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# A Critical Review of User Fit-out in Habitable Rooms in High-Rise Residential Apartments in Malaysia

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**Abstract**

Nowadays, high-rise residential apartments (HRRA) are developing very fast in major urban areas in Malaysia. However, the layouts of these apartment units seem to be too typical and lacking certain contextual socio-environmental considerations. A residential unit accommodates more than just rooms. There are distinct spaces with various Use-Territories (UTs) inside every room created by furniture layout. During the design stage, usually less importance is given to UTs. In search of their impact, the objectives of this study were firstly to identify the most popular furniture with their approximate dimensions, secondly to find their location in terms of distance from window, and thirdly, to identify typologies of furniture layouts in terms of UTs. Based on a questionnaire survey distributed among 98 HRRA residents in the city of Johor Bahru, the conceptual furnished plans of studied rooms were drawn. That was followed by a qualitative categorization carried out to extract the typologies of mostly-used UTs. Four typologies for living room and six of that for bedroom were identified through comparative analysis. The study showed that the social behavior of occupants in terms of arranging UT may be against their indoor environmental condition of daylighting. The significance of the study lies in the fact that in a tropical country like Malaysia with abundance of daylight but associated with glare, thermal heat gain, and low air movement, social needs can bend the users' decisions to arrange pre-conceived convention of UTs in habitable rooms. Therefore, designing layouts or orienting habitable rooms should need more investigation.

**Keywords:** daylight, furniture, Malaysia, residential apartment, use-territory

## 1. Introduction

The fast development of urban population in the Southeast Asia caused the rapid increase of high-rise structures that could be used for both commercial as well as residential targets. However, the needs for making high-rise building had an upward trend especially in the last years ago in Singapore, Bangkok, and Kuala Lumpur (Rimmer & Dick, 2009). In the case of Malaysia, Petronas Towers were the turning point for building development. Since, after that more and more high-rise buildings had been built. Most of these high-rise structures are used for residential purposes. Study on furniture arrangements in HRRA is significant, as furniture layouts can influence environmental condition of housing units (such as air movement, visual and thermal comfort). However, the focus of this research was on impacts of Mostly-Used-Furniture-Layout (MUFL) on visual comfort of residents in terms of daylighting.

## 2. Background of Study

### *2.1 HRRA as a New Housing Trend in Malaysia*

The growth of requests for housing as well as the rarity of land to build landed residential buildings in main urban areas of Malaysia (Kuala Lumpur, Johor Bahru, and Penang) caused the fast increase of high-rise residential projects in those high-density regions. Although, HRRA was not the major typical housing in Malaysia, it is changing. Nowadays, living in a HRRA in Malaysia is a new trend or lifestyle for urban occupational communities. Because, facilities provided at HRRA is more complete and more stylish compared to the low-rise ones. Furthermore, it is near the city and giving easier access to the public utilities and work. In the

last ten years, the number of HRRA in Kuala Lumpur grew to nearly 41% and this figure increased annually (Ta, 2009). In 1998, the Malaysian housing policy was determined in the urban areas for all groups with different income level. The government attempted to attain sustainability, adequacy, comfort and affordability for housing sectors in Kuala Lumpur that nowadays achieved 94% of housing units (Farea, Ossen, & Isah, 2012). Actually, there is not still a uniform definition for high-rise apartments. A study by Goody, Chandler, Clancy, Dixon, and Wooding (2010) describes four types of apartments in terms of height as, low, mid, high, and super high-rise (skyscraper) apartment that the high-rise apartment was ranged from sixteen to fifty stories. While, based on the Green Building Index (2013) criteria, it is divided into three categories as, landed, low-rise and high-rise, though, a high-rise building nominated as a building in which the topmost floor is more than 18.3 meters (appx. six stories) above the ground level (GBI, 2013).

### *2.2 Significance of 'Flexibility' in Today's Housing*

Design of high-rise apartments has severe limitations compared to landed or low-rise apartments in terms of room layouts. This resulted in low satisfaction of users of HRRA due to their different spatial needs. As the user's need may be altered over time, users tend to change the spatial layouts of their residential units for instance pulling down a partition wall to have a bigger space in order to fulfill their needs. However, variable household needs forced them to look for different layouts of space in their residential units. Thus, a house that might be matched based on the users' spatial requirements can be considered to have flexibility in layout configuration as well (Wong, 2010). Flexible or open building design is not a new approach especially in mass housing design. The term 'flexibility' has never been clearly identified (Gijsbers, 2006). Conventionally, during the construction, there are the fixed elements termed as 'support', and there are those elements that can be changed or added by users or even by designers that are termed as 'infill', which are the partition walls (Habraken, 1976). Flexibility can be emerged during the first construction processes like structure, until the last stage, especially infill development (Khan & Dhar, 2012). Sullivan and Chen (1997) showed that the concept of flexibility can exist and play a major role at the infill level in mass housing projects. Besides, a study by Gijsbers (2006) revealed that a greater open plan or open shell can result in more degree of flexibility in the contemporary private housing (Khan & Dhar, 2012). However, just an open space may not be good enough for users if it does not fit the required furniture. Therefore, there is a need to study the possible arrangements of furniture, which has been defined as study of Used-Territory (UT).

