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Morphological adjustments of domestic spaces: Spatial adaptations in the apartments of the lower-middle-income group in Dhaka.

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ABSTRACT

The enormous growth of the population in Dhaka results in massive stress on its accommodation, infrastructure, utilities, services, and other facilities. In this critical urban situation, lower-middle-income families can only avail minimal spaces for their domestic use. However, living in such small areas is challenging for these families to appropriate functional use and activities. In addition, for economic reason they rent-out part of the apartments and both families adjust within the limited spaces. All these result into physical alterations to their domestic space layouts which are originally designed by professionals. This research aims to identify the spatial pattern of the altered morphological character of the domestic space through space syntax analysis using jass software. Thus, it tries to find out how the altered layout reflected their social realities and how different they are from the original designed apartments in spatial terms. Fifteen apartments have been analyzed through comparing the originally built and altered layouts in relation to users functional and other social needs. The study identified significant changes in the zoning of domestic space. These adaptations have a considerable impact on the morphology of the domestic area, which retained specific characteristics from the original layout but put the apartment together in a new way. Though it is tough to maintain privacy and segregation within this limited space, it is a significant concern to the occupants during the alteration. It is identified that through control of access, use of partitions, and reallocation of activities those small apartments are altered into less ringy and more tree like configurations. All these alterations have significantly modified the integration and control values of different domestic spaces, thus altered the original layouts into a more acceptable one in social and functional terms.

KEYWORDS

Domestic Space, Building Morphology, Spatial Organization, Space Syntax, Spatial Adaptation

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1 INTRODUCTION

Dhaka, the capital of Bangladesh, is one of the most populated cities in the world. It is also predicted that Dhaka will be the 6th largest megacity globally, with a 28.08 million population in 2030. The rapid growth of Dhaka's population has also led to greater demand for housing units, including land for housing. Various literature found that different socio-political, cultural, economic, and physical forces have acted in different degrees on the growth of urban pattern, design, and organization of the house form of Dhaka (Imamuddin, 1982). The city's population increase led to the multi-storied compact apartments to meet the housing demand (Rashid, 2000). Different public and private agencies supply housing to these urbanites though it is insignificant compared to the actual needs. However, the price and the delivery system determined for allotment of these provisions is hardly accessible by the lower-middle-income people. There is minimal housing provision for the lower-middle-income group in the formal sector. Government staff housing is the only housing provision in the formal sector, especially for the lower-middle-income group. According to government accommodation rules, every government employee is entitled to a standard floor area allotted to them as a dwelling space on a rental basis (MoW. 1992). This form of public housing is highly subsidized for its tenants. Government cannot provide them with larger apartments against their lower range of income; as a result, mostly large families, either nucleus or joint, are occupying these houses who cannot afford bigger apartments with their limited income. The apartments which are entitled to the lower-middle-income families range from approximately 46-74 sq. m. However, many apartments houses are as small as 39.5 sq. m. Here architects face a difficulty while designing such apartments. Most of the time, the architects designed these apartments, only considering a small family but without realizing the actual needs of these income groups. As a result, except their limited floor areas, the design solutions are not very different in spatial organization from any other small apartments of other income groups.

Due to limited size, the dwellers have to adjust their lifestyle within the given area through a number of physical alterations in the apartments while living. Sometimes such alterations change the actual use of a space for which it is designed. According to Hillier and Hanson, the possibility of better design increases by understanding the relation between spatial morphology and social life (Hanson, 1998). Moreover, the analysis of domestic space configuration provides the link between the design of dwellings and their social consequences (Hillier et al., 1984). Thus the morphological characters and the alterations need to be studied to make a more appropriate design solution for the domestic space of lower-middle-income people. This research is intended to investigate lower-middle-income houses' space-use patterns and spatial organization to determine domestic space's morphology through spatial analysis. In the urban houses of Dhaka, the household activities can be classified into family activities and formal activities (Imamuddin, 1982; Khan, 1999 and Rashid, 2000). Family activities are working, eating, sleeping, cooking, etc., performed in the inner part of the house. In contrast, formal activities are socializing, receiving guests, which include participation in the community, served in the outer part of the

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house near the entry. However, the studied apartments for this research show that the domestic spaces used by the dwellers are far different from the architect's original design. Hence this research looks into the morphological adjustments to these small apartments by the occupants due to alterations and tries to identify their reasons to recognize the architectural morphology of domestic space concerning the socio-cultural and functional needs of the lower-middle-income group in Dhaka.

2   DOMESTIC SPACES AND ADAPTABILITY

House is not only a list of activities or rooms but also the integration and segregation between different domestic activities (Hanson, 1998). A house is a pattern of spaces, governed by the complex conventions of space types, the connection, and sequence. People require a place that is suitable for their needs. Ukoha and Beamish (1997) assert that providing additional dwelling units alone, without considering their suitability to the actual needs of the residents, does not give an accurate measure of whether a housing program is successful or not. Housing suitability relates to the dwelling that meets the spatial requirements of housing residents relative to the functions for which the spaces would be used. It can be judged by spatial size, layout, and circulation patterns, as well as by the degree of privacy and flexibility it offers at different stages of a household's life cycle (Agyefi-Mensah et al., 2010). Many researchers indicated that the user's demands determine the role of space (Jong & Voordt, 2002; Tipple et al., 2002 and Lawson & Ogden, 2006). Space in every home will vary, according to the culture and customs of inhabitants. So the space will need to be adapted to inhabitants' activities to be functional, while users will often adjust to the available space. The functionality of a building means that the building complies with its functional programs, set by the spatial conditions, requirements, and efficient maintenance of building elements. It shows the capability to serve the design purpose. Adaptability means the ability of space designs to accommodate functional and dimensional changes required by the occupants. Additionally, some adaptations might also be required to meet changing user needs over time. Important determinants of adaptability derived from literature are generality and flexibility. Generality refers to a movement in function without affecting characteristics, whereas flexibility refers to a shift in function with low expenses and interruptions in operation (Bullen, 2007 and Douglas, 2006). Adaptability in this research deals with the rooms or spaces of the houses to be changed and adapted for various domestic activities in line with the user's needs.

