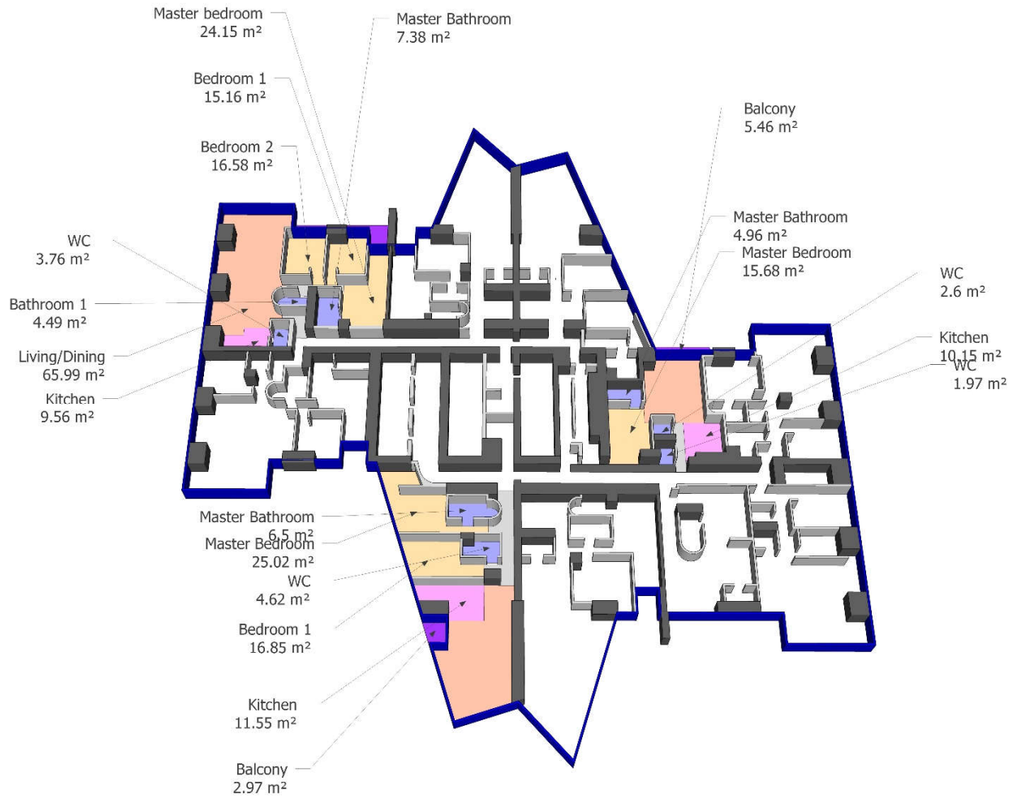
Floorplate reference – level unknown

No Tier 1 data available for model (Source: Google Earth)

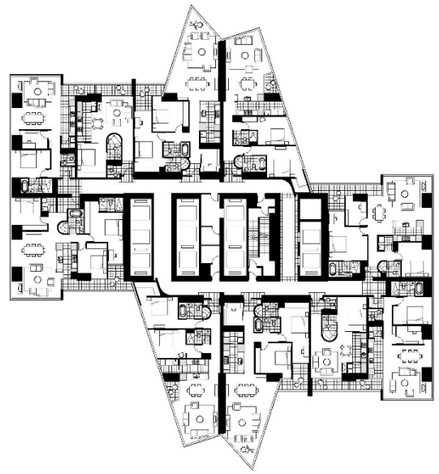
Source diagrams of floorplates and 3D model

			Apartment Types		Apartment Breakdown																			
Name	Typical Floor	Floor Type	1	2	3	Type	Rooms Types																	
							Master Bedroom	Master Bathroom	Master Closet	Bedroom 1	Bathroom 1	Bedroom 2	Bathroom 2	Living/Dining	Kitchen	WC	Maid Quarters	Balcony 1	Balcony 2	Balcony 3	Balcony 4	Other	Total	Total Usable	Percentage Usable
Etihad 2			1	4	0	1-bedrom	16.73 m²	5.41 m²						26.56 m²	7.2 m²	1.4 m²						6.86 m²	64.15 m²	57.29 m²	89.31%
						2-bedroom	16.73 m²	5.41 m²		9.23 m²	4.8 m²			26.56 m²	7.2 m²	1.4 m²						6.86 m²	78.18 m²	71.32 m²	91.23%
						2-bedroom	10.15 m²	6.38 m²	1.94 m²	10.44 m²	4.76 m²			24.71 m²	6.4 m²	1.5 m²						0.99 m²	67.25 m²	66.26 m²	98.53%