### *2.3 Furniture Creates Use-Territory*

Previous studies stated that a house should not be considered as a collection of rooms only with each room having one single and separate function. In spite of giving rooms a name such as bedroom or living room, each room can include various territories inside that serve different purposes (Yi & Yi, 2010). The focus of this study was on territory rather than room function. Territory was considered as the belonging sense of space and property. The concepts of territory and UT are interrelated and often overlapped (Abu-Ghazzeh, 2000). The term 'Use territory' mentioned an area that is needed for an individual activity to take place (Wong, 2010). For instance, a place for reading, sleeping or eating can be separately named as an UT. Hence, it is one step deeper than layout design of a residential unit and the ergonometric dimensions derives from human movements and its direct interaction with the furniture immediately next to the specific activity. UT included two parts; physical space occupied by definite furniture that has a specific border, and the space needed to operate it which has intangible boundary (Al-Shamy, 2013; Wong, 2010). Although in luxurious layout, UT may be not a big concern, in residential apartments with tight spaces particularly in mass housing where modular system is significant, an explicit implication of UT is necessary in order to reduce the wastage of spaces (Al-Shamy, 2013). Nowadays, mass housing was observed as a vital issue for the community welfare. However, design of modular system by knowing how residents use spaces can fulfill the different spatial requirements of end users in mass housing (Wong, 2010). Basically, in a specific space, flexibility can be obtained by transferable furniture. Instead of room walls, this furniture as the moveable partition can create a territory (Yi & Yi, 2010). Finally, it can be declared that UT is the smallest unit of space need to be considered during design process, which is constituted of different furniture. The furniture layouts and the space around them represent the UT for each user's associated activity (for instance, computer desk + chair = work/study territory) (Wong, 2010). Eventually, by identifying the activities carried out in the housing units, in addition to spaces configuration, standardized furniture can be better designed as well.

### *2.4 Furniture as a Significance Factor for Environmental Performance*

Based on the personalization, residents can alter furniture layout to match it with their lifestyle. Indoor environmental status of HRRA such as thermal comfort, air movement and also visual comfort can definitely be

modified by changing furniture layout (Yi & Yi, 2010). Therefore, different furniture layouts can influence the indoor environment condition of residential units. Daylight can be considered as one of the major environmental factors of indoor condition. This study emphasized on examining the impact of furniture arrangements on incidence daylight coming to every UT in order to investigate whether social needs of residents (in terms of MUFL) were in accord with the required environmental needs (in terms of daylighting) or not. However, it is necessary to specify which UTs in residential units need more daylight compared to other UTs and which one of them needs the highest amount of daylight in HRRA. Since, each habitable room usually has some UTs that are more daylight-dependent compared to others. Hereby, the term 'Most Daylight-dependent Use-Territory' (MDUT) in this study referred to the activity that requires the highest daylight among all the other UTs in habitable rooms (living room and bedroom) of case studies.

### *2.5 Summary*

Residential apartments could be considered based on the activities, not on room type, as rooms are always occupied with furniture and used by occupants. Although, there are a host of studies on the spatial features of housing units and their room layouts, none focused on UTs in HRRA in Malaysia, which is one level deeper. On the other hand, there is not still a basic study about the typologies of furniture layouts and their characteristics for habitable spaces of HRRA in Malaysia, which can also be helpful for manufacturers.

## 3. Method

In order to find typologies of furniture layout in the existing HRRA, it was significant to look for all possible UTs, their location in rooms, their associated furniture, and the position of furniture in habitable rooms in HRRA. This study employed qualitative and quantitative research procedures. Firstly, quantitative data was collected from the field survey. In this case, 98 questionnaire surveys were distributed among residents who live in HRRA in Johor Bahru. For this purpose nine contemporary HRRAs were considered as the case studies. The questionnaire included three parts: demographic data, information on use-territories, and queries on furniture and its specifications. The aim of questionnaire was to identify the most desired UT configuration, which were applied by users in their residential units. However, data on wide range of various configurations of UTs with their related furniture were also targeted. Then, by collecting data from the third part of questionnaire (furniture), the conceptual furnished plan of habitable rooms (living room and bedroom) was drawn. Thus, 98 furnished plans were acquired. The statistical methods via applying SPSS tool (Statistical Package for Social sciences) were conducted to analyze the quantitative data. Results were presented by using descriptive statistics (frequency and percentage). Secondly by conducting the qualitative method of categorization, the furnished layouts in terms of their location in the room, the concept of adjacency was used to label the categories. Afterwards, by deleting identical layouts in terms of furniture location, MUFLs can be figured out for every room. Finally, the locations of the UTs in MUFL (with highest frequency of usage among residents) were considered and compared with The CIBSE (Chartered Institute of Building Services Engineers) standards to detect whether the MUFL was adjusted with visual comfort in terms of daylighting or not. This source produces a Code for interior lighting which gives lighting requirements for every area inside a building.

