Protibesh@BUET
January 2009, Volume 13 Issue 1
pp 43-54

Integrating Open Space in Compact Layout: Study of a High-Density Residential Development in Hong Kong

Afroza Parvin
Associate Professor, Architecture Discipline, Khulna University
e-mail: afroza@hkusua.hku.hk

Abstract
In response to several urban problems such as demand of higher development density, traffic congestion, accessibility in urban core, design of compact urban layout has been adopted as a popular urban development option in many large cities. In the compact layout provision of local open space is crucial for the quality of life of the people living in extreme high-density built environment. The vertically distributed mixed land uses are accompanied with local open spaces at different levels to offer active and passive recreation, and social interaction spaces for the communities. In many instances the provision of multilevel open space-layout has been criticized for being too complex to access and to use. But whether the provision of open spaces in the overall spatial layout can itself be given some explicit description and be subjected to functional formulation is a problem which has been hardly tackled by architectural research. Using a computer-based technique known as "space syntax" this study investigates the spatial configuration of a high-density mixed use residential development to understand its relation to the patterns of open space use. Findings of the study suggest that, notwithstanding the effect of grade separated multilevel circulation spatial configuration has significant effect on the patterns of open space use in high-density compact built environment.

Keywords: Spatial Configuration, Open Space Use, Space Syntax, Hong Kong.

1.0. Introduction

Worldwide popular adoption of compact urban development has been compelled by the most pressing needs to create new urban spaces. This leads to the mixture of residential, commercial, and service facilities in the central urban areas. Such developments are generally incorporated with multilevel circulation system which is usually supported by mass transportation system like underground train. While there are many examples of successful compact development, there are examples that fail to function as predicted by the designers or the developers. In many instances, the spatial layouts are associated with some common problems such as, lack of intelligibility induced by the functional and spatial complexity of multilevel space network; and inconsistent relationship between the spatial configuration of the system and spatial distribution of multi-functional land uses.

High-density urban development of Hong Kong is most often referred to as good examples of compact development by the researchers advocating for such development pattern as the future urban design direction. In the extreme high density urban areas relatively unintelligible circulation systems characterized by mass-transit transportation system, level variation, mixed land use, and complex transition between levels make it difficult not only for the users to orient themselves to the overall spatial environment but also for the designers and planners to predict likely pattern of open space use. In many instances, the public realm is experiencing lack of communal space and over-use of public domain (Xue, et.al., 2001). Furthermore, in an extreme high-density context where most of the people are living in small flats with tight living environment, there are under-used spaces and left-over spaces evident in many areas. The local open spaces[i] appear at different levels in terms of various types of public spaces like parks, playground, neighborhood community space, children play area, seating out area, pedestrianized decks, and podium. This variety of spatial expressions induces various patterns of space use that eventually impacts upon the socio-spatial behavior of the people (Hillier, and Iida, 2005; Hiller et. al., 1989; Peponis, et al. 1989; Canter, et.al., 1975).

The compact spatial layout with communal open spaces in Hong Kong offers a fertile base for the development of an empirical knowledge-base that will help to better understand the relationship between the spatial configuration and patterns of open spaces use in compact layout. To this end, the study focuses on two important issues – firstly, how to describe the complex spatial configuration in a systematic way; and secondly, what is the impact of the configuration on the use of open spaces. It is hypothesized that *in high density multilevel urban complexes the spatial configuration has significant impact on the pattern of open space use*. However, previous researches suggest, efficiency of space use is also subject to several local urban design parameters like: location in relation to the transportation hub; surrounding land use; level variation; and so on (Chang and Penn, 1989; Parvin, et. al., 2006a; Parvin, et. al., 2006b). Furthermore, regarding the high density context where land uses are arranged vertically access to the spaces in upper

levels is confined to the transitional spaces. Thus this study proceeds with a sub-hypothesis that these *local urban design parameters also have significant influences on the way people use the spaces*. The study applies a computer-based technique known as "space syntax" for the spatial analysis of a case study area and conducts correlation analysis in order to test the research hypothesis. To analyze the effect of configuration on open space use the study involves study of both outdoor open spaces on the ground level and indoor public spaces at multilevel in a mixed-use compact residential development.

2.0. High-density Spatial Morphology and the Provision of Open Space

Hong Kong's current urban form supports the contemporary belief in the need to reduce the physical separation of activities. The basic provision of the local community with necessary commercial and GIC facilities, and open spaces favors the creation of pedestrian friendly spatial configuration. The larger development in podium-tower concept generally houses district level retail outlets i.e. large commercial-cum-residential complexes served by high speed mass transit railway (MTR) station in the podium while residential or office use in the tower. By connecting the mixed land uses at different floor plates, extending up to the surrounding areas, the space network with open spaces at different level not only becomes the vital element of the compact morphology but also a vital element in people's everyday life

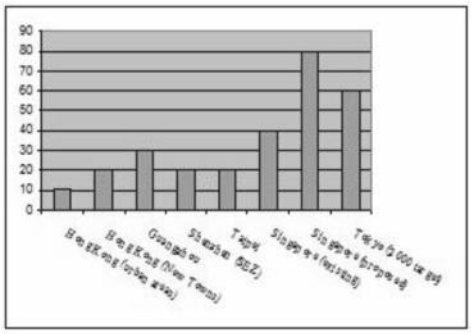

Figure 01: Chart showing the comparison of open space provision (hectares per 100,000 people) in Hong Kong and other region in Asia. *Source*: Llewelyn-Davis in association with Hong Kong Productivity Council (1997).

