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Relocating home activities: spatial experiments in Malaysian apartment houses to accommodate the vernacular lifestyle

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ABSTRACT

To cope with the fast urbanisation and population growth, the public and private sector housing developments in Kuala Lumpur have prioritised the high-rise apartment building. After decades' massive development, this housing type became the most dominant dwelling form in the city. For centuries, the traditional Malay house has evolved to suit to the vernacular lifestyle, but now the urban life mandates that people adapt themselves to this alien concrete house. This paper investigated the hidden cultural link between these two seemingly different house forms. Using graph-theoretic methods, we traced how old domestic activities were transferred to the modern housing and revealed how the old spatial order of front/back and high/low distinctions could be re-configured inside the high-rise apartment housing in a creative way by Malaysian architects. There have been frictions and compromises between the past and present, but the outcomes of this research clearly indicate that there exists a cultural DNA of Malay housing that guides the whole process of housing evolution.

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Traditional Malay houses; apartment housing; spatial orders; gender roles; cultural DNA

1. Introduction

In many Asian countries, an unprecedented growth of urban population has occurred in the second half of the 20th century. Along with the explosive economic growth, more and more labour forces surged to major cities, and as a consequence, there was a high demand for housing. For these countries, housing construction has been seen as an effective means of the development-oriented economy (Doling and Ronald 2014). In Malaysia, the urbanisation rate has been growing fast – from 26.8% in 1970 to 76% in 2018 (UN 2019). As a result, the housing stock has grown dramatically in major cities, and in the metropolitan area of Kuala Lumpur, the high-rise apartment housing became the most dominant dwelling type to meet the escalating demand. Adapting the traditional family life to the new modern dwelling caused a significant challenge, disrupting their inherited everyday routines, especially for Malay people who migrated from rural villages called a campong.

This paper aims to illuminate how the spatial configuration of the Malaysian apartments have gone through the trial and error process in the second half of the 20th century to reach a possible solution to accommodate inherent Malay domestic culture. To achieve this, three objectives were further defined to enable a logical approach to the main research question from different angles. First, understanding the change in domestic culture through the process of house transformation from the traditional house to the modern vernacular house, and then on to the apartment housing. Second, mapping the location of domestic activities in the traditional house and tracing the process of their re-distribution in the following phases of house transformation. Third, statistical analysis of apartment house plans to filter out the most common spatial properties from their layout patterns by using a graph-theoretic method. By combining the findings from these three analytical approaches, it was possible to gain a comprehensive understanding of the transformation of Malay houses and their changing culture.

2. Background

2.1. Traditional living in a campong and its environment

A campong is the most common type of settlement across Malaysia, comprised of many Malay houses and their compounds. Being a close-knit society, each house is lived by a multi-generational family – grandparents, parents and children – living under one roof (Hashim, Ali, and Samah 2009). As the traditional Malay house is regarded as a unit of a larger community in a village (Mursib and Mohamad 1998), it belongs to a lot of land shared by other houses owned by close kin (Ibrahim et al. 2020). The spatial design of a campong naturally grows in relation to its natural

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environment, and commonly its houses were located nearby a transportation route, such as a river (Raja Bahrin 1988; Ibrahim et al. 2020). In reference to the Malay socio-cultural values, the compound of the traditional Malay house usually consists of courtyards and spaces in between individual houses to serve for children's playground, gatherings and communal activities such as wedding and other celebrations (Ibrahim et al. 2020). The surrounding landscape accommodate various natural settings and open spaces for villagers such as a kitchen garden at the backyard and a livestock farmland (Ani, Mohmed, and Rahman 2012). The orientation of the traditional Malay house refers to *Tajul Muluk*, a set of written rules (Al-Ahmadi 2000). It regulates that its front is facing Mecca, the holy city of Islam, and because this requires the alignment of the linear form of the house to the East-West direction, it also helped lowering the solar gain during the daytime (Ibrahim et al. 2020; Yuan 1987). Besides religion, the Malay's customary laws also dictate the positioning of the traditional Malay house which include that the house of the younger must not be in the front of those belonging to older relatives (Ibrahim et al. 2020). The socio-cultural values of the Malays also include warm hospitality as they frequently entertain guests during social or religious events while maintaining separation between male and female (Ani, Mohmed, and Rahman 2012). Thus, the domains of men are at the front part of the house while those for women at the back portion of the house (Hosseini et al. 2014).

2.2. Migration to urban areas and the change in the family structure and values

By introducing the National Economic Policy (NEP) in 1971, the government encouraged Malays to migrate to urban areas to solve "economic, ethnic and regional imbalances" (Hashim and Rahim 2010). As a result, the Malays formed the majority (68.3%) of the urban migrants (Malaysia 1979). Urbanisation and migration greatly affected their housing environment and lifestyle – from the kinship-based kampong living to the compact urban living in the modern collective housing which is shared with unknown neighbours. This also presented further threats to the traditional Malay extended family structure, subsequently transforming it into a nuclear family structure where a married couple becomes the self-sufficient unit of a family (Kling 1995). The national statistics clearly show this trend of a decreasing number of average household size and its greater impact on Metropolitan Kuala Lumpur region which is the biggest urban area in the country. While the average household size changed from 5.22 in 1980 to 4.31 in 2010 across the country, that of the metropolitan KL changed from 4.87 to 3.72 (Department of Statistics Malaysia 2010).

Adapting to the new typology of housing which mandates living with previously unknown neighbours by sharing walls, cultural values and privacy concept amongst Malays has been changed too. With the disappearance of the old designated guest receiving space, combined with the lack of clear division between male and female zones, the familial privacy and gender separation from neighbours and visitors had to be compromised in the new urban housing (Hashim and Rahim 2010; Mohamad Tajuddin 2003; Hashim, Ali, and Samah 2009). At the same time, as women's participation in the labour force has significantly increased (from 15% in the 1950s to 47% in 1995), the domestic responsibilities such as cooking, cleaning and laundry had to be supported more by men (see Hirschman 2016). These conditions discussed above, i.e. the nuclear family structure; the disappearance of gust receiving space; the compact urban dwelling that has no clear gender zoning; and women's active participation in the labour force must have all influenced the more gender-neutral roles of both men and women in the modern homes.

3. Transformation of the Malay house

3.1. Traditional Malay house

The traditional houses in Malaysia can be defined as a timber-framed structure on stilts that has evolved to adapt to the tropical climate (Mursib and Mohamad 1998). To keep the structure undamaged from dampness, houses are elevated from the ground using timber posts (Figure 1). In the hot and humid climate, this raised position helps ventilation for human comfort allowing air flow under it (Crouch and Johnson 2001). The space underneath is also used for storage or breeding livestock. Before going up to the main floor via a staircase, people leave their shoes on the stone slab on the ground and wash their feet. The interior of the house consists of a sequence of spaces, from the public male area at the front to the private female area at the back (Mursib and Mohamad 1998).