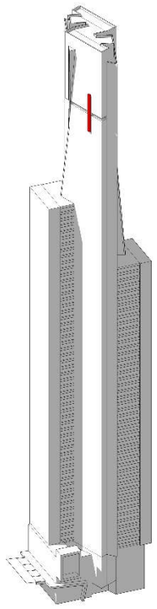
6.2.8 Eureka Tower factsheet



3D model created of interior arrangement of bedrooms



Floorplate reference – level 11-24

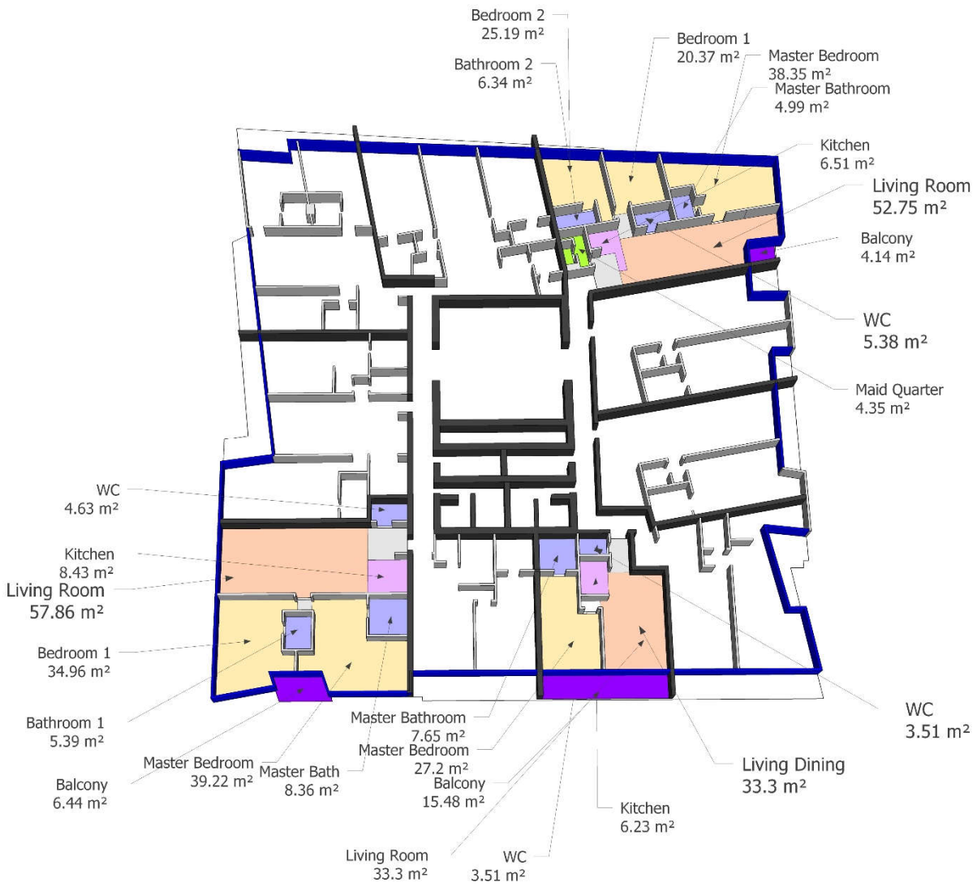


3D model utilising typical floorplates (Source: Architect)

Source diagrams of floorplates and 3D model

			Apartment Types		Apartment Breakdown																			
Name	Typical Floor	Floor Type	1	2	3	Type	Rooms Types																	
							Master Bedroom	Master Bathroom	Master Closet	Bedroom 1	Bathroom 1	Bedroom 2	Bathroom 2	Living/Dining	Kitchen	WC	Maid Quarters	Balcony 1	Balcony 2	Balcony 3	Balcony 4	Other	Total	Total Usable	Percentage Usable
Eureka Tower	26-52	Symmetrical	4	4	2	1-bedroom	15.68 m²	4.96 m²						27.66 m²	10 m²	4.6 m²		5.46 m²				3.79 m²	72.3 m²	68.51 m²	94.76%
						2-bedroom	25.02 m²	6.5 m²		16.85 m²				41.44 m²	12 m²	4.6 m²		2.97 m²				10.77 m²	119.7 m²	108.95 m²	91.00%
						3-bedroom	24.15 m²	7.38 m²		15.16 m²	4.49 m²	16.58 m²		65.99 m²	9.6 m²	3.8 m²		12.91 m²				13.6 m²	173.6 m²	159.98 m²	92.16%

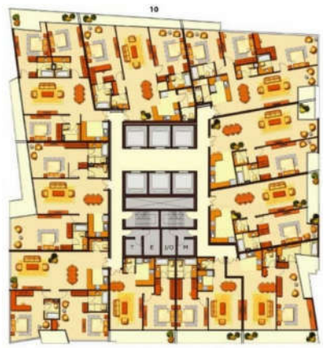
6.2.9 Ocean Heights Marina factsheet



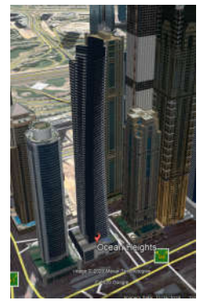
3D model created of interior arrangement of bedrooms

Typical apartment 2B

Typical apartment 1B



Floorplate reference – level unknown

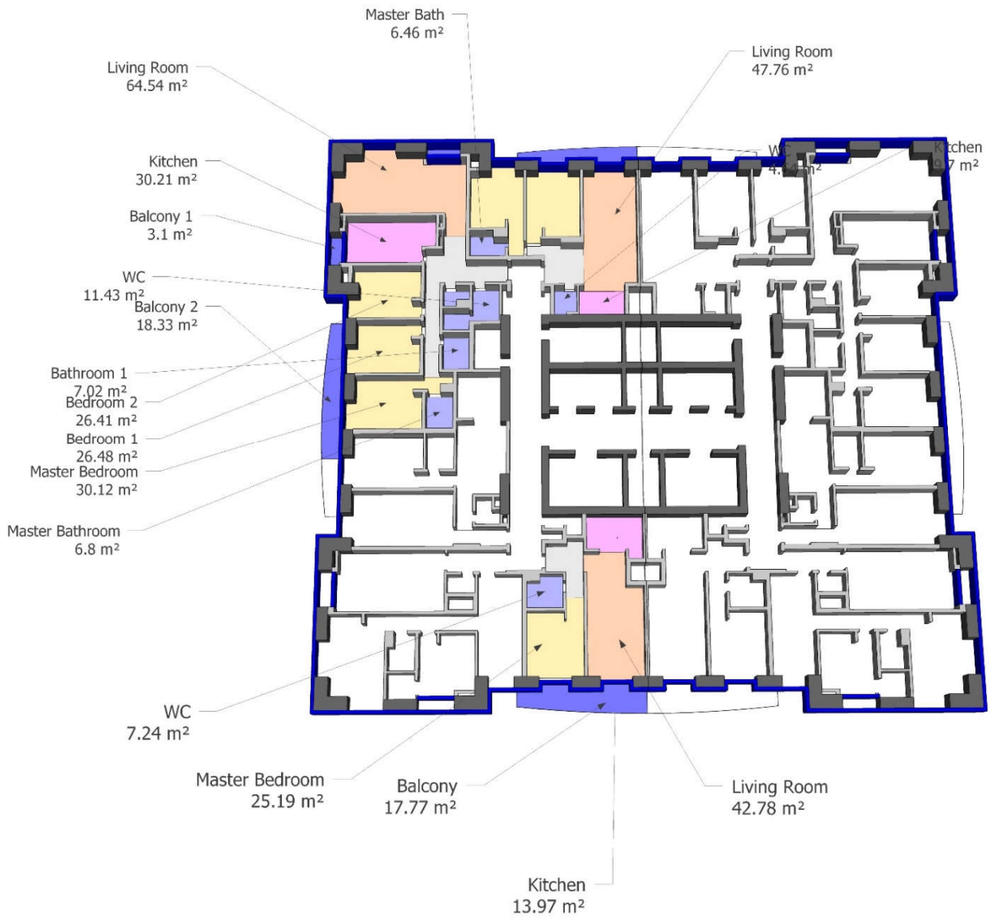


No Tier 1 data available for model (Source: Google Earth)

