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Cities in the Sky: Elevating Singapore's Urban Spaces

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Abstract

Singapore has seen a phenomenal and an unprecedented transformation from a swampland to a high density urban environment since its independence in 1965, made possible largely and single-handedly by the sustained efforts of its government. Indeed, urban space is a key vehicle for achieving urban social, environmental, economic, and cultural sustainability. The dense urban context in Singapore has seen an emergence and increase in elevated spaces in the form of sky-gardens, sky-bridges and sky-courts in a range of building types, seemingly seeking to tie together the different horizontal and vertical components of the city. This paper, therefore, examines the effectiveness of elevated urban spaces and pedestrian networks in Singapore and their ability to contribute to the horizontal to vertical transitions, and consequently to the urban vitality and accessibility. It does this through the analysis of two key developments: Marina Bay Sands and the Jurong Gateway. In particular, it considers the implications of certain constraints placed on urban spaces by their inherent location at height, in addition to the familiar privatization of public spaces, over-management of spaces, and their somewhat utilitarian characteristics. The paper argues that some of these issues may pose detrimental effects on the publicness of these spaces that in turn may lead to such spaces being underused and therefore adding redundancies and further stress to Singapore's urban land. Finally, the paper outlines key strategies that may help overcome the aforementioned issues, including the disjuncture associated with elevated spaces such that they may become a seamless extension of the urban spaces on ground.

Keywords: elevated urban spaces, high density urban environments, sky-gardens, sky-bridges

1. Introduction

55% of the world's population lives in urban centers today; this is expected to rise to 68% by the year 2050. With further urbanization and population growth is projected to add another 2.5 billion people by the urban areas of which almost 90% occurring in Africa and Asia (United Nations, 2018). To accommodate this trend of increasing density, our urban environments are expanding not only horizontally, but also vertically, leading to the tall buildings that are typical of today's city skylines. Graham and Hewitt (2012) note "the extraordinary vertical extension of built space both upwards and downwards within the last few decades", with elevated and subterranean infrastructure (Hebbert, 2012) and novel visions of multi-tiered city environments (MVRDV, 2007). This can be seen particularly in cities with geographic limitations, such as the island nation of Singapore.

Vertical density can solve problems associated with land scarcity, but tall buildings can also create an island effect that disintermediates citizens from their communities. This, along with the shrinking public spaces and growth in vehicular traffic at ground, has seen the proliferation of sky-bridges, sky-courts, and sky-gardens as pedestrianized public/quasi-public spaces and networks at height that are increasingly seeking to connect tall buildings with their surrounding environments. Indeed, one of the first examples of elevated pedestrian networks was created in Minneapolis, Minnesota by a developer, as opposed to government planners, to meet the needs of shoppers during the cold winter months, highlighting the role of elevated walkways as also an effective tool to design around an area's climate.

Hong Kong is one of the first cities in Asia to use an extensive elevated footbridge network. The vertical structures that flourished to address the city's densely packed population – in addition to its large roads and hilly terrain – led Hong Kong to develop an integrated elevated pedestrian network within commercial centers in the 1970s (Tan and Xue, 2016), and a new comprehensive underground and elevated pedestrian network comprised of escalators and walkways in the 1980s. Another facet in the increasing appeal of elevated spaces is that the number of cars on the road in urban areas has steadily grown, competing with pedestrians for space. The conflict between pedestrian and vehicular traffic has become a major concern in urban and transport development and the incorporation of overhead pedestrian bridges, or sky-bridges, seems to suggest that cities are seeking to reinstate the viability of walking in the city. In many cases, sky-bridges are deployed in locations with high levels of pedestrian traffic, but with systemic prioritization to maintaining the flow of

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vehicular traffic: That is, bridges obviate the need for pedestrian-focused stoplights. As cities strive for urban intensification, they are adopting the multiple and intensive land use (MILU) development model defined by Lau and Coorey (2007), which is described as an extruded three dimensional model that distributes density and land use, and integrates with vertical layering of transport with mass rapid transit below ground level, vehicular traffic at ground level and elevated walkways above ground.

Sky-bridges, however, are not the only typology of elevated spaces populating urban areas. Sky-courts and sky-gardens are also used, beyond the purpose of mobility, to serve as destination spaces, both communal and public, for resting and social activities, much like the parks and sidewalk benches that populate the ground level of most cities and towns. Just as sky-bridges are used to redistribute increasing pedestrian populations to reduce congestion, sky-courts and sky-gardens may alleviate overcrowding in public spaces such as parks and plazas, or replace the ground level spaces lost to development. As such networks connecting urban structures have grown, and many developments have seen theirs mesh into three-dimensional multi-level webs.

2. Singapore Context

In congruence with much of the fast urbanizing Asia and Middle East, the island nation of Singapore has evolved into a high-density, vertical 'city in a garden'. Indeed, there is a widespread adoption of the 'vertical city' model with public, quasi-public and communal spaces, often manifesting as green spaces, at height in a range of building typologies.

Following the initiation of mass, high-density, high-rise public housing by the Housing Development Board (HDB) in the 1960s, the focus of the 70s was to improve community interaction and residents' quality of life (Yuen, 2011), and saw the emergence of the porous 'void decks' at the base of the towers, that essentially comprised of structural columns and cores, that could be used and appropriated for various community uses, activities and functions. With land pressure and continued urbanization, the towers have grown much taller, isolating residents from ground. In response to this, the HDB sought to create new grounds higher up, that led to the use of podium car parks as elevated green/gardens and playgrounds; and eventually the incorporation of communal spaces (sky-gardens, sky-courts and sky-bridges) at strategic locations through the building's verticality, thus bringing such spaces within easy reach of the buildings' residents (Hadi et al. 2018).

This idea is not new though, with Le Corbusier first introducing communal functions on the roof top, with retail and other public functions distributed on the intermediate levels of the Unite d'Habitation (1952). Amongst others, notably, the 33 storeys housing blocks of Prutt-Igoe in St Louis (1954) with streets at every three storeys was ridden with crime, anti-social behavior and decay attributed to lack of visual surveillance and "defensible space" (Newman, 1972); and poor maintenance, build quality and general decline of the surrounding local economy (Graham, 2016; Bristol, 1991). Such models of high rise living have perhaps been largely disregarded in the west, due to the fear expressed of, in and about high rise living associated with crime and social malaise (Lees and Baxter, 2011) or maybe due to the lack of occupants' individual and collective engagement in the use and management of communal spaces. However, "the high-rise tower has spread from its avant-garde modernist forebears to cities worldwide, facilitated by state building programs, standardized processes of production and a machine aesthetic" (Harris, 2015), as also evident in Singapore. Indeed, high rise housing has evolved and its notion shifted from the low-cost solutions for the poor to the well-heeled and sought after urban living (Costello, 2005).

In much of today's Singapore, sky-bridges have become important paths for pedestrians because of the road widenings aimed at reducing vehicular traffic congestion. These covered networks provide the added benefit of shielding walkers from the heat and rain common in the tropical nation. Sky-bridges can be seen throughout Singapore's urban landscape – not just over roads, but also as design elements of the condominiums and government housing developments (for e.g., Pinnacle@Duxton, Skyhabitat, Skyville@Dawson) and other typologies including office and mixed use buildings, and malls.

Beyond the elevated pathways, sky-gardens and sky-courts have also proliferated in Singapore. The city-state has adopted a garden city planning model through its Green Plot Ratio (GnPR) which measures the density of greenery based on Leaf Area Index (LAI); and Landscaping for Urban Spaces and High-Rises (LUSH) program which requires greenery lost to development to be replaced on site via greening of facades and communal areas from ground to the roof tops. Such greenery not only offers urban citizens closer access to park-like environments, but it also works as a bioclimatic strategy and aims to reduce the Urban Heat Island (UHI) effect, improve air quality and the urban ecology in Singapore. Importantly, the pervasive greenery, offers respite from the high-rise, high density built environment, and an opportunity to improve the health and well-being of its urban residents.