As illustrated in Figure 2, the *anjung* and *serambi* are public spaces; the former is the covered porch where residents rest or chat with visitors, and the latter is a formal reception area for male guests. Passing the front male zone, one encounters the main living area, the *rumah ibu* where family members do all kinds of everyday activities including praying, sleeping, studying and other housekeeping works. Through a passageway, called the *selang*, it is connected to the female zone, the *dapur*, at the back where women gather and cook. Simply put, the whole domestic configuration can be categorised into three zones, i.e., formal reception (anjung and serambi), private living (rumah ibu), and female cooking (dapur), following a linear sequence that is linked to the yard by the front and back entrances (Crouch and Johnson

Figure 1. Traditional Malay house, 2016, photograph. Source: Author.

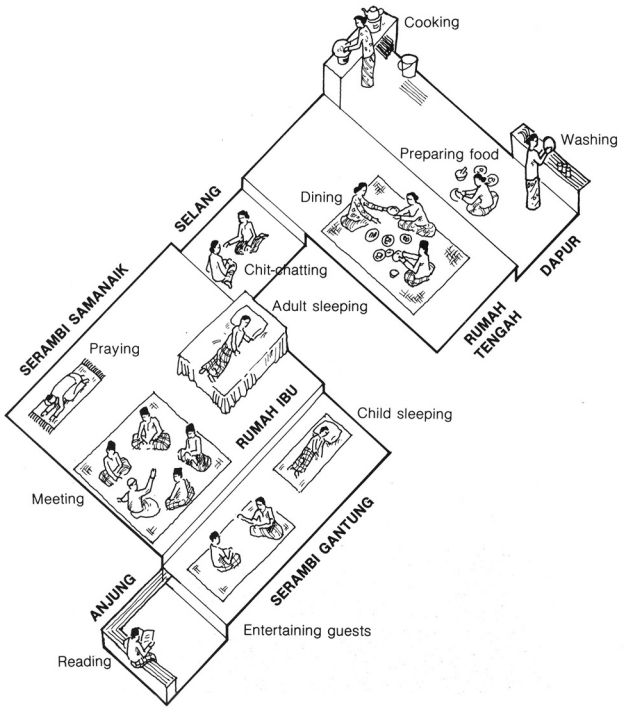

Figure 2. Interior space of a traditional Malay house, graphic, Source: Yuan 1987, 36.

2001). What is remarkable is that the spatial organisation of the interior is based on an "open sequence" that is experienced by the change in volume or floor levels rather than by partitions (Yuan 2001).

3.2. Modern vernacular house

During the 20th century, many modern vernacular houses were built, and existing vernacular houses underwent modernisation (Lee and Lau 1998). Increasingly, these houses utilised modern materials such as concrete, zinc, and glasses and their formal language and spatial organisation became simpler (Figure 3). The house front typically has a concrete staircase and, depending on the owner's intention, it could be purely functional or designed to accommodate the anjung for people to sit and chat. Entering the house, there appears a living area that acts as the serambi and the rumah ibu. Many variations can be made; some houses integrated them but others split them by screens or partitions. Passing through the selang, one steps down to arrive at the dapur which is now dominantly finished with a concrete floor at the ground level. Thus, the level distinction between the high rumah ibu and the low dapur is maintained in the modern way. The dapur is usually furnished with a dining table, and a toilet and a washing room are often adjacent to it. The modern vernacular house has an important meaning in the housing evolution in Malaysia in that the essence of traditional spatial properties was maintained during the turbulent time of urbanisation and

Figure 3. Modern vernacular house, 2012, photograph and drawing. Source: Author.

modernisation (Ju, Omar, and Ko 2012). It suggested a modernised way of structuring Malay domestic living so that the following generations of collective housing, i.e., the terraced houses, semi-detached houses, and apartment houses could find their reference from it.

3.3. Apartment housing

According to the 2018 UN survey, Malaysia is ranked fifth in Asia in urban population rate (76%), excluding small countries with urban population less than 10 million (Nations 2019). Due to the radical increase in housing demand and scarcity in usable land inside major cities, apartment housing has become an unavoidable choice. The proportion of apartment housing in Malaysia was 19.9% in 2010 but Kuala Lumpur taken alone, it goes up to 66.6% (Department of Statistics Malaysia 2010). The history of Apartment housing in Malaysia has started with Suleiman Court development in 1958, followed by Razak Mansion flats (1962; Figure 4) and Pekeliling flats (1964), all built in Kuala Lumpur as low-cost affordable housing.

These early flats had a minimum number of basic spaces for living: an integrated living cum dining room, a kitchen, a bathroom, and one or two bedrooms. Due to their small unit size, coupled with the low budget, it was difficult to think about the way to consider culturally appropriate layouts to satisfy the residents.

From the 1980s, there was a construction boom for the middle-class apartment housing which actively experimented possible ways to mould Malay vernacular living in its high-rise form (Figure 5).

Although its design approach is completely different from those of the traditional and modern vernacular houses, many efforts have been made to overcome formal constraints. To provide a culturally appropriate living condition, unique spatial features were adopted. For example, it was typical that air-wells and pocket spaces are inserted on the periphery of each unit, making the outline of the building block more complicated. Air-wells are vertical air tunnels and pocket spaces are deep cut-outs on the exterior façade that allow maximum exposure to the open air for ventilation and cooling. These vertical voids are unique design features in Malaysian apartment housing that entail a wider range of layout variations. Since air-wells are positioned at the internal side of the building, they tend to be linked with service spaces such as the drying yard, the kitchen, and the bathroom on the communal corridor side. Owing to these vertical voids, the unit plan could develop deeper and more intricate. As in Figure 5, having two symmetrical rows of units around the axis of the central corridor, the typical structure of the high-rise apartment housing had no choice but abandoned the traditional idea of facing the west towards the Mecca. The orientation of each unit, therefore, was decided by the overall layout of building blocks within the given site in a way to maximise the number of buildings and their gross floor area.

4. Methods

4.1. Diagrammatic method to analyse space-activity interaction

The transformation of Malay housing form discussed so far, from the traditional house to the modern apartment housing, looks radical. There seems to be no formal connection between the two. What has been changed is not only the shape. Some spaces like the yard have disappeared and some new spaces emerged. Those multi-functional spaces in the old house have been converted into various functional spaces with new modern names. Thus, to precisely measure the socio-cultural change that might have happened rather gradually, the formal analysis of comparing the two heterogeneous housing form would be too limiting and superficial. To deal with this problem, we used the conceptual frame of "space-activity interaction" in the domestic space, borrowed from

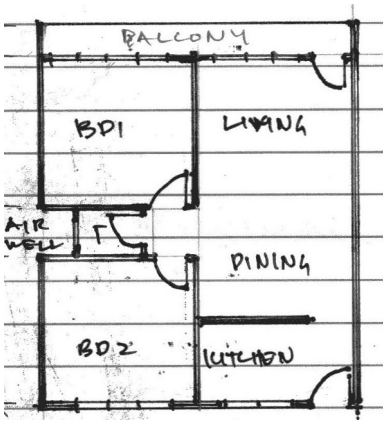

Figure 4. Razak mansion flat, 1962, sketch. Source: Author.