## 4. Data Analysis and Result

### *4.1 Results from Questionnaire Survey*

Cronbach's alpha for testing the reliability of study was applied. This variable was 0.745 that showed acceptable internal consistency. Previous studies revealed that for an exploratory study Cronbach's alpha should be more than 0.60 to be adequately reliable (Hair, Black, Babin, Anderson, & Tatham, 2006; Newton & Meyer, 2010). Meanwhile, the KMO (Kaiser-Meyer-Olkin) measure and Bartlett's test was performed to specify the sample adequacy (Field, 2000; Mousavi, Khan, & Javidi, 2013). So, the KMO value was 0.816 that implied valid and adequate survey sampling.

#### 4.1.1 Stage I: Identifying the Most Commonly Used Furniture

As the physical space of UTs are necessarily always occupied by specific furniture, so study of required furniture in HRRA was a major task in this research. In this case, firstly the relevant furniture related to every UT was investigated. Later on, residents' ideas through member checking method clarified whether they applied the mentioned furniture in their housing units. If the furniture usage had the high frequency it was considered for the next stage of analysis, while if it has got low usage it was deleted. The common furniture that could be applied in living room and bedroom were dining table (with chairs), desk (with chair), sofa, coffee table, display cabinet, TV set, carpet, bed, dressing table, wardrobe and shelf. Figure 1 depicts common UTs in the habitable rooms (bedroom and living room) with their own related furniture.

| Computer, reading, writing | Social meeting with family | Eating | Watching TV | Storing & Changing clothes | Relaxing and Resting | Make up | Sleeping |
|---|---|---|---|---|---|---|---|
|  |  |  |  |  |  |  |  |
|  | |  | | |  | | |

Figure 1. UTs with their associated furniture

Figure 2 shows the percentage of furniture usage by respondents in their residential apartments. As it was clear, all of the introduced furniture had applied by most of the users (more than 50%) in their houses. By the way, more than 80% of respondents applied bed, desk, wardrobe, sofa, dining table and TV set, while this figure was between 50% - 70% for other studied furniture.

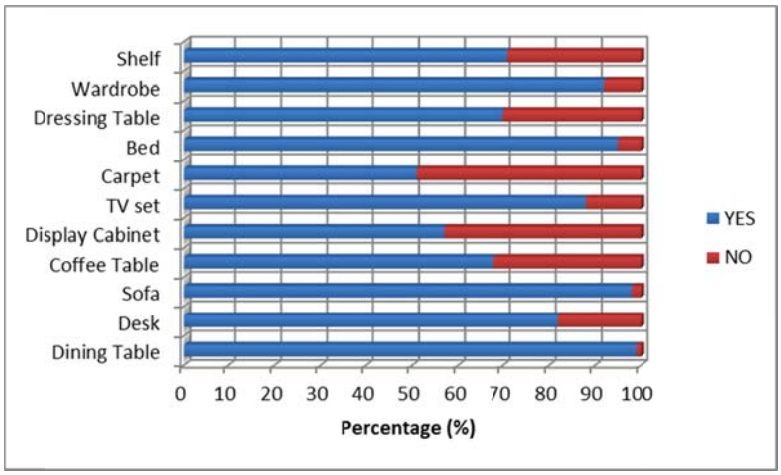


Figure 2. Frequency of furniture usage in habitable rooms of HRRA

4.1.2 Stage II: Identifying the Location of Most Commonly Used Furniture in Terms of Rooms

After identifying the mostly used furniture in the case rooms, its location was specified whether they were located in living room, bedroom, or all rooms of HRRA. Table 1 demonstrates the percentage of used furniture in the case rooms (living room, bedroom, all room). It can be detected that dining table, sofa, coffee table, TV set, display cabinet, and carpet were used mostly in living room. On the other hand, those furniture including bed, desk, dressing table, wardrobe and shelf were mostly considered to be applied in bedrooms as one can anticipate.