Source diagrams of floorplates and 3D model

			Apartment Types		Apartment Breakdown																			
Name	Typical Floor	Floor Type	1	2	3	Type	Rooms Types																	
							Master Bedroom	Master Bathroom	Master Closet	Bedroom 1	Bathroom 1	Bedroom 2	Bathroom 2	Living/Dining	Kitchen	WC	Maid Quarters	Balcony 1	Balcony 2	Balcony 3	Balcony 4	Other	Total	Total Usable	Percentage Usable
OHM	Unknown	Assymetrical	5	4	1	1-bedroom	27.2 m²	7.65 m²						33.3 m²	6.2 m²	3.5 m²		15.48 m²				3.79 m²	97.16 m²	93.37 m²	96.10%
						2-bedroom	39.22 m²	8.36 m²		34.96 m²	5.39 m²			57.86 m²	8.4 m²	4.6 m²		6.44 m²				8.36 m²	173.7 m²	165.29 m²	95.19%
						3-bedroom	38.35 m²	4.99 m²		20.37 m²	6.34 m²	25.9 m²		52.57 m²	6.5 m²	5.4 m²	4.35 m²	4.14 m²				9.54 m²	178.4 m²	168.9 m²	94.65%

6.2.10 Princess Tower factsheet

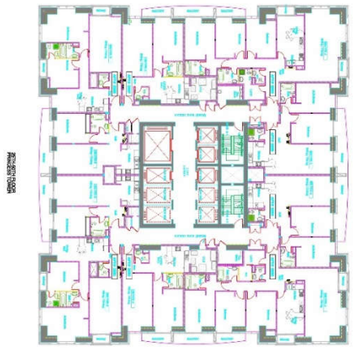


3D model created of interior arrangement of bedrooms

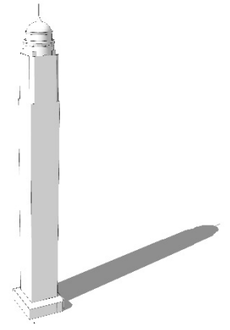
APARTMENT NO : 1
LEVELS 7th~70th

Typical 2B Apartment (corner)