The Pinnacle@Duxton, for one, includes communal spaces at different heights that take the form of sky-bridges and sky-gardens on its 26th (allowing access to building residents only) and 50th storey (publicly accessible) with additional public facilities also on ground and level three of this notable public housing development. Various studies (Yuen et al., 2003; Graham and Hewitt, 2012; Hadi et al., 2018) associate popularity of such elevated spaces with views, escapism from the overcrowding that such spaces offer, and access to cooling breezes in the hot humid conditions. This approach may also be attributed

to "aesthetic, environmental and brand motives" (Yadi et al., 2018); and the representation of high quality living congruent with the city's image and status as a successful global city (Teo, 2015).

3. Literature Review

While the global pursuit for vertical cities with multi-level networks and increasing elevated urban spaces continues, with many potentials and benefits to urban areas, they are also accompanied by some concerns.

According to Pomeroy (2012), rooftop spaces offer alternative social and habitable spaces to those on ground. Sky-courts or sky-gardens have the ability to provide the "necessary social infrastructure to ensure interaction and co-presence", and, in the right conditions, may serve the communal functions of public space, allowing the congregation of people and facilitating activity. Their elevation also gives users views of the city, "providing opportunities for society to survey the city as a means of recreation and delight" (Pomeroy, 2012). Steyerl (2011) talks about the vertiginous experience of vertical spaces and the associated prevalent sense of groundlessness and the metaphor of free falling as an observed condition. Deriu and Kane (2018) also note the proliferation of thrill and vertigo inducing spaces in cities, such as the glazed sky walks and platforms, and the widespread and established desire for "increasingly visceral urban experience".

Many contemporary urban mixed use, retail, hotels and CBD office buildings and their roof top spaces, however, include exclusive uses (typically restaurant, bars, and observation decks) and adopt exclusionary practices that are symbolic and the most tangible expressions of economic prowess, and societal hierarchies. Lloyd and Auld (2003) highlight the problems associated with the familiar focus on increasing "economic values at the expense of social values" and that public spaces can only be infused with social value if they are regularly used by the communities and provide an environment for "cultural and social expression" on a growing basis.

Harris (2015) argues that "the vertical, especially in terms of height, should not necessarily be seen as offering and representing a strongly dominant and exclusive position over the more every day and marginalized world of the horizontal below". This paper suggests that by "understanding urban verticality as the provisional achievement of (horizontal and vertical) entanglements of people, systems, rules, practices, technologies and things, some of the Cartesian framing of the vertical against the horizontal can be breached and broadened" (Harris, 2015). Graham and Hewitt (2013) emphasize that "a fully volumetric urbanism is required which addresses the ways in which horizontal and vertical extensions, imaginaries, materialities and lived practices intersect and mutually construct each other".

William Lim, a well-known Singaporean architect, defined public space as one that is "open to all"; this definition stood in contrast to what he referred to as "quasi-public" spaces, like shopping malls, which contain private elements (Lim, 2014). He argued: "It is increasingly obvious that much of current public space is no longer easily accessible to the general public," due to the fact that "they are greatly restrictive and diminished in affordability, accessibility, and social meaning" even though they may appear like conventional public space (Lim, 2014).

Similarly, Minton (2012a) voices her concerns with regards to the growing trend of the privatization of public realm and public spaces in London since the 1970s. She draws attention to the associated ills of all manners of restrictions and controls that have detrimental effects on user behaviors and access and advises safeguarding public interest first and ensuring that public spaces are truly public. Minton (2018) cites privately owned malls such as Liverpool One, Cabot Circus in Bristol, and Westfield Stratford City in London, all of which are policed, and adopt stringent regulations with regards to access, behavior, prohibition of many activities and uses, thus affecting their publicness.

Such spaces managed by private developers may be subject to "hard and soft controls" as defined by Loukaitou-Sideris and Banerjee (1998). Hard controls are active and may take the form of private security, CCTV systems and regulations that prohibit certain activities or subject them to certain conditions. On the other hand, soft controls are passive, and include "a range of symbolic restrictions that passively discourage undesirable activities or make others impossible through removing opportunities (Loukaitou-Sideris and Banerjee, 1998). Such controls may create psychological barriers that could inhibit the intensity and variety of the use of public spaces and make them uninviting and/or exclusive.

Minton (2012b) highlights the lack of evidence that high security environments, 'Secured by Design' and the use of CCTVs prevent fear of crime and make people feel safer and suggests that in fact alarmingly both, crime and fear of crime rose in such environments. Examining specific cases in England, Minton (2009) charts the privatization of public spaces over three decades and attributes security focused environments with CCTVs, security staff and exclusionary practices with growing fear and mistrust, undermining personal control and responsibility, and limiting the expression of democratic society in the UK and US. She advocates a return to genuinely open squares and public places of continental Europe, where it is more common for all generations, regardless of income and social class, to mix more freely, and reconsideration of the model of privately owned public spaces (POPS).

Over-crowding is another concern attributed to tall, high density urban living, and amongst other factors, its perception is dependent on the availability of community facilities, as well as the quantitative and qualitative aspects of its open, shared and private spaces (Yuen and Yeh,

2011; Anderson, 1972; Jacobs, 1961). Hadi et al. (2018) highlight issues related to high rise, high density living and their impact on the experience of elevated communal and public spaces through the detailed examination of the specific case of the Pinnacle@Duxton. The project brings to light the conflicts associated with such spaces – the psychological discomfort and fear, issues of access, maintenance, use, appropriation, safety, regulations, restrictions and control, all of which affect the users' experience. Notably, consistent with the findings of Gifford (20017), fear of strangers and anti-social behaviors expressed by building owner and managers was the predominant consideration for the greater social control, top down processes and heavy handed governance measures adopted. However these have presented the greatest barrier, and discouraged use, appropriation and 'social freedom' within the elevated sky-gardens (Hadi et al., 2018), despite the provision of very breathtaking and expansive urban spaces at height.

Another important issue is that too many new elevated paths could see a thinning of pedestrian density at grade, potentially affecting safety and vibrancy within cities. Cui et al. (2013) conducted a comprehensive research on the development of "grade separation pedestrian system" and found it to have significant impacts on a city. They found that enclosed and elevated pedestrian systems created more safe and comfortable environments with the potential also to strengthen the commercial concentration within city centers. However, that they may also lead to the decline of retail and public space at the street levels and eventually damage the overall image of city centers (Ciu et al., 2015).

Elevated spaces are often incorporated to simply aid circulation across larger city entities and their big land parcels. Thus, they are frequently overwhelmingly utilitarian in design and treated as mono-functional conduits for movement, resulting in low appeal and vitality. Additionally, poorly designed, non-descript or illegible elevated spaces may not be visually accessible or clearly discoverable. Salingaros (1999) highlights the importance of spatial variety within urban spaces. Spatial variety, here relates to the visual, experiential and functional diversity provided within a setting. Urban spaces with great spatial variety can also be flexibly adjusted to different activities and weather conditions to increase their users' comfort and choices, encourage social interaction, and build a sense of control over the space (Salingaros, 1999). Cho et al. (2015) suggest the use of the variety and number of pedestrian routes to increase opportunities for urban exchanges as well as the use of 'architectural, natural and human activity nodes'.

Jacobs and Appleyard (1987) recommend spaces that encourage diverse involvement opportunities and imaginations, and that are more meaningful to the community and individuals so that the community feels more attached and connected to the development. While Hopkins (2018) refers to need for agency to achieve a balance between individual and collective freedom and sites the hybridized spaces of school projects by Carlo Cappai and Maria Alessandra Segantini of C+S Architects that meet their fundamental role whilst also acting as "spatial resources for communities to develop new social and economic relations. They suggest "Freedom is an opportunity and a burden and that "Agency lies in recognizing that paradox – both for architects and the people they serve.

