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Skycourts and skygardens: towards a vertical urban theory

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SKYCOURTS AND SKYGARDENS:
Towards a Vertical Urban Theory

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Towards a Vertical Urban Theory

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Abstract

The public realm has given birth to alternative social spaces that have been created as a means of replenishing the loss of open space within the modern city. The creation of more hybrid building forms and typologies that balance open space within high density development is a phenomenon increasingly being realised in Asian cities, and has started to redefine the tall building within the city. This thesis focuses on two semi-public social spaces that cross the urban-architectural-landscape boundaries - skycourts and skygardens.

It considers them in light of their social, economic, environmental and spatial contribution to the urban habitat. The thesis argues that they are 'alternative' social spaces that form part of a broader, multi-level open space infrastructure that replenishes the loss of open space within the urban habitat. It sets out to illustrate how such semi-public spaces can be incorporated into high-rise structures, and be suitably placed into a hierarchy that supports the primary figurative spaces on the ground or, in their absence, create them in the sky.

It was observed that skycourts and skygardens have become another social space within the urban vocabulary of the city, yet currently remains predominantly managed by the corporation or landowner that controls them. They are differentiated from their public counterparts by the fact that they can never be truly public unless they become ceded to state ownership and permit the individual, group or association the freedoms of speech, action and movement that one normally finds in the public domain of the street and the square.

Despite not being public spaces, skycourts and skygardens have evolved given changing social, spatial, environmental, cultural, economic and technological needs that have engendered public domain characteristics. This may bode well for society's co-presence and may enhance urban life quality as well as the natural and built environment.

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Authors declaration

I declare that all the material contained in this thesis is my own work.

1. Introduction

The subject of my research has been primarily on how the increasing privatisation of the public realm has given birth to alternative social spaces that have been created as a means of replenishing the loss of open space within the modern city. It has focused on the skycourt and skygarden as two semi-public social spaces, and their social, spatial, economic, cultural, environmental and technical contribution to the 21st century urban habitat. The research to date has explored various hypotheses in order to provide a holistic view of these urban-architectural-landscape typologies that had not been previously explored.

Much has been written in spatial/ urban terms on the gradual transformation of the traditional city into the modern city – the former characterized as a city of spaces defined by the street and the square; the latter a city of objects (Sitte 1889; Koetter and Rowe 1978). The environmental impact of the modern city, and in particular its global adoption as a means of rapid urbanization has been well documented (Arnfield, Herbert and Johnson 1999; Rizwan 2008; Wong and Chen 2006; Brenner and Kiel 2010). Object making and the spatial depletion of the public realm has also been shown to yield social as well as physiological impacts through the privatization of space (Kohn 2004; Field 1992; Burge 2004; Zimrig 1983). This has arguably given rise to a contemporary re-evaluation of more traditional spatial and urban forms in the city (Calthorpe and Fulton 2001). There have also been studies of traditional and contemporary building types that have sought to replenish the loss of open space for social co-presence and interaction, such as the 18th century *court*, 19th century *galleria*, the *atrium* and *Mall* (Geist 1983; Dennis 1986; Saxon 1986; Goss 1993).

Skycourts and rooftop skygardens have been covered to a lesser extent and have tended to veer towards the landscaping of rooftop environments (Osmundson 1999), or the architecture of rooftop extensions and their alternative uses (Melet and Vreedenburgh 2005). Rooftops have also been explored in the Asian context as an alternative habitable space (Wu and Canham 2009). Roof terraces, escalators,

travellers and podiums have also been considered as a dystopian nexus within urban habitats such as Hong Kong, whereby life exists above a disappearing ground plane (Frampton et al. 2012). 'Streets in the sky', and elevated platforms as a result of post-war modernization have been reviewed in the works of the architects Alison and Peter Smithson (Risselda 2011), as well as in more contemporary adaptations as bridge links in high rise buildings such as in Cesar Pelli's Petronas Twin Towers in Kuala Lumpur (Wood 2003). Skyourts have also been considered as a means of helping reduce a tall building's overall ecological footprint within the skyscraper (Yeang 2002). More landscape driven quantitative analysis of urban greenery, whether in terms of biological measurement (Ong 2003), ambient temperature reduction (Alexandri and Jones 2008), energy consumption (Wong 2003), urban heat island (Wong 2006), or the potential for urban farming (Despommier 2008) have also been well documented, alongside socio-physiological studies that considered the well-being of individuals in proximity to urban greenery (Ulrich 1986; Kaplan 1995).

Such a review of existing literature relating to the gradual eradication of the public realm, the privatization of space and the development of skycourts, skygardens and peripheral rooftop topics; coupled with the environmental, socio-physiological and economic benefits of urban greenery, identified that little research had been undertaken on social space at height. The study of the skycourt and skygarden as vertical social spaces would seek to bring the spheres of urbanism, landscape and architecture together within the high-density city. In this respect, the research necessitated their initial evaluation in the context of other social spaces in order to establish their positions as worthy additions to the semi - public urban vocabulary alongside more traditional examples that included the *hotel*, *galleria* and the *mall*. It would then allow for a closer examination of their social and spatial characteristics by considering the skycourt and skygarden as:

- spaces of movement and transition
- spaces of social interaction
- spaces that can increase density within the city
- spaces that can enhance a building's environmental performance

- spaces that can be measured in terms of their urban greenery provision

The context for much of this research and practice takes place within the Asian City, and in particular, Singapore, for several reasons. The City State's spatial constraint of being an island with a predicted population growth from 5 million people in 2011 to 6 million by 2020 (Singapore Statistics 2014) has seen continued vertical urban densification to meet both the social demand for housing and the economic demand of a nation seeking continued prosperity in the financial and technology sectors. The city-state has embraced alternative social spaces of interaction given such spatial constraints, and has more recently embraced the skycourt and skygarden as a means of offering open space replenishment for their socio-environmental benefit within both private and public development projects. My studio has found a natural outlet to apply such research regionally, and have become one of the recognized leaders in the field by helping to establish the skycourt and skygarden as part of a new urban vocabulary for its inherent socio-cultural, economic, environmental, physiological and ecological benefits within the Asian urban habitat.

2. Design and Research Projects for consideration

Part of my original contribution to knowledge therefore is not only the authorship of academic papers and books relating to the subject matter, but also the ability to test ideas through commercial projects at the micro scale of singular buildings to the macro scale of masterplanning commercial districts. For the purpose of this report, the following articles, chapter contributions and books are being submitted for consideration:

Pomeroy, J, (2012), 'Consultancy On The Application Of Green Plot Ratio To Selected Building Typologies in Singapore', unpublished.

Pomeroy, J, (2011), 'Defining Singapore public space – from sanitization to corporitisation', *Journal of Urban Design*, 2010, Vol 16, no. 3, pp381-396.

Pomeroy, J, (2014), 'Gramercy Residences' in *Green walls in high-rise buildings*, (Eds.) Wood, A, Safarik, D, Images Publishing Group, Chicago, pp156-163.

Pomeroy, J, (2012), 'Greening the urban habitat: Singapore' in *CTBUH Journal*, 2012, no 1, pp30-35.

Pomeroy, J, (2011), 'High-density living in the Asian context', *Journal of Urban Regeneration and Renewal*, 2011, vol. 4, no.3, pp413-424.

Pomeroy, J, (2012), 'Internal environment and planning' in *The Tall Building Reference book*, (Eds.) Parker, D, Wood, A, Routledge, UK, pp123-132.

Pomeroy, J, (2008), 'Skycourts as transitional space: using space syntax as a predictive theory' in *Congress Proceedings, Tall and Green: Typology for a Sustainable Urban Future*, Council on Tall Buildings and Urban Habitat, 8th World Congress 3rd-5th March, Dubai, pp580-587.

Pomeroy, J, (2014), *The skycourt and sky garden: greening the urban habitat*, Routledge, UK.

Pomeroy, J (2009), 'The skycourt: a comparison of 4 case studies' in *CTBUH Journal*, 2009, no. 1, pp28-36.

Pomeroy, J, (2007), 'The skycourt: a viable alternative civic space for the 21st century?' in *CTBUH Journal*, 2007, no. 3, pp14-19.

Pomeroy Studio, (2015) *Distil Design Disseminate: design and research projects of Pomeroy Studio*, Dechen House, Singapore.

The creation of more hybrid building forms and typologies that balance open space within the object are increasingly being realised in Asian cities and beyond and have started to redefine the tall building within the vertical city. Skycourts and skygardens are being incorporated into tall buildings and the urban habitat to reduce perceived densities and provide more habitable environments that also promote a greener urban habitat. To document this development / trend I brought together my research, and the design projects of various international architects in a book, entitled *The Skycourt and skygarden: greening the urban habitat* (Pomeroy 2014). The burgeoning interest of incorporating green spaces into architecture provided an opportunity to document hybrid - building projects with such vertical social spaces that would serve as a reference to practicing architects and designers. Observations made on the skycourt and skygarden's evolution would then serve

further academic pursuit in a largely untapped research area. In addition, commercial projects that incorporate such vertical social spaces will be submitted as a collated portfolio, entitled *Distil Design Disseminate: Design and Research Works by Pomeroy Studio* (Pomeroy Studio 2015). This will be accompanied by a case study of one particular skycourt recently completed and published by the Council on Tall Building and Urban Habitat in a book titled *High-rise greenery in tall buildings*. Finally, the design project portfolio will be balanced by a research project that sought to define new planning policy and landscape guidelines for Singapore, titled *Consultancy On The Application Of Green Plot Ratio To Selected Building Typologies in Singapore*. Such endeavors seek to demonstrate how my research has been applied to not only design projects but has come to also influence legislative processes and governmental guidelines in Singapore.

This report seeks to provide a commentary and critique that places both the book, the selected papers published and commercial design / research projects executed by Pomeroy Studio within the context of urban, architectural and landscape theory. All of the papers selected have immediate relevance in their investigation into the decline of public space and the birth of alternative social spaces; and particular socio-environmental, socio-spatial, and socio-economic properties of skycourts and skygardens. The commentary will seek to identify the tangible benefits they offer, and the reasons why they have become part of the urban vocabulary. Evolutionary observations, gleaned from the case studies from the book publication will aim to provide a predictive theory as to their continued evolution.

3. The birth of alternative social spaces

The starting point for my research was to consider the public realm and its decline in the context of the traditional and modern city. Particular consideration was given to the meaning of 'public', the manner in which people behave in the public domain, and how both the people and their places have adapted to increasing external socio-economic, spatial, cultural and technological influences over time. This would allow the onward consideration of how the built environment has physically adapted to such influences, and as a consequence given birth to alternative social spaces that bear public domain characteristics.