Typical 3B Apartment



Floorplate reference – level 25-50

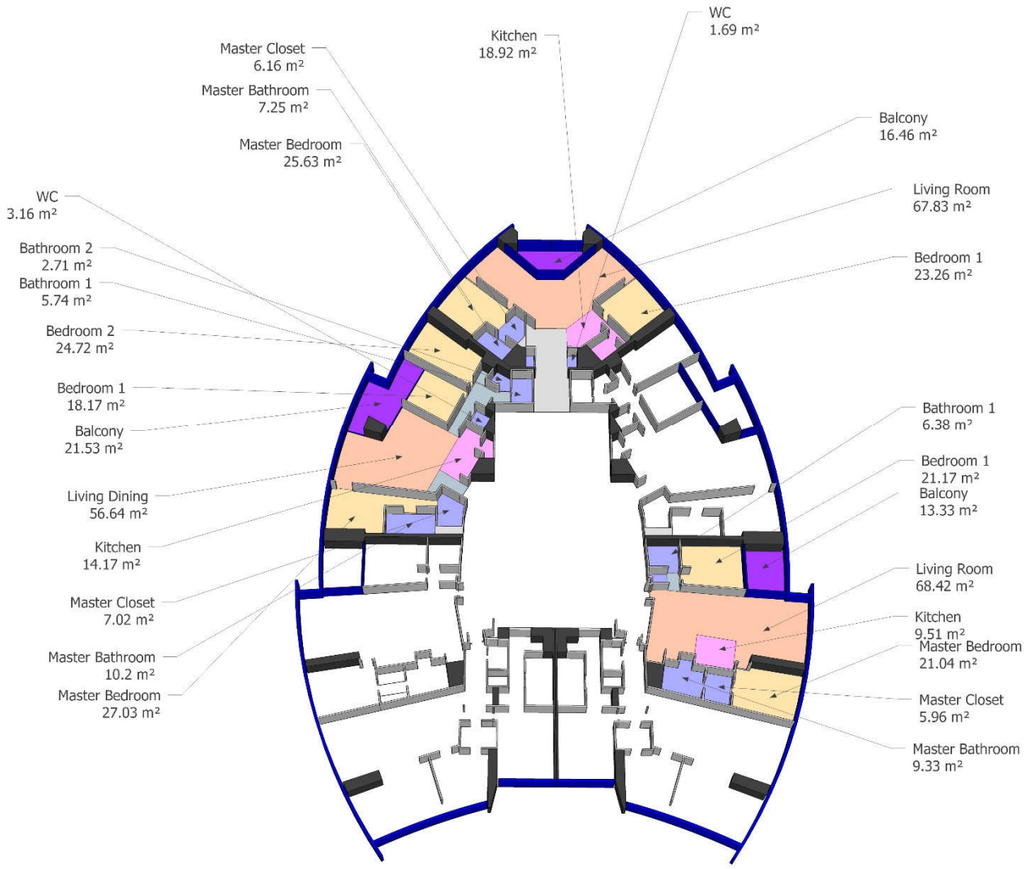


3D model utilising typical floorplates

Source diagrams of floorplates and 3D model

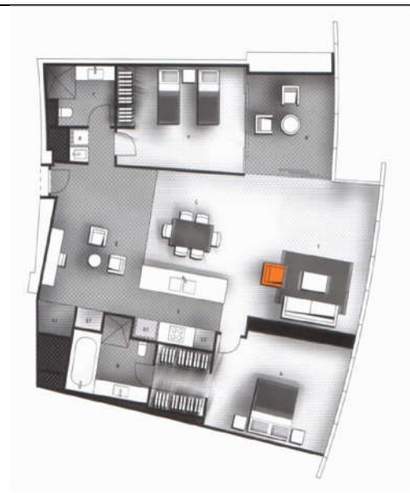
			Apartment Types		Apartment Breakdown																			
Name	Typical Floor	Floor Type	1	2	3	Type	Rooms Types																	
							Master Bedroom	Master Bathroom	Master Closet	Bedroom 1	Bathroom 1	Bedroom 2	Bathroom 2	Living/Dining	Kitchen	WC	Maid Quarters	Balcony 1	Balcony 2	Balcony 3	Balcony 4	Other	Total	Total Usable	Percentage Usable
Princess Tower	25-50	Symmetrical	4	2	2	1-bedroom	25.19 m²							42.78 m²	14 m²	7.2 m²		17.77 m²				10.16 m²	116.9 m²	106.77 m²	91.31%
						2-bedroom	28.6 m²	6.46 m²		28.59 m²				47.76 m²	9.7 m²	4.6 m²		17.17 m²				14.57 m²	157.5 m²	142.92 m²	90.75%
						3-bedroom	30.12 m²	6.8 m²		26.41 m²	7.02 m²	26.41 m²		64.54 m²	30 m²	11 m²	4.35 m²	3.1 m²	18.33 m²			30.35 m²	259.1 m²	228.71 m²	88.28%

6.2.11 Q1 Tower factsheet

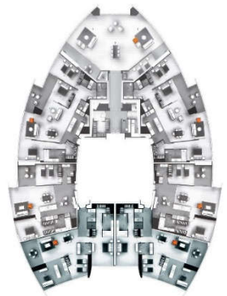


3D model created of interior arrangement of bedrooms

Typical 2B Apartment (corner)



Typical 2B Apartment



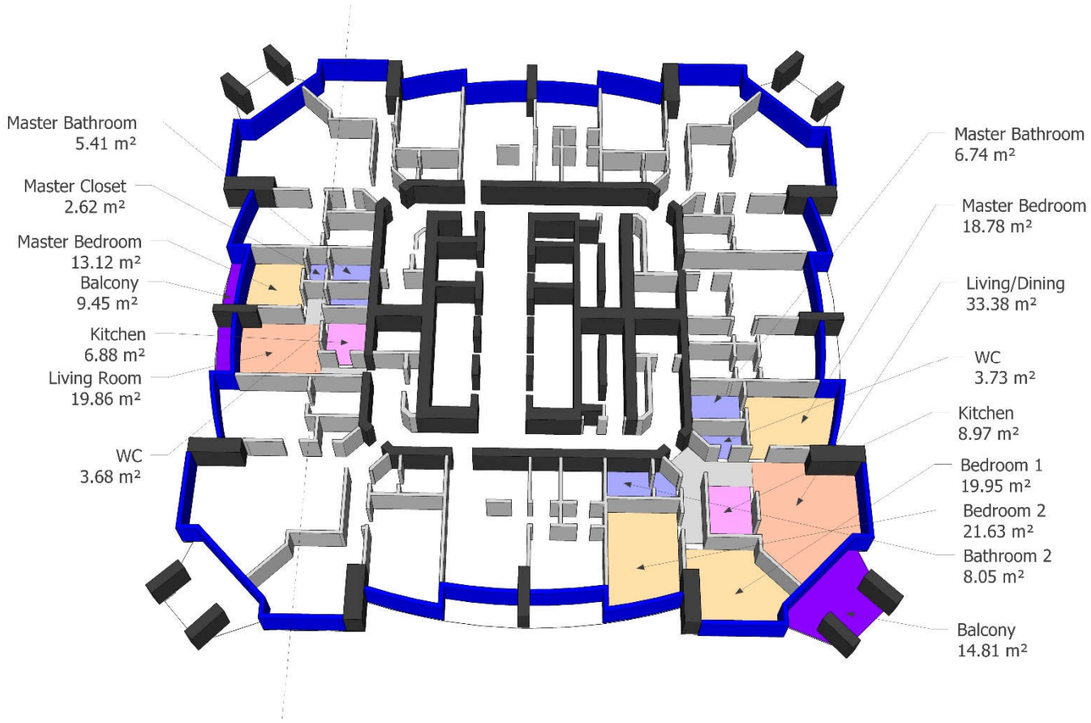
Floorplate photographic sitch

No Tier 1 data available for model (Source: Google Earth)

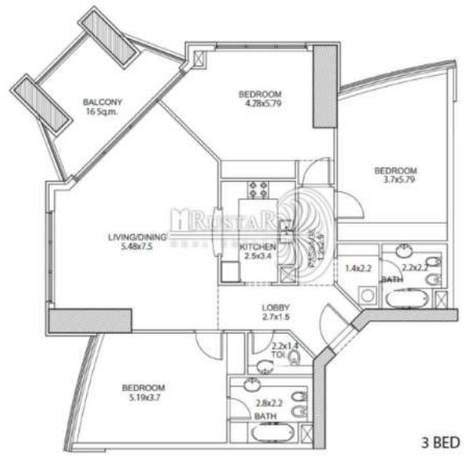
Source diagrams of floorplates and 3D model

			Apartment Types		Apartment Breakdown																			
Name	Typical Floor	Floor Type	1	2	3	Type	Rooms Types																	
							Master Bedroom	Master Bathroom	Master Closet	Bedroom 1	Bathroom 1	Bedroom 2	Bathroom 2	Living/Dining	Kitchen	WC	Maid Quarters	Balcony 1	Balcony 2	Balcony 3	Balcony 4	Other	Total	Total Usable	Percentage Usable
Q1 Apartments	42-54	Symmetrical	0	3	4	2-bedroom	21.04 m²	9.33 m²	5.96 m²	21.17 m²	6.38 m²			68.42 m²	9.5 m²	2 m²		13.33 m²				1.56 m²	158.7 m²	157.11 m²	99.02%
						2-bedroom	25.63 m²	7.25 m²	6.16 m²	23.26 m²				67.83 m²	19 m²	1.7 m²		16.46 m²				27.06 m²	194.3 m²	167.2 m²	86.07%
						3-bedroom	27.03 m²	10.2 m²	7.02 m²	18.17 m²	5.74 m²	24.72 m²	2.71 m²	56.65 m²	14 m²	3.2 m²		21.52 m²				17.93 m²	209 m²	191.09 m²	91.42%

