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A CONFIGURATION GENERATOR

Housing as a toolkit for spatial exploration by users

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ABSTRACT

Social Logic of Space (1984) showed conceptual house plans of 3x3 room layout that can generate completely different permeability graphs. Hillier and Hanson's point was that a genotype of a building can only be retrieved by looking at its spatial connectedness, not its geometric form. Since then, researchers have successfully verified there are culture-specific housing genotypes in each society. We try to re-think about this archaeological process of genotype retrieval by designing a new housing scheme that will be used as an open genotype test-bed. Based on a concept of 'incremental self-build housing', an apartment unit plan of 2x3 interpretable layout was developed for Malaysian low-income city dwellers. Generating a large number of spatial variations out of a single geometry, it can accommodate a wider range of domestic life styles. 24 examples of different configurations were suggested and tested by space syntax analyses to show how a small number of rooms can generate a huge variety of spatial possibilities. At some point in post-occupancy, it is expected that we will get the idea on what 'actuals' occur amongst all 'possibles' and what dominates while others vanish. By identifying the most socio-culturally adapted plans and decoding the embedded spatial connectedness, it is hoped that we can filter out the modern Malaysian genotype. It is a new way of thinking of a house not as an end product but as a process. Here, finding a genotype does not come from measuring a frozen building form from the past but from continuously looking at its transformation in time - how residents experiment their own way of living to arrive at an optimum solution. In this experiment, the role of architects will be to offer a dwelling toolkit for users to explore configurations that will eventually reveal statistically meaningful genotypes within a given context.

KEYWORDS

Genotype, Incremental housing, Configuration generator, Toolkit.

1. BUILDING GENOTYPE REVISITED

In Social Logic of Space (1984), Hillier and Hanson showed four house plans with identical room layout yet with different access patterns (figure 1). By representing them with justified graphs, they clarified that a same geometric form can accommodate completely different patterns of domestic living. Building on this idea, they made an assumption that if there appears dominantly recurring patterns within a wide variety of possible syntactic configurations, they are culturally embedded patterns of spatial invariants which are shared and transmitted through generations in that society, i.e. genotypes.

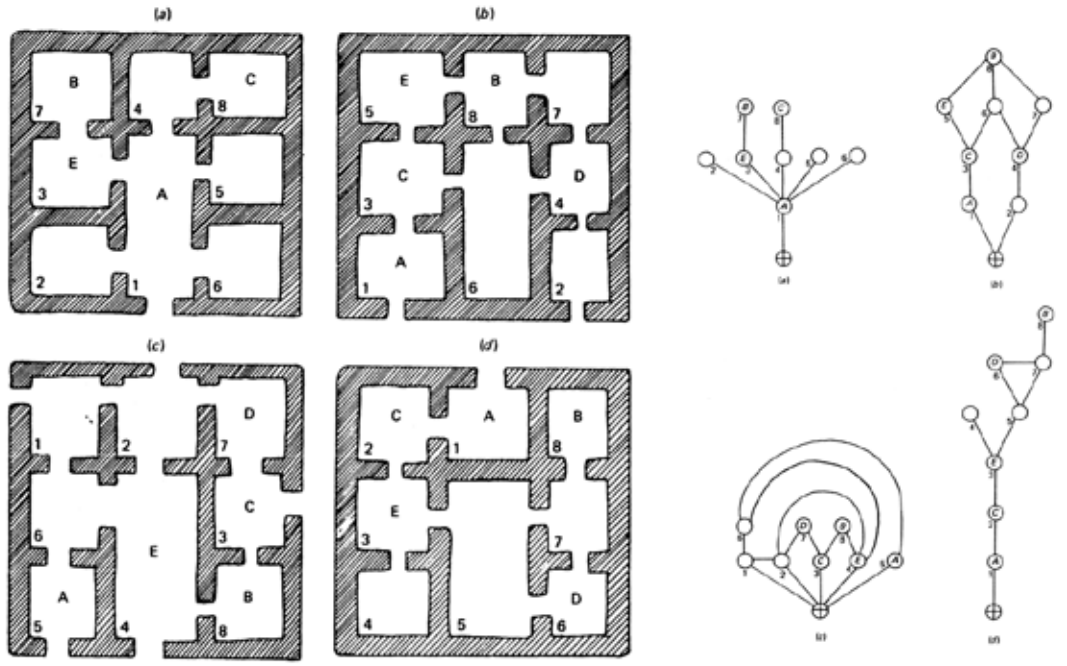

Figure 1 - Four theoretical house plans in Social Logic of Space (Hillier and Hanson, 1984)

