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Mortality Rates in Swiss High-Rises

Debating Tall: Ice on High-Rise

Talking Tall: Korea's "Invisible" Tower

In Numbers: Highest Helipads

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Architecture/Design
The "Sky Neighborhood" Layout

> "Mortality decreased with increasing floors: residents on the ground floor had a 22% greater hazard of death from any cause compared to residents of the eighth floor and above."

Panczak, et al. page 32

The "Sky Neighborhood" Layout

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Mazlin Ghazali set up Arkitek M. Ghazali in 1993. Since 2000 this firm has built up nearly 12,000 units of affordable housing projects, many using system construction methods. Mazlin has also collaborated with his co-authors in thermal comfort and courtyard-based housing layouts which has yielded patents for the key aspects of that work. He is now working on commercializing the new "Sky Neighborhoods" concept providing cost efficient courtyards to high-rise apartments.

Anniz Bajunid is trained as an architect with experience in Malaysia, United States, United Kingdom, and Japan. He is presently a senior lecturer and a PhD candidate at Universiti Teknologi MARA, Malaysia. His current research pursuits are in understanding the social and physical dynamics of tessellation planning, particularly the environment-behavior of cul-de-sac courtyard micro-neighborhoods.

Mohd Peter Davis is a biochemist from UK. He was a lecturer and researcher in modern sheep production in Malaysia. Struck by the absurdity that sheep in barns were living more comfortably than humans in Malaysian terrace houses, he changed his research direction to design and build cool, affordable IBS houses on campus which led to his collaboration with his co-authors – Mazlin Ghazali and Anniz Bajunid.

Over the last 50 years, many researchers have concluded that high-rise apartments by and large are not suitable for children and young families. Creating small neighborhoods by way of sky courts can be a step toward solving this intractable problem. We attempt to demonstrate that a prototype design, whereby sky courts are provided to all units, with a minimal loss of saleable area due to circulation. This study compares the residential portion of this new concept against other types of apartment layouts, including single-loaded balcony corridor access, with double-loaded central corridor access, central-lobby tower blocks, and "scissor" style internal and external corridors.

Background

Subsidized and affordable high-rise housing has plenty of critics. Cappon wrote: "Young children in a high-rise are much more socially deprived of neighborhood peers and activities than their single-family-dwelling counterparts; hence, they are poorly socialized and at too close quarters to adults, who are tense and irritable as a consequence" (Cappon 1972).

A more even-tempered Gifford, in a 2007 review of 129 high-rise research papers over 56 years on the human experience of tall buildings, concluded that:

- Most people living in high-rise housing found it less satisfactory than other housing forms
- Social relations in high-rise housing were more impersonal, and residents were less likely to help each other than in other housing forms
- Crime and fear of crime was greater
- Living in high-rises may independently account for some suicides

However, on the issue of raising children, he was trenchant: "…Numerous studies suggest that children have problems in high-rises; none suggest benefits for them." (Gifford 2007). Even 30 years earlier, Conway concluded that for "…families with small children, the evidence demonstrates that high-rise living is an unsuitable form of accommodation." (Conway & Adams 1977). Dalziel suggests that the defects of high-rise housing spring mainly from the quality of the spaces between the street and the apartment – the "intermediate spaces," and laments them as "weird, anonymous space… neither public nor private."

Indeed, high-rise housing necessitates providing access from the building entrance at street level to the front door of every apartment on the upper levels of the buildings. Elevators, staircases, lobbies, and corridors provide passage to individual apartment units.

And so it is that conventional high-rise apartment layouts are often categorized by the method of access to each apartment – for example, single- or double-loaded corridors for slab blocks, and central lobbies for tower blocks. However, all these alternatives involve spaces such as lobbies, elevators, and corridors that are not only costly, but are not considered saleable space. To save costs, these areas are largely devoid of plant life, unsuitable for children's outdoor play, and usually used by residents who remain strangers to each other.