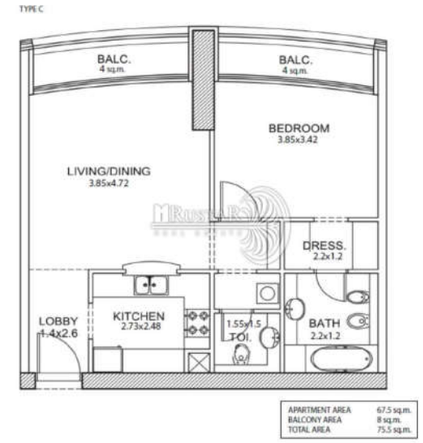
6.2.12 The Torch factsheet



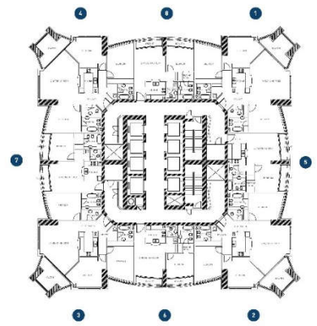
3D model created of interior arrangement of bedrooms



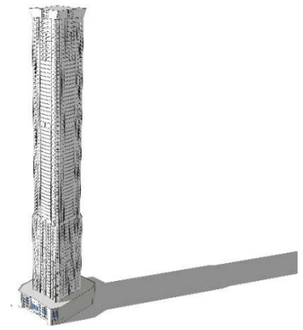
Typical 3B Apartment (corner)



Typical 1B Apartment



Floorplate reference – level 66-73

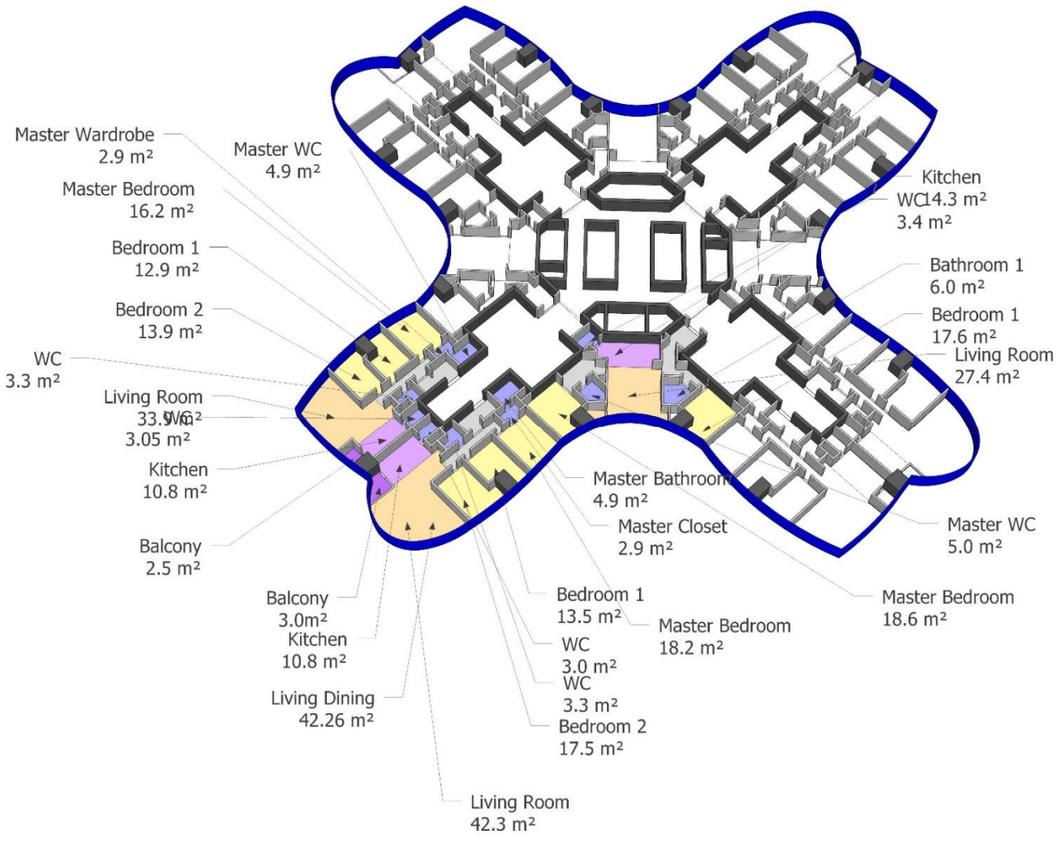


3D model utilising typical floorplates

Source diagrams of floorplates and 3D model

			Apartment Types		Apartment Breakdown																			
Name	Typical Floor	Floor Type	1	2	3	Type	Rooms Types																	
							Master Bedroom	Master Bathroom	Master Closet	Bedroom 1	Bathroom 1	Bedroom 2	Bathroom 2	Living/Dining	Kitchen	WC	Maid Quarters	Balcony 1	Balcony 2	Balcony 3	Balcony 4	Other	Total	Total Usable	Percentage Usable
The Torch	66-73	Quadrant	4	0	4	1-bedroom	13.12 m²	5.41 m²	2.62 m²					19.86 m²	6.9 m²	3.7 m²		9 m²	9 m²			5.71 m²	75.28 m²	69.57 m²	92.41%
						3-bedroom	18.78 m²	6.74 m²		19.95 m²		21.63 m²	8.05 m²	33.38 m²	9 m²	3.7 m²		14.81 m²				11.6 m²	147.6 m²	136.04 m²	92.14%

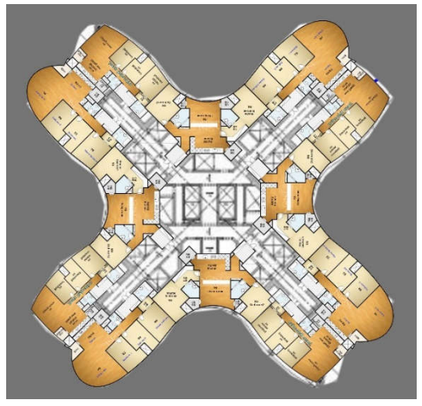
6.2.13 We've the Zenith factsheet



3D model created of interior arrangement of bedrooms

Typical 2B Apartment (spine)