These statistically meaningful patterns or deep structures of spatial commonalities can be retrieved by investigating any built systems through syntactic analysis as explained by Hillier:

"As we will see, what we discover through applying these techniques to the analysis of spatial and formal patterns in architecture, wherever they are found and whatever their embodiment in either buildings or urban systems, are invariants in patterns which lie not on the surface of things but which are buried in the nature of configurations themselves. These invariants we can think of as deep structures or genotypes." (Hillier, 2004: 60)

For decades, researchers around the world has adopted this concept of genotypes and analysed vernacular and modern houses to prove there are certain types of permeability patterns that suit to particular way of indigenous behaviour. When a society is settled and maintains its socio-cultural coherency for generations, it is highly probable that there emerge underlying configurations of behavioural patterns materialised and embodied by the spatial structure of its cities and buildings. However, when it is undergoing radical changes, the existing genotypical patterns would be influenced by socio-cultural or political changes as represented by the configurational transformation of yeoman farmhouses in Oxfordshire in English through 17th century (see Hanson, 1998: 56). Henry Glassie (1975) discussed about formal change of folk housing in Middle Virginia and suggested three phases of cultural change. The first phase is

'balance' where the society maintains the established pattern of culture without no serious challenge; the second phase is 'change' by the internal and external impact and it is subdivided into 'disequilibrium – expansion – synthesis'; and the third 'new balance' where things are getting into the new status of equilibrium after the change. When we are lucky to investigate the built forms belonging to the first and third phases, it might be relatively easy to pin down culture-specific patterns of genotypes; but if they belong to the second phase of change, it will not be a simple task to reveal what could be a meaningful spatial manifestation of the social norm of that time. Hillier perfectly pointed out this circumstance and suggested 'generative mode' of spatial configuration:

Where we find strong genotypes, we find them associated with strong rules of behaviour, because the form of the building is already a mapping of that behaviour. But when the social rules decay, or are no longer enforced, then the spatial configuration reverts to the generative mode. (Hillier, 2004: 304)

In Malaysia, through centuries, typical forms of vernacular houses have been evolved to adapt to the regional climate with their own unique spatial layout. This 'balance' has been challenged when the country began to be urbanised in an unprecedented speed after 1970s. As the cities become more populated without enough land to build houses, multi-level collective housing became the most appealing solution for the government and developers. From luxurious condominiums to cheap low-cost housing, empty plots in major cities in Malaysia are now filled with highrise apartment blocks. Without enough time to test its adaptability in the market, this new housing typology was randomly designed and quickly constructed, and as a result, a huge amount of reports have been made by private and public sector that indicate how ill-planned and unsuitable they were to meet the demand of the people. This dissatisfaction is much bigger for the dwellers in the low-income housing which typically has limited floor areas with lower quality of construction standard. To cope with this issue, we have developed an apartment house prototype that will make a completely different approach to the problem. It is an incremental self-build house, of which the basic structural frame is provided first and further fit-outs are implemented later by residents. It is based on 'open building' concept where structural frame and internal infills are intentionally separated to facilitate layout changes by users. With no fixed configuration, this housing scheme encourages dwellers to decide where to allocate doors, partitions and windows within the floor area of 65 square metres. Our intention is to allow people to choose their domestic behavioural patterns and through the process of post-occupancy evaluation, we can indentify statistically meaningful spatial configuration which might be labelled as emerging genotypes in the modern apartment housing that has potential to be regenerated for better satisfaction of living conditions for the low-income population in Malaysia.

