Public space Evolution in High-density Living in Singapore

Ground and Elevated Public Spaces in Public Housing Precincts

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Public Space In High-Density Living In Singapore
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In Asia, the growth of the cities has significantly increased residential development, far above that in urban areas in Europe and North America. In Hong Kong, for example, we are seeing a plot ratio of over 5 in densely populated districts. For example, in Switzerland, a plot ratio of even 1.5 is regarded as high density. Many cities in Asia already have four times as many people per square metre of ground as their counterparts in Europe. High-rise residential towers, thirty to fifty floors high, are not a rarity, and more recent examples show that the limits of residential density have not yet been reached. In addition to increasing housing capacity, such extreme density in urban areas also signalises the loss of public space as an essential buffer zone in which people can meet, socialise, and generally seek momentary refuge from an environment pressing in upon them.

In Singapore, we investigated the development of public spaces in residential construction state-funded by the HDB (Housing Development Board) from the 1960s to the present day. These spaces are consciously defined as public spaces, although they are often also used as the communal spaces of purely residential precincts. The examples analysed in Singapore showed clearly that in some cases, these spaces are indeed public used not only by apartment residents, but also by shops, doctor’s surgeries, crèches, and the like. Out of 32 precincts, each with a different organization of public spaces, we systematically examined six cases with a plot ratio of at least 3.0, looking at both public space provision and its effect on social aspects considering both an architectural and sociological bases.

The present report systematically examines and categorises the built “anatomies” of the precincts with their communally and publicly used spaces, their spatial organizations and their differing user activities and intensities. The effect of shifting publicly used spaces from the ground floor to the vertical axis has not so far been the subject of research, yet it does present a new challenge for future high-density residential developments. The “Pinnacle @ Duxton” building complex illustrates the extremes to which this phenomenon can go, showing that on 2.5 hectares, seven residential high-rises are being interconnected at the 26th and 50th storeys via “sky bridges” to create public as well as communal spaces that people can use for relaxation, retreat, or social purposes. In this example, with a plot ratio of over 9, people per square meter, most of the free space on the ground floor is taken up, resulting in a loss of public space at street level. Accordingly, this free space had to move into the vertical, which in turn hampers accessibility.

The publicly and communally used spaces in precincts define
and present themselves as thresholds or threshold zones between private use and the urban infrastructure. The ways in which public spaces are used are closely related to quality of life within highly dense residential areas. At the same time, economic factors, such as rental yields are significant, but these are not examined within the framework of this study. A particular challenge lies in identifying the different requirements of the ethnically diverse user groups that live in Singapore. The conclusions from this study can offer suggestions for the development of new residential typologies in the future.

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Public Space In High-Density Living In Singapore

Contents

Preface .................................................................................................................................6

1 Introduction: Aims and Objectives ..............................................................................11

2 Research Methodology ...............................................................................................15
  2.1 Architectural Analysis Properties .......................................................................16
  2.2 Socio-Spatial Analysis Properties .......................................................................17

3 Contexts ..........................................................................................................................19
  3.1 Density ......................................................................................................................21
  3.2 Increasing Density: Elevated Spaces in Singapore .............................................25
  3.3 Historic References to Public Spaces .................................................................29
  3.4 Public Spaces in Singapore ....................................................................................35
    Facilities in Public Spaces .........................................................................................43
    Void Decks and Pavilions .........................................................................................45
    High-rise Public Housing in Singapore ....................................................................47

4 Case Studies: Architectural Anatomy and Socio-Spatial Analysis .........................49
  4.1 Evaluation of 32 Precinct Data Base ...................................................................51
  4.2 Vertical Organization: Typological Elements .....................................................55
  4.3 Selection of 6 Case studies ....................................................................................58
  4.4 Typological Element-based Case Studies .............................................................69
    Pioneer @ Jurong West ...............................................................................................71
    Treelodge @ Punggol ...............................................................................................89
    Central Horizon @ Toa Payoh ..................................................................................107
    The Peak @ Toa Payoh ...........................................................................................125
    Bras Basah Complex @ Rochor ..............................................................................143
    Pinnacle @ Duxton ..................................................................................................161
  4.5 Preliminary Findings to the Case Study ...............................................................178

5 Comparative Analysis ....................................................................................................183
  5.1 Architectural Results .............................................................................................184
  5.2 Space Restrictions of HDB ..................................................................................191
  5.3 Socio-Architectural Comparison on Space Quality .............................................195

6 Conclusion ......................................................................................................................209
  6.1 Space Elevation and Density .................................................................................210
  6.2 Space Use and Appropriation ...............................................................................213
  6.3 Influence of Space Elevation on Space Use .......................................................214
  6.4 Possible Considerations on Public Space Design ..............................................216
  6.5 Further Discussion ...............................................................................................217

Glossary ..............................................................................................................................218

Appendices ........................................................................................................................222
  Appendix 1 Architectural Calculations (including area calculation data) .................222
<table>
<thead>
<tr>
<th>Appendix 2</th>
<th>Social Science Calculations (including population data)</th>
<th>224</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appendix 3</td>
<td>Interview Questions</td>
<td>225</td>
</tr>
<tr>
<td>Appendix 4</td>
<td>Carparking Calculations</td>
<td>226</td>
</tr>
<tr>
<td>Appendix 5</td>
<td>26 Precinct Design and Descriptions</td>
<td>227</td>
</tr>
<tr>
<td>Appendix 6</td>
<td>Module Contributions and Impact</td>
<td>254</td>
</tr>
</tbody>
</table>

Acknowledgements ........................................................................................................ 258

Bibliography & Electronic Sources ............................................................................. 259
Public Space In High-Density Living In Singapore
1 Introduction: Aims and Objectives

Urbanization in Singapore has led to an increasing sprawl of built space after the 1960s. The land limitation on the island has led to buildings growing higher, with their heights escalating gradually and public spaces migrating to levels higher than ever before. The aerial view of Singapore is that of a "city in a garden", but the ground level may diverge from this perception.

As continuous urbanization transforms the urban landscape into a densely built skyline, with public spaces at all possible levels, it becomes apparent that the value of open space, green space or public space has become significant to the cityscape.

Public housing dominates the building sector of Singapore, as it accommodates more than 80% of the Singaporean population. Since the 1960s, the Housing and Development Board (HDB) of Singapore has designed public housing complexes, namely precincts, which become increasingly dense, with heights escalating from 7 to 50 storeys. HDB offers not only housings, but also public spaces for every precinct to satisfy the daily needs of thousands of users.

In Singapore, there is a clear distinction between the public spaces of the urban realm and the public spaces of the HDB precincts. The precinct public spaces offer an atmosphere in terms of a microclimate that can be occupied routinely. The precinct public spaces "link" infrastructure with private spaces but offer many challenges in terms of their management, the lack of boundaries (as would appear in, e.g., a multi-occupancy context in Singapore). They are organized in many ways according to their density, land area and effectively their plot ratio.

According to the density of each precinct, public spaces can be elevated on podium roof decks, multi-storey car parks, and even sky bridges at higher levels. As urbanization shows no signs of decline, the 2013 Singapore Population White Paper by the Government of Singapore reported that the future of Singapore is expected to bring a higher number of people into its land. How to intensify the living density without reducing the quality of the living environment is the question that confronts not only Singapore, but also other parts of the world facing similar situation.
This research is developed on the database of 32 observed HDB precinct public spaces in Singapore. Via a deeper investigation of social and architectural data in the six (6) selected HDB precincts, we wish to explore and discuss the effect of public space elevation on the spatial use.

The aims of this research specifically are to explore the typology of public space in high-density housing developments in Singapore and discuss its relation with the space use and social behaviours. By doing so, this research is able to identify the connections between space density, allocation, provision, and public space organization, and demonstrate which architectural factors can influence space use and appropriation positively or negatively.

**Research Hypothesis**

With the increasing population density in Singapore, the ground space on the urban street level in public housing precincts in Singapore will be used more intensively by other uses rather than housing. Hereby, public spaces in precincts will be elevated off the ground to higher levels. This elevation of the public space will influence space use and appropriation.

**Research Question**

1. Does the increase in density influence the provision of public spaces in housing precincts in Singapore in terms of elevation?

2. How does the elevation of public spaces affect the use and appropriation of public space?

As there is not enough knowledge on “how” public spaces in HDB precincts are organized, developed and used in Singapore, this work endeavours to understand and reveal the differences in space uses in high-density vertical living as well as to identify typological elements of public space and their relation to space use and appropriation. To accomplish these aims, the study will utilise two-folded architectural-social study.

The overall goal of this work is to increase our understanding of space-use, space accessibility and space use. In this sense, the Singaporean public housing precincts also display a space provision with varied permission, freely, based on restrictions or authorisation only (Avey and Avolio, 2007).

**Outlook**

The results of this study can benefit the fields of housing design in Singapore and elsewhere by highlighting:

1. Users’ activities and the relation between design and appropriation of space.
2. The development tendencies for high-density vertical residential precincts in the future.

3. The culture of Singapore in designing high-density public spaces in residential projects in the future.
The methods of this empirical research have been selected to reflect the focus on architectural and socio-spatial elements. The catalogue based on an empirical observation of public spaces indicates public space typological elements and forms the cases studied in this research. The selection of cases in this study was based on the design attributes connected to building density.

32 public housing precincts in Singapore were selected from 16 out of 26 New towns because of their comparatively high density as well as similar adjacency to external public transport networks. Based on this exploration, this research identified typological elements of public spaces. Among these precincts, six (6) cases were further selected as representative of the combination of the typological elements, high GPR, year of completion and types of vertical and horizontal access to pedestrians and vehicles.

### Architecture
ETH Chair for Architecture and Building Process
- Characteristics of Housing Precincts and Public Spaces

### Social Science
ETH Wohnforum / ETH CASE
- Socio-Spatial Organization
- Use and Appropriation

**Research Methodologies**
2.1 Architectural Analysis Properties

The Architectural studies are based on the literature review and site visits. They inform us about the architectural “anatomy” of public spaces in public housing precincts in Singapore.

The on-site preliminary exploration of the architectural “anatomy” included visiting precincts to collect information on the following:

1. General information
   • Year of completion
   • Location
2. Density
   • Building
   • Population
   • Car parking
3. Spatial organizations
   • Number of Blocks
   • Car-parking lots
4. Allocation on the ground
5. Typological elements
   • Ground public space
   • Elevated public space
6. Accessibility
   • Vertical and horizontal physical accesses
   • Restrictions

Building Density
One of the greatest challenges of this study was the lack of reliable data sources. The master plans by the URA offered generic GPR figures reflecting general visions rather than real-life situations. Thus, our Module had to re-measure all the data provided and proceed in introducing a GPR*, which is a new plot ratio based on the AutoCAD master plans provided by the URA to inform our Module, by on-site data collection, literature surveys, and on-site observations.

More specifically, the GFA was calculated based on the plot ratio according to the URA master plan. The verification by means of AutoCAD take-offs showed that the URA master plan plot ratio did not reflect the built surface accurately. It appeared that in most cases, the real GFA is approximately 10% higher than defined in the URA master plan except Bras Basah Complex. This suggests the increase of an additional 10% of building area (URA regulations). The indicated plot ratio of Bras Basah cannot be directly related to the built situation, as before 1989, Singapore’s building code was based on population density (P/ha) rather than GPR. The fact that the URA master plan plot ratio could not be used without verification can also be seen in the list of 32 evaluated precincts where several older estates (built based on P/ha density) show plot ratios, which are obviously too high for what is currently being built. Therefore, in the study of the six (6) cases, the new plot ratio GPR* was used, which was equal to the URA plot ratio with extra 10% bonus.

Population Density
Another challenge of this program is the lack of actual and historical data on the population density of each precinct analysed. While the HDB annual reports provide more general population data, case-specific data was not accessible. Thus, this program considers population density in terms of the provision of flat types and numbers of flats on each floor of each block on-site. Hence, this data represents a calculated population density in terms of the precinct design capacity only.

Car Density
Vast urbanization and an increased population density also relate to the number of parking lots each precinct would need to provide for their residents. This study aimed to get a better understanding of density through counting the number of car parking lots on each of the six (6) case study sites to identify a discrepancy between the number of car parking lots on the precinct plans (as photographed on lift entries on site) and actual parking lots. Car density thus based on counts, reflecting real-life conditions.

Accessibility
The analysis of the six (6) studied cases is based on the horizontal and vertical accessibility to and connectivity of the public spaces.

1. Horizontal networks:
   • Open ground
   • Vehicular networks, car access and dead-ends
   • Pedestrian network and points of public access
   • Void decks
2. Vertical networks:
   • Vertical transport system to flats
   • Vertical transport system to:
     Elevated void decks
     Podium roof decks
     MSCP podium roof decks
     Eco-decks
     Skybridges and skygardens
2.2 Socio-Spatial Properties

This study defined social properties public spaces, as identified and used by people, found in the 6 studied cases. One key aim is to identify “how” the vertical evolution of public spaces affects human behaviour and use of public spaces. Thus, on-site non-participatory observation and structured interviews were conducted to gain a better understanding of human interaction on the ground and in elevated public spaces.

**Space Type**
Defined space is a term used in this research to describe spaces equipped with infrastructure and particular furniture other than spaces with benches on walkways without any defined functions. These spaces include:

- Playgrounds
- Precinct pavilions
- Sitting pavilions
- Fitness corners (for elderly and general)
- Resident corners
- Void decks
- Urban farms
- Jogging tracks
- Hard courts
- Barbecue pits

Free undefined spaces observed are:
- Open green spaces
- Walkways (covered and uncovered)

**Space Organization**
The space organization was investigated using an environmental image map from the discipline of urban planning to understand the environment that contributes to visitor’s experience in the precincts’ public spaces. Lynch (1960) devised this map to diagram the elements in the space that contribute the visitor’s image of a place. This method allowed us to identify the space elements as:

- Landmarks: The external point-references symbolizing directions or locations.
- Districts: The two-dimensional extents or sections of the space with some common identifiable characteristics.
- Nodes: The junctions of transport or concentrations of activities
- Paths: The channels along which people move.
- Edges: The linear boundaries between two (2) phases.

**Space Use**
The on-site observations were carried out specifically from 08:00 am to 18:00 pm on one weekday (Wednesday), from 14:00 pm to 19:00 pm on Friday afternoon, and from 08:00 am to 18:00 pm on one (1) weekend (Sunday) for two (2) working weeks. During the observations, more than 4000 visits were observed in the public spaces across the six (6) studied precincts, varying from 300 to 1300 according to the particular situation of each precinct. Observations were directed towards the exploration of:

- Activity phenomena
- Points of access to public spaces
- Characteristics of space users, such as age and gender
- Location and duration of activities
- Types of interactions in defined and undefined spaces

The types of public spaces categorized the activities. The total number of visits and the average time-spent in the spaces were calculated to represent the practical interactions among people moving around or inhabiting the spaces. The types of activities were also classified, and their numbers and duration were calculated to investigate the appropriation of each space in the precincts.

To understand the reason behind users’ behaviours in the public spaces, regardless of whether related to the space provision and organization, structured interviews were carried out with random interviewee selection in the six (6) studied location. Overall, 7 participants in each precinct were given recall questions for the first round. To cover the various household situations, such as the household structure and ethnics, the second round of interviews was conducted. More than 50 participants completed the interviews in the six (6) precincts. The information from the interviews revealed factors that influenced the space use by a sociological method as coding and interpreted certain phenomena and the differences of space use across the six (6) precincts.

The combination of these approaches demonstrated the interrelations between environmental elements, space elevation, and spatial use. Some spatial quality factors that differed across cases indicated the influence of the environmental elements in the use and appropriation of space.
Public Space In High-Density Living In Singapore

Source: Chinatown Singapore 1960s. Photo Credit: Derek Tait (http://blogtoexpress.blogspot.ch/2011_05_01_archive.html)
A rich body of literature has considered the unique public housing provision program of post-independent Singapore (e.g., Bishop, Phillips and Yeo 2004; Castells, Goh and Kwok 1990; Chua 1997; Koolhaas 1995; Lai 1995; Lee 1996; Lim 1989; Lim 2004; Luck 2004; Sim, Yu and Han 2003; Wong and Yap 2003; Yeoh and Huang 1996; Yuen 2005a; 2005b; Zhu 2002). Castells, Goh and Kwok (1990), for example, argued that housing provision plays a key role in the establishment and upkeep of modern post-independent Singaporean state. By means of housing provision, costs of living have been lowered, employment opportunities have been provided, urban infrastructure has been generated, and capital formation has been directed. Through a well-conceived ownership scheme, most Singapore's residents live in public housing and are owners. In fact, following Zhang and Tan (2008), public housing became a standard way of life in Singapore’s welfare state. According to Lai (1995), housing was also used as an instrument to culturally integrate the nation. Singapore’s Housing Development Board (HDB) has applied specific formulas of multi-ethnic mixing in housing estates to create a well-integrated, multi-ethnic state. In the same line of thought, Chua (1997) argued that the HDB’s commitment to universal housing provision gives the Singaporean its unique political stability.

Most of the above-mentioned literature has examined the development of Singapore’s built environment exclusively from a large-scale perspective, that is, from a political, cultural, economic or urban design point of view. For example, Koolhaas placed his analysis of Singapore in the “extra-large” scale section in his 1995 book S, M, L, XL. Yet, besides that body of research, a significant but smaller scholarship examined the ways in which inhabitants of HDB estates shape the interiors of these estates. Chua’s work (1997), for example, included an ethnographic study of a community’s transformation from a traditional village (a “kampung”) to a high-rise settlement, comprising an account of how residents lived in their newly acquired flats. Additionally, Castells, Goh and Kwok (1990) analysed the shaping of post-independent Singaporean interiors. Focusing especially on the effect of home ownership, they showed that owners spend a significant amount of money to design the interior of their flats.

Furthermore, based on an analysis of a series of regular articles in the HDB publication “Our Home,” which showed how selected residents decorated their flats, Cairns and Jacobs (2006) explored the complex relationship between this interior design advice and the commitment to modernist design principles, the self-conscious pragmatism as well as the incorporation of a limited market logic characterizing Singapore’s public housing program. Moreover, Yuen (2005a) conducted a series of interviews with residents in two 30-story blocks to investigate the living experience in high-rise public housing in Singapore, which she discussed again in 2009 with specific focus on Singapore’s housing strategy (Yuen 2009). In a study of the perception and expectations of rooftop gardens, she also extended her research on the residents’ use and evaluation of common space in high-rise buildings (Yuen and Hien 2005). The proposed FCL Research project aims to contribute to these findings and to deepen the existing knowledge of spatial organization and living quality in Singapore high-rise buildings.
3.1 Density

Amos Rapoport (1975) defined density, a term being referred to as crowding, as a perceived value comprising two (2) aspects: the number of people in the unit area and the space available for people in the unit area. In other words, except for the physical feature, density is also strongly related to the interactions between space and the people using the space.

Density as Population per Unit Area
The fundamental concept of density reflects population per unit area. For example, the population density of Singapore is 7301 people per km². Both the population density and the building density can be used as measures of density.

Density as Space Available per Person
However, according to Rapoport, density should go beyond its fundamental concept, as some other environmental or social factors, explained by Rapoport as the interrelationship between people and people, people and objects, and objects and objects, also influence perceived density or crowdedness. Even with the same population per space unit, certain factors may contribute to different perceptions of density.

Rapoport (1975) listed environmental cues that relate to the way in which people understand and engage with urban environments. These cues relate to, for instance,

1. the building’s height to space rate;
2. the spatial openness and apparent complexity;
3. the light levels and sense of the space being natural;
4. the noise levels and its sources;
5. the smells and its sources;
6. the signs in the space;
7. the traffic flows in and around the space.

A list of social cues includes:
1. the sense of control of interactions;
2. the levels of attractive stimuli;
3. the connection with the adjunction spaces for use;
4. the levels of non-residential used space;
5. the levels of interactions;
6. the levels of social homogeneity;
7. the levels of cultural sharing.

Alexander (1993) also added that socio-cultural attributes could influence perception of density. In addition, while architectural attributes, morphology as well as environmental elements can influence the perception of building density, architectural design can influence the perception of closeness between people (Cheng, 2010). The cues above indicate that although the physical and population density is high in one space, it is possible and workable to reduce the feeling of stress and improve the comfort of space in terms of density by designing or re-organizing the space, ultimately improving the quality of the space.

Further, regarding the design or planning, the relationship between the dwelling buildings and the surrounding spaces in residential areas must be considered, as concluded by Rapoport, not only from the physical aspect but also from the social respective. Based on this understanding, the framework of the project has been established.

Building Density in Singapore
As density increases in Singapore, as reflected by a high URA value in Master planning, this research focuses on GPR higher than 2.8. In its six (6) case studies selected, it explores the evolution of building density and elements that define it as analysed architecturally (in section and plan). The population density is extracted in social science terms as a precinct’s capacity to host its residential block community in the public space provided. Navigation within the perceived space and its reported as well as observed use are further recorded and analysed, as influenced by the Lynchian way, and presented in the findings section of this book. The promotion of social and physical attributes of human interaction contributes to the perception of density and sense of “liveability” (Rapaport, 1975). High-density in Singapore is considered a building-related value.

Gross plot ratio (GPR) is calculated as follows.

\[
GPR = \frac{\text{Total covered area of all floors of buildings on a plot}}{\text{Area of the plot}}
\]

The above refers to density as plot ratio, which is used as an indicator of development control and land-use in different areas of the city in addition to being used for cost forecasting and resourcing a given construction quality (Cheng, 2010). Density can be defined in many different ways.
Density as Rate

Singaporean Authorities, according to the “General Considerations” of the URA, describe density in terms of six (6) rates, which include the GPR calculation as well as the precinct blocks’ maximum height. Specifically, these rates are stated below.

- Landed house
  Resultant from height
- Low-density
  GPR: ≤ 1.4
  Height: apx. 5 storey
- Medium-density
  GPR: ≤ 1.6
  Height: apx. 12 storeys
- Medium high-density
  GPR: ≤ 2.1
  Height: apx. 24 storeys
- High-density
  GPR: ≤ 2.8
  Height: apx. 36 storeys
- Very high-density
  GPR: > 2.8
  Height: > 36 storeys

The act of elevating public spaces in Singapore offers a new paradigm that is analysed in connection with the building design in this research. The higher the building density, the more likely it is that a public space of public housing precincts will appear off the ground.

Since the 1950s, rapid economic growth as well as population growth has led to a new urbanization history that has led to densification of urban development of many cities around the globe (Ng, 2010). This densification has transformed urban topographies into lands where their openness diminishes and buildings go higher, forming high-density environmental agenda for planners, governments, and policymakers.

High density is thus not just a question of a ratio of buildings per site area (GPR) but a consequence of planning that draws a research interest around the world. High-density, according to Cheng (2010), represents not only an architectural problem, but also poses an understanding of a nation as well as of its related culture.

In social terms, high density relates directly to a notion of overcrowding, which is a perceived value. This notion may vary according to different national guidelines and according to different populations. High density in the UK equates to 60 or more dwellings per net hectare (TCPA, 2003) whereas in the USA, it represents 110 dwellings per hectare or more (Ellis, 2004). In Israel (Cheng, 2010), the same terminology for high density equates to 290 dwellings per hectare.

As these rates vary considerably, high density is explored as a high building density. This is a countable value, which refers to plot ratio and is a measure of density. It should be noted that high building density is not analogous to the creation of overcrowding a problematic urban conditions. An example of this is Hong Kong. In the 1980s, the plot ratio increased by two (2) in one decade and reached a GPR of five (5); however, according to Cheng (2010), Sullivan and Chen (1997), as well as Ng and Wong (2004), the space for living also increased by 1.8 m$^2$ to 5 m$^2$.

Obviously, high density can lead to positive or negative condition (Cheng, 2010, Pun, 1994; Churchman; 1999, Breheny, 2001). Certain scenarios present the merits and detriments of high density. Some suggest for instance that high building density leads to more effective space use and improved quality of living (Cheng, 2010). Other ideas; however, counter the latter by suggesting the inevitable negative effects of high-rise megacities that sprawl uncontrollably. According to literature survey (Ng, 2010), infrastructure projects in high-rise high population density environments should correspond to an optimum balance that would lead to negative effects if tipped. These infrastructure projects involve transportation networks, electricity and telecommunication networks as well as drainage and sewage systems.
Public Space In High-Density Living In Singapore
3.2 Increasing Density Elevated Spaces in Singapore

Since the 1960s, vertical flat construction has increased from 70,000 (apx. 10 storey high) to 900,000 in 2005 (Yuen, 2009) when vertical living moved occupants to the 40th storey. Flat types and blocks developed according not only to the Singapore population levels, but also to building structural characteristics that nowadays comprise hybrid and cluster blocks that are the successors of the point and slab block formations.

Slab blocks are the first type initiated in the 1960s in Singapore. These offered common corridors between flats. Neighbours are thus allowed to use them but not to extend their housing boundaries beyond the corridor. Interaction between neighbours can therefore take place in the corridors.

As in the beginning, HDB developed slab blocks that were designed uniformly and located at equal distances from one another, HDB further aims to add differentiation in the design of spaces to accommodate various user preferences. Hence, the uniqueness of block facades, heights and formation was pursued. HDB precincts no longer appear at a uniform height but can be organized in different volume combinations of low-rise and high-rise, e.g., in 4-storey blocks and 25-storey point blocks, and different shapes (such as Block 259 a clove-leaf-like HDB development in Ang Mo Kio). The highest and densely organized HDB precinct is nowadays the “Pinnacle@Duxton” that rises up to the 50th storey and includes more than 1,800 housing units in seven (7) towers. These towers are connected by a skybridge on the 26th floor and a skyterrace on the 50th. Building heights however, are not the single factors that determine the effects of density on spatial design and public space provision.

The 1960s have signified a tipping point for Singapore’s landscape transformation from a low-rise landscape to an increasingly high-rise cityscape. Increasing density is a major contributor to the current image of Singapore. Density influences the ground, as void decks are increasingly occupied by built space (Tay, 2012), supplemented by precinct pavilions and public spaces elevated above the ground level. Rapid urbanization and upbeat in construction of public housing led to a few problems, such as car parking, which was previously on the ground.
A number of historical references of HDB have led to the vertical migration of public spaces in Singapore. These steps are described by typological elements of HDB precincts and are the product of building density and the acknowledged need of people to gather outside the private housing areas. The first public spaces that were elevated off the ground were experimental. The Singapore Urban Research Group (SPUR) developed them in the late 1960s and 1970s.

In historical terms, the elevated public spaces have shown successive elements that appear currently in HDB precinct developments and form overall high-rise high-density image. Literature surveys (cf. Yeung, 2013) have shown that these elements have appeared as follows:

**Podium Roof Deck with Low-Rise Housing**
Mid -1960s to 1970s
These public spaces were designed to incorporate more communal gatherings and facilities (such as hawker centres that were previously occupying the streets) (HDB, 2006; HDB Annual Report, 1967).

**Podium Roof Deck with High-Rise Housing**
1970
These public spaces expanded upon the above element that aimed to contribute to differentiating HDB precinct pedestrian network and lifestyle from the motorized transport network of the city (Heng and Low, 2009; HDB Annual Report, 1970 and 1978; HDB Annual Report, 1974/75 and 1978/79).

**Neighbourhood Park as Supplement**
1970 - 1980
The new focus of HDB developments shifted from the urban network and connectivity to New Town neighbourhoods that were developed in mid-80s to increase residents’ sense of privacy through their separation. In this period, surface parking jeopardized the openness of the ground (HDB, 2006; HDB Annual Report, 1979/1980 and 19980/1981 and 1986/87).

**Multi-Storey Car Park (MSCP) Roof Gardens**
2000 (Beginning)
National objectives for a more sustainable lifestyle and land use for increased social integration have led to an increased development of roof gardens (HDB Annual Report, 2002/03; HDB, 2006).
Eco Deck (E-Deck) and Sky Gardens
Mid-2000

These were introduced as alternatives to free ground space for car parking. Elevated spaces that can promote a more serene and sustainable living are the so-called E-Decks and sky-gardens, according to HDB (2007). HDB (2007) developments promoted these solutions to boost inter-resident gatherings and community bonding.

Podium Roof Gardens
2011 to Present

More roof gardens were introduced in this period with the aim to promote ease of inter-block access and community bonding (HDB, 2006).

The elevation of public spaces has highlighted that vertical connections and planning for access to and from the ground are central in design investigation and analysis in the future. Elevated spaces have been described in both positive and negative contexts. Literature surveys (cf. HDB, 2007; Bay, 2004) on the benefits of Singapore’s housing estates have indicated the following:

- The interplay between solids and voids may benefit user perception of the scale of vertical intervention
- Increased cross ventilation and day lighting within the volume of the buildings
  - Filtered ground level noise
  - Greater number of alternatives for social interaction (e.g., Bras Basah Complex)
- Enhanced sense of spatial control and perception of security
  - Improved horizontal circulation across blocks above the ground (e.g., Pinnacle@Duxton, Central Horizon in Toa Payoh)

Etherington (2000) mentioned in his work on ‘the Invisible City’ and presented at the International housing conference (hosted by HDB) that high-density has led to the development of HDB housing with public spaces forming “streets in the sky”. Pomeroy (2014) mentioned that socio-economic and planning influence the “skycourts and skygardens” towards “greening the urban habitat”, such as, utilising the exterior circulation routes, solar heat gain, acoustics and thermal comfort.
Source: Raffles Place Park and Clock 1970s. Photo Credit: Facebook Group “Nostalgic Singapore”, http://remembersingapore.wordpress.com
3.3 Historic References to Public Spaces

Part of every city’s inclusiveness is to offer provision of spaces for the public. Public spaces can be both participatory social spaces for retreat as well as locations of visual retreat. Historically, a public space is the type of space that is open for all people to access and carry out various activities. Spaces for public assembly, for art, and for athletic, spiritual and political engagement have existed since the ancient times. Modern history has proven that individuals use public greens, piazzas and open spaces for enjoyment (Carr et al., 1993). Public spaces play a central role in the way cities are seen today as symbols of a collective wellbeing (Amin, 2006) or so called “demos”.

To date, the public spaces, streets, and places can be crossed freely while offering urban environments for social gatherings and social use. Previous studies (Kofman and Lebas, 1996; Lefebvre, 1968; Purcell, 2002) developed classical ideas about the urban virtues of public space in terms of the creation of a sense of citizenship. According to Amin (2007), public spaces are supposed to influence human interpersonal practices in common premises as well as formally designed collective spaces where people can develop the sense of a space for “us”.

Research has suggested that public spaces can offer a plurality and multiplicity of physical and non-physical assets (Amin, 2006). Public spaces offer a naturalized demarcation of division between gated spaces, passages and territorial trajectories. The use of such spaces relates to numerous factors, such as the materiality, rules and regulations of the urban realm, furniture and physical demarcations. These assets can offer a sense of territoriality and a negotiation of the public spaces urban capacities (cf. Amin, 2006). The relation between public spaces and the society can also be symbolic in the cityscape. As the public space can exert a relative “power” on the infrastructure and societal development, it forges the urban culture on every urban environment. The public space also becomes increasingly integrated in new technological and cyber communication combinations (Blickstein and Hanson, 2001). Rules related to signposting may be obvious, but may be less explicit and may relate to visual socio-economic and cultural cues (Rapoport, 1975) and the idea of physical connectivity and spatial identity.

In this sense, the idea of spatial “democracy”, topography and geography has become central in space use theorization. Henry Lefebvre’s right to the city, amongst others, has offered a new viewpoint on the definition of a public space. The public space may not widely coincide with a so-called all space, as ever since its initial development, it involved restrictions that are highly related to the politics about a space and about aspects regarding space that are approved or discomforting in various cultures.

Therefore, this space faces a challenge of not only being a physical space, but also a phenomenological space being owned by a government or by largely privatized and own by private organizations. These restrictions can result in the urban redevelopment that would change the public into a private urban space. Privatized public spaces, however, offer only restricted space and are often not open to unlimited access. On the contrary, access to public spaces is free of charge. Qualities of public space are defined by their accessibility; provision of social engagement with the space offered and comfort represented by the spatial environmental conditions.

As public spaces may appear “free” and unrestricted, certain elements of space, essential design or socio-economic and political factors can make them appear “restricted”. These restrictions and social requirements in various settings have also posed numerous philosophical controversies and socio-architectural challenges. Restrictions are proposed to be an action within reason. These restrictions have been regulated according to the reasoning of public speech and social assembly, and they were adopted in the space politics and law of the United States according to the First Amendment of the United States Constitution of 1791. This constitutional amendment was followed by XXVII Amendments and additional ungratified ones. Public spaces may not include only physical spaces and government-owned property, but also forums like newspapers, where people may express their views. In open spaces, where an unrestricted number of people may engage, a civil unspoken agreement of acknowledging the existence of another in-space but also not intruding in personal boundaries applies. Hence, each individual in space maintains his/her own privacy in a public space, abiding by the rules of social and cultural engagement. Spaces that are offered to the public may relate to entertainment and various recreational activities.

The history of public space developments has not only been based on a European context but also largely on an Asian context, the latter of which includes Chinese and Singaporean-Malay cultural contexts.
Public Space In High-Density Living In Singapore

Singapore-Malay Background: Kampung Spirit

Before the HDB re-envisioned the future of planning in Singapore, vernacular living in Singapore influenced the formation of a community environment in the name of a “Kampong”. Kampons are known to be historic settlements of Singapore (i.e., villages). There is, however, a kampong in Singapore still alive, representing a spirit of settlements of the past. Kampong Buangkok or “Selak Kain” in Malay stands for the activity of lifting up ones sarong (sarong: Malay cloth). All public engagement concerns the outdoor open space, with the kampong heartlands also forming the core of the kampong activities. These spaces currently have been gentrified and reused under essentially different public space formations.