Typical 3B Apartment



Floorplate photographic sitch

No 3D data available

Source diagrams of floorplates and 3D model

			Apartment Types		Apartment Breakdown																			
Name	Typical Floor	Floor Type	1	2	3	Type	Rooms Types																	
							Master Bedroom	Master Bathroom	Master Closet	Bedroom 1	Bathroom 1	Bedroom 2	Bathroom 2	Living/Dining	Kitchen	WC	Maid Quarters	Balcony 1	Balcony 2	Balcony 3	Balcony 4	Other	Total	Total Usable	Percentage Usable
We've the Zenith	52 - 75	Quadrant	0	4	8	2-bedroom	18.6 m²	5 m²		17.6 m²	6 m²			27.4 m²	14 m²	3.4 m²						22.34 m²	114.6 m²	92.3 m²	80.51%
						3-bedroom	18.2 m²	4.9 m²	2.9 m²	13.5 m²		17.5 m²		42.26 m²	11 m²	6.3 m²		3 m²				14.86 m²	134.2 m²	119.36 m²	88.93%
						3-bedroom	16.2 m²	4.9 m²	2.9 m²	12.9 m²		13.9 m²		33.9 m²	11 m²	6.1 m²		2.5 m²				14.85 m²	118.9 m²	104.08 m²	87.51%

6.3 Australia 108 Apartment Breakdown by Floor

The table is designed to show the tower from the bottom floor (-2) to the very top floor (roof) in ascending order, mimicking a vertical section of the tower.

The tower is broken down into bedroom types, total number of rooms and the grand total.

\	Floor Name	Studio	1-Bedroom	2-Bedroom	3-Bedroom	4-Bedroom	Section Ttotal	Grand Total
Roof								
	Total	3	418	523	158	1		1103
		0.27%	37.90%	47.42%	14.32%	0.09%	100.00%	
100	Sky Penthouse					1	1	1103
99	Plant							
98	Plant							
97	Nova				2		2	
96	Sky Lounge							
95	Stellar Rise				4		36	
94	Stellar Rise				4			
93	Stellar Rise				4			
92	Stellar Rise				4			
91	Stellar Rise				4			
90	Stellar Rise				4			
89	Stellar Rise				4			
88	Stellar Rise				4			
87	Stellar Rise				4			
86	Star Rise				8		120	
85	Star Rise				8			
84	Star Rise				8			
83	Star Rise				8			
82	Star Rise				8			
81	Star Rise				8			
80	Star Rise				8			
79	Star Rise				8			
78	Star Rise				8			
77	Star Rise				8			
76	Star Rise				8			
75	Star Rise				8			
74	Star Rise				8			
73	Star Rise				8			
72	Star Rise (x)				8			
71	Sky Lounge 2							
70	Sky Lounge 1							
69	Belt Truss/Plant							
68	Belt Truss/BMU							
67	Sky Rise 2B		8	10			198	24
66	Sky Rise 2B		8	10				
65	Sky Rise 2B		8	10				
64	Sky Rise 2B		8	10				
63	Sky Rise 2B		8	10				
62	Sky Rise 2B		8	10				
61	Sky Rise 2B		8	10				
60	Sky Rise 2B		8	10				
59	Sky Rise 2B		8	10				
58	Sky Rise 2B		8	10				
57	Sky Rise 2B		8	10				
56	Sky Rise 2A		8	10			234	
55	Sky Rise 2A		8	10				
54	Sky Rise 2A		8	10				
53	Sky Rise 2A		8	10				
52	Sky Rise 2A		8	10				
51	Sky Rise 2A		8	10				
50	Sky Rise 2A		8	10				
49	Sky Rise 2A		8	10				
48	Sky Rise 2A		8	10				
47	Sky Rise 2A		8	10				
46	Sky Rise 2A		8	10				
45	Sky Rise 2A		8	10				
44	Sky Rise 2A		8	10				
43	Outrigger/Plant							
42	Outrigger/Plant							
41	Sky Rise 1B		8	10			504	27
40	Sky Rise 1B		8	10				
39	Sky Rise 1B		8	10				
38	Sky Rise 1B		8	10				
37	Sky Rise 1B		8	10				
36	Sky Rise 1B		8	10				
35	Sky Rise 1B		8	10				
34	Sky Rise 1B		8	10				
33	Sky Rise 1B		8	10				
32	Sky Rise 1B		8	10				

31	Sky Rise 1B		8	10				
30	Sky Rise 1B		8	10				
29	Sky Rise 1B		8	10				
28	Sky Rise 1B		8	10				
27	Sky Rise 1A		8	10				
26	Sky Rise 1A		8	10				
25	Sky Rise 1A		8	10				
24	Sky Rise 1A		8	10				
23	Sky Rise 1A		8	10				
22	Sky Rise 1A		8	10				
21	Sky Rise 1A		8	10				
20	Sky Rise 1A		8	10				
19	Sky Rise 1A		8	10				
18	Sky Rise 1A		8	10				
17	Sky Rise 1A		8	10				
16	Sky Rise 1A		8	10				
15	Sky Rise 1A		8	10				
14	Sky Rise 1A		8	10				
13	Plant							
12	Plant							
11	Recreation	3	2	3			8	
10	Carpark							
9	Carpark							
8	Carpark							
7	Carpark							
6	Carpark							
5	Carpark							
4	Carpark							
3	Carpark							
2	Carpark							
1	Carpark							
0	Ground Floor							
-1	Basement							
-2	Basement Lift Pits							