If Hillier and Hanson's original approach was 'archaeological' in the sense it emphasises the possibility of genotype retrieval from artefacts of the past, our approach is 'procedural' to acknowledge the fast-changing trend in the market and to embrace the temporality of users' changing preferences in our search for the candidates for modern genotypes.

2. MALAYSIAN CONTEXT

The tropical climate in Malaysia influenced the indigenous house form. Due to the humid monsoon season, the traditional house has developed the timber-frame structure elevated on piles. Malaysian housing culture has gone through a radical change during the last half of the twentieth century. With fast-rising numbers in the indexes of population, industrialisation, urbanisation, and gross domestic product (GDP) per capita, the mainstream housing culture has moved from the traditional floor-sitting culture in a detached house towards modern furniture-based living in a collective housing. As the proportion of urban population has increased from 26.8% in 1970 to 61.8% in 2000, it became a major goal for the Malaysian government and local authorities to build as many affordable houses to cope with a housing shortage problem in cities. The Public Low-Cost Housing Programme (PLCH) from the First Malaysia Plan (1970-75) clearly notes that the programme is 'to improve the quality of life, eradicate poverty

among the low-income group and to resettle the urban squatters' (Mohit, 2010). In urban areas, due to the high land price, both the public and private sectors opted for a higher density type: apartment housing. In particular, for the low-cost housing developments, which should comply with the regulation of 'less than RM 25,000 of unit price', the high-rise would be the only feasible option. The 2010 population and housing census shows that apartment housing occupies 19.9% in the whole country, but when Kuala Lumpur is taken alone, its proportion goes up to 66.6% (Department of Statistics Malaysia, 2010). Those who were accommodated in the apartments were not only from rural areas outside the city but from squatter settlements within the metropolitan area. In any case, adapting their family life to the new multi-storey dwelling was a significant challenge for them, disrupting their existing routines. It has been reported that the main issues of dissatisfaction in low-cost highrise apartments are cleanliness, community breakdown by racial conflict, small unit size, inadequate facilities, crime and social ills, and inability to allow home-based business (Aziz, 2012). Amongst these, from the designers' perspective, we are more interested in two particular issues: small unit size and inability to allow home-based business. The new housing is smaller than their former squatter homes and thus typically called 'pigeon holes' and 'chicken coops' by dwellers (Ali, 1998; Yeoh, 2001; Bunnell, 2002; Suffian, 2009). For low income families, home is not only for living but needs to be used to generate income by allowing proper spaces for home-based enterprises for those who want to work but cannot leave their homes (Aziz, 2012).

In developing the low-income housing, we examined the way Malay people live in their traditional setting. Although life styles have changed, there are things that still have significance in the modern life style. First, there is a unique way of treating the level of the floor in Malay houses. Traditionally, the front living area was elevated by taller stilts while the cooking and dining area was positioned lower, and this practice continues even in modern vernacular houses (Figure 2).

Figure 2 - Modern vernacular Malay house in Kuala Lumpur (source: author)

It is based on the distinction between the served space which is formal and clean and the serving space which is dirty and informal (Seo, 2015). In principle, any space that belongs to the former is elevated while those to the latter are lowered. Thus even in modern apartment houses, we can find that bedrooms, living rooms and formal dining rooms are typically positioned higher while toilets, bathrooms, kitchens and balconies are lowered at least a few centimeters in their level of the floor. Second, along with the distinction between the formal front and the informal back, traditional houses had two entrance doors as in figure 2. In their hierarchical spatial setting, it could have been more effective to have two separate entrances rather than one. Although this has almost disappeared in modern apartments, many high-end flats still provide two entrance doors; one for residents and the other for servants. Third, Traditional Malay houses were not

constructed all at the same time. Once you build the main structure of living house, it was gradually growing by adding additional spaces. So basically the housing has the characteristics of incremental growth following people's demand and family sizes. In developing our design scheme, these three indigenous traits were examined and applied. As the main complaints of apartment residents are attributed to the sudden and radical change in domestic environment, it was considered to implant these elements to the new home design.

