

**A STUDY ON MORPHOLOGICAL CHARACTERS OF DOMESTIC SPACES
FOCUSING THEIR ALTERATIONS IN THE APARTMENTS OF LOWER
MIDDLE INCOME GROUP IN DHAKA**

by

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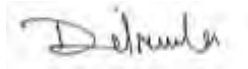
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ABSTRACT

The gigantic growth of population in Dhaka results a huge stress on its accommodation, infrastructure, utilities, services and other facilities. In this critical urban situation lower middle income families can only avail very limited spaces for domestic use. However living in such tiny spaces seems to be very challenging for these families to appropriate functional use and activities. To accommodate in extremely limited space many occupants have make some physical alterations on space or activity in their apartments. These interventions alter the morphology of domestic spaces, geometrically and topologically, thus express users' preference. Therefore the objective of this study is to identify the altered morphology of domestic space for lower middle income families by studying spatial character of domestic spaces, activities and their adaptations. This study also aims to investigate resident's preferences and needs of their housing units in terms of their functional efficiency. To achieve this goal fifteen apartments from Dhaka have been selected through some criteria and analysed spaces as originally built and after being modified by their occupants. Space-syntax method is used to identify the characteristics of spaces. The questionnaire from the respondents and the observation during field survey is also analysed.

The study identified significant changes on zoning and activity pattern of domestic space. These alterations have a major impact on morphology of domestic space, which retained certain characteristics from the original layout but put the apartment together in a new way. Activity analysis identifies maximum spaces of the apartment is multifunctional. Though it is very difficult to maintain privacy and segregation within this limited space but it is a major concern to the occupants during the alteration. The inadequacy of functional space is another reason for alteration.

From this current study it can be said that there is a mismatch between the design of domestic space and the residents' needs, preference and aspiration creating designer-user gaps which lead to adjustment of aspirations or adjustment of the house through alterations and adaptations.

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GLOSSARY

Space Syntax is a method for describing and analysing the relationships between spaces of urban areas and buildings.

Graph is a figure representing the relationships of permeability between all the convex spaces or axial spaces of a layout. The spaces are represented by circles or dots (called nodes) and the links with lines. It is possible to also use links in order to represent relationships of visibility between spaces.

Justified Graph is a diagramming technique for revealing the topology of a spatial organization. A justified graph organizes the spaces in a building in relationship to each other with the carrier at the bottom and the other spaces arranged in rows above corresponding to the number of steps in from the carrier.

Convex Space is a space where no line between any two of its points crosses the perimeter. A concave space has to be divided into the least possible number of convex spaces.

Root Point is a point inside or outside of a building from where syntactic measures of other spaces are taken.

Ring - When one space is linked to another space with more than one link in syntactic measure it is called ring.

Ringiness - Having rings in a space syntax tree is a special character of the tree. This character is called ringiness. It describes the arrangement and distribution of spaces in a building. Those spaces that share a ring can be accessed from any point of that ring. Ringiness determines the level of privacy and relation between spaces of a building.

Syntactic step is defined as the direct connection or permeable relation between a space and its immediate neighbours or between overlapping isovists. In an axial map a syntactic step may be understood as the change of direction from one line to another.

Integration is a static global measure. It describes the average depth of a space to all other spaces in the system. The spaces of a system can be ranked from the most integrated to the most segregated.

Segregation means spaces are deeper from all other spaces. More segregated spaces have higher mean depth values.

Integrated vs. segregated means two contrasting types of spatial layouts, the former indicating all spaces are close to all others, and the latter meaning all spaces are far away from all others.

Depth between two spaces is defined as the least number of syntactic steps in a graph.

Control is a dynamic local measure. It measures the degree to which a space controls access to its immediate neighbours taking into account the number of alternative connections that each of these neighbours has.

Permeable space is that can be accessible from other spaces.

Genotype is the generic makeup of a building or an individual space usually with reference to a specific characteristic under consideration.

Uni-linear sequence is such a series of bi-permeable spaces which are linked to their next space but does not form any ring and thus ends in a terminal uni-permeable space.

Morphology in architecture is the study of the evolution of form within the built environment.

CHAPTER 01 INTRODUCTION

1.1 Introduction

Dhaka, the capital of Bangladesh, has a greater population density and a rate of expansion compared to every other mega cities of Asia. According to U.N.'s data booklet, the population of Dhaka is now the 9th largest megacity (UN DESA, 2018). It also forecasts that Dhaka will be the 6th largest megacity of the world with a population of 28.08 million in 2030. Dhaka is now growing at an unprecedented rate with a density of 47,400 people per square kilometre and at least 1,418 people are adding to the population of Dhaka every day (Dhaka Tribune, 2018). The gigantic growth of population in Dhaka results a huge stress on its accommodation, infrastructure, utilities, services and other facilities (Akter, 2013).

Among the different category of urban population according to income groups; the middle income category is largely extended including three divisions like lower-middle, middle-middle and upper-middle. Among them lower middle income group, a majority fraction of Dhaka city's households, has severe problem in accessing housing at present market price (Islam and Shafi, 2008). In the urban area the public sector has probably contributed directly or indirectly to not more than 10 percent of all urban housing activity during the last 40 years (Afroza, 2000). However, different government agencies are supplying housing, both rentals and home ownerships, although the percentage of this type of housing is insignificant. For the lower middle income group, there is very few subsidized housing provision in formal sector. However, the price and the delivery system determined for allotment of these provisions is hardly accessible by the lower middle income people (Draft Dhaka Structure Plan, 2015).

1.2 Present State of Problem

About 65% of the Dhaka's population is due to migration. At this rate of migration, it is assumed that every year more than 120,000 dwelling units will be required to house the growing population. The rapid growth of Dhaka's population has also led to greater demand for housing units including land for housing (Draft Dhaka Structure Plan, 2015). In this urban situation lower-middle income families, can only avail very

compact space as their dwelling. On the other hand most of these families live in the rental apartment. However living in the compact space for a family with a household no of 5 to 6 is a great challenge in terms of functional use and activity. Specially when they live in a rental house as it is not designed for any specific user.

People want to personalize their house with their own functional need, social context and life style which influences the morphological character of domestic space. However creating a generic spatial layout for a domestic space is really a complex work for professional. Besides there is a close link of the lifestyle with the socio-economic changes which affects the spatial layout of domestic space. Lifestyle is an important socio-cultural force which has a great impact on housing development. It can be defined by the way of living of individuals, families (households), and societies, which they manifests in coping with their physical, psychological, social, and economic environments on a day-to-day basis. However the lower middle income occupants who live in a very compact space they have to adjust their lifestyle within. They are usually make many physical alterations on the space of their apartments, such as using veranda as bedroom or kitchen, closing the doors by placing furniture, dividing the space by partition/curtain etc. Sometimes such alterations change the actual use of a space which is not designed for. Thus these alterations create a major impact on morphology of the domestic space, which retained certain characteristics of the original layout but put the apartment together in a new way. Such alterations imply that how the architects designed the sequences of space or connections in the dwelling; the dwellers can't use in the same way when they live there. Apparently it seems that the alteration happen only for functional inadequacy but there may have some other socio-psychological issues. However it is known that possibility of better design increase, as Hillier and Hanson argues, 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). Therefor the morphological characters and the alterations need to be studied to make more appropriate design solution for domestic space of lower middle income people.

1.3 Research Question

The man environment relationship is a complex phenomenon. Every culture influences the way people use spaces, which in turn are manifested in its domestic architecture.

The houses that human beings occupy directly reflect their attitudes, habits, self-expressions and their way of perceiving life. The human-environment interaction affects lifestyles and shapes living spaces with various spatial organizations. When spatial organizations that belong to different cultures are analysed, the aspects of life that are specific to the user emerge in the interrelation of spaces (Saatci & Onder 2015).

A house should provide varied spatial property to conduct different domestic activities, ranging from social, personal to intimate activities. However in the present state the dwellers that live in a small apartment they relatively have low specialization of spaces/rooms. As the spaces/rooms of small apartment can captured variety of activities within the key space. The strength of boundary between the locations of many activities and their related objects was quite fluid across the interior spaces in most of the cases. Canter and Lee (1974) pointed out that the functional differentiation of rooms was reduced in a house with a small number of rooms. If only limited physical space is available, it becomes more difficult to resolve conflicts among spatial needs. Residents may cope with this situation by eliminating some activities, or by doing some potentially incompatible activities in the same room. The question is what activities will be eliminated and what activities begin to coexist spatially. How people manage to combine different activities for the efficient use of a limited number of rooms?

From the above mentioned background and discussion the main research question develop as follows:

What are the user preferences about the morphology of dwelling space in respect with their socio-economical aspect for lower middle income family?

1.4 Research Objectives

This research is intended to investigate the space-use pattern and spatial organization of lower middle income house to find out the morphology of domestic space through spatial analysis.

The specific objectives of this study are:

- To understand the relation between the space use pattern and the character of spatial organization of domestic space for lower middle income group.
- To identify the morphological changes due to alterations with the consequences and their reasons behind.

1.5 Specific Aim with Possible Outcome

This research will help to find out the morphology of apartment in housing for lower middle income people considering their socio-economic status. This may also help to understand the actual situation for designing residential family unit with minimum area.

The specific aim is to identify the architectural morphology of domestic space in relation to the functional and social need of the lower middle income group in the context of Dhaka.

This study will give an understanding on when people have to live in a very limited space, how they deal with the functional and social need of domestic space. Also it may give a light on the living pattern of the lower middle income families and their spatial need, which may help professionals in designing domestic spaces for them in the context of Dhaka.

1.6 Rationale of the Study

Residential satisfaction studies seek the feedback of housing residents; such evaluations being done relative to what individuals consider to be housing needs and aspirations (Galster and Hesser, 1981). The definition of what constitute “needs” to the residents is considered to be an outcome of the social environment and is best expressed relative to residents’ behaviour, attitude or opinions (Awotona, 1982). The design and consequent use of spaces in built form is the intervening variable linking architecture and human behaviour (Hillier, 2007). An appreciation of this and a consideration of Hillier and Hanson’s (1984) argument that not understanding the relation between spatial morphology and social life places constraints on the possibility of better design, highlights the significance of the present study. Residential satisfaction studies are likewise important within the context of housing research due to their significant role in providing evaluative feedback (Canter and Rees, 1982). Such feedback from residents increases the likelihood of improved design features in buildings and the planning of residential developments as a whole, and has been identified by Canter and Rees, (1982) „as being an integral part of the design processes“.

On other hand with an eye on urbanization, population growth and efficiency, when the only solution is to live in smaller place, effective use of space is a big theme. With examining the social and ethical issues creating tiny spaces can be a challenge, but can

also lead to super smart solutions. Susanka (1998) is famous for saying that new houses are too big, waste resources needlessly and that we, as a society, have the smarts to be able to do things better. Her point is that just because the house is smaller, you don't have to give anything up. Tiny houses enable simpler living in a smaller, more efficient space. If small house prove as a viable, formally acceptable dwelling option; this study will give a design guideline for architects to design. Local government agencies also will take measure to discuss zoning and coding regulations that can reduce the obstacles to small living. In fact, if we carry the thinking along, smaller, simpler and better designed houses will cost less and probably open up homeownership to more people.

1.7 Scope and Limitations

This study focuses on public sector housing (govt. staff housing) which is designed by architects as a generic design as opposed to individual design. Which are matches in all aspects regarding socio-economic variables due to the standard procedure of allotment for apartments thus increase internal validity. Moreover in individual design there is not much scope to alter the spatial configuration for the tenants this is why the govt. staff housing is chosen as oppose to individual design. On the other hand the study is focuses only on the public sector housing of Dhaka for easy access to data collection and survey of researcher.

1.8 Outline of Methodology

Study will have to follow the Ethnography approach as the respondent's observation and experience will take importance for data collection to understand the living situation completely. The unit of the study is a single residence. Many aspects of the research have justified this study as a mixed method approach. This study has a rich and holistic approach from real life position and need very prolonged contact because of the interviews and the observation to understand the scenario which is justified this stud as qualitative. The research design will be open ended (questionnaire survey, interview etc.). Data format will be Textual obtained from images and questionnaires. Researcher has the flexibility to design the research and will allow the adjustments in process. For example, participant's responses on particular interview questions will affect the addition, omission or rephrasing for next study design. The study also includes space syntax analysis. This phase of this study is justified it as quantitative.

Table 1.1: Four elements of enquiry for this study based on Groat's research method model (2013)

System of enquiry : Naturalistic				
	Theoretical elements of this study	Justification	Sources of data	
Epistemology	Constructivism	Complexity and multi-dimensionality of culture and housing study	Literature on the socio-economic environment and way of living of LMI people and the spatial organization and space use pattern of dwelling space in the context of Dhaka.	
Theoretical perspectives	Interpretivism Symbolic Interactionism	Value of community, becoming persons in the process	Samples from different area within particular cultural context of Dhaka.	
Methodology	Mixed method (Qualitative & Quantitative) Ethnography	Focus on how respondent make sense of their own circumstances	Collect data from particular respondent and household.	
Methods	Multiple Tactics	Different techniques with certain samples	Informal interviews	Academic, architects, households' visits
			face-to-face questionnaires	Approx. 15 households in different area of Dhaka
			Photographic documentation	Internal photos of flats
			observation	Move through the house, talk and participate with family activities
			Space syntax analysis	Distributiveness, Typology, Integration, Depth and control value

Table 1.2: Conceptual framework based on Groat's research method model (2013)

	Independent variables	Dependent variables
Conceptual	Dweller's lifestyle choice Personal and social interaction Space use pattern	User preference/ need about functional space of dwelling
Operational	Spatial organization Zoning Spatial alterations	Building morphology

The research is intended to analyse spaces as originally built and after modifications by their occupants, studying domestic space uses and their adaptations with the current

status of their housing units in terms of their functional role. For a better understanding of the consequences of these alterations, firstly, changes to the original plans and organization scheme have to be characterized and second, the original plans were compared with the transformed ones in terms of user need. Alterations/ adaptations/ modifications made by the users on a single space and the use of the same place for different activity patterns will also be assessed. The research work is organized in two parts. The first part consists with an in-depth field study which includes the questionnaire survey and data collection about the respondents. The second part is data analysis which is designed to understand the morphology of house; „space syntax method“ is used for this purpose. Finally it will try to answer the issues raised in real life (questionnaire and Observation) by the findings from literature and spatial analysis. The following sequence of activities will follow to be carried out the study.

1.8.1 Literature review

Available relevant literature from home and abroad based on published articles, journals, books, web sites, drawings and documents from respective authorities e.g. Department of Architecture and Centre for urban studies (CUS) and other unpublished records from are reviewed extensively to gain knowledge which help -

- To understand the socio-economic environment and way of living of lower middle income people
- To identify the indicators of morphological characters of dwelling space in the context of Dhaka

1.8.2 Field survey

Data collection (photographs and drawings) about the respondents, observation, questionnaire survey, informal interview with designer and concerning authorities etc. have to be performed in field survey part. Observations are focussed on any changes made to participants“ homes such as alterations of walls, door, position of furniture, etc. by participants to suit their respective requirements. Photographs are useful tools for analysing rooms and spaces on floor plans and to cross check with measurements taken on-site.

Target group for the study

As the lower middle income families are not economically solvent to avail home ownership, they depend on the rental house. For this study the samples are selected

from the govt. staff housing (public sector housing) because of two major reasons. As rental housing in private sector the dwellers“ don’t have much scope to alter the spatial configuration as they stays for a shorter period of time. On the other hand in public sector (govt. staff quarter) they stays for a longer period, and don’t have to change the house in frequent which influences them to alter the spatial organization of dwelling space according to their need which is the prime concern of this study. Moreover govt. staff quarters are designed by professionals as a generic design opposed to individual design. According to Govt. accommodation law these quarters are allotted to govt. employees. It has different dwelling size (area) with respect to their salary grade on govt. pay scale. Thus it will match in all aspects regarding socio-economic variables of the samples which increase internal validity.

Dwelling size

The apartments which are entitled for lower middle income families is ranges from approx. 46-74 sq. m. (500-800 sq. ft.) according to govt. accommodation law (MoW. 1992). However in actual situation during field survey there are many houses which are as low as 39.5 sq. m (425 sq. ft.). The space include only the area of apartment without any common spaces like stair, common lobby etc.

Sample selection criteria

There are some selection criteria for sampling which is applied here for this study. The apartments must have some alterations/ modifications by occupants. Random sampling for greater reliability from the govt. staff housing of Dhaka. 15 residences in total are selected for this study which is a minimum for most qualitative interview studies. It works very well when the participants are homogeneous (Guest et al., 2006).

Questionnaire design

A questionnaire survey is conducted to go through into the socio-economic and demographic characteristics of the household. The questionnaire has also investigate the space use pattern, placement of furniture and home utilities which are used in the house to understand the activity domain and to examine the adaptation and alterations made by dwellers in their apartments and the reasons for the changes are made.

1.8.3 Data analysis

Data on social and functional aspects will be analyzed and compared with spatial layout. However spatial layout will be analyzed through Justified Accessibility Graph

(J-graph) theory of Space Syntax method which represent, quantify and interpret spatial pattern of buildings in such a way that their underlying „social logic“ can be understood. Justified Accessibility graph (J-Graph) will be prepared by JASS software (Justifies Analysis of Spatial Systems, version 1.0). Finally inferences will be drawn in relation to literature study.

Table 1.3: Diagram of Research Methodology

Step 01 Research question formation	Problem identification	Research objectives
Step 02 Literature Review (Secondary data resource)	Understanding the context and formation of methodology	Review the evolution and typology of the lower middle income group apartments in the context of Dhaka
		Study about the theory and application of space syntax methodology through case study analysis
Step 03 Field Survey (Primary data resource)	Data collection	Floor plans with furniture layout and Photographs
	Questionnaire survey & Observation	Space use pattern through Activity analysis Alterations & their reasoning
Step 04 Analysis	Morphology investigation	Plan investigation focusing alterations
		Syntactic analysis using J-Graph
Step 05 Findings	Conclusion and recommendation	Social interpretation of syntactic analysis focusing morphological changes/ alterations

1.9 Organization of the Thesis

The entire research structured within six chapters in this thesis.

Chapter 01 Introduction

Chapter one is where the research problem is stated elaborately with the explanation of present condition of the research topic by identifying target group. The importance between the relation of spatial organization and the user aspiration stated clearly and identify the key factors that should be studied. The justification of the study is also stated with specific aim and objectives. This chapter also explains the methodology of the whole research process for this thesis which includes both functional and social study. The scopes and limitations of the study are also mentioned in this study.

Chapter 02 Literature Review

Chapter two presents the literature review related to the research issues. Domestic space organization in relation with social and cultural aspect is described briefly in this chapter. The evolution and typology of house form in the context of Dhaka is also studied. The basic theory and application of Justified Accessibility Graph (J-graph) theory is studied to relate the social study with the spatial properties developed by space syntax method. In order to acquire a better knowledge about the research topic, the living condition of lower middle income people in the context of Dhaka is also explained in this chapter. The background of the study area is described and gives a general discussion about development of the housing for the govt. employees over different time with their spatial organization and internal layout.

Chapter 03 Case studies

Chapter three describes the background and development of case study areas and the detail about the studied samples. The user characteristics; the respondents' profile, their occupancy pattern, economic status have described in this chapter. The physical description of their original and altered plans has explained here. This chapter also addresses the results from questionnaire and the drawings collected during the survey by analysing them from their social and functional aspect. The key factors responsible for the mismatch between actual and altered use of space is also identify here with addressing the major problems through some specific observations.

Chapter 04 Syntactic Analysis

In chapter four spatial analyses with the help of j-graph is done here and made a comparison between original and altered spatial organization. And try to find out a common pattern of the spatial organization of lower middle income houses and the alterations they have adopted.

Chapter 05 Conclusion

From survey findings the issues responsible for the alterations in lower middle income housing have been defined in this chapter which conclude this research with some major recommendations.

CHAPTER 02 LITERATURE REVIEW

2.1 Introduction

This chapter includes the review of literature as a secondary data resource related to the research issues. For the convenience of discussion this chapter is structured in six parts. As the study is about the morphology of domestic space so the first part of this chapter is about the domestic space organization in relation with different social and cultural aspect and the domestic activities. The alterations of domestic space in terms of functionality and adaptability are discussed in second part. The evolution, typology and activity pattern of urban house form in the context of Dhaka is also studied in third and fourth part. However in fifth part in order to acquire a better knowledge about the research topic, the background of the study area is described and gives a general discussion about development of the housing for the govt. employees over different time with their spatial organization and internal layout. Finally in last part the basic theory and application of Justified Accessibility Graph (J-graph) theory is explained in this chapter to understand the methodology in detail which can relate the social study with the spatial properties.

People require housing which is suitable to their needs. Ukoha and Beamish (1997) assert that providing additional housing units alone, without considering their suitability to the actual needs of the housing residents, does not provide an accurate measure of whether a housing programme is successful or not. Housing suitability relates to the dwelling meeting the spatial requirements of housing residents relative to the functions to which the spaces would be used for. 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).