Vernacular architecture in Singapore has signified a communal bonding that would depend upon self-sufficiency and act collectively over commonly accepted social patterns and a sense of sharing a common tradition (Rapoport, 1969) that also related to gender related activity (e.g., with women and children growing together around play and informal communications; Chua, 1997).
Artist’s Impression of the Modern Kampung by HDB. That is “Kampung Admiralty” in Woodlands (2014 Build-to-order scheme development), Source: http://www10.hdb.gov.sg/hdbvsf/eampu07p.nsf/0/14JULBTOWLM_page_6147/$file/about.htm
Chinese Cultural Background

China and its typical culture have strong influence on Singapore because of their strong ties in terms of commerce and migration as well as the majority of population.

The concept of public space has emerged with the development of commercial activities in the city in the ancient time. In effect, the restriction on population administration and the importance of family-based relations shaped the cities with inward spaces inside houses dominantly without public spaces in the cities before Song Dynasty (approximately 600 AD). The spaces in the cities were divided clearly into private spaces (e.g., dwellings, palace, etc.) and city space (e.g., streets). Citizens were not allowed to gather in or occupy the city space on any occasions.

The prospective private commerce activities at the beginning of Song Dynasty started to break the boundary walls between private spaces and city spaces by developing business areas between private and city spaces. These trends were further developed into a housing typology with covered public corridors in the front, which can be easily found in the southern part of China today. This building type, with the early immigrants intertwined in the Chinese community, shaped the cityscape of the downtown area of Singapore in its early age.

High-rise nowadays offers a new possibility and pattern in Singapore (Chang, 2000), which brings more possibility to the idea of public engagement in a wider variety of built spaces vertically. To acknowledge the times of the Kampong, the HDB has aimed to bring back the Kampong spirit and essentially community bonding in the vertical high-density living.

Nowadays, a mission of new designs is to provide enough space for a community to engage with in environmentally friendly environments. Eco-features are finally being integrated into public spaces of HDB precincts to create an urban quality of living comfortably.
Source: Diagrams from the Howard 1902 edition
3.4 Public Space in Singapore

Sir Stamford Raffles founded modern Singapore in 1819. Until the 1960s, a number of organizations (e.g., SIT) aimed to address certain housing shortages by proposing different methods to enhance the quality of life (Yuen 2007; 2009).

The development of Singapore’s residential construction has followed a unique path since 1960, largely because it has been almost exclusively steered by the country’s public housing authority, the Housing and Development Board (HDB). Self-sufficient New Towns (planned communities) have given rise to a succession of residential and building typologies targeted specifically and strategically at identifying and solving the ever-changing challenges at hand over the past 50 years.

Both Singapore’s surging population and its increasingly affluent society have fuelled this development, resulting in the unabated densification within the limited stretch of land that comprises Singapore. Continually evolving flat designs have been going hand-in-hand with an array of building types that have emerged over time, ranging from slab blocks, point blocks, and clustered blocks to the more recent skybridge towers. The number of floors in new residential construction has progressively risen over the years from the 10-story to 15-story earlier slab blocks to the more recent construction of the first skybridge type, the 50-story Pinnacle@Duxton. Not only have buildings been getting increasingly higher, the distance between them has been shrinking, as guidelines regarding their allowable spacing have relaxed (Wong and Yeh 1985, Tan 1994).

Prime Minister Lee Kuan Yew offered a new vision about the development of the urban development of Singapore to offer a clean and green city for a better quality of life within its urban landscape. He envisioned a “Garden City” that would, through urban greening, offer more recreation activities to the Singaporean population as well as globally attractive setting for foreign interest, assets and investment. Singapore, with its new motto for spatial development, has initiated an urban transformation through a green policy that further stimulated a new “move” to develop Singapore as a sophisticated metropolis, a “City in a Garden”. This was accomplished through greenery plans and conservation of natural heritage that also involved members of the community.

The politics of greening the city is actually twofold (Seng, 2011). The formation of the public sphere is based upon balancing out the high-density developments with designated open spaces. This idea reaches back to the middle-class colonial period that has been influencing the perception of the city (Seng, 2011). The second point, related to the provision of more open spaces throughout the city, concerns an urban sociological perspective where the population is invited to comply with the idea of a commune (Huat, 1995; Seng, 2011).

Recent studies on the development of Singapore into a green city emphasize modernism and its related interconnected elements, such as these of streets and plaza, which are instrumental in the formation of an urban identity. During the decolonization of Singapore, colonial architecture and national housing shared an open space as the public sphere that ideologically could connect or draw apart (Beng-Huat, 1995). In promoting Singapore as the place that links the home to the land, the constructed landscape was actively directed towards a more ideological, rhetorical paradigm of giving the city a new “homeland” comprising high-density housing and their related open spaces (Seng, 2011).

The notion suggesting the relation between the urban utopias and housing models has its origins in the West, and its health and sanitary systems developed in the second half of the 19th century. In these terms, the paradigm had significantly influenced perception of the open space as a key element that could unify a town and a country. Ebenezer Howard pioneered this idea. In 1902, he wrote about the “Garden Cities of Tomorrow” that further gave rise to the “Garden City Movement”. This movement offers a method to plan urban environments founded in the initial writing of Sir Ebenezer Howard in 1898 in the UK. Garden cities in the plans of Howard were intended to offer self-contained communities and greenbelts that would be proportionate to all other uses, i.e., housing, industrial and agricultural. These ideas were based on an overarching concept of creating municipalities that incorporate the ideas of beauty “as-well-watered gardens” (Seng, 2011). Interestingly, this idea of creating a satellite city has also led to economy related ideas, such as those proposed by the British economist Charles Benjamin Purdom who wrote in “The Building of Satellite Towns” about Howard’s centralized system of nationalization created by building satellite towns through creating a rental system to benefit the locals (Seng, 2011).

Specifically, Howard aimed to provide a designated control to the expansion and development in the suburbs. Abercrombie re-evaluated this idea at a metropolitan and regional scale in the 1940s. The proposed system belonged to the London County and Greater London Plans (Seng, 2011) and proposed a hierarchy of open spaces within the city. Howard's idea about the open space also proposed a way in which all socio-economic defects could be resolved. Le Corbusier later rationalized the idea about the open
Rooftop gardens, green roofs, sky terraces, landscaped balconies and green walls co-exist. As density increases, a movement of greening has influenced the transition of a vertical city to a "city in a garden".
Interaction of public space users that frequent the playground routinely.

"Singaporeans are not only concerned about the amount of space and efficient rate of usable floor area, they also emphasize the need for social interaction. A more spacious area is a major contributing factor to the improvement of interaction and living quality as a whole" (Chan at al., 2002)
space and gave it a new meaning of a space that surrounds or is contained in built space. Open space needs not be cultivated. According to the URA (Urban Redevelopment Authority; founded in Singapore in 1974), the work of Le Corbusier has been central to the key developmental actions in Singapore. It was inspired by Le Corbusier’s five (5) points towards a new architecture, such as that of designing roofs, roof terraces and roof gardens. Rooftop gardens, green roofs, sky terraces, landscaped balconies and green walls co-exist. As density increases, a movement towards greening has politically influenced the transition of a vertical city to a “city in a garden”.

In February 1960, under the aegis of Singapore`s Ministry of National Developments, a state organization called Housing and Development Board (HDB) was founded. The mission of HDB was to provide affordable and inclusive accommodation for a vast majority of the Singaporean population that occupied slums and squatters. Vertical housing developments were built in Singapore that led to the emergence of densely occupied New Towns (Yuen, 2007). These housing developments are currently accommodating approximately 82% (approximately 250,000 people) of the existing population of Singapore and take-up 650 ha (=6, 500,000 m$^2$) of land, according to HDB. Only 9% of the population of Singapore occupied state-owned apartments (HDB, 2012) prior to the intervention of HDB (Yuen, 2007). The need to accommodate increasing amounts of people in Singapore leads to an increase in the number of floors in residential building (i.e., recently from 12 to 30 - 40 stories; Yuen, 2007). Liveability and sustainability are two (2) key words introduced currently in the urban vocabulary of the high-rise building development.

Singapore offers an interest of both public space and built space management. In the words of Lionel March (1960), it is a “good example in which the image of Manhattan has been adopted on sites so small that the footprints of the tower blocks are often less than 25% the area of a typical New York high-rise.”

The vertical city, driven by a rising population density, emphasizes its existence by creating new spaces for people to use collectively. Public spaces appear on the ground terrains, and they are being pushed inside the building structures. Public spaces are produced colonized or decolonized (Hee & Ooi, 2003), gentrified and developed in an almost uneven manner. These spaces are produced and reproduced according to age (e.g., senior citizens fitness space, children’s playground and more). Singaporeans value the relation of spatial provision and emphasize social interaction (Chan et al., 2002; Griffiths, 2000). This challenge becomes more apparent when public spaces become more densely occupied by built spaces.

While density increases, the ground public space is subject to allocation of ground areas (AGA) for various uses, such as for car parking. Public spaces re-appear off the ground; however, this time they offer elements of the built environment, such as a skybridge. As the overall population of Singapore is expected to increase further in the following decades (2050 estimates of the Singapore White Paper, 2013), it is an open research question to identify how architectural design and its anatomy can influence space use and decision-making.

Studies have shown that a single tennis court (March, 1960) is equivalent to the Singapore People`s Action Part provision of public open space (excluding private patios and gardens) per Singapore dweller. This is equivalent to 5520 square Km for current citizen population. The tennis court provision, in the words of Lionel March (1960), is therefore shrinking at ground level and being moved into organized and highly prescribed built spaces in Singapore. Land availability can however be a product of a visual cue leading to a social significance (Rapoport, 1977).

Public spaces in Singapore are products of AGA and thus can be understood as continuously fragmented spaces (Barthes, 1986). In these terms, this research will follow the Lynchian notion of paths in social analyses. Spatial mappings will be used to represent a more meaningful exploration of the “culture” of movement and routine activity flows (Rapoport, 1982).
HDB offers typological elements of habitable spaces. During the long-term use, residents develop their own ways of space appropriation and engineer a membership of socially included-excluded groups within multi-occupancy units.
A residents corner is a predominantly community-based space for resident recreational activities and community gathering.
3.4.1. Facilities in Public Spaces

Singapore offers 26 New Towns that are combinations of neighbourhoods, which are composed by precincts, i.e., clusters of blocks linked by public spaces. Each HDB precinct offers similar elements but has diverse shapes, morphologies, and vertical and horizontal organisations. The public spaces of each precinct are predominately recreation based, in essence, they are fitness or relaxation orientated; however, they also differ, as they are designed to entertain thousands of users and communities.

The provision and level of provision of different types of design facilities in public space may vary considerably. Based on site visits, these public facilities can be as the followings and can consist of various spatial morphologies based on their furniture. The aim for common facilities is to promote a community spirit in HDB precincts.

**Predominantly Community-Based Spaces**
1. Spaces for seating and interacting
   - Void Deck
   - Seating pavilion
   - Resident corner
   - Senior Citizen Centre
2. Spaces for playing and exercising
   - Non age-specific
     - Jogging track
     - Wellness path
     - Hard court (e.g. basketball court)
   - Age-specific spaces
     - Playground
     - Specialized fitness corners
       (e.g. for elderly community members)
3. Spaces for eating
   - Barbeque Pit
4. Spaces for gardening and farming
   - Urban farm
5. Spaces for gathering and events
   - Precinct Pavilion

**Space Open to Community and Non-Community Members**
1. Circulation and Transport-related Spaces
   - Parking spaces: covered and or uncovered
   - Pedestrian network: covered and or uncovered
2. Free spaces
   - Open green spaces
   - Void Deck
3.4.2 Void Decks and Pavilions

Void decks were introduced as public spaces in public housing of Singapore in the 1970s. They were designed with the aim to create void spaces for daily activities under the pillars of buildings. These void spaces would provide enough open areas for community gatherings and bonding to flourish (National Heritage Board, 2013). The introduction of void decks was also considered as a way to reinvent the Kampung spirits, which boost the idea of togetherness in high-rise high-density living environment. Nowadays, non-profit groups and welfare organizations have been re-organizing and using void decks (Tay, 2012). These spaces are thus currently used as day care, childcare, elderly care and community centres. These facilities increase the visits of residents to the void decks, as they just exist a few floors below the residential flat. Overall, according to HDB reports, approximately 640 facilities directed by about 230 organizations occupy the void deck spaces (Shuli and Tay, 2012) within the city.

High-density of living environment has allowed people to gather in shared pavilions (cf. Tay, 2012). Interestingly, these pavilions offer an alternative to using a void deck. However, different from void decks, their booking system is based on the community management and limits the use of community pavilions, since when social event takes place, there is no space left for occasional activities.
3. 4. 3 High-rise Public Housing in Singapore

The design of the Singaporean high-rise housing has undergone various phases of development with respect to the national economy and political thinking. Considering the speed of design change, we could expect that the observed developmental design stages may be stabilized in the future and a relative normalization may occur in spatial design.

To understand the driving forces of the planning missions, there is merit in exploring briefly the historical path that the modern city-state, Singapore, has experienced to develop its current urban infrastructure transformation and appearance. From 1819 to 1960, a number of organizations were founded with the mission to modernize housing; however, the widest majority of developmental projects were conducted from the 1960s onwards. Through the phases of continuities and discontinuities (such as the Asian financial crisis; 1997), the current picture of the Singaporean lifestyle of today was constructed.

In February 1960, under the aegis of Singapore’s Ministry of National Developments, the Housing and Development Board (HDB) was founded to plan and provide affordable and inclusive accommodation for the Singaporean population. The history proved that soon after the foundation of the HDB, large-scale developments strove and housed a nation vertically in new town developments. Forty years later, HDB reported that approximately 82% (approximately 250,000 people) of the existing population of Singapore lives on approximately 350 ha of land. That is the highest land provision in contrast to all other projects that of the city (HDB, 2000a). The Singaporean population started to grow into state-owned apartments only after the interventions of the HDB, and only 9% of the population lived in these apartments at the early year of HDB (HDB, 2012).

One downturn occurred in housing developments in Singapore when the Asian Financial Crisis happened. The need to accommodate increasing numbers of people in Singapore has led to an increase in the number of floors in residential building (i.e., recently from 12 to 30 and 40 stories; Yuen, 2007). In this process, the theme of liveability and sustainability has become central in the urban vocabulary for high-rise building developments.

The increasing number of dwellers in a limited landscape area has offered a density-related viewpoint about the public housing within the city (cf. Wong and Yeh, 1985). In this setting, it has become important to identify influences on the urban settlements design in relation to (Doxiadis C.A.; 1968):

- the spatial morphology
- the pattern of space use (in relation to human behavior)
- functional and organizational factors
4. Case Studies: Architectural Anatomy and Socio-Spatial Analysis

The twofold case study of this research was conducted in two (2) steps: the exploration of 32 public housing precincts, and the deep study on the six (6) selected cases. The study on the 32 cases established the preliminary database for the project in the first step. The cases were selected based on the density of buildings, while demonstrated the typological elements of public spaces in public housing in Singapore. The combinations of these typological elements were used as the selection criteria of the further study on the six (6) cases in the second step. The data collected from literature and on-site architectural investigations were presented as space “autonomy” explaining the physical connection among public spaces and between public spaces and other functional spaces in the precincts. The Information from on-site observations and interviews, along with space image following Kevin Lynch’s theory, depicted the use of public spaces in the real situation. Certain comparisons were made to understand the possible considerations on the space quality.
Evolution In High-Density Living In Singapore

- Ang Mo Kio, Block - 401-406
  - 1971-1979
- Treetodge, Punggol, Block - 305
  - 2007
- Sengkang, River Walk
  - 2005
- Punggol Field Periwinkle
  - 2005
- Rochor Center, Queen Street
  - 1977
- Clementi Heights, Block - 452
  - 2007

- Sengkang, Block - 124, Rivervale Drive
  - 2005
- Pioneer, Jurong West
  - 2000
- The Premiere, Tampines
  - 2009
- Punggol Field / Grove, Block - 201-205
  - 2007
- Sembawang Green, Admiralty Link
  - 2004
- Marine Parade, Block - 77-79
  - 1975

- Forfar Height, Queenstown
  - 2005
- The Peak, Lorong 1A, Toa Payoh
  - 2012
- Central Horizon, Toa Payoh
  - 2008
- Membina Court, Tiong Bahru
  - 2007
- Waterloo Center, Queen Street
  - 2005
- Redhill Rise, Redhill Road
  - 1996

- Eunos Court, Geylang
  - 2006
- Bras Basah Complex, Bain Street
  - 1980
- Admiralty Zone - 5, Woodlands Drive
  - TBC
- Pinnacle, 1 Cantonment Road
  - 2009
- Clementi Towers (Clementi Mall)
  - 2011
- Chua Chu Kang, Block 686
  - 1997

- Linear Green, Bencok
  - 2008
- CityView, Kallang, Boon Kang
  - 2008
- Queenstown, Block - 45-49
  - 1960
- Tiong Bahru, Block - 18-23
  - 2011
- Toa Payoh, Block - 213-224
  - 2005
- Ang Mo Kio, Block - 456
  - 1973

- Queenstown, Block - 24-32
  - 1963
- Buangk Kimberley, Hougang
  - 2008
4.1 Evaluation of 32 Precincts Data Base

This research is based upon initial empirical exploration of 32 public housing precinct formations in Singapore. These correspond to the wide range of public housing GPR in Singapore that range from very low to very high.

The selection criteria are based on the following attributes.

1. **GPR**
   GPR is defined as plot ratio as preliminary indicated by the URA Master plans. More specific figures on the real life conditions effective on-site were based on the re-calculation of the GPR as GPR*.

2. **Location**
   Location refers to the location of the precinct in the city, as this empirical research has aimed to cover a wider spectrum of locations and not limit its scope to only one region.

3. **Urban Connection**
   Urban location refers to the adjacency to different forms of public transport to account for the potential of social interaction with infrastructure that exists outside the immediate precinct periphery.

The 32 HDB precincts catalogued in this empirical research offer a better understanding of the evolution of public spaces. These are the following.

- Block 456-461, Ang Mo Kio
- Block 401-406, Ang Mo Kio
- Linear Green, Bedok
- City View, Boon Keng
- Bras Basah Complex, Central
- Membina Court, Bukit Merah
- Block 18-36, Bukit Merah
- Clementi Towers, Clementi
- Clementi Heights, Clementi
- Block 686-688, Chua Chu Kang
- Eunos Green, Geylang
- Buangkok Link, Hougang
- Pioneer, Jurong West
- Block 66-71, Marina Parade
- Pinnac1, Duxton
- Treelodge, Punggol
- Punggol Field, Punggol
- Grove, Punggol
- Periwinkle, Punggol
- Punggol Field, Punggol
- Block 45-49, Queenstown
- Block 24-32, Queenstown
- Forfar Heights, Queenstown
- Rochor Centre, Central
- RedHill Rise, Tiong Bahru
- River Walk, Sengkang
- Block 124, Sengkang
- Sembawang Green, Tiong Bahru
- The Premiere, Tampines
- Block 213-224, Toa Payoh
- Central Horizon, Toa Payoh;
- The Peak, Toa Payoh
- Waterloo Centre, Central;
- Woodlands Drive, Woodlands
52 Public Space Evolution In High-Density Living In Singapore
Public Space Evolution In High-Density Living In Singapore
4.2 Vertical Organization: Typological Elements

As the building density increases in public housing precincts, increasing number of public spaces are found within building structures and at higher levels. Following the precedent of HDBs descriptions of the development of public spaces in precincts historically, this research further understands the evolution of density and GPR in relation to architectural elements and more specifically the elevation of public spaces above the ground.

One study on the development of the green spaces in Singapore (Yueng, 2013) presented the evolution of the green space in the HDB housing environment. This study inspired our understanding of the vertical development of the spaces in Singapore. However, as we are focusing on different space types, we cannot use the space catalogue directly in this research.

In analysing the characteristics and locations of the public spaces in 32 precincts (see Appendix 3), it has become apparent that in terms of architecture, all designs, even if they offer relative similarities, are different. Based on the exploration of the sites above, five (5) key typological elements of the vertical evolution of public spaces are found. These have highlighted six (6) combinations that have formed the case studies of this research. These five (5) elements are:

1. **Ground:**
   Public spaces are located at the urban street level and linked directly with the transport or pedestrian in the urban scale. The spaces might be a bit higher than are the surrounding streets according to the natural landscape, but there is no man-made structure beneath the spaces.

2. **Raised Platform:**
   Public spaces are situated on a structured platform 1-2 storeys higher compared to the urban street level, and they are linked with the urban streets by outdoor slops or stairs. The platform might be as big as the site, and the structures beneath the platform are normally used as multi-storey car parking areas or some other functions.

3. **Podium:**
   Public spaces are situated on the roof of a structured podium where residential towers are located. The podium can be usually four (4) to 11 storey high, and the spaces in the podium structure can be used in different ways, for instance, multi-storey car parking area, commercial area, office space, or even residential spaces. The public spaces on the podium may be linked with the urban streets with indoor stairwells, elevators or escalators.

4. **Roof Deck Garden:**
   Public spaces are situated on the roof of a building, four (4) to eight (8) storey above the urban streets. The spaces are linked with the urban streets only with indoor stairwells or elevators. The space beneath buildings can be used variously, as residential areas, multi-storey car parking areas, commercial areas or office areas.

5. **Skybridge:**
   Public spaces are situated on the surface of a connecting structure among residential towers at a very high level, usually more than 12 storeys above the urban street. These spaces are linked to the urban streets with indoor stairwells and lifts.

In this understanding, these five (5) typological elements of public space development were summarized according to plot ratio and vertical formation to demonstrate the vertical evolution of the public spaces in high-density living environment in Singapore.
Public Space Evolution In High-Density Living In Singapore
4.3 Selection of Six Case Studies

In architectural terms, elements are naturally combined to form diverse precincts and their related public spaces. For this reason, this research can only propose empirical results based on real-life case study explorations. These explorations by default involve one or more public space elements.

Through the 32 precinct site-observations, it has been confirmed that the broad categorical elements presented variations and many combinations (see Table on the right). Variations and combinations have been preliminarily found to relate to:

**Architectural practice.** Architectural practice offers combinations of categories to finally create new housing complexes that could potentially define a new category of elements.

Departing from broad categorizations to more specific case studies and site-analyses, a program has been settled that attends to the research hypothesis and questions.

**Selection Criteria**
This research breaks new ground on analysing real-life conditions in high-rise high-density living environment in Singapore. The selection of its case study sites is based on:

*Location of the precinct in the city:
The involved sample cases were distributed across the city.*

*Year of completion:
The cases involved are developments no older than the 35 years.*

*Plot ratio:
The cases involve GPR no lower than 3.0 to accommodate the vertical evolution of public spaces. Here, it is necessary to remember the challenge with obtaining the “real-life” values instead of the provided values by URA Master plan. Thus, the initial 32-precinct observations were premised upon the GPR values on URA Master plan. Further selection of the six (6) cases and more studies of the so-called “real-life” GPR* were endeavoured.

*Essential use:
The cases involve one mixed-use housing development in order to explore whether any differences in space use and appropriation could occur in contrast to predominantly housing estates.*
Public space elements:
The cases represent the combinations of the vertical evolution of public spaces.

The 32-precinct sample is a database that contains samples from the state. Some samples were older than 1980s and have a GPR outside of the 2.8 to 8.4 range (across the URA Master plan). More specifically, the 32-precinct set includes the blocks in “Queenstown” built in the 1960s, the “Pinnacle @ Duxton” built in 2009, and “The Peak” in Toa Payoh built in 2012, one of the newest developments of HDB. In accordance with the four points of these selection criteria, the sites that were selected include:

1980s, Rochor (central Singapore) - Bras Basah Complex
URA Master Plan GPR: 4.2
GPR* (plotted by the researcher-Team): 4.7
Elements: Podium

2000, Jurong West (western Singapore) - Pioneer
URA Master Plan GPR: 3.0
GPR* (plotted by the researcher-Team): 3.3
Elements: Ground

2008, Toa Payoh (central Singapore) - Central Horizon
URA Master Plan GPR: 4.0
GPR* (plotted by the researcher-Team): 4.4
Elements: Ground, podium, roof deck garden

2009, Tanjong Pagar (central business district) - Pinnacle @ Duxton
URA Master Plan GPR: 8.4
GPR* (plotted by the researcher-Team): 9.2
Elements: Raised platform, skybridges

2010, Punggol (northeastern Singapore) - Treelodge
URA Master Plan GPR: 3.0
GPR* (plotted by the researcher-Team): 3.3
Elements: Raised platform

2012, Toa Payoh (central Singapore) - The Peak
URA Master Plan GPR: 4.2
GPR* (plotted by the researcher-Team): 4.6
Elements: Ground, roof deck garden
Public Space Evolution In High-Density Living In Singapore

- Treelodge@Punggol
- Central Horizon@Toa Payoh
- The Peak@Toa Payoh
- Bras Basah Complex@Rochor
- Pinnacle@Duxton

<table>
<thead>
<tr>
<th>Project Location</th>
<th>URA-GPR</th>
<th>GPR*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pioneer (Western)</td>
<td>3.0</td>
<td>3.3</td>
</tr>
<tr>
<td>Treelodge (Northeastern)</td>
<td>3.0</td>
<td>3.3</td>
</tr>
<tr>
<td>Central Horizon (Central)</td>
<td>4.0</td>
<td>4.4</td>
</tr>
<tr>
<td>The Peak (Central)</td>
<td>4.2</td>
<td>4.6</td>
</tr>
<tr>
<td>Bras Basah Complex (Central)</td>
<td>4.2</td>
<td>4.7</td>
</tr>
<tr>
<td>Pinnacle@Duxton (CBD)</td>
<td>8.4</td>
<td>9.2</td>
</tr>
</tbody>
</table>

URA - GPR FROM MASTER PLAN AND GPR* PLOTTED
GPR* - RESEARCH BASED PRELIMINARY STUDY
Precinct Name: **Pioneer**
URA Plot Ratio: 3.0
GPR (Plotted; see Appendix 1): 3.3
Precinct Capacity: 5600
Location (New Town): Jurong West
Public space elements: Ground
Precinct Name: **Treelodge**
URA Plot Ratio: 3.0
GPR (Plotted; see Appendix 1): 3.3
Precinct Capacity: 2100
Location (New Town): Punggol
Public space elements: Raised platform
Precinct Name: **Central Horizon**
URA Plot Ratio: 4.0
GPR (Plotted; see Appendix 1): 4.40
Precinct Capacity: 4600
Location (New Town): Toa Payoh
Public space elements: Ground, podium and roof deck garden
Precinct Name: **The Peak**

URA Plot Ratio: 4.2

GPR (Plotted; see Appendix 1): 4.62

Precinct Capacity: 4600

Location (New Town): Toa Payoh

Public space elements: Ground and roof deck garden
Precinct Name: **Bras Basah Complex**
URA Plot Ratio: 4.2
GPR (Plotted; see Appendix 1): 4.73
Precinct Capacity: 620
Location (New Town): Central Area
Public space elements: Podium
Precinct Name: **Pinnacle@Duxton**
URA Plot Ratio: 8.4
GPR (Plotted; see Appendix 1): 9.28
Precinct Capacity: 7200
Location (New Town): Central Area
Public space elements: Raised platform and Skybridges
4.4 Case Studies

In this part, six (6) selected precincts and their public spaces were studied deeply from both architectural and sociological perspectives.

In terms of architecture, the ground space allocation were analysed according to the building density and the organization to present the effect of the density to the public space evolution in the current high-density living environment.

From the sociological respect, the data from on-site observations and interviews were analysed to describe the daily activities and behaviours in the public space and to explain the reasons behind these phenomena. Kevin Lynch’s space analysis and accessibility analysis further present the interrelations between the horizontal and vertical space organizations and people’s understandings of the spaces, which finally influence the variation of space use.

With different spatial elements and combinations, the studies on these six (6) precincts would also indicate the relations between space elevation and the changes in space use, which are discussed at the end of the report.
70 Public Space Evolution In High-Density Living In Singapore
4.4.1 Pioneer @ Jurong West

The Pioneer represents average HDB precincts built around 2000 with relatively high building density. The characteristics of these precincts include ground level public spaces, horizontal networks of vehicle-pedestrian path, independent MSCP, and cluster residential blocks equipped with lifts serving every floor.

The precinct is located near an industrial area in the western part of the island. Several industry-related infrastructures are placed around the precinct. This remote location with long distance to the downtown is the major drawback of the precinct until the completion of the adjacent MRT station around 2010.

Most public spaces are laid out in the middle of the precinct, with various facilities surrounded by residential blocks, internal streets and pedestrian networks. By studying this case, the use of public spaces at the ground level was presented. It offered the fundamental understanding of further comparison of various situation triggered by spatial elevation.

<table>
<thead>
<tr>
<th>Year of Construction</th>
<th>2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plot Size (Total Area of Precinct)</td>
<td>67000 m²</td>
</tr>
<tr>
<td>Gross Floor Area</td>
<td>221000 m²</td>
</tr>
<tr>
<td>Estimated Number of Residents</td>
<td>5600</td>
</tr>
<tr>
<td>Number of Floors</td>
<td>16</td>
</tr>
<tr>
<td>Counted total Capacity of carparking</td>
<td>1272</td>
</tr>
</tbody>
</table>
The Singapore HDB precincts are formed based on Building footprint, drive way and surface-parking as well as open spaces. The facilities for public use include:

- Void decks
- Precinct pavilion
- Playgrounds
- Fitness Corner
- Open space
- Sitting areas
- Resident corner
- Community garden
- Green spaces
- Walkway

The diagrams here show that 67% of the total site area is open to the sky and is non-building related public space that includes driveways and surface parking. Overall, 10% is the building footprint that includes void decks at the ground level. These typological elements are designed to house approximately eight (8) people per 100 m² as a total site area provision. On the other hand, each resident in this precinct can have 7m² open space on the ground.

This precinct does not offer public above-ground spaces. Our researchers counted the car parking lots on-site and it was found accessible.

The car parking provision per 100 m² of total site area is 1.9. Based on a provision of 25 m² per car, our calculations have also shown that 47.5% of the total site would provide the effective space required for parking if it was located on the ground surface. Building two multi-storey car parking lots saved a great amount of ground space. In effect, around 60% of the site area was left open.

These figures demonstrate the observed levels of ground and multilevel space allocations and aim to illustrate occupant-related as well as building and car related factors of density.
Car-parking space organization and connection to urban transport

Allocation of different spaces at ground level of the precinct:

- 10% Carpark Building Footprint
- 23% Building Foot Print, includes:
  - 10% Built Space
  - 13% Void Deck at Ground Level
- 8% Road Network and Surface Parking
- 59% Open Ground
Total multilevel provision of public space:

- Ground open area incl. pavillons: 39600 m²
- Ground level void deck: 8600 m²
- Total multilevel public space: 48200 m²

All public space of the precincts is located at ground level which is 72% of total site area.

Open ground per GFA (Without Void Deck): 0.18

Open Ground per Person (Without Void Deck): 7 m²

Total ground public space per GFA: 0.22

Total ground public space per person: 8.6 m²
Public Space Evolution In High-Density Living In Singapore
Spatial Observation and Analysis

Based on Lynchian space analysis method
Observation and Interviews on Pioneer @ Jurong West

General Impression
The Pioneer space may exhibit a typical picture of the public space use in average HDB precinct. It suggests some temporal and spatial dimension of rhythms in space use.

The Pioneer space is most frequented between 15pm and 19pm in the afternoon after the school hours. Young students walked across the precinct and the public spaces, played and communicated with one another in the playground and the open green spaces. Some younger children and their guardians (e.g., parents, grandparents, or domestic helpers) came to the public spaces at that time. Later, working people returned home and joined the people using the spaces.

People also use the public spaces in early morning when the spaces are not exposed to the sunshine directly. Older people exercised in the fitness corner and then rested with friends in either the sitting pavilion or resident corner. Some young mothers with their babies sitting in the prams used the sitting pavilion before the lunchtime.

The most impressive phenomena in the precinct were that most activities were concentrated in the central area of the precinct while few activities were found in the void deck or pedestrians peripherally, specifically only one tenth of the activities in the central area. Most activities appearing in the pedestrian networks and the void deck, either covered or uncovered, were passing through. The stay in these two (2) spaces was comparatively shorter, composed primarily by brief interactions among neighbours and waiting for preschool to open or taxis.

In addition, there was no visit observed in the peripheral playground for children aged 1-2 years old, the precinct pavilion connected to the MSCP, the community garden and the hard court. A traditional Chinese funeral was held in that precinct pavilion connected to the MSCP before the start of the observation. The pedestrian path next to the hard court was under the construction, and the hard court was enclosed as the storage. The community garden was locked all the time during the entire observation process.

It is obvious that the core of the central area was the playground where most people gathered. The activities became increasingly inactive, with the increased distance to the playground in the central area. These changes with certain regular patterns might be interpretable by investigating the characteristics of spaces. Further steps for understanding these rhythms were taken trying to explain the interrelations between the space use and the spatial characters.

Space Organization
A spatial observation through Lynchian space analysis method indicated that most public spaces in the Pioneer (see the left page) are concentrated in the centre of the precinct.