3. OPEN BUILDING AND INCREMENTAL CONSTRUCTION

The issue of providing spatial flexibility has at least a half-century long history. It has been constantly discussed throughout the second half of the twentieth century. On a small scale, it could be applied to a single house level by providing movable partitions as in Schröder house and on a bigger scale to a mass construction level by utilizing the frame/infill concept as represented by SAR method. When we use the term 'open building' however, it includes more comprehensive meanings that surround the issue of flexibility. It means that the process of construction permits at many different levels a possibility of architectural intervention or participation of users or experts. Standardized multi-unit housing typically has a limit in allowing a wide spectrum of lives due to its small number of unit types, but open building can offer more configurational freedom to residents. Our strategy aims to increase the resilience to cope with future transformation of domestic layout but without sacrificing too much of efficiency by modularising the demountable components.

The most critical problem of low-income housing in Malaysia is its affordability for poorer people. Although the ceiling price has been set by the government, many low income families cannot secure the amount of money to buy it. For the government and local authority, it is also difficult to fund the low income housing more than they do now. We aim to solve this social problem by adding the time dimension to open building construction with the name 'Incremental SI (structure-infill) housing. It is the housing supply system where structure is built first with reduced amount of budget, and infill is added later in an increment manner. Unlike normal open building construction, this allows the bare structure of the first phase construction to be utilised as a basic shelter, and in the following phases, those who moved in can participate in the incremental construction of their homes. By splitting the total construction into smaller manageable volumes, it is expected that the local authority can initiate the development with less risk and financial burden within a limited timeframe. As the nature of house is 'incremental', those who moved in can also have flexibility of handling and managing their construction plan, based on their own financial status.

The concept of incremental construction is not new. In many developing and developed countries, this kind of participatory housing development has been experimented. There are expected gains by implementing incremental housing. First, by adopting support approach rather than supply approach, the quantity of low-income dwellings can be increased. Second, government can share the cost of development with households. Third, the managemental communication between authorities, communities and participants can be made more efficient. Fourth, it can reduce uncontrolled, low density urban sprawl and encourage high density, compact development. Fifth, through the engagement of households and community leaders, a good governance can be established. Sixth, local communities are strengthened, job opportunities are created, and household incomes are increased; curing social conflict and anti-social behavior (Turner and Wakely, 2015). In spite of these potential benefits, many attempts have been failed due to the malfunction or dissatisfaction in delivery, finance, location, and maintenance.

In our research, we decided to put the issues of the delivery and finances aside because our goal was to suggest a new design solution. We targeted the area of urban squatters as potential sites and investigated a possible solution that is more livable and affordable and also adaptable to poorer people's needs. In the viewpoint of building as an asset, it has been observed that the typical reason of failure in the development of incremental housing is the deterioration of built environment by using varying non-standard materials by non-professional workers (Hassan

et al, 2015). Thus we attempted to provide certain level of building quality by obligating the use of standard component, i.e. windows, partitions and doors. In the following section, it is suggested how we conceptualized the design approach and how we solved the problem of incremental construction, flexibility, sustainability, and quality control.9