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However, the 'success' of providing housing for about half of the population in compact living environment has been achieved at tremendous costs in the form of high property price and congested living space[ii]. Compared to the other countries of the world, Hong Kong still ranks among the lowest in terms of open space provision (Figure 1). Nonetheless, researches show there are many instances of underused, deserted and leftover open spaces. Some researches found uneven distribution, inconvenient location, and poor accessibility hinder the optimum use of open space and results in surplus of open space in some areas while lack of it in others (Gilges, 1998; Coorey, and Lau, 2005; Li 1999; Law, 2000; Chang, 2000; Cheung, 2001; Liu, 2001). Gilges (1998) found, nearly three quarter of the total population are living in underserved neighborhood. Li (1999) in his study identified accessibility as an important factor contributing to the seldom (or no) use of open spaces in Wanchai. He also suggested that sometimes accessibility appears to be the only criteria for people to use open space. Law (2000) established user-friendly criteria to evaluate the open spaces in Hong Kong. Among them, accessibility is proposed as the most important one. In her study, accessibility of open space is evaluated according to users' response and perception. Chang (2000) indicated that in terms of accessibility, over 65% of the people prefer to go to the nearest green space. In terms of facilities and accessibility, the respondents' rated accessibility as more important than the provision of facilities. Liu (2001) indicated that small open spaces within urban areas should be accessible to all groups and should provide freedom for action. However, most of these studies stressed on the design qualities as major contributor to the effective use of open spaces in the context of Hong Kong, and ended up with design guidelines to be incorporated at design level. Even though accessibility has been identified as one of the key parameters, few of them investigated it in depth. Moreover, there is hardly any research that investigates the use of open space with regard to the urban layout or its spatial configuration where the open space is embedded in.

3.0. Methodology

To test the hypothesis, the study analyzes the Po Lam area, a high-density mixed use residential development that houses a multilevel commercial complex Metro City. The study applies the spatial modeling and observational techniques of the space syntax, developed by Hillier and Hanson (1984).

3.1. Space Syntax

Space syntax is a theory and a set of methods about space built on ideas which reflect both the objectivity of space and our intuitive engagement with it (Hillier, 2005). The space syntax methodology treats the built environment as a system of space analyzing them 'configurationally', and trying to bring to light their underlying patterns and structure (Hillier, 2004). The methodological key of space syntax is that it not only provides a way to describe the global structure of a built space without losing a view to its local structure, but also establishes a theoretical account that makes the social origin and consequence a part of the description (Hillier and Hanson, 1984). Central to the analysis is the concept of *integration*. It is a global measure that explains the relationship of each space to the space network as a whole represented by axial map. The axial map consists of the 'longest and fewest' straight lines that passes through at least one permeable threshold between two adjacent convex spaces (a convex space is one in which each point is directly visible and accessible from every other point, a piece of space always forms part of the fattest space it can) [iii]. This study also analyzes the configuration in terms of *connectivity* (it is the most obvious local property that represents the number of connections or intersecting lines a line has); *accessibility* (correlation between integration and axial depth from major surrounding routs); *intelligibility* (it is the degree of correlation between connectivity and integration values of each line. It depicts how connected each line is to others; i.e. how many neighbors it has intersecting it, and how integrated it is into the system as a whole); and *local area effect* (correlation between local (radius 3) and global integration (radius n)). *Local area effect* represents the 'integration continuity' which means that local and global areas are spatially well embedded in a system without strong self-contained enclaves, thus the street pattern can tie different parts together in a system.

3.2. Field Observation

In Po Lam area twenty open spaces are observed to study the patterns of space use in terms of number of users and type of activities. Among the observed spaces Figure 2 shows 12 outdoor open spaces on the ground level (marked by dotted circles), rest are indoor spaces situated at different levels. The patterns of space use are recorded applying the 'static snapshot' technique. In this method both moving and stationary users are recorded in three categories of activity: sitting, standing, and playing. The data is collected by observer walking around in each space and taking mental snapshot of the activity in the afternoon between 4:00-6:00pm in three week days. To cross-check the data derived from the mental snapshot video recording (by handheld digital camera) at regular interval (5 minutes video at 20 minutes interval) is also carried out during the field observation. The data is recorded diagrammatically on large scale map of the spaces where people are represented by circles. Sitting people are noted as a circle with a line underneath; standing people are as a plain circle; and playing people are as circle with an arrow. In addition people who are talking are noted drawing circle around them. The data is expressed in terms of total number of people per space per day. During the field observation period an informal interview asking some narrowly defined questions is also conducted randomly to have an understanding on four relevant aspects – 1) the catchments of the users; 2) origin-destination pattern; 3) users status (resident or visitor); and 4) preferred spaces.