13 residential blocks with some enclosed spaces (e.g., residential units, pre-school, community centre, etc.) on the ground floor contain two (2) strong layers around the central area to the urban environment, leaving only one opening to a primary school on the east of the precinct. The central area is not visible from outside. The greenery, grasses or bushes, further shape the public spaces, forming an east west oriented green belt. The spaces laid in or around the belt include a playground, a fitness corner, a sitting pavilion, a precinct pavilion, and a resident corner. Some other public spaces are scattered on the periphery of the precinct, such as a baby playground for children aged 1-2 years old, a precinct pavilion connected to one of the MSCP, a community garden and a hard court. Void deck and pedestrian networks link all these spaces, central or peripheral, as well as the residential blocks and MSCP. The lift lobbies of each residential block in the void deck at the ground level are the transfer nodes from vertical to horizontal. A mixed path for both vehicle and pedestrians circles between the rows of residential blocks, and ends up to the urban transport and two (2) MSCP respectively. Four (4) urban streets with heavy traffic lay surround the precinct. A MRT station and a pair of railways are erected parallel to one side of the precinct above one of the streets.
The observation conducted in the Pioneer focused mainly on the central area where most of the public spaces (e.g., playground, fitness corner, open green spaces, precinct pavilion, sitting pavilion, resident corner, and void deck) are located. The void deck, pedestrian networks and green spaces around the central area were also observed during the whole process.

The number of visits by types of spaces shows that playground was the most frequently visited space type in the precinct, with the 220 total visits. The second most frequently visited space was open green space, followed by fitness corner and sitting pavilion. There were relatively fewer visits observed in the void deck, and no visit was observed in either hard court or community garden.

The average duration of visits by the types of spaces shows that the public spaces with the highest mean time per visit were the open green spaces, resident corner, sitting pavilion, playground, and precinct pavilion. Some other spaces, on the other hand, were used for passing through, such as the void deck and the pedestrian paths.
The number of visits by the type of space appropriation shows that the primary activity in the precinct was playing, which was observed more than 50 times daily on average. The secondary activity was rest followed by informal communication, exercise and eating. These five (5) activities accounted for more than 90% of total activities observed in the Pioneer.

The average duration of visits by the types of space appropriation shows that the maximum duration appeared in the activities of baby-sitting and smoking, and the average time spent on these two (2) activities were more than 50 minutes, although these activities appeared less frequently. Besides walking pets, individuals spent the shortest amount of time exercising and studying, the time spent on these two (2) activities was around 20 minutes on average. The average duration of the two (2) primary activities, i.e., playing and rest, were more than 40 minutes.
Proportion of Space Appropriations by Type of Public Space
Based on the visit numbers of each space appropriation

Playground
- Playing: 81%
- Exercises: 5%
- Rest: 7%
- Informal Communication: 7%

Fitness Corner
- Playing: 24%
- Exercises: 26%
- Rest: 23%
- Informal Communication: 9%
- Eating: 1%
- Baby-Sitting: 17%

Sitting Pavilion
- Playing: 6%
- Exercises: 4%
- Rest: 63%
- Informal Communication: 24%
- Smoking: 1%
- Waiting: 2%

Void Deck
- Playing: 5%
- Exercises: 5%
- Rest: 11%
- Informal Communication: 32%
- Waiting: 21%
- Maintenance: 26%

Open Green Space
- Playing: 13%
- Exercises: 14%
- Walking-Pets: 1%
- Rest: 42%
- Informal Communication: 16%
- Smoking: 7%
- Waiting: 3%
- Maintenance: 4%

Pedestrian Network
- Playing: 11%
- Exercises: 33%
- Walking-Pets: 5%
- Rest: 2%
- Informal Communication: 44%
- Smoking: 5%

Resident Corner
- Rest: 49%
- Informal Communication: 32%
- Studying: 2%
- Eating: 13%
- Smoking: 2%
- Waiting: 2%

Precinct Pavilion
- Playing: 78%
- Exercises: 20%
- Rest: 2%
According to the number of visits and the average duration of each space appropriation, the proportion of space appropriation in the entire precinct by total time spent is presented in the diagram. It shows that individuals spent most time playing, resting, engaging in informal communication and eating, which accounted for more than 80% of the overall time spent in the spaces.

The majority of the space users in the precinct were 20-39 years old adults, regarding to the categorization by age. The difference of visit numbers among the age groups indicated that a considerable amount of young adults used the public spaces in the precinct by themselves.
The factors that influenced the interviewees’ use of the space in the precinct are listed in the following diagram. Among the four (4) categories, design and environment were most influential, as they were mentioned with the greatest frequency. Three (3) sub-categories under environment, urban surroundings, natural surroundings, and human surroundings contributed almost equally to the space use. The most frequently mentioned factors were the presence of facility and the provision of sitting furniture in the design, the sanitary condition of the spaces in management, and the foreign workers’ use in the social context.

The access diagram on the right page shows that from every single flat unit, people can reach the ground public spaces directly through lifts in each residential block. The public spaces in the central area are interconnected and form a space district. It is obvious that any route across the precinct would pass through this district. The remaining public spaces (e.g., the peripheral baby playground, the precinct pavilion next to the MSCP, the hard court and the community garden) only linked to the pedestrian networks by themselves.

**Frequency of Influential Factors in Interviews**
*Based on the times interviewees mentioned factors (Numbers in the brackets)*

- **Design (17)**
  - Presences of Facilities (6)
  - Presence of Sitting Furniture (5)
  - Landscape (3)
  - Presence of Shelter (2)
  - Illumination (1)

- **Environment (19)**
  - Urban Surrounding (6)
    - Air Quality (3)
    - Urban Traffic Network (2)
    - Volume of Noise (1)
  - Natural Surrounding (7)
    - Wind (Ventilation) (2)
    - Temperature (2)
    - Shade (2)
    - Green Plants (1)
  - Human Surrounding (6)
    - Population Density (3)
    - Interruption (2)
    - Volume of Sound (1)

- **Management (5)**
  - Sanitary Condition (5)

- **Social Contexts (8)**
  - Foreign Workers (6)
  - Community Network (2)
Public Space Evolution In High-Density Living In Singapore

Access Diagram

- BLK 652A
- BLK 652B
- BLK 652C
- BLK 653A
- BLK 653B
- BLK 653C
- BLK 655A
- BLK 655B
- BLK 654A
- BLK 654B
- BLK 654C

To MRT and Bus Stop
To Jurong West Street 61

Floor 1
Floor 2
Floor 3
Floor 4
Floor 5
Floor 6
Floor 7
Floor 8
Floor 9
Floor 10
Floor 11
Floor 12
Floor 13
Floor 14
Floor 15
Floor 16

- Residential Unit
- Covered Pedestrian Networks
- Uncovered Pedestrian Networks
- Jogging Track
- Stairwell
- Elevator Shaft
- Elevator Stop
- Staircase Stop

- Residential
- Fitness Corner
- Open Green Space
- Sitting Pavilion
- Resident Corner
- Multi-Functional Pavilion
- Community Center (Enclosed)

- Hard Court
- Community Garden
- Multi-Storey Car park
- Commercial Unit
- Void Deck

- BLK 652A
- BLK 652B
- BLK 652C
- BLK 653A
- BLK 653B
- BLK 653C
- BLK 655A
- BLK 655B
- BLK 654A
- BLK 654B
- BLK 654C

To Jurong West Street 61
Public Space Evolution In High-Density Living In Singapore
Summary
The shortcut to or from MRT station and the lack of partitions between the city and the precinct lead to the crossing-through flow and the non-residents’ use in the space. The feeling of crowdedness led to an abandonment of peripheral space and residents leaving the public spaces in the evening. However, on the other hand, the interviewed residents also expressed their understanding that the ground spaces were as open as any urban spaces to the publics without any restrictions. Residents indicated their preference of diversity of facilities with plenty of sitting furniture around the space, the nice landscape, the comparatively cooler temperature, and the comfortable ventilation through the whole precinct. Facilities containing these features attracted both residents and non-residents.

Nevertheless, the interviewees also repetitively mentioned the negative factors brought about by the heavy urban traffic around the precinct, including strong air pollution, traffic noise and safety issues. Their negative effects were highlighted when people discussed the peripheral areas, especially the peripheral baby playground that the residents avoided.

As an almost 15-years old HDB precinct, the Pioneer accommodated not only Singaporean citizens, but also temporary residents working and studying in the Jurong New Town. Both the fixed friendships among the older residents living here for more than 10 years and the temporary social connections among households with young children were the two (2) major social networks in the precinct built in the long-term space dwelling process and affected people’s space use. People preferred to stay in the public spaces longer when they found some companions. Brief interactions with neighbours transformed to long-term conversation accompanied by sharing food, reading or some other sedentary activities. Meanwhile, dwelling longer in the spaces made it easier for people to establish their social network. This explained the importance of the provision of sitting furniture in the public spaces, as it can enhance the interrelation between people and spaces.

Observation, interviews and Lynchian space quality of the Pioneer show the regular patterns in the space use, involving both space dwelling and passing through at the ground level. These patterns were built on the balance among several influential factors, including not only physical conditions but also social contexts.
4.4.2 Treelodge @ Punggol

As a part of the Punggol 21, the new housing model in Punggol New Town, Treelodge @ Punggol is designed as the first eco-precinct in HDB. A number of eco-friendly technologies as well as the new spatial organization are implemented in the precinct to provide a comfortable and sustainable green living to the community.

The study on the Treelodge emphasised the influence of this one-to-two-storey public space on people’s behaviour and space use.

Year of Construction 2010
Plot Size (Total Area of Precinct) 30000 m²
Gross Floor Area 99000 m²
Estimated Number of Residents 2100
Number of Floors 16
Counted total Capacity of carparking 362
Public Space Evolution In High-Density Living In Singapore

Community Space (Restricted)
HDB Precinct Blocks
Collective Public Space (with Admission fee)
Collective Public Space (Open to all)

Horizontal Circulation (Walkways Covered)
Transportation Network (External and Internal)
Vertical Circulation
Dead Ends
Staircase Regular stop
Lift Regular stop
Carpark
MRT Station

Horizontal Circulation (Walkways Uncovered)
Pedestrian Crossing
Pedestrian Circulation Area Between Precinct and Urban Network

Open Green Space
ECO Precinct Space
Urban Farming
Play Area
Fitness Corner
Running Track
Hard Court (e.g. Basketball Court)
BBQ Pit
Food Court
Commercial Space
Precinct Pavilion

Void Deck
Built Spaces in the Void Deck (Residential, Commercial, Maintenance)

0 20m 50m 100m
This precinct, which was completed in around 2011, comprises seven (7) cluster blocks that are 16-storey high and accommodate residential needs at a plot ratio of 3.3 (plotted). The public spaces provided at the Treelodge are mainly on the elevated 2nd storey E-deck and some void decks adjacent to the car parking area on the ground as well.

The public spaces of the Treelodge are characteristic for their provision of community facilities on the E-deck that is elevated from the ground and car-parking area is beneath the deck at the ground level. The facilities for public use are:

- Two void decks (on the ground and above the ground)
- Precinct pavilion
- Playground
- Fitness Corner
- Open space
- Community garden
- Jogging track
- Walkway

The public space on the open-air E-deck that is elevated off the ground and sits on car park area involves 56% of the land area. Void deck covers additional 6% of the site area above ground as well as 18% of the site area on the ground where the car park is located.

The car parking provision per 100 m² of total site area is 1.2. Based on a provision of 25 m² per car, our calculations have also shown that 30.7% of the total site would be the effective space required for parking if this was on the ground surface.

The figures that appear on these pages demonstrate the observed levels of ground and multilevel space allocations and aim to illustrate occupant-related as well as building and car related factors of density.
Allocation of different spaces at ground level of the precinct

- 21% Open Ground
- 18% Void Deck on the ground
- 5% Building Footprint
- 56% Podium Block Footprint

Vehicular network and parking provision
Public Space Evolution In High-Density Living In Singapore

Total multilevel provision of public space:

- Ground open area incl. pavilions: 6000 m²
- Elevated open area: 12000 m²
- Ground level void deck: 5400 m²
- Upper level void deck: 1800 m²
- Total multilevel public space: 25200 m²

Open ground per GFA (Without Void Deck): 0.06

Open Ground per Person (Without Void Deck): 2.9 m²

Total multilevel public space per GFA: 0.26

Total multilevel public space per person: 12 m²

All public space of the precincts is located at ground level and raised platform level.
Spatial Observation and Analysis
Based on Lynchian space analysis method
Observation and Interviews on Treelodge @ Punggol

**General Impression**

The observation in the precinct focused on the second floor, specifically the E-deck, where all public spaces are located. The ground space for car parking and transport was also observed.

The space appears to be most frequented between 16pm~19pm on both weekdays and weekends. Young children used the playground and the precinct pavilion after their school hours around 16pm while adults used the fitness corner for exercises and the open green spaces for strolling and resting before or after the dinnertime.

For the first time, we observed the use of the community garden in the precinct. A middle-aged woman used the space almost every day around 18pm. She trimmed and watered plants, cleaned the garden, and brought some vegetables and fruits home after locking door of the garden. The entire process took approximately 10-30 minutes.

Certain spaces were not used efficiently in the precinct. The car parking area or the decorative greenery spaces at the ground level used primarily for passing through. People used those spaces mainly for transport, such as parking cars or bicycles, taking on or off cars or vehicles, etc.

**Space Organization**

The Lynchian space analysis method (see the left page) was used to interpret the entire public space of the precinct.

The orientation of the entire precinct is easily recognized, as two (2) of its ends facing the MRT station and the LRT stop, respectively. Both the residential blocks and the main paths both at ground level and on the second floor parallel the urban street on the northeastern side of the precinct. A Chinese temple is located on the northwestern corner of the estate.

The structure of the entire precinct is clear. Seven (7) residential blocks parallel the two (2) sides of the vehicle lane on the ground. Except the lift lobbies and entrance yards for each block, the entire ground level is used as a garage for car parking and garbage collection. The spaces for pedestrians and daily activities are located on the second floor. In addition to lifts, several outdoor staircases and slop by the side of the residential blocks connect the ground and the second floor as well as the urban networks. Several gaps between the residential blocks and the deck solve the lighting and ventilation problems of the ground garage around each residential block. The residential blocks are structurally independent of the elevated public spaces while being linked to the elevated spaces by a bridge, which the only way to approach each residential block. Relying on the structure of the garage, a peripheral open green space is located on the northeastern side of the precinct. A narrow jogging track runs around the entire site.

The area of the public spaces on the second floor is determined by the entire building structure. The primary path, which is the covered pedestrian way in the middle, penetrates the entire deck from the precinct pavilion at one end to the fitness corner at the other end. Combined with the bridge leading to each residential block, a fish-bone-like network is created. A number of stainless steel panels stand along with the primary path, introducing Eco-technologies applied in the precinct. A number of benches are fixed on the either side of it. Three districts can be recognized on the second floor: the precinct pavilion area, the playground and around open green spaces and the fitness corner area, all of which allow for the engagement in major activities, such as playing and exercise. Interestingly, fences or parterres enclose the playground for the sake of safety and security.
The analysis of the number of visits by the type of spaces in the Treelodge indicated that playground, precinct pavilion and fitness corner were the most frequently visited spaces, followed by fitness corner. Overall, less than ten (10) visits were observed in the jogging track and the community garden. Different from other studied precincts, we recorded no visit in the void deck or the peripheral open green space next to the urban street.

The average duration of visits by type of public spaces shows the average time spent in different public spaces during the period of observation. The Figure shows that the average time spent at the playground was the highest. The average duration in the pedestrian networks was 21 minutes. The difference between the pedestrian networks and other spaces in time spent was small in the precinct. Individuals spent the least amount of time in community garden among all public spaces in the precinct.
The number of visits by the type of space appropriation shows that the primary activity in the precinct was playing and exercises. These two (2) activities accounted for more than 75% of the total activities observed in the precinct. Some activities, such as eating, baby-sitting and studying, were seldom observed.

The average duration of visits by the types of space appropriation shows that individuals spent most time playing, and the average time spent on this activity was more than 30 minutes. The average duration of the other space appropriation was around 20 minutes, while the shortest average duration was observed for walking pets.
Proportion of Space Appropriations by Type of Public Space
Based on the visit numbers of each space appropriation

Playground
- Playing: 85%
- Exercises: 2%
- Walking-Pets: 1%
- Rest: 6%
- Informal Communication: 4%
- Baby-Sitting: 1%

Open Green Space
- Exercises: 60%
- Walking-Pets: 16%
- Informal Communication: 4%
- Studying: 8%
- Maintenance: 12%

Fitness Corner
- Playing: 27%
- Exercises: 30%
- Walking-Pets: 3%
- Rest: 11%
- Informal Communication: 11%
- Eating: 5%
- Baby-Sitting: 9%

Jogging Track
- Exercises: 100%

Precinct Pavilion
- Playing: 34%
- Exercises: 34%
- Walking-Pets: 8%
- Rest: 13%
- Informal Communication: 4%
- Studying: 6%
- Baby-Sitting: 1%

Community Garden
- Maintenance: 100%

Pedestrian Network
- Playing: 37%
- Exercises: 29%
- Walking-Pets: 4%
- Rest: 18%
- Study: 4%
- Baby-Sitting: 4%
- Maintenance: 4%
Based on both the number of visits and the average duration of each space utilisation, the proportion of space utilisation in the entire precinct by total time spent is presented by the diagram. It shows that individuals spent the longest time playing and exercising, accounting for 80% of the overall time spent in the public spaces of the precinct.

Most space users in the precinct were young children and 20-39 years old adults. Only few teenagers were observed using the spaces in the precinct. This may be related to the demographic structure of the precinct, as the Treelodge is one of the latest HDB estates in the island, and the majority of the households are nuclear families with young couples.
The influential factors of the space use and the times mentioned by the interviewees in the precinct are presented in the following diagram. The factors belonging to design aspect were mentioned most in the interviews, followed by the factors under the category of natural surroundings, while the factors pertaining to social context and human surrounds were mentioned least. The factors, such as the presence of facilities and natural ventilation on the site, were perceived as the most influential factors in the precinct.

The access diagram shows that the second floor public spaces could be accessed in different ways. Except for the main entrances at the ends of the precinct, the spaces are reachable by the lifts in each residential block from either the ground floor or every flat floor. These lift stops consist of a 3-dimensional circulation network in the precinct. From urban environment, there are three (3) layers embracing the major spaces in the middle: the jogging track is the first layer, the peripheral open green space is the second one, and the rowed residential blocks are the third one.

**Frequency of Influential Factors in Interviews**

Based on the times interviewees mentioned factors (Numbers in the brackets)

**Design (24)**
- Presences of Facilities (9)
- Presence of Sitting Furniture (3)
- Landscape (1)
- Presence of Shelter (2)
- Illumination (3)
- Accessibility (5)
- Adjacency to Garbage Chute (1)

**Management (3)**
- Entrance Permission (1)
- Sanitary Condition (2)

**Urban Surrounding (9)**
- Air Quality (2)
- Urban Traffic Network (2)
- Volume of Noise (2)
- Location Distance (3)

**Natural Surrounding (15)**
- Wind (Ventilation) (6)
- Temperature (2)
- Shade (2)
- Green Plants (2)
- Scenery (3)

**Social Contexts (2)**
- Community Network (2)

**Human Surrounding (4)**
- Population Density (3)
- Volume of Sound (1)
Public Space Evolution In High-Density Living In Singapore
Summary
Based on the observation, the spatial analysis through Lynchian theory and the information from the interviews were combined together to interpret the activities in the spaces of this precinct.

The popularity of the playground was obvious, as there were large differences in both the frequency of visit and duration between playground and other spaces. The usefulness of the precinct pavilion was highlighted during the observation, as it is the only covered outdoor space on the second floor. A number of people played, exercised, walked their dogs, and rested in the precinct pavilion.

The interviews supported the residents’ fondness of the precinct. The advantages of the elevated space were twofold. First, elevated space separated the pedestrian path and the daily activity spaces from vehicle and urban traffic. Though lifted off the ground as an isolated island in the area, the interviewees felt much safer with a strong sense of ownership. The second advantage is that residents did not have to be exposed to the natural weather after they arrived in the precinct, especially in rainy days. Residents can reach their flats directly from the ground garage by lifts; hence, they did not have to walk outdoors from normal multi-story car park to residential blocks.

The presence of facilities in the spaces is mentioned as the most attractive factors to the space use. This explains the popularity of the playground and the fitness corner, while as the only space with shelter, the frequent use of the precinct pavilion during the observation was understandable. However, as the two (2) sides of a coin, it is acceptable that people would visit other spaces because of the provision of the facilities. In fact, the Waterway Park on the other side of the precinct that offers various sport facilities and equipment and the neighbourhood playground next to the precinct had already driven a number of resident away from the Treelodge. Numbers of young children and students played in several playgrounds; and their duration in each playground was reduced as a result. Some interviewees even considered that the spaces in the precinct were the alternative to the Waterway Park.

The comparatively long duration in the primary path on the second floor than that in the other studied precinct was an interesting discovery in the precinct. The primary path, as the only covered path through the precinct, enforced the use of the space. The increased opportunity for interaction among the residents and the provision of sitting furniture (e.g., benches) helped certain spaces transformed from pass through ones to dwelling spaces. Another difference from other cases was the rare use of the void deck. The space analysis by Lynchian theory showed that the void deck underneath each residential block is separated and isolated without any defined function. Certain similarity with other precincts was found in the space used as the centre-periphery pattern, which appeared in the Pioneer as well. The observations, interviews and the access diagram showed that the spaces located on the inner layer of the precinct tend to be visited more frequently.

The study of the Treelodge showed the space use in the precinct with one-or-two-storey high public space elevated off ground. Interviews rather than observations suggested the advantages of the elevated space, indicating that the residents accepted this space type while the design and environment factors, such as the presence of facilities and the ventilation, exerted strong influence in this precinct.
Public Space Evolution In High-Density Living In Singapore
The precinct is an experimental project on urban housing redevelopment with high population density. Located at the centre of Toa Payoh Town, one of the first HDB New Towns in the island, the precinct had the longest curved residential block in 1970s. It was a landmark from the public housing respective at that time. With the increased population and the growth of the urban network, the economic value of both land and property triggered the redevelopment of the precinct. The idea of the project was to preserve the impression of the precinct in HDB’s history while accommodating much more population. Accordingly, a long curved residential podium with five (5) cluster residential towers was designed for the precinct.

The lush greenery spaces offered by the precinct are located on the ground level, on the roof deck of the MSCP and on the podium of the residential blocks. This project was also the first precinct providing multi-tier green landscapes in HDB with the purpose of optimizing the use of the limited land.

This precinct showed what happened when some public spaces were elevated to the podium roof deck and the roof deck of the MSCP. The differences in space use demonstrated the influence of space elevation onto the spatial behaviour and daily activities.

<table>
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<th>Specification</th>
<th>Value</th>
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<tbody>
<tr>
<td>Year of Construction</td>
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<tr>
<td>Plot Size (Total Area of Precinct)</td>
<td>30000 m²</td>
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<tr>
<td>Gross Floor Area</td>
<td>132000 m²</td>
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<tr>
<td>Estimated Number of Residents</td>
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</tr>
<tr>
<td>Number of Floors</td>
<td>40</td>
</tr>
<tr>
<td>Counted total Capacity of carparking</td>
<td>645</td>
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</tbody>
</table>
Public Space Evolution In High-Density Living In Singapore
This precinct was built in mid-1960s to accommodate its residents in 12-story curvilinear slab block. Rapid growth in Singapore has influenced the demolition of the development and its redevelopment in 2008 to accommodate many more people in its 40-storey premises at a plot ratio of 4.0 (plotted). A 12-storey high curvilinear slab block (podium) that connects to an 8-storey car park with five (5) point blocks on top of this public space composes the Central horizon.

The public spaces at the “Central Horizon” in Toa Payoh are located on the ground open space. They comprise void decks; the 8-storey car park podium roof deck (also known as roof garden), which is accessible from the 12-storey housing block; and the 12-storey podium roof deck that is composed uniformly by open-air areas and void decks; sources of gathering and vertical transport (locations of interchange). The 8-storey car park podium roof deck rests on two interconnected levels due to the multi-storey typical car-park ceiling formation.

The public spaces in the Central Horizon offer the following facilities public use:

- Void decks (on the ground and above the ground)
- Precinct pavilion
- Two (2) playgrounds on the ground
- Sitting pavilion
- Fitness corner
- Hard court
- Open space
- Walkway
- Two (2) roof decks

The car parking provision per 100 m² of total site area is 2.2. Based on a provision of 25 m² per car, our calculations have also shown that 53.8 % of the total site would be required for parking if it were on the ground surface.

The figures that appear on these pages demonstrate the observed levels of ground and multilevel space allocations and aim to illustrate occupant-related as well as building and car related factors of density.
Allocation of different spaces at ground level of the precinct

- 11% Carpark Building Footprint
- 16% Building Footprint includes:
  - 6% Built Space
  - 10% Void Deck
- 16% Road Network and Surface Parking
- 57% Open Ground

Vehicular network and parking provision
Public Space Evolution In High-Density Living In Singapore

Total multilevel provision of public space:

- Ground open area incl. pavillons: 17200 m²
- Elevated open area: 5100 m²
- Ground level void deck: 3100 m²
- Upper level void deck: 2600 m²
- Total multilevel public space: 28000 m²

All public space of the precincts is located at ground level and raised platform level.

- Open ground per GFA (Without Void Deck): 0.13
- Total multilevel public space per GFA: 0.21
- Open Ground per Person (Without Void Deck): 3.7 m²
- Total multilevel public space per person: 6.1 m²
Spatial Observation and Analysis
Based on Lynchian space analysis method

The 12th Floor Podium Roof Deck Terrace

The Ground Public Spaces
Observation and Interviews on Central Horizon @ Toa Payoh

General Impression

The entire precinct is designed evenly and symmetrically. The main entrances for both vehicles and pedestrians are located in the middle of the site with a name board facing the urban street. The Toa Payoh New Town Centre located opposite to the site comprises HDB Hub, a municipal scale shopping centre, a shopping mall, an MRT & bus interchange terminal for the area, a branch of National Public Library and some other infrastructures. The HDB Hub is one of the highest office buildings in Toa area.

The observation in the Central Horizon was conducted not only at the ground level, but also on the 8th floor MSCP roof deck and the 12th floor podium roof deck in the residential blocks.

The peak time for space use in the precinct appeared before 8am in the morning and after 16pm, although people visited these places less frequently compared to the spaces in other studied precincts. Most participants were retired people doing exercises and young children playing with their guardians. The use of the playgrounds, fitness corner and void deck along with the flow of people back and forth in the precinct rose and declined smoothly.

The use of the void deck differed from the use in other precincts. The space, as indicated by observations, was used more for activities than only for passing through, as people played, exercised, communicated with one another, rested, and even studied in the void deck where some sitting furniture, such steel benches, stone tables and small piers, were provided. Undoubtedly, the void deck was the space containing most types of activities in the precinct. Conversely, fewer types of activities were observed in some other spaces on the ground, such as hard court, sitting pavilion, and precinct pavilion; nevertheless, people spent on average more time in these three (3) spaces compared to the three most popular public spaces (e.g., playgrounds, fitness corner and void deck).

Space Organization

The spaces on the ground can be divided into two (2) parts: covered spaces (e.g., void deck and the precinct pavilion) and uncovered spaces (e.g., playgrounds, fitness corner, hard court, sitting pavilion and pedestrians). Regarding the void deck on the ground covering almost one-half of the site, it is sensible that the void deck was one of the most popular spaces in the precinct.

The path network of the precinct on the ground includes two (2) parts: a mixed vehicle-pedestrian path surrounding the site with its entrance/exit to the MSCP intersecting the void deck and a pedestrian network combining the void deck and certain uncovered pedestrian way along the public spaces. Some other uncovered paths parallel to the void deck link the spaces together, such as playgrounds, precinct pavilion, and open green spaces next to the MSCP. The pedestrian path on the 8th floor MSCP roof deck circles around the space there. Several steps and slops are used to connect spaces with different height levels. Beside the two (2) staircases in the MSCP, the only entrance to the roof deck is the lift lobby in the residential block 79C. The paths on the 12th floor podium roof deck are more complicated because of the residential block structure. The alternating of outdoors spaces and covered spaces with lift lobbies are linked together by steps and slop. The structure walls and columns erected in the space zigzag the path.

On the ground, there is no strong edge between the urban and the precinct. Bushes, trees, and barriers are used to divide and shape the spaces with various purposes. The zigzag void deck next to the structures and the light shafts of residential blocks create some obscured and isolated spaces, which can also be found on the 12th floor podium roof deck. Equipped with certain sitting furniture, these isolated spaces provide suitable environment and atmosphere for private or intimate activities.

Three (3) districts with different identified functions, fitness corner and two (2) playgrounds can be recognized on the ground. These districts are all uncovered, equipped by facilities, and semi-closed by short trees, bushes or barriers. They accommodated most of the major activities on the ground level.
The number of visits by the type of public spaces shows that playground, fitness corner and void deck are visited most frequently. The void deck was visited just as many times as the two (2) playgrounds, and almost twice as many times as the fitness corner during the observation. Few visits were observed in the spaces of pedestrian networks, precinct pavilion and sitting pavilion. Different from other studied precinct, open green space was used infrequently.

The average duration of visits by type of public spaces shows that the terrace on the 12th floor residential podium roof deck and the terrace on the 8th floor MSCP roof deck were used with the longest duration. The average duration that people stayed in the playgrounds and the void deck was around 30 minutes while they spent only 17 minutes in the fitness corner. The time spent in the two (2) elevated spaces, the 8th floor MSCP roof deck and the 12th residential podium roof deck, was around 60 minutes, which was much longer compared to time spent in the other spaces in the precinct.
The number of visits by type of space appropriation shows the visits numbers of different activities on varied space levels. It shows the primary activities in the precinct were playing, informal communication and exercise. Most activities were observed on the ground, and some activities were only found on the ground, e.g. rest and waiting. The major activities on the MSCP roof terrace were informal communication, exercise and eating; while the ones on the podium roof terrace were studying and exercise.

The average duration of visits by the type of space appropriation shows the time spent on different activity types on various levels on average. Generally, the average time spent on the MSCP roof terrace was much longer than that on either the podium roof terrace or ground. The longest duration was discovered in the activity of studying on off-ground levels.
Public Space Evolution In High-Density Living In Singapore

Proportion of Space Appropriations by Type of Public Space
Based on the visit numbers of each space appropriation

**Playground**
- Playing: 59%
- Exercises: 6%
- Walking-Pets: 4%
- Rest: 14%
- Informal Communication: 6%
- Studying: 2%
- Baby-Sitting: 7%
- Maintenance: 2%

**Fitness Corner**
- Playing: 25%
- Exercises: 37%
- Walking-Pets: 3%
- Rest: 4%
- Informal Communication: 13%
- Baby-Sitting: 17%
- Maintenance: 1%

**Precinct Pavilion**
- Playing: 23%
- Walking-Pets: 15%
- Rest: 23%
- Informal Communication: 31%
- Studying: 8%

**MSCP Roof Terrace**
- Exercises: 23%
- Walking-Pets: 18%
- Informal Communication: 25%
- Studying: 4%
- Eating: 20%
- Maintenance: 10%

**Sitting Pavilion**
- Playing: 14%
- Exercises: 18%
- Walking-Pets: 14%
- Rest: 4%
- Informal Communication: 14%
- Studying: 7%
- Smoking: 4%
- Maintenance: 25%

**Void Deck**
- Playing: 18%
- Exercises: 10%
- Walking-Pets: 3%
- Rest: 8%
- Informal Communication: 39%
- Studying: 6%
- Eating: 4%
- Baby-Sitting: 6%
- Smoking: 4%
- Maintenance: 2%

**The 12th Floor Terrace**
- Playing: 8%
- Exercises: 29%
- Walking-Pets: 6%
- Informal Communication: 13%
- Studying: 34%
- Baby-Sitting: 4%
- Smoking: 2%
- Maintenance: 4%

**Hard Court**
- Playing: 52%
- Exercises: 26%
- Informal Communication: 4%
- Eating: 18%

**Pedestrian Network**
- Exercises: 50%
- Walking-Pets: 10%
- Rest: 10%
- Waiting: 10%
- Maintenance: 20%

**Open Green Space**
- Playing: 14%
- Exercises: 18%
- Walking-Pets: 14%
- Rest: 4%
- Informal Communication: 14%
- Studying: 7%
- Smoking: 4%
- Maintenance: 25%
The proportion of space utilisation in the entire precinct by total time spent is presented by the diagram. It shows that individuals spend most time playing, exercise, informal communication and studying, accounting for almost 80% of the overall time spent in the public spaces of the precinct.

On the ground level, the major activities were playing, exercising, resting, and informal communication, all of which accounted for more than three quarters (75%) of the total time spent on the ground level.

On the elevated space level off the ground, more than 80% of time was spent on the activities, such as exercises, informal communication, and studying.

The differences between the ground level and the elevated space levels in the proportion of total time spent in different spaces indicated that the elevated spaces were used more for inactive, private, individual, or intimate activities, such as exercise, informal communication and studying. However, it is interesting that no rest activity was observed on the elevated space levels, although these levels accommodated activities like informal communication and studying. This suggests that people use these off-ground levels with strong intents, which might not be achieved on the ground level.

Besides different activities, the types of users also varied with the levels of the public spaces. The users on the ground were mainly young children under the age of ten (10) and young adults aged 20–39 years old while on the podium roof terrace, the teenagers from 10–19 were the main group. They use the spaces for study almost every day.
The influential factors mentioned in the interviews with both residents and non-residents presented that the categories of design and natural surroundings played the primary roles in the space use while the categories of management and social contexts might not play such an important role in the space use. The factor mentioned most frequently by the interviewees was accessibility and the natural ventilation of the spaces, both of which affected people’s space use more than the provision of facilities in the spaces and the scenery around the space.