The "Sky Neighborhood" Concept

This paper proposes the "Sky Neighborhood" concept as a new kind of arrangement, whereby access to each unit is through six-story-high landscaped courtyards. In this way, corridors can be eliminated, and as such, not only can the social and environmental quality of intermediate spaces in high-rise housing be improved; the cost of constructing unsaleable circulation space might be reduced. Through a comparison with a selection of other types of high-rise housing layouts, its aim is to demonstrate that, indeed,

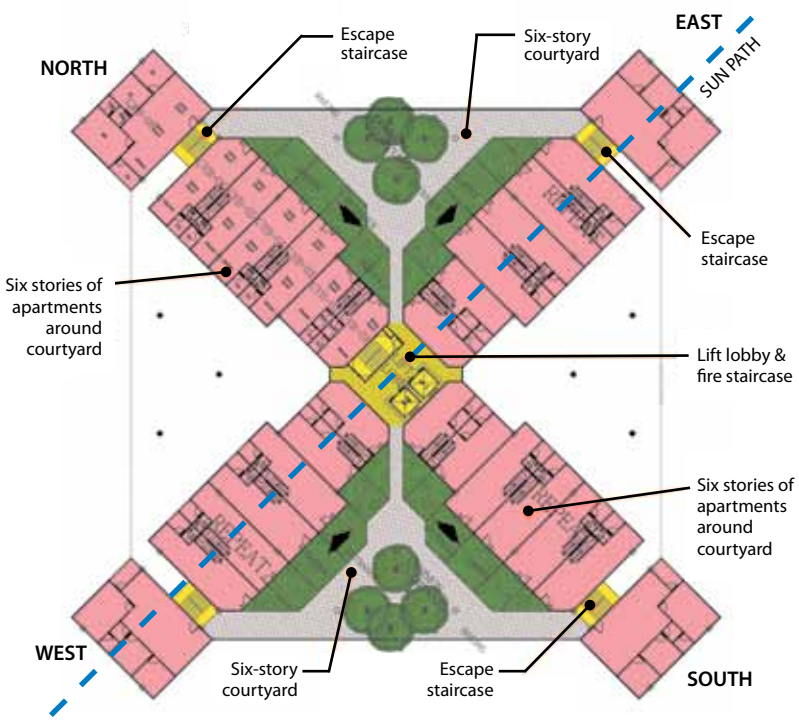

Figure 1. Sky Neighborhoods apartment layout.

> "The basic module in this layout comprises two double-story apartments, which occupy three floors, one placed on top of the other, such that access to both apartment units is on the courtyard level, with the first unit connected to another floor below the courtyard level, and the second joined to another floor above the courtyard level."

circulation space can be minimized, even as communal space is maximized.

In the next section, a detailed introduction to the "Sky Neighborhood" concept illustrates how duplex apartments can be arranged to create six-story courtyards with access to all apartment units. The section also presents the case for the "Sky Neighborhood" as an improvement to conventional types of apartment layouts and as a cost-reducer of key aspects of high-rise housing.

We then explain the methodology of the study of the circulation space in the "Sky Neighborhood" model, as compared with other examples of apartment layouts. This is followed by results and discussions, and concluding remarks in the final section.

Introduction to the "Sky Neighborhoods" Apartment Layout Concept

This concept presents the idea of multistory housing with apartments grouped around large covered courtyards, six stories high, which have one side open to the exterior. Typically, two-story apartments are stacked one on top of the other, such that each apartment unit is either on the access level or one level removed from it. Four or more pairs of these apartment units are arranged around and accessed directly from each courtyard. Elevators are suitably located off one or more of the courtyards, providing access to the courtyards and the adjacent units (see Figure 1). Escape staircases are located where necessary, and the dimension and layout of the structure allows lower-level car-parking facilities to be provided efficiently.

The basic module in this layout comprises two double-story apartments, which occupy three floors, one placed on top of the other, such that access to both apartment units is on the courtyard level, with the first unit connected to another floor below the courtyard level, and the second joined to another floor above the courtyard level (see Figure 2). However, stacking these apartments on top of each other, such that the courtyards flip from one side to the opposite side, produces a six-story high courtyard (see Figure 3).

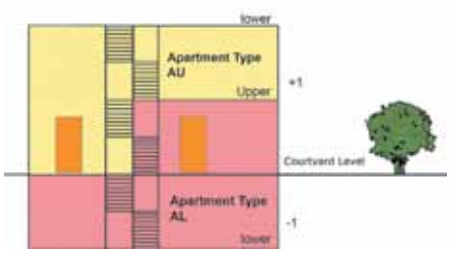

Figure 2. Basic interlocking apartment module.