2.1   Application of Space Syntax Analysis

The literature presented the theoretical foundations and methodology of space syntax as a research strategy for studying the spatial layout of domestic space with examples of how these methods were employed for studies in different contexts and communities. Space syntax offers objective analyses within architecture and allied disciplines of the built environment to support documented and observed phenomena about space that are especially beneficial in a scientifically motivated era where hard facts are often preferred over observed entities. As all examples reveal,

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combining space syntax analysis with documentation of buildings, observation of space use patterns, socio-cultural information, and other demographic data offer robust and realistic results for future architectural and housing studies. From the literature, some critical findings have been established. Kenji Omata (1992) studies Japanese students' house plans, examines room usage and how people combine different activities to efficiently use a limited number of spaces in Japanese houses. The results indicate that the functional differentiation of rooms is reduced in tiny houses. Multifunctional use of family space has introduced. In many situations, family and entertainment rooms overlapped, although private space was separate from both. Based on an analysis of each house's construction and arrangements, Monteiro (1997) contrasts the spatial distribution of domestic activities of various socioeconomic groupings. The findings showed that the more integrated activities are the social ones, involving all family members and guests. The most segregated parts are the personal space (resting, bath). For a small house, privacy is a matter of timing, not the room, and the most integrated spaces are located in the inner area of the house. By comparing the original and revised organization, Altas and Ozsoy (1998) examine the adjustments and adaptations made by users in living space to determine probable design types for future alterations for residential satisfaction. They concluded that user satisfaction depends on size, shape, solid-void relation, furniture type, etc., other than the dwelling size. There is a complex relationship between the perceived space and actual dwelling size in terms of space organization. The proper organization of rooms can encourage flexible use or adaptation in a dwelling. In 2003, Franca and Holanda investigated room use concerning time. The study concluded that the communal spaces are ringy and private areas are tree branches. Dining acts as a transition between the ring and tree-like systems and strengthens access control to the most segregated parts of the house. The kitchen has higher integration, so it expresses its importance in the family role. Living is for visitors, and the kitchen is for family interaction. According to age, gender, time, and activity, Asquith (2006) looked at how space was used in the family household. It concluded that looped or linear spaces are frequently utilized and multifunctional rather than branched syntax. Women and younger children prefer more integrated areas than males, and older they prefer more segregated spaces. Franca and Holanda (2009) analyze the configuration of space occupation and use by inhabitants to understand the people's way of living in apartments. They compare the original and modified plans. They concluded that apartments become less distributive after the modifications that reinforce the isolation of the private area. Smaller apartments are more permeable and integrated but less private. On the contrary, larger apartments are less integrated and have a greater level of privacy. The study shows that the needs of occupants can change the various dimensions of domestic space. Despite the need for privacy in the private area (e.g., bedrooms), functional differentiation has reduced, and multi-functionality has increased in domestic spaces in small apartments. Furthermore, segregation results from timing rather than space in a compact residence. A better understanding of the morphology of small apartments is observed using space syntax and the outcomes from the literature. Hence, space syntax could be an effective tool to determine the type and character of the alterations in the lower-middle-income groups' apartments in Dhaka.

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3   RESEARCH METHODOLOGY

The research is intended to analyze spaces as initially built and after modifications by their occupants, studying domestic space uses and the adaptations with the house's current status in terms of their functional use. The original plans are compared with the altered ones to understand the adaptations. Data collection through observation, questionnaire survey, interviews with designers and concerning authorities, etc., is performed in the field survey part. The focus of the survey is on any morphological changes such as alterations on walls and doors, the position of furniture, using the partition & curtains, etc., made to the houses by the occupants to suit their requirements and the reasons for such changes. The space syntax method is used for data analysis to understand the morphology of the dwelling space.

For this research, fifteen samples were selected from Dhaka's different government staff housing. In Dhaka, these dwellers cannot afford their dwellings in the private sector, so ones allotted they do not change their houses frequently. It helped them alter the spatial organization of dwelling space according to their needs, which is a prime concern for selecting these case studies. The respondent's socio-economic variables are matched due to the standard allotment process, which increases the internal validity of the research. All of the respondents are class-III and IV, government employees. The space allotted to these families is calculated by only the area of a dwelling unit without any common spaces like stairs, common lobby, etc. For greater reliability, the apartments are selected through some sampling criteria, such as the samples must have some modifications by their occupants.

3.1   Space Syntax: Theory, Techniques and Variables

Space Syntax is a tool by which buildings are transformed into the form of an adjacency graph to represent, quantify and interpret the spatial pattern of buildings so that their underlying 'social logic' can be understood. Space Syntax generated techniques to identify and describe characteristics of spaces that occur in relevant repetitions within the different systems of a specific society, interpreting from them a correlation to social factors. It is a fact of space that creates the spatial relation between function and social meaning in buildings.