Finally, the adoption of environmentally friendly design strategies directly impacts upon the quality of a space and user comfort (Salingaros, 1999) and may induce visitors to extend their stay in a development augmented with elevated facets. These may include passive design strategies, greenery and water features that may improve thermal comfort. Furthermore, a seamless integration of natural features with the physical environment would stimulate human interactions with the spaces and with one another, while also helping to alleviate urban heat island effect (Cho et al., 2015). However, for example, Hadi et al. (2018) highlighted the fear of uprooting of trees and plants during high winds and the health and safety hazard that led to the reduced greening efforts at the Pinnacle@Duxton which in turn diminished the opportunity for escape from the dense and overcrowded environments. The lack of shelter from heat and rain also affected the use of the sky-gardens as also highlighted by Samant and Na (2017), pointing to the significance of greening in the tropical conditions of Singapore.

4. Aims and Objectives

As cities, such as Singapore, continue to grow vertically, and as we increase the provision of such elevated public spaces in dense urban environments, it becomes more vital for us to develop a deeper understanding of vertical urbanism and in particular of the elevated spaces and how they may augment an urban area. The aforementioned studies point to the conflicts associated with public spaces across complex three-dimensional environments and the consequent need to consider the design, use and management of such spaces so as to not only avoid redundancies in our already stressed high density urban environments, but to also improve vitality, accessibility, and transitions across different components of a city.

Hadi et al. (2018) rightly point out that in the context of urban geography, the focus of most research has been on horizontalism, that disregards the verticality, "ignoring the vertical realm and the experiences, practices and textures of vertical life" (Harris, 2015; Graham and Hewitt, 2012; McNeill, 2005). They highlight that the mere provision of communal spaces at height may not ensure the creation of successful high rise housing; they point to the need for further research on the design of sky-gardens, such that the safety and security issues prevalent at height might be balanced with social and emotional needs.

Citing Robinson (2011), Harris (2015) points out that "accompanying this pursuit of multiple geographical

imaginations of urban verticality, it is also important to contrast and connect vertical urbanisms across different sites, spaces and networks, and across historical periods, engaging with recent calls advocating experimental yet rigorous comparative perspectives and gestures in urban research". This paper, therefore, examines the effectiveness of elevated urban spaces and pedestrian networks in two important hybrid, large-scale development projects in Singapore: Marina Bay Sands (MBS) and Jurong Gateway. The projects include a system of ground-level and elevated privately owned public spaces (POPS) and are therefore prone to implicit and explicit barriers affecting their publicness, as highlighted by Lim (2014).

More specifically, this paper seeks to address: What are the factors or qualities required for elevated public spaces and networks to successfully spur urban transitions, accessibility and vitality? How can pedestrian sky-bridges be best designed to enhance their walkability and promote social activities? How can elevated public spaces be designed as seamless extensions of their ground-level counterparts?

This study also considers how the developments' physical constraints, multi-party management structures, exclusivity signalling, climate adaption decisions and circulation-focused designs affects elevated spaces and networks. Ultimately, this paper develops key insights to generate a catalogue of basic design principles that could be used to improve the effectiveness of vertical networks.

5. Methodology

The findings in this paper are, in part, developed based on research undertaken in an elective module at the Department of Architecture at the National University of Singapore (NUS). The module sought to explore the meanings and manifestations associated with the new and emerging urban space typologies evident in large-scale, hybrid and high-density developments. It aimed to understand the myriad challenges and possibilities presented by the vertical environments in the context of Singapore. The module engaged students in the closer inspection of this new genre of urban spaces as it potentially contributes to changes in urban vitality, user accessibility and connectivity, precinct programming, and affects the larger network of public spaces within cities.

The module sought to engage students in the supervised research and analysis of elevated spaces within MBS and Jurong Gateway that function as nuclei for people, programs and facilities due to their particular spatial, visual and functional characteristics. The Integrated Urban Space Framework developed by Cho et al. (2016) – with its subthemes of "Hardware" (roughly design), "Software" (essentially programming) and "Orgware" (principally management) – formed the primary lens and analytical framework for the examination of these cases.

Methods of analysis included physical mapping, observational analysis, and critical evaluation of the ground level and elevated public spaces, and the main paths connecting them. This mapping was specifically used to understand 1) the architectural and spatial qualities of such spaces and the vertical access points connecting them, 2) the programs and amenities incorporated within the spaces and 3) their management/operational aspects. This multiprong approach was adopted to understand the design drivers, production, use and management of such spaces in large scale, complex and hybrid environments.

5.1. Case Studies

5.1.1. Marina Bay Sands (MBS) Overview

Marina Bay Sands is a project developed by Las Vegas Sands Corporation. This mixed development houses a five-star hotel, a casino, restaurants, a shopping mall, a convention center, a theatre, and a museum. It is designed to be an integrated resort in downtown Singapore. It officially opened in 2010 and has since become a national landmark and symbol of modern Singapore.

In its conception, Marina Bay was supposed to foster an "emotional attachment" using the strategies of placemaking and place management (Auger and Lee, 2015). The Singapore government now sees Marina Bay as the "nation's civic core" that projects Singapore "as a modern and globalized city-state" (CLC, 2015). It also serves the function of a "business and financial focal point of Southeast Asia" (Anderson and Choo, 2015). "Marina Bay has become the symbolic heart of the new Singapore, a 'green and blue' equivalent to the historic Padang, a nexus of commerce and civic life" (Auger and Lee, 2015). In many ways the businesses cater to tourists and short-term visitors to Singapore more than they do to the locals — which can be seen from the mix of retail options, advertising and more.

As a development, MBS connects Singapore's Marina Bay area to its Gardens by the Bay park. Between those two destinations lies the development's mall, casino, theatre, expo, and hotel. Starting from a café- and bench-dotted waterfront promenade, a pedestrian can walk into the multilevel atrium-style mall – called the Shoppes – and from within that same structure access the casino, expo and theatre. The next building back is the hotel, which is connected to the Shoppes by the underpasses. The basement level of the MBS development features a mass rapid transit (MRT) station and underground pathways that offer direct access to the Shoppes, the hotel and the Gardens by the Bay. Additionally, sky-bridge – an elevated walkway runs from atop the Shoppes (mall), into the hotel, above the lobby and restaurant area (Lion Bridge), and on into the Gardens by the Bay park (Garden Bay Bridge), thus bridging across two high speed roads – the Bayfront Avenue and the Sheares Avenue. The development also includes rooftop sky-gardens above the Shoppes and the hotel. Plans and images of the MBS development are shown in Fig. 1 to 10.