The access diagram shows the connection among all spaces in the precinct. The spaces on the ground are connected to the void deck by uncovered pedestrian paths. A pedestrian path from north to south penetrates the sitting pavilion, the hard court and the fitness corner. The vertical circulation in each residential block consists of a staircase and two (2) groups of lifts. These two (2) groups of lifts serve lower-level floors (e.g., the first floor to the 21st floor) and higher-level floors (e.g., the first floor, the 21st floor to the 40th floor) separately. As a directly link to the residential block 79C, the MSCP also connects with the residential blocks 79B and 79D by unappealing corridors indirectly.

**Number of Visits by Age of Space Users**

![Frequency of Influential Factors in Interviews](image)

**Design (36)**
- Presences of Facilities (10)
- Presence of Sitting Furniture (3)
- Landscape (4)
- Presence of Shelter (1)
- Space Surface (2)
- Accessibility (16)

**Management (6)**
- Pets (2)
- Sanitary Condition (4)

**Social Contexts (5)**
- Community Network (4)
- Non-Resident (1)

**Environment (68)**
- Urban Surrounding (10)
  - Air Quality (3)
  - Urban Traffic Network (4)
  - Volume of Noise (3)

**Natural Surrounding (40)**
- Wind (Ventilation) (15)
- Temperature (5)
- Shade (2)
- Green Plants (5)
- Scenery (10)
- Insects (3)

**Human Surrounding (18)**
- Population Density (7)
- Volume of Sound (4)
- Interruption (3)
- Pedestrians (4)
Access Diagram
Summary

Many interviewees explained that they did not use the spaces on the 8th or the 12th floor because it was not easy to go there. A close look at the access diagram shows that for most residents, it is complex to reach the terraces on either the 8th floor MSCP roof deck or the 12th floor podium roof deck, as they have to change lifts at least once to get there while the ground floor is the only space that all residents can reach directly. This inconvenience in the vertical circulation, as suggested by both the observation and interviews, may limit the visits to those two spaces.

The presence of the facilities in the spaces was the secondarily most important design factor. Especially on the 8th floor MSCP roof deck, the lack of the facilities on the roof deck pushed the users away from the space. The interviewees stated that they did not use the elevated spaces much because they did not know what to do there, though the natural environment (e.g., scenery of the city, ventilation, temperature, and green plants, etc.) there was much better compared to that on the ground. They said they would use those spaces more if there were facilities on either the 8th floor or the 12th floor. For most residents, they used the elevated spaces only on some special days when the community committee organized certain activities there, such as the Mid-Autumn Festival, Chinese New Year, the National Day, and Hari Raya, etc.

The adjacency to the urban networks and infrastructure allowed people to travel in and around the precinct. However, this convenience also brought some disadvantages. There were two (2) flows of people swarming from or to the MRT station through the precinct. One flow appeared along the void deck, aggregating residents from five (5) residential blocks. The other flow crossing the site from north to south consisted of non-residents living in nearby HDB precincts. These two (2) flows passed through the ground spaces of the precinct and affected people’s use of the spaces on the ground. Some interviewees indicated that they were being interrupted on the ground, and some expressed that they could not concentrate on their own work on the ground.

The heavy urban traffic itself was another issue. The interviewees complained about air pollution, noise and dust as the negative factors on the ground, which drove people to the elevated spaces if they wanted to dwell outdoors in the precinct. On the other hand, it also explained the comparatively short stay on the ground.

The uses of the 8th MSCP roof deck and of the 12th floor podium roof deck also demonstrated some influential factors of public space use, despite the similarity of the visit frequency and duration. People had different reasons for visiting these two spaces. Whether the scenery and the ventilation were blocked was one of the pivotal keys for people choosing the spaces. People preferred the space with open views and comfortable ventilation because of the tropical climate of Singapore. Green plants, however, contributed to the space use in both positive and negative aspects. The interviewees with young children preferred less greenery with less dirt or insects while older individuals were fond of quietness, shade and fresh air offered in green spaces.

The study on the Central Horizon showed the use of multi-tier public spaces in HDB precinct. The observations and interviews suggested the variation in space use with the elevated levels from ground to roof deck or podium roof deck. Specifically, the frequency of visits decreased while the duration of stay increased at higher levels. This variation appears to be related to certain influential factors, such as the provision of the facility and the vertical accessibility of the space, as design influences, and outward scenery and ventilation, as environment influences.
The precinct is one of the latest HDB housing estates in the island. The high density of both buildings and population within limited land is the obvious characteristic of the precinct. A private architecture company designed the precinct following the Build-to-Order (BTO) scheme. This scheme proposes the design of a HDB estate in the housing market first. Whether the estate would be built depended on the sale. Usually, the entire process takes at least three (3) years.

In order to improve the quality of living environment, certain design strategies were used in the precinct: balconies were added to all residential units and a door with the access control system was installed in the void deck in each residential block. Certain new concepts in landscape was introduced as well, for instance, eco-system garden for butterflies. The roof deck of the MSCP is used as green terrace to supplement the public spaces on the ground. A sculpture named “Family” at the main entrance demonstrates HDB’s desire to offer housings with better living environment.

The precinct with public spaces both on the ground and on the roof deck of the MSCP illustrates what happens when some public spaces are elevated off the ground. The situation observed can be used to investigate the influence of the roof terrace on people’s activities and behaviours.

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<th>Year of Development</th>
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<td>Gross Floor Area</td>
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<td>Estimated Number of Residents</td>
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<tr>
<td>Number of Floors</td>
<td>42</td>
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<tr>
<td>Counted total Capacity of carparking</td>
<td>809</td>
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</tbody>
</table>
Public Space Evolution In High-Density Living In Singapore

- Community Space (Restricted)
- HDB Precinct Blocks
- Collective Public Space (with Admission fee)
- Collective Public Space (Open to all)
- Vertical Circulation
- Horizontal Circulation (Walkways Uncovered)
- Horizontal Circulation (Walkways Covered)
- Transportation Network (External and Internal)
- Pedestrian Crossing
- Pedestrian Circulation Area Between Precinct and Urban Network
- Dead Ends
- Staircase Regular stop
- Lift Regular stop
- Carpark
- MRT Station

- Open Green Space
- ECO Precinct Space
- Urban Farming
- Play Area
- Fitness Corner
- Running Track
- Hard Court (e.g. Basketball Court)
- BBQ Pit
- Food Court
- Commercial Space
- Precinct Pavilion

- Void Deck
- Built Spaces in the Void Deck
  (Residential, Commercial, Maintenance)
Five (5) cluster blocks compose the Peak that was completed in 2012, of which three (3) are 40-storey high and two (2) are 42-storey high and accommodate residential needs at a plot ratio of 4.62 (plotted).

The public spaces at “The Peak” in Toa Payoh are on the ground open space and on the multi-storey car park (MSCP) podium roof deck. Void decks exist only within the 42-storey blocks; however, these spaces are on the 22nd floor and are devoted to refugee purposes. The facilities existing in the public space of this precinct are:

- Void decks (refugee purposes)
- Precinct pavilion
- Two (2) Playgrounds (on the ground)
- Fitness Corner
- Sitting pavilion
- Open space
- Barbeque pits
- Walkway
- Podium roof deck garden

The ground public space forms 76% of the site and the MSCP podium roof deck takes up 12%.

The car parking provision per 100 m² of total site area is 2.8. Based on a provision of 25 m² per car, our calculations have also shown that 26.7 % of the total site would be required for parking if it were on the ground surface.

The figures that appear on these pages demonstrate the observed levels of ground and multilevel space allocations and aim to illustrate occupant-related as well as building and car related factors of density.
Public Space Evolution In High-Density Living In Singapore

Vehicular network and parking provision

Allocation of different spaces at ground level of the precinct

- 56% Open Ground
- 17% Road Network and Surface Parking
- 15% Building Footprint
- 12% Built space
- 3% Void Deck at Ground Level
- 12% Carpark Building Footprint
All public space of the precincts is located at ground level and raised platform level.

Total multilevel provision of public space:

- Ground open area incl. pavilions: 15720 m²
- Elevated open area: 3600 m²
- Ground level void deck: 980 m²
- Upper level void deck: 00 m²
- Total multilevel public space: 20300 m²

Open ground per GFA (Without Void Deck): 0.12
Open Ground per Person (Without Void Deck): 3.5 m²
Total multilevel public space per GFA: 0.16
Total multilevel public space per person: 4.5 m²
Public Space Evolution In High-Density Living In Singapore
Spatial Observation and Analysis
Based on Lynchian space analysis method
Observation and Interviews on The Peak @ Toa Payoh

General Impression
The precinct was observed in the spaces on both ground level and the 7th floor roof deck on the top of the MSCP. The dominance of the public spaces on the ground kept most activities on the ground level while very few daily activities were found on the 7th floor MSCP roof deck.

The playground space in the precinct appeared to be used mostly between 15pm to 19pm after the school hours.

It is interesting to find that the two (2) playgrounds attracted different types of users. The one next to the main entrance that is equipped with facilities for children aged 2-5 years old attracted great amount of young children and students from both the precinct and the nearby HDB precincts. The playground opposite to the precinct pavilion and equipped with facilities for children aged 8~12 years old was used more by young residents aged 20~39 years old with their children. Being adjacent to one of the playground, the squared precinct pavilion acted as an alternative to the hard court or open spaces. A number of young people and teenagers were observed playing basketball, badminton and skating in the pavilion by themselves or with their young children.

Space Organization
The site of the precinct is slightly higher than urban street level and the nearby neighbourhoods. This altitude difference becomes obscured by the edges of the precinct. Five (5) cluster residential blocks and one MSCP divide the entire site into three (3) districts, two (2) playground-fitness corner areas, and the precinct pavilion. Grasses and bushes are used to shape the paths and open green spaces while separating the private flat units on the ground floor from the public environment. The so-called bio-retention swale creates a green belt for birds and butterflies that circles around the entire public spaces, acts as drainage, and forms the edges of certain spaces (e.g., playgrounds and fitness corners). Compared to the other studied precincts, the open green spaces are compressed. The 7th floor MSCP roof deck might supplement the space shortage on the ground. The edges of this roof deck are the structure walls of the MSCP.

A mixed vehicle-pedestrian path around the precinct links to the urban network. The primary pedestrian path, half covered and half uncovered, penetrates the entire site, connecting all buildings, facilities, and public spaces together. Several intersections in the pedestrian networks are significant nodes for meeting, waiting and brief interactions, for instance, the intersection between the primary path and the one leading to the MSCP where people from various directions inevitably meet at the intersection.

Aside from the lifts in each residential block and the MSCP as the vertical nodes, several other nodes around the site serve different purposes or functions. Two (2) big shelter structures connecting the mixed path and the primary pedestrian path are used as the traffic conversion nodes for people waiting for or getting in and out cars or minibuses. The exits/entrances to the MSCP are the nodes for waiting and meeting. Some other activity nodes can be recognized as the playgrounds and precinct pavilion.
The number of visits by the type of public spaces indicates the number of visits to the different public spaces in the Peak. It shows that playgrounds were visited most frequently, followed by the precinct pavilion and the fitness corner.

The average duration of visits by type of public spaces shows the average duration of visits to different public spaces during the period of observation. It shows that the average duration of visits was the highest for the 7th floor MSCP roof deck. The average duration in that space was 60 minutes. Barbecue pits and precinct pavilion were the spaces with the longest duration on the ground. The average time spent in these two spaces was 38 minutes and 35 minutes respectively while the average time spent in other spaces was less than 30 minutes, including the playground and the fitness corner. However, these spaces were rarely used during the observation. These places experienced less than ten (10) visits daily.
The number of visits by the type of space appropriation shows that most activities were conducted on the ground. Overall, ten (10) types of daily leisure space utilisation were observed in the entire precinct, and 60% of activities observed in the spaces included playing and exercising. Very few leisure activities were found on the MSCP roof deck terrace, and only four (4) types of space utilisations were observed.

The average duration of visits by the types of space utilisation shows that the people spent most time studying (more than 60 minutes) in the spaces on average, followed by eating and baby-sitting, even those three (3) types of activities contributed very little to the number of total visits. The average duration of activities on in the MSCP roof terrace were close to those on the ground.
Proportion of Space Appropriations by Type of Public Space
Based on the visit numbers of each space appropriation
The proportions of space appropriation by the total time spent on each types of activity in the entire precinct, on the ground, and on the 7th floor MSCP roof deck terrace show the real use of all spaces in the precinct.

The major activities on the ground were playing, exercising, resting and informal communication. These four (4) activities constituted more than 80% of overall time spent on the leisure daily activities both on the ground and in the entire precinct.

On the roof deck terrace, the daily leisure activities, as playing and informal communication, accounted for about 70% of time spent there. However, the most frequently observed activity was maintenance by workers, which accounted for one third of space visits in the terrace. Different from the ground space, residents used the roof deck terrace much less compared to non-residents, especially the foreigners cleaning and maintaining the environment of the precinct. These people spent their spare time resting, chatting, and playing card games in the shade of the terrace.
Most space users were young adults aged 20~39 years old in the entire precinct. The differences in the number of visits between young adults (20~39) and young children (0~9) implies engagement in independent activities in the precinct. The people using the MSCP roof deck terrace were mainly young adults aged 20~39 years old. This may correspond to the major users of foreigners in the space.

The access diagram shows that residents can access the ground directly from any floor using the lifts in each residential block. A lift in the MSCP serves every floor as well as the roof deck. The MSCP is separated from the residential blocks. The only way to approach the MSCP is the primary pedestrian path. Two (2) groups of space clusters are clearly recognisable. Most spaces are not connected directly with the covered paths. Elevated void decks in the 42-storey residential blocks are used as the fire escape on the 22nd floor.

**Frequency of Influential Factors in Interviews**
Based on the times interviewees mentioned (Numbers in the brackets)

- **Management (15)**
  - Pets (1)
  - Sanitary Condition (3)
  - Booking System (6)
  - Restriction and regulation (2)
  - Facility Condition (3)

- **Design (21)**
  - Presences of Facilities (12)
    - Presence of Sitting Furniture (1)
    - Landscape (4)
    - Presence of Shelter (1)
    - Space Surface (1)
    - Accessibility (2)

- **Environment (24)**
  - Urban Surrounding (4)
    - Air Quality (4)
  - Natural Surrounding (11)
    - Wind (Ventilation) (2)
    - Temperature (1)
    - Shade (2)
    - Scenery (4)
    - Insects (4)
  - Human Surrounding (9)
    - Population Density (5)
    - Volume of Sound (2)
    - Interruption (2)

- **Social Contexts (4)**
  - Community Network (2)
  - Foreign Workers (2)
Public Space Evolution In High-Density Living In Singapore

Access Diagram

Floor 1
To Bus Stop
To Nearby Precincts

Floor 2

Floor 3

Floor 4

Floor 5

Floor 6

Floor 7

Floor 8

Floor 9

Floor 10

Floor 11

Floor 12

Floor 13

Floor 14

Floor 15

Floor 16

Floor 17

Floor 18

Floor 19

Floor 20

Floor 21

Floor 22

Floor 23

Floor 24

Floor 25

Floor 26

Floor 27

Floor 28

Floor 29

Floor 30

Floor 31

Floor 32

Floor 33

Floor 34

Floor 35

Floor 36

Floor 37

Floor 38

Floor 39

Floor 40

Floor 41

Floor 42

To Nearby Precincts
To Bus Stop
To Lor 1A Toa Payoh

To Nearby Precincts
To Bus Stop
To Lor 1 Toa Payoh

To Nearby Precincts
To Bus Stop
To Lor 1 Toa Payoh
Summary
The information from the interview shows that the most influential factor of the space use was the presence of the facilities in the spaces. This factor influenced the use of spaces in two respects. First, the provision of facilities explicated the popularity of the playgrounds and fitness corners on the ground and rare use of the 7th floor MSCP roof deck. Some interviewees stated that they are coming to the precinct is because of those facilities. Most interviewees stated that they did not have the reason to use the roof deck on the MSCP, as there was no facility but only small green plants. Second, the limited facilities referred to the comparatively low use of the space. Some interviewees said that the types of facilities available were limited; hence, they had to go to somewhere out of the precinct for certain adult exercises, such as playing basketball and football.

Some interviewees demonstrated the necessity to include few quiet spaces in the precinct. More than two interviewees indicated their preference for the 7th floor roof deck compared to the ground spaces because of its quietness and isolation from the public. Certain commonality was found in their routes, that is, they usually drove home after work. After parking their cars, they read newspaper on the roof deck for approximately 20 minutes. They went home just before the dinnertime but left the newspaper in the recycling bins. Nevertheless, these interviewees could use the space only from about 17pm to the sunset, as the whole space is exposed to the sunshine in the daytime. In effect, such quiet and uninterrupted space is difficult to find on the ground through Lynchian method. Most spaces are adjacent to either the primary pedestrian path or the mixed vehicle-pedestrian path. This may indicate the need for private spaces other than social spaces or domestic spaces where people can behave differently than they would in public or at home.

The vertical accessibility of the space was not an issue anymore in this precinct, although the MSCP roof deck is separated from all residential blocks. The interviews indicated that the elevation of the public space above the ground from any residential block to the MSCP was acceptable. In the meantime, the horizontal accessibility became the key reason for the uneven use of the spaces in the precinct. A close look at the space analysis shows that the space cluster next to the main entrance of the precinct is located on the way from a hawker centre and a primary school to the MRT station. The flow of people passing through brought a great mount of visits to the space, especially to the playground. A group of students living in the Central Horizon @ Toa Payoh played in The Peak almost every day, as this playground is on their way home. Hidden from the outside, the other space cluster was used more by residents than by the public.

As a newly developed precinct, the urban streets surrounding the site were not very heavily used. Accordingly, the effect of traffic was not strong while the influence of space utilisation management rose was the second most important factor. In addition to the provision of the facilities, both residents and non-residents stated that high quality along with good condition and cleanliness of the spaces also influence their decision to engage in some activities in the playgrounds and fitness corners here, despite the existence of several similar spaces next to the precinct.

Nonetheless, management can also reduce the use of the spaces. The use of the barbecue pits follows the booking system under the control of local Town Council. Most equipment was locked during the entire observation, unless residents wanted to use the area. As a result, residents avoided using this space, while non-residents used this space for temporary retreatment.

The Peak location comprised spaces that were located predominantly on the ground while some public spaces were available on the MSCP roof deck. The observation and the interviews suggested the importance of facility provision in the public spaces. The function of the precinct spaces between the general public spaces and the private spaces was suggested by what observed and talked on the elevated space on the MSCP roof deck.
Public Space Evolution In High-Density Living In Singapore
4.4.5 Bras Basah Complex @ Rochor

The Bras Basah Complex was developed on a lot of land for shop houses running book or relevant business in the Rochor Area in the downtown. The complex building retains the building style of shop houses by reserving the bottom podium for book or stationary stores while erecting residential blocks above. The comprehensive collection of textbooks and art supplies has brought the Bras Basah Complex the reputation of “Book Centre” in the island.

The Bras Basah Complex’s most prominent characteristic is the combination of the residential blocks with the commercial podium on one plot of land. Unlike the situation in average HDB precincts, the public spaces for residents are located on the roof deck of the commercial podium while the spaces on the ground are considered more as urban spaces rather than precinct spaces.

The mixed spatial use by both the residents and the commericals led to the public spaces being elevated to the roof of non-residential podium. The 80s’ style circulation with indirect access to the space and the space characteristics influence the space utilisation in the precinct.

Year of Development 1980
Plot Size (Total Area of Precinct) 11000 m²
Gross Floor Area 51000 m²
Estimated Number of Residents 620
Number of Floors 25
Counted total Capacity of carparking 237
Public Space Evolution In High-Density Living In Singapore

Community Space (Restricted)
HDB Precinct Blocks
Collective Public Space (with Admission fee)
Collective Public Space (Open to all)
Horizontal Circulation (Walkways Covered)
Transportation Network (External and Internal)
Vertical Circulation
Pedestrian Crossing
Pedestrian Circulation Area Between Precinct and Urban Network
Dead Ends
Staircase Regular stop
Lift Regular stop
Carpark
MRT Station

Open Green Space
ECO Precinct Space
Urban Farming
Play Area
Fitness Corner
Running Track
Hard Court (e.g. Basketball Court)
BBQ Pit
Food Court
Commercial Space
Precinct Pavilion
Horizontal Circulation (Walkways Uncovered)
Precinct Pavilion

0 20m 50m 100m
The Bras Basah housing complex was completed in the 1980s. It comprises two (2) parallel 20-storey slab blocks that sit on top of a 4-storey commercial podium block. The 5th floor that forms the commercial podium roof deck is the public space provided for the housing precinct that accommodates residential needs at a plot ratio of 4.73 (plotted). The facilities for public use are:

- Void decks
- Playground
- Fitness Corner
- Open space
- Resident corner
- Walkway

The public space on the ground includes mainly commercial and public uses; however, the elevated public space is devoted to residential use and composed by void decks and open-air space facilities, constituting 46% of the elevated space.

The car parking provision per 100 m² of total site area is 2.2. Based on a provision of 25 m² per car, our calculations have also shown that 53.8% of the total site would be required for parking if it were on the ground surface.

The figures that appear on these pages demonstrate the observed levels of ground and multilevel space allocations and aim to illustrate occupant-related as well as building and car related factors of density.
Allocation of different spaces at ground level of the precinct

- 34% Open Ground
- 66% Commercial Building Footprint
Total multilevel provision of public space:

- Ground open area incl. pavillions: 3700 m²
- Elevated open area: 3900 m²
- Ground level void deck: 00 m²
- Total multilevel public space: 8800 m²

All public space of the precincts is located at ground level and raised platform level.
Spatial Observation and Analysis
Based on Lynchian space analysis method
Observation and Interviews On Bras Basah Complex

General Impression
The observation in Bras Basah Complex was conducted on the 5th floor podium roof deck only. During the process, one of the biggest bookstores “Popular Bookstore” opened an entrance/exit on the 5th floor podium roof deck. The gates next to the cashiers face the public spaces on the roof deck.

Although being compressed into a small area, the spaces on the roof deck seem to be well used by the public rather than only by the residents of the building. Three (3) types of users can be found on the site except for the residents.

First, the staffs working in the commercial podium use this space regularly in the daytime for rest or recreation, eating and communication strictly following their working schedules. Second, the people living or working nearby attended certain regular social activities, such as gathering after church, Kung Fu classes organized by fitness companies, and learning workshops held by instrument stores, among others. These leisure and recreation activities usually occurred in the late afternoon and on the weekends, and they largely contributed to the use of spaces, such as the resident corner, open green spaces, and void deck, where people can find enough room and furniture to sit or even lie down. These two (2) types of users usually stay in the space for more than 50 minutes.

Third, people shopping in bookstores visited this space for a comparatively short period while waiting, smoking, taking a break or making a phone call. These people used covered pedestrian paths (e.g., corridors) much more than the open spaces, because these paths were connected with several main vertical circulations in the commercial parts.

Some residents of the precinct also used the podium roof deck spaces, though not as much as the non-residents. They came early in the morning or late in the evening in order to enjoy the cool temperature and comfortable ventilation. Some residents did simple exercises in the open green space individually in an attempt to avoid sharing the space with the non-residents.

The special features of the space use in the Bras Basah Complex were explored via observations, and some of these features can be explained by the space analysis through Lynchian theory and the interviews.

Space Organization
The simple structure of the entire complex building made the space on the podium roof deck easy to recognize. The connected roofs of the four (4) commercial parts form all roof deck spaces, except the southern part fully occupied by Popular Bookstore, the light wells and the courtyards of the commercial facilities, which shape the remaining spaces into a central open green space, two (2) void decks and two (2) peripheral open green spaces. Three (3) activity districts can be recognized as the resident corner located in one of the void decks; the playground and the fitness corner located in one of the peripheral open green spaces; and the central open green space. The covered one-side corridors both in the residential blocks and around the bookstore are integrated into the pedestrian networks of the space. The staircases are linked either to the commercial podium or to the residential blocks, and a cargo lift is the node for the transfers from vertical to horizontal circulation on the 5th floor roof deck.
The number of visits by the type of public spaces shows the number of visits to the different public spaces in the Bras Basah Complex. The popularity of the resident corner and open green spaces are obvious according to the visit numbers. Different from other studied precincts, playground was not used as much and no visit was observed in the fitness corner.

The average duration of visits by type of public spaces shows that people used resident corner, void deck and open green space much longer compared to other spaces of the precinct, with the average duration of more than 50 minutes while they used some other spaces, such as playground and pedestrian paths, more for passing through rather than dwelling.
The number of visits by the type of space use shows that people used the spaces mainly for rest or retreat, informal communication and gathering, while comparatively fewer space users walked their pets, waited, smoked or played in the spaces there.

The average duration of visits by the types of space appropriation shows that people spend the longest time engaging in exercise and group gathering, with the average time spent on these two activities was more than 80 minutes. The average time spent on inactive interests, i.e., rest, informal communication, studying and eating, was around 30 minutes. The average time spent on playing was considerably less, which was obviously different from other studied precincts.
Proportion of Space Appropriations by Type of Public Space
Based on the visit numbers of each space appropriation

Playground
- Playing: 53%
- Exercises: 17%
- Rest: 11%
- Informal Communication: 14%
- Studying: 5%

Void Deck
- Playing: 2%
- Exercises: 2%
- Gathering: 13%
- Rest: 45%
- Informal Communication: 21%
- Studying: 2%
- Eating: 7%
- Smoking: 3%
- Maintenance: 5%

Resident Corner
- Gathering: 33%
- Rest: 18%
- Informal Communication: 17%
- Studying: 3%
- Eating: 27%
- Maintenance: 2%

Pedestrian Networks
- Playing: 4%
- Exercises: 2%
- Rest: 11%
- Informal Communication: 15%
- Studying: 7%
- Smoking: 4%
- Waiting: 35%
- Maintenance: 22%

Open Green Space
- Exercise: 35%
- Walking-Pets: 2%
- Rest: 17%
- Informal Communication: 15%
- Studying: 17%
- Smoking: 7%
- Maintenance: 7%
It is understandable that the major activities on the podium roof deck included resting, informal communication, group gathering, eating and group exercises, accounting for appositely 80% of the time spent on the site.

Most space users in the precinct were adults, especially 20-39 years old, accounting for more than 50% of visits in the spaces. Few young children and teenagers were observed in the spaces, and most of them were non-residents. This might be attributed to the maturity of the precinct, as the complex building was already 30 years old and the commercial activities supported the podium on the other side.
The interviews showed that the residents were more interested in nearby urban facilities, such as Front Canning Park, fitness club in Raffle’s Place, Bowling Club and shopping centres, among others. The convenient urban transport, fresh air, nice cooler temperature, comfortable ventilation, and the quietness without interruption were the major factors that drove them out of the precinct not only on the weekends and holidays but also on the weekdays. Interestingly, these factors, on the other hand, were also the reasons that attracted non-residents to the podium roof deck. For instance, the open green space supported a Kung Fu workshop of 20 people three times per week. These nearby cooler and quieter void decks located away from urban traffic or crowds with sitting furniture were the first choice of people working in the complex building.

In other words, the podium roof deck in the precinct has spaces with the quality in-between the environment of urban street level and certain functional public spaces. These spaces, as supplements to the urban public spaces, served certain local functions that were not satisfied by the urban street spaces.

Frequency of Influential Factors in Interviews
Based on the times interviewees mentioned (Numbers in the brackets)

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<thead>
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<th>Design (15)</th>
<th>Environment (37)</th>
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<td>Presences of Facilities (3)</td>
<td>Air Quality (3)</td>
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<td>Illumination (4)</td>
<td>Location Distance (4)</td>
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<td>Landscape (3)</td>
<td>Volume of Noise (1)</td>
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<td>Adjacency to Garbage Chute (3)</td>
<td>Natural Surrounding (11)</td>
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<td>Accessibility (2)</td>
<td>Wind (Ventilation) (3)</td>
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<td>Social Networks (8)</td>
<td>Temperature (5)</td>
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<td>Community Network (4)</td>
<td>Green Plants (2)</td>
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<td>Non-Resident (3)</td>
<td>Scenery (1)</td>
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<td>Foreign Workers (1)</td>
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<tr>
<td>Foreign Workers (1)</td>
<td>Pedestrians (2)</td>
</tr>
</tbody>
</table>
Public Space Evolution In High-Density Living In Singapore
Summary

The complicated access to the 5th floor podium roof deck determines the space use. Residents did not need to pass through the roof deck when they moved between the city and their private flats. It is much easier for them to go to the urban ground level than to the podium roof deck. The residents who used the space most all lived on the 6th floor. For these residents, it was the same for them to go to the roof deck and to the ground street. Meanwhile, the integration of the pedestrian network with the commercial parts and the visibility of the space from around high-rise buildings make this space inclining to the urban level than to the precinct level. This may explain why it attracts public more than it does the residents.

Additionally, people, except cleaners taking charge of the residential blocks, did not go to the two (2) peripheral open green spaces located at the northeastern and southwestern parts, in spite that the shade of the buildings covered these two (2) spaces most of the time in the daytime and blossom of the trees in the spaces were nice and impressive. The uselessness of the peripheral open green spaces as well as the fitness corner demonstrated some negative factors mentioned in the interviews with both residents and non-residents. The characteristics of these spaces are obvious that they are located adjacent to the garbage shafts of the residential blocks, they have no artificial lightening in these spaces, and wet laundry was hanged above the spaces. The uncomfortable smell of garbage in the space and the poor illumination caused people to avoid these spaces. Lynchian theory demonstrated some other characteristics. The spaces are enclosed, having only one visible entrance. The paths to the spaces are comparatively unappealing and twisted through the void deck. Several enclosed rooms in the void deck even block the sight from or to those spaces. One third of the interviewees indicated that historically, the invisibility made those spaces crime-prone. Some warm-hearted residents even tried to warn the people who were going to those spaces individually during the observation and interviews.

The unpopularity of the playground unfolded some other issue of the space, that is, the particularity of each single precinct. Superficially, the layout and the provision of the facilities of the space are similar to those in other HDB precincts. This similarity, in effect, reduces the usability of the space. As stated by the interviewees, these universalized facilities by HDB were not suitable for the residents simply because very few children aged 2~5 years old lived in the precinct. This was testified by the observation that the users of the playground were all non-residents.

The observation on the 5th floor podium roof deck of the Bras Basah Complex supported that the public use of the spaces was driven mainly by the commercial function of the podium and the indirect access to the space from the residential block. The data demonstrated that with the spaces elevated to the podium roof deck level, the frequency and duration of sedentary activities (e.g., rest and recreation, communication etc.) surpassed those of moving activities (e.g., playing, exercises, etc.). This might relate to the special situation of the Bras Basah Complex, however, the information from the interviews indicated the necessity of the space at the urban level. The study on this precinct also verified that providing public spaces involved more than just offering sufficient number of spaces, as certain quality and appropriateness of facilities had to be upheld.
4.4.6 Pinnacle @ Duxton

As a landmark of the State and the milestone of the Housing Development Board’s achievements, the Pinnacle created a new strategy for public space provision involving extremely high buildings and population density. Some public spaces were elevated from ground level to lower podium roofs (e.g., the 3rd floor) and to much higher sky bridge levels (e.g., the 26th floor and the 50th floor). The introduction of the resident permission system on the 26th floor testifies to the changes in the frequency and duration of space use to some extent.

This case demonstrates what happens when the public spaces with certain priority and restrictions are located on the high levels within the building structure.

Year of Development     2009
Plot Size (Total Area of Precinct) 28000 sqm
Gross Floor Area          259000 sqm
Estimated Number of Residents 7200
Number of Floors          50
Counted total Capacity of carparking 1097
Public Space Evolution In High-Density Living In Singapore

- Precinct Pavilion
- Historical Park
- Playground 1
- Playground 2
- Food Court
- Precinct Green
- Fitness Space
- Open Seating Area

Community Space (Restricted)

HDB Precinct Blocks

Collective Public Space (Open to all)

Collective Public Space (with Admission fee)

Community Space (Restricted)

Void Deck

Built Spaces in the Void Deck
(Residential, Commercial, Maintenance)

Transportation Network (External and Internal)

Horizontal Circulation (Walkways Covered)

Horizontal Circulation (Walkways Uncovered)

Vertical Circulation

Pedestrian Crossing

Pedestrian Circulation Area Between Precinct and Urban Network

Dead Ends

Staircase Regular stop

Lift Regular stop

Carpark

MRT Station

Open Green Space

ECO Precinct Space

Urban Farming

Play Area

Fitness Corner

Running Track

Hard Court (e.g. Basketball Court)

BBQ Pit

Food Court

Commercial Space

Precinct Pavilion

Horizontal Circulation (Walkways Uncovered)

Vertical Circulation

Pedestrian Crossing

Pedestrian Circulation Area Between Precinct and Urban Network

Dead Ends

Staircase Regular stop

Lift Regular stop

Carpark

MRT Station
The Pinnacle is a 50-storey high public housing precinct that was completed in 2009. It comprises seven (7) towers that sit on a 1-storey car park (plus 2-storey basement) connected by 2 sky-bridges (on the 26th floor and on the 50th floor).

This precinct accommodates residential needs at a plot ratio of 8.4 (URA).

The following public space facilities exist for public use at the Pinnacle:

- Void decks
- Precinct pavilion
- Four Playgrounds (three on the E-Deck and one on the Skybridge of the 26th floor)
- Fitness Corner
- Sitting pavilion
- Open spaces (on the E-Deck and one on the Skybridge of the 26th floor)
- Hard court
- Jogging track
- Walkway
- Podium roof deck garden

The characteristic of this HDB precinct is that as of now, it is the highest public housing precinct in Singapore. It offers three levels of public spaces whereby 50% of the site on the ground is public while the 26th floor and 50th floor skybridges account each for 21% of the total site.