JASS software generates the Justified Accessibility Graph (J-Graph) for both sets of apartments (original & altered) to understand the spatial organization. Convex space is represented as a circle in the graph, and lines represent its connections to other spaces. The main entrance to the house is considered the root to conduct all calculations. The analysis is carried out with five parameters. Distributedness expresses the system of convex spaces. The ring system (more distributive) implies different options of connecting spaces. A tree-like system (less distributive) indicates that only one possible route exists among the spaces. Every convex space in a J-graph would fall under one of four topological space types based on their connections (Hillier, 2007). Thus, 'a-type' is terminal spaces with a single link; 'b-type' is thoroughfares with more than one link; 'c-type' lies on a ring and movement; 'c-type' space provides a choice; 'd-type' is junctions

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located between two or more rings. The physicality of space topology differentiates passages, connections, and place types (Hanson, 1998). Integration describes the average depth to all other spaces in the system. A space with the highest degree of integration can be accessed easily and quickly from the neighboring areas under normal conditions. In contrast, when a space has the lowest degree of integration, it is less accessible due to its topological distance farther away from the others, thus most segregated in the house. Depth is topological distance, measured by the number of convex spaces that separate the areas within the system and from the outside. Control value measures the degree to which a space controls access to its immediate neighbors, considering the number of alternative connections each has. If the control value is less than one, the control of the space becomes weak (Hillier & Hanson, 1984).
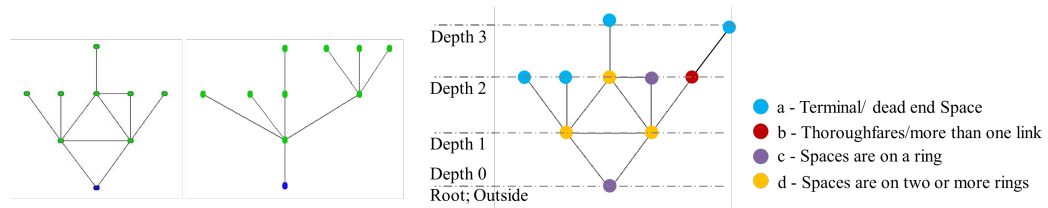

Figure 1: Ringy and Tree graph; Depth and Typology (left to right)

4   CASE STUDIES

When the dwellers start to live in any house despite having the same initial design, the users have altered the house differently according to their own choices and needs. Hence three differently altered case studies with one original plan layout have been selected. Thus, fifteen cases have been selected for this research, which has five original plan layouts to identify sufficient alterations and get possible alternate alterations. The original plans of the samples are denoted by A, B, C, D, and E. A-1, A-2, A-3, denotes the altered examples of original sample A. Similarly, B-1, B-2, B-3 for the original sample B and, thus, samples C, D, and E (Fig.3). The lower-middle-income houses are mainly composed of primary functional spaces like living, dining, kitchen, one or two bedrooms, verandas, bath, and toilets. In many cases, these apartments have separate baths and toilets to enhance functional usability. The samples have very compact internal arrangements. Due to limited area, architects usually designed the living space as multifunctional for living cum bedroom purposes. These rooms are denoted here as liv-bed. Many users also used their dining and veranda for bedroom purposes in the altered layout. In such cases, these spaces are mentioned as din-bed and ver-bed, respectively. All the rooms are denoted according to their new use in an altered layout.

Figure 2: Azimpur, Green road, Mirpur BCSIR and Palashi Government Staff Housing (left to right).

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The respondent's socio-economic and demographic information has been summarised to understand their status. According to the Bangladesh government's 8th national pay scale, the basic pay of Class-III and IV employees (Grade 11-20) ranges from 8250-12000 BDT/month. A common trend among these families is extended families, though nuclear families are currently increasing in other income groups in Bangladesh. Among fifteen samples, ten families are extended with immediate family members or sometimes with distant relatives. In a few cases, the family of a married daughter also lives with her parents though living with a girl's family in our society after marriage is very unusual. These circumstances occurred because they could not afford to live in separate apartments. Again for some extra economic benefit, despite the limited area and large household size, many occupants give a room of their apartment for sublet. Five families have given one of their rooms for sublet among all the case studies. They have used the same apartment entrance and shared the facilities with the allottees like toilet, bath, kitchen, etc.

Table 1 :Socio-economic and demographic data of the case study families. Here, E=Extended & N=Nuclear family (family type); N=No & Y=Yes (sublet)

Apartment size	Sample No	Occupancy period	Household size in person	Family Type	Sublet	Salary grade
425 sq. ft.	A-1	16	4	E	N	16
	A-2	12	5	E	N	16
	A-3	8	6	E	Y	20
530 sq. ft.	B-1	16	5	E	N	16
	B-2	20	3	N	N	20
	B-3	5	4	N	N	14
580 sq. ft.	C-1	15	3	N	N	16
	C-2	15	5	E	N	16
	C-3	5	5	E	Y	16
690 sq. ft.	D-1	42	6	E	Y	14
	D-2	5	5	N	N	16
	D-3	12	5	E	N	11
800 sq. ft.	E-1	5	7	E	Y	16
	E-2	19	4	E	Y	13
	E-3	19	3	N	N	11

5 FINDINGS

The original and altered plans are analyzed, complementing the information found from the observation and questionnaire during the field survey. The plans are investigated concerning space use and alterations in layout. After alterations, the spaces are identified by the major activities of that particular space. In the original layout, two types of entry have been observed. When they have two entrances from outside, one directly enters the liv-bed and another in a foyer. After alterations, all the apartments have ensured foyer space by closing the direct entry to the liv-bed or giving a partition in the dining area. The users controlled the access primarily by giving partition and closing a few doors permanently to achieve privacy and for effective space use to place the furniture in the room as they have minimal space. In local culture, living is used mainly to socialize with outsiders and guests. The respondents have stated that besides living, the dining and bedrooms are also used to entertain the female guest. Dining is used for eating and doing other household works and also used as bedrooms at night beside the regular dining activity due to the shortage of rooms in the altered apartments. Dining and the room where the TV is placed act as family gathering space. From the spatial analysis of this study, in altered