Table 1. Location of studied furniture

| | Dining Table | Desk | Sofa | Coffee Table | Display Cabinet | TV set | Carpet | Bed | Dressing Table | Wardrobe | Shelf |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Living room | 50 % | 22 % | 86 % | 79 % | 54 % | 75 % | 40 % | 0 % | 2 % | 0 % | 27 % |
| Bed room | 31 % | 59 % | 4 % | 8 % | 20 % | 5 % | 9 % | 92 % | 82 % | 66 % | 49 % |
| All rooms | 19 % | 19 % | 10 % | 13 % | 26 % | 20 % | 51 % | 8 % | 16 % | 34 % | 24 % |
| Most-used Location | Living room | bed room | Living room | Living room | Living room | Living room | Living room | Bed room | Bed room | Bed room | Bed room |

4.1.3 Stage III: Identify the Most Popular UTs

At this stage, those possible UTs were identified which might be more common in living rooms and bedrooms of HRRA. These UTs consisted of sleeping, storing and changing clothes, eating, relaxing and resting, watching TV, make-up, social meeting, reading, writing, and computer-related working. Figure 3a reveals the usage percentage of UT in HRRA during the daytime (8am-5pm) by respondents. Based on this bar chart, the territory related to computer working has the highest usage in the daytime among all other UTs, while make-up territory has the least frequency of usage among all. Figure 3b depicts the subjective ideas of respondents regarding UTs which should receive more daylight during daytime. However, a great majority of respondents declared that activities related to desk working (writing, reading, and computer working) should receive more daylight compared to other UTs. It can be seen in Figure 3a these three activities (writing, reading, and computer working) considerably used by residents during the daytime.

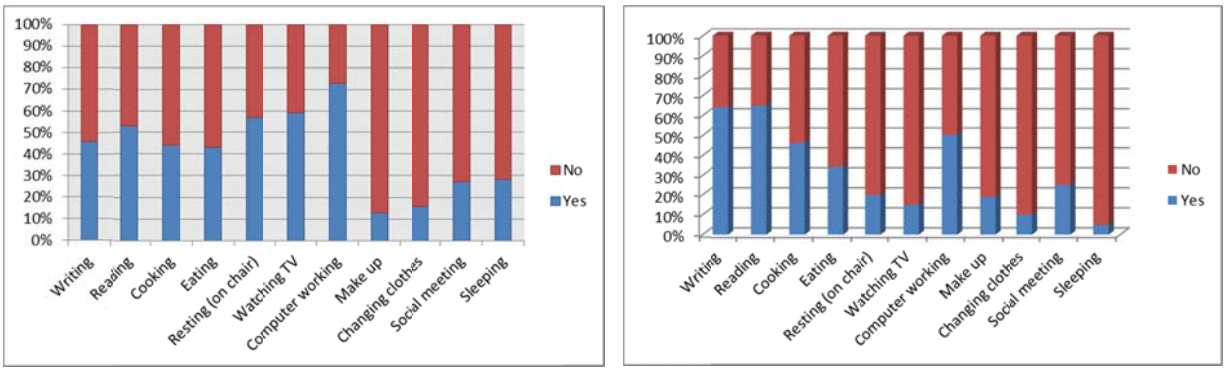


Figure 3. a) Usage of UTs by residents during the daytime, b) daylight-dependent UTs

4.1.4 Stage IV: Identifying the Location of Furniture inside the Room

After specifying the location of furniture, its position in the relevant room should be clarified. Window plays the major role in order to provide visual comfort, especially for daylighting. In this research, rooms with only one window (side lighting) was studied, hence, position of furniture was assessed based on its distance from the window. Accordingly, four options were introduced for furniture position; along wall with window, center of room, along sidewalls and along wall opposite window. Figure 4a depicts the position of furniture in living room. It is clear that sofa, display cabinet and TV set were mostly located along sidewalls, while coffee table and carpet were frequently positioned in the center of room. Dining table was the only furniture that had the farthest distance from window among all. Moreover, the relevant furniture in bedroom was mostly positioned along sidewall (Figure 4b). So desk, dressing table, wardrobe, and shelf had the highest and lowest frequencies along sidewalls and center of room, respectively. Bed was the only furniture in bedroom that positioned along wall with window most of times.