It has been documented in literature that space use in completed housing projects oftentimes differ with what the designers originally intended (Tanghe et al., 1984; Kent, 1993; Hanson, 2001); some explanatory factors to this disparity are presented. One of such relates to the differences in the value system of professionals making design decisions to those of the actual users of the space. When the assumptions underlying such decisions are contrary to user needs and values the result oftentimes is

dissatisfaction with housing (Tanghe et al., 1984; Hanson, 2001). According to Rapoport (1977), behaviour within a setting is dependent on the potential the setting holds to be adapted to a range of uses. He asserts that ignoring such factors and designing excluding support cues and not appropriately defining boundaries within settings, has resulted in some designed environments being rejected by housing residents. This point of view is also supported by Hillier (2007), who maintains that when spatial form ignores social rules and important physical cues, residents will either modify patterns of behaviour to fit the spatial form, or modify the space to suit what they require (Dassah, 2011).

To fulfil the specific objectives of this thesis the literature review is divided into four parts. To achieve the first objective the first part of literature study illustrate what are the major factors which should be assess to understand the underlying phenomenon of spatial organization of domestic space and how the space and user influence one another to shape up the configuration of domestic space. It is also designed to understand about the domestic space and its various determinants such as social, cultural and functional dimensions. Moreover the relationship between domestic space and different household activities is also discussed to understand the spatial dimensions of space. To achieve the second objective the adaptability of domestic space is explained and analysed. Different theoretical aspects such as flexibility, functionality are discussed in the second part of literature. How the needs of occupants' can change the different dimensions of domestic space is also discussed here. The third part of the literature review focused on the development and the activity pattern of domestic space in urban consolidated type house. The evolution, space standard, spatial elements and organization of the house dedicated to the target group of this thesis (govt. staff housing) is the prime concern here to discuss. The final section is about the basic theory of Justified graph (J-graph), a tool which is used in this thesis to understand and analyse the domestic space and why morphological study is important to understand the spatial organization of domestic space and the social logic underlying behind in it. Many case studies are discussed here to understand how to use this tool and what are the outcomes of using the tool.

2.2 House Form and its Determinants

According to Hanson (1998), house is not only a list of activities or rooms but the important thing about a house is that it is a pattern of spaces, governed by the complex

conventions of space types; the connection and sequence of space moreover the integration and segregation of the different domestic activities.

Many studies illustrate the complexity of built forms by interpreting the messages from the spatial structure. In general, spatial study can be conducted in two ways, from the observation of buildings tracing back to the experience of users or builders, or from the living experience of built space followed by speculation about how spaces are created (Cuisenier, 1997). Cuisenier defines the first type of spatial approach as morphological, focusing on the arrangement of spaces, and the other approach as phenomenological, referring to the actual experience of people living in that space. In order to create a supportive built space, the arrangement of space depends on the nature of activity, users' cultural values and norms. Such a range of physical conditions is not randomly structured; therefore, spatial study from a configurational aspect relies on assumptions from both functional and social logic. The configurational approach of spatial arrangement is based on the theoretical concept that if built space is composed of organizational units; it is because they are responding to precise living patterns. The way space is organized by its inhabitants gives a deeper understanding of experience taking into account a social system. It is therefore necessary to examine those patterns in order to understand the organizational principles underlying the built spaces. The publications of *Architectural Morphology* by Steadman (1983) and *The Social Logic of Space* by Hillier and Hanson (1984) have introduced the analyses of domestic space configuration through architectural morphology. The study of spatial configuration is an approach that reveals the social order embedded in spatial pattern. It has since become a tool applied around the world in a variety of research disciplines and design applications. According to Steadman spatial study begins with the investigation of a morphological diagram that is based on the building floor plan. Shape and the arrangement of spaces provide information for an explanation of spatial relations in a systematic manner. In order to compare dwellings with one another and to interpret their sociological significance, Hanson proposed to understand the space pattern existing in them (Hanson, 1998). Analysis of domestic space configuration provides the link between the design of dwellings and their social consequences (Hanson, 1998).

2.2.1 Spatial dimension and social relations of domestic space

Houses are more complex phenomena and usually encode a wealth of social and symbolic information which constitute a shared framework of spatial patterns. Social

phenomena are durable in that they leave traces of the material form of their existence in the way in which the pattern of domestic space is arranged. Space configuration, object arrays and people's routines can therefore be decoded so that the social and symbolic information are retrieved directly from the study of how houses are organised and used (Hanson, 1998). The arrangement of space associates with a logical process because it must at least serve the functional objective (Hillier and Hanson, 1984). Spatial properties and their arrangements are culturally and behaviourally formulated. Since built spaces directly influence behaviour, in order to understand the interaction between people and environments, the design of spaces and user's occupancy are main factors to be concerned. Mercer supports the idea to study built spaces from their arrangements. A certain type of behaviour seems to occur in a certain type of space, therefore, a physical setting can identify a user's identity and social relations (Mercer, 1975).

Being a physical shelter, home environments are spaces possessing many symbolic, cultural and behavioural dimensions. Rapoport mentioned that there is a link between behaviour and house form in two senses: first, behavioural patterns including desires, motivations and feelings are essential to the understanding of built form, since built form is the physical reflection of these patterns; second the forms once built affect behaviour and the way of life (Rapoport, 1969). Although form is difficult to understand outside the context of its setting, culture and the way of life it shelters because the design and use of houses reflects cultural values and ideas (Lee & Parrott, 2004).

The relation between the house form and some of the major social and cultural factors which have an impact on house form such as lifestyles, customs, community, religious beliefs, family structure, social organization, way of livelihood and so on to overview and integrates the information to outline the characteristics of house form (Rapoport, 1998). It must be remembered that there are some other factors that affect house design, such as climate, construction techniques, cost etc. Then, as Rapoport (1969) claims, these non-cultural factors, nonetheless, seem to be secondary to socio-cultural factors. Cultural values and norms take precedence over these non-cultural factors and shape house form. Although their importance is not to be denied, the main determinant of the physical arrangement of the house is the cultural matrix (Ozaki, 2002). A contextualized view of social space, as part of human culture, leads us to a better

understanding of social space and its significance in society. However the physical, social, cultural and economic characteristics of the houses can be affected by the users' preferences which is also seen here in the case study houses of this thesis. Physical, social and cultural characteristics of the houses are closely related with the socio-demographic structure, lifestyle, spatial behaviour, functional use of spaces and planned period of residency of the user. These parameters affect the user's spatial behaviour, even though the syntactic characteristics of the house remain the same (Edgu and Unlu, 2003).

2.2.2 Domestic space design and household activities

Domestic activities are those that people do in and around their houses. There are different ways of classifying household activities. For example, Bender's in Yanagisako (1979) proposed the definition of "domestic activities" as activities concerned with the day-to-day necessities of living, including the provision and preparation of food and the care of children. Similarly, Fortes (1978) pointed out that the core of most conceptions of "domestic" are two sets of functional activities including those pertaining to food production and consumption and those pertaining to social reproduction, including child-bearing and child-rearing.

Ahrentzen et al. (1989) identified 5 categories of home activities: 1. Domestic work – preparing and cooking food, indoor cleaning, laundering, ironing, repairing and upkeep of clothes, gardening, animal care, upkeep of heat and water supplies, etc.; 2. Child-care activities – feeding and bathing children, reading stories, indoor games, medical care, being affectionate with child, putting kids to bed, etc.; 3. Private needs – personal hygiene, medical care, sleep, etc.; 4. Active leisure – hobbies, needlework, artistic creations, playing musical instrument, etc.; 5. Passive leisure – listening to music, or radio, watching TV, reading, conversing, relaxing, etc. However Monteiro (1997) grouped activities into six different sets of domestic actions as household chores (e.g. ironing, cooking, washing clothes), extended chores (e.g. playing with children, doing special task), passive leisure (e.g. watching TV, reading, studying, dating), interactive leisure (chatting, meeting friends), private or personal needs (e.g. taking a bath, sleeping), and communal needs (e.g. dining, having lunch). Zapata, (2006) in his researches in Bolivia and Mexico, observed the domestic activities that are usually carried out by children. Therefore he only classified household activities into 5

categories such as: taking care of children or elderly, carrying wood or water, cooking or cleaning the house, buying groceries for household, and washing or ironing clothes.

The review underpins the large variety of domestic activities. They show differences in the lists of activities as well as in the classification of the activities, mostly due to the differences in research purposes. Therefore it can be noticed that the lists were developed by considering the focus of the research, which implied the inclusion or exclusion of particular activities.

2.3 Alterations of Domestic Space - Functionality and Adaptability

A space design is the outcome of the design process that determines the use, the functions, as well as the dimensions of the space for a proposed user. The inhabitant's needs, activities and ability determine the requirements for the space and concurrently the functions and dimensions of the spaces. Inhabitants interact with the spaces they use. The design process involves the analysis and design of spatial and occupancy requirements, including but not limited to space layouts and final planning.

A literature review of meanings of 'Space Design' relevant for this thesis provides rather similar views of scholars regarding space design emphasizing the function of space as a place for people to conduct activities according to the culture and unique customs of the respective community in which they live. (Geoffrey, 1973; Holm et al., 2006; Merriam Webster; Ralph and Wand, 2009; Samarasinghe and Pahalawaththa, 1997; Szokolay, 1980; Tipple et al., 2002; Yi & Yi, 2010; Brunson et al., 2001). De Jong and Voordt (2002) indicated that the function of space is determined by the user's demands. Brunson et al., (2001) discussed 'space' in their efforts to explain public areas. They noted that space has different meanings for people if it accommodates different human activities. This means that the same space could get a different form influenced by activities conducted in it. Accordingly Samarasinghe (1997) and Tipple et al. (2002) indicated that a space is determined by the activities that take place within. Moreover a space therefore is a product of social translation, transformation and experience. Consequently, space in every home will vary, according to the culture and customs of inhabitants. Lawson and Ogden (2006) pointed at the user's activities in the space which determine its functionality. So the space will need to be adapted to inhabitants' activities to be functional, whilst users often also will adapt to the available

space. Additionally, some adaptation might also be needed to meet changing user needs in the course of time.

The definition tells that the functionality is the tendency of a product design (i.e: space design) to serve a certain function and is capable to perform a predetermined task (Merriam Webster, 2002). The functionality of a building means that the building complies with its functional program such as set by the spatial needs, requirements and system performance as well as durability and efficient maintenance of building elements. It shows the capability to serve the design purpose. The general function of the finished housing product is the provision of a built environment and shelter to meet human needs. Human needs are un-limited and diverse, as diverse as human activities are. Many human activities require space (Maslow, 1970). This means that spaces can have different functions in accordance with the activities that are supposed to take place in these spaces. According to several sources above, it can be concluded that functionality is the ability of design to enable the users to carry out their activities as expected, so the design will achieve what is assigned to them. This study also investigated whether the space provides for carrying out the household's daily domestic activities adequately.

Adaptability means the capability of space designs (indoor and outdoor) to accommodate functional and dimensional changes required by the occupants. There is a multitude of definitions for adaptability; many of them coincide with concepts such as flexibility. Important determinants of adaptability derived from literature are generality (change of function without changing characteristics); elasticity (increase or change of function by possibilities to attach parts to, or detach parts from other building parts) and flexibility (change of function by changing the technical structure at minimal costs and abruptions in operation) (Bullen, 2007; Douglas, 2006). Functional change is the change of functions of the spaces for domestic activities in an effective manner in order that there are no disturbances between them. Dimensional change is the change of the space size and volume horizontally or vertically to meet user's requirements for space. According to research that has been executed by Septanti (2015), the most important aspects of flexibility for low income house relates to how the user can have possibilities to re-arrange, re-adjust and make additions to the living space according to their needs over time. Some literatures below show how low income people adapt their house that causes of their needs that change overtime. Housing design can start from a basic shape

as any ordinary housing that can be expanded in future in some different ways based on the need of occupants. Formal housing can become informal ones by the process of extension and alteration (transformation) by users without permission, or in ways that do not fulfil standards. Silas (2003) proclaim that adaptability of space design is most needed in the housing that is provided to low income people. These people have less affordability in finance, knowledge and capability. So that, they need to change their house and possibilities to develop the original design to achieve one based on their force and affordability. Adaptability in this research deals with the capability of the rooms or spaces of the houses to be changed and adapted for various domestic activities in line with the user's needs.

2.4 Development of Urban House Form of Dhaka

From different literature it is found that various socio-political, cultural, economic and physical forces have acted in different degrees at different time on the growth of urban pattern, design and organization of the house form of Dhaka (Imamuddin, 1982). Mass migration in 1947 between India and Pakistan (1947-1971) made a major demographic shift in the urban composition of Dhaka city. The concept of nuclear house was first introduced in a 'rehabilitation' project at Mohammadpur in 1953 by Public Works Department (Shabin, 1997). The construction of housing colonies for government servants followed this. First residential units were Palassey Barracks, Dhakeswari Quarters (single storied row houses) and Azimpur Estate (medium rise multi-storied walk-ups). Urban houses in the post-colonial period (after 1757) formed an integration of living and service parts of the house into a single mass as Consolidated type and it became the model for the later mass housing. Single family houses in individual plots followed this consolidation and later was arranged in different levels tied with a staircase as vertical circulation. The common feature about these residential buildings is that they are all accommodated in multi-storied walk-up blocks with each staircase serving two units. Houses became separated into three distinct zones-Formal, Informal and Service zones. In The internal arrangements of spaces, a high degree of compartmentalization is found and a corridor like space runs through the centre. In some cases corridor transferred into a fat linking space, which usually was used as a dining or family living space.

Dhaka being the capital of the sovereign Bangladesh experienced a new dimension of development from 1971. The population increase of the city led the multi storied compact apartments to meet the housing demand (Rashid, 2000). The housing societies and developers became the supplier of the multi-storeyed housing stock to various groups of people. In 1980s a large acceptance of the concept of living in flats were seen although real estate business started in late 1970s. REHAB (Real Estate Housing Authority of Bangladesh) claims the number of houses supplied by the sector from the beginning till 2002, were nearly 20,000 units in total. (Sthapoty O Nirman, 2002) The tendency and need of the people to stay nearer to the city centre as well as popular vision of standard living has been addressed by the developers, converting the need and resources of individuals into material terms of a house form (Islam, 2003) .Compact space arrangements resulted in smaller rooms in the multi-storied apartments for scarcity of space. Flats were arranged about the staircase and lift core serving the units. Due to compact layout, dining acts as a connecting space of all the adjacent spaces.

2.5 Activity Pattern in Urban Houses of Dhaka

Based on the works of the researchers (Imamuddin, 1982; Shabeen, 1997; Khan, 1999; Rashid, 2000; Islam, 2003), the household activities in the urban houses can be classified into two groups: Family activities- such as working, sleeping, cooking, washing, bathing, eating, etc. Formal activities- such as socializing, receiving guests, which include participation in the community. Family activities such as working, eating, sleeping, cooking etc. are performed in the inner part of the house while formal activities such as socializing, receiving guests, which include participation in the community, are performed in the outer part of the house near to the entry. Khan 1999, while studying the colonial architecture in Bangladesh has drawn a comparative description of the household activities of the members in urban houses of different periods. He mentioned that in the Urban Consolidated Houses of Dhaka Different Activity and Spaces of Work and household areas are separated. Entertaining and socializing with guests took place in the living room near the entrance in public zone. Resting and Sleeping took place in bedroom or veranda space. Bath and toilet are separated in two zones. One in the outer zone for guests, another in the inner zone for family/ female members near to the bed rooms. Eating food take place by sitting in chair and food served on table in the Dining or veranda. Cooking take place in kitchen

along with servant's room, store and veranda form a separate zone and it is attached with the main household space.

2.6 Govt. Staff Housing - A Brief Overview

The government is the single largest provider of built up housing in Bangladesh mainly in the form of accommodation for its employees. The concept of housing as blocks of flats was first initiated by the government. Till the arrival at the scene of private developers, the only effort at large scale housing production was from the government. Although the number of units provided is far less than the number of employees, government housing continues to be a strong influence on urban housing in general. Though the designs and consequent detailing varied considerably, yet a prototype of four -storied yellow coloured two flat type dwelling could be recognizable. Government housing can therefore be said to be representational of urban housing in general (Rashid, 2000).

In the public sector most activities related to housing are carried out on behalf of the Government by the Ministry of Housing and Public Works and different departments / directorates under it namely Department of Architecture, Public Works Department (PWD), Housing & Settlement Directorate (HSD), City Development Authority namely Rajdhani Unnayan Kartripakkhya (RAJUK), Urban Development Directorate (UDD) etc. There are different agencies that are responsible for regulation and control over the design and construction of housing its location, necessary infrastructure, services and social facilities essential for housing areas. Although there are so many agencies involved in the housing activities the scope of their services remains limited. Most of the housing were created for government servants and also for employees of different organizations during the early fifties and afterwards. These housing areas comprises walk-up apartment and all of these units are proto-type and the only variation is its limited area in square feet and almost in every Government residential area buildings are not densely built (Saha, 2006).

2.6.1 Public housing space standards

The classifications of the government pay scale can be considered in defining income groups in the context of Bangladesh. This classification does not define the income groups according to the pay scale, but rather reflects the social status of the government employees (Chowdhury, 2013). In the socio-cultural context of Bangladesh class III

and class IV govt. employees are considered as lower middle income families who are categorised from grade 11 to rest of the below grade of current govt. pay scale. In 1969, the WPI Ministry of the Provincial Government issued a manual on office and residential space standards for government officers and employees.

Table 2.1: Residential Space Standards for Government Officers and Employees, 1969

Category of Officer/ Employees	Allotable floor areas (Sq. ft.)	Type (Categories of flats)
Secretary	4000 3000	Bungalow Bungalow
Class I	1750 1500 1300	F Type E Type D Type
Class II	840	C Type
Class III	612	B Type
Class IV	519	A Type

Table 2.2: Classification of accommodation & entitlement of govt. employees; Residential space standards for govt. officers and employees, 1992 (Allotable floor area according to grade); Source: Compiled by author; (Afroza, 2000; MoW, 1993)

Categories of Officer/ Employee	Pay scale Grade	Basic pay BDT/ month (7 th pay scale)	Basic pay BDT/ month (8 th pay scale)	Allotable Floor Areas (Sq. Ft.)	Entitlement
Class I	Grade 1 to 3 Partial	40000-29000	78000-56000	1800+200 for garage	Superior type
	Grade 3 & 4	29000-25750	56000-50000	1500	F type
	Grade 5 to 6 partial	22250-18500	43000-35500	1250	E type
	Grade 6 partial to 9	18500-11000	35500-22000	1000	D type
Class II & III	Grade 10 & 11	8000-6400	16000-12000	800	C type
	Grade 12 to 17	5900-4500	11300-9000	600	B type
Class IV	Grade 18 to bellow	4400-4100	8800-8250	500	A type

After the emergence of independent Bangladesh in 1971, there appeared widespread government activities and a rapidly increasing number of employees to be housed across the country. In 1980 according to the directives of the Ministry of Public Works and Urban Development formulated residential space standards for 21 levels of National Pay Scale, arranged in 6 residential groups (IM-25/77/80, dt 9.5.80). After a number of revisions in May 1992, the Ministry of works issued housing entitlements in the form of a gazette notification (SRO no 106-Law/92 S-2/2M-12/91, dt 9.5.92).

The process is an indication of the attitude of the Government for drastic lowering of residence size 1800 sq. ft. flats instead of Bungalows of 3000-4000 sq. ft. for higher categories of officials and providing more accommodation to low paid employees. The Department of Architecture has developed a set of standard residential building designs for different levels of government servants. These are repeated wherever necessary all over the country to meet the housing needs of government servant (Afroza, 2000).

2.6.2 Development of housing for govt. employee

There are millions of people working for the government all over Bangladesh. The idea of providing housing to the employees finds its roots in the colonial past of India. When capital was shifted from Kolkata to Delhi in 1911, an immediate need was felt for housing all the employees as British wanted their administrative machinery in India to be manned by people strongly committed to British rule and dedicated to their ideology, uninfluenced by local populace. Many residential colonies were built in New Delhi (new city planned by Lutyen) for the officers and staff. This trend continued even after independence and till today. Government continue to provide rental housing to their employees posted in various parts of the country during the service period. The house provided by the government is to be vacated by the employee after their retirement from the service (Saquib, 2000).

From Bungalows to Flats

The colonial public housing units mostly built for high officials were single-family bungalows on generous lots complete with gardens, patios, servants' quarters and even service stairs and service lanes. Bungalows used to be built for high officials and barracks for employees. In 1947 after the partition of India there arose an immense problem regarding the accommodation of govt. servants who had migrated from India. For the employees of the Central Government, the Pakistan Public Works Department established Motijheel colony in Dhaka and Agrabad Colony in Chittagong. The Provincial Government set up Azimpur Colony and Eskaton Garden Governmental Housing for the government officers in Dhaka city. The post-colonial fifties witnessed a change. Copies of colonial models but on smaller lots and multi-storey walk-up flats were promoted as the 'modern' and 'optimal' solution. The designs of housing units or flats were still characterized by lavish allocation of space with huge verandas and wide corridors reminiscent of colonial bungalows.