Rapoport (1976, 1990). He suggested how the study of culture can be related to the built environment. Since culture and built form are different in scale, in that the former is much broader in scope while the latter a subset, there should be a sequence where culture is gradually reduced to become a manageable component, i.e., activities (Figure 6).

Through this process, he maintains, the built environment can be investigated in a more effective manner. Using this framework, this research focuses on "space-activity interaction" in the domestic space. A house contains a wide spectrum of day to day activities allocated to different rooms or locations. In the pre-modern society, a cultural norm governed how they are distributed in the domestic space. These activities, however, start to migrate to different locations when the house form and culture change. Along the way, new activities emerge and some of the old ones disappear. Under this conceptual framework, we traced the movement of key domestic activities in Malay houses by means of space-activity diagrams. It is an effective method for grouping activities in relation to their locations and clustering them based on their socio-cultural properties. When the diagrams from each phase of housing evolution are correlated, it is possible to map out how individual activities are transferred through the housing transformation, exposing a hidden movement of the socio-cultural dimension in the Malay house.

4.2. Graph-theoretic method to analyse spatial configuration

In high-rise apartment housing, the building block enforces a higher-level geometric constraint onto each unit. To reveal the logic in unit planning, therefore, it is necessary to factor in its boundary condition as well as the internal room arrangement. When an architectural space is designed within the constraint of boundary geometry, it typically adopts the "permutational approach" as against the "additive approach" (Steadman 1970). It is the way a unit plan generates its form without causing friction on the boundary. To explore the permutational design method, a graph-theoretic method has been developed (Seo 2007, 2017). Figure 7 shows how this method is applied. It is a way of converting unit plans with varying shapes and sizes into a single format to facilitate systematic quantification and comparison.

First, inside the unit plan, each space is marked by a dot and its connectedness by lines. When a room is accessed by a door, it is represented by a continuous line. When it is accessed through an opening wider than the width of two doors, it is represented by double lines. When it is adjacent but not accessible, a dotted line is used. In such cases where an opening to a neighbouring space is not for access but for ventilation, a track line is used. Openings to air-wells and pocket spaces fall into this category. Being outside the unit, air-wells and pocket spaces are marked by hollow dots to be distinguished from interior spaces. Once the connections are all drawn, it is modularised by stretching and straightening the boundary to make it a rectangular shape. This enables a clear reading of how a unit is interacting with the four surrounding building conditions – the open front, the communal corridor at the back, and the party wall on each side. Using this graph representation, it is possible to quantify and extract common denominators in a deductive way.

For the analysis, 34 sample apartment plans were collected and investigated. They were built from 1990 until 2015 in the metropolitan Kuala Lumpur area that includes the city of Kuala Lumpur and Ampang Jaya. As our purpose is to find out how old spatial values are reinstalled in the new setting, it was necessary to focus on the units that have less restrictions in configuration. For this, sample plans were collected from the medium-cost apartments, serviced apartments, and condominiums while the low-cost apartments were excluded. In addition, to reveal a wider range of design attempts, those plans with one bedroom were excluded. The final sample is consisting of 28 three-bedroom, 5 two-bedroom and 1 four-bedroom plans. These 34 plans

Figure 5. Typical apartment block plan in Malaysia, 2018, graphic. Source: redrawn by the Author.

Figure 6. Process of dismantling culture, graphic, Source: redrawn from Rapoport (1976, 1990).

were converted to a graph format explained above and analysed to find out embedded properties that are shared by multiple number of plans. Through this process, culture-specific elements that are indigenous to Malay housing culture were revealed and their meanings interpreted.

5. Chronological analysis of the Malay house transformation

5.1. Space-activity interaction through the evolution of housing

Figure 8 shows the diagram of space-activity interaction which traces the movement of domestic activities through the three important stages of housing evolution, i.e., the traditional house, the modern vernacular house, and the apartment housing. The traditional house and the apartment housing are the most dominant dwelling form of the past and the present, and the modern vernacular house is the essential link between them. Each vertical column contains circles representing living spaces that belong to each housing type.

The first column on the left shows five representative spaces in the traditional house. The linear order from the top to the bottom follows the actual sequence of spatial journey in the house. The most typical activities of each space are written next to each circle; thus, the anjung includes "formal entering" and "relaxing" and the serambi "guest entertaining". The rumah ibu is the informal family space for various daytime activities and sleeping, and therefore represented with a larger circle to emphasise its capacity. To get to the next space, the dapur, one leaves behind the high-level zone in the front and enters the low-level zone in the back. The boundary between the two zones is marked by the thick dotted line in the diagram. The circle representing the dapur is also bigger with its various activities and shaded to indicate its lower level. It has a back entrance which is used for females and children to go out to the yard. The yard is on the outside realm, so its boundary against the interior domain is marked by a thick line and its circle shaded darker to symbolise its lowest level. The yard contains many essential outdoor functions such as storing things in the piloti underneath the rumah ibu and other sanitary activities in the privy and at the well.

Having all key activities of the traditional house aligned on the left, it is possible to trace how these activities are moving towards right, relocating themselves as the house form changes. Their final destinations can be identified by finding their position on the far-right side of the diagram. For example, "informal entering" that used to happen in the dapur was transferred to the same dapur in the modern vernacular house, but in the apartment house, it was combined with "formal entering" and placed at the entrance hall which is now the only entry point to the house. For those spaces that emerge or disappear, circles were drawn with dotted lines. For example, in the modern vernacular house, the anjung began to lose its importance and in many cases reduced to a mere stair landing. The bedroom, on the other hand, emerged as a new partitioned space at this phase. Hence, dotted circles were used for them. In the last phase, these spaces either completely disappear as the anjung or fully settle in as the bedroom.

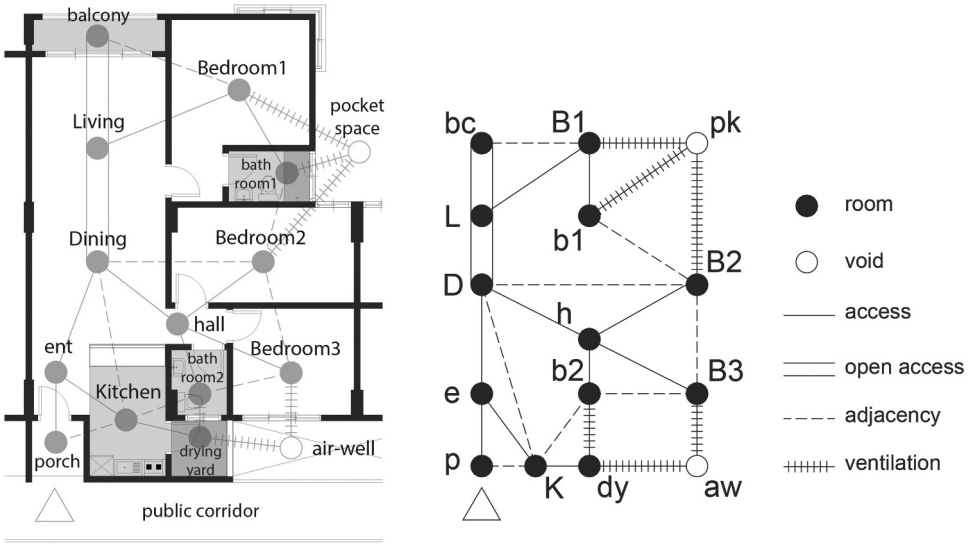

Figure 7. Typical apartment unit plan in Malaysia and its graph representation, 2018, graphic. Source: Author.