The car parking provision per 100 m² of total site area is 3.9. Based on a provision of 25 m² per car, our calculations have also shown that 97.9% of the total site would be required for parking if it were on the ground surface.

The figures that appear on these pages demonstrate the observed levels of ground and multilevel space allocations and aim to illustrate occupant-related as well as building and car related factors of density.
Allocation of different spaces at ground level of the precinct

- 43% Carpark Building Footprint
- 34% Open Ground
- 2% Road Network and Surface Parking
- 14% Void Deck at Ground Level
- 7% Building Foot Print
Total multilevel provision of public space:

- Ground open area incl. pavillons: 9600 m²
- Elevated open area: 24000 m²
- Ground level void deck: 4000 m²
- Upper level void deck: 4000 m²

All public space of the precincts is located at ground level, raised platform level and skybridges.

Open ground per GFA (Without Void Deck): 0.04 m²

Open Ground per Person (Without Void Deck): 1.3 m²

Total multilevel public space per GFA: 0.16 m²

Total multilevel public space per person: 5.8 m²
Public Space Evolution In High-Density Living In Singapore
Spatial Observation and Analysis
Based on Lynchian space analysis method

The 26th Floor Skybridge

The 3rd Floor Podium Roof Deck
Observation and Interviews on Pinnacle @ Duxton

**General Impression**

The observation at the Pinnacle was conducted in the lower podium roof deck on the 3rd floor and in the skybridges on both the 26th floor and the 50th floor.

A dramatic difference in public space use and appropriation between the Pinnacle and any other HDB precinct involved the tourist visits. Tourists with recognizable characteristics, such as uniforms, group badges, and guides, strolled around the spaces on both the 3rd floor and the 50th floor, accounting for a large proportion of the space use in the precinct. The great number of these tourists, and their stay of more than 20 minutes on average, comprised a part of the daily life in the Pinnacle and enhanced the importance of the sky terrace for the whole estate.

It is clear that, besides tourist visits, playing and exercising were the major activities conducted in public spaces in the Pinnacle. These activities took place in almost all types of spaces in the precinct. Other two (2) types of activities that appeared in almost all the spaces involved resting or retreating and informal communication.

Special utilisation of jogging track and the fitness corner was noted in the Pinnacle. Both of these spaces are located on the 26th floor sky bridge and have access control. Although visitors spent on average the same amount of time in these two (2) spaces, the jogging track was used much more frequently, as frequently as the playgrounds and the open green spaces in the entire precinct combined while the fitness corner was seldom used. These observations differed from those in other HDB precincts.

It was interesting to observe that except for the sitting pavilion (including the sitting area on the 3rd floor and the little wooden pavilions scattered around the whole precinct), most spaces in the Pinnacle supported a greater number of moving activities (e.g., playing, exercising, walking pet, and gathering, etc.) compared to sedentary activities (e.g., resting, engaging in informal communication, eating, baby-sitting, and studying, etc.). This suggests that these spaces are not well utilised and are used for individual purposes or small group gatherings rather than community socialization. Exercising and tourist visits far exceeded chatting in both frequency and duration, which also suggests that these spaces are not local, community-driven spaces of communion (Bell and Newby, 1976).

**Space Organization**

While the observation helped us determine the utilisation public spaces in this precinct, it could provide limited insight into why the public spaces are being used in this way. A closer analysis of the space shows that the orientation of the site is notable, as it connects to the CBD in the east and Outram Park MRT Station, the Police Headquarters and the Central Hospital in the west, as well as Chinatown in the north. Large steps with the name of the precinct link urban pedestrian paths and the 3rd floor podium roof deck on the northwestern and southern sides. Thus, the Pinnacle stretches across distinct areas of the city without being in any single one.

Applying Lynchian theory to the spatial analysis, it is clear that the building strongly influences the structure of the public spaces in the precinct. Although elevated from the urban street level to two (2) storeys high within the building structure, the spaces on the third floor were designed to exhibit the landscape of the area. Some grassy slopes were added in and around the third floor to minimize the structural difference to the urban landscape. The structure of the entire building, including the multi-storey car park, the residential blocks and the skybridges, defines most edges of the public spaces. Three activity districts are divided by the slopping landscape for playing, resting and sport activities. Each district is equipped with different facilities.

One of the benefits of the elevated space is the separation of vehicle lanes from pedestrian’s paths and public spaces. People driving home can park their cars in the MSCP underneath the third floor and reach their flats via lifts. Three (3) types of lifts serve the precinct: one for the lower level floors (the Basement, the first floor to the 26th floor), one for the higher floors (the basement, the first floor to the third floor, and the 26th floor to the 50th floor), and fire lift for every single floor. These lifts that stop in the public spaces are the intersection nodes from vertical to horizontal. The void deck, a parallel covered pedestrian linking all these nodes and some urban infrastructures together establish the primary path for navigating the public spaces.

The 26th floor sky bridge and the 50th floor sky terrace are also shaped by the structure of the seven residential blocks. A rotating steel-bar door blocks the only entrance from each lift lobby to these two spaces. Only people with certain access cards or tickets can pass through the doors to the use of these spaces and demonstrate some ownership and priority over the use of these spaces.
The number of visits by the type of public spaces shows the number of visits to the different public spaces in the Pinnacle. It shows that the skybridge terrace, jogging track, playground and open green space were the most frequently visited spaces while fitness corner was the space with fewest visits during the observation.

The average duration of visits by type of public spaces shows the average duration of the use of different public spaces during the period of observation. It shows that the hard court, playground, and sitting pavilion were utilised with the highest mean duration of more than 50 minutes while in the other public spaces, the average time spent on each visit was more than 20 minutes. This suggests that some spaces are used strictly for passing through while other spaces are being used for longer periods even with the fewer number of visitors.
The number of visits by the type of space utilisation shows that visitors are using the spaces mainly for playing, exercising and tourist visits. The total visits of these spaces were almost the same. Some space utilisation, such as walking pets, studying, eating, or smoking, were only observed on the 3rd floor podium roof deck but were not found on either level of skybridges, which is probably related to the regulations on the skybridges.

The average duration of visits by the types of space utilisation shows that on the podium roof deck, individuals engaged the longest in informal communication, followed by playing, exercising, and resting while in the skybridges, they spent the longest time resting or retreating. Overall, the average time spent in the skybridges was shorter compared to that on the podium roof deck.
Proportion of Space Appropriations by Type of Public Space
Based on the visit numbers of each space appropriation

* Tourist Visits on the 3rd floor podium roof deck was not involved in the calculation by the space types because tourists walked around all space on that level, while was calculated regarding to the space appropriation in the entire precinct.
The precinct has four (4) playgrounds located on the 3rd floor and on the 26th floor. These playgrounds provide various types of facilities for different age groups. Despite being close to the pre-school (a kindergarten for early childhood education before the primary school), the use of playgrounds varied significantly. The playground in the front of the pre-school was used as those in the other HDB precincts, that is, pre-school children and their parents used the space before or after school time. They usually spent almost one hour there. In comparison, the two playgrounds behind pre-school were used rarely during the period of the observation. The visits to the playground on the 26th floor were similar in frequency to the well-used playground on the 3rd floor, however, they were utilised with shorter duration.

The hard court (the basketball playground) on the 3rd floor was also one of the most frequently used spaces in the precinct. Organized group activities, such as basketball classes by the resident community committee and the weekly basketball matches held by non-residents, drew people to the space regularly. Their activities framed the duration of their use of the space. More than 60 minutes was spent by each visitor on average, the longest duration of any space in the precinct. On the contrary, few people used the hard court for any duration without such programmed activities.

Most space users in the whole Pinnacle were aged 20~39 years old and 40~59 years old. The two age groups accounted for almost 80% space users in the precinct. There were differences in the types of space users between the 3rd floor podium roof deck and the skybridges: more teenagers were found on the 3rd floor podium roof deck while more young children, young adults (20~39), middle-age adults (40~59) and old people were observed on the skybridges than on the podium roof deck. This might be related to the access control system and the sport facilities on the 26th floor, which attracted more residents.
The access diagram on the right hand side shows the location and the relations among spaces and circulations in the precinct. People in each residential block can approach all spaces directly by elevators from any floor of the building. Almost all spaces on the same level are interconnected. On the 3rd floor, two (2) space clusters appear according to the connections to the main path. The one embraced by five (5) residential blocks contains most spaces, such as playground, open green spaces, hard court and sitting pavilion while the other one includes two (2) playgrounds on the backside of the void deck. The layouts of the skybridges are even.

Based on the interviews, this structure of the space explains some observed phenomena. The diagram below presents an overview of the findings from the interviews. Specifically, the figure shows the frequency of the factors that attracted them to or drove them away from the spaces. The more frequently the factors were mentioned during the interviews, the darker the colour of the factors and vice versa. The mentioned factors were categorized as design factors; environment factors including three sub-categories, such as urban traffic, nature, and surroundings; management factors and social context.

### Frequency of Influential Factors in Interviews
Based on the times interviewees mentioned (Numbers in the brackets)

**Management (23)**
- Sanitary Condition (3)
- Booking System (1)
- Restriction and regulation (11)
- Access Control System (8)

**Design (22)**
- Presences of Facilities (11)
- Presence of Sitting Furniture (3)
- Landscape (1)
- Presence of Shelter (2)
- Accessibility (5)

**Social Contexts (18)**
- Community Network (9)
- Non-Resident (9)

**Environment (24)**
- Urban Surrounding (4)
  - Air Quality (4)
- Natural Surrounding (36)
  - Wind (Ventilation) (12)
  - Temperature (5)
  - Shade (3)
  - Scenery (15)
  - Green Plants (1)
- Human Surrounding (17)
  - Population Density (4)
  - Volume of Sound (6)
  - Interruption (6)
  - Pedestrians (1)
Public Space Evolution In High-Density Living In Singapore

To Cantonment Road
To Bus Stops and Overhead Bridge
To Community Centre

BLK 1A
BLK 1B
BLK 1C
BLK 1D
BLK 1E
BLK 1F
BLK 1G

To Neil Road
Floor 1
Basement
Floor 2
Floor 3
Floor 4
Floor 5
Floor 6
Floor 7
Floor 8
Floor 9
Floor 10
Floor 11
Floor 12
Floor 13
Floor 14
Floor 15
Floor 16
Floor 17
Floor 18
Floor 19
Floor 20
Floor 21
Floor 22
Floor 23
Floor 24
Floor 25
Floor 26
Floor 27
Floor 28
Floor 29
Floor 30
Floor 31

Playground
Fitness Corner
Open Green Space
Sitting Pavilion
Resident Corner
Multi-Functional Pavilion
Community Center (Enclosed)

Hard Court
Community Garden
Multi-Storey Car Park
Commercial Unit
Void Deck
Elevator Stop
Staircase Stop

Residential Unit
Covered Pedestrian Networks
Uncovered Pedestrian Networks
Jogging Track
Stairwell
Elevator Shaft
Urban Street
Summary
The analysis on the observation, interviews and the space quality through Lynchian theory in the Pinnacle suggests that public spaces here are utilised less and used more as passageways. It also suggests that activities are less “community-driven” and more individual- or family-based. The elevated spaces with their advantages, such as nice scenery, cool temperature and good ventilation can attract people moving off the ground (e.g., the 50th floor skybridge); however, proper facilities and easy accessibility can motivate people to utilise the spaces (e.g., the 26th floor skybridge).

The interviewees mentioned that the strongest factor that prevented them from spending much time on the 50th floor skybridge was the lack of the facilities. In fact, people could only stroll around and enjoy the scenery, the comfortable wind and temperature in that space. For the people already living in the estate for more than 4 years, the familiarity of the scenery might result in declined interest in the space and finally decreased number of visits, except on some special dates, such as National Day.

The accessibility of the space is also important, especially when considering the infrequent use of the fitness corner on the 26th floor. Half of the interviewees mentioned that the rotating steel-bar doors blocked their way to the 26th and the 50th floor skybridges, as certain things, such as wheelchairs, prams, children’s bicycles, and walking sticks could not easily pass through those narrow doors. The procedure for special assistance from the management was also complicated and time consuming. In contrast, the installation of these rotating steel-bar doors also accounts for the use of the jogging track on the 26th floor. Because the park-like artificial landscape on the third floor podium roof deck and its proximity to the city attracted the people dwelling or working nearby, half of the interviewees felt more secure and a stronger sense of ownership with the existence of the doors. They were more willing to use the space on the 26th floor rather than other spaces that they had to share with public.

In addition to the rotating doors, the restriction on the 26th floor and the 50th floor also included restrictions placed upon eating, drinking beverages, walking pets, playing loud music, and social events, and the like. The negative effect was obvious when interviewees said it was not convenient that they, and especially their young children, had to go back home for some water and food after they stayed in these spaces for more than 30 minutes, as they were not allowed to eat or drink there. On the other hand, this strict regulation helped keep the environment clean and tidy, increasing the appeal of these spaces to the residents.
4.5 Overview of the Case Study

Total Visits to Public Spaces Observed in Six (6) Precincts
Including leisure daily activities, functional activities and tourist visits

Total Visits to Public Spaces

During the two-week observation of the site, more than 4000 visits were observed totally across the six (6) studied cases. The maximum number of visits was observed in Pinnacle @ Duxton and minimum number of visits was observed in Treelodge @ Punggol while the observed visits in the other four precincts were around 600.

Ratio of Daily Visits to the Estimated Resident Population in Six (6) Precincts
Including leisure daily activities, functional activities and tourist visits

Relation between Daily Space Use and Population Density

The percentage of daily visits in relation to the resident population across the studied cases was around 3% except Bras Basah Complex, which was 19%. This indicated that the frequency of the public space use in these HDB precincts was closely related to the population density of the precinct. The Bras Basah Complex was an exception to this. This suggests that public space use can be strongly driven by certain commercial environment.
Average Time Spent in Public Spaces in Six (6) Precincts
Including leisure daily activities, functional activities and tourist visits

Average Time Spent in Public Spaces
The average time spent in the public spaces was 36 minutes across the six (6) precincts. The six (6) studied precincts differed primarily with regard to the number of visits rather than average duration. The visitors spent the longest time in Bras Basah Complex due to the regularly organized activities on the podium roof deck. This indicates the influence of the group activities on space use on the one hand and the lack of large public spaces with certain quality for group activities in the neighbourhood on the other one hand. These spaces are accessible directly and publicly, separated away from the interruption of urban traffic networks and possessing certain natural environment, such as nice ventilation and cool temperature as well.

Number of Total Visits by Age of Space Users in Public Spaces in Six (6) Precincts
Including leisure daily activities, functional activities and tourist visits

Types of Space Users
Concerning the types of people, most HDB public space users in the six (6) studied cases were people aged between 20 and 39. This was probably because the six (6) selected precincts were relatively new, so that the dominant dwellers were comparatively younger compared to those in other HDB estates. The playgrounds had the most cumulative visits across all the six (6) precincts, which might be attributed to the half-day curriculum in the Primary School education system in Singapore. As a result, one of the young couple or domestic helpers has to stay at home and take care of young children.
Regarding the popularity of public spaces in HDB precincts, both the frequency and duration of the space use should be considered equally. Without frequency, long duration in the spaces might have resulted from few people’s dwelling space; while without duration, frequently used space might have resulted from the amount of passing through without any stay. Neither of these two (2) situations can be considered as popular.

**Space Use in Different Type of Space**

The most frequently used space in HDB precincts was the playground, followed by open green spaces and roof terrace garden. Almost 1000 cumulative visits were observed to the playgrounds in the six studied precincts while the cumulative visits to the open green spaces and the roof garden were around 500 for both. Very few visits were observed in the barbecue pits and community garden, as there was only one barbecue pit found in the six (6) studied precincts. Community gardens, although sited in several precincts, were locked during the entire observation. The number of visits to other types of spaces was between 360 and 140.

These observation results were certainly related to the provision of the spaces in each precinct. Regarding the playground, for example, some precincts, such as Central Horizon, The Peak, and Pinnacle, provided more than one playground, which can definitely increase the number of visits even though the possibility of visiting each type of space was the same. Some types of spaces were rarely seen in the HDB precincts, such as barbecue pits and urban farming gardens.

On the other hand, certain spaces, like the playground and jogging tracks, were used with greatest frequency at specific times of the day, which was probably attributed to the living patterns of Singaporeans and the intensive use of the hard courts for group training or matches during the weekends.

Another issue concerns the tourists on the roof gardens, especially in the terrace of the skybridge of the Pinnacle @ Duxton. In effect, the tourist visits in the Pinnacle accounted for a large proportion of the space use on the terrace, which cannot be separated from the space use situation; nevertheless, they influenced the normal daily space use by residents.

**Duration in Different Type of Space**

Visitors usually spent more time in the hard courts than in any other types of public spaces, followed by resident corners and sitting pavilions. The average time spent in the hard courts was 60 minutes while the average time spent in the other two (2) spaces was approximately 50 minutes. In contrast, the average time spent in the playgrounds was less than 40 minutes. These corresponded to the activities in the space as the usual activity on the hard courts involved organized sport games. In the resident corner and sitting pavilions, people usually rested and communicated with each other informally and played in the playground. According to the interviews, people usually spent 30 minutes playing, as they indicated that young children probably needed water and food after 30 minutes’ playing. Another possible reason was related to the daily schedules of homemakers or domestic helpers, as they used some gaps of time to accompany children playing in the public spaces. However, the rare use of the playground in the Bras Basah Complex is an exception.

Very few people used the barbecue pits and community garden although the time spent there was considerable. A possible reason for these findings is that the barbecue pits are controlled by a booking system, and the community gardens can only be used by the community committee members. These restrictions limited the access of average residents while enhancing the single purpose of use and lengthening the stay in these spaces.

Pedestrian networks also supported some visits or activities. These activities could involve brief interactions among neighbours, such as informal communication and greetings, and they were always conducted within 20 minutes.

By considering the number of visits and the average duration in the spaces, the five (5) most popular space types in HDB precincts were the playground, open green spaces, roof decks or podium roof decks, resident corner and void deck.

Based on the above understandings, it was not easy to determine whether one space type was used more intensively compared to another, especially when comparing the playground, open green space, residential corner and sitting pavilion.

**Types of Space Appropriate**

Generally, there were 14 types of utilisation of public spaces according to the observation. These can be categorised as:

- **Moving activity:** Playing, Exercise, Walking Pets, Gathering, and Tourist visits
- **Sedentary activity:** Rest, Informal Communication, Studying, Eating, Baby Sitting, Smoking, and Waiting
- **Functional activity:** Maintenance and Retail
The first two (2) categories were leisure activities conducted in the course of everyday life while the last category was work with certain material gains. This study focuses on leisure activities. Except for tourist visits and retail, which were only observed in Pinnacle @ Duxton, the remaining spaces in the public spaces of the six (6) studied precincts were utilised in varied proportions.

**Main Activities**

According to the observation, there were four (4) major activities in the public spaces: playing, exercises, rest and informal communication. These four (4) activities accounted for more than 70% of total visits in the six (6) precincts. These four (4) activities were observed in almost all types of public spaces while their proportions to the entire space appropriation varied according to the types of spaces and the facilities in the spaces. The average time spent in the major activities was between 35~40 minutes.

**Space Category Based on Appropriation**

Based on appropriation, the spaces can be classified as:

- **Active space for mainly moving activities:**
  - Playground, Fitness Corner, Precinct Pavilion, Hard Court, and Jogging Track

- **Inactive space for mainly sedentary activities:**
  - Void Deck, Sitting Pavilion, Resident Corner, Barbecue Pits, Podium and roof garden (e.g. the MSCP roof deck in The Peak @ Toa Payoh, and Central Horizon @ Toa Payoh)

- **Undefined space:**
  - Open Green Space

However, some spaces were not used as they were envisaged, such as precinct pavilion and barbecue pits. The former was designed for large-scale gatherings, such as wedding ceremonies, funerals, parties and other community activities. The latter was set as an area for family barbecue parties and picnics, both of which were managed based on booking system under the control of the Town Council. To keep these spaces in good condition, this booking system actually limited the daily use of the space.

Another interesting outcome was observed in the pedestrian networks and fitness corner. Although these were designed for moving and activities in the precinct, a considerable amount of sedentary activities were observed in these two (2) spaces, such as informal communication, waiting, rest or recreation, or even studying. The quality of these spaces might be the key to its use for these purposes.

The considerable differences were also discovered in the four (4) major activities. The duration and frequency of rest or recreation, exercises and informal communication in the Pinnacle were much greater compared to those in other precincts. This could mean that the elevation of the spaces played an important role in the space use; however, the answer is still unclear.

**Influential Factors from Interviews**

The interviews indicated that the most important indicators of the use of various spaces were design factors and natural environment factors, while urban surroundings and social contexts were less important. This suggests that on the one hand, residents to some extent accept the space use by non-residents in the precincts while on the other hand, it might indicate that the elevated spaces were separated from urban spaces, offering more privacy and priority.

The most frequently mentioned influential factors were:

- Presences of facilities,
- Natural ventilation,
- Scenery around the spaces,
- Accessibility,
- Space population density, and
- Community networks.

These factors were highlighted variously in different public space elements.

**Review on the hypothesis of the project**

The preliminary findings of the observation and interviews provide some information on the space use in the six (6) precincts. Activities conducted in the public spaces the precinct with only one typological element (e.g., ground space in the Pioneer @ Jurong West, low level podium roof deck in the Treelodge @ Punggol, and commercial podium roof deck in the Bras Basah Complex) and the ones with multi-tiers public spaces (e.g., the Central Horizon @ Toa Payoh, The Peak @ Toa Payoh, and Pinnacle @ Duxton) indicated some differences in the use of the space across different levels.

For instance, despite the residential population density of the precincts, the use of the playgrounds varied from one case to another. The longest average duration in the playground appeared in the Pinnacle, which was approximately twice as long as those in the other precincts. Similar situations were discovered in fitness corner and open spaces as well.

Based on these understanding, the hypothesis of the study in social aspect can be specified further as:

- What was the difference in space utilisation between the space levels in the six (6) precincts?
- What factors drove these differences in space use?
The 26th floor Skybridge of the Pinnacle@Duxton as well as its 50th floor Skygarden represent highly-restricted public spaces. The 26th floor is restricted to residents only, by the use of access cards. The 50th floor is restricted to use, however an EsiLink (public transport card in Singapore for bus and MRT use) is needed in order to pay the 5 SGD general public access to the skygarden.
5 Comparative Analysis

The data and information collected from the six (6) studied cases were used to compare space use and appropriation in various situations of public space elevations in public housings.

Crossing the six (6) cases, the comparison was implemented in three (3) aspects: in terms of architecture design, building density, the allocation of the ground space and the organization of car parking were the keys for discussing space elevation and its inter-relations to these three (3) keys; in terms of management, the restriction of public spaces in HDB was discussed; and last but not least, in terms of socio-spatial study, the physical condition and practical situation were compared within certain types of public spaces with the purpose of understanding space quality and its influence on the space use.
5.1 Architectural Results

This research has found some densification at the ground level (i.e., the GPR increases across the sites observed), the public space provision per square meter of housing area seems to remain relatively stable (across all 32 precincts examined), which we believe is based on Singapore-based design standards.

Another interesting result is that while land availability has been observed to constantly decline (due to widespread urbanization), public spaces started to be built above the ground. This leads to:

1. New design elements (above ground)
   - Raised platform
   - Podium
   - Roof deck garden
   - Skybridges
2. A new understanding about what is public space, that vanishes off the ground due to densification (Chua, 2012; Tay 2012).

Public Space / More than 100% of Site Area
Our case studies have shown that the cumulative public spaces in public housing complexes can in fact provide more than 100% of the total site area. See below the Pinnacle @ Duxton.

Elevated Public Space
As literature has shown that ground openness is subject to ground densification, new in-built elevated opening or covered spaces are being developed in elevated public space. These public spaces however do not “compensate” for facilities missing from the ground. Our case study observations have shown that the same facilities can appear on and above ground in the same precincts. Thus, the provision of facilities in public spaces at multiple levels is considered preliminarily as cumulative.

Allocation of Public Space
One of the key factors that represent the densification of the ground space in public housing precincts in Singapore is the allocation of the ground area (AGA) and the allocation of multilevel area (AMA). This definition has been introduced by this research to describe that the public openness on the ground is steadily allocated to other uses, different to the ones related to the commons.
The AGA refers to spaces only on:

1. **Allocation of Ground Areas**
   5 observed methods of allocating the ground in relation with:
   - GFA
   - People
   - Cars
   Thus more specifically, we take:
   **GFA related**
   - **Allocation of Ground Areas / AGA 1**
     Open ground space (excluding void deck) per GFA
   - **Allocation of Ground Areas / AGA 1(a)**
     Open ground space (excluding the void deck, road network and surface parking) per GFA
   **People related**
   - **Allocation of Ground Areas / AGA 2**
     Open ground space (excluding the void deck) per person
   - **Allocation of Ground Areas / AGA 2(a)**
     Open ground space (excluding the void deck, road network and surface parking) per person

   Car related
   - **Allocation of Ground Areas / AGA 3**
     Car density (number of car parking spaces per 100m² site area)

   The AMA refers to spaces only on:

2. **Allocation of Multilevel Areas**
   2 observed methods of allocating the effective public space additively in all multilevel elevated areas.
   These appeared to be related with:
   - People
   - GFA
   Thus more specifically, we take:
   **People related**
   - **Allocation of Multilevel Areas / AMA 1**
     Total multilevels effective public space (including the void deck) per m² per person
   **GFA related**
   - **Allocation of Multilevel Areas / AMA 2**
     Total multilevels effective public space (including the void deck) per GFA

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<tr>
<th>Precinct Facilities</th>
<th>Other Spaces</th>
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<tr>
<td>Jurong West Pioneer</td>
<td>Ground</td>
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<tr>
<td>Punggol Treelodge</td>
<td>Raised Platform</td>
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<tr>
<td>Toa Payoh Central Horizon</td>
<td>Ground</td>
</tr>
<tr>
<td>Toa Payoh The Peak</td>
<td>Ground</td>
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<td>Rochor Bras Basah Complex</td>
<td>Podium</td>
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<tr>
<td>Duxton Pinnacle</td>
<td>Raised Platform</td>
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<td></td>
<td>Skybridge 26</td>
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<td>Skybridge 50</td>
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* Urban Farm
### Public Spaces $S(p)$

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<tr>
<th>Precinct Name</th>
<th>Ground</th>
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<th>Multilevel</th>
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<td>Open Space</td>
<td>Void Deck</td>
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<td>$S(p)$ excl. &amp; S(p) incl. = S(p) excl. + (Void Deck)</td>
<td>$S(p)$ excl. + (Void Deck)</td>
<td>Total Open Elevated</td>
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<td>39600</td>
<td>8600</td>
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<td>5400</td>
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<td>Toa Payoh Central Horizon</td>
<td>21900</td>
<td>17200</td>
<td>3100</td>
</tr>
<tr>
<td>Toa Payoh The Peak</td>
<td>19720</td>
<td>16200</td>
<td>1000</td>
</tr>
<tr>
<td>Bras Basah Complex</td>
<td>3700</td>
<td>3700</td>
<td>0</td>
</tr>
<tr>
<td>Pinnacle Duxton</td>
<td>10000</td>
<td>9600</td>
<td>4000</td>
</tr>
</tbody>
</table>

### AGAs of Open Ground Spaces (excl. Void Deck) $S(p)$

<table>
<thead>
<tr>
<th>Precinct Name</th>
<th>D(p)</th>
<th>AGA 1</th>
<th>AGA 1(a)</th>
<th>AGA 2</th>
<th>AGA 2(a)</th>
<th>AGA 3</th>
<th>AMA 1</th>
<th>AMA 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>S(p)/ GFA</td>
<td>(S(p)-Road Network)/ GFA</td>
<td>S(p)/ Person</td>
<td>(S(p)-Road Network)/ Person</td>
<td>Car Density = Number of Car Parking Spaces/100m² Plot size</td>
<td>S(p)tot./ Person</td>
<td>S(p)tot./ GFA</td>
</tr>
<tr>
<td>Jurong West Pioneer</td>
<td>8.36</td>
<td>0.20</td>
<td>0.18</td>
<td>8.04</td>
<td>7.07</td>
<td>1.90</td>
<td>8.61</td>
<td>0.22</td>
</tr>
<tr>
<td>Punggol Treelodge</td>
<td>7.12</td>
<td>0.06</td>
<td>0.06</td>
<td>2.90</td>
<td>2.90</td>
<td>1.23</td>
<td>12.05</td>
<td>0.26</td>
</tr>
<tr>
<td>Toa Payoh Central Horizon</td>
<td>15.33</td>
<td>0.17</td>
<td>0.13</td>
<td>4.76</td>
<td>3.74</td>
<td>2.15</td>
<td>6.09</td>
<td>0.21</td>
</tr>
<tr>
<td>Toa Payoh The Peak</td>
<td>15.86</td>
<td>0.15</td>
<td>0.12</td>
<td>4.29</td>
<td>3.22</td>
<td>2.79</td>
<td>4.22</td>
<td>0.14</td>
</tr>
<tr>
<td>Bras Basah Complex</td>
<td>5.64</td>
<td>0.07</td>
<td>0.07</td>
<td>5.97</td>
<td>5.97</td>
<td>2.15</td>
<td>14.19</td>
<td>0.17</td>
</tr>
<tr>
<td>Pinnacle Duxton</td>
<td>25.71</td>
<td>0.04</td>
<td>0.04</td>
<td>1.39</td>
<td>1.33</td>
<td>3.92</td>
<td>5.78</td>
<td>0.16</td>
</tr>
</tbody>
</table>
This chart shows that the GPR* and the car parking (as counted on-site, see Appendix 4) per 100 m² increase relatively. With the exception of the Bras Basah mixed-use complex, the population density per 100 m² across our six (6) case study sites also seems to vary.

In addition to plotting the relation between car parking per 100 m², GPR* and the population density, we also looked at the effect of the organization of the car park lots on car park footprint on the ground level.

This chart shows that despite of identified non-consistent building code requirements, the required area per plot size for parking seems to be related to GPR*. In addition, the car park footprint at ground level may not correlate with the required area per plot size. Future research should confirm or refute this conjecture. We assume that the car park footprint may correlate with parking organization (e.g., 0% for subterranean parking, 10-12% for MSCP, 40-60% for spread parking).

This chart shows that the bigger the car park footprint at the ground level, the smaller the open ground area (potential public space) and vice versa. The mixed-use Bras Basah commercial base is an exception to the cohort study due to its large footprint of its commercial base.
In this data set, Bras Basah has shown to offer a mixed-use development. This is interesting in terms of the socio-spatial utilisation; however, it seems to add an exception in the study of the relation of population density and GPR* across the case studies.

The chart on the left shows that, with the exception of Bras Basah (involving commercial uses on its 4-storey podium), the higher the GPR*, the higher the population density per 100 m² site area.

More analysis in statistical terms however, should work to support this statement.

The factors examined are GPR* and the allocation of the multilevel effective public space (including the void deck) per GFA (AMA 2). The cohort study preliminarily indicates that the gross plot ratio GPR* increase (as re-calculated by the researcher Team in aiming to reflect to “real-life” building density) did not seem to affect multilevel effective public space (including the void deck) per GFA across the case study cohort.
Space-allocation in public housing precincts can be explored in various ways. The above has aimed to specify seven (7) ways that have been observed on-site.

Overall, the main idea behind the definition of these new factors is to understand the effects of density on space-use, population density and space provision per person as well as provision of related to people and infrastructures, hence cars and their allocation in space.
Restrictions (Defining activity in public space)
5.2 Space Restrictions of HDB

As observed in 32 precincts in Singapore, the levels of freedom and restriction were attached to the use and development of the space. Each precinct’s residential community and town council manages these spaces. They belong to the HDB and the residents of each precinct are able to communicate their needs to both managing and owning authorities. Although the HDB public spaces in precincts are open to all, they comply with three (3) types restrictions. These are the following:

Free Open to All
Playgrounds, walkways, pathways, undefined green spaces as well as short term use of void decks and precinct pavilions.
Restricted (free or bookable)
Void decks (partially or in full) and precinct pavilions.


Restricted (defined)
- Payable spaces, such as the 50th floor of the Pinnacle@ Duxton skybridge and car parking in multi-story car parks.
• Facilities requiring an access card (Pinnacle@Duxton 26th floor skybridge and ground access to the housing blocks of the Peak in Toa Payoh).

http://www.h88.com.sg/article/Living+at+The+Pinnacle+at+Duxton%3A+Part+2/

• Signage denoting visually with cues (such as signs) that the certain space is restricted to the residential community only (that can be part of a void deck and may appear as a resident corner and study corner).
Public Space Evolution In High-Density Living In Singapore
5.3 Socio-Architectural Comparison on Space Quality

The comparative analytical study integrated the investigations of both physical quality of spaces and human behaviours or activities on the site. The investigation of the space physical quality was conducted via Lynchian environmental image mapping and identification of the site to understand the environment that contributes to the visitors experience in the precinct’s public spaces. The social observation in the space was implemented to understand people’s behaviours in public spaces. The total number of visits, the average time spent, and the utilisations of the spaces were calculated to represent the practical interactions among people moving around or inhabiting in the spaces. The combination of these two (2) approaches demonstrated the interrelations between environmental elements, elevation of the spaces, and spatial use among the comparable cases. Some spatial quality factors differed across cases, indicating the influence of the environmental elements on people’s activities and behaviours.