Descriptive qualitative analysis supplemented by simple correlation analysis is conducted to understand the interrelation between the configuration and the patterns of community space use. The effect of configuration is analyzed: 1) at ground level that includes spaces in Po Lam residential development on the ground level only; and 2) at multilevel that includes spaces at different levels in the Metro City commercial and residential complex situated at the middle of Po Lam. At ground level *integration* values are correlated with the number of users of the community spaces. In order to include the effect of the level variation different weighting is incorporated with axial integration value of the axial lines at different levels. The weighting of level variation (L) is discussed in the later part.

4.0. The Study Area

Figure 2 shows the survey map of the study area of Po Lam. The larger area marked by dotted line is the Po Lam area studied for space use at ground level and the small area marked by small dotted line is the Metro City complex studied for the public gathering spaces at multilevel. The case study area is a large residential development situated in the Po Lam district in Tsuen Kwan O New Town in Kowloon Bay. It includes public and private housing estates, open spaces, parks and GIC facilities while the Metro City (Figure 3) includes three commercial Plazas, residential towers above; and three adjacent housing estates. In terms of residential density, building density and population density the area is a High Density residential Zone (R1), with maximum domestic plot ratio of 8 and population density of around 2500 person per hectare. The land uses are systematically arranged at different levels (Figure 4) in terms of shopping complex that comprises four levels on the ground, apartment blocks start from the podium level above the shopping plazas, major government institution or community (GIC) facilities, commercial facilities. The Mass Transit Railway

(MTR) station is the focal point of the whole development with retail and public transport facilities and very high-density residential development around it.

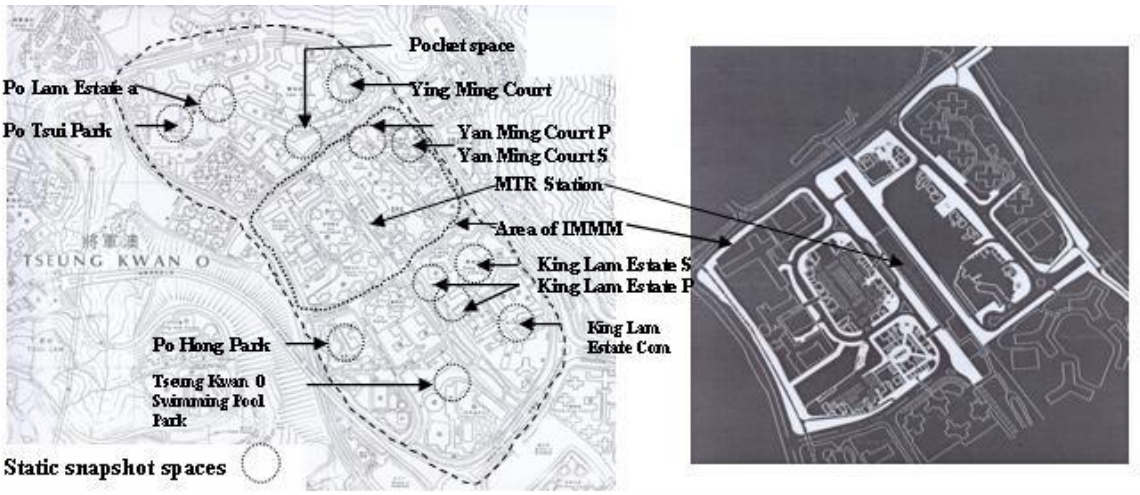

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Figure 02: Survey map showing study area PoLam
Figure 03: Detail plan showing public circulation spaces of the Metro City

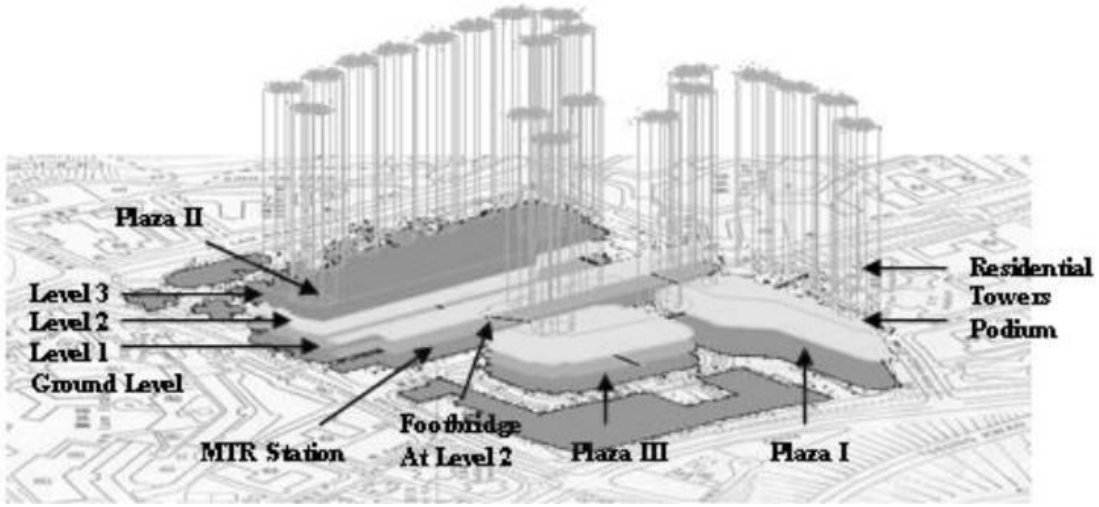

Figure 04:. Diagrammatic representation of the Metro City multi-level complex showing land use.