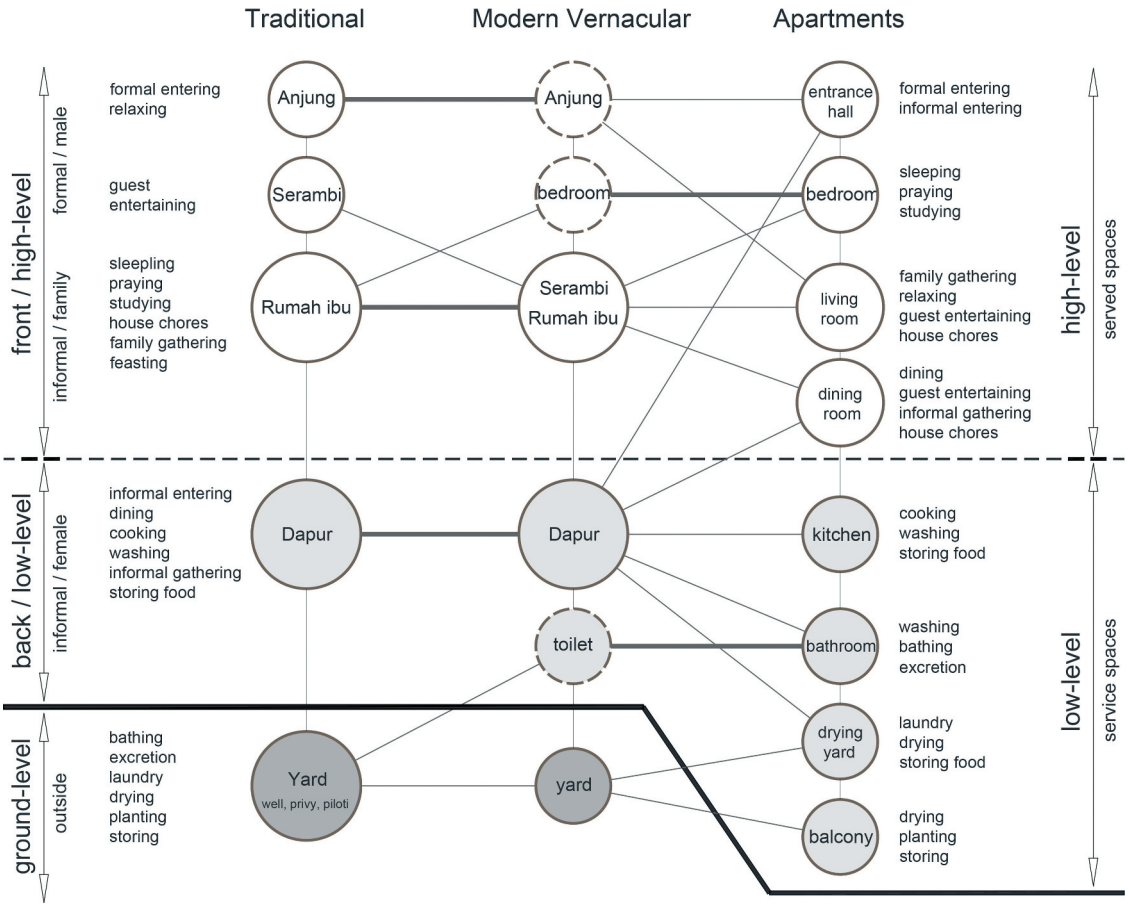

Figure 8. Space-activity interaction in the Malay housing evolution, 2018, graphic. Source: Author.

5.2. Distinction of front/back and high/low

The arrows on the left summarise two spatial orders that are strongly embedded in the traditional Malay house: the front-back distinction and the level distinction. The former defines the linear order of spatial layout by the status of the users. The latter, on the other hand, defines the order of activity allocation by the floor levels, i.e., the high-level, the low-level, and the ground level. The front-back distinction is associated with the status and sex of the users. The anjung and the serambi at the front provide a formal zone for guests and males. The rumah ibu is a mixed zone for both males and females but categorised as a front space since it is the most central space with its architectural significance and often accommodates public activities such as feasting and guest receiving as well as private everyday activities. At the back is the dapur, a space for women and children, which is entered from the rear entrance. This front-back distinction clearly defines the

internal space by following the linear order of guests, males and females. Thus, it regulates the way the residents and visitors are controlled and communicated. The front-back distinction was still operating in the modern vernacular house, but it lost its clarity in the apartment house due to two major reasons: the social change where the male-female segregation became weaker and the architectural restriction in apartment housing where the linear sequence of room arrangement is not possible anymore.

Whereas the front-back distinction regulates the hierarchy of people, the level distinction regulates the symbolic hierarchy of activities. The house floor of the traditional Malay house is typically lifted from the ground due to the tropical humidity and heavy rainfall that would damage its wooden structure (Domenig 1980; Waterson 1990; Crouch and Johnson 2001). After generations' of repeating practice, this has developed into a clear division between "the wet earthen level" versus "the dry elevated level", and further into a conceptual dichotomy of "the dirty lower level" versus "the clean higher level" (Seo 2012, 2015). Then it became a regulatory norm that lower-levels accommodate dirty activities such as cooking and washing, while high-levels cleaner activities such as sleeping and praying. The term "dirty" is used here in a symbolic way following Mary Douglas (1966) to denote those activities using water, soil or others that require cleaning after the execution. In the diagram, as we slide down through the arrow, the activities such as cooking and washing appear at the low-level, and excretion and laundry appear at the lowest level of the ground. What is remarkable in the housing evolution is the persistence of this level of distinction. As the arrows on the right show, even after the front-back distinction became extinct, it has survived the transformation in housing form and culture. In Malaysian apartments, with no exception, balconies, drying yards, and bathrooms have their floor level lowered, about a few centimetres. Even kitchen floors are lowered in many cases. Those new spaces that inherit activities from the old low-level spaces, i.e., the dapur and the yard, show a strong tendency to preserve the very nature of the original spaces, the relative lowness of their floors, even in the modern context. This is a phenomenon that cannot be explained by practical reasons alone. It is one of the most distinct characteristics of Malay domestic culture that survived the test of time.

5.3. Changing status of activities

Tracking the movement of activities, it is observed that some activities have abandoned their low-level membership on the way. For example, the activity of dining and informal gathering, which once belonged to the low-level dapur, has crossed the boundary and settled in the dining room which is now in the high-level zone in the apartment house. As the contemporary dining room becomes a main stage for guests and family members by being integrated with the living room, this signifies the centralisation of those activities. The old high-level activities, in contrast, all remained in the same high-level after the transformation.