Several pairs of spaces were used for the comparative analysis:

- Spaces of the same type, on the same levels and from the same precinct;
- Spaces of the same type, on the same levels, but from different precincts;
- Spaces of the same type, from the same precinct, but on different levels.
### 1. Spaces of Same Type on Same Level in Same Precinct

#### Playgrounds in Pioneer @ Jurong West:

<table>
<thead>
<tr>
<th>Space Appropriation</th>
<th>Playground in the Centre</th>
<th>Playground in Periphery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>Central of the precinct</td>
<td>At the periphery</td>
</tr>
<tr>
<td>Total Number of Visits</td>
<td>231</td>
<td>0</td>
</tr>
<tr>
<td>Average Time Spent</td>
<td>43 mins.</td>
<td>0 mins.</td>
</tr>
</tbody>
</table>

![Pie Chart](chart.png)

- Playing
- Exercises
- Rest
- Communication

| Space-Open |● |
| Space-Closed | ● |
| Space-Semiclosed | ● |
| Space-Shade | ● |
| Space-Covered | ● |
| Space-Facility | ● |
| Space-Sitting Furniture |● |
| Space-Illuminated |● |
| Space-Visible from Outside | ● |
| Ground-Flat |● |
| Ground-Slopping | ● |
| Ground-Decorative | ● |
| Ground-Soft |● |
| Edges-Defined |● |
| Edges-Obscured | ● |
| Edges-Structures | ● |
| Edges-Barrier | ● |
| Edges-Greenery |● |
| Edges-Slopping |● |
| Edges-Steps |● |
| Paths-Mixed Use |● |
| Paths-Pedestrian |● |
| Paths-Primary |● |
| Paths-Obscured | ● |
| Paths-Covered | ● |
| Paths-Slopping | ● |
| Paths-Steps | ● |
| Nodes-Waiting & Meeting |● |
| Nodes-Distinctive Structure |● |
| Nodes-Obscured |● |
Playground in the Central Area of Pioneer @ Jurong West

Playground at the Peripheral Area of Pioneer @ Jurong West
## Playgrounds in Pinnacle @ Duxton

<table>
<thead>
<tr>
<th></th>
<th>1D Playground</th>
<th>1E Playground</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Location</strong></td>
<td>in front of the preschool</td>
<td>behind the preschool</td>
</tr>
<tr>
<td><strong>Number of Visits</strong></td>
<td>76</td>
<td>2</td>
</tr>
<tr>
<td><strong>Average Time Spent</strong></td>
<td>58 mins.</td>
<td>10 mins.</td>
</tr>
<tr>
<td><strong>Space Appropriation</strong></td>
<td><img src="image1.png" alt="Pie Chart 1D" /></td>
<td><img src="image2.png" alt="Pie Chart 1E" /></td>
</tr>
<tr>
<td>Playing</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Exercises</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rest</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td><strong>Space-Open</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Space-Closed</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Space-Semiclosed</strong></td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td><strong>Space-Shape</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Space-Covered</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Space-Facility</strong></td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td><strong>Space-Sitting Furniture</strong></td>
<td>●</td>
<td></td>
</tr>
<tr>
<td><strong>Space-Illuminated</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Space-Visible from Outside</strong></td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td><strong>Ground-Flat</strong></td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td><strong>Ground-Slopping</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ground-Decorative</strong></td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td><strong>Ground-Soft</strong></td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td><strong>Edges-Defined</strong></td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td><strong>Edges-Obscured</strong></td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td><strong>Edges-Structures</strong></td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td><strong>Edges-Barriers</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Edges-Greenery</strong></td>
<td>●</td>
<td></td>
</tr>
<tr>
<td><strong>Edges-Slop</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Edges-Steps</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Paths-Mixed Use</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Paths-Pedestrian</strong></td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td><strong>Paths-Primary</strong></td>
<td>●</td>
<td></td>
</tr>
<tr>
<td><strong>Paths-Obscured</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Paths-Covered</strong></td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td><strong>Paths-Slopping</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Paths-Steps</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Nodes-Waiting &amp; Meeting</strong></td>
<td>●</td>
<td></td>
</tr>
<tr>
<td><strong>Nodes-Distinctive Structure</strong></td>
<td>●</td>
<td></td>
</tr>
<tr>
<td><strong>Nodes-Obscured</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The comparisons between the spaces of the same type on the same levels from the same precinct, i.e., the comparisons between two (2) playgrounds in the Pioneer and the Pinnacle, respectively, show the space use via the observation and the space characteristics through Lynchian image mapping.

**Space Use**

In the Pioneer, a great number of visits were observed in and around the central playground where people spent more than 40 minutes on average while no space use was observed in the peripheral playground. Similar situation was found in the Pinnacle on the 3th floor podium roof deck. The 1D playground in front of the preschool was used frequently. People tended to spend approximately 60 minutes there individually. On the contrary, the 1E playground behind the preschool was seldom used during the observation.

**Space Characteristics**

These two (2) pairs of comparisons present the differences spatial elements and characteristics involving:

- Exposure of the space to sunshine;
- Presence of sitting furniture in or around the space;
- Illumination in the space;
- Visibility of the space from the outside;
- Definition of space edge;
- Connection to mixed-used paths and obscured paths;
- Connection to primary pedestrian path;
- Adjacency to waiting or meeting places;
- Adjacency to obscured areas; and
- Adjacency to landmarks or distinctive structures.

These characteristics and their effect on the space use were confirmed by the interviews conducted not only in these two (2) precincts, but also in other precincts. Playground, providing a space for young children, were strongly marked as internal spaces with safety and security being the main issues. The safety and security features involved environmental quality, illumination of the space, provision of protection facilities, and partition from obscure or dangerous environment. The lack of any of these would draw people away from the space, which explains the seldom use of the peripheral playground in the Pioneer. On the other hand, certain characteristics can improve the use of playground. The tropical climate of Singapore motivated people to stay in the shade, avoiding the exposure to the strong sunshine. The dominant users of playgrounds are young children and their guardians, corresponding to the space appropriation demonstrated the existence of sedentary activities in the playground. Many interviewees stated their tendency to go to the places providing sitting furniture as well as playing equipment; otherwise, they had to shorten the duration in the space. The close connection to the primary pedestrian paths and locations people can stop and rest can also encourage people, especially children to use the space.
2. Spaces of Same Type on Same Level in Different Precincts

Terrace Garden in Central Horizon and The Peak @ Toa Payoh:

<table>
<thead>
<tr>
<th>Location</th>
<th>MSCP Terrace Garden</th>
<th>MSCP Terrace Garden</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>MSCP Roof, 8th Floor, Central Horizon @ Toa Payoh</td>
<td>MSCP Roof, 7th Floor, The Peak @ Toa Payoh</td>
</tr>
<tr>
<td>Number of Visits</td>
<td>51</td>
<td>38</td>
</tr>
<tr>
<td>Average Time Spent</td>
<td>56 mins.</td>
<td>56 mins.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Space Appropriation</th>
<th>MSCP Terrace Garden</th>
<th>MSCP Terrace Garden</th>
</tr>
</thead>
<tbody>
<tr>
<td>Playing</td>
<td><img src="chart1.png" alt="Pie Chart" /></td>
<td><img src="chart2.png" alt="Pie Chart" /></td>
</tr>
<tr>
<td>Exercises</td>
<td><img src="chart3.png" alt="Pie Chart" /></td>
<td><img src="chart4.png" alt="Pie Chart" /></td>
</tr>
<tr>
<td>Walking-Pets</td>
<td><img src="chart5.png" alt="Pie Chart" /></td>
<td><img src="chart6.png" alt="Pie Chart" /></td>
</tr>
<tr>
<td>Rest</td>
<td><img src="chart7.png" alt="Pie Chart" /></td>
<td><img src="chart8.png" alt="Pie Chart" /></td>
</tr>
<tr>
<td>Communication</td>
<td><img src="chart9.png" alt="Pie Chart" /></td>
<td><img src="chart10.png" alt="Pie Chart" /></td>
</tr>
<tr>
<td>Studying</td>
<td><img src="chart11.png" alt="Pie Chart" /></td>
<td><img src="chart12.png" alt="Pie Chart" /></td>
</tr>
<tr>
<td>Eating</td>
<td><img src="chart13.png" alt="Pie Chart" /></td>
<td><img src="chart14.png" alt="Pie Chart" /></td>
</tr>
<tr>
<td>Smoking</td>
<td><img src="chart15.png" alt="Pie Chart" /></td>
<td><img src="chart16.png" alt="Pie Chart" /></td>
</tr>
<tr>
<td>Maintenance</td>
<td><img src="chart17.png" alt="Pie Chart" /></td>
<td><img src="chart18.png" alt="Pie Chart" /></td>
</tr>
</tbody>
</table>

| Space-Open |  |  |
| Space-Closed |  |  |
| Space-Semiclosed |  |  |
| Space-Shade | ● |  |
| Space-Covered |  | ● |
| Space-Facility |  |  |
| Space-Sitting Furniture | ● | ● |
| Space-Illuminated | ● | ● |
| Space-Visible from Outside | ● | ● |
| Ground-Flat |  |  |
| Ground-Slopping |  |  |
| Ground-Decorative |  |  |
| Ground-Soft |  |  |
| Edges-Defined | ● | ● |
| Edges-Obscured |  | ● |
| Edges-Structures | ● | ● |
| Edges-Barriers |  |  |
| Edges-Greenery |  |  |
| Edges-Slop |  |  |
| Edges-Steps |  |  |
| Paths-Mixed Use |  |  |
| Paths-Pedestrian | ● | ● |
| Paths-Primary | ● | ● |
| Paths-Obscured |  |  |
| Paths-Covered |  |  |
| Paths-Slopping | ● | ● |
| Paths-Steps | ● | ● |
| Nodes-Waiting & Meeting |  |  |
| Nodes-Distinctive Structure |  |  |
| Nodes-Obscured |  |  |
Space Use

The comparison shows the use of the MSCP roof deck in the Central Horizon and The Peak. Fewer visits were observed in The Peak than in the Central Horizon while the average duration spent in these two (2) spaces were the same. In these two (2) spaces, people engaged mainly in sedentary activities while in The Peak, they engaged more in maintenance activities and in the Central Horizon, they engaged more in moving activities.

Nonetheless, the average duration in the Peak space was as long as that in the Central Horizon. A close look at the observation and interviews shows that the maintenance workers who trimmed the greenery and cleaned the space all the time were the primary users of the terrace garden in the Peak. These workers also used the space for rest and retreat, which also contributed to its reduced use by the residents. In the meantime, the users of the terrace garden in the Central Horizon were mainly the residents living close to the space, and they used the space mainly for leisure activities.

Space Characteristics

The comparison of the spatial characteristics between these two (2) spaces shows differences in:

- Exposure of the space to the sunshine;
- Presence of sitting furniture in or around the spaces;

These two (2) spaces represent two (2) kinds of spatial relations between MSCP and residential blocks: connected or independent of each other. As a new precinct, the greenery of the terrace garden in The Peak is quite small. The dominant plants, as bushes and herbs, cannot offer shade. This definitely limits the use of the space, as testified by the interviews in the precinct. Another difference is the provision of the sitting furniture in the space. The observation indicated lack of real sitting furniture in the terrace garden of the Peak. People had to sit on the floor or the borders of parterres.
### Playgrounds in Central Horizon @ Toa Payoh and The Peak @ Toa Payoh:

<table>
<thead>
<tr>
<th></th>
<th>Playgrounds in Central Horizon @ Toa Payoh</th>
<th>Playgrounds in The Peak @ Toa Payoh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>79B Playground</td>
<td>79E Playground</td>
</tr>
<tr>
<td></td>
<td>Behind BLK 79B</td>
<td>Behind BLK 79E</td>
</tr>
<tr>
<td>Number of Visits</td>
<td>77</td>
<td>95</td>
</tr>
<tr>
<td>Average Time Spent</td>
<td>27 mins.</td>
<td>32 mins.</td>
</tr>
<tr>
<td>Space Appropriation</td>
<td>Playing</td>
<td>Exercises</td>
</tr>
<tr>
<td></td>
<td>Communication</td>
<td>Studying</td>
</tr>
<tr>
<td></td>
<td>Waiting</td>
<td>Maintenance</td>
</tr>
</tbody>
</table>

| Space-Open           | ●             | ●             |                |                |
| Space-Closed         | ●             | ●             |                |                |
| Space-Semiclosed     | ●             | ●             |                |                |
| Space-Shade          | ●             | ●             |                |                |
| Space-Covered        | ●             | ●             |                |                |
| Space-Facility       | ●             | ●             | ●             | ●             |
| Space-Sitting Furniture | ●       | ●             | ●             | ●             |
| Space-Illuminated    | ●             | ●             | ●             | ●             |
| Space-Visible from Outside | ●             | ●             | ●             | ●             |
| Ground-Flat          | ●             | ●             |                |                |
| Ground-Slopping      | ●             | ●             |                |                |
| Ground-Decorative    | ●             | ●             | ●             | ●             |
| Ground-Soft          | ●             | ●             | ●             | ●             |
| Edges-Defined        | ●             | ●             | ●             | ●             |
| Edges-Obscured       | ●             | ●             | ●             | ●             |
| Edges-Structures     | ●             | ●             | ●             | ●             |
| Edges-Barriers       | ●             | ●             | ●             | ●             |
| Edges-Greenery       | ●             | ●             | ●             | ●             |
| Edges-Sloping        | ●             | ●             |                |                |
| Edges-Steps          | ●             | ●             |                |                |
| Paths-Mixed Use      | ●             | ●             |                |                |
| Paths-Pedestrian     | ●             | ●             | ●             | ●             |
| Paths-Primary        | ●             | ●             | ●             | ●             |
| Paths-Obscured       | ●             | ●             |                |                |
| Paths-Covered        | ●             | ●             |                |                |
| Paths-Slopping       | ●             | ●             |                |                |
| Paths-Steps          | ●             | ●             |                |                |
| Nodes-Waiting & Meeting | ●         | ●             |                |                |
| Nodes-Distinctive Structure | ●     | ●             |                |                |
| Nodes-Obscured       | ●             | ●             |                |                |
The table on the opposite page shows the use of the four (4) playgrounds in the Central Horizon and the Peak and the spatial characteristics through Lynchian image map.

**Space Use**

The observation shows no big difference in the space utilisation among these four playgrounds while the frequency and duration varied. According to the facilities installed, each precinct has one playground for preschool children (aged 2-5 years old) and one playground for school-aged children (aged 8-12 years old). During the observation, the playgrounds for school-aged children were used more frequently compared to the playgrounds for pre-schoolers in both two precincts. Regarding the duration, people spent around 30 minutes in four playgrounds on average. In the Central Horizon, visitors spent more time on the playground for school-aged children than on the playground for pre-schoolers; meanwhile, opposite observation was noted in the Peak.

**Space Characteristics**

The comparison of the spatial characteristics among these four (4) playgrounds showed differences in:

- Openness of space;
- Presence of sitting furniture in or around the space;
- Visibility of the space from the outside;
- Flatness of the ground surface;
- Definition of space edge;
- Connection to mixed-used paths and obscured paths;
- Cover of the nearby paths; and
- Adjacency to waiting or meeting places.

All four (4) playgrounds are all located on the ground level. They belong to two (2) independent precincts in one neighbourhood. The geographic distance between these two (2) precincts is approximately 500 meters. The comparison of the space characteristics implied that an open playground might be able to attract more people than a closed or semi-closed one. The existence of defined edges and barriers, though parting the playground from other spaces, might limit the use of the spaces. However, the visibility of the playground from outside seemed to play a negative role, as the more visible playground appeared to be utilised less. This again demonstrates the playground as an internal space that should not be too exposed to the public. The positive influence of providing sitting furniture in and around the spaces was confirmed, as the spaces with the sitting furniture were used more compared to those without the furniture. The adjacency to the mixed vehicle-pedestrian paths obviously contributes negatively to the use of the playgrounds.
3. Spaces of Same Type on Different Level in Same Precinct

Playgrounds in the Pinnacle @ Duxton:

<table>
<thead>
<tr>
<th></th>
<th>1D Playground</th>
<th>The 26th Floor Playground</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>3th Floor, in front of the preschool</td>
<td>26th Floor</td>
</tr>
<tr>
<td>Number of Visits</td>
<td>76</td>
<td>69</td>
</tr>
<tr>
<td>Average Time Spent</td>
<td>58 mins.</td>
<td>25 mins.</td>
</tr>
<tr>
<td>Space Appropriation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Playing</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Exercises</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rest</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Changing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Space-Open</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Space-Closed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Space-Semiclosed</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Space-Shade</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Space-Covered</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Space-Facility</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Space-Sitting Furniture</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Space-Illuminated</td>
<td></td>
<td>●</td>
</tr>
<tr>
<td>Space-Visible from Outside</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ground-Flat</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Ground-Slopping</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ground-Decorative</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Ground-Soft</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Edges-Defined</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Edges-Obscured</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Edges-Structures</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Edges-Barriers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edges-Greenery</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Edges-Sloping</td>
<td></td>
<td>●</td>
</tr>
<tr>
<td>Edges-Steps</td>
<td></td>
<td>●</td>
</tr>
<tr>
<td>Paths-Mixed Use</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paths-Pedestrian</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Paths-Primary</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Paths-Obscured</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paths-Covered</td>
<td></td>
<td>●</td>
</tr>
<tr>
<td>Paths-Slopping</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paths-Steps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nodes-Waiting &amp; Meeting</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Nodes-Distinctive Structure</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>Nodes-Obscured</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The playgrounds on the 3rd floor podium roof deck and the 26th floor skybridge in the Pinnacle and the terrace gardens on the 8th floor MSCP roof deck and the 12th floor podium roof deck in the Central Horizon were compared separately to assess the differences in the use of the same type space on different level of the same precinct.

**Space Use**

The table on the opposite page shows the space use and the characteristics of the playgrounds on different levels in the Pinnacle.

It shows that the frequency of the use of the two (2) playgrounds were close to each other while the average duration in these two (2) spaces was quite different. The playground visitors spent more than twice as much time on the playground on the 3rd floor podium roof deck than they did on the playground on the 26th floor skybridge.

**Space Characteristics**

The differences in the space characteristics include:

- Exposure of the space to the sunshine;
- Presence of sitting furniture in or around the spaces;
- Definition of space edge;
- Cover of the nearby paths;
- Adjacency to waiting or meeting places; and
- Adjacency to landmarks or distinctive structures.

The listed differences in space characteristics have been known to attract people to use the space more, and they can explain the difference in space use. However, this difference is more subtle than that between the playgrounds on the 3rd floor, which might indicate that space levels do not affect the space use. According to the interviews, the lift from ground to the 26th floor and the access control system that allows residents to enter the space made the 26th floor popular among the residents because they perceive certain level of ownership of these spaces.

The reduction in the average duration of time spent at the playground can be interpreted as the result of the restriction or regulation in the skybridge that people using the space cannot eat or drink there. This negative effects of restriction or regulation in the space was confirmed again here. In effect, most activities observed on the skybridge and skyterrace usually lasted about 30~40 minutes, which might be associated with certain physiological needs of human beings.
Terrace Gardens in Central Horizon @ Toa Payoh:

<table>
<thead>
<tr>
<th></th>
<th>MSCP Terrace Garden</th>
<th>Podium Roof Terrace</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>MSCP Roof, 8th Floor</td>
<td>Resident BLK, 12th Floor</td>
</tr>
<tr>
<td>Number of Visits</td>
<td>51</td>
<td>52</td>
</tr>
<tr>
<td>Average Time Spent</td>
<td>56 mins.</td>
<td>60 mins.</td>
</tr>
<tr>
<td>Space Appropriation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Playing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exercises</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walking-Pets</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Studying</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eating</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baby-Sitting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smoking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Space-Open</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Space-Closed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Space-Semiclosed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Space-Shade</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Space-Covered</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Space-Facility</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Space-Sitting Furniture</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Space-Illuminated</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Space-Visible from Outside</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Ground-Flat</td>
<td></td>
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</tr>
<tr>
<td>Ground-Slopping</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ground-Decorative</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ground-Soft</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edges-Defined</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Edges-Obscured</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edges-Structures</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Edges-Structures</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Edges-Barrier</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edges-Greenery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edges-Slop</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edges-Steps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paths-Mixed Use</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paths-Pedestrian</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Paths-Primary</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Paths-Obscured</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paths-Covered</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paths-Uncovered</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Paths-Slopping</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Paths-Steps</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Nodes-Waiting &amp; Meeting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nodes-Distinctive Structure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nodes-Obscured</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Space Use
The table on the opposite page shows that the use of the terrace gardens on the 8th floor MSCP roof deck and the 12th floor podium roof deck were almost the same. The sedentary activities accounted for 50% of the activities in both spaces.

Space Characteristics
The differences between these two (2) spaces are:
- Exposure of the space to the sunshine;
- Visibility of the space from the outside;
- Cover of the space

In this case, similar spaces were compared but in different space setting and levels. According to the previous comparison, i.e., the comparison between MSCP roof terraces in the Central Horizon and the Peak, the exposure of the space negatively affects the space use. The provision of some covered area on the 12th floor podium roof deck offsets this weakness. The covered areas with sitting furniture, based on the observation and interviews, were occupied all the time even when the weather was quite bad. This covered area attracted visits while also discouraged the visits.

Different from playgrounds as internal space, the terrace garden on the 12th floor was used by a large proportion of the users who were non-residents who worked or studied nearby. They saw and approached the space from outside with certain purposes; meanwhile very few of them knew the terrace garden on the 8th floor MSCP roof deck. The difference triggered by space levels between the two (2) spaces was presented by distinctive designs of the two terrace gardens that formed two (2) kinds of outdoor environment, a garden with lush green plants and a view deck for rest. This may relate to the limitation of the structure of the building.
Public Space Evolution In High-Density Living In Singapore
6 Conclusion

This research investigates public spaces in public HDB housing in Singapore in terms of vertical evolution. The study on the context of public space in public housing establishes theoretical and historical background of the research. Special focus is drawn onto the interrelationship between density and space evolution in vertical means. The particular situations of space use are depicted based on social and architectural on-site observations and interviews. Finally, some design considerations on public space are brought forwards for the quality of public space.
6.1 Vertical Localization of Public Space

Public spaces in high-density public housing precincts in Singapore are social spaces that connect private spaces to the urban realm. They are located between and within residential blocks, providing common facilities. Being different from general common spaces, the public spaces involved in this study include outdoor spaces and open spaces on the ground floor, i.e., void decks, in each housing precinct, which are openly accessible to thousands of their residents as well as other visitors but exclude the common spaces in the residential areas, such as corridors and circulation spaces.

The deep investigation of the six (6) sample precincts has identified that under increasing densification, public spaces will be elevated off the ground to higher levels, as the space on the ground level will be used increasingly for different purposes than the housing. It has been found that the density relates to population and car provision strategies. The higher the GPR, the more people and cars seem to be accommodated in spaces. Allocation of the ground space to parking results in the creation of elevated public spaces. Facilities offered on different levels of public space seem to influence the utilisation and duration of public space use.

Relation between Density and Localization of Public Space

The characteristics of the public space provision in the six (6) observed precincts can be generalized as below (listed according to ascending plot ratio):

1. Pioneer @ Jurong West (GPR*: 3.3): The ground area with defined thresholds is large enough to locate all public spaces on the ground.

2. Treelodge @ Punggol (GPR*: 3.3): It is obvious that elevating the public space is inevitable due to the small percentage of open space on the ground. However, neither building nor the population density is higher compared to other observed precincts. This suggests that design decision to separate people activity from traffic rather than density contributes to the localization of public space in the precinct.

3. Central Horizon @ Toa Payoh (GPR*: 4.4): The provision of the public space above the ground does not improve the entire area of the public spaces in the precincts; instead, it is offering an in-between zone linking total public space and private spaces, i.e., flat units.

4. The Peak @ Toa Payoh (GPR*: 4.6): Almost all public space are on the ground except for the roof deck garden on the multi-storey car parking, which is used by a few people. The facts that the provision of the space on the roof deck may not improve the situation on the ground along with comparatively rare use of the space indicate that the Peak could theoretically work without elevated spaces.

5. Bras Basah Complex (GPR*: 4.7): The precinct is an exception in terms of public space provision, space organization and building functional combination. The elevated public space in the precinct can be considered as a necessary supplementation to the ground, as the entire ground space serves commercial function.

6. Pinnacle @ Duxton (GPR*: 9.2): The high density of both building and population showed the impossibility of locating all public spaces on the ground, not to mention the large demands of space for car parking of the precinct. The elevated spaces also supplement the ground space.

According to these characteristics of the six (6) precincts, the following are some conclusions from the architectural aspect:

• Bras Basah is always an exemption in this matter due to the large footprint of its commercial base.
• The localization of public space is not always a consequence of density but sometimes a result of design or management choice.
• In a mono-functional precinct with little or no commercial functions and main provision of public spaces within the precinct, the threshold at which situation public spaces would be elevated can be assumed at a plot ratio of approximately 4.8-5.5.
• Based on the information and data collected in the case study, it is clear that the plot ratio and the population density are not the most crucial factors that drive the elevation of public spaces above the ground, unless the plot ratio reaches a very high value, e.g., Pinnacle with plot ratio more than 8.0.
• The primary driver in the six (6) cases that ultimately leads to the evolution of public space is the portion of open ground or more specifically, the ratio of open ground per person or per GFA. The size of this portion of open ground depends primarily on how parking is being organized. According to these characteristics of the six precincts, some conclusions from the architectural aspect can be generalized as:
  • Although there is non-consistent requirement found for the public houses in Singapore, the required area per precinct for park-
The data of the cases seem to suggest that the necessary public space amount is around 15% per GFA of the precinct. By understanding this, the ultimate density threshold of the precinct for locating all the public space on the ground level is plot ratio 4.8-5.5.

**Typological Elements of Public Space**

The observation of the 32 comparatively high-density public housing precincts has identified typological elements of public spaces that indicate the evolution of public space from flat to vertical. The names of these elements are:

- Ground
- Raised platform
- Podium
- Roof deck garden
- Sky bridge

In architectural terms, these elements have been on multiple occasions designed in-combination. In other words, a precinct may offer public spaces on the ground, a podium, the roof deck and a sky bridge. Thus, when analysing public spaces in high-density living areas that comprise these typological elements in various combinations, all precincts have been found unique in terms of their essential elements, such as their provisions, facilities, location of public space and more.

Regarding the combination of the social-spatial and architectural utilisation front, it has been identified that public spaces in high-density living are not highly frequented. An average of around 3% of the population of each public housing precinct (with the exception of the mixed-use Bras Basah Complex that joined commercial and residential functioned and thus, by definition, was used differently and engaged 19% of its population capacity) was observed using the spaces on a daily basis for an average of 36 minutes per visit. This indicates a close relation between the space use and the population density in housing precincts.

**Car Parking**

The number and organization of car-parking lots play a pivotal role in the elevation of public spaces. This study indicates that the increase in GPR relates to a relative increase in the allocation of counted parking lots across out six (6) cases. The preliminary organization of car parking can be summarized in three (3) ways:

- Basement
- Ground
- MSCP (multi-storey car park)

Despite no consistent requirements/code, the required area per plot size for parking might probably be related to GPR. However, the car-parking footprint at the ground level is very much related to the way parking is organized rather than the required area per plot size, e.g., 0% for subterranean parking, 10-12% for MSCP, 40-60% for spread parking). The bigger the car-parking footprint at ground level, the smaller the open ground area (potential public space) and vice versa.

Car parking may not relate only to a facility functionally but can reflect to the:

- GPR
- Precinct population (e.g., families, elderly)
- User perception (influential factor for space choice or not)

The user perception, based on these research interviews, may relate to a sense of air-pollution, land availability and freedom for pedestrian navigation on-site. The architectural perception suggests that the GPR may relate to provision of car-parking lots, but this number ultimately may be influenced by other societal issues that interplay, such as by the number of families on-site but not the number of people on-site.

Considering the exceptional significance of the ground (street) level as the primary place for trans-urban connection and interaction, as well as the results from our qualitative analysis showing the high value of ground public spaces, it seems important that the ground level is not being sacrificed simply to accommodate cars in the most convenient way. It seems that the localization of public spaces above the street level may be a design choice to protect users from intrusions and emissions from the street. The findings from the observations and interviews at the Pioneer suggest that the heavy traffic does indeed affect the use of public spaces in the peripheral areas (near the street) of the precinct. However, one question is to what extent removing public spaces from the street level will lead to a disruption and fragmentation of the urban fabric with negative effects on people’s interaction with their environment. On the other hand, the accumulation of heavy traffic at ground level is at least to some extent a direct consequence of a very high-density environment and the vertical expansion of the city. With that in mind it becomes obvious that the ultimate source and the solution of the problem is not to be found in the organization of car parks only but rather in keeping car traffic as low as possible and offering alternatives in housing precincts.
Discussion

The main idea of the study based on the six (6) cases focuses on the interrelations between space activities, space types and localization of space, which can be specified as:

- The relations between space activities and space, which can demonstrate the spatial requirement of a particular activity at one level;

- The relations between space activities and space localization, which can demonstrate the variation of spatial requirement of particular activities at different level of height.

According to the results from the qualitative analysis, public space cannot be seen as a place facilitating activities and interaction, but also as a place of solace and retreat. Therefore, the localization of (semi) public spaces can be seen as beneficial beyond or rather more than its necessity imposed by very high density; however, preferably in favour of ground level communal spaces and/or commercial uses rather than car parks.
6.2 Space Use and Appropriation

**Space Popularity**
The space with the highest popularity in housing precincts is the playground. Nevertheless, the situation for each playground across the studied precincts varied according to the particular condition. Certain spaces are seldom used, such as the barbecue pit and community garden, which might be relevant to the number of the spaces provided as well as the restrictions.

**Space Users**
The major users of public spaces are individuals aged from 20 to 39 years old. These include primarily young parents as well as domestic helpers that casually accompany young children and elderly people in public precinct spaces. This pattern might also relate to the age of the housing precincts involved in the investigation. This idea was verified by the exception in the Bras Basah Complex. However, this suggests the design of the public space in the public housing precincts for the future development should follow school and working hours in Singapore.

**Space Appropriation**
There are 14 types of space appropriation observed in the housing precincts.

- Playing
- Exercise
- Rest
- Informal communication
- Eating
- Baby-sitting
- Smoking
- Waiting
- Walking-pets
- Maintenance
- Study
- Gathering
- Retail
- Tourist-visit

Among above appropriations, four (4) major activities frequently taken place in most spaces are:

- Playing
- Exercise
- Rest
- Informal communication

These space utilisations are identified as moving and sedentary activities. Interestingly, moving activity, that involves human energy expenditure, is carried out for shorter durations compared to the sedentary activity that may last longer overall although by fewer people.

**Space Categorization**
According to the engagement in public spaces, i.e., moving or sedentary activities, the spaces can be classified as:

**Active public spaces for mainly moving activities:**
- Playground
- Fitness corner
- Hard court
- Precinct pavilion
- Jogging Track

**Inactive public spaces for mainly sedentary activities:**
- Void deck
- Sitting Pavilion
- Resident corner
- MSCP roof deck
- Podium roof deck

Additionally, undefined public spaces where moving and sedentary activities took place equally:

- Open green spaces
6.3 Influence of Vertical Localization on Space Use

The observations and interviews in the six (6) housing precincts have demonstrated that the elevation of the public space would influence the utilisation of the space.

Influence on Space Use
The highest level of engagement in public space is on the ground where most of the active and inactive ways of appropriation are observed, while activity seems to decline in public spaces that are elevated. This is probably related to the limitation of and reduction in space areas at various space levels. On the other hand, the spent time in the elevated spaces was longer compared to the time spent on the ground in some of the studied housing precincts. This might be related to the provision of facilities to more sedentary activities rather than to active ones on the higher space levels. The exception was also observed in the skybridge of the Pinnacle @ Duxton where residents spent more time on doing exercises than on the raised platform level.

Space visits and space localization
The space visit frequency seemed to decrease slightly from the ground level to the raised platform. The situation on the podium varied dramatically, as the podium in Bras Basah Complex was used as a main public space with fundamental facilities in the precinct while the one in the Central Horizon was set up and used only as terrace. The smallest numbers of visitors appearing on the roof deck garden suggested the lowest space visit frequency on this level. Thanks to the great amount of tourist visits on the high-elevated level in the Pinnacle, the visit frequency on the two (2) skybridges seemed to be as high as that on the raised platform in the Treelodge.

Time spent and space localization
The average time spent in the public spaces seemed to increase as the space elevated from the ground to the roof deck. This suggests that space users would stay comparatively longer in the spaces on the podium and roof deck while people would spend less time on the ground. The decline in average time spent on the high-elevated level, i.e., the skybridges of the Pinnacle, might relate to the restriction and regulation associated with utilisation of the spaces. This variation in the average time spent seems to relate to the appropriation of the spaces, as predominantly the sedentary activities seem to be practiced in the spaces elevated to either podium or roof deck.

Space appropriation and space localization
In the meantime, it is also interesting to notice that the space appropriation varied from one space level to another. The information showed that the major activities, i.e., playing, exercises, rest and informal communication, were the only activities appearing at all space levels. It is interesting to notice that the podium roof level, i.e., the podium roof deck, actually contained the biggest number of activity types among all levels. In the meantime, highly elevated level, i.e., the skybridge, was the space level with the smallest number of space activity types, which was closely related to the regulations in the Pinnacle mentioned in the previous case study.

Influence on Space Activities
The second interesting issue that attracted the researchers in this project is the inter-relationships between space elevation and users’ particular activities, i.e., playing, exercises, resting and informal communication.

Playing
A preliminary look at the observation data from the six (6) studied housing precincts suggested that the playing activities were observed on the ground and the raised platform levels much more than on the other levels, while they were seldom observed on the roof deck garden level. This may relate to the playgrounds located mostly on the ground and the raised platform levels. Although the visits to different space levels varied a lot, the time spent playing did not vary across levels.