4. DESIGN CONCEPT AND BASIC PLANS

Looking at the old precedents of housing around the world, one can find that the rooms are generally multi-functional, and activities in a room can be transferred to others without much conflict. This can be best exemplified by Palladian villas where each room has plural number of access openings leading to other rooms, not to a mediating space for movement, i.e. corridor or a central hall. When a row of rooms are directly connected sequentially like this, it makes a spatial configuration known as a 'room-to-room enfilade'. It is suggested here that this enfilade is an effective spatial device that can generate an enhanced degree of flexibility in space use as in Palladian villas. When two rooms of similar sizes are placed next to each other and directly accessed, they could support each other by accommodating similar activities when needed. When three rooms of comparable sizes are directly attached and accessed in a row, the room in the middle can support the two in each end. In this case, due to its innate ambiguity, the middle room can provide a higher degree of adaptability. The central room can either support or interchange activities with other rooms, or act merely as a buffering zone in-between. This is how an enfilade of rooms operates for functional flexibility. If the room-to-room enfilade makes a ring-shaped spatial structure that can allow an unending circular movement, then the freedom of movement and activity allocation are maximized as in Palladian villas. In the modern house, however, the ring structure is hard to be realised. This is because the modern house, especially the apartment houses are becoming a compact unit of functional container where the movement optimisation and space efficiency are encouraged by making the whole configuration linked by central halls or corridors. Another reason is the ever growing number of furniture that requires more wall surfaces rather than openings. In the typical configuration of the modern apartment unit, each functional space becomes a dead end, accessed from the central corridor or hall, allowing no interchangeability of functions. By actively providing access links to neighbouring rooms, the ring structure can be regained to induce polyvalency of function.

With the spatial strategy described above, a multi-storey walk-up apartment housing was planned (figure 3). The Incremental Housing adopted a slab block shape for its building form where units are linearly added side by side. For vertical access, communal staircases are inserted between two flat units at each floor. Reinforced concrete structure makes the basic skeleton of the whole building and each unit has six rooms that are spatially open to each other. The unit is entered by two entrances that are positioned on different levels of landing, where the second entrance is 900mm higher than the first. The unit floor plan has three horizontal zones and three vertical zones. Vertically, those rooms in the deepest side is named 'shelter zone' because it will be the initial living area when residents first move in. At the first phase of construction, the very basic fit-out will be provided in this zone and other zones will be left as bare skeleton for future growth. The second vertical zone is 'incremental zone' which is gradually filled in or fit-out in the later stages. Horizontally, the top row is 'wet zone' which has -200mm level of floor from the main living space. This is the zone to accommodate bathrooms, toilets, and other service spaces such as balconies for wet or dirty activities. The middle row is the 'lower zone'(±0). It is named so in relation to the 'upper zone' which is +900mm higher. This upper zone and lower zone split the living area into two just as in the traditional Malay house where formal living zone is typically elevated higher than the informal dining and cooking area. It is this reason that two entrances are positioned on different levels to provide direct access to the lower and upper zone.

Figure 3 - Concept and Zoning of Incremental Housing (copyright: Kyung W Seo, 2016)

When the first phase construction is completed, the shelter zone will be fit-out by using the standardised components in figure 4. These components are basically variations from the same sized module of 1,000 x 2,700mm and functions for windows, doors and partitions. Having the same size and joint details, these three components can be attached and detached from their positions and interchangeable. This will allow the change of links to other rooms and therefore convert the overall configuration easily even after the occupation. Starting from the basic house, the unit can grow to occupy the whole floor to become a fully grown house, or depending on residents needs, some rooms can be left as exterior space for other functions such as home-based enterprises or a large balcony space. During the process of this expansion, more components would be required to fill in additional openings. The additional cost for more components and other finishing materials can be earned while users are living in the basic house and spent when additions are needed. Moreover, there is a potential of the local community's involvement in manufacturing the whole or parts of the component, if we consider the low-tech design of the component, to generate their own income to meet the incremental construction cost. Figure 5 shows the basic house on the left side and the fully-grown house on the right. By changing the opening and closing of the access pattern, a large number of unit variations can be made. Since the house has two entrance doors, it is even possible to split the house into two smaller houses of which are inter-connected or completely separated.