Within the boundaries of Dhaka, Azimpur Governmental housing is the first govt. multi-storey walk-up residential flats housing project for the govt. servants. During the 1950s the then Provincial Government established this residential flat scheme consisting of 3 storied building units suitable for 6 families based on a typology consisting of two flats for two families and a staircase in between had been arranged in a cluster. In 1992 a total of 470 flats (among 3000) were constructed on the basis of 5-storied building each accommodating 10 families within Azimpur Housing Area. The second phase of 3000 flats scheme is still going on.



Fig 2.1: Row House Type (Agargaon Staff housing)



Fig 2.2: Walk up House type; Green road government housing (left), Mirpur BCSIR staff housing (right)



Fig 2.3: High-rise Type (Ongoing Project, Azimpur)

During 1996 the govt. has shown keen interest to build additional 5000 flats in the city. For this project the design consists of 16 storied high-rise buildings with lifts has been designed and those are under construction. This high- rise residential flat building for public housing is a new concept in the public sector (Afroza, 2000).

2.6.3 Spatial pattern and internal layout

The design of housing units or flats in post-colonial fifties were characterised by lavish allocation of space with huge verandas and wide corridors reminiscent of colonial bungalows. There being no space standards, the flats tended to be large and expensive. During the Pakistan period, open verandas were in vogue as it provided comfort in hot humid climate. Changed circumstances brought about many changes in the housing design. With lowering of accommodation sizes, large verandas had to be sacrificed. Flats with a greater number of smaller rooms were preferred to those with fewer bigger rooms (DoA- GoB, 1993).

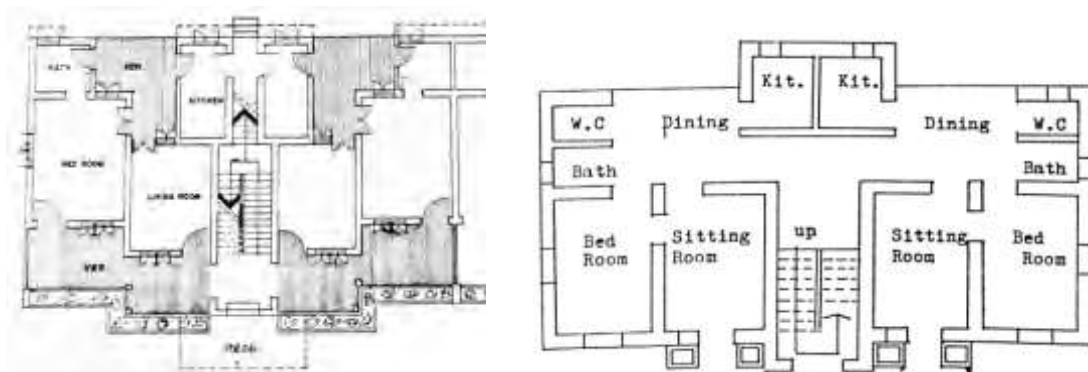


Fig 2.4: Spatial Pattern: Early style- Pakistan period (left), Later style- Bangladesh periods (right)

The Department of Architecture has developed a set of standard residential building designs for different levels of government servants. These are repeated wherever necessary all over the country to meet the housing needs of government servant. In many cases the internal layout and spatial elements all are the same, they only change their size large or small according to the allotted sq. ft.

With time, various types of built forms have evolved in the field of public housing. The earliest and most popular one is rectangular with a central staircase as in most government officers' and employees' colonies.

Internal spaces within the unit are organized in two distinct types; service and the formal zone are distinctly separated. Usually form takes the shape of L or U. Kitchen open to tertiary space usually verandah type corridor. All the spaces are combined together. Units assume a regular shape, usually rectangle. The internal arrangements of spaces in all the flats are of a common character. The smallest flat of 500 sq. ft. floor area is divided into seven different spaces; living, dining, kitchen, bath, w.c. and verandah are common element in all types. The rooms are usually used as multifunctional specially the living. This room is designed for both living and bed purpose. One to three bedrooms (depends on flat size as does the size of the individual rooms) and supporting facilities (dressing room, maid's room, kitchen verandah) depend on the flat size. Use of verandahs depends on size and location. Wider verandahs are used as dining space/ study area and also converted to rooms by adding windows.

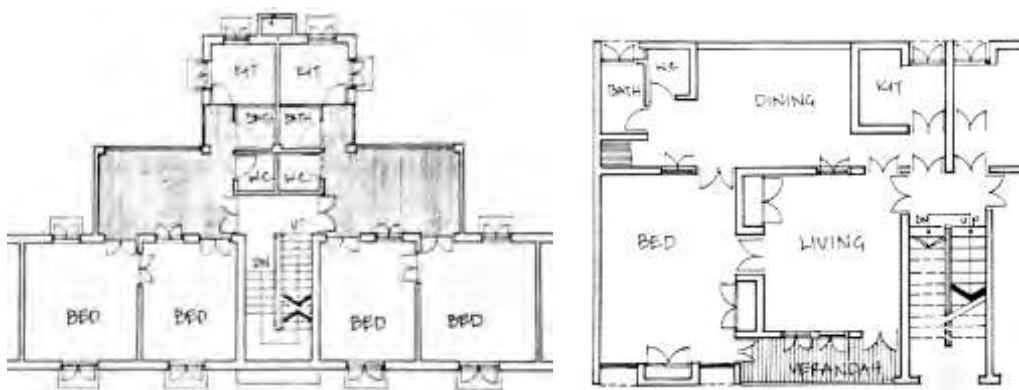


Fig 2.5: Spatial Pattern: Spread Layout type (left) and Compact Layout type (right)

2.7 Space Syntax Theory

The study of spatial configuration is an approach that reveals the social order embedded in spatial pattern. Steadman (1983) and Hillier and Hanson (1984) have introduced the analyses of domestic space configuration through architectural morphology. Among the various theories and methods which have been developed in the past decades Space Syntax has established itself in the field of architectural morphology (Steadman, 1983) for placing the intrinsic relation between society and the manmade environment at its foundation (Hillier and Hanson, 1984). From the theoretical premises Hillier and Hanson demonstrated a set of related basic rules of combination capable of generating spatial patterns that can be expressed mathematically. Space syntax emphasizes the interpretation of spatial configuration. There are two key elements of spatial layout,

convex spaces and its access. Convex space is a single space which corresponds to the experience of people in space, while access is a successful movement from one space to the other by its occupants. Both elements indicate the inhabitant's movement and interaction. The analysis of spatial configuration deals directly with building layout.

Techniques were generated by Space syntax 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 the fact of space that creates the spatial relation between function and social meaning in buildings. Space syntax is therefore, a tool by which buildings are transformed into dimensionless forms (Bandyopadhyay, 2007) or into the form of adjacency graphs to represent, quantify and interpret spatial pattern of buildings in such a way that their underlying 'social logic' can be understood. In justified graph, a space is represented as a circle and lines stemming from it represent its connections to other spaces. Main entrance to the house is considered as the root to conduct all calculations.

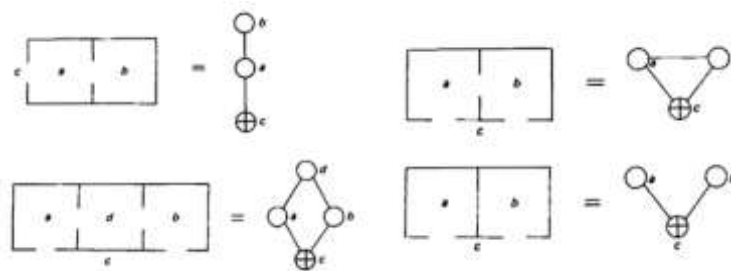


Fig 2.6: Basic configurational relationships

In this research to understand the spatial organization, Justified Accessibility graph (J-Graph) is used by JASS software for both sets of apartments (original and altered layout) and evaluate the spatial properties distributiveness, typology, integration, depth and control.

Under this research syntactic analysis carried out by following five parameters:

Distributiveness expresses the trend towards a 'ring' or 'tree-like' system. The ring system (more distributive), implies different options of connecting interspaces and the tree-like system (less distributive) does not present rings, since there is only one possible route among the spaces.

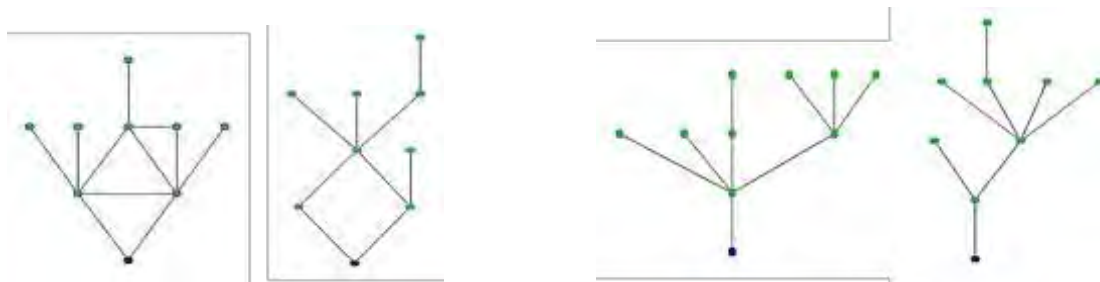


Fig 2.7: Ringy Graph (left) and Tree Graph (right)

Typology can be classified according to its topological properties and Hillier introduced four types of spaces (Hillier, 2007). The letters a, b, c and d represent the space structural dimension. Hillier (2007) summarised that every space in a J-graph would fall under one of four types of categories based on their connections as follows:

a type spaces are terminal spaces with a single link and are dead-end spaces. Spaces as such only accommodate movement to and from themselves and are characterized by static occupation (Hanson, 1998) through which no movement is possible to other spaces. **b type** spaces are thoroughfares-with more than one link- where movement is highly directed leading to a terminal space. **c type** spaces are that lie on a ring and Movement through a c-type space provides choice (Hanson, 1998). **d-type** spaces are junctions for two or more rings. Passages; junction and place types are differentiated by the physicality of a-b-c-d type-spaces.

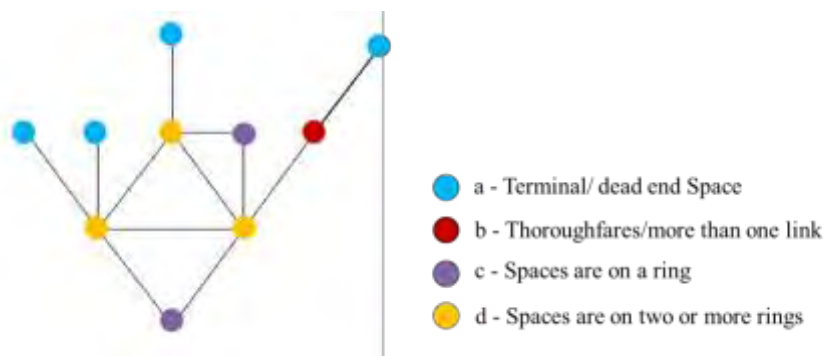


Fig 2.8: Different typology of J-graph

Integration describes the average depth of a space to all other spaces in the system. A space in the house that has the highest degree of integration can be accessed easily and quickly from the other spaces 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 the topological distance, measured by the number of convex spaces which separate the spaces within the system and these spaces in relation to the outside.

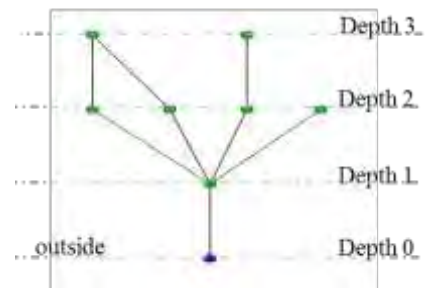


Fig 2.9: Depth from outside

Control value is a dynamic local measure. It measures the degree to which a space controls access to its immediate neighbours taking into account the number of alternative connections that each of these neighbours has. If the control value is less than one, the control of the space becomes weak (Hillier & Hanson, 1984).

2.7.1 Application of Space Syntax theory

Space Syntax is a method for describing and analysing the relationships between spaces of buildings. Since this method has developed, it has grown into an independent research area with an increasing international community. There are numerous benefits to be gained from the abstraction of architectural floor plans into graphs of nodes and connections as suggested by the method. Among them, the procedure offers easy, and well defined steps for the analysis, description, and hence the comparison of buildings - though in a two dimensional form - and their spatial qualities. Using space syntax procedure, it is easy to analyse floor plans of buildings to reveal their underlying morphological structure. Subsequently, prominent physical qualities that may dictate the use of buildings in certain ways might be deduced. The reasons that led to adopt this methodology in dealing with the syntactical characteristics of spatial configuration because this methodology combines physical and social indicators to explain the spatial-functional systems in order to identify their configurations in terms of differences and similarities. This paves the way to diagnose the strengths and weaknesses in the structures of house layouts functionally. It adopts the syntactical characteristics of spatial configuration in interpreting the structures of different house layouts. Having the ability to assess, understand, describe, and modelling of numerous formal and spatial systems provides the research a fair amount of credibility and reality.

In architectural research, many scholars apply space syntax to describe the use of space and meaning in built forms and human settlements. When the numerical variation of syntactic values follows a certain order across a sample, then it can be said that the

houses share a social logic indigenous to that culture. This 'numerical consistency in spatial patterning' is called 'a housing genotype' (Hanson, 1998). Hanson found studies of samples of traditional and vernacular houses to have been continuing over the years and an extensive database has been accumulated on the morphology of houses worldwide (Hanson, 1998). The early approaches of space syntax address the issues of social structure and cultural order in built spaces. In recent studies, researchers have searched for characteristics of space that define the inherent meanings and domestic experience. The following are only a few selections of case studies that applied space syntax to the exploration of spatial properties embedded in built spaces.

Kenji Omata (1992) studies 152 Japanese students' house plan and examines the room usage, how people combine different activities for the efficient use of a limited number of space in Japanese houses. The results indicate that the functional differentiation of room is reduced in small houses. Multifunctional use of family space has introduced; spatial coexistence of family activity, entertainment and the establishment of personal space (bedroom). High family density in small houses might result the exclusion of social activity. Also parental activities were transferred to the family space in small houses but those of the children were not. The predominance of children's space over parents' was also suggested.

Monteiro (1997) compare the spatial pattern of domestic activities of different social groups based on the analysis of each house's structure and arrangements. The study investigates 101 houses from three different neighbourhood of Brazil. Special attention was paid to drawing furniture and to registering signs of activities in each room using the justified graph analysis. Here he sorted the activities and places than check out the integration, control and depth. The findings showed that the more integrated activities are the social one by nature these activities involves the all family members as well as the visitors of the house. On the other hand the most segregated parts are the personal space (resting, bath). In the smaller house privacy is a matter of timing not the space. For small house (traditional favela house) the depth is not related to integration. These have the most integrated pattern. Most integrated spaces are located in the inner area of the house. On contrary the middle class flats like public housing dwellings have a strong connection of integration with spatial depth.

Altas and Ozsoy (1998) evaluate the dwelling space in terms of residential satisfaction of the occupants. They studied in four different types of 2 bedroom owner's dwelling in Istanbul and compare the original and altered organization to find out the potential plan types for future alterations for residential satisfaction. The alterations adaptations made by the users on a single space and the use of the same space for different activity patterns were also assessed. They concluded that user satisfaction depends on variables such as size, shape, solid-void relation, furniture type etc. other than the dwelling size. There is a complex relation between the perceived space and real dwelling size in terms of space organization. The proper organization of rooms can encourage flexible use or adaptation in a dwelling.

Franca and Holanda (2003) use justified graph in a study on 27 middle income houses in Brazil to investigate the room use with respect to time. The method taken for the study is questionnaire survey and the syntactic value of graph theory is taken to measure is integration distributiveness and closure. The study concluded that the communal spaces are ringy and private areas are tree branch. Dining acts as a transition between ring system and tree like system and strengthen the control of access to the most segregated parts of the house. Kitchen has higher integration so express its importance in family role. Living is for visitors and kitchen for family interaction.

Asquith (2006) studied about the space use in the family home according to age, gender, time and activity. This study has followed the time diary method and use justified graph theory on 18 families. It highlighted which rooms are used the most, the times when they are used and also the rooms that are not used. It could also be used to identify the rooms that tended to be gender and age specific. It concluded that looped or linear spaced are frequently used and they are multifunctional rather than branched syntax. Women choose to work more integrated space and male choose to work in more segregated space. Younger children prefer integrated space and older prefer segregated space. Looped syntax between the sitting, dining, kitchen enhances the communication.

Franca and Holanda (2009) also analyse the geometry and 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 of 200 building in Brazil and see the integration, depth and distributiveness by using justified graph. They concluded that apartments become less distributive after the modifications. It reinforces

the isolation of private area. Kitchen has little depth in later day apartment. Smaller apartments have ore permeable space, more integrated and less privacy. On contrary larger apartments have greater level of privacy and they are less integrated.

From the literature some important findings have establish. According to these researches in case of small house the functional differentiation has reduced and multi-functionality has increased in domestic spaces. Usually the multifunctional spaces are looped or linear type. Though in case of the modification of house, after modification most of the houses become less distributive, it reinforced the isolation of private area of house. Moreover in small house privacy is a matter of timing not the space. When the integration value has analysed it is found that the most integrated spaces are the social one and the most segregated one are the personal area. However it has also seen that the communal spaces are ringy and the private spaces are brunch type. Dining act as a between this two type has more control of access to the inner part of the house.

The literature study presented the theoretical foundations and methodology of space syntax as a research strategy for study of spatial layout of domestic space with examples of how these methods were employed for studies in different context and communities. This is especially beneficial in a scientifically motivated era where hard facts are often preferred over observed entities, space syntax offers objective analyses for use within architecture and allied disciplines of the built environment to support documented and observed phenomena about space. These though valid, are often considered non-generalizable and subjective. As all examples reveal, 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. Real life problems in all spheres of life, architecture inclusive are increasingly becoming complex, necessitating holistic and interdisciplinary approaches often involving other disciplines and professionals in order to adequately address them. Space syntax originating from architecture offers alternative and non-subjective options towards discovering what is hidden or implicit in space research and analyses across many disciplines. This ultimately strengthens the theoretical base of architecture, housing research and practice within and even beyond the built environment.

2.8 Conclusion

This thesis tries to understand the spatial organization of lower-middle income apartment and their space use pattern focusing the alterations which is a common phenomenon of these apartments. The development of urban house form in Dhaka and the household activity is studied to understand the space use pattern. The functionality and adaptability of domestic space is also studied for understand the alterations in this small apartments.

The development of govt. staff housing is briefly discussed here as this study focused on the housing for govt. employees. From the study it is known that the space standard for public housing is distributed according to their pay scale. After independence in 1971 the number of govt. employee is rapidly hence the space standard is gone through many revision and finally there is a drastic lowering of residence size 1800 sq. ft. flats instead of Bungalows of 3000-4000 sq. ft. for higher categories of officials. On the other hand the minimum space standard is 500 sq. ft., previously that was 519 sq. ft. which indicate the attitude of the Government for providing more accommodation to low paid employees. The buildings were usually consolidated walk-up type, rectangular in space. With lowering the accommodation sizes instead of bungalow with fewer large rooms and verandas, flats with a greater number of smaller rooms were preferred to the new apartments.

Space Syntax methodology is applied in this study for the spatial analysis. The reasons that led to adopt this methodology is using space syntax, it is easy to analyse floor plans of buildings to reveal their underlying morphological structure. This methodology combines physical and social indicators to explain the spatial-functional systems in order to identify their configurations in terms of differences and similarities. In recent studies, researchers have able to search for characteristics of space that define the inherent meanings and domestic experience.

CHAPTER 03 CASE STUDIES

3.1 Introduction

This chapter is organized in three parts. The first part is a brief description of the background and development of case study areas with detail physical description of studied apartments. The socio-demographic and economic data about the families is also discussed here. The components of domestic space of these apartments have studied here to understand the spatial organization. The second part is about the space use pattern which is described through the activity analysis. However the last part is analyzed about the alterations which take parts in the case study samples. The major alterations and the reasons are studied to identify the morphological changes. These are obtained from questionnaire which is collected from respondents' interviews, photographs and drawings during field survey. The original and the altered plans are compared and analysed on the basis of different social aspects particularly from the respondent's point of view.

3.2 Case Study Areas

The govt. staff housings are located all over the Dhaka, among them the samples are chosen from four different locations through some selection criteria. The locations are Mirpur, Green road, Azimpur and Palashi, denoted by location one, two, three and four respectively. For this study five different layouts has been chosen with different plan, size and location. The apartments how they have designed by architects and before occupied by any occupants; mentioned as original samples here. The five types of original samples are denoted by A, B, C, D and E. When an apartment is given to an allottee, they have made some modifications to the apartment according to their necessity. This modified layout is mentioned here as altered layout. Three altered apartments have taken for each original sample. Since having the same original layout different occupants have modified the apartment differently according to their own choices and needs. Total fifteen apartments have taken as altered sample for this study. The altered samples are denoted by A-1, A-2 and A-3 for the original sample A; B-1, B-2 and B-3 for original sample B; C-1, C-2 and C-3 for original sample C; D-1, D-2 and D-3 for original sample D and finally E-1, E-2 and E-3 for original sample E. The apartment size are calculated only from the unit area without including any other

facilities like lobby, parking, community space or any other area which are shared by the occupants.