The Roman understanding of 'public' came to stand for matters of governance and a process of debate for the common good of both civil society and state (Sennett 1976). According to the philosopher Jurgen Habermas, it was such a process of debate for the common good that necessitated a 'public sphere' - a common, inclusive platform that disregarded personal status and allowed civil society to critique state power and control. (Habermas 1989). The academic Peter G Rowe attributes the success of the public realm to its pluralistic nature that need not cater to the particular whims of either civil society or state, but embodies a quality that permits both entities to share space through a healthy territorial tension that in the same instance acknowledges a mutual acknowledgement of the other's existence (Rowe 1997). Social, spatial, economic, environmental, cultural and technological factors have all contributed in some form to the decline of the public realm.

Cities have historically grown out of trade and commerce, and the influx of people seeking economic prosperity is a trend that we continue to see today. Urban and suburban sprawl has been in part the consequence of such growth and, with the proliferation of new knowledge based industries, has also given rise to the concept of the *technoburbia* - out of city headquarters and business parks that seamlessly co-exist with retail malls and residential neighbourhoods to create self-sustaining entities, such as can be seen in Silicon Valley (Fishman 1987). Despite such phenomena, and for the first time in history, half of the World's population have lived in cities since 2007. This number will continue to rise to 70% by 2050 (UNFPA 2007). Population growth and the migration to cities has resulted in urbanization and the adaptation of the city that was once defined by its public open spaces to environments characterized by tall buildings - culminating in the gradual transformation from the city of spaces to the city of objects (Rowe and Koetter 1978). It is the densification of city centres, the erosion of public spaces, and the birth of alternative social space frameworks that this report concerns itself.

In addition to socio-spatial factors, Sennett argues that industrial capitalism is a further cause of the decline (Sennett 1976). The spaces used for trade and commercial transaction, such as the public domain of the market square, would soon be transformed into real estate to cater for greater swathes of people to live, work, or shop in. The casual transaction between purchaser and stallholder would be reduced to comparing, and then procuring, mass manufactured products in comfort controlled mall environments that would be privately owned. The shift from an age of industry to an age of information has also decentralized the city, and the virtual transactions and interactions (as one can see within the finance industry) further create global networks as opposed to local networks that are unfettered by geographic location and need not rely on the physical space as a means of trade interaction (Castells 2002).

Industrialization, population increase, and the consequent overcrowding that would lead to many socio - environmental ills in European cities (Engels 1845), would compromise the environmental sensitivity of the traditional city, whose streets originally facilitated a pedestrian's ease of movement, and its courtyards the provision of natural light and ventilation. The sanitizing effects of slum clearance may have enhanced life expectancy but would also see further adaptation through post-war technological advances (Hall 2002;). Road arteries for carriages would widen and give way to air-conditioned automobiles. The void spaces that once offered environmental as well as social benefit would be filled with solid cores of energy intensive elevators, stairs and service ducts and risers to allow for greater sized residential, office or retail floor plates. The consequence of the removal of open space has been shown to have an effect on human behavior. Crime and vandalism at the public level; and withdrawal, depression and illness at a private level, would be the direct consequence of environments that do not support social networks or the psycho-physiological needs of individuals (Zimrig 1983).

Cultural and technological factors have also had an influence. The age of enlightenment during the 18th century saw the study of personality as a viable alternative to faith systems. An individual's civility was more than just an act of

formality in public but an elaborate mask of private thoughts and feelings. Sennett argues that an individual's fear of society being able to read character through dress and speech, would see further self-withdrawal from the public arena for the further fear of disclosure (Sennet 1976). Today, technological advancement has allowed greater withdrawal into the comfort of personal handheld devices or the internet as a means of social interaction - a technological mask of civility that posits that our interaction in virtual public space should suffice (Lozano 1990). Whilst this may suggest heightened individualism, Manuel Castell's research into the network city phenomenon would suggest a heightened level of interconnectivity with other global cities that the humble street and square of the traditional city cannot provide - the ability to connect people across borders and time zones through a 'space of flows' that should co-exist with the traditional 'spaces of places' (Castells 2001).

Reaching for new urban solutions in the wake of the gradual privatization of space would yield alternative socio-spatial models that sought to, in the first instance, help balance open space with the object buildings within the city; and in the second instance, provide a forum to once again draw people to engage in open space - albeit this time within regulated private environments that were the consequence of commodification (Kohn 2004; Madanipour 1998). These managed 'social spaces' within the private ownership of landowners, would permit accessibility to civil society, imbuing on the individual particular freedoms of expression, but in the same instance increase the ambiguity as to what was and what wasn't permissible social behavior (Pomeroy 2007). As the spaces remained outside the jurisdiction of the state or municipality, maintenance and policing had to be made by the owner, and effectively marked the arrival of a new spatial classification - that of the semi-public realm.

The study of the semi-public realm led me to different building typologies that evolved over time as a reaction to both socio-economic need and the physical transformation of the urban habitat. The Habermasian public sphere of debate and discourse amongst civil society found outlet in the coffee houses and salons of 18th century Europe which were further popularised by literacy improvements,

accessibility to literature and a new critical journalism (Habermas 1989). The 18th century hotel's incorporation of semi-public courts within the boundaries of the private property could be used as a destination for social interaction as well as a means of bringing natural light and ventilation to the heart of the aristocratic townhouses (Dennis 1986). The 19th century galleria was a speculative opportunity for passing retail trade, made possible by its incorporation of a semi-public thoroughfare that acted as a means of transition between larger (and more trafficked) public spaces (Geist 1983).

By the 20th century, street culture was being further emulated in comfort - controlled environments. The mall represented the private corporations contribution to the urban and suburban habitat through social spaces that went through a process of commodification in their ability to be rentable venues for commercial enterprise (Kohn 2004). In the 21st century, this phenomenon has gone even further. The 'integrated resort', a self-sustaining microcosm that goes beyond the mall to include theme park, casino and other recreational activities has been heralded as an urban catalyst that contributes to local economic revitalisation and becomes adopted as part of a nation's economic growth (Walker 2007; Wong et al. 2008). Singapore and Macau's evolution from colonial trading entrepots to entertainment and leisure destinations has seen them become not only destinations for tourists but venues of social engagement for residents of Hong Kong and Singapore respectively.

It was observed that these alternative social space models had been environments that encouraged social interaction at ground level - allowing them to engage with the existing streetscape and adapt to the socio - economic needs of the people (Dennis 1986; Geist 1983; Kohn 2004; Wong et al 2008). But as we build skyward, the sense of social and spatial permeability is lost - as is the connection to the streetscape (Roaf 2010). This led to the question - is the tall building typology of the 20th century modern city compromised by a lack of social space? If the traditional city embraced alternative social spaces on the ground, should there not be the requisite social spaces in the sky in the modern city to help replenish such a loss, and provide a new platform for social interaction? (Pomeroy 2007).

This would become the crux of my research – the investigation into the role of the skycourt and the skygarden as alternative social spaces that could form an additional component within the existing urban vocabulary and take their place alongside the court, the galleria, and the mall, as semi-public space models. This was the subject of my paper, ‘The skycourt: a viable alternative social space for the 21st century?’ in *CTBUH journal*, 2007, issue 1, pp14-15. It was suggested that these social spaces, that can be traced back to the Hanging Gardens of Babylon or the recreational terraces of the towers in Al Fustat (modern Cairo) (Barghusen and Moulder 2001; Behrens-Abouseif 1992), could bear similar public domain characteristics that would allow the user a particular freedom of movement or the ability to use the space as a place of recreation, amenity and social interaction. But in order to further establish their relevance in the urban habitat, it was important to consider the characteristics of semi-public social spaces on the ground (for instance, the corporatized square and the galleria) as well as the skycourt and skygarden’s characteristics in the sky, and be able to compare and contrast their characteristics.

4. The skycourt, corporate square and arcade: comparison of characteristics

Academic research that sought to identify what constitutes successful public places (Carmona et al. 2003) was reaffirmed by the UK government’s commitment to forging a national consensus that good quality public spaces should be a political and financial priority. Reports, such as the *Manifesto for Better Public Spaces* (2004), and *By Design* (2000), demonstrated the importance of creating social spaces in order to improve the quality of life – going further to offer prompts for thinking in creating more good quality public realms. We similarly see this in CABE’s *Guide for tall buildings* (2007), and in particular its reference to the importance of including public space as an integral part of tall building developments. Yet it does not go further than offer ‘best practice’ recommendations when designing tall buildings or, more crucially in a time of increasing urban densification, offer better alternative sky-rise social spaces in addition to the Better Public Spaces on the ground as a means of socio-spatial replenishment.

By Design sought to identify what constituted 'best practice' urban design principles. In doing so, it provides a framework for the assessment of public spaces. Its application could be scalable, cross-disciplinary and cross sector – thus potentially being applicable to assessing the semi-public domains of the corporate square, the galleria, and the skycourt for their public domain characteristics. A series of contemporary sky courts of differing scales and building typologies were reviewed from different countries. This provided an opportunity to consider whether a country's social, political, economic or cultural nuances affected the outcome of the sky court in its built form, size or use. Also considered was whether the differing building typologies influenced the function and form of the sky court.

The assessment criteria, comprising both qualitative and quantitative questions based on the literature review were arranged into 7 categories (based on CABI's *7 objectives of Urban Design*) and formed a matrix with which I compared and contrasted the square, arcade and four sky court case studies which included: Burlington arcade (London UK), Broadgate arena (London, UK), Selfridges (Birmingham, UK), Singapore National Library (Singapore), Umeda sky building (Osaka, Japan), and Commerzbank (Frankfurt, Germany). Like the other social space models, skycourts and skygardens were found to be managed spaces that are physically constrained by the very structures that retains them (often the enclosure of the tall building) and are socially constrained by the implicit and / or explicit rules of the institution, company, association or group that governs the tall building (Pomeroy 2007). The following observations were published in 'The skycourt: a comparison of 4 case studies' in *CTBUH journal*, 2009, issue 1, pp28-36, which drew similarities with their grounded counterparts:

1. Character: Skycourts, depending on their position, provide an opportunity for memorable panoramic views that can prove to be a lingering iconic reminder of its position within the cityscape. Skycourts that are not afforded such views need to consider a neutrality of space that can cater for civil society's socio – cultural events, traditions, and past times to evoke a character over time.