6.4 EUREKA TOWER APARTMENT BREAKDOWN BY FLOOR

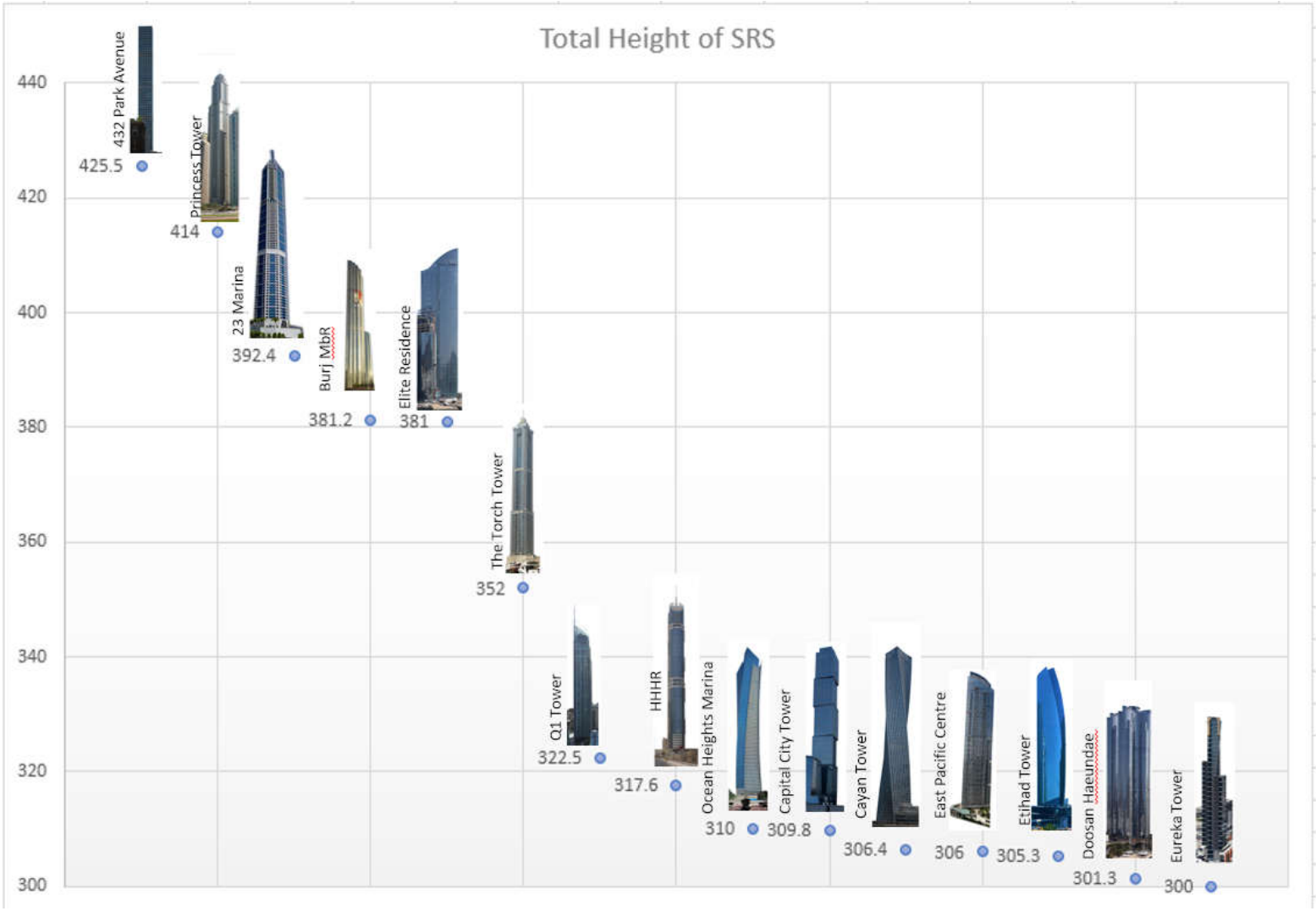
The table is designed to show the tower from the bottom floor (-1) to the very top floor (91) in ascending order, mimicking a vertical section of the tower.

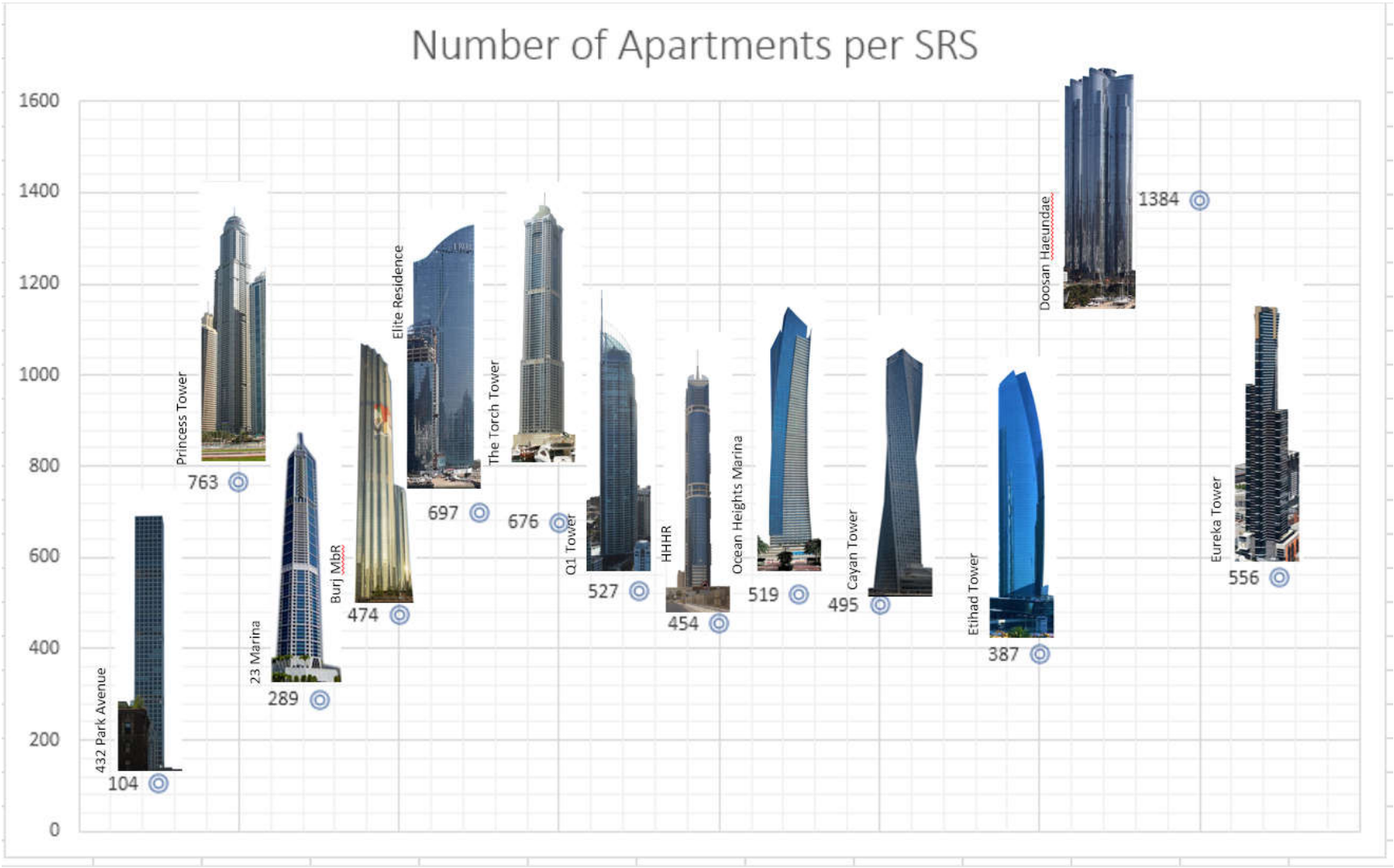
The tower is broken down into bedroom types, total number of rooms and the grand total.