4.1. Patterns of Open Space Use in Po Lam

The overall street network of the Po Lam area can be described as an irregular grid formed by main streets intersected with each other at a more or less orthogonal angle in the central part (around Metro City) with high concentration of commercial retail activities and transportation hub. Longer streets are leading from the central grid to upper (north) and lower (south) part of the grid with high concentration of mainly residential development. In the central part the open spaces are located at upper three levels connected through multilevel pedestrian circulation system, while in the residential areas open spaces are located on the ground level connected through horizontal pedestrian streets. The snapshots show that Po Hong Park is the most preferred open space (193 persons per day). In this park most of the users, mostly young adult and children, are found playing and talking. Young people are mostly playing and seem to know each other; children are found playing; and small kids are found with parents or baby sitter attending them. Second most preferred space is the small sitting out area between the government office building and the public dormitory on the Po Fung road (117 persons per day). Mostly elderly people are found here playing traditional Chinese Chess surrounded by other elderly people chatting and enjoying the game. Po Tsui Park is the third most preferred space (112 persons per day). In this park, unlike Po Hong Park, elderly people are mostly found sitting quiet and adults are found sitting and chatting; and young boys and girls are found gossiping or playing. The sitting out area in the Po

Lam estate (96 persons per day) and the King Lam estate are found to have similar users dominated mostly by the elderly and some adults. The small park adjacent to the Tseung Kwan O swimming pool (8 persons per day) and sitting out area in the Yan Ming Court (8 person per day) are found to have less users.

The multilevel spaces in the Metro City are found less preferred by the community people and found with few static users. Users in these spaces are mostly visitors. Among four levels Level Two is the most preferred one (112 persons per day) while Level One and Level Three are hardly used by the community people (average 17 persons per day). Findings from the informal interview suggest that the variation in density of users at multilevel spaces is mostly dependent on the proximity of the space to the MTR station; land-use; and location of vertical transitional spaces. However, the overall patterns suggest: 1) the outdoor open spaces are preferred to indoor commercial spaces; 2) the public parks and play grounds are used by young, adult and children coming from all the surrounding estates; 3) in the sitting out areas in the public housing estates the users are mostly elderly and women coming from the adjacent estate.

5. Configurational Analysis

Figure 5a shows the global integration pattern at radius n and Figure 5b shows the local integration pattern at radius 3 of Po Lam at ground level. The map shows values of integration in grayscale from black for the most integrated (and shallowest from all other lines on average) through to light grey for the least integrated (deepest on average). The global integration map shows the shallow integration core taking a form of incomplete grid. This grid-like core however does not extend deep into the surrounding areas, leaving most of the peripheral residential areas as rather segregated zones. It clearly shows the main structure of integration lines in which spaces along the MTR Station and commercial Plazas are picked up as the main focus of integration in the area.

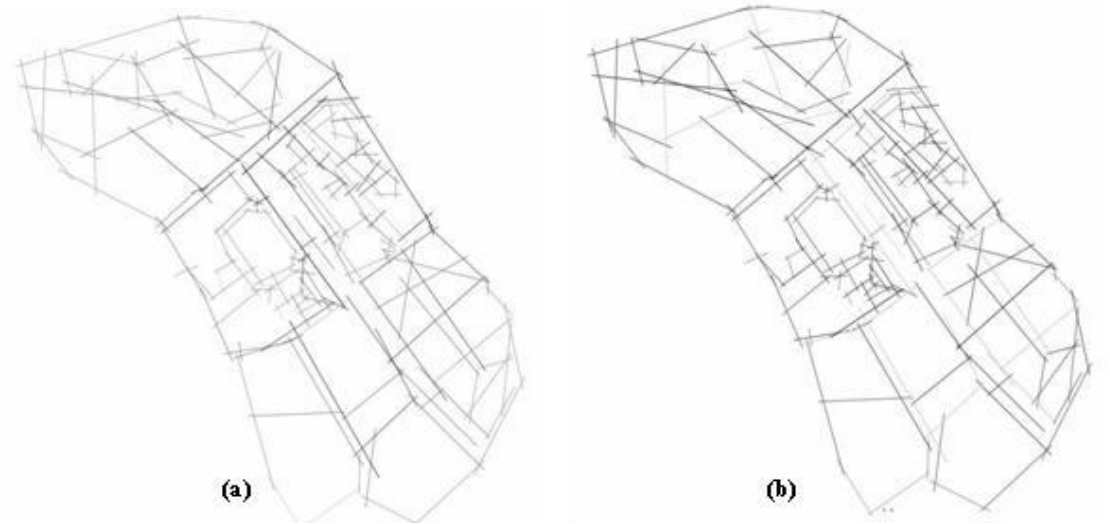

Figure 05: Global integration map of Po Lam (a); and Local integration map of Po Lam at ground level (b).

The local integration map shows the whole system is better integrated compare to the global one where spaces in the public residential estates form the most integrated core. The integration core shifts from the space around MTR Station and commercial Plazas towards the spaces around the public housing estates. It forms a linear "tree" structure extends across the housing estates through number of secondary streets branched out from the "trunk" that passes through the main streets.