Figure 9 shows sub-diagrams taken from Figure 8 to highlight the movement of activities from the male, female, and outside spaces. As their purpose is to relate the origin and the destination, the modern vernacular house as a way station was removed. The diagram on the left shows the two male spaces in the traditional house, the anjung and the serambi, transmitting their activities to the entrance hall and the living room in the apartment house. On the surface, it looks as if the same number of spaces is corresponding. Compared with the anjung and the serambi that are habitable male spaces, the entrance hall is a transitional space and the living room is not a designated male space. Evidently, the male spaces have lost their exclusive power and became absorbed into a family space. In sharp contrast, the dapur, the only female space in the past transfers its activities to five different spaces in the new setting. Along with the status change of women, their presence in the new house became more expanded and celebrated. In the case of the yard, its existence has been lost as the apartment unit could not retain it. Thus, its activities had to find their new locations at the bathroom, the drying yard, and the balcony. The drying yard is the most unique space in Malay apartment housing. It is a common practice to attach

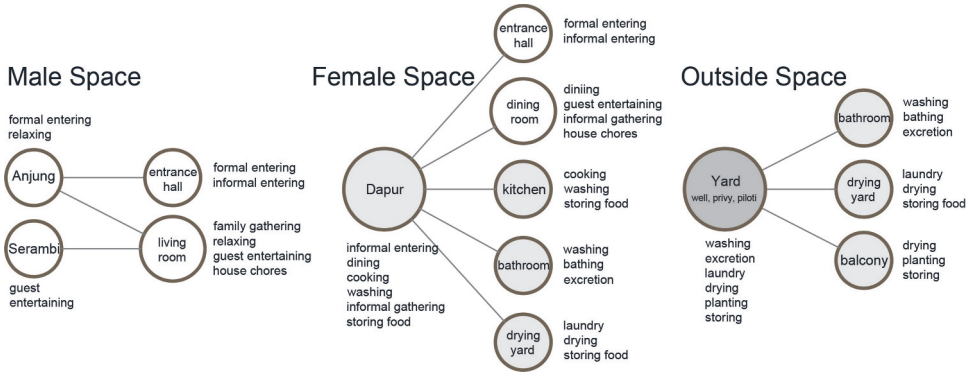

Figure 9. Activity transfer from male, female and outside spaces, 2018, graphic. Source: Author.

a service balcony to the kitchen but, as its name indicates, the drying yard can include a much wider range of activities that are inherited from the old yard. It generally accommodates washing and drying of clothing and storing of food and kitchenware, but some households even use it as a temporary wet kitchen for heavy cooking when needed. Because these new spaces inherit dirty outdoor activities, they all have their floor levels lowered to resemble the lowest position of the yard.

The transformation of the house was radical but there was continuity of domestic behaviour that guided the whole process. It appears that the life style has become modernised with a new layout. At the microscopic level, however, there is persistence in how everyday activities are practised.

6. Graph-theoretic analysis of apartment houses

Using the graph-theoretic method discussed in section 4.2, 34 sample plans built from 1990 until 2015 in the metropolitan Kuala Lumpur area were converted to a standardised graph format (Figure 10). Once converted to a graph format, these 34 plans were arrayed in a way to place the entrance on or near the bottom left corner, to give them an equal entry condition for precise comparison.

Investigating their configurational change through 25 years, no clear pattern of diachronic transition could be found. They all look different and there is no exact duplication of the same plan. Unlike other Asian countries such as Japan and Korea where a few stereotyped plans dominate the market (Seo 2007, 2015), Malaysia does not seem to have settled on a small number of agreed solutions. This implies the complexity of Malaysian apartments with its deep unit plan and additional spatial features such as air-wells and pocket spaces. The typical three-bedroom plan in Figure 7 has 15 spaces in it, while the typical middle-class plan in Seoul and Tokyo with three bedrooms have only 10 and 12 spaces (Seo 2015).

6.1. Statistics of room positions

The strength of the graph representation lies in its standardised format that allows a quick and easy classification process to sort out common denominators from a multiple number of units. The first step to this is plotting the statistical position of each room in the unit without considering their connectedness (Figure 11).

Each graph shows the distribution of a given space in the 34 plans. Dotted circles show the dominant position and their sizes are proportional to the statistical importance. The first graph on the top left shows the plots of the living room. It reveals that overwhelming 27 plans locate it on the left edge just below the open front. With other 6 cases nearby, the graph shows a strong tendency for its location in the upper left zone. The dining room also has its dominant position on the left edge, just below the living room's dominant spot. In the following three graphs, the kitchen, the drying yard and the air-well all locate their dominant positions along the bottom edge. The fact that both the kitchen and the drying yard are mostly positioned in the middle of the bottom edge means that they are sharing this middle zone by making certain links between them. Whereas these two spaces also have other minor spots, all 29 air-wells appear at the bottom-right corner

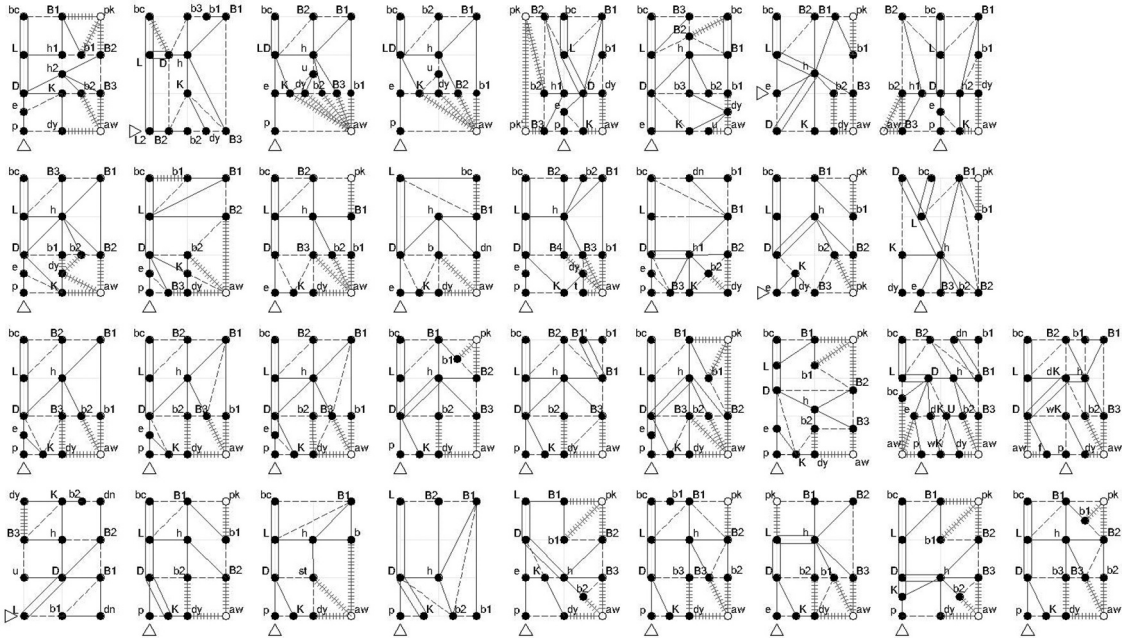

Figure 10. 34 unit plans converted to graphs, 2018, graphic. Source: Author.