3.2.1 Location one: Mirpur BCSIR staff housing



Fig 3.1: Location map of Mirpur BCSIR staff housing

The first location is Mirpur BCSIR staff housing established on 1980-1984 on an area nearly 5 acres. This housing is located on Paikpara, Mirpur 1; an area located between Der-es-Salam road and Kamal shoroni. Two original cases have selected from this housing are for this study. The areas of the case study apartments are 425 sq. ft. denoted by A and 530 sq. ft. denoted by B.

3.2.2 Location two: Green road government housing



Fig 3.2: Location map of Green road government housing

Green road government housing is established in 1958. The area is bounded by four roads these are Green road on the east, Mirpur road on west, Dhamondi road number 8 on south and another road is connected with Kalabagan first lane on the north. The area

of this housing estate is approx. 12.5 acre. The case study sample of this area is 580 sq. ft. denoted by C.

3.2.3 Location three: Azimpur governmental housing

Within the boundaries of Dhaka, Azimpur Governmental housing is the first multi-storey walk-up residential flats housing project for the govt. employees. During 1950s the then provincial government established this residential area. In 1970s the case study area is developed as D-type flat ranging from 950 to 1037 sq. ft. and C-type ranging from 650 to 850 sq. ft. these apartments are built for middle & lower-middle income government service holders. The area bounded by Peelkhana Road, Azimpur Road and stretching up to Sir Salimullah Muslim Orphanage, measures 23.64 acres land area. The area of the sample apartment of this study is 690 sq. ft. denoted by D.



Fig 3.3: Location map of Azimpur and Palashi govt. housing area

3.2.4 Location four: Palashi govt. housing area

The area is known as Palashi Barracks because Barrack type housing had been built here during British Period. Under the 3000 flats programme of government, by demolishing barrack housing, 5 storied flats of different categories for the Government servants were built on 5.39 acres of land in 1995. The size of the apartment of Palashi govt. housing is 800 sq. ft. denoted by E.

3.3 User Characteristics

In this section the socio economic and demographic information about the respondent have been collected from the field study and summarised to understand about their social status.

3.3.1 Respondent profile

The questionnaire survey is conducted to collect the necessary data. All the questionnaire is collected from the female head of the family thus enhance the internal validity of the study. However female head can describe briefly about the activity and use of domestic space. Most of the female head are housewives only 13.3% (2 no.) are service holder; both of them are doing govt. service. The house is allotted to the name of male head who is a govt. service holder except these two cases where the house is allotted to the name of female head. The age of the respondents' are varying from 36 years to 50 years. 46.7% are not completed their SSC examination whereas only 20% (3 nos.) completed their graduation. The percentage of secondary school certificate (SSC) and higher secondary school certificate (HSC) examination completed respondents are 26.7% and 6.7% respectively.

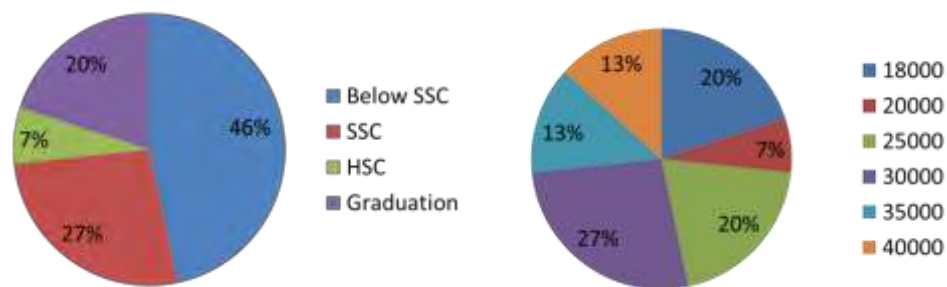


Fig 3.4: Education of female head (left) and household expenditure in taka (right)

3.3.2 Economic status

According to Bangladesh national pay scale the salary grade of the respondents ranges from grade-11 to 20 and all of them are class-III and IV govt. employees. Household expenditure varies from 18000 to 40000 taka. However a large number of families are within 25000-30000 taka range. In 53.33% household has only one earning member, whereas in 46.67% (7 nos.) cases they have more than one earning member in the family. In the case of more than one earning member it is seen that in only two cases husband and wife both is service holder rest of the cases the son or son-in-law who lived with their in-law's family are service holder.

3.3.3 Occupancy pattern

The household size of the case studies is within 3-7. Among them 33.3% (5 no.) are nuclear family, where the respondent (wife) living with husband and their children. Rest of them 66.7% (10 no.) are extended families where the respondent (female head) living with husband, children and daughter-in-law or son-in-law and in some cases the parents or any other relatives. The percentage of male and female member in the household is not varying too much, 47.1% are female and the rest of the members (52.9%) are male on average. In these staff housing they have a phenomenon of giving the room to someone who is not the member of this family as sublet. This is another source of income generation for the allottees. Usually the subtenants are female students, female job holder or young couple without any children. They have used the same entrance and shared the common facilities with the allottees like toilet, bath, kitchen etc. Among the case studies 26.7% (4 no.) residences have sublet tenants.

3.3.4 Occupancy period

Average occupancy period is 14.7 years ranges from 5 to 42 years. In one case (sample D-1), the same apartment is allotted for two generation (father and son) as both of them are govt. employee so they lived for a long period of time (42 years) at the same apartment.

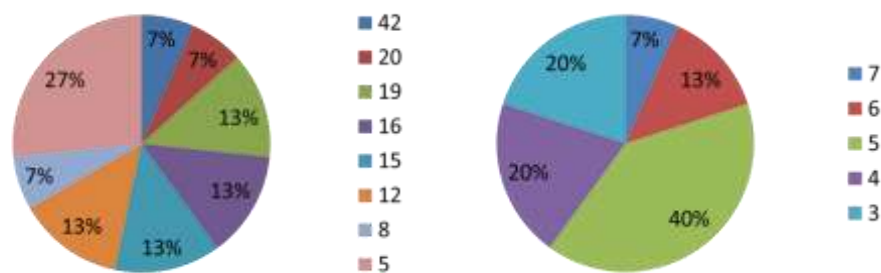


Fig 3.5: Occupancy period in year (left) and household number (right)

3.4 Spatial Organization of Domestic Space

Typically these apartments are composed with some units which are discussed under in three major groups:

- Entry and Circulation
- Major activity spaces and
- Services

3.4.1 Entry and Circulation

In original cases there are 60% apartments which have two entry and rest of the apartments (40%) have only one entry from outside. In case of only one entry it is entered directly in a foyer or a common space (e.g. dining, because they don't have any foyer) in original sample apartments. When there are two entries the second entry is directly entered to living-bed space. In original layout 80% samples has foyer space. The case study samples have very short corridors acts as a circulation space for connecting other major activity and service spaces (e.g. dining, bed, toilet etc.).

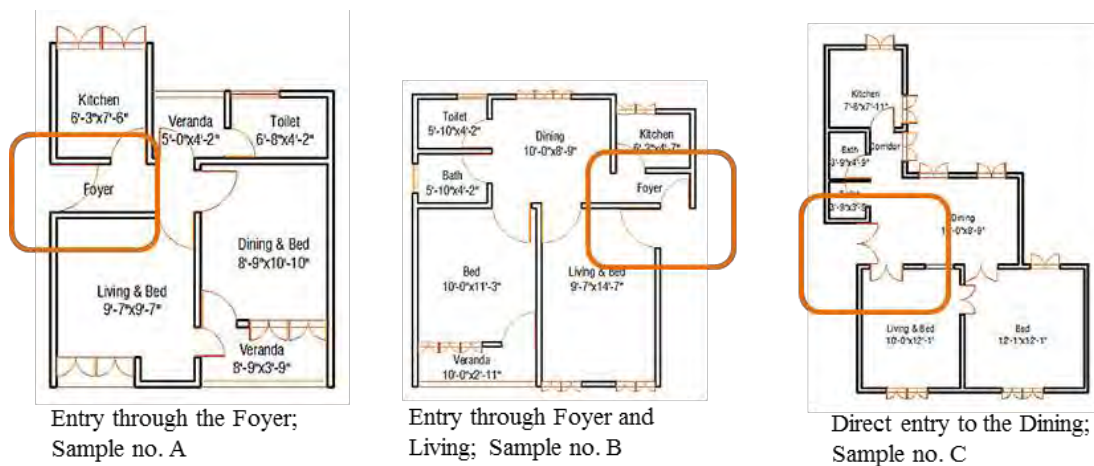


Fig 3.6: Different types of entry in original layout

3.4.2 Major activity spaces

The major activity spaces are living, dining and one or two bedroom with or without verandah. In all the original cases living space is designed to use as a multifunctional space. Living space is designed for bed also (DoA- GoB, 1993) which is denoted as living-bed. This is why in maximum apartments the front room or the living room is quite large (e.g. 18'-9"x9'-7" in group D). Dining space acts as an important space due to its location on the plan layout, its acts as transitional space between semi public and private area which connects all the other private and service spaces also.

3.4.3 Services

All these apartments have separate bath and toilet to enhance the functional usability unless the apartments are too small to accommodate two spaces (Group A). Only very few cases attached toilet has found (Group E) though it is very difficult to accommodate an attach toilet within this limited space. Some cases the bath and toilet located near the entry (Group D) so that the guest and outsider reach them easily

without hampering the privacy of the apartment. Sometimes the opposite case also happened that the toilet and bath is located in the inner side of the apartment. The kitchen is usually located in such place that it can easily connect with the dining.

3.5 Physical Description

These apartments are mostly designed by architects of Public Works Department (PWD), Govt. of Bangladesh. All of these are consolidated walk up type apartments. Distinctiveness of consolidated type is the integration of the living and service part into a single mass within a walk up limit of 4 to 6 storey building. The samples have very compact internal arrangements though the number of spaces varies according to the size of apartment. The size of the apartment is distributed according to residential standard, allotted by salary grade of the govt. employees elaborated on chapter two. The room use of these apartments is multifunctional. Such as in every cases living also used as bed which indicates as living-bed. In the same way in few cases bedroom also used as dining so it indicated as dining-bed. However in altered cases this phenomenon is increased at a higher rate, here veranda also used as bed which is mentioned as veranda-bed to describe the cases. In altered plan the use of room indicates what/ how the users used it currently, not what was designed for.

3.5.1. Group A: Sample A, A-1, A-2, A-3

In A-1, The husband and wife lived with their two nephews. In A-2, the husband and wife lived with their son, a daughter and her husband with their two years old grandchild. However in sample A-3, the family member comprises with the husband and wife with their three sons and a daughter-in-law. The earning member for the first family is only the male head but in the second family the son-in-law also have some business. However in third family the elder son and daughter-in-law both are working though the earning from in daughter-in-law is not much considerable. This is why for counting the earning member is considered two in sample A-3.

Table 3.1: Group A; Socio-demographic and Socio-economic data.

Case study		Socio-demographic data				Socio-economic data	
Size (Sq. ft.)	Sample No.	Occupancy Period	Family type	Household Size	Sublet	Earning Member	Monthly expenditure
425	A-1	16	Extended	4	No	1	18000
	A-2	12	Extended	5	No	2	30000
	A-3	8	Extended	6	No	2	35000



Fig 3.7: Group A; Plan of the case studies (Original and Altered)

The area of this type is 425 sq. ft. and the original sample ‘A’ is organized with foyer, living-bed, dining-bed, kitchen, toilet and two verandahs; total seven spaces (fig. 3.7). The altered sample A-1, A-2 and A-3 also has the same no. of spaces. However there are some major conversion in space use and layout have found in altered apartments which are made by the occupants. In original layout the veranda is connected with two rooms (living-bed and dining-bed) but the users are choose to use only one door/ connection instead of two. The door between living-bed and verandah is closed permanently by placing furniture in front of it in all three samples A-1, A-2 and A-3 due to the limited functional space. They don’t have much space to place the furniture so they choose the placement of furniture over the accessibility of space. In sample A-1 and A-3 they have use their verandah for bed also. Again in sample A-2 and A-3, they converted their kitchen into a bedroom. In all the cases they have converted their kitchen or veranda to bedroom due to need of extra bedroom and they sacrificed ease of

cooking for that. In case of converting kitchen into bed the small veranda in front of toilet and connected with the foyer, the occupants have used it for kitchen purpose. In A-2 and A-3 as they have converted their verandah into kitchen the occupants have to do their food preparation works in bedroom or veranda due to very congested space in kitchen. In this case the size of kitchen (6'-3"x7'-6") being spacious compared to total area of apartment (425 sq. ft.) may have instigated them to convert it into bed. In sample A-1 they don't have any fixed dining are. They have use both the room for dining purpose according to their convenience. When any guest comes, the family offer food in the living-bed; however for their own dining they sit on floor or bed in the other room (bedroom). One important observation of family structure is more than one couple in A-2 and A-3 who needed more separate bedrooms. As long as the families are extended the designed plan did not suited their need as these are the smallest samples among all the case studies.

3.5.2. Group B: Sample B, B-1, B-2, B-3

In B-1, the husband and wife lived with their two sons and a daughter. The elder son is also a job holder and other two are studying. In B-2 the family comprises with husband, wife and their only daughter who is a student. The third family (B-3) of this group the husband and wife lived with their two daughter, both of them are student.

Table 3.2: Group B; Socio-demographic and Socio-economic data.

Case study		Socio-demographic data				Socio-economic data	
Size (Sq. ft.)	Sample No.	Occupancy Period	Family type	Household Size	Sublet	Earning Member	Monthly expenditure
530	B-1	16	Extended	5	No	2	18000
	B-2	20	Nuclear	3	No	1	15000
	B-3	5	Nuclear	4	No	1	30000

The original sample B has organised with eight spaces; foyer, living-bed, dining, bed, kitchen, toilet, bath and a veranda. However altered samples have the same no. of spaces (fig.3.8). All three sample B-1, B-2 and B-3 have closed the door which is directly connected to outside from the living-bed. Sample B-1 and B-3 have said that they have done this because of shortage of functional space; they have very limited space for their furniture. However in B-2, the occupants have done this for security purpose and for maintenance problem. In B-2 the girl child of the occupants has lived on the front room so the parents closed the door especially due to safely purpose. In B-1 they have used the dining for bed also due to shortage of bedroom. Another

observation here is though these apartments also have veranda but they don't converted it like group A.

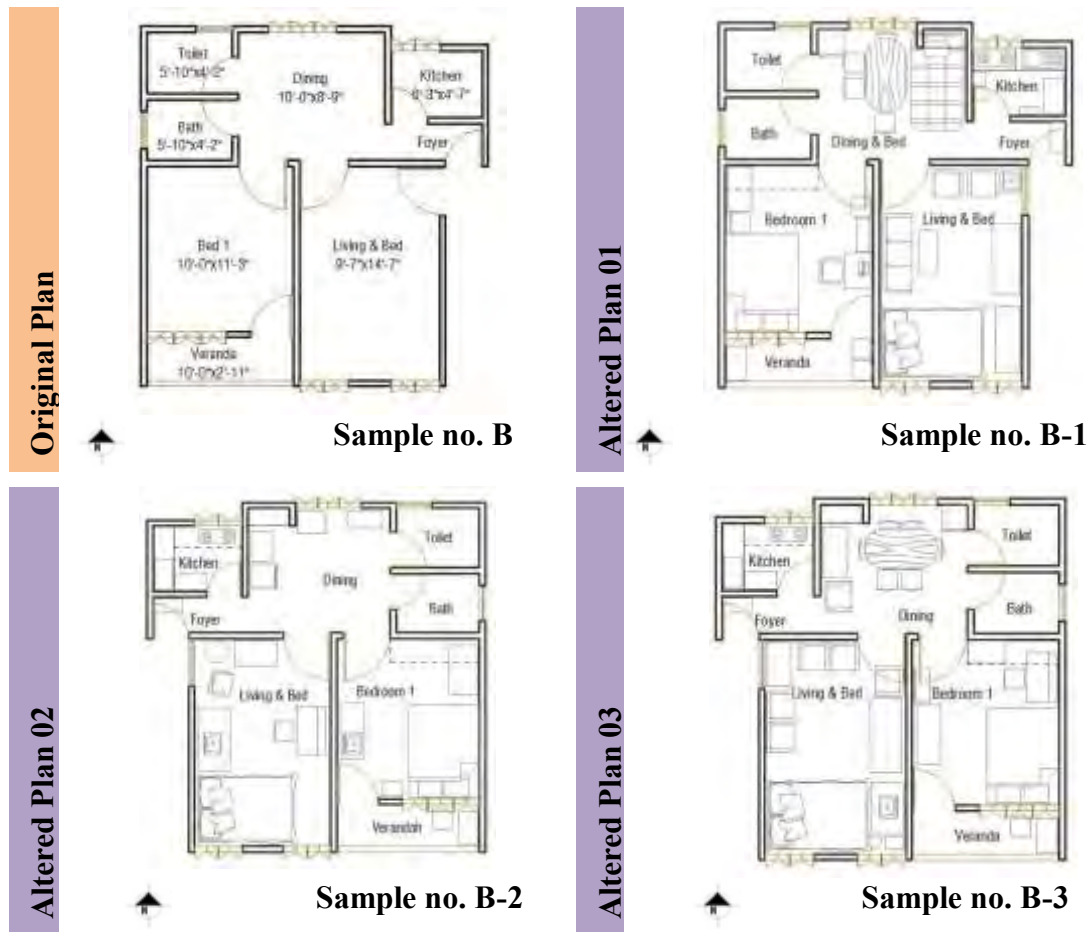


Fig 3.8: Group B; Plan of the case studies (Original and Altered)

3.5.3. Group C: Sample C, C-1, C-2, C-3

In C-1, the husband and wife lived with their daughter. However in A-2, husband and wife lived with their two sons and a daughter. In sample C-3, the family member comprises with the husband and wife with their son, daughter and the mother of male head. The earning member for the first family is only the male head but in the second family the elder son also has a job. The female head of C-1 is job holder and the male head is a retired person whereas in the other two the female heads are housewife.

Table 3.3: Group C; Socio-demographic and Socio-economic data.

Case study		Socio-demographic data				Socio-economic data	
Size (Sq. ft.)	Sample No.	Occupancy Period	Family type	Household Size	Sublet	Earning Member	Monthly expenditure
580	C-1	15	Nuclear	3	No	1	30000
	C-2	15	Extended	5	No	2	35000
	C-3	5	Extended	5	Yes	1	20000

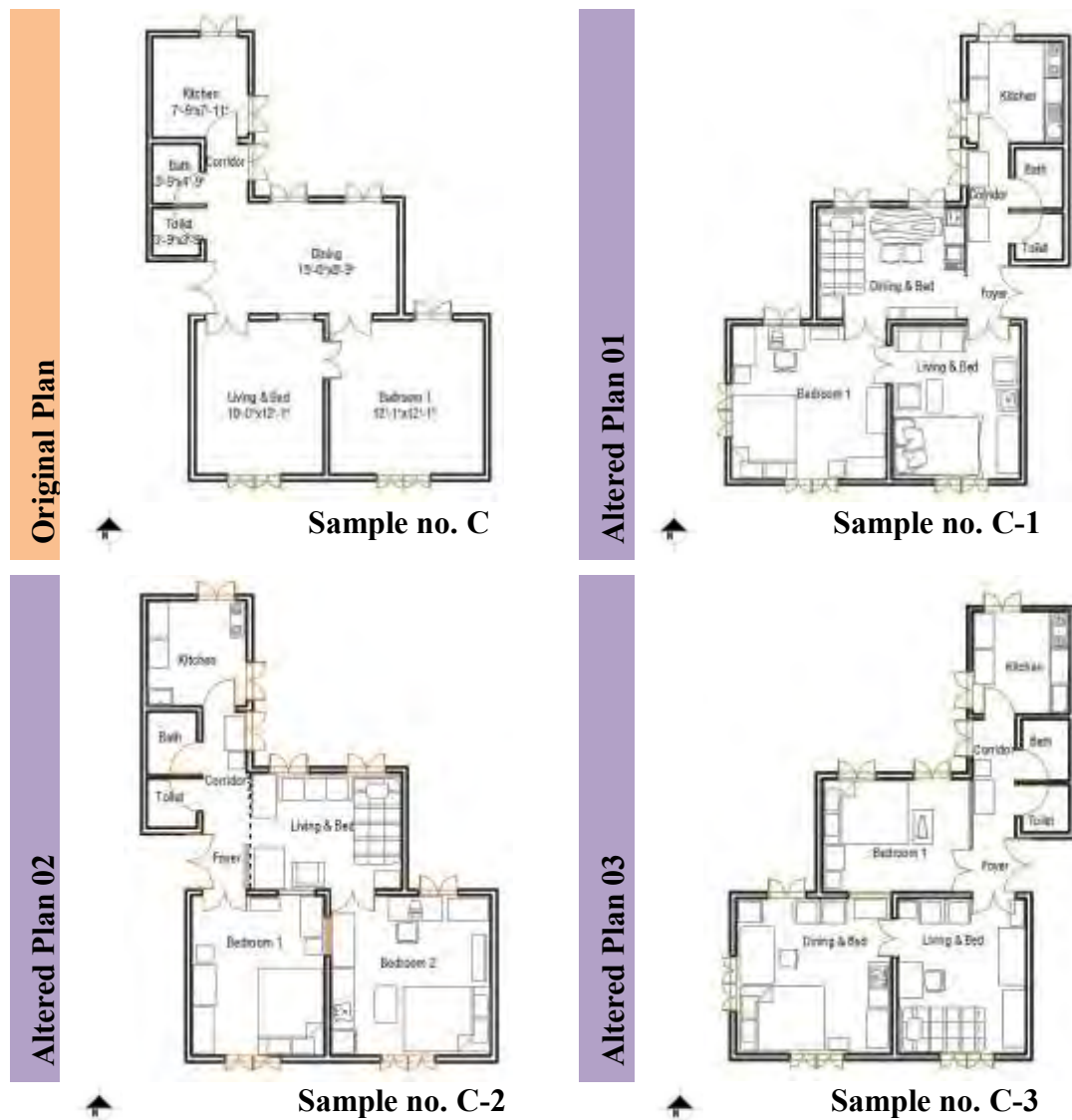


Fig 3.9: Group C; Plan of the case studies (Original and Altered)

Here the original layout has total seven spaces (fig: 3.9) in total organized with one liv-bed, dining, bed, kitchen, toilet, bath and a short corridor where as in altered layout total number of spaces is 8. With all the components which are in original layout they have ensured one foyer space in their altered layout by using partition or curtain. To ensure the privacy of the room which is originally designed for dining the occupants used a partition wall or curtain and convert it as an independent room. Besides maintaining privacy they can also place some furniture against the wall or curtain. However as the space is originally designed for dining area in altered sample C-1 used the space for dining-bed. This bed is used occasionally when any guest comes. Sample C-2 used their living-bed for only bedroom purpose whereas dining for living-bed so they can get two bedrooms. They had two bedrooms originally, now they have three.