2. Continuity and enclosure: A continuity of façade provides an opportunity for space to be used by social groups as an outdoor room for social interaction – lower levels helping support and define public spaces on the ground and address existing urban morphology, such as changes in level or transport interchange connectivity; mid-level tending towards inward looking environments for social interaction; higher levels being outward looking for the appreciation of views.
3. Ease of movement: Their ability to link different forms of circulation allows them to metaphorically become vertical arcades in the sky - a highly integrated, semi-public, transitional space that provides opportunities for greater local and global connectivity to other buildings and transport networks; thus rooting the sky courts into the network of open space within the urban fabric
4. Legibility: Their positioning and form within the tall building should consider sight lines to ensure maximum legibility in order to provide greater spatial cognition amongst occupiers and visitors; promoting an ease of movement through the tall building and beyond as well as visually signposting the space for social interaction and co-presence.
5. Adaptability: The sky court can often be constrained by the tall buildings' footprint and the dominant power (be that corporation or management company) that regulates function and use. This can be a limiting factor in terms of future adaptability and use, and places the skycourt in the realm of a privatized or semi-public space that bears public domain characteristics.
6. Diversity: Tall buildings' that incorporate sky courts tend to still be homogeneous tall buildings that lack the diversity and mix of use that would suggest the potential for it to be a heterogeneous vertical city. But with increasing inner city densification and population increase, the move towards mixed use high-rise live, work and play environments may become more commonplace, activating sky courts as new semi-public environments for social interaction and movement.
7. Quality of public realm: Consideration should be given to the creation of a vertical plot ratio system that apportions open recreation space to built-up area for civil society's use, just as open space is a prerequisite with grounded

urban developments. This could be a legislative part of the planning process, which would see the symbiosis between developer (private) and state (public) in the provision of sky court semi-public space for the appropriation by civil society.

Despite what could be deemed as similarities between the grounded and skyward social spaces, the research ultimately demonstrated that the skycourt's success lay in its ability to be a visible transitional space to move from one point to another (Pomeroy 2009). Unlike the corporate square and arcade on the ground that permits the casual pedestrian to accidentally stumble upon such spaces, skycourts require a certain level of cognition – a prior understanding of their location and function. This prompted a further study focused on movement in order to gauge whether skycourts were dependent on similar levels of visibility and integration as found at street level, and whether they can function as a 'vertical galleria' to enhance an ease of movement through the tall building and beyond.

5. The skycourt as a transitional space

In these earlier papers authored in 2007 and 2009, I drew the analogy of a skycourt being like a vertical galleria. The covered semi-public space would link public circulatory axes outside of its own jurisdiction yet provide pedestrians an ease of movement through the broader urban fabric (Geist 1983). The sky court's ability to link primary, secondary and tertiary modes of vertical circulation and the potential incorporation of retail compounded the analogy further - the skycourt being the (vertical) galleria; the lifts, escalators, staircases, ramps and other (vertical) circulation means being the hierarchical orders of boulevard, streets, paths and so on.

Sennett's assertion that 'public space has become a derivative of movement...the erasure of a live public space contains an even more perverse idea – that of making space contingent upon motion' (Sennett 1976) would also suggest a paradox – that the very mechanisms that often allow movement to take place (i.e the automobile, and its respective highways and arteries) often creates congestion and imbues frustration through impeding movement (Siksna 1998). Increased densification of

inner city centres through population increase and inner city migration further hinders flow – forcing many cities to adopt integrated circulation systems and three-dimensional land use dispositions.

The tall building is increasingly reliant on skycourts as transitional spaces, whereby lift car capacities, waiting times and floor plate efficiencies necessitate the stacking of local lift cores and the consequent incorporation of sky lobbies for onward transition from one part of the tall building to another (Barney 2002). The deployment of underground trains, parking structures, sky bridges and other technical facilities to sustain an increase in pedestrian flow have also become a necessity - without such infrastructure, the city of towers runs the risk of accessibility suffocation. The skycourt should hypothetically improve the integration of the tall building with the movement infrastructure of the city, placing circulation and ease of movement at the heart of the design and the opportunity for a discourse regarding spatial configuration and movement. Just as civil society is provided with both choice of route and mode of transport on the ground, the occupant or visitor to a tall building would be faced with a multiplicity of circulation routes and modes in the sky, stemming from and activating the skycourt as a transitional space.

This assertion needed testing, and space syntax theory was employed. It has proven that spatial configuration correlates powerfully with aggregate pedestrian movement and can explain its variance in different locations, be that in urban or building spaces (Hillier and Hanson 1984; Hillier 1996). It quantifies aspects of social pattern without reference to the individual's motivation, origin / destination, land use or density, scale, height and massing or other prompts that may bear influence. In so doing, it provides a mechanism for a predictive theory of mass movement based on rational choices of the individuals' spatial cognition. Pedestrian movement has similarly been found to correlate with spatial integration (i.e an area's predictability), which in itself is correlated to the degree of *intelligibility* of an area. The greater the spatial integration (i.e greater social co-presence of pedestrians through the interconnectivity of multiple paths), the greater the potential for main integrating axes to be frequented by pedestrians;

and in turn the more intelligible the spaces / axes. Conversely, as spaces / axes become less intelligible; the correlation between spatial integration and movement is compromised, resulting in the axes potentially being sparsely frequented by pedestrians. Using this theory, Chang and Penn (1997) found that:

1. The general trend is for pedestrians to choose the shortest and axially simplest routes.
2. Pedestrians have a direction in mind and set their directions as soon as possible when embarking on a route.
3. Pedestrian decision behaviour in route choice is affected by familiarity with an area - with footfall increasing by those familiar with the area. The remainder has to rely on their field of vision, sign posting and a cognitive understanding of the space. Therefore, an area of low intelligibility will have lower footfall and pedestrian movement as the spatial configuration / one's field of vision / sign posting may be more compromised.
4. Axial depth from integrating routes (i.e the area with most footfall) and major attractors and generators (i.e the theatre, the metro respectively) is key.
5. Grade transition / vertical level change has little effect provided they are on globally integrated axis

Multi-layer buildings were found to have a poor correlation between spatial integration and movement – their intelligibility breaking down over a series of multiple floor levels. Way-finding problems and failure to establish orientation were also evident in multi-level spaces, as their vertical circulation methods were often removed from the main integrating axis (the most pedestrian trafficked route), poorly-sign posted, and the space visually illegible. It did, however, demonstrate that even highly unintelligible places were able to have predictable movement patterns.

Skycourts and their tall buildings were found to face similar problems to the multi-layer building. The position of the vertical access, be that lift, ramp, stairs or elevator are usually deep plan - several steps removed from the main integrating (and therefore highly trafficked) axis. This leads to lower levels of visual

accessibility and intelligibility of the space. Skycourt's may not always provide the opportunity to pause, observe and orientate. In terms of floor plate configuration, the repetitive tall building typology also negates the visual diversity that often helps people orientate themselves within the streetscape. The repetitive nature of tall building floor plates should aid the cognitive understanding of the spaces, as one mentally maps the other floors within the building, based on assumptions of the floor experienced at first hand. However, different subdivisions within an otherwise repetitive floor plate that, from the outside, appear to have a homogenous skin can similarly confuse and disorientate.

My research findings were summarized in 'Skycourts as transitional space: using space syntax as a predictive theory' in *proceedings to 8th CTBUH World congress, Dubai 2008*, which concluded that if intelligible urban spaces are those which correlate spatial configuration with movement and forward visibility, sky courts should be similarly shaped to facilitate an ease of movement in order to release its potential as a transitional urban space in the sky and increase its intelligibility. This would be achieved by positioning them in highly intelligible and integrated locations; and using the skycourt as a conduit to vertical, horizontal and diagonal modes of circulation that integrate surrounding tall buildings, their skycourts, roof lines, and the ground plane of the city - just as the arcade is capable of linking primary axes on the ground.

6. Transformation of public spaces in Asia

Relocating to Singapore in 2008 quickly illustrated how many of the social space constructs in the western urban vocabulary were physically transplanted to former British colonial cities and largely executed by the Public Works Department during their colonial administration. However, cultural, climatic and social differences required their adaptation to suit the local terrain. It also revealed other spatial models not found in the West – *necessitating* a re-consideration of public and semi-public spaces in the Asian context with the purpose of seeing whether local influences made the skycourt and skygarden a more accepted element of the urban vocabulary in Asia.

The study of the public realm in Singapore demonstrated a diversity that went beyond the *padang* - the central lawn typically found in colonial cities where recreational activities and events of the colonial administrators would take place. The *5-footway* offered a public pedestrian thoroughfare that was viewed by the community as a place for mercantile and social activities – a view not shared by the municipality who sought to keep the thoroughfare clear of debris and fit for passage in the interests of preserving order and Colonial dominance through surveillance of the subservient Asian (Ooi 2004). The result was a space that was *kaleidoscopically multi-functional and sufficiently malleable in serving communal, interactive and economic purposes* [that were] *redefined as socially neutral space, subservient to the public right of way and open to view and regulation* (Yeoh 2003).

The post-colonial, new self – governing State would invoke its own form of dominance not dissimilar to the previous colonial administration in the interests of suppressing any chance of subterfuge. Potential rallying points were removed; even the national university campus was placed on a hill to reduce the chances of congregation on flat surfaces. A programme of urban redevelopment saw the slow eradication of the shophouses, their 5 footways and public spaces such as the *padang*. In their place came the tower and podium model along with public void deck spaces within repetitive, social housing blocks that resembled the spaces of Le Corbusier's *Unite's* (Ooi 2004). The explicit rules of governance that were applied to the void decks (such as the banning of running, smoking, ball games, speaking loudly, to name a few), created either a sterility of space devoid of people, or in extreme cases the contesting of the space between resident and the new municipality - often resulting in vandalism or neglect. The overtly programmed spaces that corresponded to particular socio-cultural functions tended to be the least occupied, with the least programmed spaces being the most occupied given their ability to allow for the unplanned and spontaneous (Yeoh 2003).

Economic progress and a heightened retail economy would further compromise the vitality of the traditional street and the 5-footway. Both tourists and residents migrated to the sanitised, comfort and social controlled environments of the internalised street and shopping mall (Chang 2002). Further privatization came in

the form of the Mass Rapid Transport, which, as a generator of activity and movement, became a catalyst for the reclamation of public space. Its ability to provide subterranean environment for movement as well as a continuum of public space played an important role in the reclamation process at street level (Heng 2006). There has also been a continued consideration for public open spaces as *public goods* – the argument being that the developers costs in providing such spaces can be seen as a form of betterment levy (Field 1992)– the price paid to the community in exchange for the increase in land value arising from its efforts when granted planning permission. Field suggests that planning authorities should be encouraging private developers to provide semi-public spaces for recreation, amenity and social interaction in environments that are not exposed to climate – such as the hotel lobby. Singapore’s public space evolution demonstrated three areas worthy of note:

1. Space has been contested between the dominant (Colonial or State) and subservient (local community) powers in colonial and post colonial Singapore respectively
2. There has been a pattern of reclamation and re-colonisation of space. Alternative social spaces have also sought to create a greater sense of social integration in modern day Singapore
3. The privatisation of public space has increased and the collaboration between corporation and state continues to be the preferred model for social space generation.