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layout, major activity spaces like liv-bed, dining, and bedrooms are found as multifunctional spaces holding many activities in the same place but at different times.
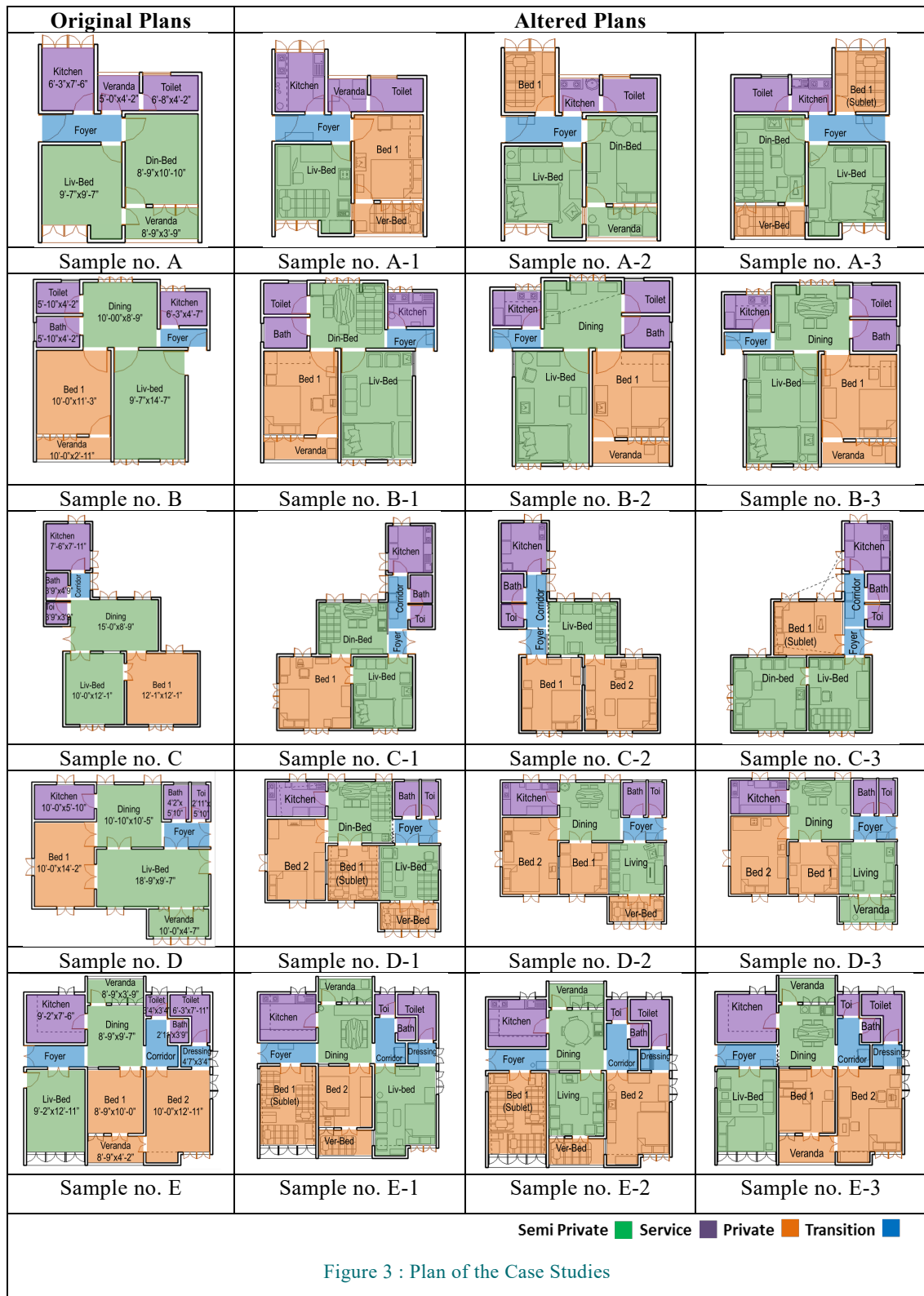
Figure 3 : Plan of the Case Studies

After alteration, significant changes have been observed in the case of the original liv-bed, dining, and the veranda space. In 100% cases of altered layout, they ensure a small foyer space from where the user can go to the living area or the inner area (i.e., dining, bed) of the apartment,

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whereas 80% of apartments have the foyer before (Fig.4). Among all the samples of which the size of the liv-bed is comparatively large, the occupants divided those rooms into two with a partition (Sample D). After partition, many users used one room only for living (20%), thus separating the formal area from the private area (Sample D-2). However, few users still used the room as a liv-bed (Sample D-1) despite the partition due to the need for an extra room. After partition, the other room is used as an additional bedroom for family members or sometimes a sublet.