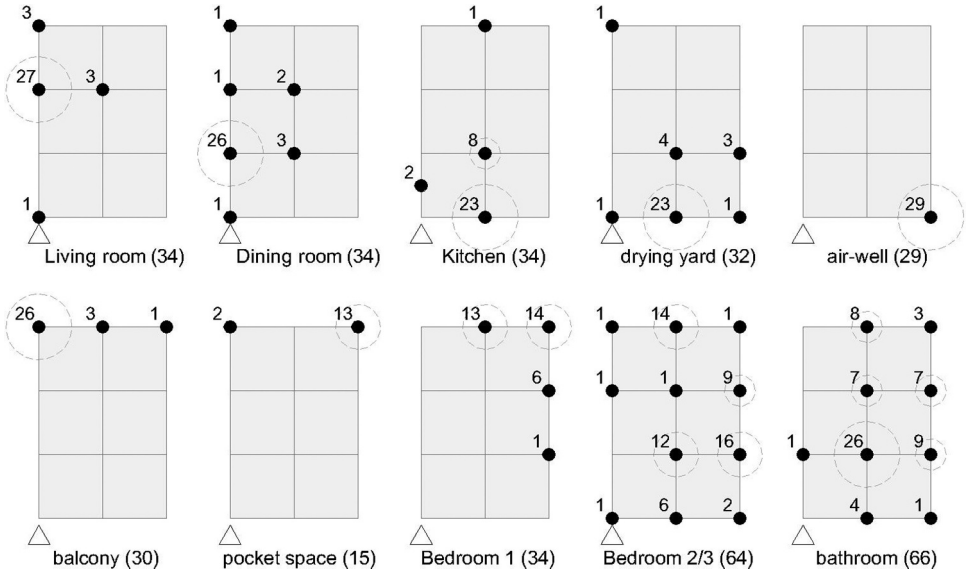

Figure 11. Frequency of allocation of each room in the unit, 2018, graphic. Source: Author.

without exception. This indicates that there exist 5 plans without air-wells. In the next row, the balcony and the pocket space are all sitting along the top edge. The former has its position 26 times on the top left corner and the latter 13 times on the other end of the open front. It is also revealed that only 4 plans have no balcony while 19 plans (56%) have no pocket space. It can be said that in the middle-class apartment plans, the balcony can be regarded as a norm but the pocket space is not. The master bedroom (Bedroom 1) appears in all 34 plans and their positions are mainly at the middle and the right corner of the open front side with minor appearances along the right edge. Compared to this, the other bedrooms are distributed across the entire domestic field. In a closer look, however, it is found that they are more concentrated on the top middle spot and the lower middle and the lower right spots. Finally, the bathroom's position shows another interesting pattern. It appears on various spots with one dominant position in the lower middle spot but it rarely appears on the left edge. Considering that bedrooms and bathrooms are usually equipped in plural numbers, it is not surprising their positions are more widespread, but they still show a clear concentration in a few dominant spots.

6.2. Syntax of room connectedness

Based on the above result, it can be assumed that if room positions are decided by a certain pattern, it is likely that some rooms are making the same type of connections with each other. Out of 10 spaces in Figure 11, it is found that 6 have a clear single dominant spot: the living room, the dining room, the kitchen, the drying yard, the air-well and the balcony. Interestingly, these 6 spaces tend to make a linear sequence inside the unit and Figure 12 shows their possible connections and frequencies in the sample. In the figure, to focus on their topological relations and growth, the spatial links are represented as straight lines.

On the far-left, the spatial link between the living room and the dining room was drawn with double lines, meaning it is an "open access" connection with an opening wider than two doors. The number at the top indicates this integrated public zone is universal, appearing 100% of the sample plans. There are a few cases where a hall (h) mediates their connection but if the open access is not interrupted, it was still regarded as an open access. When we extend the link further to the kitchen, it is found that 32 out of 34 plans (94%) have LDK sequence as in the second column in Figure 12. It seems that they are following the contemporary trend of integrating these public spaces but there is a difference in Malaysian plans. While the living room and the dining room are fully integrated without a barrier, there is a tendency that the kitchen is treated as a separate space. Out of 32 plans, only 4 have "open access" to the kitchen while the remaining 28 have a single line "access" which is less than the two-doors' width. Amongst them, 15 have a fully enclosed kitchen with a door. Along with the effort to visually separate the kitchen, many of them also have their floor level lowered to demarcate it as a different activity zone from the dining and living area. This is another culture-specific feature in Malaysian houses that is continued due to the local cooking style that generates strong aroma

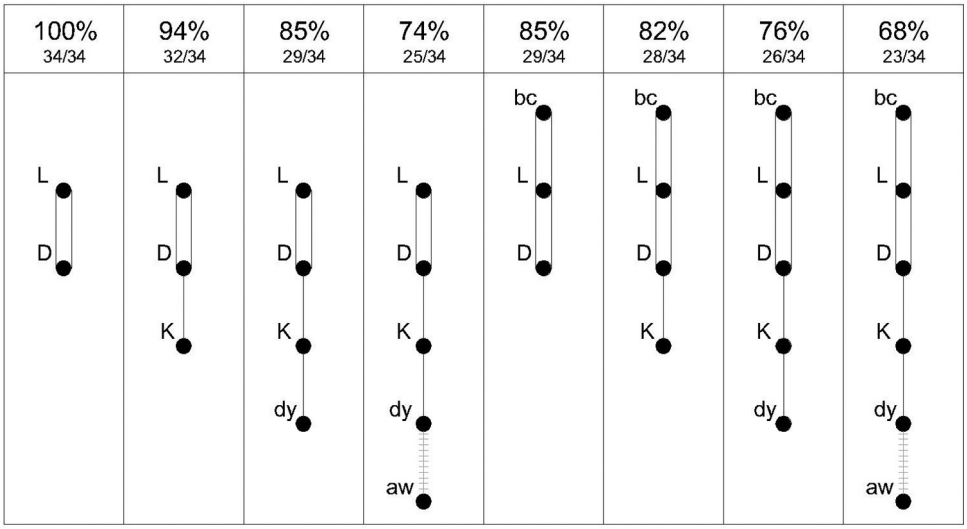

Figure 12. Dominant spatial connections in the sample plans, 2018, graphic. Source: Author.

and requires cleansing of the floor (Seo 2015). In the third and fourth columns in the figure, the LDK connection is further extended to include the drying yard and the air-well. As the drying yard typically makes a pair with the kitchen, it seems natural that 85% of the plans have this service balcony at one end of the LDK link. Finally, 74% of the plans terminate the sequence with the air-well.

The remaining four columns on the right side of the figure show how the percentages change when the balcony is added at the top of the spatial sequence. As expected, the percentages go down but still show very high numbers. On the far-right is the longest sequence we can find in Malaysian apartment plans, connecting six spaces but it is still embedded in 68% of the sample plans, that is 23 plans out of 34. It is striking that many seemingly different plans share the same sequence of spatial link. It should be noted, however, that this sequence is not manifested in a straight line but in various non-linear patterns in actual unit plans. This leads us to question about the possible way to embed this spatial link inside the rectangular boundary of the unit.