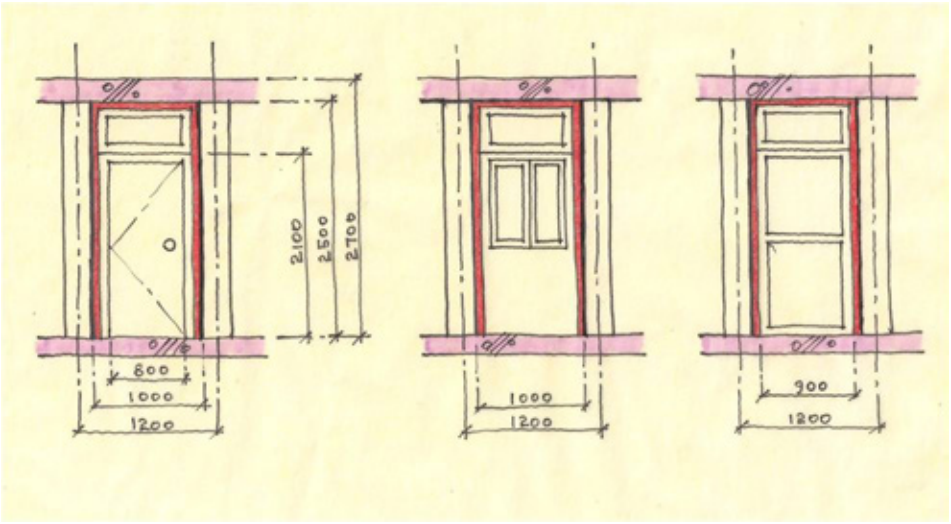

Figure 4 - Three basic components with the same module (copyright: Kyung W Seo, 2016)

Figure 5 - The Basic House and the Fully grown House (copyright: Kyung W Seo, 2016)

5. VARIATIONS AND SYNTACTIC ANALYSIS

The base frame of the incremental housing is made of reinforced concrete which is a most common practice in Malaysia. Before it gets filled in by brick masonry and components to set up internal room divisions, the arrangement of six rooms are open to all adjacent rooms like Palladian villas. With this initial condition of open structural frame, the plan enables maximum permeability. The justified format of graph representation will make it easier to identify its embedded spatial connectedness (left in figure 6). The alphabet label in each node came from figure 3. The graph has three small rings but counting all nested ones in it, there are a total of six small and large rings in the configuration. Having multiple rings, it has a potential to allow a variety of possible layout by closing and opening the accessibility. Theoretically, the lowest depth will be 3 when all openings are maintained open while the deepest depth is 6 when all rooms are linearly connected as in figure 6.

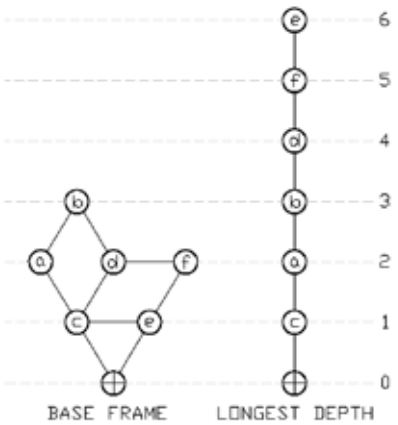

Figure 6 - J-graphs for the base frame (left) and its theoretical longest configuration (right)

This base frame is an initial condition of the skeleton of the house. Having maximum configurational freedom, users will experiment and choose their own solution that fits to their life style. With enough sample size of housing units, this can be a real-time process of finding new spatial patterns embedded in their invention of layout of which the most frequently-used ones can be candidates for 'modern genotypes'. To find out how variously the basic frame can be developed into different solutions, we simulated some representative types of layouts (figure 7).

Figure 7 - Examples of possible variations from the base frame (copyright: Kyung W Seo, 2016)

The variations are not exhaustive but show a small number of possible solutions. The first several variations have smaller houses yet with open yard spaces to satisfy low-income people's needs to raise household stocks or to run home-based businesses. Moving towards later versions of variations, the base frame is gradually filled in to become fully grown houses packed with functional rooms. It is recognisable that variant 01 and 24 are actually the two representative plans in figure 5, the former as a basic house and the latter a fully-grown house. They are perhaps positioned in two extreme ends in the whole spectrum of possible variations. Now some notable plans are converted to j-graph format to further investigate spatial properties (figure 8).