There is a major change in the character of the dining space. Due to shortage of space, some dwellers have used their dining area also for bedroom purposes (53.3%), thus changing its functional use from dining to din-bed (Sample B & C). However, in the original layout, such din-bed was only 20%. Few other dwellers shift their kitchen into a veranda and convert it into a bedroom for an extra bedroom (Sample A-2 & A-3). The veranda is also often used as a bedroom; those spaces are mentioned here as ver-bed (40%). There was no such space in the original design.
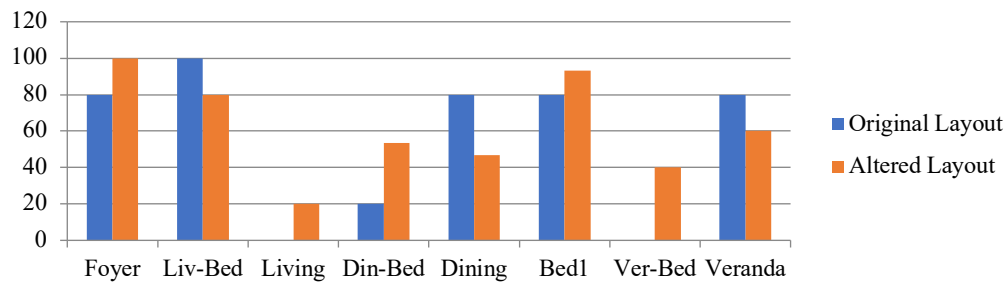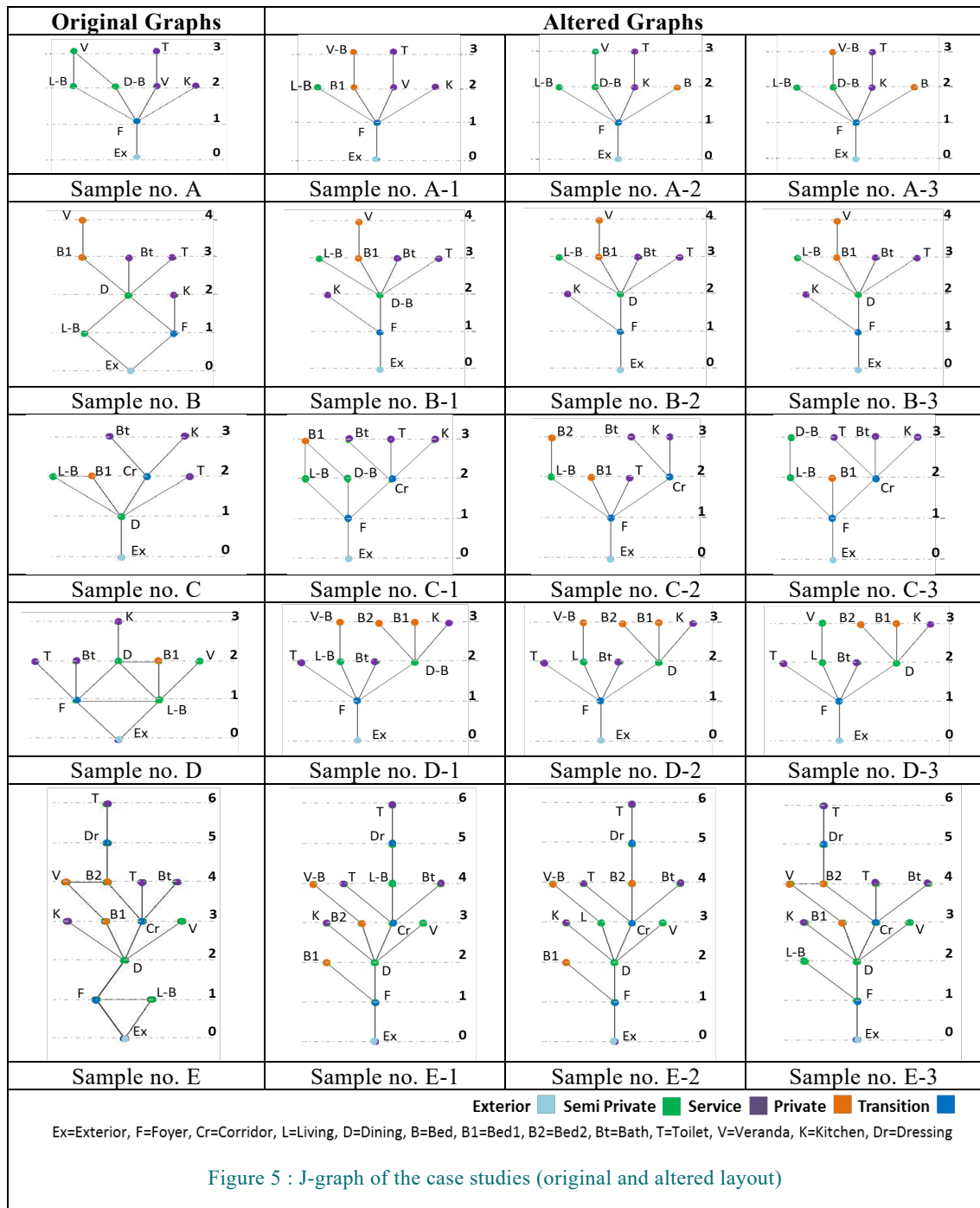

Figure 4 : Percentage (%) of domestic spaces (original and altered layout)

The spatial properties from space syntax analysis allow practical explanations regarding the effects of spatial configuration on various social or cultural variables or attributes. Space syntax research understands configured space itself, particularly its formative processes and social meaning. As discussed below, this research interprets the syntactic data from space syntax to identify domestic space's morphological adjustment for lower-middle-income groups.

5.1   Distributedness and Space Topology

In the original layout, all the five apartments of case studies had ringy configurations showing a choice in the access to the domestic spaces (Fig.5). The ring was located in maximum cases among liv-bed, dining, bedroom, and veranda. The major activity spaces are designed mostly as 'c-type' and 'd-type' in the original layout, located between single or multiple rings with more permeable access. However, after alterations, most of the apartments transformed into a tree-type layout, except C-1 and E-3, which indicate a significant feature that access becomes more controlled and limited in the altered design. Thus major activity spaces are converted to 'a-type' or 'b-type' spaces either located at the end of the configuration (living, liv-bed, and bedroom) or in a transition (mostly dining, din-bed). Such alterations make the rooms with beds more segregated, thereby increasing the degree of privacy. As a result, the dining or din-bed room acts as a node and distributes movement to the inner spaces in the house in an altered layout.

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Figure 5 : J-graph of the case studies (original and altered layout)

5.2 Depth, Integration and Control value

Here, the carrier/root is considered from the exterior lobby of the apartments. The depth values of all other spaces of the configuration are measured from the root space. In most cases, the apartments are 3-4 steps deep, except sample E, which is six steps deep (Fig.5). According to the mean depth value, most apartments become deeper after alteration. The mean depth of the major activity spaces like liv-bed, dining, and the bed has also increased (Fig.6), meaning these spaces are becoming deeper than the original design. Therefore, the inner spaces or functions became more segregated after alteration from the outside. The most increased mean depth value is found for the liv-bed spaces. Before alteration, the mean depth value of liv-bed was 1.4 (Table.2 in