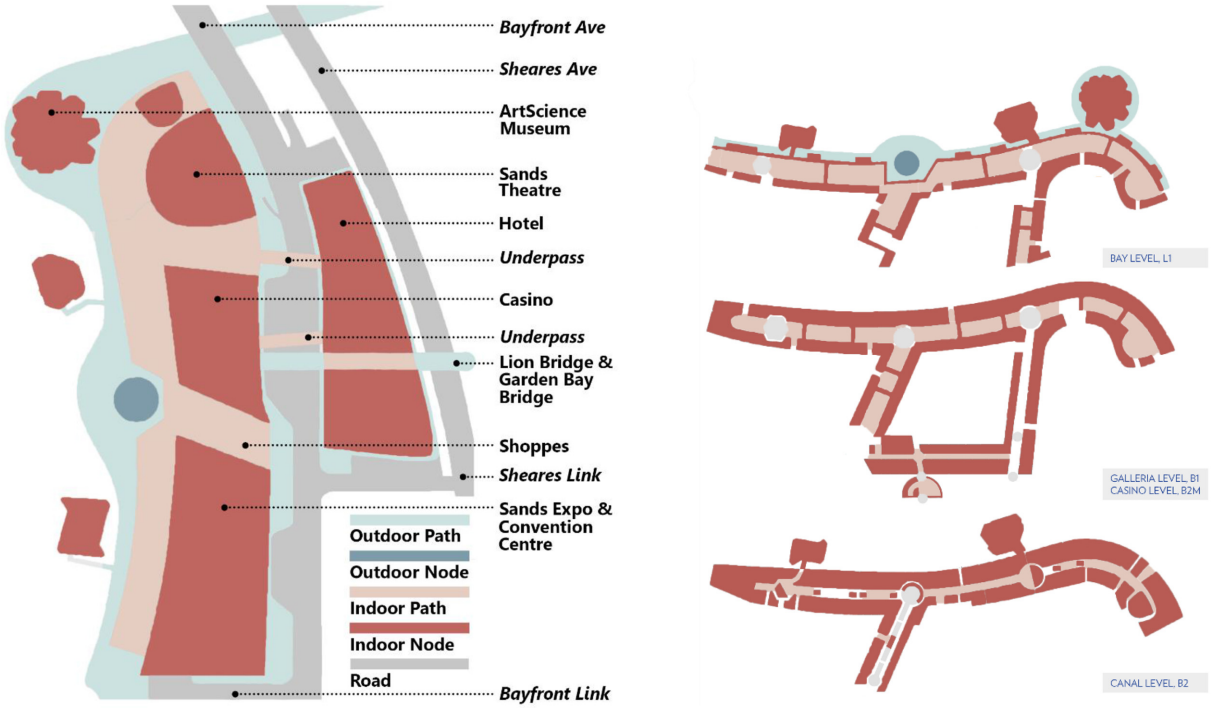


Figure 1. Marina Bay Sands Master and Floor Plans (Credit: Anna Kleinsasser).

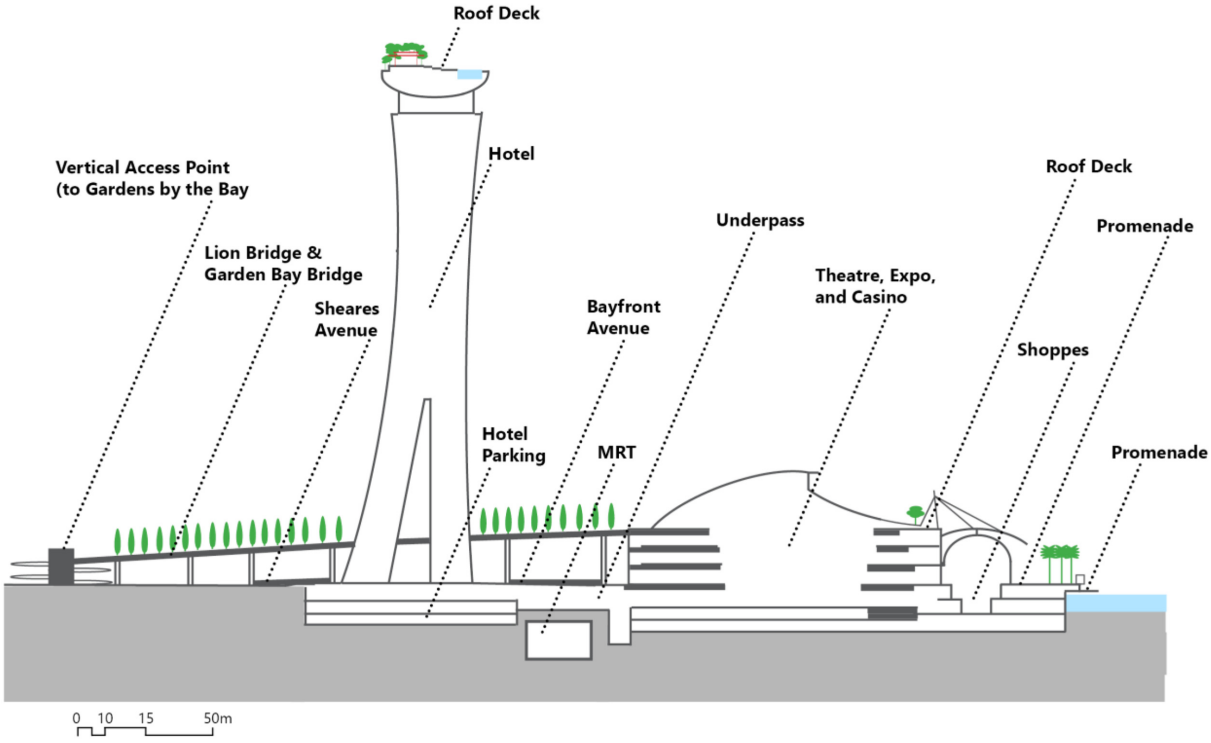


Figure 2. Marina Bay Sands Section (Credit: Anna Kleinsasser).

From an outdoor perspective, the development's three primary components are the two-tiered waterfront promenade, the sky-garden atop the Shoppes, and the elevated walkway, that formed the focus of this study. Although the sky-garden/observation deck of the hotel is extensively vegetated and allows public access, it primarily caters to hotel guests and paid visitors, therefore was deemed to restrict access to most of its parts, and consequently excluded from the study.



Figure 3. Shoppes - Exterior Promenade.



Figure 4. Shoppes - Interior Atrium.



Figure 5. Shoppes - Interior Atrium.

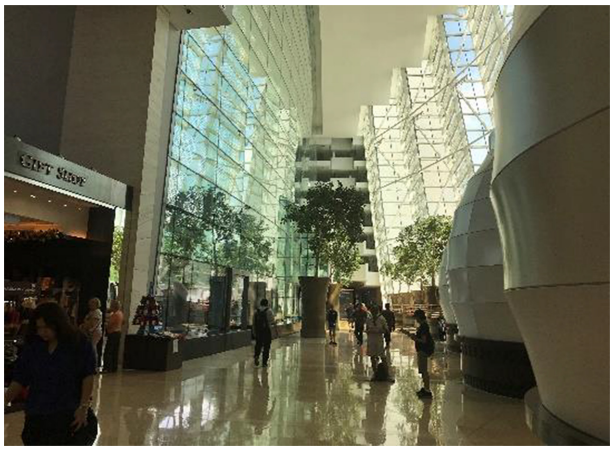


Figure 6. MBS - Hotel Atrium.



Figure 7. MBS Hotel - Internal Sky Bridge.

5.1.2. Jurong Gateway Overview

Jurong Gateway is a development of malls (Westgate with an office tower above, JEM, Big Box, IMM and JCube), an MRT (Jurong East) station, a hospital (Jem, Ng Teng Fong Hospital), and the Devan Nair Institute building. It is located in Singapore's western region and has been conceived as its second Central Business District (CBD). A network of sky-bridges, called the J-Walk, connects all of the aforementioned buildings and aids seamless connectivity between the MRT and this large scale, multi-building development (Fig. 11-13). This elevated pedestrian link way has connected the public on a level above the ground, from the MRT station to the different mixed-use developments of the region. People can access the J-Walk by stairs, elevators and escalators, making it universal to all pedestrians.



Figure 8. Sky Bridge at MBS.



Figure 9. Shoppes - Sky Garden.



Figure 10. MBS Hotel - Rooftop Observation Deck.

Sky-courts and open-air atria dot the J-Walk and connect this elevated network to other multilevel spaces within the buildings of Jurong Gateway. To cover all of the J-Walk network, a pedestrian would need to traverse through two of the three malls and the hospital. The J-Walk can also be entered through elevators and escalators located in the buildings in addition to the exterior access points (Fig. 14).