Exercises
Concerning exercise, the pattern that emerged was more complicated. The biggest number of visitors engaged in exercise on the skybridge level in the Pinnacle, thanks to the sport scheme on the 26th floor. This seems to suggest that people are more likely to exercise in athletic facilities while the situation of the podium level in the Bras Basah Complex is an exception, as the activities strongly followed certain organised regular programs other than facility in the space. In the meantime, the average time spent seems to suggest that people would spend more time exercising at higher levels rather than ground levels, although they engage in fewer activities at elevated levels. Except for the Bras Basah Complex, the long duration appearing on the raised platform level of the Pinnacle indicates the influence of organised program on the average time spent engaging in activities in the public spaces.

Rest
The rest activities were observed mainly on the levels from the ground to the podium, while very few rest activities were observed on the roof deck garden and the skybridge levels. It is interesting that the podium of the Central Horizon, the roof deck level and the skybridge level did not appear to support the rest activity well. The second largest number of rest activities in the Bras Basah Complex
suggests that this space plays an important role in the non-residents’ lives in those special urban circumstances. Nevertheless, the average time spent engaging in the rest activities at different space levels varies less compared to the visit numbers. The time spent seems to increase slightly at higher levels.

Informal communication

The observed information seems to suggest that fewer communication activities were conducted on the raised platform level and the roof deck gardens than on the other levels. However, the average time spent on this activity was greater on the roof deck gardens compared to the ground level. Combined with the activity number, it seems that people would communicate more in places that provided fewer opportunities for physical types of activities, such as the situation on the podium and roof deck levels.

Summary

According to these phenomena observed in the selected housing precincts, the influence of space localization on space use and appropriation can be generalized as following.

- Generally, the influence of space localization on activities is complicated. Certain negative impacts effects on the frequency of certain activities, such as playing, and positive effect on the duration of some activities, such as exercises and informal communication, were observed while the effects of some other factors, such as the provision of facilities, might need to be considered as well.

- It appears that some types of space, such as playgrounds and fitness corners, would be better used on the ground or the raised platform than on the higher elevated levels, while the time spent in the space would not vary much with the space elevated.

- Some space, such as open green space and void deck, might be used in spaces elevated above the ground, and the time spent in these spaces seems to be quite balanced.

- The differences in space use seem to relate to the space appropriation, and indicate that active public spaces should be located on the ground or raised platform while inactive public space should be located on the podium or roof deck garden. However, the sky bridges of Pinnacle @ Duxton are exceptions because the restriction on the 26th floor and the special function of the 50th floor played an important role in the space use as well as the space localization.

- The influence of localization on space use might also result from the vertical accessibility of the space on the higher level. This is supported by the information from interviewees in certain studied cases. A complicated and indirect way from either the ground or a private flat to the elevated space would keep people away from the space and decrease the frequency of the space use.
6.4 Design Considerations on Public Space

Certainly, the observed cases also suggest some particular conditions that can dramatically improve the use of space in some cases.

**General Considerations on Public Space Design**

According to the investigation of the six (6) public housing precincts, some possible considerations can be considered for the future development of the public spaces. For instance, the spaces near small scale infrastructures and facilities are popular, which was observed in the playground in front of the pre-school on the raised platform of the Pinnacle, in the void deck of the Central Horizon on the ground, and the void deck of the Bras Basah Complex on the podium. This also indicates the significant changes in the use of the void deck of the Pinnacle on the raised platform when a flea market was held there. Regular organized social activities also seem to enhance the use of space, which was observed in the old deck of the Bras Basah Complex on the podium and in the hard court of the Pinnacle on the low raised platform. These design considerations include:

- **Recognition**: Easy and recognizable organization of the space with clear orientation would attract people to use the public spaces more.

- **Supplementation**: Elevated spaces within building structures, especially the space as a raised platform, can supplement the scarcity of available space on the ground.

- **Protection**: It would be better for public spaces to be located away from heavy traffic either out of or in the precincts.

- **Visibility**: The public spaces should be visible inside the housing precincts while less visible to or hidden from the outside of the precincts.

- **Balance**: The balance between green space with landscapes and paved space for various activities should be considered in and incorporated into space design.

- **Boundary**: It is necessary to set the boundaries between urban space and precinct space.

- **Separation**: The public spaces for active activities should be separated from the ones for sedentary activities.

- **Localization**: The public spaces with active activities can be elevated to the raised platform level while the public spaces with sedentary activities can be elevated to even higher levels.

- **Horizontal accessibility**: The public spaces situated close to the main paths in the housing precincts and directly connected to the main paths would be used better than the rests.

- **Vertical accessibility**: Easy and safe vertical route and accesses to public spaces would motivate more people to use the public spaces.

- **Access-control**: The more the spaces moved higher into the buildings, the more consideration should be put to the safety issue, making the access-control system more useful.

- **Furniture**: Some equipment or furniture, as well as sitting furniture in the public spaces where users need to be assisted, such as playground, fitness corner for senior residents, etc., would increase the use of the spaces.

**Specific Considerations on Public Space Design**

According to the particular circumstances of Singapore in terms of social culture and natural climate, some specific considerations need to be considered based on the interviews.

- The high radiation of the sun and high temperature in the region require solutions for shade and natural ventilation in the public spaces.

- Special considerations of the cultural issues, e.g. the Chinese cultural background, would include the transmission of the space organization from the very public level, the semi-public or semi-private level, to the very private levels from the urban space to the residential spaces, as well as classification of the spaces by the identity of users. Similarly, the Malay historical cultural background as Kampung spirit suggests the need for public spaces to accommodate group activities with different scales in the housing precinct.

- The constantly increasing population of Singapore suggests the vertical growth of the residential building and the intensive provision of the ground spaces to parking and transportation in the future. Public spaces serving different user groups, i.e., the public in general, registered residents, or smaller community groups, need to be designed at various height levels within the building structure. It can also benefit the macro concept of the state as “the city in the garden” vertically.
6.5 Further Discussion

Other interesting research issues emerged when certain discussions were conducted within the research team during the study.

Privacy Gradation
Finally yet importantly, we have to consider that open spaces and even open corridors within the precinct that are perceived as “public spaces” reflect a very Singaporean concept. As European and American urban developments from the 19th century did not provide any public space within the building block at all, one could envisage very high density environments with a more clear distinction between public space (streets, parks, plazas etc.) located on public ground (within the neighbourhood) and semi-public / semi-private spaces located within the housing or mixed-use development.

The privacy gradation of the public space is an issue that has interested the researchers from the very beginning of this study. The gradation of the space can be on the one hand presented by the access-control system in the buildings, and on the other hand has been indicated by the observation and interviews.

The study of the Bras Basah Complex first indicates the existence of the privacy gradation in the public space. The podium, although it lies between the commercial blocks and the residential blocks as a buffer connecting the corridors of the residential parts directly, it is clearly considered private, as supported by the users’ behaviours and the interviews from both the public and the residents in the building. Similar information was also discovered in the precincts with raised platform space, such as the Treelodge @ Punggol and the Pinnacle @ Duxton, where interviewees expressed comparatively stronger sense of ownership. Further investigations should be conducted to determine potential interrelationships between the height of the public spaces and the privacy levels. For instance, the Pinnacle @ Duxton applies the access-control system on different levels of public spaces. This system solidifies users on the different space levels, as described in the previous section of case study.

Other Issues
Some other questions that could be addressed include:

- The capacity of space with different social activities
- The phenomenon of convergence of space users and space activities in the public space in particular social circumstances, as those in Singapore
- The privacy graduation (i.e., private to semi-private, semi-public and public) in the public space under particular social circumstances as Singapore
- The effect of personal digital appliance to the public space use
- The application of the research results to the architectural design practices

Further Research
Further research can contribute to the spatial and socio-spatial analysis of public spaces in especially high-density environments, like contemporary Asian cities. It would be desirable to enlarge the focus of the analysis from the level of building/precinct to the level of neighbourhood/city district, as a next step. This would promote a better understanding of the type of public spaces and the organization of public spaces in an urban realm- their location, their elevation, their connectivity. In the meantime, the focus of the research on public spaces would be extended to the common spaces in both urban and the building levels.

From a socio-spatial perspective, the research should generate knowledge on regulations, norms, as well as the use and (historical and contemporary) meaning of public space in high-density (Asian) cities. Understanding the past and present development of public space planning and use can help generate principles for future holistic planning and design of public space.
Glossary
With (*) we denote definitions introduced by this research

AGA*
Allocation of the ground area by ground space uses, such as car parking.

AMA*
Allocation of multilevel area

Hard Court
A paved area devoted for specific types of sports (such as basketball, badminton etc.)

Fitness Corner
An age categorized space open with the precinct public space for residents to exercise. This area offers specific equipment for light exercise (such as parallel bars, chin-up bars, and steps).

GFA
Gross Floor Area.

GPR
Gross Plot Ratio
= GFA divided by Total plot area (or in other words, total land area)

GPR*
Plotted Gross Plot Ratio
Based on the URA masterplan and newly calculated GFA (see Appendix 1)

HDB
Housing and Development Board
Founded by the government of Singapore in 1960 (February 1).

HDB Precinct
Public Housing in Singapore developed by HDB. Each precinct is composed as a cluster of housing blocks that are developed together as a single unit under the same name and different numbering of blocks (for purposes of distinction between blocks). Precincts are collective spaces that are composed by 10 blocks on average and public space.
New Towns
Singapore is composed by 26 New Towns where each New Town is a cluster of an average of 9 neighborhoods. Neighborhoods are composed by clustered HDB precincts and other urbanized uses.

NPARKS
National Parks Board of Singapore. All public green spaces are organized and maintained in Singapore by NPARKS.

MSCP
Multistorey car park.

MRT
Mass Rapid Transit

Liveability
It is understood as a generic factor of urban planning that relates to its suitability for human living comfort and sustainability.

Open Space
Uncovered clear from buildings landscape.

Podium
A podium (plural podia) is a platform that is used to raise something to a short distance above its surroundings. It derives from the Greek πόδι (foot). In architecture a building can rest on a large podium. (Wikipedia)

Precinct Community
The occupants of each HDB residential lock forming the given HDB precinct.

Public Housing in Singapore
In this research public housing is considered as HDB housing.

Public Space *
Publically-used spaces that are located between and within residential blocks providing common facilities.

Resident Committee
The Residents’ Committees (RCs) were introduced in 1978 to promote neighbourliness, racial harmony and community cohesiveness amongst residents within their respective RC zones in Housing and Development Board (HDB) estates. (http://www.pa.gov.sg/our-network/grassroots-organisations/residents-committees.html)
Residents Corner
Public spaces dedicated for the residential use only. These are devoted to the particular precinct community and are defined by signage.

Roof Deck
A terrace that is located on top of a podium.

SIT
Singapore Improvement Trust

Sitting Pavilion
Sheltered space providing seating furniture for precinct users within the public space.

Skybridge
Is a pedestrian link above ground that connects residential buildings with each other. The most characteristic skybridges in HDB precincts in Singapore are these on the 26th and 50th floor of the Pinnacle@Duxton.

S(p)
Open ground space (excluding the void deck)

Total Public Space on the Ground
All spaces, covered and uncovered, that are devoted to public use on the ground. This includes, precinct pedestrian networks and excludes the precinct vehicular network and the car parking.

Town Councils
In Singapore: Town Councils control, manage, maintain and improve the common property of HDB residential flats and commercial property within the town. Common property includes corridors, void decks, lifts, water tanks, public lighting and open spaces. (http://www.towncouncils.sg/about/WorkOfTownCouncils.html)
URA

Urban Redevelopment Authority of Singapore.
Singapore’s ambience as a green city.

Community Garden

Enclosed space devoted for some resident community member only. These spaces are restricted to gardening use only and are taken care of by community volunteers. This idea was introduced and implemented by NPARKS to contribute to the overall mission of promoting Singapore’s ambience as a green city.
Appendix 1

GFA Calculation (Example)

The URA Master data showed GPR, which applied new GPR values when crosschecked with the real condition. The GFA was calculated based on the plot ratio, according to the master plan. The verification by means of CAD take-offs showed that the master plan plot ratio did not reflect the built surface accurately. It appeared that in all cases, except for Bras Basah, the GFA is approximately 10% higher than defined in the URA master plan, which suggests that extra 10 % (URA regulations) was used. The indicated plot ratio of Bras Basah cannot be directly related to the building situation, as before 1989, Singapore’s building code was based on population density (P/ha) not on GPR. The fact that the URA master plan plot ratio could not be used unverified can also be seen in the list of 32 evaluated precincts where several older estates (built based on P/ha density) show plot ratios that are obviously too high for what is currently being built.

In some cases, it was also found that the “10 % bonus” was found the deviate considerably (by even 10% more). We conjecture that deviations observed relate to regulation improvements involving, for instance, balconies, bay windows and planter boxes. An example on the GFA calculations is attached.

Example

The brochure with the floor plans (not to scale) of a typical 110m² plan graphed on CAD shows flat sizes of every single flat. Not all floors have the same total flat area (which makes sense because the first ten (10) floors show void structure in the photos). We thus,

• Listed all flat areas for the different floors
• Added all the flat areas
• The CAD drawing is scaled so that the flat area (blue) matches the indicated total flat size according to the table to receive the accurate area for the corridor.

Result

GFA (calculation see below) = 145’000m², which is 11’000m² more than the plot ratio plus 10% bonus. In fact, it is exactly 20% above the plot ratio (site area 28800m² x 4.2 (plot ratio) = 120’960m² GFA - the additional ±24’000m² is 20% more).

This strongly suggests that the GFA is indeed much larger than for the currently built areas.

The Peak would exceed the GPR (by the URA Master plan) by 10% beyond the maximum 10% bonus. There is a scheme that allows 10% balcony area over and above the GFA allowed.

Calculation of GFA for The Peak:

Floors 1-10 > 586m² x 50 floor = 29’300m²
Floors 11-18 > 628m² x 40 floor = 25’120m²
Floors 19-42 > 644m² x 113 floor = 72’772m²

(the 644m², which is the full plan area is what I scaled the CAD plan to match - 113 floor because two (2) floors contain the emergency area)

Total for flats = 127’192m² (total of above)
204 Corridors at 88m² = 17’952m²
Lifts (first floor only) = 125m²

Total GFA ± 145‘269m² (=1.2009 x the plot Ratio according to the Master Plan x the full plat area)
### Public Space In High-Density Living In Singapore

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**Legend**

- 3-Room: 753 sqft / 70 sqm
- 4-Room: 980 sqft / 91 sqm
- 5-Room: 1,184 sqft / 110 sqm
- 5-Room: 1,184 sqft / 110 sqm
- 5-Room: 1,216 sqft / 113 sqm
- 5-Room: 1,216 sqft / 113 sqm
- 5-Room: 1,227 sqft / 114 sqm
- 5-Room: 1,259 sqft / 117 sqm

- *High Ceiling
- Parapet Wall
Appendix 2

Population Calculation (Example)

There was no official information on the resident population of public housing precincts available. The resident population of each studied precinct used in this research was estimated based on the statistic data of HDB annual report 2012-2013, specifically, the HDB housing flat units and the population in each new town under the management of HDB; as well as the types and numbers of flat units in each studied precinct.

An accommodation capacity modulus of one bedroom for each new town was calculated through dividing HDB registered population by the total public housing bedroom number of one new town. The resident population of six housing precincts was obtained by multiplying the modulus of corresponding new town with the bedroom number of the precinct respectively. The number of bedroom of one studied precinct was investigated by counting the flat unit number of each flat type on-site. Take The Peak @ Toa Payoh as an example:

This calculation tried to present the difference of population density in the entire country, i.e., the denser population in the central district (Toa Payoh Town and downtown area) than in the northeast district (Punggol Town) or west district (Jurong West Town).

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Total Area (ha)</td>
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<tr>
<td>Residential Area (ha)</td>
<td>210</td>
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<tr>
<td>Total population</td>
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<td>Population in HDB</td>
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<table>
<thead>
<tr>
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Accomodation Capacity Modulus | 1.339

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</table>

Total Population | 4706.288

Estimated Total Precinct Population | 4700
Appendix 3

Interview Questions

Part 1: Personal Information
1. Gender
2. Ethnic
3. Age
4. Vocation
5. Are you living in this precinct? If yes, do you own or rent a flat in this precinct?
6. On which level are you living in?
7. What type of flat are you living in in this precinct? How many rooms do you have?
8. How many people are living with you in your household? Are all of you one family? How many generations are there?
9. How long have you been living in this precinct?
10. Where did you live before? Can you briefly describe the living situation there?

Part 2: General Physical Presence (on the site map)
1. Are you familiar with all the public spaces in and around this precinct? Have you been to these places? If not, which spaces are you familiar with, or have you been to?
2. Can you point out the entrances that you usually use in the precinct?
3. Which parts of the public spaces in this precinct do you have the strongest impression? Or what is your first impression to the public spaces in this precinct? Why?
4. Can you think of anything that can attract you to use the public spaces and the facilities in the precinct? If yes, please specify them.
5. In your opinion, are these spaces and facilities enough for the residents here?
6. Do you know any development or improvement of the precinct? If yes, can you briefly describe the improvement?

Part 3: Spatial Use and Appropriation
1. Which public spaces do you usually go to in the precinct? What do you usually do there? How long do you usually stay there? And how often do you usually do so?
2. When you visit the public spaces, which place do you usually travel from, your flat or other places?
3. Can you use these spaces or facilities at anytime you want? (If it is possible, can you compare the precinct with your former living place?) If not, where do you usually go to as the alternatives? And how far away is that place?
4. Are these spaces in the precinct that you and your family use most often? If not, where do you usually go out of the precinct? And what factor attracts you to go there?
5. Do you usually use these public spaces alone or with a group? If with a group, how large is the group? Can you describe the group?
6. Are there any places/spaces out of your flat in the precinct that you take care of normally? Include car/bicycle-parking area. And why?
7. In what situation will you put your personal belongings out of your flat? If yes, how do you declare the boundaries of the spaces that you appropriate?
8. Which things of yours outside your flat are only temporarily?
9. If possible, are the space use and appropriation in this precinct different from your previous living place?
10. Is there any regulation or procedure that people have to obey or follow? Can you specify them?
11. Are there any physical barriers in the precinct that restrict the use of the spaces or the facilities?

Part 4: From Horizontal to Vertical
1. Have you ever been to the public spaces on the other level off the ground?
2. Do you use these off ground space as well? If yes, what do you usually do there? How much time do you usually spend there? And how often do you usually do so?
3. Why do you or why don’t you go there?
4. In your opinion, what is the main difference between the spaces off the ground and the ground?
5. Which space is easier for you to access to, the ground or the off ground space in this precinct? And Why?
Appendix 4

Counted Carparking Data

Carparking calculations, in this project, are based on our own on-site counting of car parking lots in the 6 case study sites analyzed. AGA3 is calculated as counted car parking lots per 100 m² on the ground, if all cars were parked on the ground. This is a demonstration of car density.

<table>
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<th>3rd Storey</th>
<th>4th Storey</th>
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<td>The Peak</td>
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<td></td>
<td>101</td>
<td>120</td>
<td>128</td>
<td>131</td>
<td>132</td>
<td>130</td>
<td>67</td>
</tr>
<tr>
<td>Bras Basah Complex</td>
<td>237</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>237</td>
</tr>
<tr>
<td>Pinnacle</td>
<td></td>
<td>506</td>
<td>319</td>
<td>272</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1097</td>
</tr>
</tbody>
</table>

**NUMBER OF COUNTED CAR PARKING LOTS PER FLOOR PER PRECINCT**

- BASEMENT 1
- 1ST STOREY
- 2ND STOREY
- 3RD STOREY
- 4TH STOREY
- 5TH STOREY
- 6TH STOREY
- 7TH STOREY
Appendix 5

26 Precinct Design and Descriptions
Precinct Name: Bedok, Linear Green  
Year of Completion: 2008

<table>
<thead>
<tr>
<th>Descriptive Characteristics</th>
<th>Figures and Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type and Location of Public Space</td>
<td>Ground open space</td>
</tr>
<tr>
<td>Plot Size (Total Area of Precinct)</td>
<td>35170 m²</td>
</tr>
<tr>
<td>Gross Floor Area</td>
<td>112544 m²</td>
</tr>
<tr>
<td>Number of Floors</td>
<td>17</td>
</tr>
<tr>
<td>Estimated Number of Residents</td>
<td>3750</td>
</tr>
<tr>
<td>Building Density -&gt; Plot ratio = Gross Floor Area/ Plot Size</td>
<td>3.2</td>
</tr>
<tr>
<td>Population Density = Plot Size/ Number of Residents</td>
<td>9.37</td>
</tr>
<tr>
<td>Site Coverage Ratio = Footprint/ Plot Size</td>
<td>.24</td>
</tr>
<tr>
<td>Effective Public Space = Public Space/ Number of Resident</td>
<td>TBC</td>
</tr>
<tr>
<td>Number of Parking Spaces (estimate)</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 1 = Free Ground / Gross Floor Area</td>
<td>.237</td>
</tr>
<tr>
<td>Ground Contested Space 2 = Free Ground/ Number of Residents</td>
<td>7.11</td>
</tr>
<tr>
<td>Ground Contested Space 3 = Free Ground / Number of Parking Spaces</td>
<td>TBC</td>
</tr>
<tr>
<td>Commercial and or Non domestic functions</td>
<td>Commercial space at parking lot ground level.</td>
</tr>
</tbody>
</table>

Short Description: Ground level precinct surrounded by cluster blocks.
Precinct Name: Kallang, Boon Keng, City View
Year of Completion: 2008

<table>
<thead>
<tr>
<th>Descriptive Characteristics</th>
<th>Figures and Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type and Location of Public Space</td>
<td>Open ground space</td>
</tr>
<tr>
<td>Plot Size (Total Area of Precinct)</td>
<td>20370 m²</td>
</tr>
<tr>
<td>Gross Floor Area</td>
<td>85554 m²</td>
</tr>
<tr>
<td>Number of Floors</td>
<td>40</td>
</tr>
<tr>
<td>Estimated Number of Residents</td>
<td>2960</td>
</tr>
<tr>
<td>Building Density -&gt; Plot ratio = Gross Floor Area/ Plot Size</td>
<td>4.2</td>
</tr>
<tr>
<td>Population Density = Plot Size/ Number of Residents</td>
<td>6.88</td>
</tr>
<tr>
<td>Site Coverage Ratio = Footprint/ Plot Size</td>
<td>0.26</td>
</tr>
<tr>
<td>Effective Public Space = Public Space/ Number of Resident</td>
<td>TBC</td>
</tr>
<tr>
<td>Number of Parking Spaces (estimate)</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 1 = Free Ground / Gross Floor Area</td>
<td>0.174</td>
</tr>
<tr>
<td>Ground Contested Space 2 = Free Ground/ Number of Residents</td>
<td>5.04</td>
</tr>
<tr>
<td>Ground Contested Space 3 = Free Ground / Number of Parking Spaces</td>
<td>TBC</td>
</tr>
<tr>
<td>Commercial and or Non domestic functions</td>
<td>Non-Domestic functions only.</td>
</tr>
</tbody>
</table>

Short Description: Cluster Blocks with restricted access to the block corridors.
## Precinct Name: Choa Chu Kang, Crescent

**Year of Completion: 1997**

<table>
<thead>
<tr>
<th><strong>Descriptive Characteristics</strong></th>
<th><strong>Figures and Values</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Type and Location of Public Space</td>
<td>One courtyard and ground open space</td>
</tr>
<tr>
<td>Plot Size (Total Area of Precinct)</td>
<td>95773 m²</td>
</tr>
<tr>
<td>Gross Floor Area</td>
<td>287319 m²</td>
</tr>
<tr>
<td>Number of Floors</td>
<td>TBC</td>
</tr>
<tr>
<td>Estimated Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Building Density -&gt; Plot ratio = Gross Floor Area/ Plot Size</td>
<td>3.0</td>
</tr>
<tr>
<td>Population Density = Plot Size/ Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Site Coverage Ratio = Footprint/ Plot Size</td>
<td>0.309</td>
</tr>
<tr>
<td>Effective Public Space = Public Space/ Number of Resident</td>
<td>TBC</td>
</tr>
<tr>
<td>Number of Parking Spaces (estimate)</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 1 = Free Ground / Gross Floor Area</td>
<td>0.1032</td>
</tr>
<tr>
<td>Ground Contested Space 2 = Free Ground/ Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 3 = Free Ground / Number of Parking Spaces</td>
<td>TBC</td>
</tr>
<tr>
<td>Commercial and or Non domestic functions</td>
<td>Some grocery shops at ground level.</td>
</tr>
</tbody>
</table>

**Short Description:** Ground level precinct surrounded by cluster blocks.
**Precinct Name: Clementi, Heights**

**Year of Completion: 2007**

<table>
<thead>
<tr>
<th>Descriptive Characteristics</th>
<th>Figures and Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type and Location of Public Space</td>
<td>At ground level and on terrace garden</td>
</tr>
<tr>
<td>Plot Size (Total Area of Precinct)</td>
<td>35051 m²</td>
</tr>
<tr>
<td>Gross Floor Area</td>
<td>122678 m²</td>
</tr>
<tr>
<td>Number of Floors</td>
<td>25</td>
</tr>
<tr>
<td>Estimated Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Building Density -&gt; Plot ratio = Gross Floor Area/ Plot Size</td>
<td>3.5</td>
</tr>
<tr>
<td>Population Density = Plot Size/ Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Site Coverage Ratio = Footprint/ Plot Size</td>
<td>0.41</td>
</tr>
<tr>
<td>Effective Public Space = Public Space/ Number of Resident</td>
<td>TBC</td>
</tr>
<tr>
<td>Number of Parking Spaces (estimate)</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 1 = Free Ground / Gross Floor Area</td>
<td>0.1678</td>
</tr>
<tr>
<td>Ground Contested Space 2 = Free Ground/ Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 3 = Free Ground / Number of Parking Spaces</td>
<td>TBC</td>
</tr>
<tr>
<td>Commercial and or Non domestic functions</td>
<td>No Commercial activity within precinct level.</td>
</tr>
</tbody>
</table>

**Short Description:** Cluster Blocks with a multistory car-park that offers a sky terrace on top floor.
**Precinct Name: Clementi, Towers (Clementi Mall)**

**Year of Completion: 2011**

<table>
<thead>
<tr>
<th>Descriptive Characteristics</th>
<th>Figures and Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type and Location of Public Space</td>
<td>Terrace Garden at 8th Floor</td>
</tr>
<tr>
<td>Plot Size (Total Area of Precinct)</td>
<td>16751 m²</td>
</tr>
<tr>
<td>Gross Floor Area</td>
<td>83755 m²</td>
</tr>
<tr>
<td>Number of Floors</td>
<td>40</td>
</tr>
<tr>
<td>Estimated Number of Residents</td>
<td>1300</td>
</tr>
<tr>
<td>Building Density -&gt; Plot ratio = Gross Floor Area/ Plot Size</td>
<td>5.0</td>
</tr>
<tr>
<td>Population Density = Plot Size/ Number of Residents</td>
<td>12.88</td>
</tr>
<tr>
<td>Site Coverage Ratio = Footprint/ Plot Size</td>
<td>0.43</td>
</tr>
<tr>
<td>Effective Public Space = Public Space/ Number of Resident</td>
<td>TBC</td>
</tr>
<tr>
<td>Number of Parking Spaces (estimate)</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 1 = Free Ground / Gross Floor Area</td>
<td>0.11</td>
</tr>
<tr>
<td>Ground Contested Space 2 = Free Ground/ Number of Residents</td>
<td>7.22</td>
</tr>
<tr>
<td>Ground Contested Space 3 = Free Ground / Number of Parking Spaces</td>
<td>TBC</td>
</tr>
<tr>
<td>Commercial and or Non domestic functions</td>
<td>Commercial podium</td>
</tr>
</tbody>
</table>

**Short Description:** Mixed-use precinct formed by seven (7) floors of commercial podium, a Void Deck/ Sky Terrace on the 8th floor. The development offers two (2) cluster developments that are 32 floor high each.
Precinct Name: Queenstown, Forfar Height

Year of Completion: 2005

<table>
<thead>
<tr>
<th>Descriptive Characteristics</th>
<th>Figures and Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type and Location of Public Space</td>
<td>At ground level and on terrace garden</td>
</tr>
<tr>
<td>Plot Size (Total Area of Precinct)</td>
<td>47200 m²</td>
</tr>
<tr>
<td>Gross Floor Area</td>
<td>198240 m²</td>
</tr>
<tr>
<td>Number of Floors</td>
<td>30</td>
</tr>
<tr>
<td>Estimated Number of Residents</td>
<td>2930</td>
</tr>
<tr>
<td>Building Density (\Rightarrow) Plot ratio = Gross Floor Area/ Plot Size</td>
<td>4.2</td>
</tr>
<tr>
<td>Population Density = Plot Size/ Number of Residents</td>
<td>16.10</td>
</tr>
<tr>
<td>Site Coverage Ratio = Footprint/ Plot Size</td>
<td>0.32</td>
</tr>
<tr>
<td>Effective Public Space = Public Space/ Number of Resident</td>
<td>5.16</td>
</tr>
<tr>
<td>Number of Parking Spaces (estimate)</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 1 = Free Ground / Gross Floor Area</td>
<td>0.161</td>
</tr>
<tr>
<td>Ground Contested Space 2 = Free Ground/ Number of Residents</td>
<td>10.94</td>
</tr>
<tr>
<td>Ground Contested Space 3 = Free Ground / Number of Parking Spaces</td>
<td>TBC</td>
</tr>
<tr>
<td>Commercial and or Non domestic functions</td>
<td>No Commercial activity within precinct</td>
</tr>
</tbody>
</table>

**Short Description**: Ground level precinct surrounded by cluster blocks.
## Precinct Name: Geylang, Eunos Court, Plot

**Year of Completion:** 2006

<table>
<thead>
<tr>
<th>Descriptive Characteristics</th>
<th>Figures and Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type and Location of Public Space</td>
<td>Two courtyard spaces at ground level</td>
</tr>
<tr>
<td>Plot Size (Total Area of Precinct)</td>
<td>25100 m²</td>
</tr>
<tr>
<td>Gross Floor Area</td>
<td>85340 m²</td>
</tr>
<tr>
<td>Number of Floors</td>
<td>19</td>
</tr>
<tr>
<td>Estimated Number of Residents</td>
<td>2500</td>
</tr>
<tr>
<td>Building Density -&gt; Plot ratio = Gross Floor Area/ Plot Size</td>
<td>3.4</td>
</tr>
<tr>
<td>Population Density = Plot Size/ Number of Residents</td>
<td>10.04</td>
</tr>
<tr>
<td>Site Coverage Ratio = Footprint/ Plot Size</td>
<td>0.79</td>
</tr>
<tr>
<td>Effective Public Space = Public Space/ Number of Resident</td>
<td>6.39</td>
</tr>
<tr>
<td>Number of Parking Spaces (estimate)</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 1 = Free Ground / Gross Floor Area</td>
<td>0.187</td>
</tr>
<tr>
<td>Ground Contested Space 2 = Free Ground/ Number of Residents</td>
<td>6.39</td>
</tr>
<tr>
<td>Ground Contested Space 3 = Free Ground / Number of Parking Spaces</td>
<td>TBC</td>
</tr>
<tr>
<td>Commercial and or Non domestic functions</td>
<td>No Commercial activity in precinct</td>
</tr>
</tbody>
</table>

**Short Description:** Ground level open space surrounded by cluster blocks.
Precinct Name: Hougang, Buangkok Link
Year of Completion: 2008

<table>
<thead>
<tr>
<th>Descriptive Characteristics</th>
<th>Figures and Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type and Location of Public Space</td>
<td>Open ground space</td>
</tr>
<tr>
<td>Plot Size (Total Area of Precinct)</td>
<td>54974 m²</td>
</tr>
<tr>
<td>Gross Floor Area</td>
<td>164922 m²</td>
</tr>
<tr>
<td>Number of Floors</td>
<td>17</td>
</tr>
<tr>
<td>Estimated Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Building Density -&gt; Plot ratio = Gross Floor Area/ Plot Size</td>
<td>3.0</td>
</tr>
<tr>
<td>Population Density = Plot Size/ Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Site Coverage Ratio = Footprint/ Plot Size</td>
<td>0.36</td>
</tr>
<tr>
<td>Effective Public Space = Public Space/ Number of Resident</td>
<td>TBC</td>
</tr>
<tr>
<td>Number of Parking Spaces (estimate)</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 1 = Free Ground / Gross Floor Area</td>
<td>0.213</td>
</tr>
<tr>
<td>Ground Contested Space 2 = Free Ground/ Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 3 = Free Ground / Number of Parking Spaces</td>
<td>TBC</td>
</tr>
<tr>
<td>Commercial and or Non domestic functions</td>
<td>Separate block for commercial activities</td>
</tr>
</tbody>
</table>

Short Description: Ground level public space with cluster blocks surrounding it as well as with a multi-storey car-park in a separate building.
Precinct Name: Bukit Merah, Tiong Bahru, Membina Court