The scattergrams in Figure 6(a) plot integration against axial depth at global level in which lines within the study area are shown as small black points. The scatters (Figure 6a) show that Po Lam area has very good accessibility (r^2=0.64). It implies, for the most part it has better visibility and takes only about 3 to 5 steps from the most integrated areas i.e. the MTR Station and the commercial areas. Only the peripheral spaces and some areas in the private housing estates occupy the deepest spaces with lower integration (in the lower part) indicating that at a given depth they are more segregated spaces.

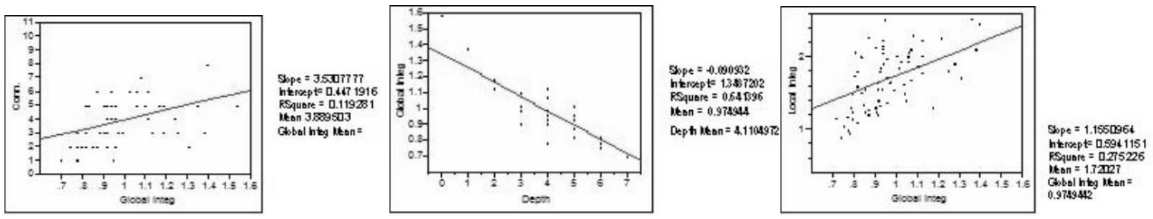

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Figure 6a: Accessibility of Po Lam.
Figure 6b: Intelligibility of Po Lam.
Figure 6c: Local Area Effect.

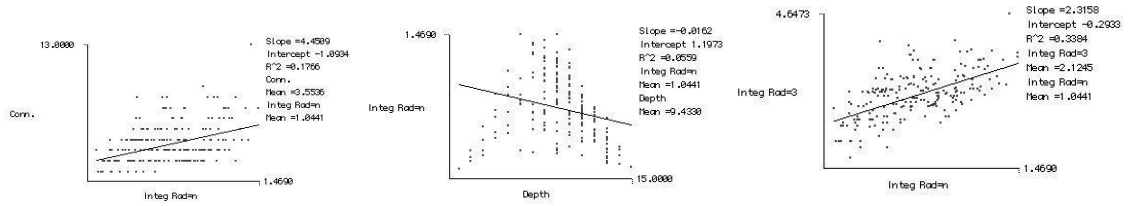

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Figure 7a: Accessibility of Metro City.
Figure 7b: Intelligibility of Metro City.
Figure 7c: Local Area Effect of Metro City.

But scatters in Figure 6(b) shows it is less intelligible (r^2=0.12) due to lack of connectivity of the well integrated spaces. This is because of the concentration of the global integration core around the commercial area which has few direct connections to the cluster of streets embedded in the surrounding housing estates. However figure 6(c) shows a strong relationship between local and global integration (r^2=0.59). Despite low intelligibility, the high degree of coincidence or overlapping between two radii of integration suggests better interfaces among the main streets and branch streets in functional terms.

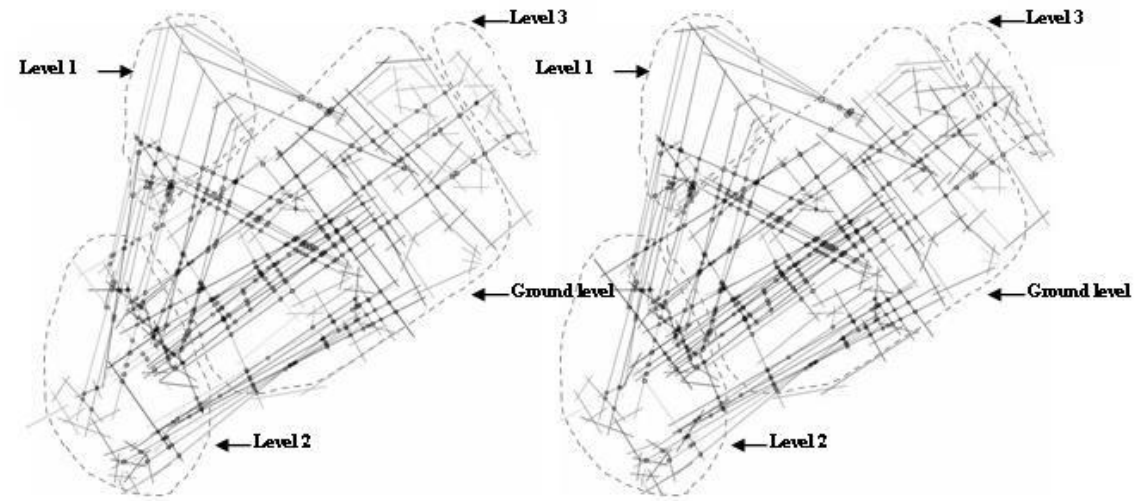

Figure 08: Global integration map of the Metro City (8); and Local integration map of Metro City (b).

Figure 8a and 8b show the global and local axial integration maps of the Metro City where different levels are presented side by side and connected by axial lines that represent the vertical transitional spaces. The global integration map (Figure 8a) clearly shows the main structure of integration in which Mau Yip road and part of Po Fung road at ground level; and at level 2 space connecting the MTR station to Plaza II and the major circulation spine including the atrium space of Plaza II are picked up as the main focus of integration in the area. Level 1 and 3 appear relatively segregated. The system shows a moderate local global correlation. In terms of connectivity, only the major circulation spine of Plaza II at Level Two becomes the most significant one. Regarding control, similar pattern follows.