The male child has lived in this room as it has less privacy. In C-2 they don't have any proper dining area; they used their living-bed or the bed for dining purpose. However in sample C-3 they have converted the dining space into a separate bedroom and rented it out, this is why they have closed the door between dining and bed to give separation. A young married couple lived in the room and they have shared common facilities like bath, toilet, kitchen etc. There was a door between liv-bed and the bed in original layout C but in C-2 the occupants have closed that door by placing furniture in front of it to ensure the privacy of both the rooms. Respondents' of C-2 have said beside the privacy, they have done this for the functional reason also. They have very limited space for their furniture placement.

3.5.4. Group D: Sample D, D-1, D-2, D-3

In D-1, the household comprises with the husband, wife, their three sons and mother of male head. All the sons are students. In D-2, the husband and wife lived with their two daughters and a son. However in sample D-3, the husband and wife with their only daughter, a niece and mother of male head. The female head of D-1 is housewife and D-2 and D-3 is a job holder.

Table 3.4: Group D; Socio-demographic and Socio-economic data.

Case study		Socio-demographic data				Socio-economic data	
Size (Sq. ft.)	Sample No.	Occupancy Period	Family type	Household Size	Sublet	Earning Member	Monthly expenditure
690	D-1	42	Extended	6	Yes	1	50000
	D-2	5	Nuclear	5	No	2	50000
	D-3	12	Extended	5	No	2	30000

In original layout there was total eight spaces; foyer, living-bed, dining, bed, kitchen, toilet, bath and a veranda (fig 3.10). However in altered layout all three of them have converted the large living-bed (18'-9"x9'-7") into two rooms by giving a partition wall between them for the need of an extra bedroom. Between these two rooms, one room is rented out by sample D-1 for some extra economic benefit. In D-1 they have put a curtain between foyer and dining because of the privacy of dining-bed area as this space is used for the sleeping area for the mother of male head. In all three altered sample the door between bed and living-bed have closed by furniture due to the privacy of bedroom as well as the functional need to place the furniture. D-1 and D-2 samples have used their veranda for bed also. D-1 has used it permanently as a child bed; elder

son has preferred to live in the veranda rather to share the bed with younger siblings in living-bed. However D-2 used the veranda-bed for emergency when they have any guest for night stay. All three of them have closed the door of living-bed which is connected directly to outside because of mostly maintenance problem. The respondents said it is difficult for them to maintain two doors for entry of the apartment. They have said, two door from outside is absolutely unnecessary especially when they have such limited space. All of them have preferred the door which is from foyer as their main door and closed the other one with living.

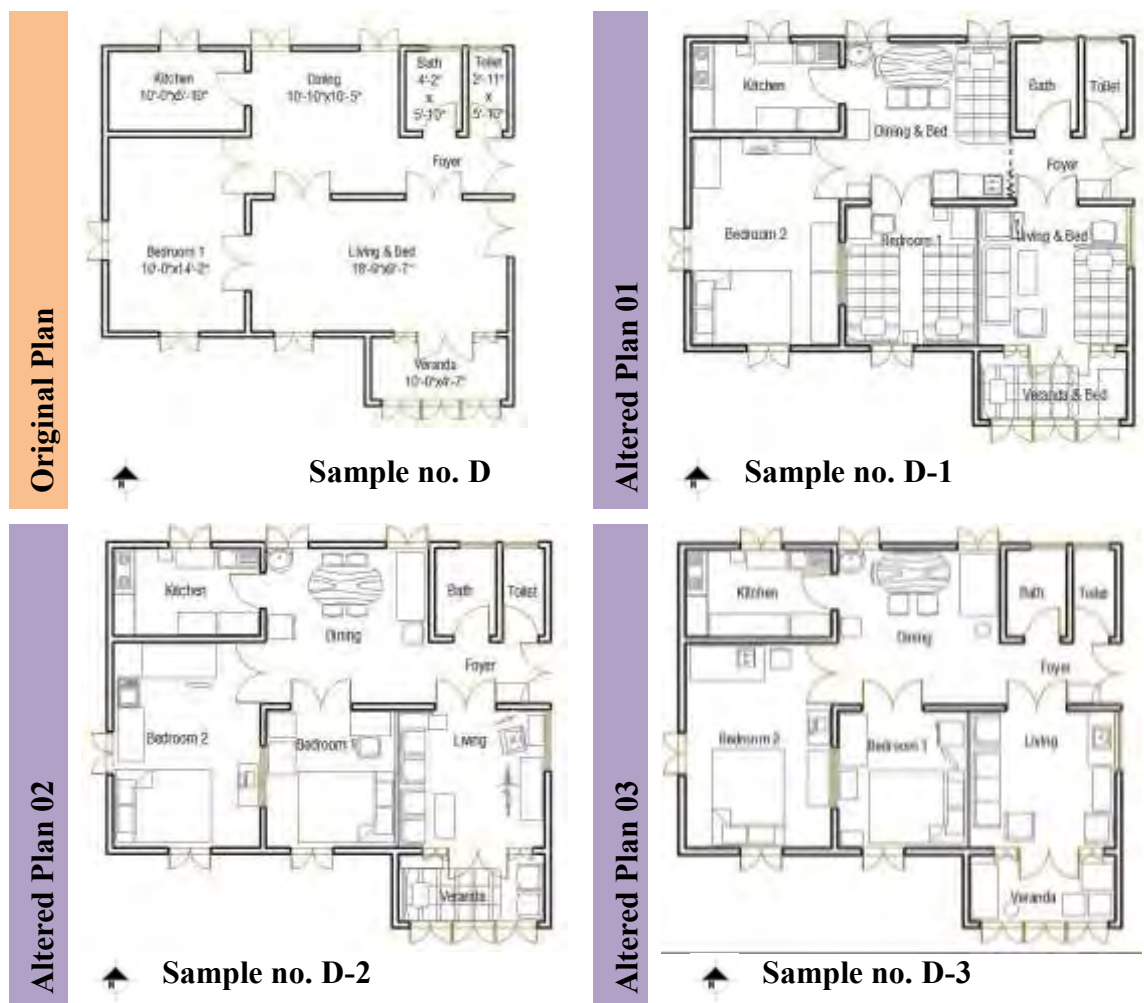


Fig 3.10: Group D; Plan of the case studies (Original and Altered)

3.5.5. Group E: Sample E, E-1, E-2, E-3

In E-1, the husband and wife lived with their four sons and a daughter. All of them are student. The female head is a housewife. In E-2, husband and wife lived with their two sons, elder son is job holder. In sample E-3, the family comprises with the husband and wife with their only daughter.

Table 3.5: Group E; Socio-demographic and Socio-economic data.

Case study		Socio-demographic data				Socio-economic data	
Size (Sq. ft.)	Sample No.	Occupancy Period	Family type	Household Size	Sublet	Earning Member	Monthly expenditure
800	E-1	5	Nuclear	7	Yes	1	25000
	E-2	19	Extended	4	Yes	2	25000
	E-3	19	Extended	3	No	1	25000

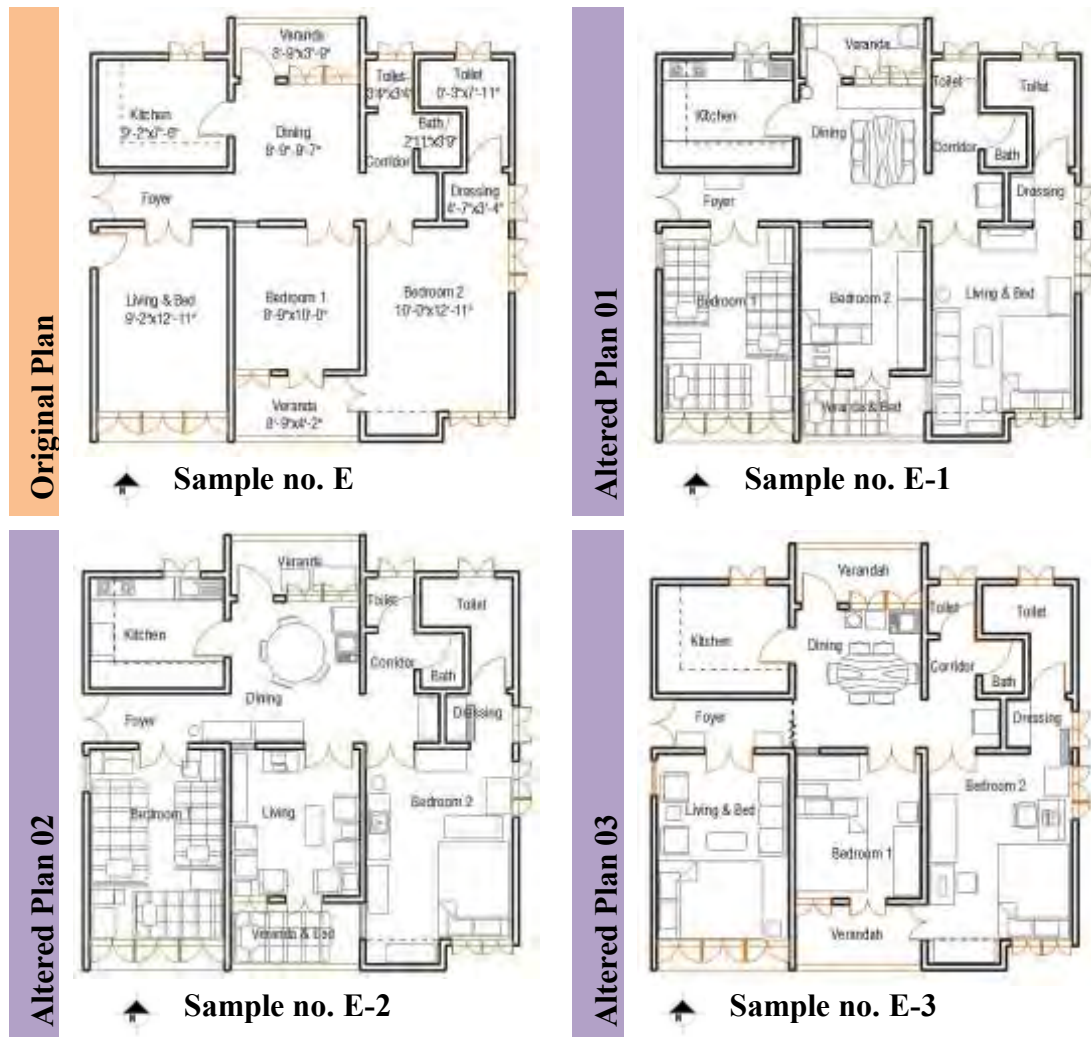


Fig 3.11: Group E; Plan of the case studies (Original and Altered)

The original layout has total thirteen spaces organized with foyer, living-bed, dining, kitchen, toilet, bath, attach toilet, dressing area, two beds, two veranda and a short corridor whereas in altered layout the total no. of spaces are remain same. The door between exterior and the living-bed has closed in all three altered layout (fig: 3.11). The respondents of sample E-1 and E-3 have told they have done this for functional reason as they don't have much space for furniture placement, whereas E-2 told they have maintenance problem, it is confusing for them to decide who to open or which

door to open. As there are two doors for apartment entry so they have choose to maintain only one door. The door between veranda and bed has closed in sample E-1 and E-2 due to functional reason. By closing that door they can save some place for furniture placement. E-1 and E-2, they have also used one of their verandas for bedroom purpose because they need extra bedroom for emergency or occasional use. Again E-1 and E-2 also converted their living-bed to bedroom and tent it to some female students for some economic benefit. This is why E-2 has converted one of their bedrooms to living and E-3 has used their bedroom for both living and bed purpose. In E-3 they have use a curtain between foyer and dining because of privacy of the inner part of the apartment.

3.6 Space Use Pattern through Activity Analysis

Here the space is analyzed according to activity. As many respondents have used more than one space for some activity so the percentage of space use is calculated based on how many respondents have answered that space for any particular activity. As we can see in many cases the space has multifunctional use, in some case the actual use is also changed. The daily household activity which is usually held in a domestic space are categorized here in mainly three broad categories-

- Private activity
- Semi private activity and
- Service activity.

3.6.1 Private activity

The two main private activities of these apartments are reading and sleeping.

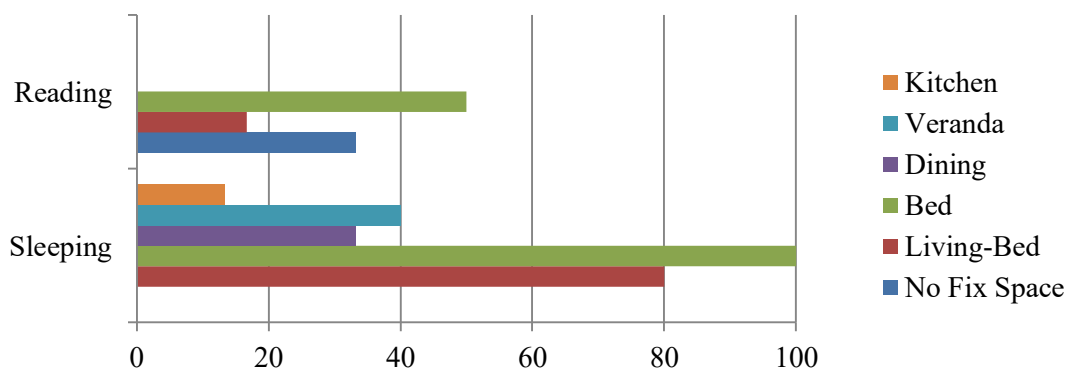


Fig 3.12: Percentage of space use according to activity (Private activity)

3.6.1.1 Sleeping

Generally these apartments have one or two bedrooms based on unit size. The occupants use these spaces mainly for sleeping. However other than bedrooms there are many spaces like kitchen, dining and veranda which are altered or modified to a sleeping area instead of their original use due to the shortage of bedroom. Veranda has a high percentage (40%) of alterations to convert it into a sleeping area. Usually boys have lived in the veranda no girls have found during the survey that is living in the veranda mostly for the privacy of the girls. The elderly boys are preferred the veranda instead of sharing the room with younger siblings. In some cases it is reserved for the emergency time i.e. if any guest have come for night stay, the family members used to stay in that place. In 33.3% cases dining used as a bedroom also, they place a small bed in the dining area. The children or the elderly person of the house used the dining area as their bedroom. The kitchen has found to use as bedroom for 13.3 percent cases, in such cases any other space (i.e. veranda) has used for cooking purpose. In these apartments usually the living is designed as a multipurpose room for both living and bedroom but in case studies it is seen that in 20% cases the occupants use a space only for living room by separating the living-bed with a partition.

3.6.1.2 Reading

In most of the cases (66.7%) children use their own sleeping area for reading either their own bedroom (50%) or the living-bed (16.7%) in which they are sleeping. However quite a large percentage (33.3%) of respondents are said that though the children have their own room but they don't use this fix place for reading, they read in the living, bed and also sometime in the dining area as well. It is because sometimes the mother wants to see the children while they are reading, to help them on their reading or to supervise them. In case of the children who are using the living-bed for their reading, sometimes they have to leave that space for some other activities. Whenever the guests have come to the house and the children have to shift into another room to continue their study. So at that case they also don't have any fixed space for their reading.

3.6.2 Semi-private activity

The major semi-private activities are eating the major meals, entertaining guest, watching TV and family gathering.

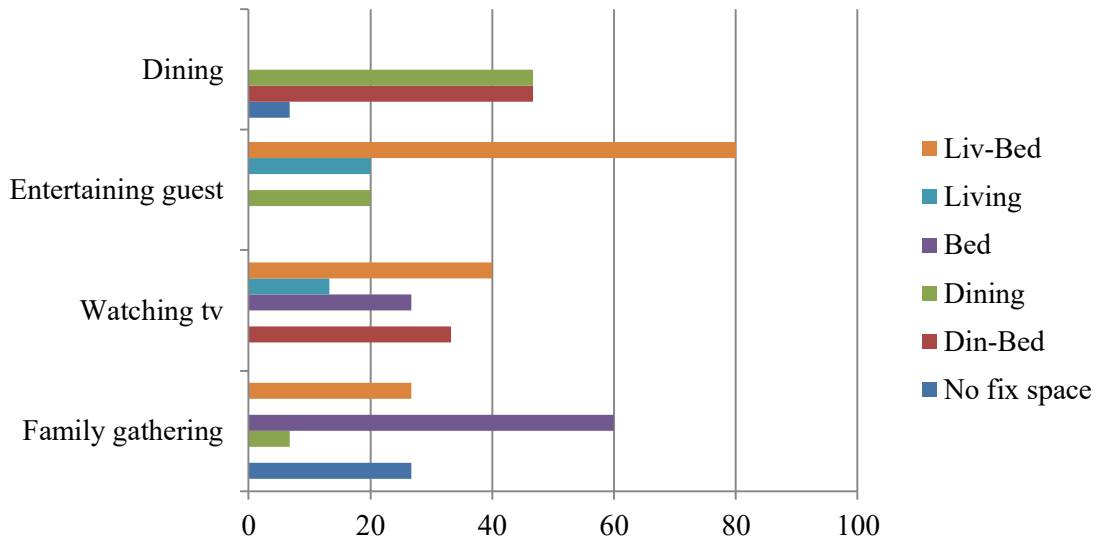


Fig 3.13: Percentage of space use according to activity (Semi-Private activity)

3.6.2.1 Dining

In two rooms apartments due to limited allocated area the occupants don't have any separate dining space; bedroom is designed such a way as it is also used for dining purpose. Usually in most cases there was a separate dining space which is designed to use as the primary space for taking meal. However in many cases the occupants didn't use this space for dining only; this is also used as a dining cum bed in some apartments. In 46.7% cases it is found that the occupants use the dining only for this purpose whereas again it is seen that another 46.7% occupants have use dining-bed for taking the meal. Sometimes dining space act as a bedroom for their personal use due to lack of bedroom and also sometime they give that space to rent for some economic benefit. In 6.7% cases it is found that they don't have any dedicated space for dining in such situation they use their bedroom or any other room for dining purpose.

3.6.2.2 Entertaining guest

Originally these apartments are designed in such a way that they have a large room which can use as a living cum bed where the user can entertain their guest. However after alterations occupants use this living-bed in eighty percent cases. Another 20% cases, respondent decided to leave a dedicated living area which is only used to entertain their guest. However the respondents also told that if the guests are female or if the guests are very close with the respondents, they also use their dining to entertain them in some cases (20%).

3.6.2.3 Watching TV

The percentage of the room for watching TV in living-bed and dining-bed is 40% and 33.3% respectively. In some cases they have two TV so one is placed in the living and another in the bedroom. 13.3% user has a TV in their living room and another 26.7% responded has a TV in their bedroom.

3.6.2.4 Family gathering

Usually they commonly meet at the time of watching TV and taking their meal and as they don't have any family living so they also don't have any specific fixed area only for family gathering so for family gathering they preferred the room which has the TV. For family gathering bedroom is used in maximum (60%) cases. Some other respondents say that they use their living-bed for this purpose and some say that they don't use any fixed space for this purpose. In both cases the percentage for the answers are 26.7. However in very few cases the respondents say that they use their dining for family gathering the percentage are only 6.7.