Year of Completion: 2007

<table>
<thead>
<tr>
<th>Descriptive Characteristics</th>
<th>Figures and Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type and Location of Public Space</td>
<td>At ground level and roof garden</td>
</tr>
<tr>
<td>Plot Size (Total Area of Precinct)</td>
<td>39532 m²</td>
</tr>
<tr>
<td>Gross Floor Area</td>
<td>138362 m²</td>
</tr>
<tr>
<td>Number of Floors</td>
<td>33</td>
</tr>
<tr>
<td>Estimated Number of Residents</td>
<td>4400</td>
</tr>
<tr>
<td>Building Density -&gt; Plot ratio = Gross Floor Area/ Plot Size</td>
<td>3.5</td>
</tr>
<tr>
<td>Population Density = Plot Size/ Number of Residents</td>
<td>8.98</td>
</tr>
<tr>
<td>Site Coverage Ratio = Footprint/ Plot Size</td>
<td>0.31</td>
</tr>
<tr>
<td>Effective Public Space = Public Space/ Number of Resident</td>
<td>TBC</td>
</tr>
<tr>
<td>Number of Parking Spaces (estimate)</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 1 = Free Ground / Gross Floor Area</td>
<td>0.19</td>
</tr>
<tr>
<td>Ground Contested Space 2 = Free Ground/ Number of Residents</td>
<td>6.11</td>
</tr>
<tr>
<td>Ground Contested Space 3 = Free Ground / Number of Parking Spaces</td>
<td>TBC</td>
</tr>
<tr>
<td>Commercial and or Non domestic functions</td>
<td>Parking lot ground floor is partially commercialized</td>
</tr>
</tbody>
</table>

Short Description: High-adjacency environment with cluster blocks and urban farming corner. There is an unused dark space attached to the Membina Food Court.
Precinct Name: Bukit Merah, Redhill Rise

Year of Completion: 1996

<table>
<thead>
<tr>
<th>Descriptive Characteristics</th>
<th>Figures and Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type and Location of Public Space</td>
<td>Open ground space</td>
</tr>
<tr>
<td>Plot Size (Total Area of Precinct)</td>
<td>46988 m²</td>
</tr>
<tr>
<td>Gross Floor Area</td>
<td>187952 m²</td>
</tr>
<tr>
<td>Number of Floors</td>
<td>30</td>
</tr>
<tr>
<td>Estimated Number of Residents</td>
<td>4540</td>
</tr>
<tr>
<td>Building Density -&gt; Plot ratio = Gross Floor Area/ Plot Size</td>
<td>4.0</td>
</tr>
<tr>
<td>Population Density = Plot Size/ Number of Residents</td>
<td>10.34</td>
</tr>
<tr>
<td>Site Coverage Ratio = Footprint/ Plot Size</td>
<td>0.27</td>
</tr>
<tr>
<td>Effective Public Space = Public Space/ Number of Resident</td>
<td>TBC</td>
</tr>
<tr>
<td>Number of Parking Spaces (estimate)</td>
<td>20</td>
</tr>
<tr>
<td>Ground Contested Space 1 = Free Ground / Gross Floor Area</td>
<td>0.18</td>
</tr>
<tr>
<td>Ground Contested Space 2 = Free Ground/ Number of Residents</td>
<td>7.49</td>
</tr>
<tr>
<td>Ground Contested Space 3 = Free Ground / Number of Parking Spaces</td>
<td>TBC</td>
</tr>
<tr>
<td>Commercial and or Non domestic functions</td>
<td>Blk 75A, C and D are partially commercialized</td>
</tr>
</tbody>
</table>

Short Description: Red colored cluster blocks, with ground surface parking, two (2) pavilions and two (2) playgrounds. A precinct, that demonstrates a sense of interconnected community bonding.
Precinct Name: Sembawang, Green
Year of Completion: 2004

<table>
<thead>
<tr>
<th>Descriptive Characteristics</th>
<th>Figures and Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type and Location of Public Space</td>
<td>Courtyard at ground level</td>
</tr>
<tr>
<td>Plot Size (Total Area of Precinct)</td>
<td>83500 m²</td>
</tr>
<tr>
<td>Gross Floor Area</td>
<td>292250 m²</td>
</tr>
<tr>
<td>Number of Floors</td>
<td>20</td>
</tr>
<tr>
<td>Estimated Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Building Density -&gt; Plot ratio = Gross Floor Area/ Plot Size</td>
<td>3.5</td>
</tr>
<tr>
<td>Population Density = Plot Size/ Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Site Coverage Ratio = Footprint/ Plot Size</td>
<td>0.305</td>
</tr>
<tr>
<td>Effective Public Space = Public Space/ Number of Resident</td>
<td>TBC</td>
</tr>
<tr>
<td>Number of Parking Spaces (estimate)</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 1 = Free Ground / Gross Floor Area</td>
<td>0.1985</td>
</tr>
<tr>
<td>Ground Contested Space 2 = Free Ground/ Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 3 = Free Ground / Number of Parking Spaces</td>
<td>TBC</td>
</tr>
<tr>
<td>Commercial and or Non domestic functions</td>
<td>Small food stall at ground level</td>
</tr>
<tr>
<td></td>
<td>commercialized</td>
</tr>
</tbody>
</table>

**Short Description**: Ground level precinct surrounded by cluster blocks.
## Precinct Name: Tampines, Premiére

**Year of Completion: 2009**

<table>
<thead>
<tr>
<th>Descriptive Characteristics</th>
<th>Figures and Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type and Location of Public Space</td>
<td>Linear courtyard public space</td>
</tr>
<tr>
<td>Plot Size (Total Area of Precinct)</td>
<td>21485 m²</td>
</tr>
<tr>
<td>Gross Floor Area</td>
<td>68752 m²</td>
</tr>
<tr>
<td>Number of Floors</td>
<td>17</td>
</tr>
<tr>
<td>Estimated Number of Residents</td>
<td>2700</td>
</tr>
<tr>
<td>Building Density -&gt; Plot ratio = Gross Floor Area/ Plot Size</td>
<td>3.2</td>
</tr>
<tr>
<td>Population Density = Plot Size/ Number of Residents</td>
<td>7.957</td>
</tr>
<tr>
<td>Site Coverage Ratio = Footprint/ Plot Size</td>
<td>0.447</td>
</tr>
<tr>
<td>Effective Public Space = Public Space/ Number of Resident</td>
<td>4.4</td>
</tr>
<tr>
<td>Number of Parking Spaces (estimate)</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 1 = Free Ground / Gross Floor Area</td>
<td>0.173</td>
</tr>
<tr>
<td>Ground Contested Space 2 = Free Ground/ Number of Residents</td>
<td>4.39</td>
</tr>
<tr>
<td>Ground Contested Space 3 = Free Ground / Number of Parking Spaces</td>
<td>TBC</td>
</tr>
<tr>
<td>Commercial and or Non domestic functions</td>
<td>No commercial activities</td>
</tr>
</tbody>
</table>

**Short Description:** Ground level precinct surrounded by cluster blocks.
**Precinct Name: Bukit Merah, Tiong Bahru**

**Year of Completion: 2011**

<table>
<thead>
<tr>
<th>Descriptive Characteristics</th>
<th>Figures and Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type and Location of Public Space</td>
<td>Ground open space</td>
</tr>
<tr>
<td>Plot Size (Total Area of Precinct)</td>
<td>26284 m²</td>
</tr>
<tr>
<td>Gross Floor Area</td>
<td>105136 m²</td>
</tr>
<tr>
<td>Number of Floors</td>
<td>30</td>
</tr>
<tr>
<td>Estimated Number of Residents</td>
<td>3500</td>
</tr>
<tr>
<td>Building Density -&gt; Plot ratio = Gross Floor Area/ Plot Size</td>
<td>4.0</td>
</tr>
<tr>
<td>Population Density = Plot Size/ Number of Residents</td>
<td>7.51</td>
</tr>
<tr>
<td>Site Coverage Ratio = Footprint/ Plot Size</td>
<td>0.336</td>
</tr>
<tr>
<td>Effective Public Space = Public Space/ Number of Resident</td>
<td>TBC</td>
</tr>
<tr>
<td>Number of Parking Spaces (estimate)</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 1 = Free Ground / Gross Floor Area</td>
<td>0.166</td>
</tr>
<tr>
<td>Ground Contested Space 2 = Free Ground/ Number of Residents</td>
<td>4.98</td>
</tr>
<tr>
<td>Ground Contested Space 3 = Free Ground / Number of Parking Spaces</td>
<td>TBC</td>
</tr>
<tr>
<td>Commercial and or Non domestic functions</td>
<td>One separate block for commercial and ground level of MSCP.</td>
</tr>
</tbody>
</table>

**Short Description:** Ground level precinct surrounded by cluster blocks.
## Precinct Name: Woodlands Drive, Admiralty Zone 5

<table>
<thead>
<tr>
<th>Descriptive Characteristics</th>
<th>Figures and Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type and Location of Public Space</td>
<td>Linear courtyard at ground level</td>
</tr>
<tr>
<td>Plot Size (Total Area of Precinct)</td>
<td>80885 m²</td>
</tr>
<tr>
<td>Gross Floor Area</td>
<td>242655 m²</td>
</tr>
<tr>
<td>Number of Floors</td>
<td>10</td>
</tr>
<tr>
<td>Estimated Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Building Density -&gt; Plot ratio = Gross Floor Area/ Plot Size</td>
<td>3.0</td>
</tr>
<tr>
<td>Population Density = Plot Size/ Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Site Coverage Ratio = Footprint/ Plot Size</td>
<td>0.38</td>
</tr>
<tr>
<td>Effective Public Space = Public Space/ Number of Resident</td>
<td>TBC</td>
</tr>
<tr>
<td>Number of Parking Spaces (estimate)</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 1 = Free Ground / Gross Floor Area</td>
<td>0.207</td>
</tr>
<tr>
<td>Ground Contested Space 2 = Free Ground/ Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 3 = Free Ground / Number of Parking Spaces</td>
<td>TBC</td>
</tr>
<tr>
<td>Commercial and or Non domestic functions</td>
<td>No commercial activity</td>
</tr>
</tbody>
</table>

**Short Description:** BTO development with ground level precinct surrounded by cluster blocks.
### Precinct Name: Ang Mo Kio, 401 - 406 Avenue 10

**Period of Completion: 1971-1975**

<table>
<thead>
<tr>
<th>Descriptive Characteristics</th>
<th>Figures and Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type and Location of Public Space</td>
<td>Ground level open space</td>
</tr>
<tr>
<td>Plot Size (Total Area of Precinct)</td>
<td>41234 m²</td>
</tr>
<tr>
<td>Gross Floor Area</td>
<td>115455 m²</td>
</tr>
<tr>
<td>Number of Floors</td>
<td>12/ 25</td>
</tr>
<tr>
<td>Estimated Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Building Density -&gt; Plot ratio = Gross Floor Area/ Plot Size</td>
<td>2.8</td>
</tr>
<tr>
<td>Population Density = Plot Size/ Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Site Coverage Ratio = Footprint/ Plot Size</td>
<td>6.7</td>
</tr>
<tr>
<td>Effective Public Space = Public Space/ Number of Resident</td>
<td>TBC</td>
</tr>
<tr>
<td>Number of Parking Spaces (estimate)</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 1 = Free Ground / Gross Floor Area</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 2 = Free Ground/ Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 3 = Free Ground / Number of Parking Spaces</td>
<td>TBC</td>
</tr>
<tr>
<td>Commercial and or Non domestic functions</td>
<td>No commercial</td>
</tr>
</tbody>
</table>

**Short Description:** Four slab blocks and two (2) point blocks on a ground level open vista. The precinct was developed in 1971 – 1975.
Precinct Name: Ang Mo Kio, 456 - 463 Avenue 10

Year of Completion: 1973

<table>
<thead>
<tr>
<th>Descriptive Characteristics</th>
<th>Figures and Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type and Location of Public Space</td>
<td>Ground level open space</td>
</tr>
<tr>
<td>Plot Size (Total Area of Precinct)</td>
<td>38793 m²</td>
</tr>
<tr>
<td>Gross Floor Area</td>
<td>16374.4 m²</td>
</tr>
<tr>
<td>Number of Floors</td>
<td>13/ 25</td>
</tr>
<tr>
<td>Estimated Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Building Density -&gt; Plot ratio = Gross Floor Area/ Plot Size</td>
<td>2.8</td>
</tr>
<tr>
<td>Population Density = Plot Size/ Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Site Coverage Ratio = Footprint/ Plot Size</td>
<td>6.63</td>
</tr>
<tr>
<td>Effective Public Space = Public Space/ Number of Resident</td>
<td>TBC</td>
</tr>
<tr>
<td>Number of Parking Spaces (estimate)</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 1 = Free Ground / Gross Floor Area</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 2 = Free Ground/ Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 3 = Free Ground / Number of Parking Spaces</td>
<td>TBC</td>
</tr>
<tr>
<td>Commercial and or Non domestic functions</td>
<td>Small commercial</td>
</tr>
</tbody>
</table>

**Short Description:** This precinct is formed by two (2) bent slab blocks and three (3) point residential blocks on a ground open space. The blocks form “islands” in the open space that was developed in 1973.
### Precinct Name: Marine Parade, Marine Parade Road

**Year of Completion:** 1975

<table>
<thead>
<tr>
<th>Descriptive Characteristics</th>
<th>Figures and Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type and Location of Public Space</td>
<td>Ground void deck / multilevel car park</td>
</tr>
<tr>
<td>Plot Size (Total Area of Precinct)</td>
<td>97860 m²</td>
</tr>
<tr>
<td>Gross Floor Area</td>
<td>274008 m²</td>
</tr>
<tr>
<td>Number of Floors</td>
<td>16/ 25</td>
</tr>
<tr>
<td>Estimated Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Building Density -&gt; Plot ratio = Gross Floor Area/ Plot Size</td>
<td>2.8</td>
</tr>
<tr>
<td>Population Density = Plot Size/ Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Site Coverage Ratio = Footprint/ Plot Size</td>
<td>4.55</td>
</tr>
<tr>
<td>Effective Public Space = Public Space/ Number of Resident</td>
<td>TBC</td>
</tr>
<tr>
<td>Number of Parking Spaces (estimate)</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 1 = Free Ground / Gross Floor Area</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 2 = Free Ground/ Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 3 = Free Ground / Number of Parking Spaces</td>
<td>TBC</td>
</tr>
<tr>
<td>Commercial and or Non domestic functions</td>
<td>No commercial</td>
</tr>
</tbody>
</table>

**Short Description:** Precinct development with point blocks and slab blocks on ground level open space as well as with a multistory carpark. All blocks offer void decks on the ground level.
### Precinct Name: Punggol, 196 - 199 Punggol Field Periwinkle

**Year of Completion: 2005**

<table>
<thead>
<tr>
<th>Descriptive Characteristics</th>
<th>Figures and Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type and Location of Public Space</td>
<td>Multilevel carpark / roof garden of 3rd fl</td>
</tr>
<tr>
<td>Plot Size (Total Area of Precinct)</td>
<td>35768 m²</td>
</tr>
<tr>
<td>Gross Floor Area</td>
<td>121611 m²</td>
</tr>
<tr>
<td>Number of Floors</td>
<td>17</td>
</tr>
<tr>
<td>Estimated Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Building Density -&gt; Plot ratio = Gross Floor Area/ Plot Size</td>
<td>3.4</td>
</tr>
<tr>
<td>Population Density = Plot Size/ Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Site Coverage Ratio = Footprint/ Plot Size</td>
<td>2.2</td>
</tr>
<tr>
<td>Effective Public Space = Public Space/ Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Number of Parking Spaces (estimate)</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 1 = Free Ground / Gross Floor Area</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 2 = Free Ground/ Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 3 = Free Ground / Number of Parking Spaces</td>
<td>TBC</td>
</tr>
<tr>
<td>Commercial and or Non domestic functions</td>
<td>No commercial</td>
</tr>
</tbody>
</table>

**Short Description:** Cluster block development with multi-level car park. There are accessible amenities on the roof garden of the 3rd floor.
Precinct Name: Punggol, 201 - 205 Punggol Field/ Grove
Year of Completion: 2007

<table>
<thead>
<tr>
<th>Descriptive Characteristics</th>
<th>Figures and Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type and Location of Public Space</td>
<td>Open / 2 multistory carparks / roof top</td>
</tr>
<tr>
<td>Plot Size (Total Area of Precinct)</td>
<td>54972 m²</td>
</tr>
<tr>
<td>Gross Floor Area</td>
<td>164916 m²</td>
</tr>
<tr>
<td>Number of Floors</td>
<td>16</td>
</tr>
<tr>
<td>Estimated Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Building Density -&gt; Plot ratio = Gross Floor Area/ Plot Size</td>
<td>3.0</td>
</tr>
<tr>
<td>Population Density = Plot Size/ Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Site Coverage Ratio = Footprint/ Plot Size</td>
<td>2.6</td>
</tr>
<tr>
<td>Effective Public Space = Public Space/ Number of Resident</td>
<td>TBC</td>
</tr>
<tr>
<td>Number of Parking Spaces (estimate)</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 1 = Free Ground / Gross Floor Area</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 2 = Free Ground/ Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 3 = Free Ground / Number of Parking Spaces</td>
<td>TBC</td>
</tr>
<tr>
<td>Commercial and or Non domestic functions</td>
<td>No commercial</td>
</tr>
</tbody>
</table>

Short Description: Cluster block in ground open space with two (2) multistory car parks and roof gardens on top.
**Precinct Name:** Queenstown, 24-32 Tanglin Halt Rd  
**Year of Completion:** 1963

<table>
<thead>
<tr>
<th>Descriptive Characteristics</th>
<th>Figures and Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type and Location of Public Space</td>
<td>Open ground space</td>
</tr>
<tr>
<td>Plot Size (Total Area of Precinct)</td>
<td>36857 m$^2$</td>
</tr>
<tr>
<td>Gross Floor Area</td>
<td>103199.6 m$^2$</td>
</tr>
<tr>
<td>Number of Floors</td>
<td>9</td>
</tr>
<tr>
<td>Estimated Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Building Density -&gt; Plot ratio = Gross Floor Area/ Plot Size</td>
<td>2.8</td>
</tr>
<tr>
<td>Population Density = Plot Size/ Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Site Coverage Ratio = Footprint/ Plot Size</td>
<td>5.01</td>
</tr>
<tr>
<td>Effective Public Space = Public Space/ Number of Resident</td>
<td>TBC</td>
</tr>
<tr>
<td>Number of Parking Spaces (estimate)</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 1 = Free Ground / Gross Floor Area</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 2 = Free Ground/ Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 3 = Free Ground / Number of Parking Spaces</td>
<td>TBC</td>
</tr>
<tr>
<td>Commercial and or Non domestic functions</td>
<td>No commercial</td>
</tr>
</tbody>
</table>

**Short Description:** Nine (9) residential slab blocks on ground open space form the precinct of Tanglin Halt.
Precinct Name: Queenstown, 45 - 49 Stirling Rd

Year of Completion: 1960

<table>
<thead>
<tr>
<th>Descriptive Characteristics</th>
<th>Figures and Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type and Location of Public Space</td>
<td>Open ground space</td>
</tr>
<tr>
<td>Plot Size (Total Area of Precinct)</td>
<td>19327 m²</td>
</tr>
<tr>
<td>Gross Floor Area</td>
<td>54115.6 m²</td>
</tr>
<tr>
<td>Number of Floors</td>
<td>7</td>
</tr>
<tr>
<td>Estimated Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Building Density -&gt; Plot ratio = Gross Floor Area/ Plot Size</td>
<td>&lt;2.8 / TBC</td>
</tr>
<tr>
<td>Population Density = Plot Size/ Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Site Coverage Ratio = Footprint/ Plot Size</td>
<td>4.6</td>
</tr>
<tr>
<td>Effective Public Space = Public Space/ Number of Resident</td>
<td>TBC</td>
</tr>
<tr>
<td>Number of Parking Spaces (estimate)</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 1 = Free Ground / Gross Floor Area</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 2 = Free Ground/ Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 3 = Free Ground / Number of Parking Spaces</td>
<td>TBC</td>
</tr>
<tr>
<td>Commercial and or Non domestic functions</td>
<td>Small commercial</td>
</tr>
</tbody>
</table>

**Short Description:** Three slab residential blocks on ground open space. The seven (7) floor developments are characteristic as they form on of the oldest HDB precinct in Singapore.
**Precinct Name: Central, Rochor Centre**

**Year of Completion: 1977**

<table>
<thead>
<tr>
<th>Descriptive Characteristics</th>
<th>Figures and Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type and Location of Public Space</td>
<td>Commercial / Void deck on 4th floor</td>
</tr>
<tr>
<td>Plot Size (Total Area of Precinct)</td>
<td>17639 m²</td>
</tr>
<tr>
<td>Gross Floor Area</td>
<td>57561 m²</td>
</tr>
<tr>
<td>Number of Floors</td>
<td>17</td>
</tr>
<tr>
<td>Estimated Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Building Density -&gt; Plot ratio = Gross Floor Area/ Plot Size</td>
<td>4.2</td>
</tr>
<tr>
<td>Population Density = Plot Size/ Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Site Coverage Ratio = Footprint/ Plot Size</td>
<td>2.5</td>
</tr>
<tr>
<td>Effective Public Space = Public Space/ Number of Resident</td>
<td>TBC</td>
</tr>
<tr>
<td>Number of Parking Spaces (estimate)</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 1 = Free Ground / Gross Floor Area</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 2 = Free Ground / Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 3 = Free Ground / Number of Parking Spaces</td>
<td>Commercial</td>
</tr>
<tr>
<td>Commercial and or Non domestic functions</td>
<td></td>
</tr>
</tbody>
</table>

**Short Description:** Four (4) slab blocks on the 3-storey commercial podium with a void deck on the 4th floor. These blocks are representative of the time-period of their development due to their color. The residential blocks are 14-storey.
Precinct Name: Sengkang, 124 Rivervale Dr
Year of Completion: 2005

<table>
<thead>
<tr>
<th>Descriptive Characteristics</th>
<th>Figures and Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type and Location of Public Space</td>
<td>Cluster blocks on ground level open space</td>
</tr>
<tr>
<td>Plot Size (Total Area of Precinct)</td>
<td>42449 m²</td>
</tr>
<tr>
<td>Gross Floor Area</td>
<td>127347 m²</td>
</tr>
<tr>
<td>Number of Floors</td>
<td>TBC</td>
</tr>
<tr>
<td>Estimated Number of Residents</td>
<td>11/ 17</td>
</tr>
<tr>
<td>Building Density -&gt; Plot ratio = Gross Floor Area/ Plot Size</td>
<td>3.0</td>
</tr>
<tr>
<td>Population Density = Plot Size/ Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Site Coverage Ratio = Footprint/ Plot Size</td>
<td>2.9</td>
</tr>
<tr>
<td>Effective Public Space = Public Space/ Number of Resident</td>
<td>TBC</td>
</tr>
<tr>
<td>Number of Parking Spaces (estimate)</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 1 = Free Ground / Gross Floor Area</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 2 = Free Ground/ Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 3 = Free Ground / Number of Parking Spaces</td>
<td>TBC</td>
</tr>
<tr>
<td>Commercial and or Non domestic functions</td>
<td>Small precinct retail services</td>
</tr>
</tbody>
</table>

**Short Description:** Precinct space development with cluster blocks and ground level open space.
**Precinct Name: Sengkang, 115 Rivervale Walk**

**Year of Completion: 2005**

<table>
<thead>
<tr>
<th>Descriptive Characteristics</th>
<th>Figures and Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type and Location of Public Space</td>
<td>Open ground space</td>
</tr>
<tr>
<td>Plot Size (Total Area of Precinct)</td>
<td>32699 m²</td>
</tr>
<tr>
<td>Gross Floor Area</td>
<td>98097 m²</td>
</tr>
<tr>
<td>Number of Floors</td>
<td>17</td>
</tr>
<tr>
<td>Estimated Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Building Density -&gt; Plot ratio = Gross Floor Area/ Plot Size</td>
<td>3.0</td>
</tr>
<tr>
<td>Population Density = Plot Size/ Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Site Coverage Ratio = Footprint/ Plot Size</td>
<td>3.89</td>
</tr>
<tr>
<td>Effective Public Space = Public Space/ Number of Resident</td>
<td>TBC</td>
</tr>
<tr>
<td>Number of Parking Spaces (estimate)</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 1 = Free Ground / Gross Floor Area</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 2 = Free Ground/ Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 3 = Free Ground / Number of Parking Spaces</td>
<td>TBC</td>
</tr>
<tr>
<td>Commercial and or Non domestic functions</td>
<td>No commercial</td>
</tr>
</tbody>
</table>

**Short Description:** Courtyard-type precinct space with cluster blocks and ground level open space.
**Precinct Name: Toa Payoh, Blk 213-224 Lorong 8**

**Year of Completion: 2005**

<table>
<thead>
<tr>
<th>Descriptive Characteristics</th>
<th>Figures and Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type and Location of Public Space</td>
<td>Open ground space</td>
</tr>
<tr>
<td>Plot Size (Total Area of Precinct)</td>
<td>82729 m²</td>
</tr>
<tr>
<td>Gross Floor Area</td>
<td>248187 m²</td>
</tr>
<tr>
<td>Number of Floors</td>
<td>17 / 24</td>
</tr>
<tr>
<td>Estimated Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Building Density -&gt; Plot ratio = Gross Floor Area/ Plot Size</td>
<td>3.0</td>
</tr>
<tr>
<td>Population Density = Plot Size/ Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Site Coverage Ratio = Footprint/ Plot Size</td>
<td>8.16</td>
</tr>
<tr>
<td>Effective Public Space = Public Space/ Number of Resident</td>
<td>TBC</td>
</tr>
<tr>
<td>Number of Parking Spaces (estimate)</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 1 = Free Ground / Gross Floor Area</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 2 = Free Ground/ Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 3 = Free Ground / Number of Parking Spaces</td>
<td>TBC</td>
</tr>
<tr>
<td>Commercial and or Non domestic functions</td>
<td>Commercial (convenient shop)</td>
</tr>
</tbody>
</table>

**Short Description:** Five (5) slab blocks and six (6) point blocks form an “island” setting in the precinct of Lorong 8 Toa Payoh that offers a ground open space. This precinct was developed in 1970.
## Precinct Name: Central, Waterloo Centre

### Year of Completion: 2005

<table>
<thead>
<tr>
<th>Descriptive Characteristics</th>
<th>Figures and Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type and Location of Public Space</td>
<td>Roof terrace / void deck on 5th floor</td>
</tr>
<tr>
<td>Plot Size (Total Area of Precinct)</td>
<td>9980 m²</td>
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<tr>
<td>Gross Floor Area</td>
<td>33726 m²</td>
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<tr>
<td>Number of Floors</td>
<td>20</td>
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<td>Estimated Number of Residents</td>
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<td>Building Density -&gt; Plot ratio = Gross Floor Area/ Plot Size</td>
<td>4.2</td>
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<tr>
<td>Population Density = Plot Size/ Number of Residents</td>
<td>TBC</td>
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<tr>
<td>Site Coverage Ratio = Footprint/ Plot Size</td>
<td>3.49</td>
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<td>Effective Public Space = Public Space/ Number of Resident</td>
<td>TBC</td>
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<tr>
<td>Number of Parking Spaces (estimate)</td>
<td>TBC</td>
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<tr>
<td>Ground Contested Space 1 = Free Ground / Gross Floor Area</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 2 = Free Ground/ Number of Residents</td>
<td>TBC</td>
</tr>
<tr>
<td>Ground Contested Space 3 = Free Ground / Number of Parking Spaces</td>
<td>TBC</td>
</tr>
<tr>
<td>Commercial and or Non domestic functions</td>
<td>Commercial</td>
</tr>
</tbody>
</table>

**Short Description:** Three (3) 16-storey slab residential blocks on the 4-storey commercial podium with a void deck on the 5th floor.
The first Scientific Workshop between Module X and BRI/HDB, CLC, FCL, NUS, NUS-Yale as well as the University of Hong Kong experts was carried out in April 29, 2013 in FCL Singapore. Key research concepts were discussed and explored and new research directions were established on the analysis of the evolution of public spaces in high-density living in Singapore. The work, since then has expanded and involved the cataloguing of 32 public housing precincts and six (6) case studies in Singapore whereby the team analysed the essential elements that compose public spaces in high-rise high-density living.

The research project involved research work as well as teaching. The new processes in academia were achieved by disseminating research concepts from our work in relation to the promoting the strategies for a more “sustainable” future of public housing in Singapore. Hence, in addition to the engagement of Module X in the Mid-Term evaluation, its works applied the Module X actively in the first semester of the 2013-2014 NUS Tembusu 3rd year curriculum.

The recent results of our joint work with NUS Tembusu on selected student interventions were presented to the international audience of the ArtScience Museum of Singapore at Marina Bay Sands. These students attend NUS Tembusu and work under the close supervision of their Tembusu Lecturers who are Dr. Tan Ai Hua Margaret, Jeremy Fernando, Professor Gregory K Clancey and Dr. Connor Clive Graham.

The outcome of this joint work has taken the form of a joint Module X FCL and NUS Tembusu. Joint NUS Tembusu and FCL Module X booklet depicts the outputs of our joint studio work.

Additionally, a weeklong intensive workshop has been scheduled jointly with the NUS Department of Architecture and the FCL Module X to take place in January 13 – 17 (2014). The aim has been to inform research in academia and empower the students of Singapore to re-imagine, envision and intervene in one site of our Module’s interest, namely the HDB precinct called Pioneer in Jurong West. The goal of this collaboration has been to engage with the Singaporean ways of thinking about the future of their own city and achieve a joint platform of new ideas about the future of cities. Overall, 23 architecture students and 3 thanica NUS Professors participated in this workshop, and three (3) joint FCL-NUS studio days were organised where the students presented their observations and proposals for the future, when the Jurong West Pioneer plot ratio will climb from 3.0 to 7.0. The final crit was offered in the third joint studio where intense and actively engaging positive discussions and feedback were exchanged.

Overall, 90 students of the NUS Tembusu attended the Senior Seminars on the topic: “Singapore as “Model” City?”

The aim of this joint NUS and FCL Module X Seminar was to analyse the architectural and social aspects of HDB public spaces in high-density housing in Singapore and further to conduct interventions in-situ. For these purposes, our team offered a two-hour lecture, accompanied the students to the six (6) sites of interest of our Module, invited them to conduct observations on-site, offered references for further reading, sat in the final crits and communicated with the NUS lecturer groups when additional guidance was needed.

The final crit group comprised:

- Michael Doherty, Artist in-residence, NUS Tembusu
- Rita Padawangi, Senior Research Fellow, Asian Urbanisms Cluster, ARI
- Catherine Young, Artist in-residence, NUS Tembusu
- Stamatina Rassia, FCL Module X Coordinator

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The joint weeklong student workshop between the FCL Module X and the NUS Department of Architecture has led, based on the student informal feedback in class, to an increased awareness of the importance of the public space in Singapore and its high value in the HDB precinct developments.

Module X also participated at the Asia Pacific Network for Housing Research Conference (APHNR) 2013 that took place in August 2013 in Kuala Lumpur. The paper delivered has been published in the Proceedings of the APHNR 2013. Michelle Jiang gave the oral presentation at the conference.

Moreover, the work of Module X was distinguished and thus the Module Coordinator was invited to be one of the Judges of the Design Competition on:

“Planning Clean and Green Townships - Heritage City of Yangon” Part of the Young Leaders for a Sustainable Future series Singapore (March 22 – 23, 2014).

Module X has initiated good communication with the URA. Through a collaborative process, URA has offered a set of historical maps and master plans, which increase our understanding of land growth, density and densification processes in Singapore. This communication aims to continue in the future with an idea to publish jointly, should the time schedule allow for it.
Public Space In High-Density Living In Singapore

FCL Module X and NUS Department of Architecture joint workshop group.

APNHR 2013
Global Housing Dilemmas: The ways forward
Asia Pacific Network for Housing Research Conference
20-22 August 2013 | University of Malaya, Kuala Lumpur, Malaysia

Urban Redevelopment Authority
To make Singapore a great city to live, work and play
Acknowledgements

We thank our expert board, including Assoc. Professor. Dr. JIA Beisi from the University of Hong Kong and Professor. Dr. HENG Chye Kiang from the National University of Singapore, for offering their insights based on their experience from Hong Kong and Singapore public housing studies.

Many thanks to Professor TAN Beng Kiang from the National University of Singapore, for offering their insights based on their experience from Hong Kong and Singapore public housing studies.

Also many thanks to Dr. HEE Limin from Centre for Liveable Cities and Dr. Jane Jacobs from NUS-Yale for their collaboration in various processes of this project; Mr. KHOO Peng Beng (Arc Studio, Singapore) architect of the Pinnacle@Duxton (an exemplary HDB precinct in Singapore for it being the highest and denser in Singapore) and Mr. NG Bingrong from HDB authority for their valuable support to the project.

We appreciate and thank Dr. Connor Clive Graham of the NUS Tembusu for his close collaboration with our social science research.

Also, we thank the NUS Architecture Department members and Professor WONG Yunn Chii for the informative meetings with our team and for our joint student workshop in January 2014. Our gratitude also goes to Dr. TAN Margaret for her collaboration and for including some of our research module in the NUS Tembusu curriculum of the 3rd year undergraduate studies. The best student works were exhibited at the ArtScience Museum in Singapore. Dr. TAN facilitated collaboration with student interns who conducted social study observations.

Finally, we thank the staff members of FCL SEC who have supported us through the processes of this project.
Bibliography


CIAM / Böhm-Kaufmann, Giedion, S., Gropius, W., Le Corbusier, Neutra, R.J. and Teige, K. (1931), Rationelle Bebauungsweisern, Verlag Englert und Schlosser, Frankfurt am Main.


Hee, L. (2001), Mapping the Street: Reading Asian Cities, URBAN DESIGN International, 6, pp. 65–75


HDB Annual Report (1967 - 2006), Housing and Development Board of Singapore.


Public Space In High-Density Living In Singapore


Menz, S. (Ed.) (2009), Drei Bücher über den Bauprozess, vdf Hochschulverlag AG an der ETH Zürich, Zurich.


Ng E. (Ed.) (2010), Designing High-density Cities – For Sozial and Environmental Sustainability, London: Earthscan.

Ng, E. and Wong, K. S. (2004) ‘Efficiency and livability: Towards sustainable habitation in Hong Kong’, in International Housing Conference Hong Kong, Hong Kong.


Seng, E. (2011) “Politics of Greening: Spatial Constructions of


http://www.nparks.gov.sg/ciag/


Public Space In High-Density Living In Singapore