Total Ap.		170	284	114	3		571	
		29.77%	49.74%	19.96%	0.53%		100.00%	
Floor Level	Floor Name	1-Bedroom	2-Bedroom	3-Bedroom	Penthouse	No. Floors	Total	
							571	557
91	LMR							
90	Plant							
89	Plant							
88	Observation							
87	Serviced Office							
86	Serviced Office							
85	Serviced Office							
84	Typ, Ap. Penthouse Top				1		3	3
83	Typ, Ap. Penthouse Top				1			
82	Typ, Ap. Penthouse Top				1			
81	Plant							
80	Typ, Ap. Penthouse		2	2		16	64	64
79	Typ, Ap. Penthouse		2	2				
78	Typ, Ap. Penthouse		2	2				
77	Typ, Ap. Penthouse		2	2				
76	Typ, Ap. Penthouse		2	2				
75	Typ, Ap. Penthouse		2	2				
74	Typ, Ap. Penthouse		2	2				
73	Typ, Ap. Penthouse		2	2				
72	Typ, Ap. Penthouse		2	2				
71	Typ, Ap. Penthouse		2	2				
70	Typ, Ap. Penthouse		2	2				
69	Typ, Ap. Penthouse		2	2				
68	Typ, Ap. Penthouse		2	2				
67	Typ, Ap. Penthouse		2	2				
66	Typ, Ap. Penthouse		2	2				
65	Typ, Ap. Penthouse		2	2				
64	Typ. Ap. Sub-Penthouse Upper	3	4	1		9	74	72
63	Typ. Ap. Sub-Penthouse Upper	3	4	1				
62	Typ. Ap. Sub-Penthouse Upper	3	4	1				
61	Typ. Ap. Sub-Penthouse Upper	3	4	1				
60	Typ. Ap. Sub-Penthouse Upper	3	4	1				
59	Typ. Ap. Sub-Penthouse Upper	3	4	1				
58	Typ. Ap. Sub-Penthouse Upper	3	4	1				
57	Typ. Ap. Sub-Penthouse Upper	3	4	1				
56	Typ. Ap. Sup-Penthouse Lower	3	5	2		2	20	20
55	Typ. Ap. Sup-Penthouse Lower	3	5	2				
54	Typ. Ap. Sup-Penthouse Lower	3	5	2				
53	Plant							
52	Typ. Ap. Upper	3	5	2		27	270	262
51	Typ. Ap. Upper	3	5	2				
50	Typ. Ap. Upper	3	5	2				
49	Typ. Ap. Upper	3	5	2				
48	Typ. Ap. Upper	3	5	2				
47	Typ. Ap. Upper	3	5	2				
46	Typ. Ap. Upper	3	5	2				
45	Typ. Ap. Upper	3	5	2				
44	Typ. Ap. Upper	3	5	2				
43	Typ. Ap. Upper	3	5	2				
42	Typ. Ap. Upper	3	5	2				
41	Typ. Ap. Upper	3	5	2				
40	Typ. Ap. Upper	3	5	2				

39	Typ. Ap. Upper	3	5	2				
38	Typ. Ap. Upper	3	5	2				
37	Typ. Ap. Upper	3	5	2				
36	Typ. Ap. Upper	3	5	2				
35	Typ. Ap. Upper	3	5	2				
34	Typ. Ap. Upper	3	5	2				
33	Typ. Ap. Upper	3	5	2				
32	Typ. Ap. Upper	3	5	2				
31	Typ. Ap. Upper	3	5	2				
30	Typ. Ap. Upper	3	5	2				
29	Typ. Ap. Upper	3	5	2				
28	Typ. Ap. Upper	3	5	2				
27	Typ. Ap. Upper (x)	3	5	2				
26	Typ. Ap. Upper (x)	3	5	2				
25	Plant							
24	Typ. Ap. Lower	4	5	1		14	140	136
23	Typ. Ap. Lower	4	5	1				
22	Typ. Ap. Lower	4	5	1				
21	Typ. Ap. Lower	4	5	1				
20	Typ. Ap. Lower	4	5	1				
19	Typ. Ap. Lower	4	5	1				
18	Typ. Ap. Lower	4	5	1				
17	Typ. Ap. Lower	4	5	1				
16	Typ. Ap. Lower	4	5	1				
15	Typ. Ap. Lower	4	5	1				
14	Typ. Ap. Lower	4	5	1				
13	Typ. Ap. Lower	4	5	1				
12	Typ. Ap. Lower	4	5	1				
11	Typ. Ap. Lower	4	5	1				
10	Recreation							
9	Carparking							
8	Carparking							
7	Carparking							
6	Carparking							
5	Carparking							
4	Carparking							
3	Carparking							
2	Summit Lobby							
1	Lobby							
0	Ground							
-1	Carparking							

6.5 VISUALISATION OF GRAPHS




Number of Apartments per SRS
1600
1400
1200
1000
800
600
400
200
0
432 Park Avenue
104
Princess Tower
763
23 Marina
289
Burj MbR
474
Elite Residence
697
The Torch Tower
676
Q1 Tower
527
HHHR
454
Ocean Heights Marina
519
Cayan Tower
495
Etihad Tower
387
Doosan Haeundae
1384
Eureka Tower
556

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