3.6.3 Service activity

The three major service activity happened in these apartments are preparing the food, cooking and drying the cloth.

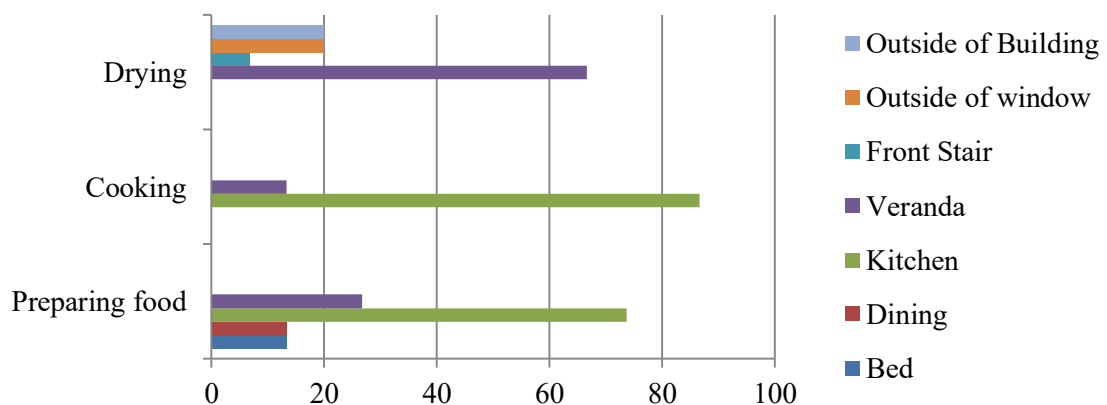


Fig 3.14: Percentage of space use according to activity (Service activity)

3.6.3.1 Food Preparation

Mostly kitchen is used as food preparing area (73.3%) but veranda, bed and dining is also used for this purpose. The percentage of use this spaces are 26.7 for veranda and 13.3 for bed and dining separately. They said they prefer to use kitchen in this purpose but due to some other reason i.e. to save the electricity bill or sometimes to stay with

rest of the family members they use the other spaces instead of kitchen for food preparation.

3.6.3.2 Cooking

Kitchen is used in most (86.7%) of the apartment for cooking. In some cases (13.3%) due to very limited size of apartment veranda is used as a kitchen instead of kitchen. Here kitchen is used for some other function i.e. bedroom etc.

3.6.3.3 Drying cloths

As all the apartments do not have the veranda and also those who have, due to their limited space, they have used their veranda in other different activities. For drying cloths besides veranda (66.7%), they also use their front stair or the outside of the window or the ground area of building front. In the case of rain or in other such situation they have used their dining, bedroom or kitchen for drying cloth as they don't have any specific space for such activity. The percentages are 20% for the front stair and the outside of the window separately and in case of the front side of the building the number is 6.7%.



Fig 3.15: Drying cloths; Group C



Fig 3.16: Drying cloths; Group D

3.6.4 Multifunctional space use pattern

Table 3.6: Multifunctional space use pattern in altered apartments according to activity type

Sl.	Type	Activity	Space	No of cases	Percentage (%)
01	Private	Sleeping	Living-Bed	12 out of 15	80
			Dining	05 out of 15	33.3
			Veranda (optional)	06 out of 15	40
			Kitchen (used as bed)	02 out of 15	13.3
			Bed	15 out of 15	100
		Reading	Living-Bed	02 out of 12	16.7
			Bed	06 out of 12	50
			No Fix space	04 out of 12	33.3
02	Semi Private	Family gathering	Living-Bed	04 out of 15	26.7
			Dining-Bed	01 out of 15	6.7
			Bed	09 out of 15	60
			No Fix space	04 out of 15	26.7
		Watching TV	Living	02 out of 15	13.3
			Living-bed	06 out of 15	40
			Din-Bed	05 out of 15	33.3
			Bed	04 out of 15	26.7
		Entertaining guest	Living-bed	12 out of 15	80
			Living	03 out of 15	20
			Dining	03 out of 15	20
		Dining	Dining-Bed	07 out of 15	46.7
			Bed/ no fixed space	01 out of 15	6.7
			Dining	07 out of 15	46.7
		03	Service	Preparing food	Kitchen
Veranda	04 out of 15				26.7
Bed	02 out of 15				13.3
Dining	02 out of 15				13.3
Cooking	Kitchen			13 out of 15	86.7
	Veranda			02 out of 15	13.3
Drying	Veranda			08 out of 12	66.7
	Outside the building			03 out of 15	20
	Outside of Window			03 out of 15	20
	Front Stair			01 out of 15	6.7

Here in most cases the same activity is placed in more than one space instead of a specific one as they have not enough space to assign a specific activity in a specific space. This is why they have to use multiple activities in the same space according to different time and different situation. Private activities (sleeping, reading) are mainly preferred to happen in a more quiet place or private area of the house; semi private activities (family gathering, watching TV, entertaining guest, dining etc.) are mainly happened in a shared space, where all the family members can come at any time and spend their time with other family members. There are some services activities like preparing food, cooking, drying cloth etc. which take place in such an area where every member of the family is not going frequently. However this segregation is very difficult to maintain in most of the cases for these apartments due to limited area.

3.7 Reasons of Alterations

The samples have overall 7-13 number of spaces in the original layout. Besides after alterations six samples increase the number of spaces. The sample C increases to eight spaces, previously it has seven and sample D apartments increases to nine spaces whereas before alterations it has total eight spaces. All the alterations found on plan and from observation during field survey is summarized here. The reasons are collected from the answers of respondents through questionnaire during field survey.

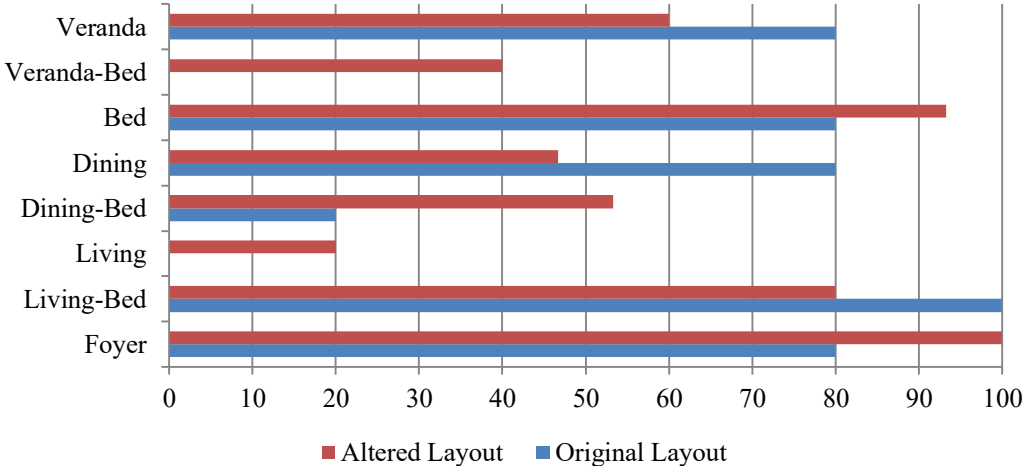


Fig 3.17: Percentage (%) of domestic space components (original and altered layout)

From the figure: 3.17 it can be seen that due to conversion of spaces there are some change on the components of domestic spaces. If we look at the percentage of individual space we can see that these apartments have a lot of changes on major functional spaces within the altered layout. 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; whereas those 80% apartments have the foyer before. Usually the living room is designed to be used as living cum bed room but after alterations it is seen that 20% respondents used the living-bed as living only by dividing the room and create a separate bedroom also. There is a major change on the character of dining space. Due to shortage of space dining room is also used as a bedroom besides dining in 53.3% apartments, but in original layout such dining cum bedroom was only 20%. Another significant change is in veranda, in original layout there are no space called veranda-bed but after alterations 40% veranda also used as a bedroom. The percentages of these spaces are calculated based on how many samples have that component/ space among total cases (15 nos.). In few cases some spaces are present more than one time especially veranda; due to this the percentage of veranda is not equal before and after the alteration.

Numerous different modifications/ alterations have found on the case study samples during the search for the common practices among the occupants; where are these alterations took place, how are they happening and why? It is found that some common alterations and the reasons behind them. Here it is a very common practice by the respondents to make some alterations in their apartments such as using partition wall and curtain in some many places, making the new room by dividing existing large room, some connections are no longer needed in both cases between interior and exterior again between the interior spaces so they close some door permanently by placing furniture before the door etc. to fulfill their requirements. The major alterations have found on all of the case studies which are briefly described in this section are took place by following three techniques -

- Control of access
- Use of partition and
- Relocation of activity

3.7.1 Control of access

When there is more than one entry to the apartment from outside, one is direct to the living and other is through a foyer space; in 100% cases the door which connects the living with exterior is closed by the occupants by placing furniture in front of the door. They mention two reason for that, 44.4% says that they don't have enough space to

place their furniture so by closing one door they have save some space. Another 55.6% says it is difficult to maintain or not so necessary to maintain two doors for same purpose this is why they have closed the one door. They only use one door which is connected to the foyer space (table 3.7).



Fig 3.18: Closed the direct entry to the living from outside, sample B-1

In some cases the rooms are interconnected through a door and again in some cases veranda is connected with more than one room. 83.3% residents have closed these doors mainly for two reasons, one is to maintain privacy of bedroom and other is lack of space in the room to place their furniture.



Fig 3.19: Closed the door of inter connected rooms



Fig 3.20: Closed any one door of veranda between the two

Table 3.7: Percentage (%) of alterations and their reasons by control of access

Alterations	Reasons	No. of cases	Percentage (%)	Total % of alterations
Between living and exterior	i. Functional	4 out of 9	44.4	100
	ii. Security	5 out of 9	55.6	
	iii. Maintenance			
Between ver and bed	i. Functional	5 out of 6	83.3	83.3
Between two bed	i. Privacy ii. Functional	5 out of 6	83.3	83.3

3.7.2 Use of Partition

33.3% cases respondents use partition wall, among them 13.3% uses to maintain privacy of dining-bed from the entry and another 6.7% uses to create extra bed room. In another 13.3% cases the occupants need individual living and bed instead of a large (i.e. 18'-9" x 9'-7") multipurpose space so they divide the space by partition wall and make two rooms (table 3.8).



Fig 3.21: Use of Partition wall, sample D-1



Fig 3.22: Use of Partition wall, sample C-1

In 20% cases, curtain uses to maintain privacy of the dining area from the foyer, as in altered situation many user use this place as a bed also so it is need more privacy than usual. Some cases curtain use in front of living-bed to maintain privacy of the other spaces from the guests this situation has created because they replace the living with dining; so in the altered situation living located on a transitional position hampering the privacy of hole apartment.



Fig 3.23: Use of Curtain, sample C-2



Fig 3.24: Use of Curtain, sample D-1

Table 3.8: Percentage (%) of alterations and their reasons by partition

Alterations	Reasons	No. of cases	Percentage (%)	Total % of alterations
Reducing room size by wall	i. Privacy	2 out of 15	13.3	33.3
	ii. For extra bed room	1 out of 15	6.7	
	iii. For individual living and bed	2 out of 15	13.3	
Use of Curtain	i. Privacy	3 out of 15	20	20

3.7.3 Relocation of activity

There are also some alterations in space type. The spaces which is designed for is not actually used in the same way when the occupants use the apartments (table 3.9).

3.7.3.1 Living-bed

The living room is usually designed as they can use as a living cum bed in most of these apartments. But at the survey it has been seen that in 20% cases living-bed is used as only bedroom. Actually it happens either when the occupants assign the living room as a sublet to a tenant for some economic benefit though they have very limited space for their own or if the occupants have lack of bedroom for their own in the apartment. In that case they have used another bedroom which is located in more deep inside of the apartment as living-bed.



Fig 3.25: Alternate use of Living

3.7.3.2 Dining

In 20% case it is seen that dining is used as dining cum bedroom due to shortage of bed. Some other cases it is used only as bedroom for sublet by giving a partition wall. Moreover in some cases as the living room used for bed due to shortage of bedroom so here dining is used as a living room.



Fig 3.26: Dining used as a dining-bed, sample D-1



Fig 3.27: Dining used as living-bed, sample C-2



Fig 3.28: Dining used as bedroom for sublet, sample C-3

3.7.3.3 Kitchen

In very few cases kitchen is also used as a bedroom 13.3% (2 out of 15 cases). It happens only when the apartment size is very small (425 sq. ft.) and they have very limited usable/activity space to use. Such cases they use verandah as kitchen for cooking purpose.



Fig 3.29: Kitchen used as a bed, sample A-2



Fig 3.30: Veranda used as a kitchen, sample A-2

3.7.3.4 Verandah

On the other hand in many cases (58.3%) verandah used as a bedroom either temporary basis only for emergency when any guest comes for night stay or permanent. This is very common phenomenon to place a bed in the verandah due to lack of bedroom. Here they use the veranda for drying cloths or other goods and also used for other culinary activities in the day time and at night it is used for sleeping.



Fig 3.31: Veranda used as a bed, sample E-1

Table 3.9: Conversion of Space use

Sl.	Original Use	Altered Use	No. of Cases	Percentage (%)	Total % of Alterations	Reasons
01	Living-bed	Bed	3 out of 15	20	20	i. Lack of Bedroom ii. Economic (sublet)
02	Dining	Din-Bed	3 out of 15	20	33.4	
		Liv-Bed	1 out of 15	6.7		
03	Bed	Bed	1 out of 15	6.7	26.7	i. Lack of bedroom
		Din-Bed	2 out of 15	13.3		
		Liv-Bed	1 out of 15	6.7		
04	Kitchen	Bed	2 out of 15	13.3	13.3	
05	Veranda	Bed	7 out of 12	58.3	58.3	
06	Veranda	Kitchen	2 out of 6	33.3	33.3	

3.8 Conclusion

This chapter is giving an overview of all the 15 samples in their original and altered state. From the discussion it can be summarized as the household number varying from 3-7 but in most cases (40%) the household number is five. Most of the female head is housewives who are not very well educated 46% female head didn't complete their secondary school certificate (SSC) examination. The household expenditure varying from 18000-40000 but a large number of families (47%) are within 25000-30000. 46.67% cases they have only one earning member. 66.7% cases they are extended family rest of the families are nuclear family.

All of the sample apartments are consolidated walk up type apartments. The numbers of functional space of the samples are in between 7-13. The major activity spaces are living, dining and one or two bedroom with or without verandah. Most of the samples have separate bath and toilet. Most of the activity spaces including the veranda are multifunctional. Though there are many alterations have seen in these apartments but all of them are took place mainly in three techniques- using the partition, controlling the access and relocating the activity. These alterations are happening mostly for functional reasons but there are some other reasons also like privacy, security and maintenance etc.

CHAPTER 04 SYNTACTIC ANALYSIS

4.1 Introduction

In this chapter, space syntax method is used for syntactic analysis. Space syntax is a method for describing and analysing the relationships between various spaces of a building. The aim of space syntax research is to develop strategies of description for configured, inhabited spaces in such a way that their underlying social logic can be enunciated. This in turn can allow for secondary theories or often practical explanations to be developed regarding the effects of spatial configuration on various social or cultural variables or attributes. A related theme in space syntax research is to understand configured space itself, particularly its formative processes and its social meaning. In this part of the study the spatial organization is analysed with the data obtained from the Space-syntax method using JASS software. The spatial properties of spaces which is analysed in this study are distributiveness, typology, depth, integration and control which are discussed in chapter two.

4.2 Syntactic description of case studies

The fifteen samples within five types of plan layout, collected from field survey have been analysed to find out the morphological character of the case study apartments. Each functional space has been identified as different convex space to analyse. The root space has been taken from the outside of the apartment entrance. The continuous corridors along with foyer have been divided into different convex spaces regarding the sequence of activity. Each convex space is marked with a different colour box in the plan (fig. 4.1, 4.3, 4.5, 4.7 and 4.9). In altered graph the name of room indicates what or how the users used it currently, not what was designed for.

4.2.1. Group A: Sample A, A-1, A-2, A-3

The distributiveness of any graph (ringy or tree) describes the arrangement and distribution of spaces in a building. Those spaces that share a ring are distributive and can be accessed from any point of that ring. Ringiness determines the level of privacy and relation between spaces of a building.

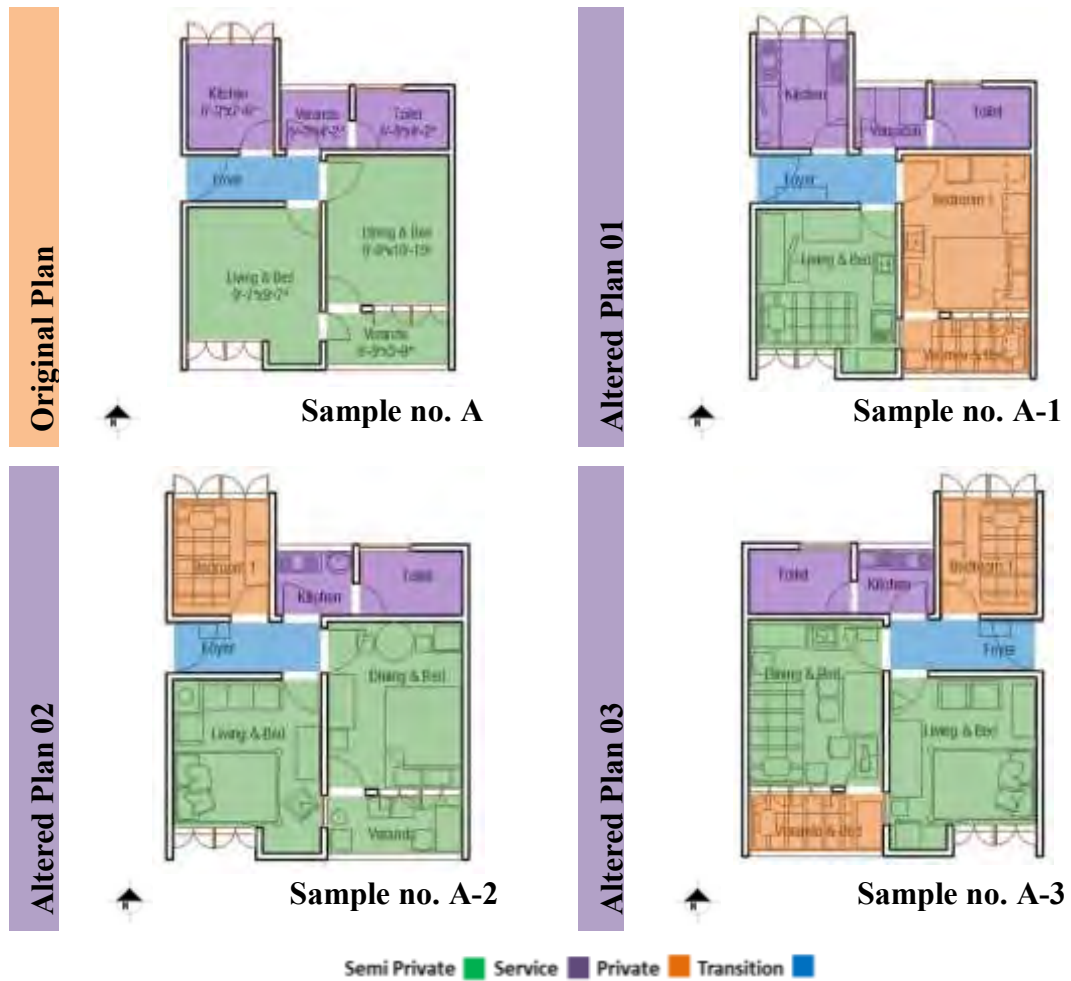


Fig 4.1: Group A; Plan of the case studies (Original and Altered)

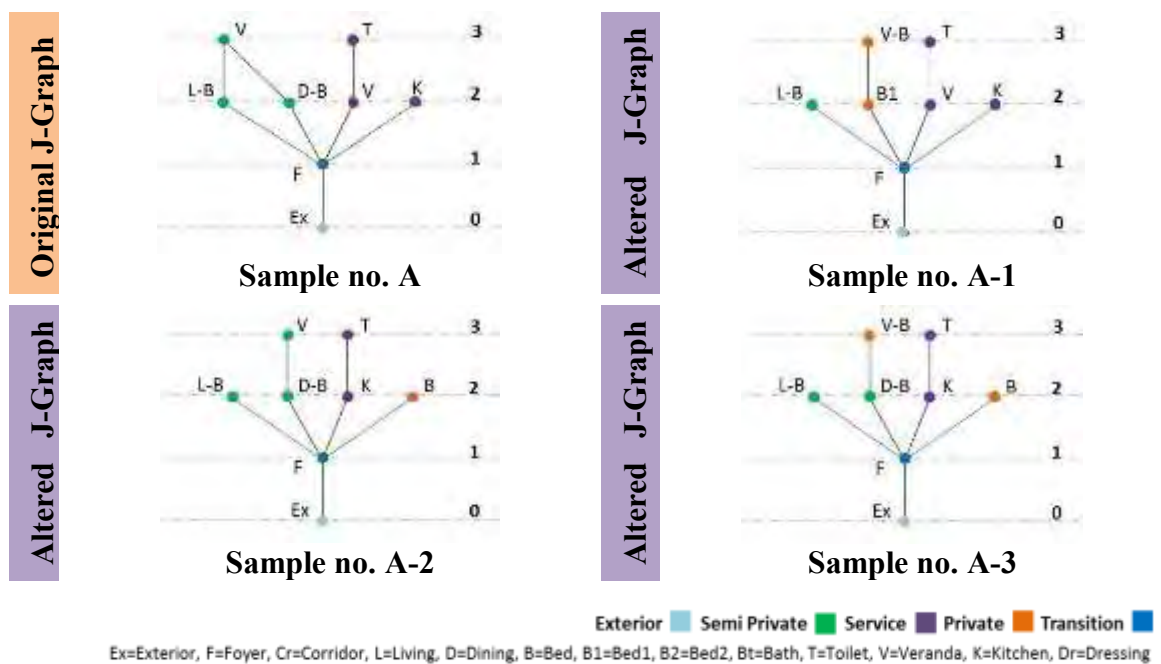


Fig 4.2: Group A; J-graph of the case studies (Original and Altered)

The most important observation about the group A is in altered graph all three became tree type configuration whereas in original graph it was ringy (fig. 4.2). In original plan the ring is located between foyer, living-bed, dining-bed and veranda, which allow the visitors to move from one space to another linked space and reduce the privacy of the apartments. However the altered tree graphs does the opposite.