The homogenous approach to design that sought to keep things apart (a spatial ‘divide and rule’) in colonial and post - colonial Singapore has given way to an increasingly heterogeneous approach to design in the States’ drive to pull things together – not least a broader social and racial demographic. Paradoxically however, the city is being served and interlinked by a continuum of privatised public space, such as the Mass Rapid Transport and retail environments, that are being controlled by dominant corporations with explicit rules of exclusion and usage, socially sanitising space for more themed civil appropriation. Post-colonial socio - economic fragility and the fear of insurgents from neighbouring countries

could explain the Singapore Government's explicit control of such spaces through corporatization to avoid social uprisings (Tremewen 1994). Yet the new 'public spaces of modernity' that the academic Sharon Zukin refers to in the West similarly shows how a predominant private – sector economic power (for instance an accountancy firm's sponsorship of a cultural event) can assert its own culture over others, and in so doing, reshape the built environment for the purposes of social, as well as public space, control (Zukin 1996) – a notion readily embraced in Singapore's recent public space policies.

My paper 'Defining Singapore public space: from sanitization to corporatisation' in *Journal of Urban Design*, vol. 15, 2011, pp381-396, concluded that as the State continues to cede power to the corporation in the interests of relinquishing the burden of providing public goods, the public / private model of creating public space could be the answer. It seemed imperative that the State started to reclaim an element of power in order to allow more spontaneous environments that were not shackled by the corporations' pursuit of profit. This would appear to be an inversion of the natural order and contrary to popular belief. But it was at this very juncture of the contest between State and Corporation that the new public realm of Singapore could be created and best used by civil society.

This also suggested that the skycourt and skygarden could be a similar product of state and corporate interest to create the semi-public domain in order to offer social space replenishment to a rapidly developing city-state. Could it be that the imperatives of sustenance and security preceded the need for recreation and amenity, and after 50 years of rapid urbanization and economic nation building, there was only now the need to consider the balance of open space for social benefit at height? This provided the context as to the skycourt's function as social spaces in the Asian context; their social programming and their potential social limitations.

7. The skycourt as a social space in the Asian context

Many an Asian city, such as Hong Kong and Singapore, sought to replicate Le Corbusier's modern city model in its rapid post-colonial urban development

programme that attempted to satisfy a developing economy's urbanisation aspirations. Less than 25% of Hong Kong's total area of only 1,104 square kilometres is developed land; a further 40% are forests, natural reserves, or marshland. Such physical constraints impose high urban densities of 29,400 persons per square kilometre, making it one of the densest cities in the World that pre-disposes itself to multi-layering of functions and its people within the city (Ng 2010; Frampton et al. 2012). In Singapore, 84 % of the population lives in high-density public housing developments and 11 % in high density and often high-rise condominium developments. Only 5% live in landed housing, creating effectively a city of tall buildings that has become an accepted habitable norm and an island state that is under constant spatial pressure (Singapore Statistics 2014).

Social groupings and complete neighbourhoods, accustomed to low-rise urban environments that permitted casual interaction, were being dismantled and re-located into high-rise urban environments, in a fashion similar to European slum clearance in the 19th century; post-war re-building in the 20th, and the century and the eventual move towards urbanization (Hall 2002). The very same groups who once gathered to do their laundry or share in common recreational activities in the 5 footways of shophouses or *kampong* village greens were finding that the very spatial mechanisms that permitted communal activity and spontaneous chance meetings with neighbours were being socially and spatially engineered (Ooi 2004; Yeoh 2003). In the worst case, many high-rise, high-density developers and authorities failed to understand the importance of such spaces being used to improve amenity, well-being, good health, productivity and social interaction, and were often omitted for economic reasons – leading to social disjuncture (Hall 2002).

In the best case, fostering community through social spaces in high-density urban habitats has become a common interest shared by both the state and corporation for the inhabitant's health and wellbeing, as well as a means of enhancing real estate value. The Urban Redevelopment Authority (the government agency responsible for the urban planning of Singapore), established urban policies that prompted the incorporation of skycourts and skygardens as permissible common

area that would be exempt from the overall development area calculation. The policy effectively sees the concept of a 45-degree line taken from the underside of any permanent or opaque structure as the means of defining the area exempt from the area calculation, and the requisite development charges. The 45-degree line permits the penetration of light and, with a greater floor to ceiling height of the aperture (i.e a taller skycourt), the greater permissible area exempt from development charges. This benefits the developer by the reduction of development charges whilst benefitting users in the incorporation of well-lit, recreational open space (URA 2008).

Residential tall building developments in Singapore have embraced the skycourt and skygarden as part of the urban vocabulary for these socio-economic reasons. Newton suites, designed by WOHA and completed in 2013, is a private condominium development in Singapore, and aptly demonstrates this phenomenon. The architect's notion of the village green as a social space is applied vertically through a series of skycourts that seek to offer amenity space for its residents. This takes place every 5 floors in the hope that their position can help forge a sense of community amongst vertical neighbourhoods, grouped in proximity to their skycourt, in a fashion not dissimilar to the village green and the cluster of kampong houses that would surround it. By taking ownership of the particular skycourt, a vertical neighbourhood may mark its territory by its social usage as a place for the localized community to meet and play, and thus imbue an implicit rule of exclusion to others 'trespassing' into their communal space.

The Pinnacle, a public housing project in Singapore, designed by ARC Studio and completed in 2010, incorporates an interstitial skydeck as a source of convenience, recreation and amenity that negates the need to travel ground-wards to relax or to exercise. Its 12 sky gardens interconnect its seven, 50 storey high-density social housing blocks comprising of 1848 family units. The sky gardens reinterpret the ground level void decks of the past social housing blocks as a series of elevated social spaces. The 26th storey intermediary gardens are privatised spaces for the sole use of all its residents, and engenders a sharing of the large 'public facility'. Yet its 50th storey sky garden levys an entrance fee to gain access to it as an

observation deck, thus establishing an explicit rule of inclusion – those who wish to pay will join those in sharing the experience of a memorable view; those who won't will be excluded.

Like its public space counterpart, these skyrise spaces can permit communal groups to form and disband, and in so doing create territorial contests amongst social groups over the space that meet regularly and project particular uses or functions. For instance, students may gather within such spaces outside of school hours to share notes before disbanding; office workers may meet with fellow workers from different departments for coffee or lunch breaks, before returning to their respective departments within a working day; residents may populate these spaces during the weekend and / or in evenings to meet with neighbours and friends before retiring to their home, and tourist groups may gather to observe a panoramic view but will similarly disband upon closing time. Its continual use by a dominant individual; group or association can imprint an element of informal territoriality on a place that may implicitly restrict the use of the space by others.

This inevitably leads to limitations on the patterns of speech and action of the individual, group and association appropriating the space given the dominant (private) parties control of the space. The social spaces are often highly classified environments that have explicit rules of exclusion that may be time-based (i.e the operating hours of the corporation and the levying of an entrance fee, as is the case with the Pinnacle) or implicit rules of exclusion that are social activity based (i.e to be part of a studying community; an office community; a tourist community, or a residential community, as is the case with Newton Suites). When considered in the context of the 5 footway and void deck, the skycourt has more in common with the latter than the former - which imbued are far greater level of spontaneity given its weaker framing of the space.

It was concluded in 'High density living in the Asian context' in *Journal of Urban Regeneration and Renewal*, vol. 4, January, 2011, pp 337-349 that unlike its open space counterparts on the ground, which tend to be governed by public interests and permit a spontaneity and freedom movement, speech and action, the skycourt

and skygarden are often semi – public and governed by private interests. This in turn imparts particular social restrictions that are more formal. Unlike the Western world's social space, the rapid urbanization of totalitarian Singapore negated the chance of such an organic growth of alternative social spaces. Singapore's economic transformation from free trade, to finance, to manufacturing, and more recently to creative industries in a space of 50 years has prioritized such growth before society's free-time. This has arguably resulted in a lag in social space for congregation and amenity, not least due to the threat of post independence subterfuge from its neighbours and from within.

It may therefore come as little surprise that skycourts and skygardens appear to be manufactured recreational spaces that have rapidly appeared as a similar consequence to rapid spatial shortage, and have been embraced by a generation who know not what a village green or padang are; or how they were once used. Like the padang and the village green though, the presence of greenery in these vertical social spaces is a constant that was observed. In addition to wanting to appreciate their environmental benefits, I wanted to also see if the presence of greenery enhanced their social use, and fostered a greater sense of community.

8. The role of greenery in the skycourt and skygarden

Singapore's cultural imperative of creating a garden city has seen the deployment of far reaching legislative guidelines that promotes the replenishment of greenery as well as the incorporation of skycourts and landscaped terraces in a bid to restore spatial balance in an increasingly high-density environment (Tan 2010). Much has been researched regarding the negative impacts of replacing open space and its landscape with building structures (thus exacerbating Urban Heat Island Effect) which includes increased health risks through higher ambient temperatures, aggravated atmospheric pollution, increased emissions of ozone precursors and increased energy consumption for cooling in the magnitude of 5% for every 1 degree of ambient temperature rise (Wong 2003).

Singapore is characterized by an urban morphology of object-driven tall and medium rise commercial, industrial and residential developments, with a

predominance of residential blocks at the peripheries set within verdant landscape. A nature reserve lies on the north, of the island, industrial warehouses and business parks to the west and a centrally located business district defined by tall buildings to the south. Studies have shown that the industrial / business parks to the west and the central business district have the highest urban heat island intensities on the island, followed by the residential areas and the park area in descending temperatures (Jusuf et al. 2007). This suggests that the inclusion of greenery helps reduce the ambient temperatures and UHI, but also offer other environmental benefits.

A literature review revealed that planted surfaces can help cool the environment by between 3.6-11.3 degrees centigrade, with wall surfaces being reduced by as much as 12 degrees centigrade (Alexandri and Jones 2008; Wong et al. 2009a). Trees can act as a shading device, with light tree canopies intercepting between 60% and 80% of sunlight and dense canopies intercepting as much as 98% (Johnston and Newton 2004). Vertical planting, the trapped layer of air between the plants, and the substrate can help absorb, reflect and deflect sound waves, and reduce low frequency noise by as much as 9.9dB (Wong et al. 2009b). Urban settings with trees may reduce dust particles to 1000-3000 dust particles per litre whilst an environment with no trees may contain 10,000-12,000 dust particles per litre (Johnston and Newton 2004). Studies in Berlin showed that green roofs absorb 75% of precipitation that falls upon them, reducing immediate rainwater discharge by 25% of normal levels whilst helping remove impurities. The filtration properties of plants can remove over 95% of cadmium, copper and lead from rainwater and 16% from zinc. Nitrogen levels can also be reduced (Johnston and Newton 2004).