The graph on the left in Figure 13 shows that 68% of the plans put the link "bc-L-D" on the left edge which is closer to the entrance. It should be remembered that the same link had 85% of occurrence in Figure 12 when its locational information was not considered. As the same link can take many different layout patterns, 68% of dominance looks very high. More rooms are added to the link as we move to the graphs on the right. By adding the kitchen, however, the percentage drops down to 26%. This means that only 9 out of 23 plans in the first graph follow this link while 14 plans have different ways of linking the kitchen. Further investigation reveals that there are many plans that connect the kitchen via the entrance hall, making an alternative "D-e-K" link. Also, it is found that the kitchen is not always placed at the bottom edge but appears in different spots within the lower zone. Next, by adding the drying yard and the air-well, the percentage drops to 21%. It looks certain that "K-dy-aw" link generates a wider range of variations unlike "bc-L-D" link, although they still show a strong tendency to stay in the lower zone. Thus, as in the last graph, if we allow a certain range of positional flexibility (indicated by arrows) for the kitchen and the drying yard, and an alternative route to link them with the dining room via the entrance hall, the percentage bounces back to 62%. Although there are still 38% of the plans that

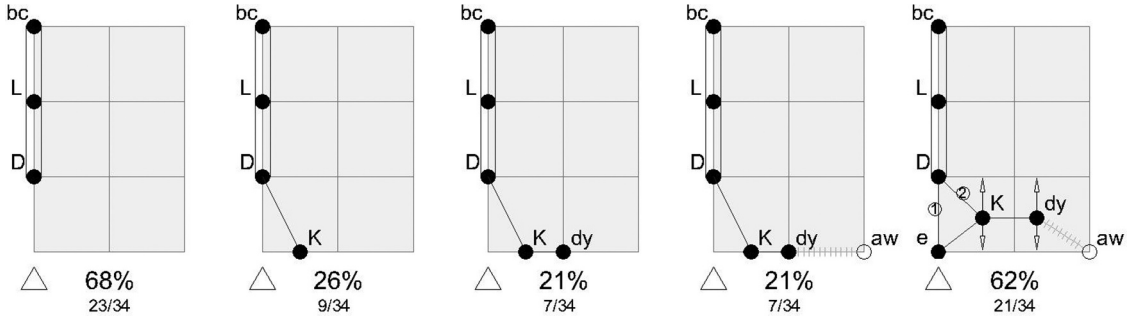

Figure 13. Positioning of the dominant spatial link inside the unit plan, 2018, graphic. Source: Author.

do not follow this pattern, their basic approach to embed this link of six spaces is not hugely different in most of the plans. In any case, the proportion of 62% looks high enough to prove that there lies a culture-specific pattern inside the house, especially when we consider the configurational complexity in Malaysian apartment plans.

7. Interpretation

It has been investigated earlier how old activities have been transferred to the modern apartment housing and how this has influenced the traditional spatial orders, i.e., the front-back distinction and the floor-level distinction. In the previous section, a graph-theoretical method was used to analyse how rooms are allocated and linked to each other inside the rectangular boundary of the apartment unit. With the statistics gathered from the analysis, now it is possible to interpret how the old spatial values have been transmitted to the new house.

7.1. Preservation of the linear sequence

In the traditional and modern vernacular houses, the linear spatial sequence from the formal front to the informal back was operating. The apartment housing, in contrast, has a different morphological logic where compartmentalised spaces are packed in a rigid boundary and it can be only entered from a single entrance. Has the front-back distinction been lost with its long spatial sequence? Superficially it looks so, but the graph analysis shows that it is still maintained in a subtle and unexpected way. Figure 14 shows how it has been disintegrated and restructured in the new setting.

The graph on the left illustrates a pattern that is embedded in 68% of the sample plans. Along the left edge, the balcony, the living room and the dining room are clustered together. Despite its function inherited from the dapur, the dining room became a member of the front zone for guests and family members by being fully integrated with the living room. As identified in the activity transfer diagram in Figure 8, this living-dining zone accommodates most of the public activities from the old front spaces, i.e., anjung, serambi and rumah ibu. Hence, this forms the new "front". At the bottom of the graph is the "K-dy-aw" link that accommodates the old back activities – hence the new "back". The kitchen encloses most of the activities from the dapur and the drying yard those from the old yard. In 62% of the plans, this link is preserved at the lower zone of the unit and is always connected to the front zone, directly or via the entrance hall. Clearly, this is an effort to generate a full "bc-L-D-K-dy-aw" sequence which is a modern translation of the old "anjung-serambi-rumah ibu-dapur" sequence. To overcome the geometric constraints of the apartment unit, Malaysian architects cleverly found a solution of bending it into an "L" shape along the left and bottom edges.

In the traditional house, the front and back entrances were at each end of the sequence for the connection with the outside yard. In the apartment house, likewise, the balcony and the drying yard, that inherit the activities of the yard, are placed at each end of the link as an internalised (and fragmented) version of the old yard. The two entrances are now combined as a single entrance and its hall is placed on the pivotal point, allowing a convenient access to both the front and back zones. In typical plans (see Figure 7), as one enters the house, the kitchen appears immediately on the right side. As the entrance hall is aligned with the "bc-L-D" axis, however, what one experiences first is a visual incorporation with the front living-dining zone. From the visitor's point of view, this gives an impression that the front zone emerges in its entirety before other spaces as if in the traditional house. This is the reason why the front zone is dominantly positioned on the entrance side while other rooms are pushed into the other side. Walking into the front zone, there appears further connections to bedrooms and bathrooms on the upper right area. Because both rooms tend to be in plural numbers – 2.88 bedrooms and 1.94 bathrooms in average per unit – their combinatorial variations can generate a wide variety of different interiors.

7.2. Air-well as a new hub linking lower level spaces

The second graph in Figure 14 evidences how crucial the air-well's role is in bonding the back zone. Four rooms constantly make connections to it: the drying yard, the bathroom, the bedroom and the kitchen. In all 29 plans where the air-well exists, the drying yard always comes with it without exception (100%). Once the pairing between the two is made, the kitchen makes an access link to the drying yard by 90% probability. The bathroom also has a close relationship with the air-well for ventilation. It has 66% of direct connection and 34% of indirect connection via the drying yard, achieving 100% link when combined. The bedroom is another frequent company with the air-well. While the master bedroom is almost always facing the open front side, the other bedrooms often find their alternative ventilation route through it (83%). The kitchen, the bathroom and the drying yard are categorised as back spaces inheriting their activities from the dapur and the yard. As discussed before, what they inherit is not just activities but a part of their physical property, i.e. the low-level of the floor. Thus, the dying yard and the bathroom always have their floor lowered, and so does the kitchen in many cases. In this