Outdoor elements of the wider development include the rooftop Westgate Wonderland, which is the largest rooftop mall playground in Singapore, and JEM Play - a honeycomb themed playground atop JEM. Replacing 100% greenery lost to development, JEM includes cascading rooftop gardens and green spaces from its level 5 to 7. While Westgate, which won the Outstanding Award under the Skyrise Greenery Awards in 2015 has sprinkling of garden spaces through the upper storeys of its office tower

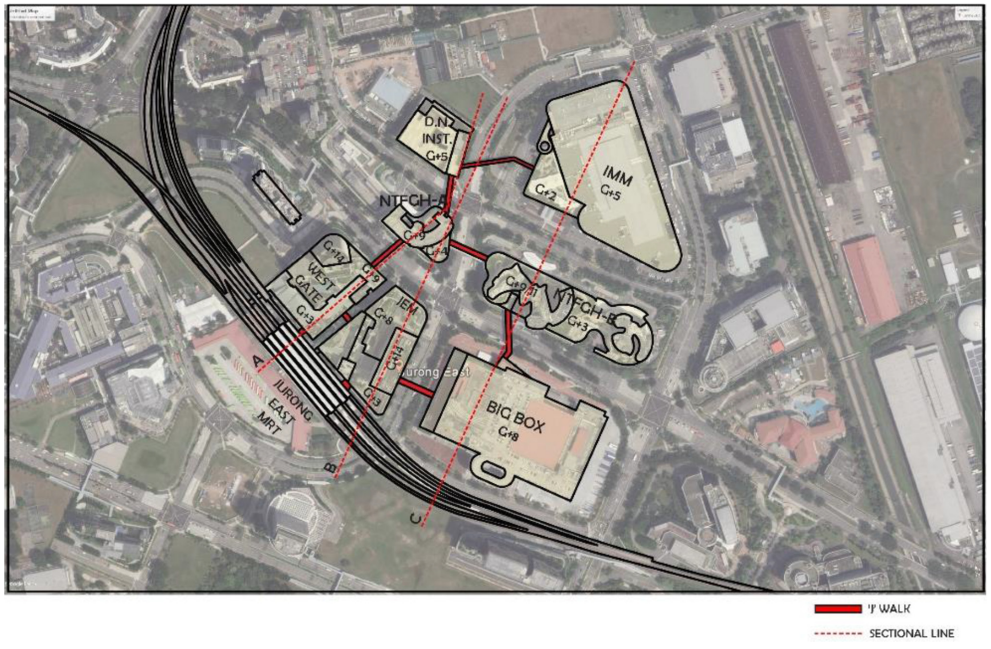


Figure 11. Jurong Gateway Context Plan.

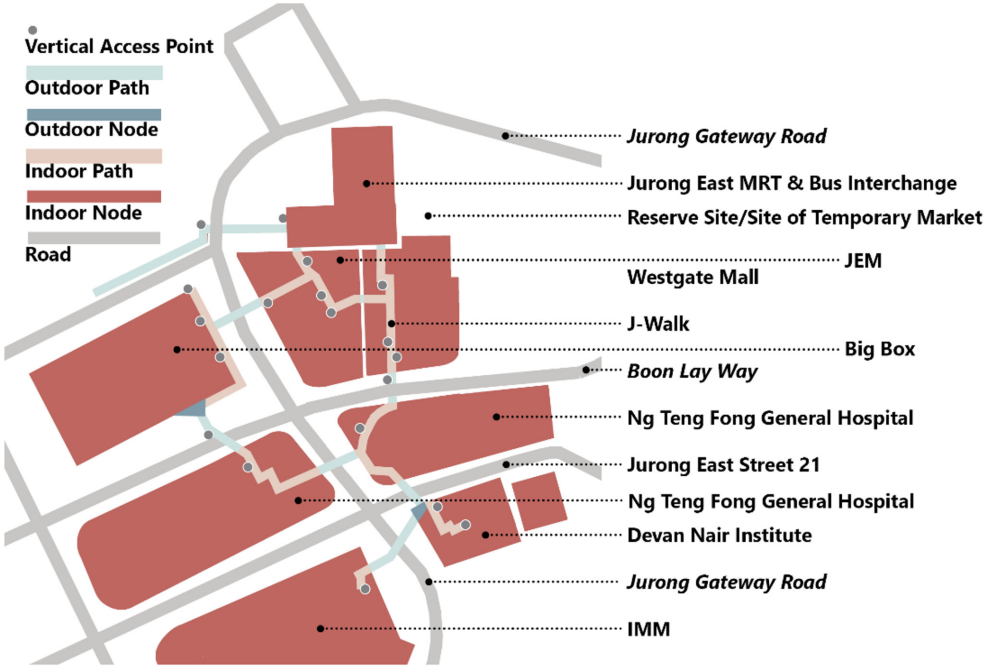


Figure 12. Jurong Gateway Plan (Credit: Anna Kleinsasser).



Figure 13. Jurong Gateway Sections showing the J-Walk Network.

as well as extensive vertical greenery. In particular, the naturally-ventilated, day-lit atrium space in Westgate includes landscaping and water features, encouraging public acess and activity (Fig. 14).



Figure 14. Westgate atrium, J-Walk and connection to sky court, exterior access point to the J-Walk.

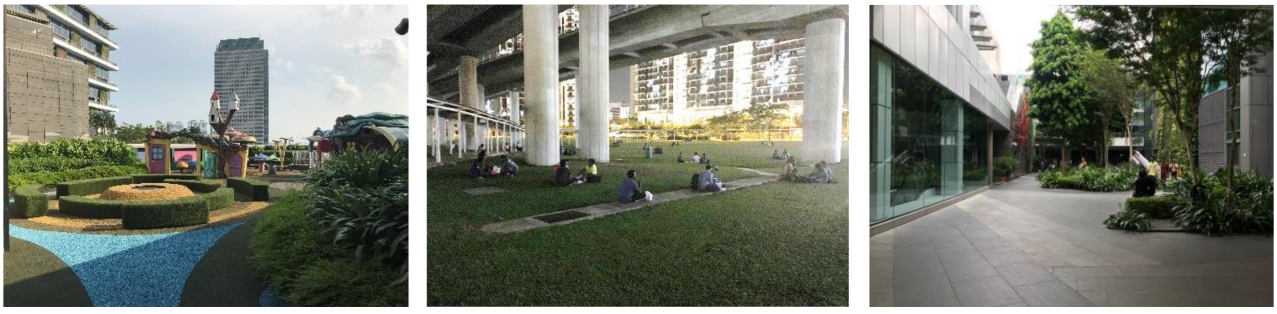


Figure 15. Outdoor elements of Jurong Gateway (Westgate Wonderland Rooftop Playground, Reserve Site -Adjacent to Westgate Mall and Jurong East MRT, Vegetated landscape between buildings at ground level)

At ground level, a reserve site adjacent to the MRT station is also used informally as a park and occasionally hosts temporary markets while the spaces in between the developments as well as the sidewalks at ground level are landscaped and include vegetation (Fig. 15). The Devan Nair Institute also includes a landscaped garden in its courtyard creating a tranquil space at the heart of this building.

6. Analysis and Findings

The two cases highlighted specific considerations, as listed and discussed below, that were fundamental if the elevated public spaces are to become seamless extensions of their ground-level counterparts, such that they enhance urban transitions, accessibility and vitality.

- Connectivity
- Climate sensitive design
- Inclusivity
- Provision of programs
- Management

6.1. Connectivity

"Connectivity refers to the degree to which the environment offers points of contact across a range of scales and purposes" and that a varied and higher number of pedestrian routes increases the opportunity for social interactions and exchanges (Cho et al., 2015). Both the projects successfully evidence this and that the elevation of urban paths and nodes can enhance mobility and connectivity and result in improved pedestrian walkability and safety. In MBS, the multilevel elevated skywalks and underground paths not only connect two buildings separated by a wide, high-speed road, but they also connect the diverse functions: hotel, expo, casino, retail, theatre, MRT station and public waterfront. In this development, the elevated and underground paths and spaces successfully complement those on the ground level to form a continuous labyrinth of public realm and streetscape, as is the goal of such multilevel networks.

Of note, sky-bridges are symptomatic of the large roads that rupture connections within a city and are successful physical connectors in developments suffering from island effect due to the large roads that surround such developments. This can be seen in MBS, where the skybridge crosses the six-lane Bayfront Avenue and Shearers Avenue (Fig. 16). The use of sky-bridges to connect larger grain developments across a mesh of high-speed roads is also noted at the J-Walk in Jurong Gateway (Fig. 17). It provides a seamless and all-weather pedestrian network between the Jurong East MRT station and several nodes. The elevated sky-bridges also connect the various developments –including Westgate, Jem, Ng Teng Fong Hospital, Big Box and Devan Nair Institute This is particularly useful when the roads are built before the developments, as is usually the case.