It could therefore be assumed that the presence of greenery in skycourts and skygardens would have similar environmental benefits, albeit localised to a building scale as opposed to the city scale – i.e the benefits of daylight penetration, rainwater collection, air-flow and its filtration taking place within or at the periphery of the building - thus further enhancing environmentally the city infrastructure of the street and square. In 'Greening the Urban Habitat: Singapore'

in *CTBUH Journal*, Issue 1, 2012, pp30-35, I sought to demonstrate the environmental benefits of vertical greenery as an environmental buffer when integrated with skycourts in a commercial office project. Employing a 'green skin' of expanded mesh and vertical planting negated the need to source expensive low-e double glazed window systems, given the shading and cooling properties of greenery. Early results demonstrated the green skin's ability to reduce direct radiation by 68 per cent and counteract glare by up to 60 percent, whilst enhancing biodiversity, reducing ambient temperatures and integrating the landscape design of the skycourts with the architecture (Pomeroy 2012).

Understanding the environmental benefits to buildings further prompted the consideration of whether these vertical social spaces and their greenery bear positive socio-physiological qualities. Studies of videotaped natural scenes were shown to speed physical and emotional recovery on people from traumatic events through nature's restorative power by triggering quick, positive emotions to help reduce physiological stress (Ulrich et al. 1990). Prisoners with windows facing surrounding hills were found to visit the infirmary with stress – related illnesses less frequently than those facing interior spaces (Moore 1982), which further supports the hypotheses of the healing properties of nature.

The motivational qualities of viewing greenery were also shown to positively affect task performance and mood (Shibata and Suzuki 2002). Nature also has the ability to revive a person's concentration (Kaplan 1995). Direct attention disorder, an inhibitory quality that can cause irritability, unwillingness to participate in group activity and inappropriate behaviour, can be treated by focusing on natural environments that are rich in such qualities and can provide stimulation, but place no demands on a person's ability to maintain concentration, in order to help ameliorate such reactions. This suggested that viewing and / or being surrounded by greenery not only offered socio-physiological benefits but also the potential to draw people out into open vertical spaces to use such areas for communal activity given their cooling environmental properties.

This was affirmed by the research of Dr. Joo Hwa Bay (2004) in his exploration of

the socio-environmental intricacies of vertical terraced spaces in Bedok court - a Singaporean residential development that dedicates 30-40% of its built-up area to skycourts. He found that 86% of the inhabitants used the skycourts for social purposes. A similar high percentage of residents came into visual or physical contact with their neighbours through such spaces. The stepping of the skycourts also allowed 66% of the residents to interact with other neighbours on different levels, attributed to the increased visual field through the staggered arrangement that allowed visual permeability.

Bay's social survey was supplemented by a climatic survey, whereby residents' votes for thermal comfort were plotted against radiant temperature for morning, afternoon, evening. With the average radiant temperature of the sky courts being 28.5 degrees centigrade, a humidity level of 61% and a wind speed of 0.75m/s, 70%-80% of the community felt slightly warm, comfortable or slightly cool for the three periods. The skycourt proved cooler than the external environment and only slightly warmer than the internal. Similar quantitative tests were undertaken for daylight factor and acoustics, which were then compared to the qualitative responses of residents. Bay asserted that the good thermal, acoustic and daylight properties of the skycourts created conducive environments for social interaction even during the hottest month (June) of the year. He concluded that a synergy of socio-climatic properties allowed the skycourts to serve the dual role of promoting community life and physiological well-being whilst acting as an environmental filter through their incorporation as vertical veranda spaces (Bay 2004).

Bay's findings of heightened activity and co-presence amongst green skyrise terraces were affirmed in a separate study undertaken by the author when observing people's behaviour in commercial office space skycourts. These were categorised as areas heavily planted and less planted with the intent to see whether their usage patterns were effected given 1) their location and 2) the presence of greenery during the course of the day. As expected, the usage of the skycourt was highly dependent on their visibility and if positioned on a popular thoroughfare, would be heavily trafficked during the course peak hours (office arrival, lunch and evening departure).

But the study also revealed that pedestrian patterns of movement were not just dictated by the shortest route, as would be the suggested case when applying the space syntax theory seen earlier. Pedestrians were more inclined to walk under the shade of trees, and often perambulate to escape the tropical heat of the sun during the afternoon, rather than take the shortest route. Furthermore, trees and foliage heightened the likelihood of extended periods of relaxation time. This prompted consideration as to whether the quantum of greenery similarly had an impact on usability, and if so, how would one go about quantifying urban greenery.

9. Quantification of greenery

The pursuit of more quantifiable measures of planting led me to consider metrics that could assign values to different types of greenery in order to ensure that the adverse environmental effects of high-density development can be mitigated through more balanced architectural and integrated landscape design. We have seen how planted surfaces are an effective way of counteracting the absorption of heat in the building fabric and its subsequent re-radiation as well as enhancing the qualities of open space and consequently their enhanced usage. The Green Plot Ratio addresses this issue along with quantification, by assigning values to particular plants based on the surface area of greenery. This is achieved by adapting the *Leaf Area Index* - a biological parameter used to monitor the ecological health of natural ecosystems and to mathematically model and predict metabolic processes. As such, it can be used to quantify planning metrics in biological terms (Ong 2003).

A hypothetical site that has 12 trees (and therefore a particular green plot ratio value) may be developed and see the consequent removal of the said number. By assigning values to different types of planting, the ability to replenish the same 'green value' of the 12 trees by alternative means (for instance turf and shrubs across the vertical or diagonal surfaces) will ensure a balance of built-up area and green leaf area is retained (or enhanced) on the site for its correlating social, economic and environmental benefits. These include enhanced carbon sequestration, water retention, and reduction in ambient temperatures; lower

running costs and more pleasurable environments in which to interact. Turf, palm, shrubs and trees are the major groups that each has assigned green plot ratio values based on the leaf area index.

Turf has the lowest green plot ratio at 2.0, as the leaf area index of a blade of grass is less than that of the other categories. Despite palm trees being larger structures, their leaf area index is still less than a shrub and has a value of 2.5. Shrubs, given their greater density of leaf coverage, have a value of 3.5; whilst the tree has the highest leaf area index at 4.0. The ability to quantifiably ascertain the effectiveness of planting on the building through the creation of a green metric goes some way to integrating architecture with landscape as opposed to being considered in isolation. Furthermore, it allows one to strategically 'package' greenery knowing that the greater the density of greenery, the greater the heat absorption. Therefore, the green plot ratio can be used as an effective tool to plan the extent of urban greenery across horizontal, diagonal and vertical surfaces.

A research project (titled 'Consultancy On The Application Of Green Plot Ratio To Selected Building Typologies in Singapore' (commissioned in 2012 by the National University of Singapore for the Government's built environment agencies) involved the assessment of 100 buildings in Singapore. It allowed mean green plot ratio values to be calculated for existing commercial, industrial and residential sectors - thus giving a quantitative indication of existing greenery patterns according to building typology within each sector. It also provided the opportunity to establish landscape guidelines to further enhance the Singapore urban habitat by applying landscaping technologies to new buildings with tangible incremental costs associated with the additional greenery. The landscaping technologies within the horizontal, diagonal or vertical plane were categorized into extensive green roof, intensive green roof, brown roof, green wall systems, planter boxes and grid structures and formed an effective modular 'kit of parts' that could be applied to:

- the ground plane (trees, palms, shrubs, and turf in their raw state; horizontal trellis structures)
- the podium level (trees, palms, shrubs, and turf in their raw state; horizontal trellis structures, intensive or extensive green roof)
- the building (trees, palms, shrubs, and turf in their raw state; horizontal and vertical trellis structures, planter boxes, green wall)
- the roof (trees, palms, shrubs, and turf in their raw state; horizontal trellis structures, intensive or extensive green roof, brown roof)

A 1 square metre module was used as the common metric in order to reduce bespoke design on the various sites, and allowed the cross comparison of planting density and cost. The individual modules within the kit of parts were then each assigned a GnPR figure and cost per square metre that included any remedial structural alterations in order to create the 1sqm landscape module. The research has culminated in mean GnPR values for existing commercial, industrial and residential building typologies and proposed enhanced GnPR values for the sectors with respective costs associated.

The ability to select a landscape 'kit of parts' that best responded to the constraints and opportunities established in the building and sustainability audit for the individual buildings allowed us to create hypothetical design scenarios to obtain optimum, maximum, and ultimate GnPR values that responded to general building constraints. It was observed that building form and user function within a particular land use category had particular characteristics that informed the appropriateness of particular planting strategies and could be incrementally added to obtain different levels of GnPR in correlation to cost.

For example, high-density commercial environments in the central business district had the potential for increased urban heat island effect given the reduction of greenery through urbanization and the consequent higher heat absorbent surfaces. Given compactness of urban form, there would also be the potential for compromised social spaces, though a greater potential for footfall at grade through spatial integration into the urban environment. The incorporation of a greater

quantum of shrubs in ground or roof cover could therefore address the environmental condition of reducing urban heat island effect more significantly than turf, trees and palms, given its higher Leaf Area Index as well as providing qualitative enhancement to the urban habitat.

Palms and trees at grade could then be used sparingly (given higher costs than turf and shrubs) to support the social condition of providing shade for pedestrians in transition from one building to another. The installation of vertical planting via trellises or green wall systems to podium car park structures and / or the east and west elevations of commercial buildings could then help reduce solar heat gain (and thus reduce space cooling loads) whilst offering the cultural dimension of the legible greening of the streetscape. Finally, the incorporation of skycourts, planted with trees and palms at the perimeter, would provide not only natural light, ventilation and social space, but also a heightened GnPR value for the development.

The 2-year research project was partially adopted as part of Singapore's Greenmark environmental assessment method. It was however not without flaws. The Green Plot Ratio provides a numerical value for the quantum of greenery that should be adopted on a particular site in correlation to cost. It did not however go further to draw a correlation between ambient temperature reduction, water absorption, noise reduction or carbon sequestration – tangible measures that would further substantiate the need for its adoption as part of building development legislation.

It is at this socio-environmental juncture that the design of skycourts and skygardens can be enhanced via more objective means, and hopefully provide a more substantiated and persuasive argument for developers to include more urban greenery within their property developments. Hillier and Hanson's space syntax method as we saw earlier provides a mechanism for a predictive theory of movement based on rational choices of the individuals' spatial cognition. When this is coupled with more objective measures of urban greenery and both are then set within a framework of an environmental model that is responsive to the

climatic conditions of a place, perhaps more conducive spaces can be created that will help foster more successful vertical communities, and a greener urban habitat.

10. Evolutionary observations of the skycourt and skygarden: past, present and future

I have argued how the semi - public realm has not always provided the full benefit of freedoms associated with the public domain. The dominant powers vested in the private interests of property developers has often defined how and when such social spaces are to be used in order to maintain social control and, from a real estate perspective, preserve asset value. Today, technology further reduces the need for co-presence in space, as society can glean the very same commodities of transference virtually via the internet. This effectively renders public, and even semi-public space increasingly obsolete in their roles of being able to bring people together in exchange. Our sense of being social in public therefore becomes deliberate and planned, as opposed to being the result of daily casual social interaction that is spontaneous and unplanned. We pass through an increasing number of privatized transitional social spaces that permit movement in order to visit the retail mall, the cinema, the café, or the museum that are the privatized destinations that society plans to meet in.