Apparently it suggests that the composite system that includes all the levels is more integrated globally but a lack of connectivity suggests an unintelligible structure. At local level the integration core shifts to the Yan King road at ground level; and footbridge connecting the MTR Station to Plaza II; and major circulation spine of Plaza II. Locally Level One and Level Two appear to be better integrated. As a whole the complex is found to have better accessibility and intelligibility at local level. Scattergrams in Figure 7(a) plot integration against depth at radius n that shows a poor accessibility. The system also appears to be less intelligible in Figure 7(b). Figure 7(c) shows a weak relationship between the local and global integration. This poor relationship between two radii of integration suggests a broken relationship of interfaces with consequences for the movement economy that leads the movement to a pure origin destination movement pattern (Hillier, 1996, p. 178). Spatial modeling of the whole system that analyzes the multilevel spaces of Metro City together with its surrounding Po Lam area at ground level in one composite axial map shows similar trends as found while analyzed separately.

5.1. Impact of Configuration on Open Space Use

For Ground Level

In Po Lam, for the spaces on ground level, the correlation analysis between the global integration and the density of open space use (Figure 9a) reveals a moderate correlation coefficient (r^2=0.26). From the conventional statistical point of view the correlation (r^2=0.26) appears to be "insignificant", however, with regard to the sub-hypothesis about the key urban design parameters to have strong influence on the way people use the spaces, the apparent low statistical value (r^2=0.26) of correlation between the configurational property alone and density of open space use is considered to be significant. Furthermore, taking the configurational properties alone, findings of this study and other previous studies (Cheung and Penn, 1989; Parvin, et. al., 2006a; Parvin, et. al., 2006b) found statistical values of the correlation coefficients fall within the range of 0.18 to 0.30. Thus the effect of local integration is also found moderately significant with a correlation coefficient of r^2=0.25 (Figure 9b). Correlating with the depth (r^2=0.26) and connectivity (r^2=0.23) it is found that depth has greater effect on the density of users than connectivity. Based on these initial findings for ground level this study partially tested the sub-hypothesis for multiple levels in the following section.

For Multiple Level

The interview findings suggest the significance of the local urban design parameters such as in what level the space is located, i.e. the level variation; and direct accessibility from MTR and from their residence as important factors to choose a particular open space. However, among others, level variation was mentioned as an important factor to opt for an open space to use for their every day community activities. Since the spatial modeling alone does not consider the effects of other urban design parameters on the patterns of space use, in order to include the effect of level variation (most of the interviewees preferred space on the ground level) on open space use the integration value is approximated by dividing it with a value derived for different levels. The value is objectively quantified based on the field observation (1 for ground level; 2 for Level Two; and 4 for Level 1 and Level 3) and attributed to each axial segment in the multilevel complex. The values are set on the basis of knowledge of the occupancy; and preferences of the users (derived from informal interview) regarding the ease of direct connection to the MTR station.

Inclusion of level values with the spatial properties results in a highly significant correlation coefficient (r^2=0.69) (Figure 10a). It implies that the effect of configuration on open space use at multi-level layout becomes stronger when the level variation is taken into consideration. The local integration is found to have even higher effect (r^2=0.81) on the density of space use. Analyzing the correlating between density of users with depth (r^2=0.04) and connectivity (r^2=0.54) it is found that depth of multilevel spaces is not important at all to the users while connectivity is found to have significant impact.

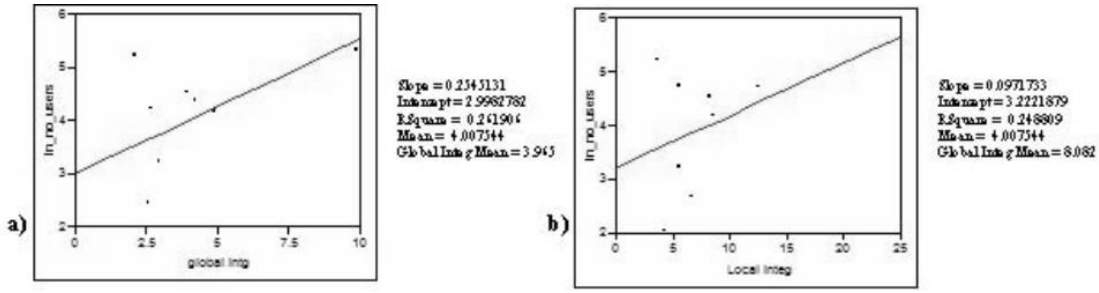

Figure 09: Result of Space Syntax Analysis of Po Lam at Ground Level, global (a); and local (b).