One of the challenges of multilevel networks is limited visual connectivity or lack of visual cues. This is evidenced in both the developments. Access points to the J Walk are not visually apparent from Westgate's atrium (Figure 18)



Figure 16. View from Marina Bay Sands Sky Bridge crossing Bayfront Avenue.



Figure 17. J-walk crossing, Jurong East Road.



Figure 18. J-Walk access point not apparent from Westgate Mall atrium.



Figure 19. Lack of clear visual access points to escalator to the sky-bridges and sky garden.

while in Marina Bay Sands, upon exiting the MRT, visitors have to go through several floors of shopping malls before they finally reach the promenade area. That limitation is true not only of paths, but also of sky-gardens and sky-courts with both the projects' rooftop spaces largely hidden to first-time visitors (Fig. 19). Furthermore, sky-bridges and paths are oftentimes unnamed and unmemorable, and become illegible multilevel connections.

Such obscurity and illegibility leads to poor wayfinding and disorientation despite extensive signages, affecting the visitor experience in these networks. In Jurong Gateway, for one, many parts of the network could not be experienced unless a pedestrian was specifically seeking them out (Fig. 20). Additionally, access to the J-Walk was also not always clear from the street level.

In the context of such three dimensional and multilevel pedestrian networks, Chang (2002) shows that pedestrian choices are habitual, and that the length and simplicity of route and wayfinding are some of the most influencing factors. The study also found that as direct visual perception through complex environments is difficult; wayfinding plays a significant role in the distribution of movement densities and that clear spatial structuring is necessary.



Figure 20. Access point to J-Walk not visually apparent from the street.

Furthermore, given the large scale, hybrid nature of such developments, it is important to ensure legibility through the use of distinct nodes – "architectural, natural and human activity nodes" (Cho et al., 2015); "spatial diversity" (Salingaros, 1999); and "a fully volumetric urbanism" (Graham and Hewitt, 2013). Thus, clear articulation of three-dimensional, well-structured networks marked by distinguishing nodes could potentially improve connectivity, legibility and wayfinding in such large scale and complex environments.

6.2. Climate sensitive design

As the practice now stands, climate frequently only factors into the design process to ornament space with subtle references to the outdoor – think indoor trees or flowers. That is a mode of thinking inspired by the popularization of air-conditioned spaces. Through careful planning and design, it is however possible to successfully design comfortable interactions with the actual climate whereby thermal comfort can be achieved even during the hottest parts of the day. This is observed in the ground level open-air, linear atrium configuration of the Westgate mall (Fig. 21) which gives a steadier temperature and aids thermal comfort (Hung and Chow, 2001).

At MBS, however, many of the outdoor spaces, including the rooftop space above the Shoppes and sky-bridges, suffer from the insufficient provision of trees and structures that provide effective shading. On a hot summer afternoon, the MBS promenade is largely exposed to the sun, meaning that the indoor climate-controlled atmosphere of the shopping mall is more popular and the elevated spaces are uninhabited, with the exception of a few shaded areas on the promenade (Fig. 22-24). MBS hotel sky-garden entails an access fee, and was not included in the study, however, it incorporates several hundred plants and trees and was designed to cool the ambient temperatures.

J-Walk's covered walkways are, however, designed appropriately for the climate (Fig. 25). Not only are they very

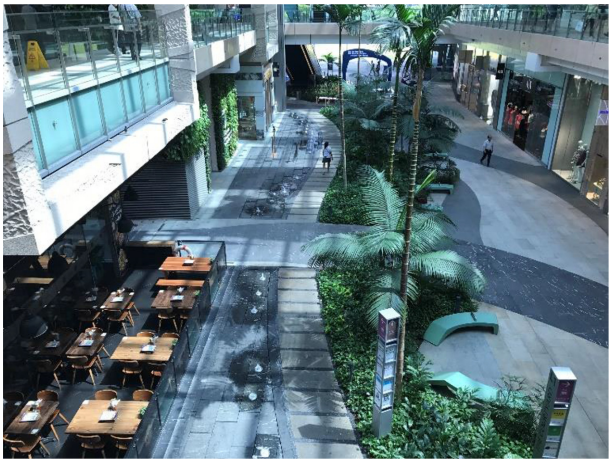


Figure 21. Westgate Mall Open-Air atrium space with greenery.



Figure 22. Insufficient provision of plants and structures that provide shade or shelter on MBS's sky-bridge.



Figure 23. MBS's promenade is largely exposed to sun during the day.



Figure 24. One of few shaded spaces on MBS's promenade.



Figure 25. Sheltered J-Walk.

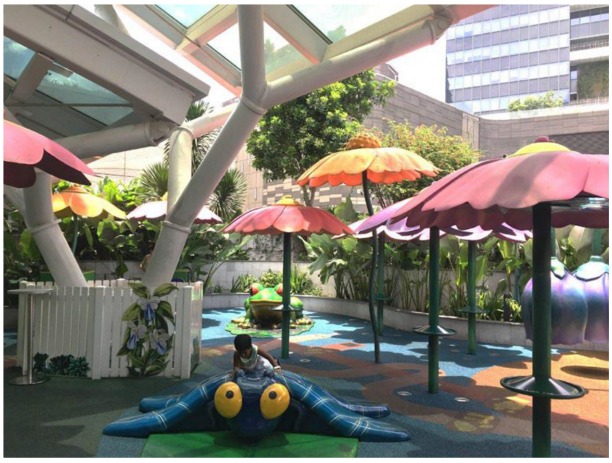


Figure 26. Rooftop playground at Westgate.

useful in high heat and rain storms alike, visitors actively seek them out as an alternative to other outdoor, unsheltered pathways. At Jurong Gateway, the rooftop play area in Westgate lacks cover, which is problematic, given that the rain is a regular occurrence in Singapore. It has some shade from the midday sun, but it was designed without the heat in mind (Fig. 26). Parents appear to be reluctant to let their children play on the too-hot-to-handle structures when temperatures are high.

The roof top green spaces at JEM and Westgate do not connect seamlessly with the larger network of green spaces, they lack amenities and activities, signal danger with the inclusion of CCTVs at JEM, and are secluded and restrict use in some areas at Westgate, thus not being used effectively, as also noted by Hadi et al. (2018) in Pinnacle@Duxton when restrictions are in place.

To ensure user comfort in outdoor areas, both projects do adopt certain measures to protect from sun and rain, and orientate public spaces to harness winds for passive cooling, however, with varying levels of success. A more rigorous environmental approach, through passive design and greening of such spaces would improve shade, shel- ter, micro-climatic conditions and thermal comfort that would encourage sustained use and support urban vitality, as also previously highlighted by Samant and Na (2017) through their study of the sky-garden at the Pinnacle@ Duxton.

6.3. Inclusivity

A widespread misconception is that urban spaces/POPS connecting developments cannot be truly public because they are managed by private entities. In truth, all spaces are subject to management controls to some degree – whether it be by government agencies or private firms – and so there are varying degrees of publicness seen throughout our urban areas. The challenge for development networks like those connected by elevated and underground pathways is to achieve a posturing that welcomes the public and encourages use.

Both Jurong Gateway and MBS aspire to be public facing, but for different reasons. The Marina development serves commercial and civic functions at the core of Singapore's CBD, and the Jurong Gateway includes many retail malls that want to encourage the public to spend time – and money – on their premises. However, largely opaque street facades and inward looking design with atria and sky-bridges engulf street life into these buildings - turning their backs to the city with very little activity bordering the main access roads to these developments (despite the greening of the street environment). Such abandonment of street life, as Ciu et al. (2015) warn, is potentially damaging to the vitality of the area.