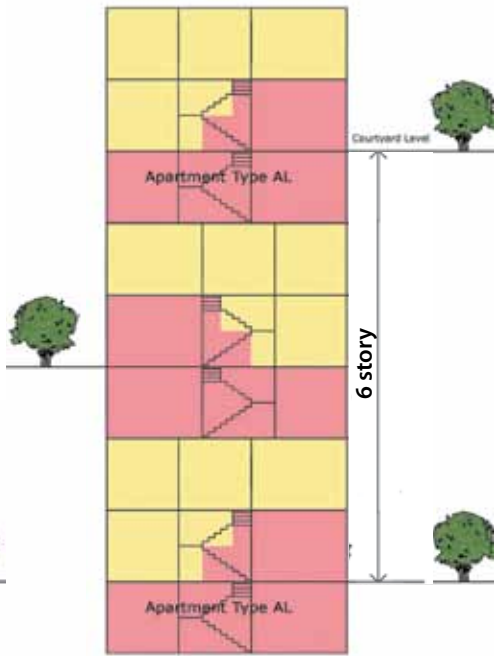

Figure 3. Basic apartment module stacked to create a six-story-high courtyard.

Type of Apartment Access	Example		% circulation and services on each access floor		% sellable apartment built up area each access floor		Units accessed on each access floor
External corridor or balcony access	413, Woodlands Drive 4, Singapore		18.80%		81.20%		6
Central corridor	Binapuri, Selangor, Malaysia		16.03%		83.97%		8
Central corridor	Dataran Mantin, Mantin, Malaysia		14.06%		85.94%		23
External scissors corridor	Robin Hood Gardens, London		12.58%		87.42%		39
Central lobby	Blues Point Tower, Sydney		11.90%		88.10%		7
Internal scissors corridor	Unite d'Habitation, Marseilles		8.12%		91.88%		58
Affordable "Sky Neighborhood" concept example	Circulation and services	5.10%	**13.49%**	80.82% internal	**86.51%**		**36**
	Public portion of courtyard green	8.39%		5.69% front yard			

Table 1. Comparison of the efficiency of the corridors and lifts between different types of apartment layout.

Social and Environmental Benefits

The courtyards – six stories high, open to the sun and air on one side – are suitable for planting medium-sized trees, shrubs, and grass, making them more attractive for social and recreational use. In equatorial Malaysia, the location of the test case, the blocks are best aligned north, south, east, and west, such that all the four courtyards can get sunlight (see Figure 1). This design thus admits plenty of light and ventilation but provides cover from direct rainfall.

Each courtyard will have a communal semi-private space shared by residents who live in the apartments around it. In addition, in front of most of the apartments will be a front-yard garden that can act as a buffer between the common space outside and the private domain inside. This arrangement of small groups of apartments surrounding a communal courtyard makes it easy for neighbors to get to know each other. Children can play in the courtyards under the watchful eyes of their parents and neighbors (see Figure 4).

Potential for Reducing Cost

Perhaps the most important cost feature is that, unlike conventional sky courts or sky terraces, the courtyards in the "sky neighborhoods" layout are not located in such a way that potential saleable or rentable floor space is sacrificed. Thus, there is no loss of potential revenue.

Apart from this opportunity-cost advantage, there are potential cost savings resulting from the omission of corridor space, a reduction in the number of required elevators, and the omission of fire doors to each apartment.

Figure 4. Six-story-high courtyard.

Circulation spaces – corridors, stairs, elevators, lobbies, etc. – are minimized to less than any existing type of apartment. Indeed, in the design prototype presented here, there are no corridors. The communal courtyard and circulation spaces, including the elevator lobbies and staircases, occupy less than 5% of the total built-up area on the residential floors (see Table 1).

The elevators only need to stop at every third floor, thus reducing elevator waiting times, elevator provision, and associated costs. In this example, only two elevators (with 13 elevator stops) are provided. However, to cater to larger numbers of residents, the passenger elevators are large enough to double as service elevators, suitable for stretchers and the transport of large furniture. This cost-saving feature becomes even more prominent when compared to supertall buildings, which typically require two separate banks of elevators. For example, Singapore's Pinnacle@ Duxton is a 50-story building that has a set of elevators servicing floors 1 to 25, and another set for the 26th to the 50th floor.