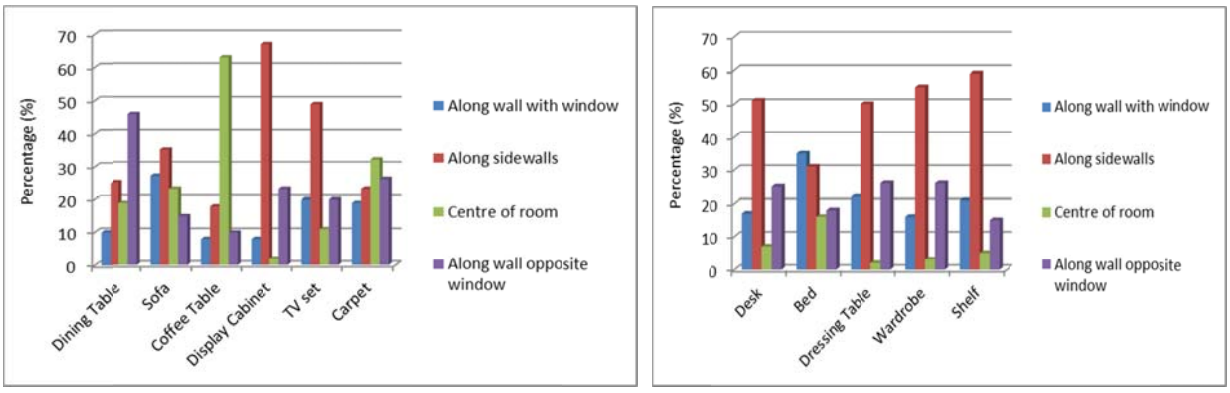


Figure 4. Furniture position, a) in living room, b) in bedroom

4.1.5 Stage V: Measuring Adjacency between Furniture

To measure the adjacency, correlation analysis was conducted among the major furniture. Table 2 shows the Pearson correlation between furniture in living room. Based on it, dining table was only correlated with display cabinet. Although display cabinet had significant correlation with dining table and TV set, it was more correlated with TV set. Besides, sofa had significant correlation with coffee table, while coffee table in addition to sofa had also significant correlation with TV set, so that this value was more for latter. However, TV set was significantly correlated with coffee table and display cabinet, but was more significant with coffee table. Finally, among all studied furniture in living room, carpet was the only one that had no significant correlation with others.

Table 2. Correlation matrix analysis of furniture located in living room

| | Dining table | Sofa | Coffee table | Display cabinet | TV set | Carpet |
|---|---|---|---|---|---|---|
| Dining table | 1 | .133 | .036 | .299***** | .255 | .252 |
| Sofa | .133 | 1 | .357****** | .074 | .194 | .069 |
| Coffee table | .036 | .357** | 1 | .190 | .460****** | .201 |
| Display cabinet | .299* | .074 | .190 | 1 | .428***** | .194 |
| TV set | .255 | .194 | .460** | .428* | 1 | .221 |
| Carpet | .252 | .069 | .201 | .194 | .221 | 1 |

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Table 3 illustrates the Pearson correlation among furniture located in bedroom. According to that, desk only had significant correlation with shelf, while shelf was significantly correlated with dressing table, wardrobe, and desk, so that this value was the most for the latter ones. Meanwhile, dressing table was correlated to bed, wardrobe, and shelf; however, it had the most significant correlation with wardrobe. Furthermore, wardrobe had significant correlation with bed, dressing table, and shelf, while with dressing table this value was the most. Lastly, shelf also had correlation with desk, dressing table, and wardrobe though it was most significantly correlated with desk.

Table 3. Correlation matrix analysis of furniture located in bedroom

| | Desk | Bed | Dressing Table | Wardrobe | Shelf |
|---|---|---|---|---|---|
| Desk | 1 | .164 | .066 | .131 | .390****** |
| Bed | .164 | 1 | .281* | .292* | .186 |
| Dressing Table | .066 | .281* | 1 | .448** | .325* |
| Wardrobe | .131 | .292* | .448** | 1 | .347* |
| Shelf | .390** | .186 | .325* | .347* | 1 |

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

4.1.6 Stage VI: The Other Inherent Characteristics of Furniture that Affect Location

Location and position of furniture and UT are dependent on users' behavior after they brought furniture in their housing units, and could have different layouts based on social or environmental needs. In addition to location of furniture and its position with regard to window, there are other specifications that should be focused on. These factors contain size, material, surface color and brightness of furniture. Besides, furniture may have inherent characteristics that could leave little choice to buyers, and also there is the issue of resident's personalization. Table 4 represents frequently-selected specifications of used furniture by end-users in terms of size, material, surface color and brightness in HRRA in Johor Bahru. Although there might be a host of various selections by users, the table below depicted the mostly-selected ones. All factors of furniture (size, material, color, brightness)

were supposedly considered based on the standardized furniture in Malaysia. In terms of furniture size the variables were put based on the furniture type. For instance, five options were considered as the typical numbers of chair for dining table in Malaysia, including: two, four, six, eight and others. However, dining table with four chairs was often used by respondents in their housing units. In terms of material, it depended on the furniture type, as well. For example, five materials i.e. wood, metal, plastic, glass and leather were deemed for dining table, and among them all, wood was chosen as mostly-applied material for dining table. Besides, around eleven colors were set for every furniture in this study, which in case of dining table, brown color has got the most popularity among residents. Finally, for the brightness of furniture, five types i.e. very dark, dark, medium, light, and very light were assumed. For this, a 5-point Likert scale was conducted to analyze the results based on the mean score. The summary of results in this table revealed that most of used furniture was woody material with brown color and medium brightness in this survey.