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appendix), whereas, after alteration, they become 2.42 (Table.3 in appendix). In the original layout, the depth of the liv-bed and dining was either 1 or 2. However, after alteration, the value changes to 2 and 3. This shift in depth value has occurred for two reasons: closing the direct door to the living room from the outside and ensuring the foyer after entry for functional reasons, thus enhancing the room's privacy. Remarkably one living-bed has shifted in depth 4 (Sample E-1) because the original liv-bed converted to a bedroom for sublet. The number of bedrooms in depth 3 has increased by partitioning the larger liv-bed (Sample D-1/D-2/D-3).
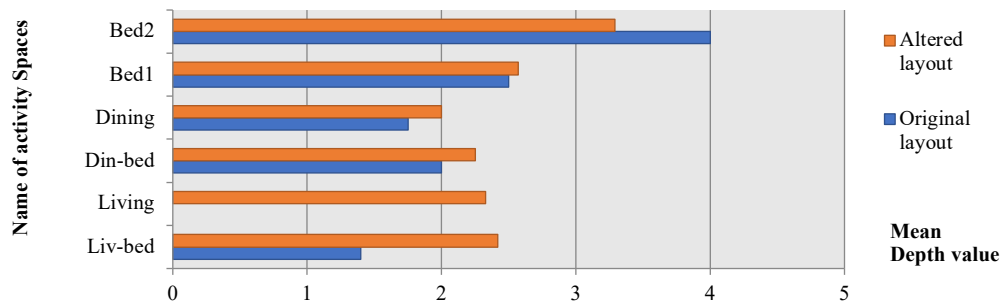

Figure 6 : Mean depth of different spaces in original and altered layout

In the original layout, the mean integration of the apartments was around 1. However, after alteration, all the values are lower than 1. An integrated space in the house allows more direct access to the rest of the house than a less integrated space (Hillier & Hanson, 1984 and Hillier, 2007). As the mean integration of all the altered apartments has a lower value than the original one, therefore the altered apartments become less integrated into an altered situation (Table 4 & 5 in appendix). Thus, many functions have become more segregated than in the original design. When altered, the most integrated spaces are the spaces holding social interaction (foyer, living, dining, din-bed), and the segregated spaces are the personal or private activities (bedrooms and service). The foyer, circulation, and dining act as the node and distribute movement to the inner spaces in the house in an altered layout. These spaces have the highest mean integration value in original and altered layouts. In altered design, the liv-bed and bedrooms become less integrated as these spaces are used for sleeping purposes besides their usual activities. Thus, these private spaces become more private by segregation. After alteration, the mean integration value of all the individual spaces has decreased except the din-bed. The new din-beds are altered functions of existing dining with a high integration value (sample B-1/C-1/C-3/D-1).
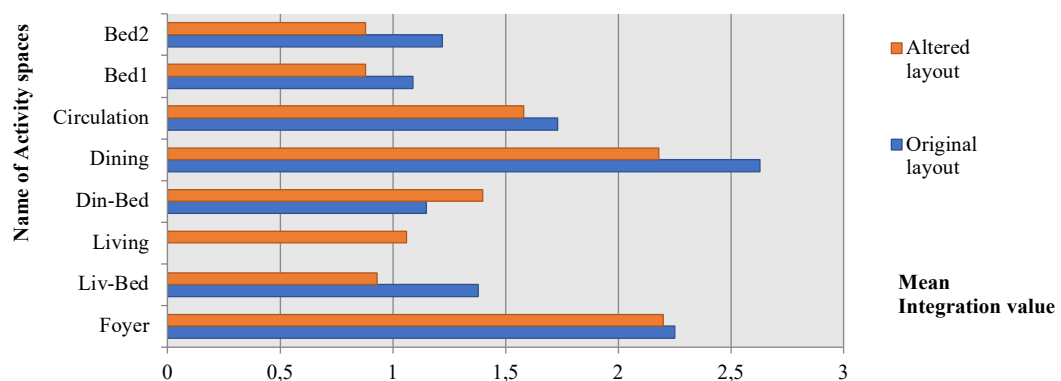

Figure 7 : Mean integration of different spaces in original and altered layout.

The control value is a dynamic local measure. It measures how well a particular space permits or restricts access to other spaces within the overall system. The semi-public or common spaces in a domestic layout like the foyer, dining, dining-bed, and circulation have higher control value after the alteration, which means more control is attained by the spaces over the accessibility to its adjacent spaces (Table.7 in appendix). Liv-bed and other bedrooms have less control value after the alterations, which indicate that these spaces require high segregating quality in domestic layout as they are private activity spaces. In both original and altered layouts, the control value of dining always appears high. This syntactic measure represents that dining always acts as a major transitional space regarding privacy and accessibility.
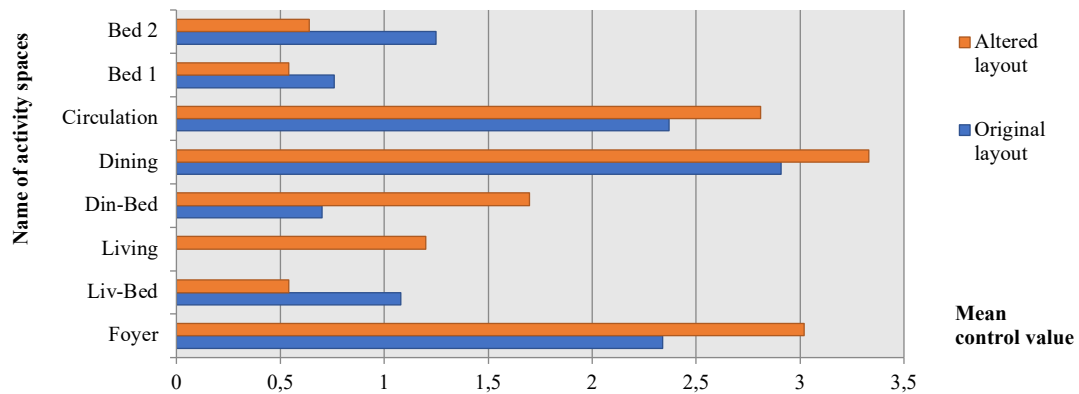

Figure 8 : Mean control value of different spaces in original and altered layout.