In case of fire, smoke – a major cause of fatalities – is easily dissipated from the courtyards, which form an important part of the escape route. Because apartments open to a well-ventilated access route, according to Malaysian fire protection rules, the apartment entrance doors need not be fire doors. In addition, the courtyards can be seen as safety platforms: every apartment is at most two stories above one of these platforms. This makes escape and firefighting easier.

It is true that the construction of the courtyard structure and the provision of the soft and hard landscape will add substantial cost, but the courtyard areas will gain features that aid the selling of the garden-apartment units. The front-yard garden can be allocated directly to an individual apartment and may be counted as built-up area (see Figure 5). The communal courtyards can be marketed as an amenity at the doorstep of every garden apartment.

Finally, it is argued that the courtyards alleviate the sense of overcrowding that can be found in affordable and mid-market, high-density

30-STORY DESIGN PROTOTYPE	
Plot ratio	4.9
Density	163 units/acre
Communal courtyard	70% of plot area, 18 m^2/unit (194.6 sf/unit)
Communal courtyard and private front yard garden	107% land area

Table 2. High plot ratio, high-density; more green area is created than development land used.

Side corridor or balcony	Single-loading corridor on one side of a row of apartments	Narrow-slab block	Intermediate double aspect units
Central corridor	Double-loading corridor in the middle of two rows of apartments	Wide-slab block	Intermediate single aspect units
Central Lobby	Apartments are directly accessed from the central lobby	Tower block	Corner apartments
Alternate floor corridors	Single-loading corridor on one side of a row of two-story apartments or maisonettes	Narrow-slab block	Double aspect maisonettes
Scissors corridor	Double-loading corridor in the middle of two rows of two-double-story apartments or maisonettes	Narrow-slab block	Double aspect maisonettes

Table 3. Types of apartment layout.

high-rise housing. The high-density and plot ratio of the design prototype would contribute to savings on land cost (see Table 2).

Methodology

Comparing "Sky Neighborhood" Apartments to Existing Apartment Layouts

The main goal of this study is to compare the area-use efficiency of a design prototype of this concept against other existing types of apartments. To achieve this goal:

1. We analyze existing apartment building layouts.
2. We then break down apartment building areas into different use categories for analysis.
3. The same analysis is conducted against the "Sky Neighborhood" design prototype example.
4. A comparison is then made between existing apartment building types and the affordable "Sky Neighborhood" example.

Conventional High-rise Apartment Design

All high-rise housing requires a solution for providing access from the street level public domain into the building, through elevators to the upper levels of the building, then from the elevators to the individual apartments. High-rise apartment design can be classified according to the way the apartment units are arranged and how access to each unit is provided (see Table 3).

A collection of plans – one example from each of these existing types of apartments – was assembled. Apartment buildings with alternate-floor corridors and scissors corridors are not common. The most famous example of the latter is the Unite d'Habitation, designed by Le Corbusier and built in Marseilles and several other locations. A well-known example of an apartment with alternate-floor corridors is Robin Hood Gardens in London, designed by Alison and Peter Smithson.

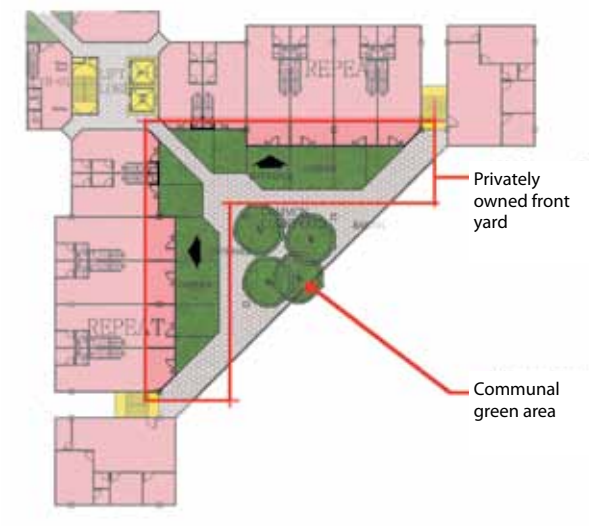

Figure 5. Courtyard arrangement.