Marina Bay Sands, with being an exclusive mixed-use development comprising a hotel, mall, theatre, convention center and casino, inherently faces the challenge with regards to ensuring inclusivity. Elements of commercially-oriented design and the high-end nature of the MBS hotel and mall runs the risk of making those who don't intend to shop feel unwelcome or uninvited. That said, Architect Moshe Safdie envisioned the hotel atria and shopping promenades and arcades to be public in character, and designed spaces to encourage unrestricted movement of all visitors, whether they be customers or curious bystanders. This is certainly a novel approach for what is an iconic, luxury hotel.

Public passes through the hotel space via the sky-bridge that cuts across the public atria, thus connecting the mall to the Gardens by the Bay across two major roads – but fundamentally separating onlookers from those staying, dining and partying at the hotel (Fig. 27). Indeed, there is also direct access from the underground MRT and the mall onto the atria floor which forms the hotel's main lobby area. It is conceived as internal street lined with shops, cafes and restaurants and allows promenading and people-watching. However, the hotel's location within the development means it is separated from some of the most heavily trafficked public areas (waterfront promenade) by the large, potentially uninviting, luxury mall (Fig. 1). In contrast to the sky-terrace on top of the shops, access on

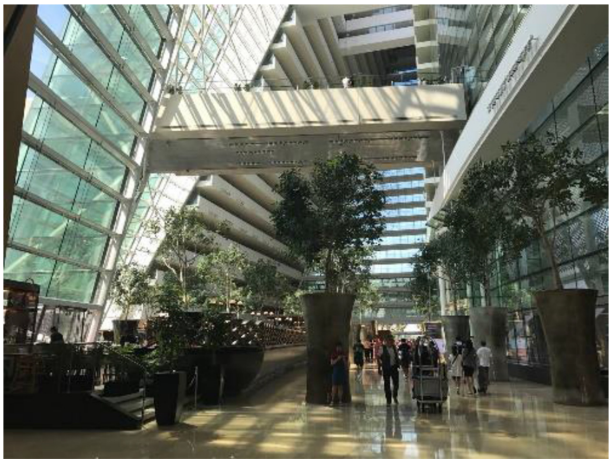


Figure 27. Marina Bay Sands Hotel Atrium with the elevated bridge.

the hotel roof deck is also segregated to cater exclusively to the hotel guests, restaurant and club patrons, with visitors paying an entrance fee to access the observation deck.

Despite the architect's efforts to create an inclusive and accessible environment at MBS, and although in parts it is very successful, due to the high end, iconic and nationally significant attributes of this project, there is an inevitable prioritization of economic values. This in turn manifests into an exclusive environment that feels somewhat restrictive, unaffordable, and uninviting, synonymous with the concerns also highlighted by previous studies (Lloyd and Auld, 2003; Minton, 2012 a; and Lim, 2014). For developments to be truly inclusive, it is vital to adopt design strategies that encourage participation of diverse users, and the removal of all manners of explicit and implicit barriers that may detrimentally affect users' experiences. Minton (2018) cites successful examples of the Rijksmuseum and Van Gogh Museum in Amsterdam; and the redesigned central square in Brixton, with no security presence; and Amanda Levete's new courtyard entrance to the V & A Museum in London with no bollards and bag searches. The V&A stated "We have created a less formal, more public place that is as much of the street as it is of the museum, attracting and welcoming in new audiences, and making ideas of accessibility and democracy very explicit" (Mairs, 2017).

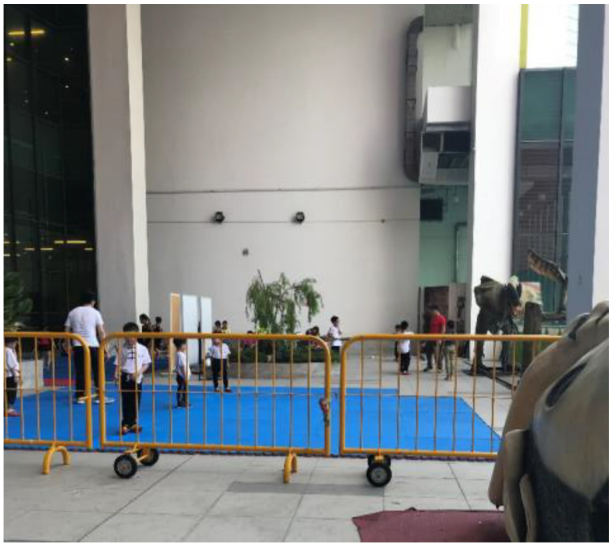


Figure 28. Karate and Gymnastics Classes for children held in sky court at Big Box (connected to J-Walk).

6.4. Provision of programs and street activation

The proliferation of elevated and underground pathways is commonly known to detract from the vibrancy of urban areas by taking people off the street level as also evidenced by Ciu et al. (2015). However, the two case studies evidence that in fact these networks can potentially make urban environments more vibrant by connecting disparate elements of a hybrid development and overcoming the island effect caused by the large roads that typically bound such developments. In order to add to vitality, though, the provision of appropriate design strategies and programs is key.

How the elevated spaces and sky-bridges are accessed and how they meet the street is obscured and somewhat illegible in both the developments. In particular, when the sky-bridges/elevated spaces meet the street, the vertical connections should become significant, memorable, prominent and distinctive nodes that are legible, visible, and encourage public activity and interaction through the incorporation of relevant amenities and programs.

Activities and events are crucial elements of urban spaces as they intensify the use of urban space by diverse users (Salingaros, 1999) and there are strong links between the intensity of activities and the quality of the urban space (Gehl, 2010). For example, in Westgate, the rooftop garden includes a 12,000-square-foot playground, and children's gymnastics classes are often held in the sky-courts in the Big Box and the Devan Nair Institute (Fig. 28 and 29).



Figure 29. Sky court at Devan Nair Institute where events are held.

In MBS, the roof terrace on top of the Shoppes is often used by visitors to view the nightly light show on the bay (Fig. 30 and 31). However, such programs, amenities, and seating areas are located away from the main pedestrian traffic routes, unlike on the ground level, where pedestrians are often walking alongside areas of community activity. Incorporation of programs and amenities within or along sky-bridges, therefore, would be more appropriate to support inhabitation and vibrancy. This would allow the sky-bridges to not merely being utilitarian conduits/ passages within our vertical environments and cities but truly act as streets in the sky.

Furthermore, opportunities for holding public events and activities should be created along such thoroughfares such that they are sustained and the spaces attract people regularly. Jacobs and Appleyard (1987) recommend diverse involvement opportunities that are meaningful to the community and individuals while Gehl (2010) suggests the inclusion of 'necessary, optional and social' activities within the public realm to achieve this. Moreover user perception of urban spaces is also vital, i.e. the psychological component. It places emphasis on the relationship between people and urban space, issues that relate to the diversity of its uses, choice of activities, seating, amenities, interactivity, privacy as well as the identity, history and culture of the urban space (Cho et al., 2015).



Figure 30. Sky garden on roof top of the Shoppes at MBS.



Figure 31. People watching the Light Show from the sky garden on the roof top of the Shoppes at MBS.

With regards to a multi-layered city, Rotmeyer (2006) advises that each layer must conserve itself within the larger functional framework of movements and activity. Indeed urban spaces are understood as dynamic and often conflicting systems of synergies between spatial typologies and programs, as well as methods of utilization and management, rather than as isolated and static entities (Montgomery, 1998). When considering the three-dimensional network of urban pathways and spaces comprising transitional and destination spaces, a systemic approach to the organization and distribution of programs, amenities and activities is necessary. Across a complex, hybrid development encompassing several entities, they should ideally complement each other, such that they cater to the diverse users.