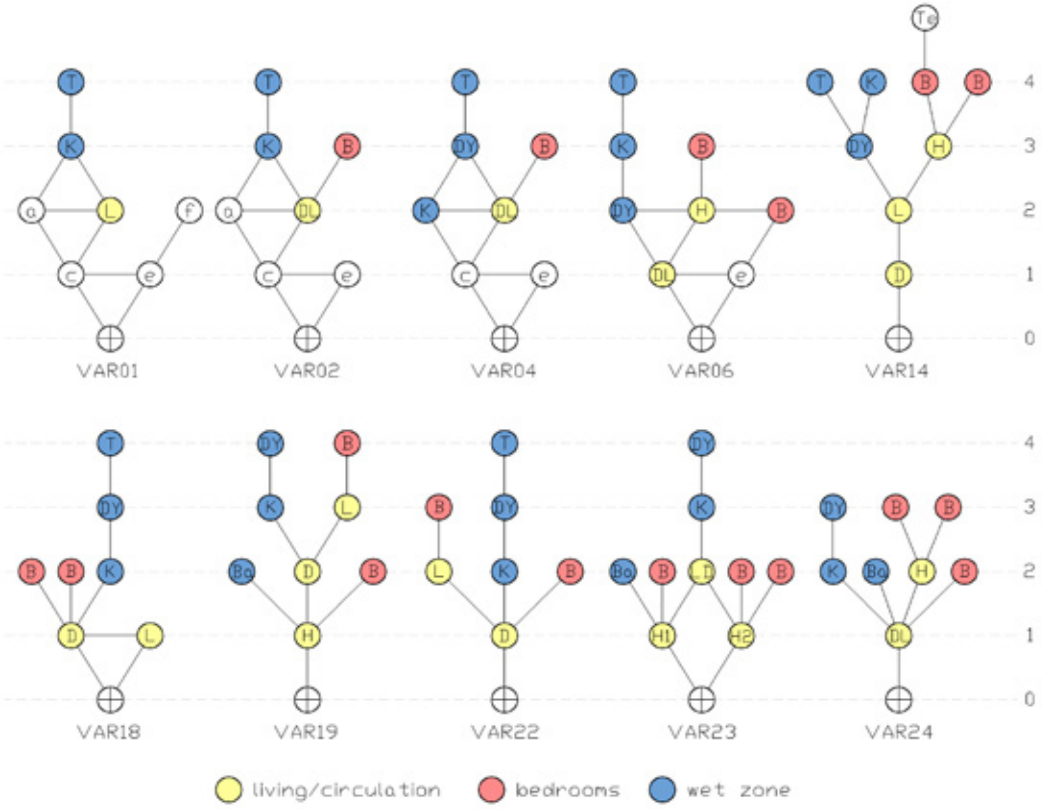

Figure 8 - Examples of possible variations from the base frame (copyright: Kyung W Seo, 2016)

It is found that graph patterns do not exhibit similar distribution at all. Variant 01, 02, 04 and 06 have un-enclosed yard spaces with multiple rings but this does not seem to influence the overall depth of the system. Most of the graphs have depths of 4 which is between the theoretical minimum and maximum of 3 and 6. With many graphs sharing a branching-out pattern, variant 14 has the deepest structure with the terrace at depth 5 while variant 24 has shallower structure. This is a small amount of sample plans but still shows the power of an open plan, enabling a wide variety of configurational possibilities. When similar functions are colour coded, there emerges a strong tendency of clustering. The yellow indicates living and circulation spaces that are unexceptionally located adjacent to the exterior or entrances and make strong connection with other yellow spaces; thus always exist in a single cluster. The blue indicates wet spaces, i.e. bathroom, toilet, kitchen and drying yard which is the typical semi-open utility room in Malaysia for washing machine and drying laundry. Due to the zoning concept of the base frame, these wet spaces are naturally clustered in the wet zone on one end of the floor plan, and as a result, they tend to make a cluster or at least locate themselves at the end of branches of the graph. Finally, the red indicates bedrooms. As expected, they are all positioned at the end of branches as separate islands. Overall, it can be said that the configuration of this open plan is decided by