The remaining typologies are ubiquitous. The plans of the two double-loaded corridor examples were taken from the lead author's architectural practice. The sample of a single-loaded corridor was taken from the Singapore Housing Development Board. The floor plans were drawn based on information provided by the Board's website. This is a small set of examples with selections of the single-loaded and double-loaded corridors, as well as the tower-block elevator-lobby access, which was based on the author's available resources. The authors were confident that, at this exploratory stage, the differences between the "Sky Neighborhoods" and these examples would be sufficient to enable preliminary conclusions.

In the analysis of the following examples, we look at the typical floor or floors that are accessed from a single corridor or lobby. The areas within the circulation spaces – including the elevator lobbies, public staircases, and corridors – and services were measured. The space taken up by voids, including the elevator cores, is excluded.

- There are two factors concerning circulation that were taken into account: the first is the calculation of the circulation area, expressed as a percentage of the total built-up area of the relevant floor or floors. The lower the percentage, the more efficient the layout.
- The second factor is the number of units accessed by a single bank of elevators. The grouping of elevators has a significant effect on their efficient use. Placing elevators next to each other in one lobby is more efficient than having them spread out over different locations. Having many units share a single bank of elevators is more efficient than having fewer.

Single-loaded corridor

In this type of apartment layout, the apartments are all placed in a row on one side of a corridor, and which is open on the opposite side. The apartments can have windows along the corridor, which are useful for natural

light and ventilation, but obviously impinge on the privacy of the homes. The example given is the 413 Woodlands Drive 4 in Singapore (see Figures 6 and 7).

Double-loaded/central corridors
The central corridor is more efficient than the single-loaded corridor example, serving apartments on both sides. However, the apartments it serves can only have windows on the external wall. The apartments may have internal air wells alongside the double-loaded corridors (see Figure 8). Nevertheless, the ventilation and light from these air wells are inferior to windows on the external wall.

Figure 6. 413 Woodlands Drive 4, Singapore.

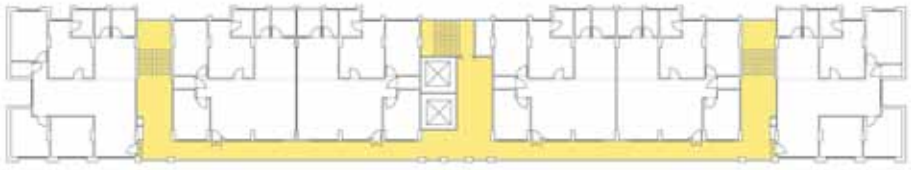

Figure 7. 413 Woodlands Drive 4, Singapore – Single-loaded corridor.

> "The 'Sky Neighborhoods' concept can be seen as a relocation of the spaces set aside for amenities and communal gardens to the front of each apartment. It can be argued that this is where apartment dwellers can most easily enjoy the open space and communal amenity. It also has the beneficial side effect that, in this arrangement, corridors are eliminated."

Central Lobby
In the tower block, apartments are positioned around a central elevator lobby. In this set-up, there is a minimum of corridor space. On the other hand, the number of units that can be served by the single elevator lobby is limited. Here, the efficient arrangement of circulation space is offset by the rather inefficient sharing of elevators by a small number of housing units (see Figures 9 and 10).

Internal "Scissors" Corridor
The scissors corridor is an especially clever innovation, first introduced by Le Corbusier in Unite d'Habitation in Marseilles in 1952 (see Figures 11 and 12). Here, internal double-loading corridors serve two rows of maisonettes opposite each other in an interlocking arrangement. These corridors – and the "skip-stop" elevators – are only required to serve every three floors. The percentage of floor space taken up by the central corridor is very low – only 8.12% – and the elevators in this case need only stop on one floor and skip the other two. That one stop serves 58 units. This is an extremely efficient layout, and is not more common because the corridor in this type of layout is rather long, narrow, and has virtually no windows. Also, the apartment units are also designed to be long and narrow, with bedrooms that hardly seem to accommodate a double bed. Still, considerable ingenuity has been applied to securing the efficient deployment of circulation space and elevators.

External "Scissors" Corridors
In the 1970s, Alison and Peter Smithson developed an improvement on the scissors-corridor layout concept by designing single-loaded external corridors (see Figures 13 and 14). Here, the quality of the access corridor was much improved. The wide, well-ventilated external- access corridors were promoted as "streets in the air."

Figure 8. Dataran Mantin Apartments – Double-loaded/central corridors.