Table 4.1: Group A; Syntactic data of the case studies; here O=Original and A=Altered

Name of Spaces	Typology				Depth				Integration				Control			
	O	A			O	A			O	A			O	A		
	A	A-1	A-2	A-3	A	A-1	A-2	A-3	A	A-1	A-2	A-3	A	A-1	A-2	A-3
Foyer	c	b	b	b	1	1	1	1	3.45	3.45	3.45	3.45	3.50	4.00	4.00	4.00
Living-Bed	c	a	a	a	2	2	2	2	1.15	0.86	0.86	0.86	0.70	0.20	0.20	0.20
Dining-Bed	c	b	b	b	2	2	2	2	1.15	1.15	1.15	1.15	0.70	1.20	1.20	1.20
Bed 1			a	a			2	2			0.86	0.86			0.20	0.20
Kitchen	a	a	b	b	2	2	2	2	0.86	0.86	1.15	1.15	0.20	0.20	1.20	1.20
Toilet	a	a	a	a	3	3	3	3	0.57	0.57	0.57	0.57	0.50	0.50	0.50	0.50
Ver attach to Dining/ Common space	b	b			2	2			1.15	1.15			1.20	1.20		
Veranda attach to Bed	c		a		3		3		0.69		0.57		1.00		0.50	
Ver-Bed		a		a		3		3		0.57		0.57		0.50		0.50
Mean					2.14	2.14	2.14	2.14	0.95	0.89	0.89	0.89				

Due to the change in distributiveness, the typology (table 4.1) of the spaces is also changed. After alteration the foyer and dining-bed become b-type space, the transitional space though it is seen that before and after alteration foyer is the main distributive node of the apartment from where all the other spaces are distributed. On the other hand the living-bed and veranda/ veranda-bed become dead end space in all the altered graph of A-1, A-2 and A-3. It indicates that after alteration the living-bed and veranda-bed become more segregated and increased the privacy of the space. It enhances the privacy of the dining-bed spaces by controlling the access to the veranda from living-bed which is located on the end of the branch. Thus easy access to dining-bed is also become limited. There is some dissimilarity in kitchen between A-1, A-2 and A-3, here the kitchen of A-1 is a dead-end space but A-2 and A-3 is in transitional space because of the relocation of the cooking activity in A-2 and A-3.

Particularly for this group the depth of different space do not change at all thus remaining the mean depth value same. However the mean integration value decreased in altered layout from 0.95 to 0.89 mentioned in the table 4.1 though in all three altered layout has the same mean integration value. Living-bed changed from 1.15 to 0.86 in

all three altered layout. As we know that the integration value below one represents the segregating tendency of the complex. So it indicates the high degree of privacy after alteration of living-bed which makes it a dead end space. This is happened by stopping the access to veranda from living-bed. In the case of control value most of them has changed in altered layout. The foyer, dining-bed has larger value in altered layouts which indicate that, these spaces have a very strong control on the accessibility over their neighbouring spaces as these are the only way to reach the neighbouring space. In sample A-2 and A-3 kitchen also has the same scenario because of the relocation of kitchen to a veranda. Whereas the living-bed and veranda attach to bed have opposite scenario as these spaces become dead ends after alteration.

4.2.2. Group B: Sample B, B-1, B-2, B-3

The original graph (fig. 4.4) for sample B has ringy configuration and the ring is located among foyer, living-bed and dining area with outside. The links between the interior and the exterior of a house is an important dimension of configurational analysis to understand the relative importance and inhabitant-visitor relationship for the planning and organization of the house. That is, when spaces are distributed with the exterior in a ring, the interior spaces become shallower and easily permeable for the visitors (Hillier & Hanson, 1984). However in altered graph all three samples have converted to tree type configuration thus creating the altered layout more segregated enhancing the privacy. The typology (table 4.2) of the spaces is also changed. After alteration the foyer and dining become the transitional space or b-type space and the living-bed becomes dead-end space or a-type space obtain more privacy in all the altered graph of B-1, B-2 and B-3. However before alteration, they all were in a ring. This is happened for closing the door which is directly entered to living-bed. It indicated that before alteration these spaces have less privacy visitor occupants had very easy accessibility to the inside of the house toward dining. The mean depth of the apartments have changed after alteration, in original layout the mean depth was 2.38 but after alteration it become 2.63; therefore the entire apartment become more deep from outside. Specially the living-bed, before alteration depth value was 1 but after alteration it become 3 becoming the living-bed highly segregated and deep space. This is happened due to the closing of the direct entry from outside to the living-bed, so it enhances the depth of living-bed which also ensures the privacy of that room.

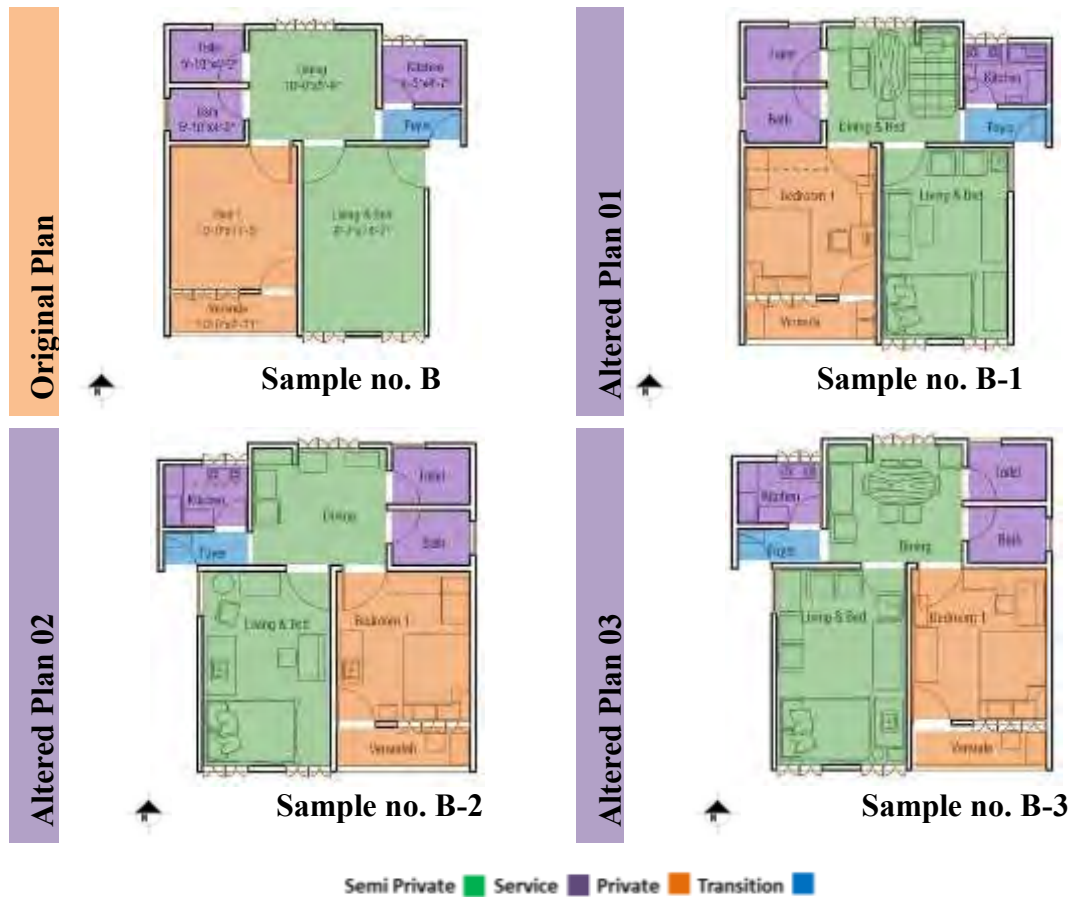


Fig 4.3: Group B; Plan of the case studies (Original and Altered)

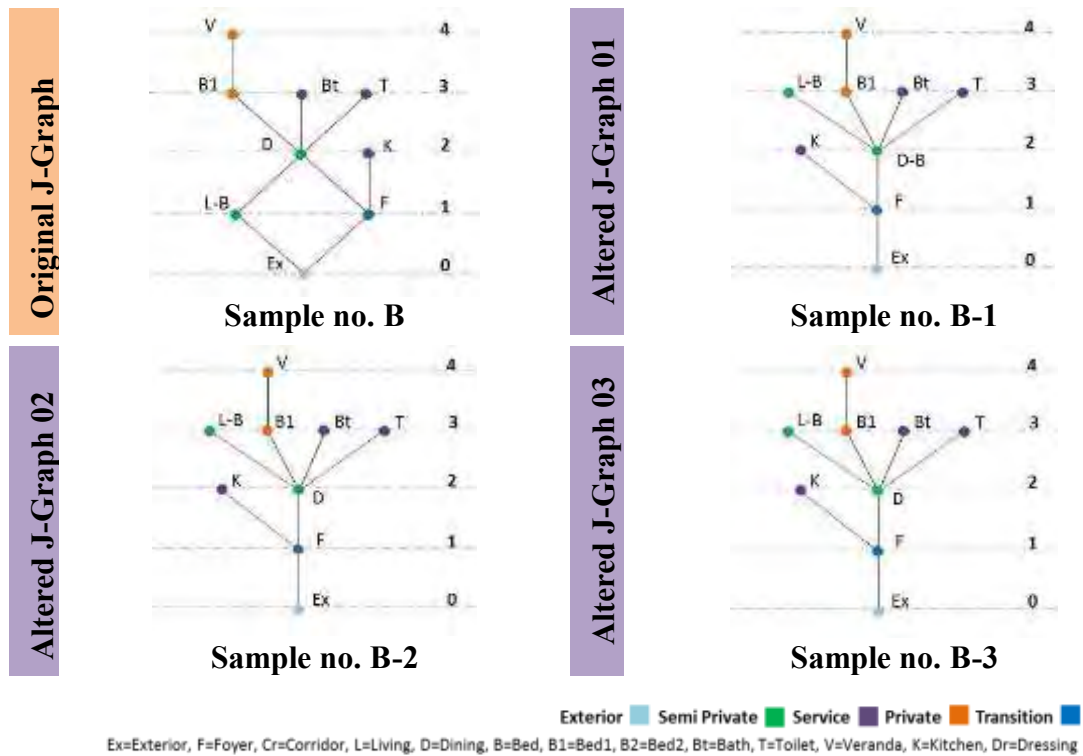


Fig 4.4: Group B; J-graph of the case studies (Original and Altered)

Table 4.2: Group B; Syntactic data of the case studies; here O=Original and A=Altered

Name of Space	Typology				Depth				Integration				Control			
	O	A			O	A			O	A			O	A		
	B	B-1	B-2	B-3	B	B-1	B-2	B-3	B	B-1	B-2	B-3	B	B-1	B-2	B-3
Foyer	c	b	b	b	1	1	1	1	1.48	1.48	1.48	1.48	1.70	2.20	2.20	2.20
Liv-Bed	c	a	a	a	1	3	3	3	1.11	0.89	0.89	0.89	0.70	0.20	0.20	0.20
Din-Bed		b				2				2.96				3.83		
Dining	c		b	b	2		2	2	2.96		2.96	2.96	3.33		3.83	3.83
Bed 1	b	b	b	b	3	3	3	3	1.11	1.11	1.11	1.11	1.20	1.20	1.20	1.20
Kitchen	a	a	a	a	2	2	2	2	0.68	0.68	0.68	0.68	0.33	0.33	0.33	0.33
Toilet common	a	a	a	a	3	3	3	3	0.89	0.89	0.89	0.89	0.20	0.20	0.20	0.20
Bath common	a	a	a	a	3	3	3	3	0.89	0.89	0.89	0.89	0.20	0.20	0.20	0.20
Ver attach to bed	a	a	a	a	4	4	4	4	0.59	0.59	0.59	0.59	0.50	0.50	0.50	0.50
Mean					2.38	2.63	2.63	2.63	0.95	0.91	0.91	0.91				

On contrary the mean integration value has slightly decreased in altered layout from 0.95 to 0.91. The entire three altered layout has the same mean integration value. The most significant change is happened on liv-bed area here the integration was 1.11 but after alteration it becomes 0.89. As we know that if the integration value is below one it represents the segregating tendency of the complex. This indicates to the degree of privacy of living-bed area. In case of control, the foyer and dining area has increased value in altered layouts from 1.70 to 2.20 and from 3.33 to 3.83 respectively so these spaces has high control value which again indicates a strong control over its neighbouring spaces. As after the alteration there are no other option to enter the apartment except through this foyer and dining. These syntactic measures are the characteristics to represent these spaces where visitor inhabitant relation took place. However the living-bed has opposite scenario, it has lower control value than the original layout as it is become the dead-end space instead of between a ring. The low integration value as well as very low control value proves that the living-bed have high segregating quality.

4.2.3. Group C: Sample C, C-1, C-2, C-3

As the distributed system is the set of spaces through which the visitors, subjected to more or less control, may pass. That is, visitors, during the course of their activities, are moved from one place to another, and often can experience much of the interior as a series of spaces (Hillier & Hanson, 1984). The ringy interior of these buildings allow the visitors to move from one space to another linked space which reduce the privacy of these buildings.

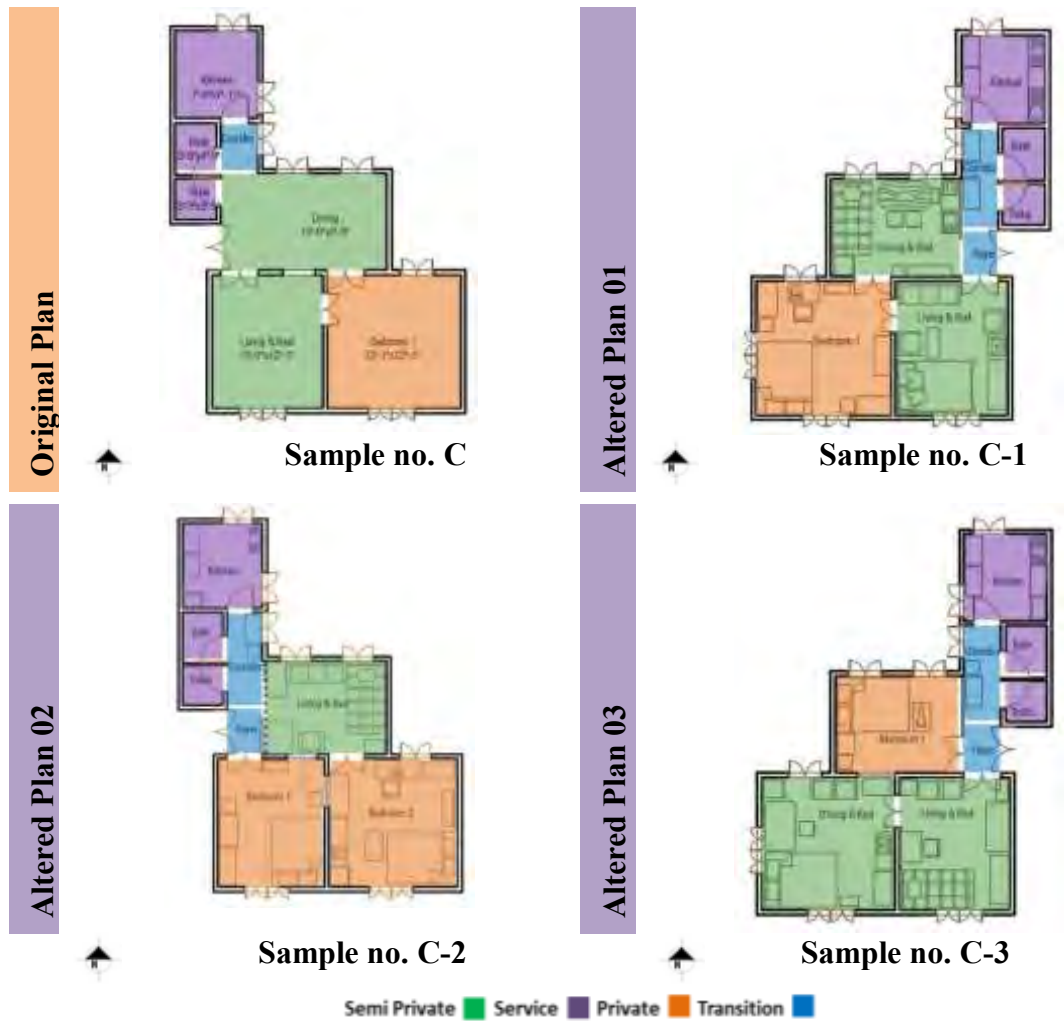


Fig 4.5: Group C; Plan of the case studies (Original and Altered)

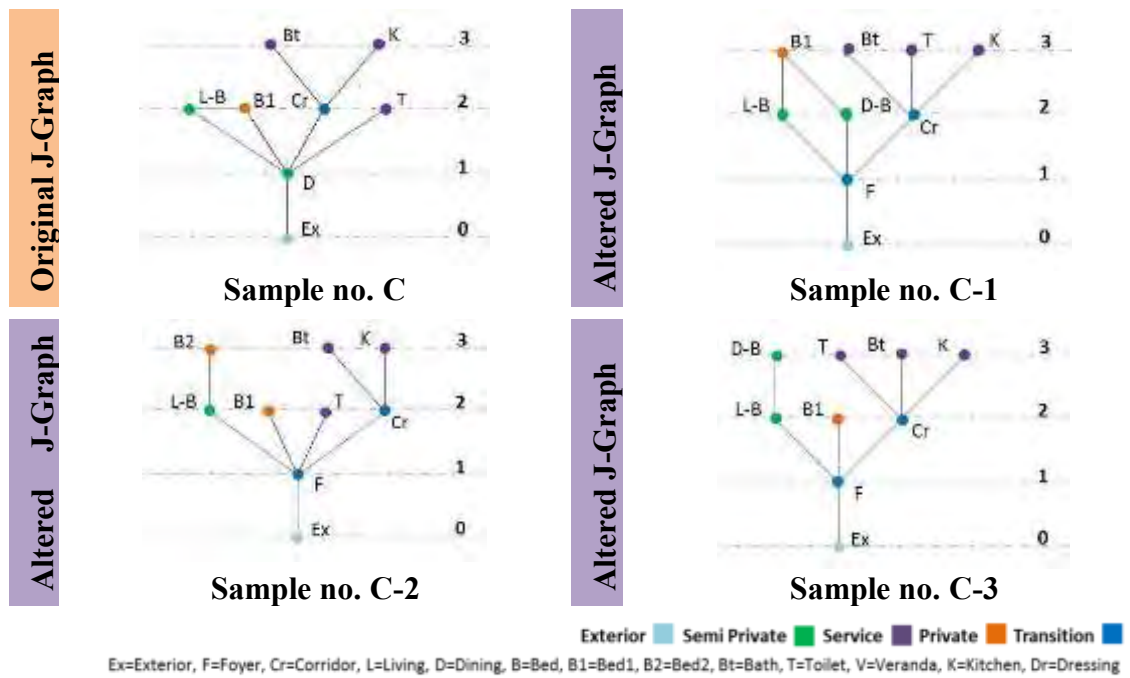


Fig 4.6: Group C; J-graph of the case studies (Original and Altered)

Table 4.3: Group C; Syntactic data of the case studies; here O=Original and A=Altered

Name of Space	Typology				Depth				Integration				Control			
	O	A			O	A			O	A			O	A		
	C	C-1	C-2	C-3	C	C-1	C-2	C-3	C	C-1	C-2	C-3	C	C-1	C-2	C-3
Foyer		c	b	b		1	1	1		1.48	2.96	2.22		2.25	3.83	2.75
Living-Bed	c	c	b	b	2	2	2	2	0.99	0.99	1.11	0.99	0.70	0.50	1.20	1.25
Dining-Bed		c	a	a		2	3	3		0.99		0.55		0.75		0.50
Dining	c				1				3.45				3.33			
Bed 1	c	c	b	b	2	3	2	2	0.99	0.63	0.89	0.81	0.70	1.00	0.20	0.25
Bed 2			a				3				0.59				0.50	
Kitchen	a	a	a	a	3	3	3	3	0.69	0.63	0.68	0.74	0.33	0.25	0.33	0.25
Toilet common	a	a	a	a	2	3	2	3	0.86	0.63	0.89	0.74	0.20	0.25	0.20	0.25
Bath common	a	a	a	a	3	3	3	3	0.69	0.63	0.68	0.74	0.33	0.25	0.33	0.25
Circulation/transition	b	b	b	b	2	2	2	2	1.72	1.27	1.48	1.77	2.20	3.50	2.20	3.25
Mean					2.14	2.38	2.33	2.38	0.99	0.80	0.91	0.87				

Unlike the previous samples in this case the ringy configuration of original layout remains in one of the altered sample C-1 (fig 4.6); though C-2 and C-3 becomes tree. In this case the two branches are derived from foyer; one towards service and other towards living space. In original layout the ring is located between living-bed, dining area and bedroom. However in altered graph of C-1, we have seen that the foyer space has added with the previous ring though in the original layout there was no foyer space. In altered graph of C-2 and C-3 the living, dining and the bed remain either as a transitional space or the dead end space instead of the ring by controlling the access to the bed. As a foyer space has added to the apartment so the mean depth value has increased in altered layout 2.38 for C-1 and C-3 (table 4.3) whereas 2.33 for C-2 from the original 2.14 thus the entire apartment become more deep from outside. Here apartment the dining area is converted to dining-bed and increased its depth to 2 for C-1 and 3 for C-3 from the original 1 thus it make more private space than before.