Wishing to firstly collate previously published papers and then further explore the phenomenon of skycourts and skygardens as 'alternative social spaces' set within the context of current global building projects, I embarked on authoring *The Skycourt and Skygarden: Greening the Urban Habitat* (Pomeroy 2014). The book was divided into 4 sections. Part 1, entitled *Civility, Community and the Decline of the Public Realm* explored the traditional context of the city as the forum for our interaction. It set out to define being out 'in public'; the meaning of the words 'civility' and 'community', and what constitutes 'public realm' before considering the elements that contributed to its decay. Part 2, entitled *Defining the Skycourt and Skygarden* sought to consider their functional role and requisite benefits in terms of social, cultural, economic, environmental, technological, and spatial parameters within the urban habitat. Part 3, entitled *Global Case Studies* sought to

document projects that incorporate skycourts and skygardens as integral elements to a building's design. Part 4, entitled *Towards A Vertical Urban Theory* put forward 'prompts for thinking' to optimise the design of skycourts and skygardens in order to integrate such spaces into the fabric of the 21st century hybrid city.

It was observed that the skycourt and skygarden has become another social space within the architectural vocabulary of the urban habitat, and currently remains predominantly managed by the corporation or landowner that controls them. They are differentiated by the fact that they can never be truly public unless they become ceded to state ownership and permit the individual, group or association the freedoms of speech, action and movement that one normally finds in the public domain of the street and the square. The 40 skycourt and skygarden case studies constructed, under construction and on the drawing board that were reviewed as part of my book, similarly demonstrated this. These semi-public realms are, as the academic / architect John Worthington describes new social spaces, 'seismic creations' – created in an instant; highly classified to their correlating building function, socially controlled by the dominant private power, and spatially constrained by the structure retaining them.

To this end, they have not necessarily promoted a social spontaneity, and their immediate creation is arguably the antithesis to the public realm that incrementally evolves with time and is the result of a continuous contestation of its space by its users, which, in itself, creates interest through the unplanned and unpredictable. Despite the reasons why they are currently not public spaces, we have started to see their evolution, given changing social, spatial, environmental, cultural, economic and technological needs that permit the nurturing of public domain characteristics. This may bode well for society's co-presence and may enhance urban life quality as well as the natural and built environment.

The book observed that earlier completed examples were little more than private terraces, very occasionally planted, and often accessed from the occupied internal areas of the building that retained them. They were often imprinted with the function and control of the dominant power that occupied the habitable space

within. Their privatized nature often reduced chances for spontaneity; and the occupants within generally imprinted an implicit control on the skycourt's social use through their observation of such spaces by others. Their control therefore permitted only the occasional use by the worker or resident, which was often dependent on the familiarity of others within its proximity. Their use was predominantly one of the occasional lunchtime visit, or coffee break, and did not necessarily sustain regular patterns of use or heightened social interaction amongst groups.

However, examples completed more recently showed the promise of more 'public' orientated environments, and their greater usage as an environment for transition as well as social interaction. Unlike their mono-functional predecessors that were less integrated with circulatory patterns, newer skycourts and skygardens formed both internal and external spaces that became more integrated into the cores of tall buildings – spatially linking vertical methods of circulation and facilitating transition; and socially linking occupants through the heightened probability of chance meetings and opportunities for spontaneity. As tall buildings continued to soar higher and embrace an increasingly mixed-use programme, the skycourt adapted to cater for a greater multiplicity of function. The skycourt, as an interstitial space within the mixed-use tall building, started to become a 'spatial gel' that glued together the disparate series of land use components within the tall building as well as beyond via the skybridge. This fostered greater usage and a sense of community amongst people from different backgrounds, groups and associations from different parts of the development and city. With society's heightened environmental awareness, the incorporation of greenery within skycourts and skygardens also became more prevalent in the acknowledgement of its environmental, ecological, and socio-physiological benefits.

In line with such social, spatial and environmental development, the examples in the book that were under construction have been the product of an era when alternative social spaces have started to be placed into a hierarchy of urban spaces in terms of scale, use, and classification that support existing public spaces, and arguably start to blur boundaries between what is public, semi-public and private.

What were once slender viewing balconies have become skycourts and terraces for individuals, families and groups to enjoy as individual private spaces with a greater multiplicity of function. Larger, more neutral skycourts positioned in prominent and easily accessible parts of the buildings have started to serve as broader circulatory interchanges that allow the casual interaction on an almost vertical neighbourhood level. When coupled with skybridges, they have become nodes of activity that further heighten social interaction by the presence of both income generating and recreational opportunities. In some countries such as Singapore, the progressive development of skycourts and skygardens has been enabled through economically incentivised legislation in the interests of promoting the cultural identity of a 'greener' city. Such legislative power, with the promise of enhanced permissible developable area and therefore enhanced return on investment, has allowed such skyrise social spaces become an increasingly popular addition to the urban architectural vocabulary of the urban habitat.

Banham's comment that 'no architect who considers himself worthy of his craft can bear to stand by and see his design destroyed, especially grand designs in the scale of the city' (Banham 1976), is having to be re-evaluated given a rapid urbanization to cater for 70 per cent of the global population living in cities by 2050. The re-birth of the megastructure, an all encompassing framework that can house the functional parts of the city, not only explores porosity by the erosion of the building fabric to create social space, but also the counterbalancing of objects to create the very same. Arguably, this can be viewed as the space left over following form creation and may be conceived spatially as a 'vertical modernism'. This is where counter-poised, object-driven blocks are left freely to float in undifferentiated sky space, and places the skycourt and skygarden as secondary to the blocks, and thus challenges the idea of containing social space as seen in previous examples.

The works on the drawing board embraced and developed both the concept of the point block tower and the interlinked series of tall buildings as megastructures. This could be in part attributed to population increase, the migration to city centres and the consequent urbanization, which necessitates an increase in

density, scale, and multiplicity of uses within developments. This consequently requires a greater ratio of sky rise social spaces to built-up area. These environments – loftier to permit light and ventilation to percolate deeper inside the floor plates, greener and appropriately orientated to maximize climatic responsiveness, more integrated with circulatory patterns within the tall building and the city to permit an ease of movement, and activated by communal as well as economic uses to encourage greater social interaction within the development, may well prove to bear more public domain characteristics than its predecessors.

My Studio's project work has benefited from the research and I would like to think that it has been able to differentiate itself from the other projects considered in the book given the overriding aim to ensure that a balance between social space, building object, and urban greenery is achieved through an evidence based approach to the design that continually asks questions relating to social, economic, environmental, spatial, cultural and technological parameters (Pomeroy Studio 2015). This is most recently demonstrated in an appointment to masterplan the last remaining parcel of land within the award winning *KL Sentral* business district, Malaysia. 'Sentrex', an acronym for Sentral Exchange, will be 5.7acre high-density mixed-use development that features the tallest building within KL Sentral, and will be the final piece of the 77-acre jigsaw puzzle that was originally masterplanned by the famed Japanese architect Kisho Kurakawa. My research into the functional benefits of skycourts and skygardens within high-density urban habitats attracted Malaysian Resourced Corporation Berhad who were seeking to develop its last plot of vacant land in Central Kuala Lumpur along solid green design principles.

The development seeks to keep true to its namesake as a hub of business and social exchange. It comprises a landmark mixed-use tower, a small office / home office (SoHo) tower, an entertainment and leisure hotel tower, a science centre, a bus terminal and a high-end retail destination. One of the key design drivers was to inject an elevated public plaza that would act as a hub of social interaction, celebration and information exchange within KL Sentral. The plaza functions as an interactive science park and a venue for a range of year around activities.

Skycourts and private sky terraces then take place as a series of semi – enclosed recesses and protruding landscaped platforms respectively - helping reduce perceived densities through open spaces and its requisite urban greenery.

The integration of a bus terminal, retail arcade, public podium plaza and skycourts provides a seamless connectivity that is further enhanced by the developments pedestrian permeability – acting as circulatory interchanges for both occupants and visitors of the development. The occupant or visitor is faced with a multiplicity of circulation modes in the sky (lifts, skybridges, escalators, staircases, ramps and other circulation means), making the podium plaza and skycourts transitional places of chance meeting and exchange. Incorporation of greenery to the podium plaza, skycourts, skygardens and sky terraces also help mitigate external climatic factors by acting as a ‘sponge’ to noxious pollutants in the atmosphere. Proposed vertical and diagonal greenery also provide linkage between horizontal planted surfaces and a transitional path for the coexistence of insects, birds, plants, animal species.

The future city is almost Utopian in nature, and arguably once again follows Banham’s observations of how the perceived future often has elements of reality that can be found within the existing habitat (Banham 1976). The case studies were found to demonstrate how the theoretical solutions of students are heavily influenced by the issues that beset the city of tomorrow and are underpinned by more radical technologies and ideas that seek to address: densification, space replenishment, social re-engagement, climate change, fossil fuel depletion, food and water distribution. The future city may well be utopian and challenging in nature to safeguard against complacency and to continue the line of development of how visions can become a reality.

11. Published works

Pomeroy, J, (2012), 'Consultancy On The Application Of Green Plot Ratio To Selected Building Typologies in Singapore', unpublished.

Pomeroy, J, (2011), 'Defining Singapore public space – from sanitization to corporitisation', *Journal of Urban Design*, vol 16, no. 3, pp381-396.

Pomeroy, J, (2014), 'Gramercy Residences' in *Green walls in high-rise buildings*, (Eds.) Wood, A, Safarik, D, Images Publishing Group, Chicago, pp156-163.

Pomeroy, J, (2012), 'Greening the urban habitat: Singapore' in *CTBUH Journal*, no. 1, pp30-35.

Pomeroy, J, (2011), 'High-density living in the Asian context', *Journal of Urban Regeneration and Renewal*, vol. 4, no.3, pp413-424.

Pomeroy, J, (2012), 'Internal environment and planning' in *The Tall Building Reference book*, (Eds.) Parker, D, Wood, A, Routledge, UK, pp123-132.

Pomeroy, J, (2008), 'Skycourts as transitional space: using space syntax as a predictive theory' in *Congress Proceedings, Tall and Green: Typology for a Sustainable Urban Future*, Council on Tall Buildings and Urban Habitat, 8th World Congress 3rd-5th March, Dubai, pp580-587.

Pomeroy, J, (2014), *The skycourt and sky garden: greening the urban habitat*, Routledge, UK.

Pomeroy, J (2009), 'The skycourt: a comparison of 4 case studies' in *CTBUH Journal*, no. 1, pp28-36.

Pomeroy, J, (2007), 'The skycourt: a viable alternative civic space for the 21st century?' in *CTBUH Journal*, no. 3, pp14-19.

Pomeroy Studio, (2015) *Distil Design Disseminate: design and research projects of Pomeroy Studio*, Dechen House, Singapore.