Figure 11. Unite d'Habitation, Marseilles. © Greg Maxwell/CC BY-SA 2.5

Figure 9. Blues Point Tower, Sydney. © Hpeterswald/CC-BY-SA-2.0

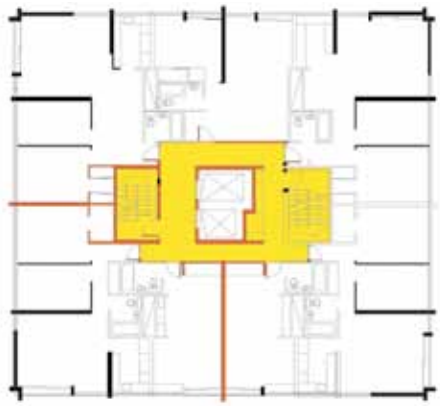

Figure 10. Blues Point Tower, Sydney – Central lobby. Source: French 2008

Results

Constructed-area Breakdown Comparison

To investigate the circulation space advantage of the "Sky Neighborhoods" apartment, an analysis of the constructed area of the 30-story design prototype was undertaken.

Space usage was divided into five categories: apartment interior, apartment exterior (the front yard of the units), communal courtyard area, circulation space (comprising corridors, elevator lobby, and staircases), and services. The tabulation below is that of a typical courtyard and the three stories of apartments accessed from it. The "internal area" of the apartments is calculated across three stories. The "garden" area is the front-yard green that is found only on the courtyard level. The "communal courtyard" is the landscaped area shared by the residents that is also used to access the apartments. The "circulation" area comprises the staircases over three floors and the elevator lobby at the courtyard level. The services available include the refuse collection center and service risers.

Table 1 shows that with the "Sky Neighborhoods," the circulation space occupies only 4.32% of the total floor area served by the corridor. With service areas added in, the percentage for circulation plus services is only 5.1%. This is a remarkably low figure. As shown in Table 1, it is substantially more efficient than any previous design for

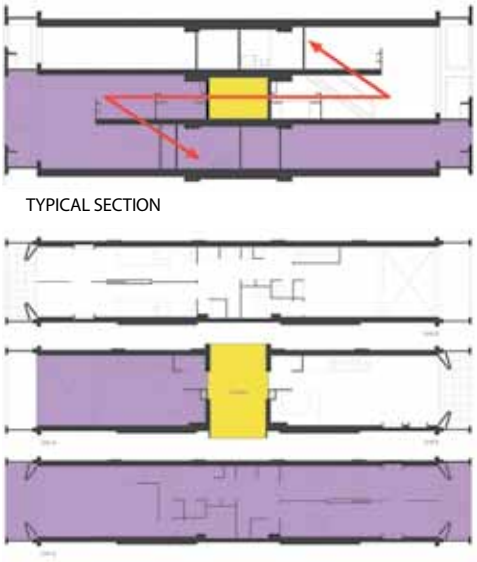

Figure 12. Unite d'Habitation, Marseilles – Internal "Scissor" Corridor. © Gunawan Wibisono/CC BY-SA 2.5

tall residential buildings. Even the "scissors" corridor access of Unite d'Habitation – with its long, windowless central corridor, and narrow apartment units – at 8.12% is less efficient than the "Sky Neighborhood." The corresponding figures in Table 1 for other layouts range from 11.9 to 18.8%.

This substantial efficiency improvement is all the more remarkable, because it is achieved by making the apartment design more attractive, not less, and by extending the benefits of a landscaped courtyard to every

Figure 13. Robin Hood Gardens, London. © Steve Cadman/CC-BY-SA-2.0

Figure 14. Robin Hood Gardens, London – External scissors corridor. Source: French 2008

apartment. Indeed, the introduction of the courtyard is the key.

Most apartments will have some provision for communal amenities and gardens; these have conventionally been provided on the ground-floor deck or the grounds around the building. They have also been provided on the rooftops. As illustrated at the beginning of this paper, the provision of these amenities, whether on the ground, in a sky court, or a landscaped open deck on an upper floor, not only incur additional construction cost, but also represent an opportunity cost – the loss of space within the building envelope that could otherwise be used to build even more apartments or other saleable space.