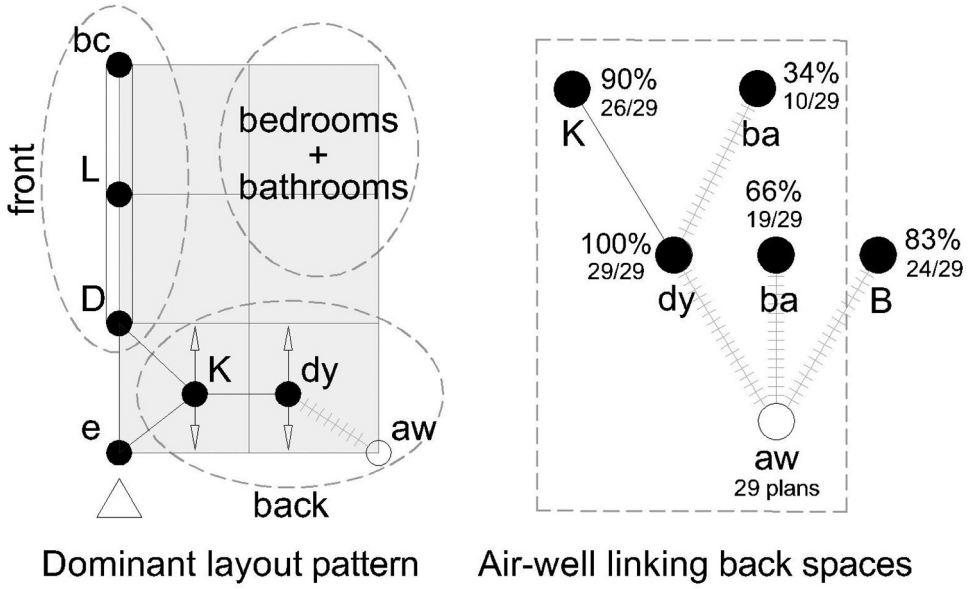

Figure 14. Morphological logic in Malaysian unit plan, 2018, graphic. Source: Author.

respect, the old distinction in floor levels also manifests itself in the new house. As marked by the dotted box in the figure, it is the air-well that brings these low-level spaces together. Hence, it takes a unique status as a new hub linking scattered low-level spaces together by providing an artificial outdoor environment from the inside of the building.

8. Conclusion and discussion

This paper investigated the transformation process of Malay houses and their changing domestic culture. At the beginning, we looked at the wider social context where economic growth, urbanisation and migration that influenced the changing values of community and families, and how this has impacted the house transformation – from the traditional Malay house to the modern vernacular house, and then on to the apartment houses which became the most dominant dwelling type in the metropolitan Kuala Lumpur. Then, using methods of space-activity diagrams and the graph-theoretic method, we analysed house plans to reveal how old spatial orders have been transmitted to the modern houses.

First, the space-activity diagram revealed that the old distinction of the clean high-level versus the dirty low-level floors is still operating in the modern apartments, while that of the male front versus the female back has been gradually dissolved. It was found that modern spaces, such as the kitchen, the bathroom, the drying yard and the balcony, that inherit the activities of the dapur and yards in the traditional house have their floors lowered to reinstate the same environment suitable for wet and untidy works.

Second, using the graph-theoretic method, we converted 34 apartment plans to a standardised graph format for statistical analysis of layout patterns. It was found that there exists a dominant location in the unit for each functional room and there is a statistically meaningful trend of maintaining a room sequence of "balcony-living room-dining room-kitchen-drying yard-air well", which resembles "anjung-serambi-rumah ibu-dapur" in the traditional house. The old front/back distinction has been blurred, along with the increasingly neutralised gender role division, but there has been an ongoing effort by Malaysian architects to implant the old spatial sequence, even inside the compact modern house.

The findings of this research revealed that the housing transformation in Malaysia has been intense and radical but there is a hidden dimension of cultural values that influenced the shaping of modern houses. This research suggested a deductive way of seeing the process of housing transformation from the inside rather than from the outside. By focusing on activities and spatial configuration, it was possible to filter out the elements that have been transmitted from one house type to another despite their formal differences.

There is a wide variety of layouts in Malaysian apartments that have been experimented and tested over many decades, and it has been shown that there has been a collective effort to maintain the old spatial values of the front-back distinction and the high-low level distinction with varying degrees of success. This does not mean, however, the experiment has arrived at a universal solution. There still exist different approaches in the market to retrieve the old spatial properties (Figure 15).

The first plan on the left is the typical plan that holds the typical spatial pattern discussed so far. The second one is the atypical plan where the living room is so placed as to face the common corridor and the kitchen the open front side. It is a reversed spatial order of the front and back from the typical one. Although it is not a common solution, the fact that this pattern keeps appearing in the

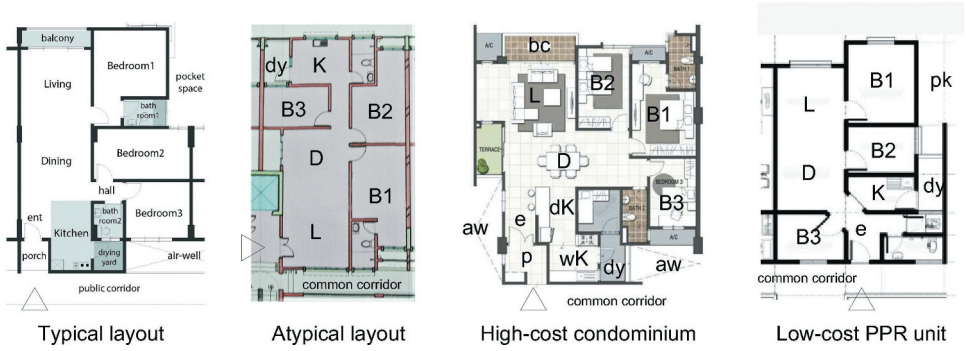

Figure 15. Various plans in the market, 2018, graphic. Source: Redrawn by the author.

market implies that there exists a preference for placing the living room, the most representative front space, immediately after the entrance. Despite its apparent disadvantages such as a visual conflict between the living room and the corridor, the reversed pattern enables an orthodox way of conserving the traditional spatial sequence from the perspective of the guest. The third one is the high-cost condominium with a more elaborated spatial arrangement. It has two sections for cooking, i.e., the dry kitchen and the wet kitchen, where the floor of the latter is lower than the former for heavy cooking. The last plan on the far right is the standard low-cost flat developed by the National Housing Department from 1998. It is a more compact type with a reduced number of spaces. Looking at the four unit plans together, it is clear that they are all different in their design approach with different target consumers. What they have in common, however, is the sequence of the key spaces, that is "L-D-K-dy" that has its remote origin from the traditional house. Based on this basic structure of sequence, additional spaces such as the balcony, the wet kitchen and the air-well are added depending on their capacity and needs. In any case, those spaces from the old lower zone tend to have a lower level of the finished floor.

This paper has illuminated the spatial characteristics that enabled a hidden link between the old and new houses. The sample gathered in this paper was above the level of low-cost unit plans, and this was to explore a wider possibility of spatial configuration to highlight culture-specific aspects. It would be meaningful therefore that future research focuses on the low-cost unit plans to find out what kinds of spatial elements are given priority and what are suppressed for the economically viable solutions.

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