12. Bibliography

- Alexandri, E, and Jones, P, (2008), 'Temperature decreases in an urban canyon due to green walls and green roofs in diverse climates' in *Building and Environment*, vol. 43, no. 4, April, pp480-493.
- Arnfield, AJ, Herbert, JM, and Johnson, GT, (1999), 'Urban canyon heat source and sink strength variations: a simulation – based sensitivity study', in *Congress of Biometeorology and International Conference on Urban Climate, WMO, Sydney*.
- Baker, N, and Steemers, K, (2000), *Energy and environment in architecture, a technical guide*, Taylor Francis, London.
- Ballard, JG, (2003), *High Rise, Flamingo*, London.
- Banham, R, (1976), *Megastructure: urban futures of the recent past*, Harper and Row, New York.
- Banham, R, (1984), *The Architecture of the well-tempered environment*, University of Chicago Press, Chicago.
- Barghusen, JD, Moulder, B, (2001), *Daily Life in Ancient and Modern Cairo*. Twenty-First Century Books, Minnesota.
- Barney, G, (2002), *Vertical transportation in tall buildings*. CIBSE National technical conference, 18th June, London.
- Bay, JH, (2004), 'Sustainable community and environment in tropical Singapore high rise housing: the case of Bedok court condominium', in *Architectural Research Quarterly*, vol. 8, no.3/4,pp333-343.
- Behrens-Abouseif, D, (1992), *Islamic Architecture in Cairo*. Brill Academic Publishers, Leiden.
- Best, U, and Struver, A, (2002), *The Politics of Place: Critical of Spatial Identities and Critical Spatial Identities*, The International Critical Geography Group, Tokyo.
- Betsky, A, (2005) 'Preface' in *Rooftop architecture*, (Eds.) Ed Melet and Em Vreedenburgh, NAI publishers, Netherlands, pp7-8.
- Blum, AF, (2003), *The Imaginative Structure of the City*, McGill-Queen's Press, Montreal.
- Brenner, N, and Kiel, R, (2011) 'From global cities to globalized urbanization' in *The City Reader*, 5th edition, (Ed.) Le Gates, Routledge, London, pp600-607.

- Burge, PS, (2004), 'Sick Building syndrome' in *Occupational and Environmental Medicine*, vol. 61, no.2, pp185-190.
- Calthorpe, P, and Fulton, W, (2001), *The Regional City: Planning for the End of Sprawl*, Island Press, Washington DC.
- Chang, D, Penn, A, (1997), *Integrated multi level circulation systems (IMCS) in dense urban areas*. 1st International Space Syntax symposium, London, April, pp31.1-31.14.
- Chang, JH, (2002) *(De)forming the 'streets': land reclamations and the (re)production of urban spaces in Singapore*, Proceedings, 2th Great Asian Streets Symposium 'Public space' 25th-26th July.
- Carmona, M, Heath, T, Tiesdell, S, Oc, T, (2003) *Public Places Urban Spaces*, Architectural Press, UK.
- Carmona, M, and Wunderlich, FM, (2012), *Capital spaces: the multiple complex spaces of a global city*, Routledge, UK.
- Castells, M, (2001, 2002) 'Space of flows, space of places: materials for a theory of urbanism in the information age' in *The City Reader*, 5th edition, (Ed.) Le Gates, Routledge, UK, pp572-582.
- Cheng, V, (2010) 'Understanding density and high density' in *Designing high density cities for social and environmental sustainability*, (Ed.) Ng, E, Earthscan, London, pp3-17.
- Chiang, K. and Tan, A, (2009), *Vertical greenery for the tropics*, National Parks Board, Singapore.
- Chui, E. (2008), 'Rooftop housing in Hong Kong: an introduction', in *Portraits from above – Hong Kong's informal roof top communities*, (Eds.) Wu, R, and Canham, S, Peperoni Books, Germany, pp246-259.
- Commission for Architecture and the Built Environment (2007), *Guidance on Tall Buildings*, CABI, London.
- Commission for Architecture and the Built Environment (2004), *Manifesto for better public spaces*, CABI, London.
- Council on Tall Buildings and Urban Habitat (2012), 'Tall buildings in numbers', in *CTBUH Journal*, 2012, no.1, pp36-38.

Council on Tall Buildings and Urban Habitat (2011), 'The tallest 20 in 2020: entering the era of the megatall', in *CTBUH press release*, December, pp1-7.

Currie, BA, and Bass, B, (2010), *Using Green Roofs to Enhance Biodiversity in the City of Toronto*, a discussion paper prepared for Toronto City Planning, Toronto, Canada.

Daley, RM, and Johnson, S, (2008), 'Chicago: building a green city' in *Congress Proceedings, Tall and Green: Typology for a Sustainable Urban Future*, Council on Tall Buildings and Urban Habitat, 8th World Congress 3rd-5th March, Dubai, pp23-25.

Davey, P, (1997), 'High expectations', in *Architectural review*, EMAP, UK, vol. 202, no. 1205, pp26-39.

Dennis, M, (1986), *Court and garden*, MIT Press, Cambridge, MA.

Despommier, D, and Ellingsen, E, (2008) 'The Vertical Farm: the skyscraper as vehicle for a sustainable urban agriculture' in *Congress Proceedings, Tall and Green: Typology for a Sustainable Urban Future*, Council on Tall Buildings and Urban Habitat, 8th World Congress 3rd-5th March, Dubai, p311-317.

DETR / CABE, *By Design – Urban design in the planning system: towards better practice*, DETR, 2000.

Dirzo, R, and Mendoza, E, (2008), 'Biodiversity', in *Encyclopedia of Ecology*, (Eds.) Jorgensen, SE, and Fath, B, Elsevier BV, Amsterdam, pp368-377.

Engels, F, (1845), 'The Great Towns' from Engels *The condition of the working class in England in 1844*. Public domain.

Evans, GW. (2003), 'The built environment and mental health', in *Journal of Urban Health*, vol. 80, no. 4, pp536-555.

Frampton, A, Soloman, J, Wong, C, (2012), *Cities without ground: a Hong Kong guidebook*, Oro editions, California.

Frampton, K, (1992), *Modern architecture, a critical history*, Thames and Hudson, London.

Field, BG, (1992), 'Public space in private development' in *Public space: design, use and management*, (Eds.) Chua, BH, Edwards, N, Singapore University Press, Singapore, pp104-114.

- Fishman, R, (1987), *Bourgeois utopias: the rise and fall of Suburbia*, Basic Books, New York.
- Gabay, R, and Aravot, I, (2003) 'Using Space Syntax to understand multi layer, high-density urban environments' in *Proceedings, 4th International Space Syntax Symposium, London*, pp73.1-73-18.
- Geist, GF, (1983), *Arcades – a history of a building type*, MIT Press, Cambridge, MA.
- Goss, J, (1993), The Magic of the Mall: An Analysis of Form, Function, and Meaning in the Contemporary Retail Built Environment in *Annals of the Association of American Geographers*, vol. 83, no. 1, March, pp18-47.
- Gotze, H, (1988), 'Roof Planting from a Constructional Viewpoint' in *Garten und Landschaft*, vol. 98, no.10, pp49-51.
- Habermas, J, (German (1962) English Translation 1989), *The Structural Transformation of the Public Sphere: An Inquiry into a Category of Bourgeois Society*, Thomas Burger, MIT Press, Cambridge MA.
- Haemmerle, F, (2002). *Der Markt für grüne Dächer wächst immer weiter*. Jahrbuch Dachbegrünung, pp11-13.
- Hall, P, (2002). *Cities of tomorrow*, Blackwell, London.
- Heng, CK, and Rashid, M, (2006), *Reclaiming places for the people: the role of the MRT in perceiving public spaces in central Singapore*, Proceedings, 4th Great Asian Streets Symposium 2006 'Reclaiming the city' 6th-8th December.
- Hillier, B, and Hanson, J, (1987), 'The architecture of community: some new proposals on the social consequences of architectural and planning decisions', in *Architecture and Behaviour*, vol.3, no.3, pp249-273.
- HKSAR, (2008), 'Census and statistic department' <<http://www.censtatd.gov.hk/..index.jsp>>[accessed 25 April 2010].
- Hillier, B, (1996), *Space is the machine*, Cambridge University Press, Cambridge.
- Hillier, B, and Hanson, J, (1984), *The social logic of space*, Cambridge University Press, Cambridge.

- Hui, SCM, and Chan, KL, (2011), 'Biodiversity assessment of green roofs for green building design', in *Proceedings of Joint Symposium 2011: Integrated Building Design in the New Era of Sustainability*, 22 November, Kowloon, Hong Kong, pp10.1-10.8.
- Jencks, C, (2002), *The New Paradigm in Architecture: the Language of Post-modernism*, Yale University Press , New Haven, CT.
- Johnston, J, and Newton, J, (2004), *Building Green: A guide to using plants on roofs, walls and pavements*, Greater London Authority.
- Jusuf, SK, Wong, NH, Hagen, E, Anggoro, R, Hong, Y, (2007), *The influence of land use on the urban heat island in Singapore*, Habitat International, vol. 31, no. 2, June , pp232-242.
- Kaiser, H, (1981), 'An Attempt at Low-cost Roof Planting', in *Garten und Landschaft*, vol.91, no.1, pp30-33.
- Kaplan, S, (1995), 'The Restorative Benefits of Nature: Toward an Integrative Framework' in *Journal of Environmental Psychology*, no.15, pp169-182.
- Kohn, M, (2004), *Brave New Neighborhoods: The Privatization of Public Space*, Routledge, New York.
- Kuo, FE, Sullivan, WC, Coley, RL, Brunson, L, (1998), 'Fertile ground for community: Inner-city neighborhood common spaces' in *American Journal of Community Psychology*, vol. 26, no. 6, pp823-851.
- Lozano, E, (1990), *Community design and the culture of cities*, Cambridge University Press, Cambridge.
- Madanipour, A, (1998) 'Social exclusion in European cities: processes, experiences and responses' in *The City Reader*, (Ed.) Le Gates, 2011, Routledge, London, pp186-194.
- Marshall, S, (2004), *Streets and Patterns*, Taylor Francis, UK.
- Martin, L, and March, L, (1972) (Eds.), *Urban space and structures*, Cambridge University Press, Cambridge.

Mason, RB, (1995), *Muqarnas: Annual on Islamic Art and Architecture*, Brill Academic Publishers, Leiden.

Mawhinney, M, (2002), *Sustainable Development: Understanding the Green Debates*, John Wiley and sons, Hoboken.

McMillan, DW, and Chavis, DM (1986), 'Sense of community: A definition and theory' in *American Journal of Community Psychology*, vol.14, no.1, pp6-23.

Melet, E, and Vreedenburgh, E, (2005), *Rooftop architecture*, NAI publishers, Rotterdam.