Discussion

The "Sky Neighborhoods" concept can be seen as a relocation of the spaces set aside for amenities and communal gardens to the front of each apartment. It can be argued that this is where apartment dwellers can most easily enjoy the open space and communal amenity. It also has the beneficial side effect that, in this arrangement, corridors are eliminated.

It is possible to counter that the courtyard area, or a portion of it, should actually be counted as circulation space. However, doing so contrasts with conventional categorization of circulation spaces on architectural plans. The corridor is unequivocally categorized as a mono-functional circulation space: its purpose is to allow for movement from one area to another. On the other hand, any space or room will have within it some circulation space. For example, a living room contains within it a portion that can be used to move around, but by convention we simply call it "the living room," and when one measures and displays its area, one doesn't subtract away the circulation space within that room. In the same way, it is consistent with accepted convention that one measures and displays the courtyard area without deducting the circulation space within it under a separate category.

Further, circulation space is only one of several factors that effectively reduce saleable space. One can contend that the public portion of the courtyard should be in the same category as circulation space, in the sense that it reduces the net saleable area of apartments. This is true enough. However, when we compare the efficiency of the design in terms of the percentage of total saleable built-up area, the "Sky Neighborhoods" design prototype is still quite good at 86.51%, slightly less than that of Blues Point Tower (88.1%), Robin Hood Gardens (87.42%), and Unite d'Habitation (91.88%).

However, this is not a fair comparison. The authors have only been analyzing the areas accessed from a typical corridor, which in both the cases of Unite d'Habitation and the design prototype, involves only three floors. In fact, the Unite d'Habitation is famously raised on *pilotis*, with an open deck on the ground floor, and a rooftop deck and swimming pool, both of which serve as communal spaces. This means that two out of 18 levels (11.11%) in this building have no saleable floor area. A Sky Neighborhoods apartment, designed without communal amenities on the roof top and with a minimum of communal provisions on the ground floor, could prove to have a higher percentage of saleable area. This comparison has not been formally conducted, but further study can easily settle this issue. This same argument also applies to Blues Point Tower and Robin Hood Gardens.

Apartments are conventionally designed as slab or tower blocks, where the maximum width of the building is constrained by the

need for the apartments to have windows to the open air. For this reason, if one wants to increase the number of units, the easiest way to do so would be to increase the number of floors. However, the cost of construction increases disproportionately with the height of the building. On the other hand, it is not easy to avoid increasing the height just by making the building wider. Air wells within the building that open to the sky have to be introduced to bring light and air into the building interior, or else, the building plan is split with narrow recesses that do the same thing. The large courtyards in "Sky Neighborhood" apartments can be seen as a useful and attractive spatial device to bring in light and air into the interior of an apartment building.

The provision of the spacious sky courts, large elevator cabins, and tall elevator lobby ceilings should help overcome the sense of crowding that is perceived in conventional high-rise housing.

Conclusion

The "Sky Neighborhood"concept, in providing a six-story-high courtyard in front of every duplex apartment, while using that courtyard as communal open space adjoining privately owned gardens, aims to ameliorate the social defects of high-rise, high-density housing. At the same time, by using the courtyards to provide access to each home, construction cost is lowered through reduced circulation spaces and elevators (see Figure 15).

This study has found that a "Sky Neighborhood" design uses substantially less circulation space when compared to six other types of apartments. Indeed, it can be said that in the "Sky Neighborhood" model, corridors were eliminated and replaced with courtyards.

However, the study of the "Sky Neighborhood" concept can still be considered to be at a preliminary stage, as there are many other aspects that need to be thoroughly examined. For example:

- Make a more detailed comparison with a carefully selected group of comparators that takes into account not only the circulation space, but also the services, the spaces set aside as amenities, including sky courts, void decks, and communal facilities, as well as the internal and external saleable apartment area.
- Investigate in detail if fewer elevators can be provided in a "Sky Neighborhood" apartment building when compared to conventional apartment-building types.
- Qualitatively and quantitatively compare the "Sky Neighborhood" concept with the more recent innovations in apartment layout design, especially those from Singapore that have included "Sky-rise greenery" on the upper levels of high-rise, high-density housing.
- Consider the effects of limiting disabled access by all units being two stories, with internal stairs. ■

Unless otherwise noted, all photography credits in this paper are to Arkitek M. Ghazali

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Figure 15. View of "Sky Neighborhoods" tower.