6.5. Management

The management structures of elevated networks and sky-gardens affect their accessibility and usability. That is, public versus private, and singular versus multi-party coordination of these spaces inevitably alters the experience of the users of developments like the MBS and Jurong Gateway. When hybrid developments come under the purview of different managements, access may be restricted to varying degrees or closed for parts of the network, compromising user experience, and disorienting and inconveniencing them if they have to seek alternative routes in complex settings. This is fundamentally an issue of coordination between separate parties that potentially benefit from the network tying them together.

Over-management is also an issue as it typically takes the form of over-regulating visitor behaviors through a number of restrictions and regulations that prohibit certain activities (such as consuming food) and prevent users from appropriating these spaces. For example, the rooftop spaces in Jurong Gateway restrict eating and drinking, which deters the public from using these spaces for gatherings and lunch breaks. In contrast, the ground level spaces around Westgate near the MRT and the temporary markets are heavily used. The grass field, which is mostly uncovered and thus open to rain and sun, is even heavily used, likely because these spaces appear more as neutral public infrastructure than the spaces within the mall do, given their behavioral pressures and restrictions.

Privatization of such spaces and the ensuing control of user access, activities and behavior and diminished access (Minton, 2012a; Lim, 2014) discourages community engagement and the possible social values and meanings that such spaces could potentially engender. This in turn has detrimental impacts on their use and vitality, as also

found by Hadi et al. (2018) and results in their eventual decline. Despite the inherent constraints presented by such spaces and networks at height, future developments should seek to emulate the conditions of the 'genuinely open squares and public places' as advised by Minton (2009). Such spaces should encourage unimpeded access; free use, expression, appropriation and even community engagement in their design and management such that it creates a sense of ownership, belongingness, identity and pride amongst their users. As Jane Jacobs so rightly highlights in her seminal work, The Death and Life of Great American Cities (1961), that 'cities are shared spaces, and that we need everyone to participate in their creation'.

7. Conclusions

The aim of this study was to determine how multilevel urban spaces can be effectively employed in large scale hybrid developments, and identify successful applications to maximize their potential, using two cases in Singapore.

This research shows that effective and varied multi-level networks offer people choice and opportunities to extend vibrant street life into the vertical dimension, separate pedestrian and vehicular traffic for increased walkability and safety, connect disparate components of large scale and hybrid developments, and inject vitality and publicness to the privatized city fabric. In general, lessons can be learned from the design, management, and use of Marina Bay Sands and Jurong Gateway about the role of elevated spaces and networks in increasing urban vitality, accessibility, and horizontal to vertical transitions, and inclusivity.

The following strategies are suggested through the findings of this research to guide the design and planning principles for the development and re-development of sky-bridges, sky-courts, and sky-gardens in order for these paths and nodes to contribute to high quality multi-level networks.

7.1. Improve user comfort and vitality through appropriate environmental design strategies to encourage people to dwell

Climate responsive design is necessary for these spaces as lack of appropriate protection from sun and rain, especially in tropical cities such as Singapore, will discourage use. These spaces could act as urban acupunctures and can be deployed to improve thermal comfort, particularly in tropical, hot-humid conditions. Well-designed spaces provide not only paths for mobility in all weather conditions, but also social spaces to rest/dwell/occupy and participate in as individuals or in groups. To this end, the incorporation of sky-gardens (with appropriate planting to provide shade) and vertical greenery is also very important as is spatial variety and delightfulness that such spaces could potentially add.

7.2. Plug in developments to larger systemic planning infrastructure and integrate multi-level networks into larger spatial and functional networks of a city

The use of sky-bridges to connect larger grain developments across a mesh of high-speed roads may help overcome the island effect associated with such developments. Just like ground level spaces, multi-level networks best encourage use when they are designed as multifunctional combinations of diverse transitional and destination spaces.

Ideally, planning agencies should play an important role in the development of multilevel networks as infrastructure with standard design guidelines. A large scale systems approach allows for improved connectivity outside isolated developments but also ensures that the quality of these networks and nodes are optimized in terms of location of access points, special access requirements, signage, public transportation integration, comfort, use and spatial quality. In order to incorporate sky-bridges, sky-gardens, sky-courts, and underground networks as socially sustainable urban spaces, these multilevel networks must be treated not as isolated features of individual projects but rather as an infrastructure that is legible, visible, and coordinated with all components of the site, as well as its immediate and wider context.

These multi-level networks of paths and nodes must not only be physically connected through vertical access points, but these vertical access points should be made noteworthy (through their design and programs) to facilitate legibility, wayfinding and promote immediate understanding of the presence of elevated or underground spaces. This is important to transcend the psychological barriers often associated with the visual disconnection inherent in multi-level networks within complex large scale hybrid developments. Furthermore, the multilevel networks and public spaces at all levels should be legible, easily accessible and memorable, and contribute to the clear spatial structuring of such developments.

7.3. Improve inclusivity and accessibility across the different entities of a large scale hybrid development

Just as the ground level urban environment is a patchwork of privately owned and publicly managed spaces, so too should multi-level networks contain a mix of paths and nodes managed by different entities. This will reflect the spectrum of publicness that one expects to find as they navigate through any city and allow for a mix of functions and user groups. That said, the public spaces in so far as possible, should be neutral grounds that are accessible and inclusive yet not commodified whereby the users are subjected to the pressures to spend or feel unwelcome.

Inclusivity can be improved through removal of implicit and explicit barriers, whilst also employing comprehensive wayfinding measures, and branding and design that lends them a distinctive identity and legibility. The effectiveness of elevated urban spaces and pedestrian

networks can be strengthened by ensuring physical/visual connectivity (despite the level changes) within and between the development and across the section such that the elevated and underground spaces compliment those on ground.

7.4. Provision of programs across the section and along the streets is important

Provision of appropriate programs and amenities, unhindered access, appropriate environmental controls and spatial diversity is vital to the vibrancy of elevated networks and public spaces including sky-gardens. Such provision should support the daily, weekly, seasonal and temporal – temporary and permanent activities, festivities and events. Across the different entities within a large-scale hybrid development, programs and activities should be carefully orchestrated such that they complement each other and sustain the interest and participation of different user groups. Beyond the development, these spaces and networks should be integrated with the larger city wide programmatic and circulatory networks.

Activating the streets is also important to avoid the widespread internalization of urban spaces whereby the city outside is left bereft of any life. To create a continuum of experiences from ground into the elevated realm, the three dimensional labyrinths including the vertical connections should be designed as important, visible and legible nodes and networks of activity and amenities. Indeed, they should be integrated with the external streets to create a continuum of urban spaces and therefore of city experiences.

Green areas, seating, street furniture and incorporation of specific activities encourage people to linger in spaces and, as such, they should be provided in the design of nodes that are well integrated with the multi-level networks.

7.5. Implement Effective Management Strategies and Partnerships

Though management and operation of these networks and nodes may been overseen by different entities, to avoid negative consequences of fragmented management, all efforts should be made to implement standard operating hours and ensure that public rights of access and connectivity is maintained at all times. Event coordination should also be carried out in tandem as events taking place within the area of management of one entity will likely impact pedestrian flow or congestion in another.

Public-private management partnerships are encouraged as they could be pivotal in encouraging vibrancy in the elevated and underground spaces. Furthermore, over-regulation, restriction of activities and uses, and implicit or explicit barriers have negative consequences on the manner in which public spaces are used and occupied and should thus be avoided. Dwelling, participation and appropriation, and management of spaces by diverse user groups should be actively encouraged, thus calling for the reconsideration of the privately owned public spaces.

Finally, the study of the two hybrid projects highlight the vital role of multi-level public spaces and networks and the vertical distribution of public domain in large scale urban developments in aiding accessibility, connectivity, legibility, inclusivity and vitality. They point to the increasing relevance of such spaces for stratified and multi-level transit led developments, and in supporting horizontal to vertical transitions in the context of vertical urbanism. This calls for a much more top-down integrated planning approach whereby such developments are plugged into larger city-wide systems, on the one hand, combined with bottom-up, participatory and approach to the design, use and management of POPS whereby novel social, cultural and economic relations may be realized and such spaces are democratized.

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