Table 4. Mostly-used furniture specification in terms of size, material, color, and brightness

| | ***Size*** | ***Material*** | ***Color*** | ***Brightness (Mean score)*** |
|---|---|---|---|---|
| ***Dining table*** | with four chairs | Wood | Brown | Medium (2.88) |
| ***Sofa*** | with three chairs | Leather | Brown | Medium (2.87) |
| ***Coffee table*** | - | Wood & Glass | Brown & White | Light (3.05) |
| ***Display cabinet*** | Medium (with two doors) | Wood | Brown | Medium (3.04) |
| ***TV set*** | - | - | Black | - |
| ***Carpet*** | $2_{(m)}$ x $3_{(m)}$ | - | Red | Dark (2.68) |
| ***Desk*** | - | Wood | Brown | Medium (3.04) |
| ***Bed*** | Queen size | Wood | White | Light (3.06) |
| ***Dressing Table*** | - | Wood | Brown | Medium (2.84) |
| ***Wardrobe*** | Medium (with two doors) | Wood | Brown | Dark (2.67) |
| ***Shelf*** | - | Wood | Brown | Medium (3.00) |

*4.2 Typologies*

At this stage, based on data collected from the questionnaire survey the conceptual plan of living room and bedroom of respondents was drawn after determining average dimensions of the rooms, location of window, and size of the window. Therefore, these three remained as constant. The furniture layout of 98 living rooms, and 98 bedrooms for every respondent were collected from the survey. Since the location of the UTs inside the rooms were of prime importance for this study, it was important to keep similar group of furniture in the room, and get the average size of those furniture. After that, the location of the UTs with similar group of furniture remained as the only variable. With 40% as the cut-off mark, living room consisted of Dining Table (with Chairs), Sofa, Coffee Table, Display Cabinet, TV set, and Carpet. Bed room consisted of Bed (with Bedside Table), Dressing Table, Wardrobe, Shelf, and Desk (with Chair). With a minimum of 5 occurrences as the cut-off mark, the arrangements of these furniture in Figure 5, and 6 depict the typologies of mostly-used furniture layout in living rooms and bedrooms of HRRA in Johor Bahru. Among all typologies, plan W had the highest usage by respondents (33%). Afterwards, plan Z, Y, X were following which had 25%, 16%, and 14% respectively. Accordingly, altogether these four typologies constituted of 88% of all plans in this study. Among all six typologies of bedroom, plan A had the highest utilization by end-users (24%), while plan C received the lowest usage (10%). Furthermore, plan E, F, D, and B had 19%, 17%, 12%, and 11% respectively. Totally, the six typologies of furniture layout related to bedroom constituted of 93% of all the bedroom plan of this research.

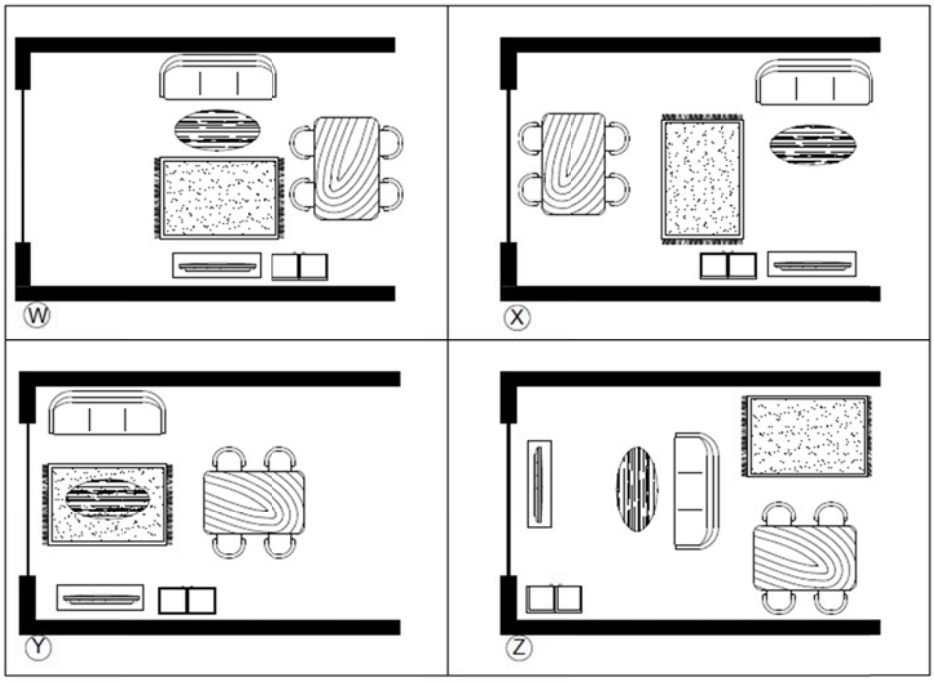


Figure 5. Typologies of mostly-used furniture layout in living room in HRRA in Johor Bahru