locating living and circulation spaces together as a single cluster at the lowest part of the graph; followed by wet spaces at deeper levels; and finally distributing individual cells of bedrooms at the end of appropriate branches. It is visually clear that the living and circulation spaces are in the most integrated positions in the house while wet spaces the most segregated positions; and bedrooms in varying positions yet as separate cells. Obviously, the base frame of the house seems to have some internal configurational restrictions, generating repeating patterns of clustering and distribution of functional rooms. However, it is striking at the same time that this simple geometry of 2x3 room layout has such a potential to generate uncountable number of different types of floor plans. Undoubtedly, this unit variations out of a single base frame is possible due to the open plan with room-to-room enfilade and rings that are two essential spatial devices for the configurational freedom as discussed in section 4.

6. CONCLUSION: HOUSING AS A TOOLKIT FOR MASS CUSTOMISATION

We have targeted urban squatter area to apply our design solution. It is the area stigmatised as an urban ill and the government and local authorities want to remove and build new high-rise apartments. It has been pointed out by many researches that apartments are not conforming to the needs of low-income people and creating other problems for the city. We saw the most critical problem of the mass housing from the design aspects that do not fit to the local domestic behaviors and suggested a new solution to it. The design intention of the incremental housing is to provide a base frame of dwelling that reflects Malaysian context, yet allow users' individual preferences. Inherited with the vernacular wisdom of level-distinction, two entrances and yards, and adapting them to the modern concept of open building for the interchangeability of activities and configurational freedom, the incremental housing can be an appropriate solution for those who need affordable yet livable homes. Moreover, the incremental housing actively utilises the sustainable tradition of vernacular Malay housing which transforms and grows in time in relation to the family size and needs. This is a time-based thinking that regards the house not as a frozen mould to regulate domestic behavior but as an open field for endless spatial exploration. Eventually, this will lead us to question what genotypes really mean in the future of architecture. Architects' role then will be to provide a toolkit by which users can continue to exercise new way of living and unconsciously engender statistically meaningful spatial structures in their collective efforts. A house in this way will become a configuration generator.

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REFERENCES

Aziz, Faziawati Abdul (2012), The Investigation of the Implication of Squatter Relocations in High-Risk Neighbourhoods in Malaysia, PhD Thesis, Newcastle University, UK.

Department of Statistics Malaysia (2010) *Population and housing census 2010: Characteristics of Living Quarters*, Kuala Lumpur: Department of Statistics Malaysia.

Glassie, H (1975), *Folk Housing in Middle Virginia*, University of Tennessee Press, Knoxville, USA.

Hanson, J (1998), *Decoding Homes and Houses*, Cambridge University Press, Cambridge, UK.

Hassan, Abbas M. (2015), Smart Buildings as an Approach to Affordable Housing: Assessment of Formal Housing, in *Proceedings of APNHR Conference*, Gwangju, Korea.

Hillier, B and Hanson, J (1986) *Social Logic of Space*, Cambridge University Press, Cambridge, UK.

Hillier, B (2004), Space is the Machine, Cambridge University Press, Cambridge, UK.

Mohit, M. A., M. Ibrahim, Y. R. Rashid (2010), "Assessment of residential satisfaction in newly designed public low-cost housing in Kuala Lumpur, Malaysia". *Habitat International*, 34:18-27

Seo, Kyung Wook (2015), Making a Home: Architectural Features, in *Routledge Handbook of Families in Asia*, ed. Stella R. Quah, Routledge, London.

Seo, Kyung Wook (2016), New Direction for Low Cost housing in Malaysia, in *Final Report: Incremental SI (structure-infill) Housing for Low-income Population in Malaysia*, ed. Kyung Wook Seo and Sharifah S. S. Madzar, unpublished research report submitted to British Council, Northumbria University, UK.

Turner, John FC and Patrick Wakely (2015), Fifty Years of the Community-Led Incremental Development, in *Ground Rules for Humanitarian Design*, ed. Alice Min Soo Chun and Irene E Brisson, John Wiley & Sons Ltd, UK.