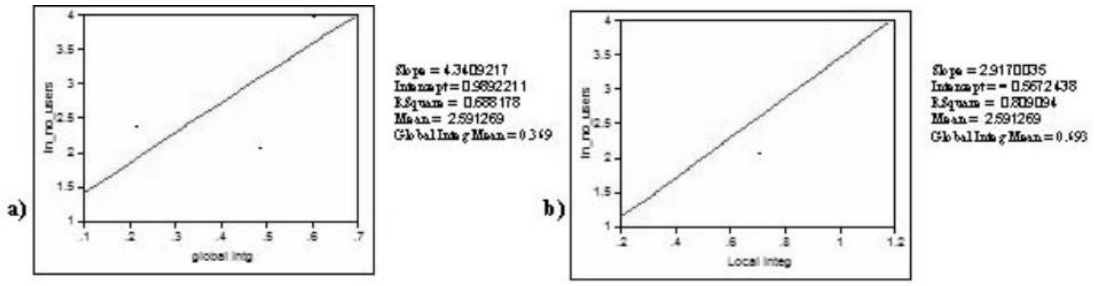

Figure 10: Result of Space Syntax Analysis of Metro City at multilevel, global (a); and local (b).

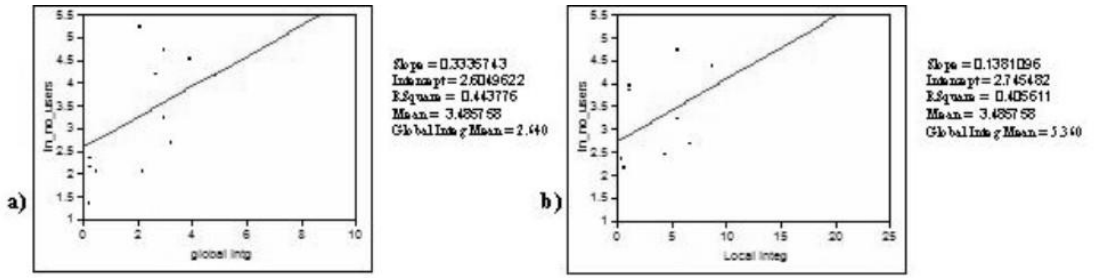

Figure 11: Result of Space Syntax Analysis of Po Lam at multilevel, global (a); and local (b).

For the composite system of Po Lam residential development that includes both open spaces on the ground level and at multilevel, the correlation analysis shows the effects of both global integration (r^2=0.41) (Figure 11a) and local integration (r^2=0.44) are moderately significant. However, local integration is found to have stronger effects than that of global integration. Correlation analysis with depth (r^2=0.35) and connectivity (r^2=0.36) reveals similar trends where connectivity is found to have slightly higher effects on the density of users in the composite system.

From the above findings it is observed that, as a whole, in the composite system, (1) local spatial properties have greater effects on the density of open space use; and (2) spaces on the ground level have more users compare to the spaces on the upper levels. It is particularly evident when the multilevel complex of Metro City is observed. The findings imply two different but interrelated explanations. Firstly, from syntactic point of view, the global spatial properties represent spatial configuration with regard to all the spaces in the system and calculates integration regarding the most integrated global core (here around the MTR Station and commercial Plazas) while local spatial properties include individual constituent parts of the system and calculates integration regarding the immediate or neighboring spaces. Comparing the patterns of open space use and the local integration core it is found that from the most integrated local spaces the axial depth of the open spaces is between one to two steps. Similarly, regarding most obvious local property connectivity, the spaces with better connectivity are found to have higher number of users. Therefore, to explain space use at constituent parts i.e. the local open spaces, local configurational properties appear to be more effective. This proposition is substantiated by the field observation that reveals most of the open spaces, particularly the spaces provided for the individual housing estate or surrounding estates, space users are mostly coming from the surrounding housing estates. Therefore, the more a space is locally integrated the more it is able to attract users from the adjacent housing estate, and similarly the more connections a space has, the more it is able to attract people from immediate surroundings. Secondly, regarding the multilevel distribution of spaces, although most of the spaces are at walking distance, preferences of users are highly biased by the accessibility of a space where level variation is found to have negative influence on the resident users. This is also attributed to the narrow global integration core that covers a few central spaces. Therefore, spaces at upper levels even with higher global integration are found to have few users because of lack of connectivity with the surroundings. Combining these two explanations there emerges new hypothesis that, in high-density residential mixed use development local configurational properties can explain substantial amount of variation in the patterns of community space use.