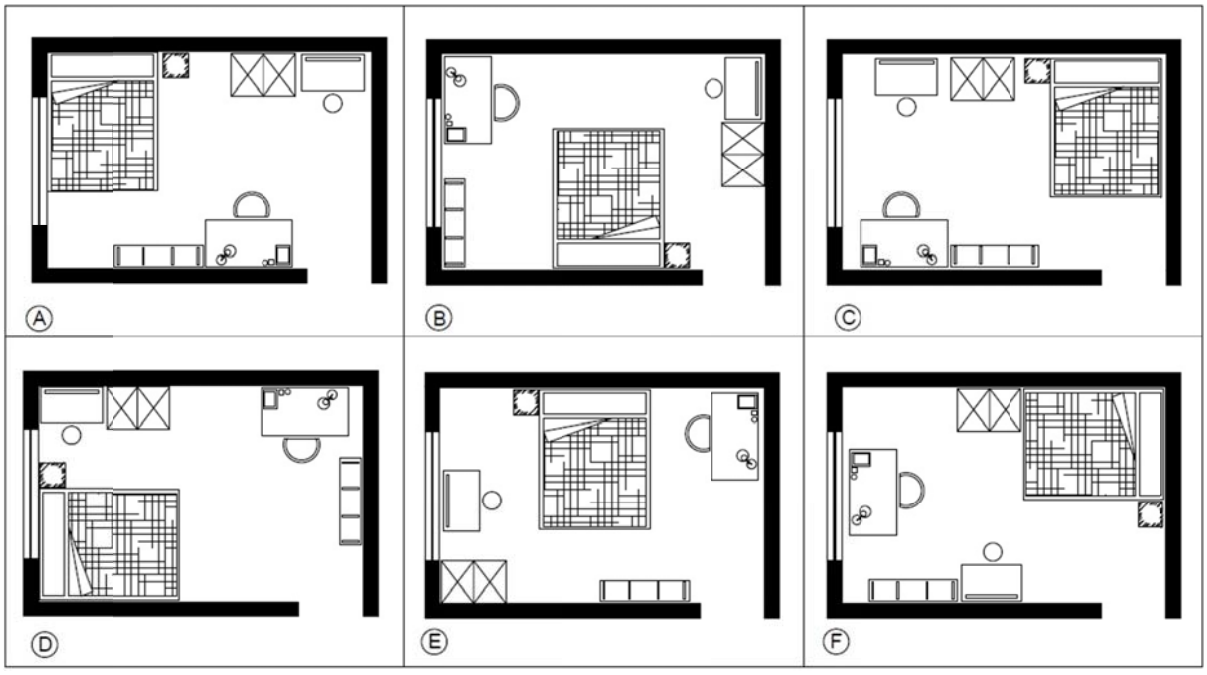


Figure 6. Typologies of mostly-used furniture layout in bedroom in HRRA in Johor Bahru

## 5. Discussion

According to the data collected from the questionnaire survey, the mostly-used furniture location, its position with regard to window, and its degree of proximity to other furniture were investigated. Based on the mostly-used furniture placement in living room (Figure 4a) and its proximity to other furniture by Pearson correlation analysis (Table 2), the mostly-used placement of furniture in the living room could be drawn (Figure 7a). As it can be seen, dining table was mostly placed far from window, while Sofa, TV set, and Display Cabinet

often positioned in the middle parallel to sidewalls. Moreover, Coffee table and Carpet were mostly placed in the center of living room. However, the area near window had no furniture in most of cases. On this basis, three major UTs were identified with their location in the living room namely, eating zone (included dining table) mostly placed at the back of room, resting zone (encompassed sofa, coffee table, and carpet), and watching zone (consisted of TV set and display cabinet) often located in the middle of room. Lastly, the zone near window can be left without furniture (Figure 7b).

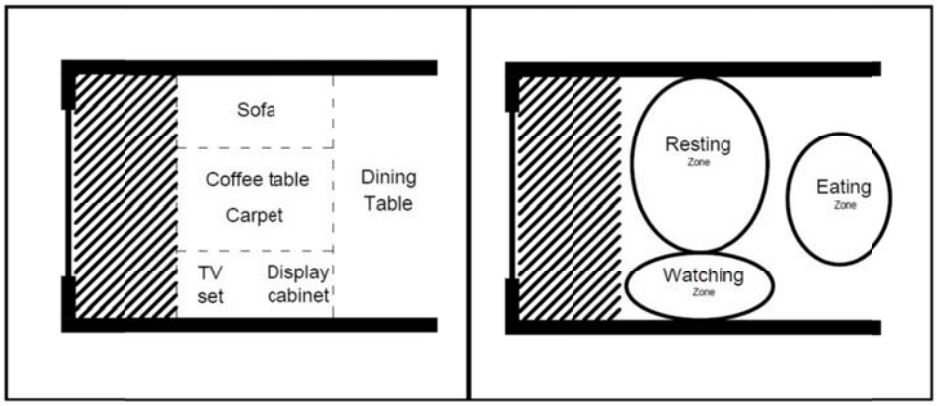


Figure 7. a) Location of mostly-used furniture zones in living room, b) mostly used UTs in living room with location