6   DISCUSSION

This research has focused on user preferences about the morphology of dwelling spaces concerning the social, functional, and economic needs of the lower-middle-income families in Dhaka. It also identifies the morphological adjustments, the reasons for such adjustments, and the consequences, which helps determine domestic space morphology through space syntax analysis. Dwellers altered the apartments in many ways, such as by controlling the access (permanently closed door of living from outside), shifting the main entrance (ensured the entry through foyer), using partition (for making one room into two), internally shifting the activity between space (kitchen converted to bedroom and veranda into the kitchen). Less access can accommodate more furniture, which is a prime concern for these families.

The studied apartments had ringy configurations in the original layout. Those became tree-like configurations after alterations, indicating more choices in the access to the domestic space in the original layout but limited in the altered layout. The original layouts are more distributive, having alternative routes. Whereas the altered layouts are less distributive, a single sequence of spaces creates one or two branches afterward. Hence the major activity spaces change their space topology from within a ring or junction to mostly terminal spaces. The original plans provide access with more than one link, whereas, after alterations, the movement is highly directed, leading to a dead-end space. The social or common space (din-bed, foyer, corridors), mainly used for family interaction and sometimes for attending female guests other than taking meals, has a

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greater integration and control value in both layouts, original and altered. Personal spaces like bedrooms or other multifunctional spaces, which are also used as beds (liv-bed or ver-bed), had high integration in the original layout. In an altered layout, the value decreased. These syntactic patterns indicate that the occupants need more privacy, layering between spaces, and segregation in private areas from the outside and visitors. Though it seems a primary concern for designing a Bengali house, however is difficult to achieve for a lower-middle-income family due to their large household size and small dwelling area. Besides, these families need extra rooms in their apartments for many socio-economic pressure. They have a larger household size and always need some extra income. Sometimes, they rent a room to an outsider other than family members. These reasons compelled these families to use most of the spaces as multifunctional and shift activity or partition to make extra bedrooms. In other words, multi-functionality of space is highly necessary, especially for lower-middle-income houses. Space should be designed so that it can hold many activities. During designing, architects considered this multifunctional idea in a few spaces (e.g., liv-bed), but the idea is not vividly expressed in the plan. As a result, the expected living pattern of the designers is not fully followed by the dwellers in these apartments.

7   CONCLUSION

This research founds that how the designers initially determine a space's function is not how users use it. Architects planned the apartments in a more distributive and integrated way. In contrast, users converted it to less distributive and less integrated networks within a deeper and controlled space considering their social and economic situation. The users have to personalize and adapt the house to their needs and lifestyle. As the families have lived in these apartments for a long time, they have tried to solve their emerging spatial needs. Through the alterations, residents can cope with the inadequacy of their homes since they lack the economic power to shift their dwellings to a bigger or more adequate one. It can be stated that the adaptations mainly take place to use the limited dwelling area more effectively. Although due to limited spaces, these houses cannot accommodate all the activities. Hence designing the multifunctional spaces through time adjustment and space zoning could increase the house's functionality. In this way, spaces could have achieved higher value in terms of functionality when they could accommodate multiple activities in the same space. Although the functionality of space also means there are no disturbances among activities that are not fully satisfied here. The research also finds that privacy acts as a major determent of the alterations of these residences. Besides enhancing the functionality of space, all the alterations and changes have been made in the apartments; privacy is a major reason behind them, especially in the personal spaces. The initial design of current public housing for lower-middle-income families was incompatible with their spatial configuration of domestic space. The designer could not understand the users' needs and aspirations. From this research finding, it can be clearly stated that in the current process of mass housing production, architects do not need to meet the end-user throughout the design stage of the project, creating 'designer-user gaps' (Rodriguez Machado 2004; Ziesel, 1984).

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Understanding the trends and the reasons for the alterations from this investigation will help the concerned authorities and architects re-evaluate the future design of houses and housing.

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APPENDIX

Table 2 : Depth value of the Case studies (Original)

	Sample A	Sample B	Sample C	Sample D	Sample E	Mean Depth
Foyer	1	1		1	1	1
Liv-bed	2	1	2	1	1	1.4
Din-bed	2					2
Dining		2	1	2	2	1.75
Corridor/circulation			2		3	2.5
Bed 1		3	2	2	3	2.5
Bed 2					4	4
Kitchen	2	2	3	3	3	2.6
Veranda (with bed)	3	4			4	3.67
Veranda (with living/liv-bed)				2		2
Common Bath		3	3	2	4	3
Common Toilet	3	3	2	2	4	2.8
Common Veranda	2				3	2.5
Mean Depth	2.14	2.38	2.14	1.88	3.31	2.84

Table 3 : Depth value of the Case studies (Altered)

	A-1	A-2	A-3	B-1	B-2	B-3	C-1	C-2	C-3	D-1	D-2	D-3	E-1	E-2	E-3	Mean
Foyer	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Liv-bed	2	2	2	3	3	3	2	2	2	2			4		2	2.42
Living											2	2		3		2.33
Din-bed	2	2	2	2			2	3	3	2						2.25
Dining					2	2					2	2	2	2	2	2
Corridor/circulation							2	2	2				3	3	3	2.5
Bed 1		2	2	3	3	3	3	2	2	3	3	3	2	2	3	2.57
Bed 2									3	3	3	3	3	4	4	3.29
Kitchen	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	2.6
Veranda (with bed)		3		4	4	4									4	3.8
Ver-Bed	3		3							3	3		4	4		3.33
Ver(living/liv-bed)												3				3
Common Bath				3	3	3	3	3	3	2	2	2	4	4	4	3
Common Toilet	3	3	3	3	3	3	3	2	3	2	2	2	4	4	4	2.93
Common Veranda	2												3	3	3	2.75
Mean	2.14	2.14	2.14	2.63	2.63	2.63	2.38	2.33	2.38	2.33	2.33	2.33	3.38	3.38	3.38	2.99