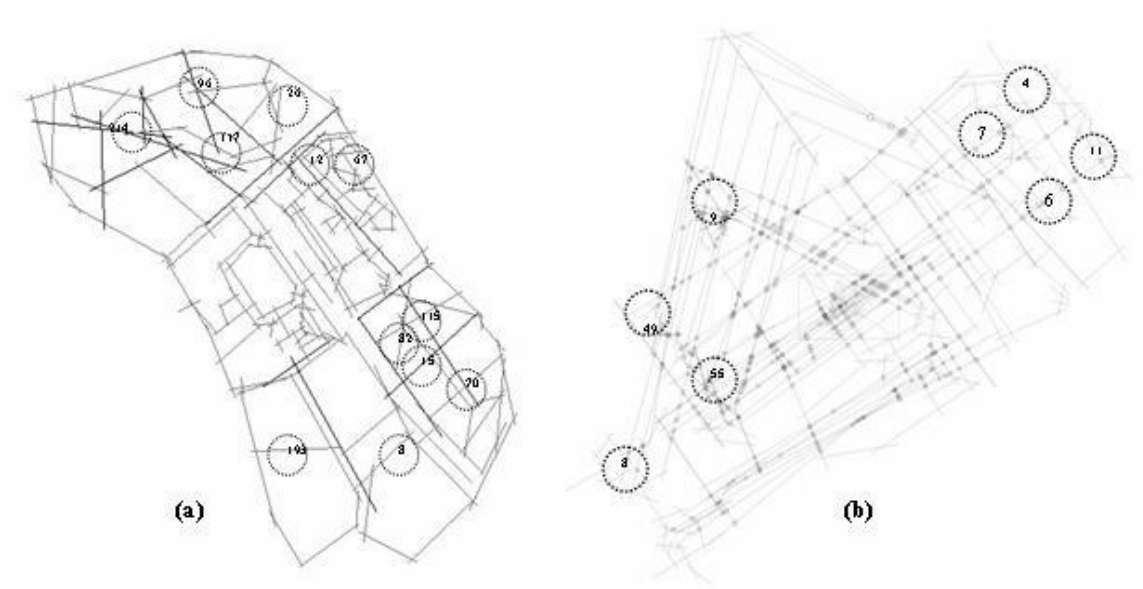

Figure 12: Density of space use on 10% Local Integration core of Po Lam (a); and Density of space use on 10% Local Integration core of Metro City.

In light of this new hypothesis, distribution of user density is plotted against ten percent local integration core for Po Lam and Metro City shown in Figure 12(a) and 12(b) respectively. Figure 12 (a) reveals, out of four spaces with highest number of users three are concentrated on the street spaces covered by the local integration core, while the fourth one is just one step from the core. The most segregated spaces are mostly found with minimum number of users. Similar trend follows in the use patterns of multilevel spaces in Metro City 12 (b). As mentioned earlier, due to the poor connectivity the spaces at upper levels are found with less resident users and more visitors. This might be attributed to the higher concentration of commercial land use in the upper levels. However, notwithstanding the land use variable and level variation, distribution of user density reveals clear influence of spatial configuration particularly in terms of accessibility and intelligibility of the spaces.

6.0. Discussion and Conclusion

The study outcome is twofold; firstly, the case study reported here shows that the configurational analysis offers one possibility to research into dense urban environment whose spatial form would otherwise escape conventional representation. Regarding the use of open spaces on ground level, syntactic modeling alone is found to explain moderate amount of variability, while regarding the use of multilevel spaces, notwithstanding the effects of urban design variable like MTR, land-use or level variation, spatial configuration is found to have significant[iv] impacts on the pattern of open space use. Secondly, regarding the elements of spatial analysis themselves, the study outcome suggests, in analyzing high-density residential configuration local properties are more important. In light of the finding from this study some strategic design guidelines can be drawn towards the optimal use of open spaces in high-density compact built environment. *First*, the location of public open spaces should be on the ground level and connected by pedestrian circulation spaces characterized by well integrated local core, and continuity rather than fragmentation and discontinuity. *Second*, according to the activity patterns, spaces should be laid out in terms of hierarchy with greater emphasis on accessibility than depth. A larger open space well connected to the global integration core can render greater density of stationary users. By contrast, a smaller space linked to the local integration core can render smaller amount of users. *Third*, layout should have a syntactic core that represents more easily accessible open spaces within a system. A centralized core would allow individuals to traverse central spaces in all directions. Thus each constituent open space at different levels will be integrated in a system. *Fourth*, there should be syntactic shallowness in the whole layout to ensure relative accessibility of one space from any other space within the complex and to provide less segregated environment overall. It can be provided by designing continuous street layouts characterized by relative intelligibility throughout instead of disconnected enclosure or cul-de-sacs. *Finally*, and most importantly, continuity of integration should be preserved so as to achieve more vital urban environment by creating better interface between global and local areas. Continuous circulation would allow individual parts to aggregate into a whole without

segregating parts from one another even at various levels. Thus it can tie the vertically distributed land uses and open spaces in a continuous space system.

However, notwithstanding the powerful and independent effect of spatial configuration on use of space (Hillier et al, 1987; 1993; Peponis et al, 1989), important research issues with regard to the unique urban environment of Hong Kong are still there to address. Further research is needed particularly to unveil the multiple interacting effects of the key urban design parameters like the presence of transportation hub, mixture of land-use, vertical transitional space and so on which may have influence on the degree and extent to which spatial configuration can have its effect on the patterns of space use.

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[i] In this study open space implies 'local open space' in Hong Kong's residential developments. According to the Hong Kong Planning Standard and Guidelines, open space is divided into two types: local and district. Local open space is to serve the concentrated population in the immediate vicinity, while district open space is to serve wider areas at district level.

[ii] Liu, e. al. (1999) estimated the average saleable area of private housing is about 15.6m^2, which becomes even reduced in public housing excluding the common area.

[iii] For details of the syntactic measures and mapping techniques refer to Hillier & Hanson, 1984.

[iv] In general variability of use of community spaces in many of these studies is described by a variety of other non-spatial and social factors which are claimed to have significant effects on different patterns of neighboring activities. Owing to the existing knowledge on the higher significance of other social and non-spatial factors, although the correlation coefficients found in this study appear moderate statistically, with regards to the independent effect of spatial configuration on use of space (Hillier et al, 1987; 1993; Peponis et al, 1989) the correlations are considered to be highly significant.

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