Moore, EO, (1982), 'A prison environment's effect of health care service demands' in *Journal of Environmental Systems*, vol. 11, no.1, pp17-34.

National Library Board of Singapore, (2008), *Redefining the library*, NLB.

Newman, O, (1972), *Defensible space: crime prevention through urban design*, Macmillan, New York.

Newman, O, (1980), *Community of interest*, Garden city, Anchor/Doubleday, New York.

Ng, E, (2010), 'Preface' in *Designing high density cities for social and environmental sustainability*, (Ed.) Ng, E, Earthscan, London, pp1-5.

OECD, (2012), *Compact city policies: a comparative assessment*, OECD.

Oldfield,P,(2013),'CTBUHwebsite' <<http://www.ctbuh.org/TallBuildings/AcademicStudentWork/UniversityofNottingham/tabid/2287/language/en-US/Default.aspx>>[accessed 12 April 2013].

Oldfield, P, Trabucco, D, Wood, A, (2008), 'Five Energy Generations of Tall Buildings: A Historical Analysis of Energy Consumption in High Rise Buildings', in *Congress Proceedings, Tall and Green: Typology for a Sustainable Urban Future*, Council on Tall Buildings and Urban Habitat, 8th World Congress 3rd-5th March, Dubai, pp300-310.

Ong, BL, (2003), 'Green Plot Ratio: an ecological measure for architecture and urban planning', in *Landscape and Urban Planning*, Elsevier Science BV, vol.3 no.4, pp197-210.

Ooi,GL, (2004), *Future of space; Planning, space and the city*, Eastern University Press, Singapore.

- Osmundson, T, (1999), *Roof gardens: History, design and construction*, WW Norton, New York.
- Peck, S, Callaghan, C, Kuhn, M, and Bass, B, (1999), 'Greenbacks from Green Roofs: Forging a New Industry' in *Research report: Canada Mortgage and Housing Corporation*.
- Per, AF, Mozas, J, Arpa, J, (2011), *This is Hybrid*, A+T publishers, Vitoria – Gasteiz.
- Pomeroy, J, (2012), 'Consultancy On The Application Of Green Plot Ratio To Selected Building Typologies in Singapore', unpublished.
- Pomeroy, J, (2011), 'Defining Singapore public space – from sanitization to corporitisation', *Journal of Urban Design*, vol 16, no. 3, pp381-396.
- Pomeroy, J, (2014), 'Gramercy Residences' in *Green walls in high-rise buildings*, (Eds.), Wood, A, Safarik, D, Images Publishing Group, Chicago, pp156-163.
- Pomeroy, J, (2012), 'Greening the urban habitat: Singapore' in *CTBUH Journal*, no 1, pp30-35.
- Pomeroy, J, (2011), 'High-density living in the Asian context', *Journal of Urban Regeneration and Renewal*, vol. 4, no.3, pp413-424.
- Pomeroy, J, (2012), 'Internal environment and planning' in *The Tall Building Reference book*, (Eds.), Parker, D, Wood, A, Routledge, UK, pp123-132.
- Pomeroy, J, (2008), 'Skycourts as transitional space: using space syntax as a predictive theory' in *Congress Proceedings, Tall and Green: Typology for a Sustainable Urban Future*, Council on Tall Buildings and Urban Habitat, 8th World Congress 3rd-5th March, Dubai, pp580-587.
- Pomeroy, J, (2014), *The skycourt and sky garden: greening the urban habitat*, Routledge, UK.
- Pomeroy, J (2009), 'The skycourt: a comparison of 4 case studies' in *CTBUH journal*, no. 1, pp28-36.
- Pomeroy, J, (2007), 'The skycourt: a viable alternative civic space for the 21st century?' in *CTBUH Journal*, no. 3, pp14-19.
- Pomeroy Studio, (2015) *Distil Design Disseminate: design and research projects of Pomeroy Studio*, Dechen House, Singapore.

- Pusharev, B, and Zupan, J, (1975), *Urban Space for Pedestrians*, MIT Press, Boston.
- Puteri, SJ, and Ip, K, (1986), 'Linking bioclimatic theory and environmental performance in its climatic and cultural context – an analysis into the tropical highrises of Ken Yeang', in *PLEA 2006, 23rd conference on passive and low energy architecture*, Geneva, Switzerland, 6-8th September.
- Redlich, CA, Sparer, J, Cullen, MR, 'Sick building syndrome' in *The Lancet*, vol. 349, no. 9057, pp1013-1016.
- Risselda, M, (2011), *Alison and Peter Smithson: a critical anthology*, Ediciones Polifrafa, Barcelona.
- Rizwan, AM, Dennis, LYC, Liu, C, (2008), 'A review on the generation, determination and mitigation of Urban Heat Island' in *Journal of Environmental Sciences*, vol. 20, no.1, pp20-128.
- Roaf, S, (2010), 'The sustainability of high density' in *Designing high-density cities for social and environmental sustainability*, (Ed.) Ng, E, Earthscan, London, pp27-39.
- Rowe, C, and Koetter, F, (1978), *Collage city*, MIT Press, Cambridge, MA.
- Rowe, PG, (1997), *Civic realism*, MIT Press, Cambridge, MA.
- Ryan, CM, and Morrow, LA, (1992), 'Dysfunctional buildings or dysfunctional people: an examination of the sick building syndrome and allied disorders' in *Journal of Consulting and Clinical Psychology*, vol. 60, no. 2, pp220-240.
- Sennett, R, (1976), *The fall of public man*, Faber and Faber, London.
- Saxon, R, (1986), *Atrium buildings: development and design*, Architectural Press, Michigan.
- Shibata, S, and Suzuki, N, (2002), 'Effects of the foliage plant on task performance and mood' in *Journal of Environmental Psychology*, vol. 22, no. 3, pp265-272.
- Siksna, A, (1998), 'City centre blocks and their evolution: a comparative study of 8 American and Australian CBD's', in *Journal of Urban design*, vol.3, no.3, pp253-284.
- Sinn, E, (1987), 'Kowloon walled city: its origin and early history', in *Journal of the Hong Kong Branch of the Royal Asiatic society*, vol.27, pp30-31.

Sitte, C, (1889), 'The relationship between buildings, monuments, and public squares' and 'The enclosed character of the public square' in *The Art of Building Cities*. Public Domain.

Sudjic, D, (2005), *The edifice complex*, Penguin, London.

Sukkel, W, and Hommes, M, (2009), *Research on organic agriculture in the Netherlands. Organisation, methodology and results*, Wageningen University and Louis Bolk Institute: Driebergen.

Tan, PY, (2010), *The greening of the high-rise environment in Singapore: an overview of policy and projects*, Inaugural International skyrise greenery conference November 1st-3rd, Singapore.

Tauranac, J, (1997), *Empire State: The making of a landmark*, Martins Griffin, New York.

Tomlinson, J, (2003), 'Globalisation and cultural identity' <<http://www.polity.co.uk/global/pdf/GTreader2eTomlinson.pdf>> [accessed 5 February 2012].

Tremewan, C, (1994), *The political economy of social control in Singapore*, Macmillan, London.

Ulrich, RS, (1981), 'Nature versus urban scenes: some psycho-physiological effects', in *Environment and Behavior*, vol. 13, no.5, pp523-556.

Ulrich, RS, (1983), 'Aesthetic and affective response to the natural environment' in *Human Behaviour and Environment: Advances in Theory and Research*, (Eds.) Altman, I, and Wohlwill, JF, Plenum, New York, pp85-125.

Ulrich, RS, (1986), 'Human responses to vegetation and landscapes' in *Landscape and Urban Planning*, vol. 13, no.1, pp29-44.

Ulrich, RS, Simons, RF, Losito, BD, Fiorito, E, Miles, MA, Zelson, M, (1990), 'Stress recovery during exposure to natural and urban environments' in *Journal of Environmental Psychology* vol. 11, no. 3, pp201-230.

United Nations, (1987), *Report of the World Commission on Environment and Development: Our Common Future*.

UNFPA, (2007), *State of World Population 2007: Unleashing the potential for urban growth*. UNFPA, New York.

- URA, (2008), *Government circular on communal landscaped terraces, sky terraces and roof terraces*, Urban Redevelopment Authority, Singapore.
- Vollers, K, (2009), 'The CAD- tool 2.0 morphological scheme of non – orthogonal high-rises, in *CTBUH Journal*, no.3, p38-49.
- Walker, D, (2007), *The economics of casino gambling*, Springer, Berlin.
- Watkin,D, (2005), *A History of Western Architecture*. Watson-Guption Publications, New York.
- Watts, S, (2010), 'The economics of high-rise' in *CTBUH Journal*, no. 3, pp44-45.
- Webb, M, (1990), *The City Square*, Thames and Hudson, London.
- Wong, NH, Wong, VI, Chen, Y, Soh, J, Ong, Cl, Sia, A, (2003), 'The effects of rooftop garden on energy consumption of a commercial building in Singapore', in *Energy and Buildings*, vol .4, no. 35, pp353-364.
- Wong, NH, and Chen, Y, (2006), 'The urban heat island effect in Singapore' in *Tropical sustainable architecture: socio-environmental dimensions*, (Eds.) Ong BL and Bay JH, Architectural press, London, pp181-200.
- Wong, NH, Tan, AYK, Tan, PY, Wong, NC, (2009a), 'Energy simulations of vertical greenery systems' in *Energy and Building*, vol.12, no.41, pp1401-1408.
- Wong, NH, Tan, AYK, Tan, PY, Chiang, K, Wong, NC, (2009b), 'Acoustics evaluation of vertical greenery systems for building walls' in *Building and Environment*, vol. 45, no.2, p411-420.
- Wong, TC, Yuen, BK, Goldblum, C, (2008), *Spatial planning for a sustainable Singapore*, Springer, Berlin.
- Wood, A, (2003). 'Pavements in the sky: use of the skybridge in tall buildings' in *Architectural Research Quarterly*, Cambridge University Press, UK, vol. 7, no. 3/4, pp325-333.
- Wood, A, (2009), 'Singapore visit, August 2009' in *CTBUH Journal*, no.3, pp52-56.
- Wu, R, Canham, S, (2009), *Portraits from Above - Hong Kong' s Informal Rooftop Communities*, Kunsthaus, Hamburg.
- Yeang, K, (2002), *Reinventing the skyscraper*, Wiley academy, Hoboken.

Yeoh, BSA , (2003), *Contesting space in Colonial Singapore: Power relations and the urban built environment*, Singapore University Press.

Zimrig, C, (1983), 'The built environment as a source of psychological stress: impacts of buildings and cities on satisfaction and behaviour' in *Environmental stress* (Ed.) Evans, GW, Cambridge University Press, Cambridge, pp151-178.

Zukin, S, (2011), *Naked city: the death and life of authentic urban places*, Oxford University Press, Oxford.

Zukin, S, (1996), *The cultures of cities*, Blackwell, London.