Table 4 : Integration of the Case studies (Original)

	Sample A	Sample B	Sample C	Sample D	Sample E	Mean Integration
Foyer	3.45	1.48		2.96	1.1	2.25
Liv-Bed	1.15	1.11	0.99	2.96	0.69	1.38
Din-Bed	1.15					1.15
Dining		2.96	3.45	2.22	1.89	2.63
Corridor/circulation			1.72		1.73	1.73
Bed 1		1.11	0.99	1.11	1.16	1.09
Bed 2					1.22	1.22
Kitchen	0.86	0.68	0.69	0.81	0.9	0.79
Veranda (with bed)	0.69	0.59			0.99	0.76
Veranda (with living)				0.89		0.89
Common Veranda	1.15				0.9	1.03
Common Bath		0.89	0.69	0.89	0.87	0.84
Common Toilet	0.57	0.89	0.86	0.89	0.87	0.82
Mean Integration	0.95	0.95	0.99	1.21	0.92	

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Table 5 : Integration of the Case studies (Altered)

	A-1	A-2	A-3	B-1	B-2	B-3	C-1	C-2	C-3	D-1	D-2	D-3	E-1	E-2	E-3	Mean
Foyer	3.45	3.45	3.45	1.48	1.48	1.48	1.48	2.96	2.22	2.75	2.75	2.75	1.1	1.1	1.1	2.2
Liv-bed	0.86	0.86	0.86	0.89	0.89	0.89	0.99	1.11	0.99	1.1			0.99		0.67	0.93
Living											1.1	1.1		0.99		1.06
Din-bed	1.15	1.15	1.15	2.96			0.99		0.55	1.83						1.4
Dining					2.96	2.96					1.83	1.83	1.89	1.89	1.89	2.18
Corridor/circulation							1.27	1.48	1.77				1.6	1.6	1.73	1.58
Bed 1		0.86	0.86	1.11	1.11	1.11	0.63	0.89	0.81	0.79	0.79	0.79	0.67	0.67	1.16	0.88
Bed 2								0.59		0.79	0.79	0.79	0.99	0.99	1.22	0.88
Kitchen	0.86	1.15	1.15	0.68	0.68	0.68	0.63	0.68	0.74	0.79	0.79	0.79	0.9	0.9	0.9	0.82
Common Veranda	1.15												0.9	0.9	0.9	0.96
Common Bath				0.89	0.89	0.89	0.63	0.68	0.74	0.92	0.92	0.92	0.83	0.83	0.87	0.83
Common Toilet	0.57	0.57	0.57	0.89	0.89	0.89	0.63	0.89	0.74	0.92	0.92	0.92	0.83	0.83	0.87	0.8
Veranda (with bed)		0.57		0.59	0.59	0.59									0.99	0.67
Ver (liv-bed/liv)												0.61				0.61
Ver-bed	0.57		0.57					0.61	0.61				0.63	0.63		0.6
Mean	0.89	0.89	0.89	0.91	0.91	0.91	0.8	0.91	0.87	0.95	0.95	0.95	0.83	0.83	0.91	

Table 6 : Control value of the Case studies (Original)

	Sample A	Sample B	Sample C	Sample D	Sample E	Mean CV
Foyer	3.5	1.7		2.95	1.2	2.34
Liv-Bed		0.7	0.7	2.45	0.83	1.08
Din-Bed	0.7					0.7
Dining		3.33	3.33	1.9	3.08	2.91
Corridor/circulation			2.2		2.53	2.37
Bed 1		1.2	0.7	0.45	0.7	0.76
Bed 2					1.25	1.25
Kitchen	0.2	0.33	0.33	0.25	0.2	0.26
Veranda (Bed)	1	0.5			0.83	0.78
Veranda (Living)				0.2		0.2
Common Veranda	1.2				0.2	0.7
Toilet common	0.5	0.2	0.2	0.2	0.25	0.27
Bath common		0.2	0.33	0.2	0.25	0.25

Table 7 : Control value of the Case studies (Altered)

	A-1	A-2	A-3	B-1	B-2	B-3	C-1	C-2	C-3	D-1	D-2	D-3	E-1	E-2	E-3	Mean
Foyer	4	4	4	2.2	2.2	2.2	2.25	3.83	2.75	3.75	3.75	3.75	2.2	2.2	2.2	3.02
Liv-Bed	0.2	0.2	0.2	0.2	0.2	0.2	0.5	1.2	1.25	1.2			0.75		0.33	0.54
Living											1.2	1.2		1.2		1.2
Din-Bed	1.2	1.2	1.2	3.83			0.75		0.5	3.2						1.7
Dining					3.83	3.83					3.2	3.2	3.08	3.08	3.08	3.33
Corridor/circulation							3.5	2.2	3.25				2.7	2.7	2.53	2.81
Bed 1		0.2	0.2	1.2	1.2	1.2	1	0.2	0.25	0.25	0.25	0.25	0.33	0.33	0.7	0.54
Bed 2								0.5		0.25	0.25	0.25	1.2	0.75	1.25	0.64
Kitchen	0.2	1.2	1.2	0.33	0.33	0.33	0.25	0.33	0.25	0.25	0.25	0.25	0.2	0.2	0.2	0.38
Veranda (Bed)		0.5		0.5	0.5	0.5									0.83	0.57
Veranda (Living)												0.5				0.5
Ver-Bed	0.5		0.5					0.5	0.5			0.5	0.5	0.5		0.5
Common Veranda	1.2												0.2	0.2	0.2	0.45
Common Toilet	0.5	0.5	0.5	0.2	0.2	0.2	0.25	0.2	0.25	0.2	0.2	0.2	0.25	0.25	0.25	0.28
Common Bath				0.2	0.2	0.2	0.25	0.33	0.25	0.2	0.2	0.2	0.25	0.25	0.25	0.23

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