According to the mostly-used furniture placement in bedroom (Figure 4b) and its adjacency to other furniture by correlation matrix analysis (Table 3), the mostly-used placement of furniture in bedroom of case studies can be drawn (Figure 8). As it can be observed, Bed was mostly placed at the area near window. However, Wardrobe, Shelf, Dressing Table, and Desk were positioned in the middle area of room, while desk and dressing table were farther from the window compared to Wardrobe and Shelf. Finally, bedroom could be divided to three UTs, namely sleeping zone, studying (included desk and shelf) and servicing zone (wardrobe and dressing table). Thus, the central area and ones on the back were often vacant in most case studies.

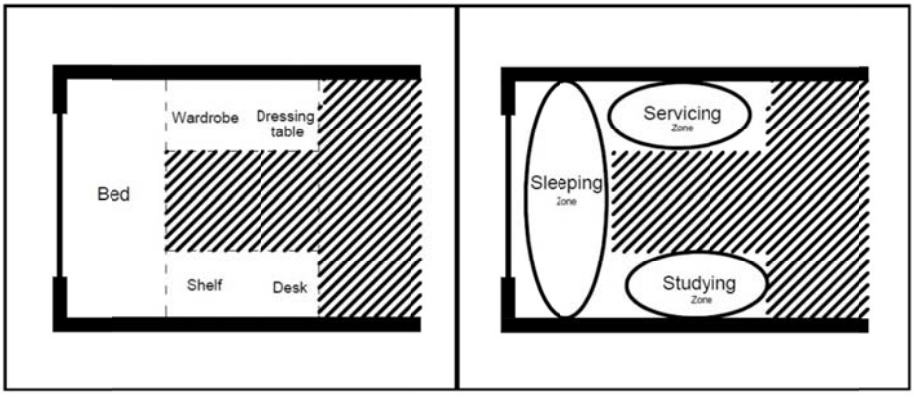


Figure 8. Location of mostly-used furniture zones in bedroom

According to the survey, activities related to desk working (reading, writing, and computer working), especially computer working had the highest frequency of usage by residents during daytime in the case studies. Besides, respondents declared that these activities need more daylight compared to other UTs. However daylighting is one of the major indoor environmental conditions that should be optimized in habitable rooms of residential apartments. Based on data collected from questionnaires, desk working was considered as MDUT in this study. As activities related to desk were located in bedroom, for daylighting study, this room can be analyzed. Based on CIBSE codes for interior lighting –indicating lighting requirements for every space inside a building- the sufficient illuminance for sleeping activity is 100 Lux, while for activities related to desk working the required

illuminance at working plane is 300 lux (Chartered Institute of Building Services Engineers [CIBSE], 1994). Thus, sleeping zone need less daylight compared to study zone. This also verified by analyzing the questionnaire survey. However, based on Figure 8, sleeping zone in most cases received more daylight (nearest UT to window) in comparison with study zone (farthest UT to window). Finally, it can be concluded that the mostly-used furniture layout in the existing bedroom of HRRA in Malaysia was not compatible with the standard daylighting requirements.

## 6. Conclusions and Recommendations

In this study, typologies of MUFL in bedroom and living room in HRRA in Malaysia were investigated. 4 furniture layouts for living room and 6 for bedroom were identified as MUFL, as well as the basic combination of UTs for both rooms were detected. The locations of the UTs inside the two rooms were also explored. Considering the window position, their location to some extent conflicted with the daylight they need for the related activities. Indoor environmental factors such as visual comfort (in terms of daylighting) can alter based on different furniture arrangements. The acquired environmental condition by various furniture layouts was one of the main factor impressed human behavior. However, the environmental needs of occupants should be considered before setting the furniture layout. This can resulted in suitable indoor environmental conditions. In this study, desk working activities (reading, writing, and computer working) were considered as MDUT in the case studies. As this UT was frequently located in bedroom, so daylighting study needs to be conducted more in bedroom compared to living room. The study showed that the mostly-used furniture zone in bedroom cannot be accorded with daylighting needs for every UT. Thus, the social needs of occupants in terms of furniture layouts were against their indoor environmental needs in terms of sufficient daylighting for each activity. The future study can focus on these typologies of furniture layouts and theirs impacts on indoor environmental condition in HRRA. Besides, the information of this study can be valuable for furniture manufacturers and interior designer to provide typological sets of furniture layouts for high-rise housing apartments.

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