The mean integration value was 0.99 in original layout but in altered layout it becomes 0.80, 0.91 and 0.87 for C-1, C-2 and C-3 respectively. Unlike previous samples these altered layout has different integration values. The most significant change is happened on dining area here the integration was 3.45 but after alteration it becomes 0.99 and 0.55 for the sample C-1 and C-3 respectively. In the case of control value the altered layout has different values for different samples. Especially the dining area has major change from original layout, in which dining has a control value of 3.33, in altered cases it become 0.75 and 0.50 for C-1 and C-3 respectively. As in original plan dining has the main entry so this space is more integrated and has more control over the neighbouring space but after adding the foyer dining become less integrated and

controlled area. Here after alteration dining area used for bed also. Low integration value as well as very low control value proves that, these spaces have high segregating quality which indicates to the degree of privacy of a space.

4.2.4. Group D: Sample D, D-1, D-2, D-3

The original graph of sample D is ringy type (fig 4.8) and there are multiple rings, the rings are located among foyer, living, dining and bed with the exterior area. The position of the living-bed is in the intersection point of more than one ring among which at least one connects the exterior. This made the living-bed as the locus of the visitor-inhabitant interface. The visitors, during the course of their activities, are moved from one place to another, and often can experience much of the interior as a series of spaces (Hillier & Hanson, 1984). Whereas in altered graph all three samples are like tree. The tree has two branches one directed to dining area connected to the private spaces like bed and kitchen another is towards semi-public spaces like living, veranda and toilet. By controlling the direct entry to living-bed from outside and secondary entry from dining by giving the partition into the room make the living-bed less integrated and deeper. However the tree graphs enhances the privacy of the living-bed or other bedrooms which are located on the end of the branch. Due to this change the typology (table 4.4) of the spaces is also changed. The foyer, living and dining become the transitional space or b-type space but the bedrooms are dead-end spaces or a-type space by losing the interconnection (ring) between them. However before alteration they all are c-type or d-type spaces, between one or more than one ring so much integrated with each other.

The Samples (D-1, D-2 and D-3) have the same mean value of depth and integration in altered cases. In case of the mean depth it has increased from 1.88 to 2.33; means these apartments become deeper from outside thus have achieve segregating quality. Whereas in case of integration in has decreased from 1.21 to 0.95 in altered layout. Thus high integrated spaces from where the spatial character of the complex can be controlled are converted to low integrated space which indicates the degree of privacy is increased in altered apartments. The integration value of living-bed has a great shift from the original 2.96 to 1.10 in altered layout. Though in the sample D-2 and D-3, they have make two different room in the space of living-bed for an extra room.

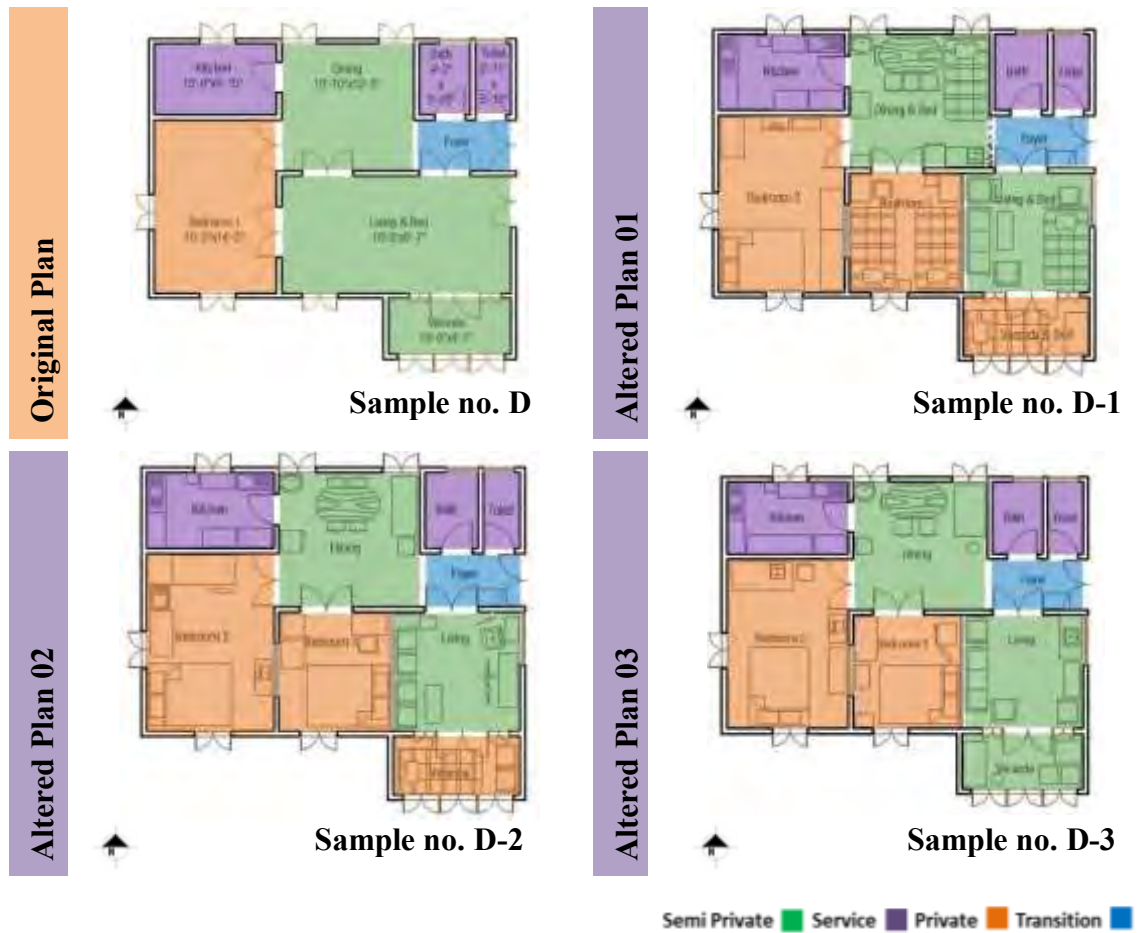


Fig 4.7: Group D; Plan of the case studies (Original and Altered)

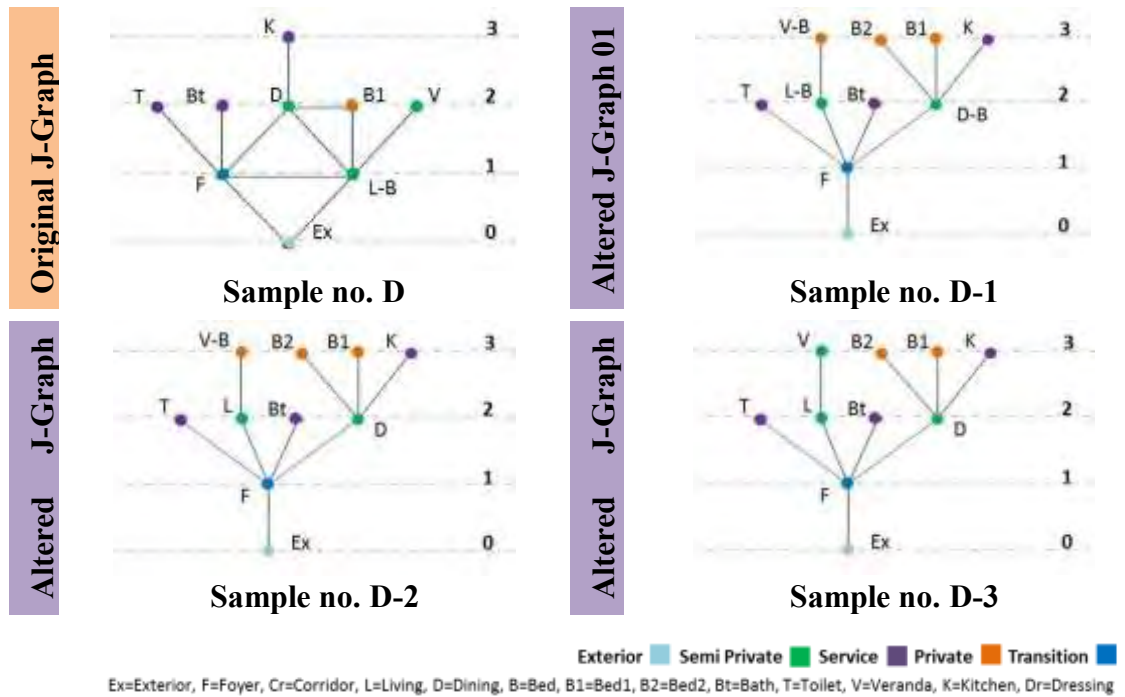


Fig 4.8: Group D; J-graph of the case studies (Original and Altered)

Table 4.4: Group D; Syntactic data of the case studies; here O=Original and A=Altered

Name of Space	Typology				Depth				Integration				Control			
	O	A			O	A			O	A			O	A		
	d	D-1	D-2	D-3	D	D-1	D-2	D-3	D	D-1	D-2	D-3	D	D-1	D-2	D-3
Foyer	d	b	b	b	1	1	1	1	2.96	2.75	2.75	2.75	2.95	3.75	3.75	3.75
Liv-Bed	d	b			1	2			2.96	1.10			2.45	1.20		
Living			b	b			2	2			1.10	1.10			1.20	1.20
Din-Bed		b				2				1.83					3.20	
Dining	d		b	b	2		2	2	2.22		1.83	1.83	1.90		3.20	3.20
Bed 1	c	a	a	a	2	3	3	3	1.11	0.79	0.79	0.79	0.45	0.25	0.25	0.25
Bed 2		a	a	a		3	3	3		0.79	0.79	0.79		0.25	0.25	0.25
Kitchen	a	a	a	a	3	3	3	3	0.81	0.79	0.79	0.79	0.25	0.25	0.25	0.25
Toilet common	a	a	a	a	2	2	2	2	0.89	0.92	0.92	0.92	0.20	0.20	0.20	0.20
Bath common	a	a	a	a	2	2	2	2	0.89	0.92	0.92	0.92	0.20	0.20	0.20	0.20
Ver attach to Living	a			a	2			3	0.89			0.61	0.20			0.50
Ver-Bed		a	a			3	3			0.61	0.61			0.50	0.50	
Mean					1.88	2.33	2.33	2.33	1.21	0.95	0.95	0.95				

In case of control value most of them has changed in altered layout but the foyer, living-bed and dining has significant change. The foyer and dining has gotten a larger value after alteration from 2.95 to 3.75 for foyer and from 1.90 to 3.20 for dining. Clearly these spaces have more control on the accessibility to their surrounding spaces where as the living-bed has the opposite scenario. All these happen due to close the direct access to living-bed from outside. Because of this the only entry to apartment is foyer thus it has increased its control value so as the dining.

4.2.5. Group E: Sample E, E-1, E-2, E-3

The original graph of sample E is ringy type and there are two ring one in the entry connected the foyer, living and exterior and another is in inner part of the apartment connected the dining, bed and veranda through a small corridor (fig 4.10). However altered graph E-1 and E-2 is tree type but E-3 remains ringy with one ring in inner part of the apartment. However this converted the E-1 and E-2 into more segregated and private whereas E-3 is more accessible inner area to visitors. The foyer, dining is major transitional space or b-type space from which all the other spaces are distributed (table 4.5). The mean depth value has increased in the altered layout to 3.38 from 3.31 in all three altered graph whereas in case of integration value it has decreased its value from original 0.92 to 0.83 for E-1 and E2 and 0.91 for E-3. The significant change on depth value is observed in living-bed; it increased from the original 1 to 4 and 3 for the E-1 and E-2 respectively. In this case such changes happen because the occupants' has shifted the activity into an inner room which is more deep space.

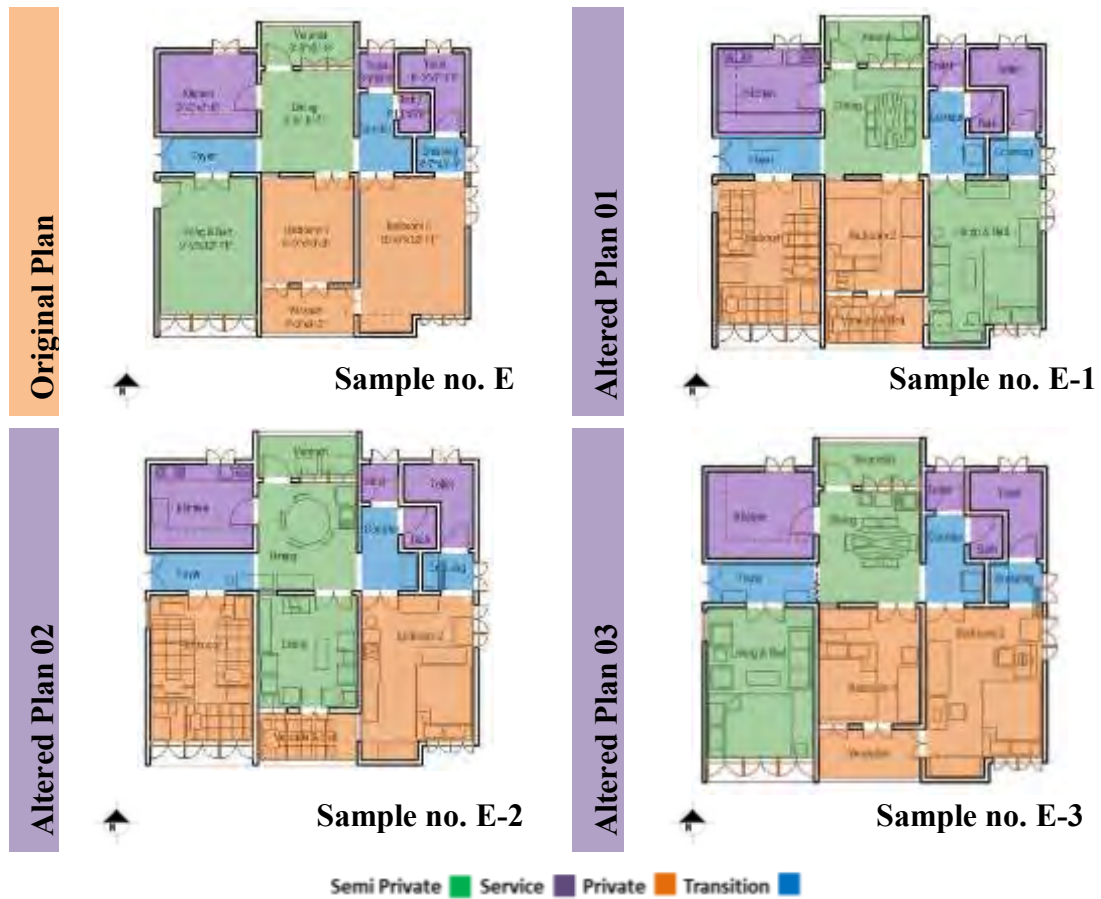


Fig 4.9: Group E; Plan of the case studies (Original and Altered)

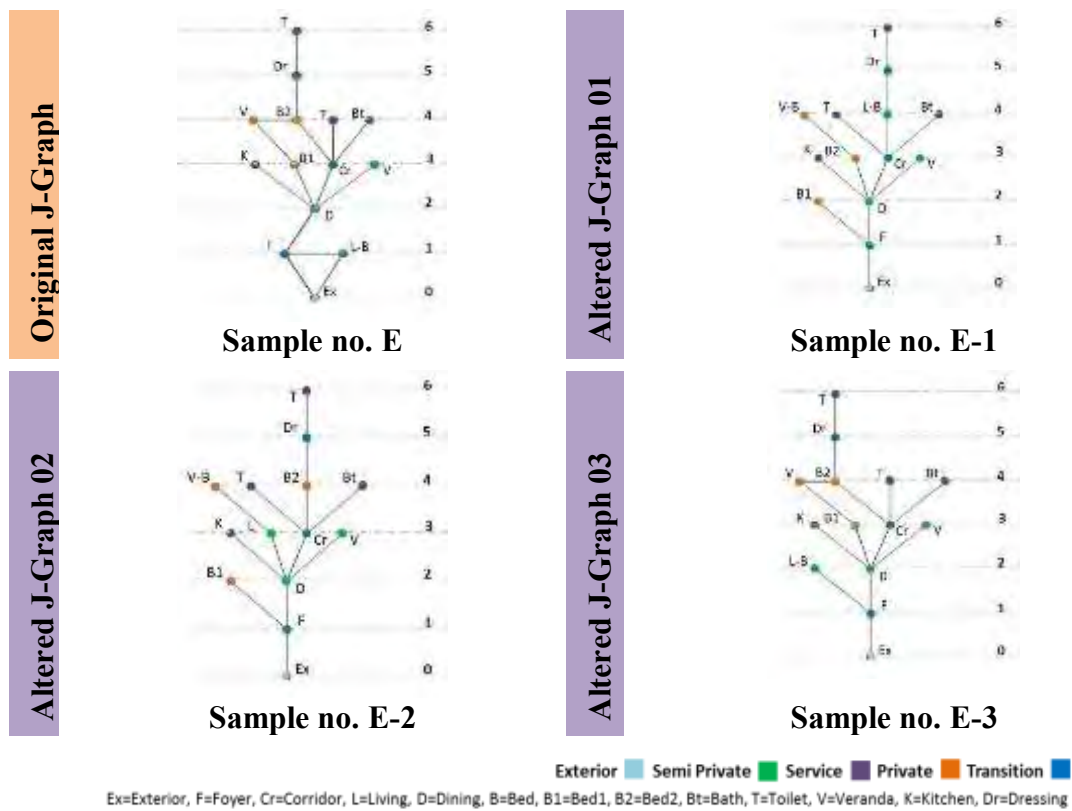


Fig 4.10: Group E; J-graph of the case studies (Original and Altered)

Table 4.5: Group E; Syntactic data of the case studies; here O=Original and A=Altered

Name of Spaces	Typology				Depth				Integration				Control			
	O	A			O	A			O	A			O	A		
	E	E1	E2	E3	E	E-1	E-2	E-3	E	E-1	E-2	E-3	E	E-1	E-2	E-3
Foyer	c	b	b	b	1	1	1	1	1.10	1.10	1.10	1.10	1.20	2.20	2.20	2.20
Liv-Bed	c	b		a	1	4		2	0.69	0.99		0.67	0.83	0.75		0.33
Living			b				3				0.99				1.20	
Dining	c	b	b	c	2	2	2	2	1.89	1.89	1.89	1.89	3.08	3.08	3.08	3.08
Bed 1	c	a	a	c	3	2	2	3	1.16	0.67	0.67	1.16	0.70	0.33	0.33	0.70
Bed 2	c	b	b	c	4	3	4	4	1.22	0.99	0.99	1.22	1.25	1.20	0.75	1.25
Kitchen	a	a	a	a	3	3	3	3	0.90	0.90	0.90	0.90	0.20	0.20	0.20	0.20
Toilet common	a	a	a	a	4	4	4	4	0.87	0.83	0.83	0.87	0.25	0.25	0.25	0.25
Bath common	a	a	a	a	4	4	4	4	0.87	0.83	0.83	0.87	0.25	0.25	0.25	0.25
Attach toilet	a	a	a	a	6	6	6	6	0.53	0.48	0.48	0.53	0.50	0.50	0.50	0.50
Ver attach to Din/ Common space	a	a	a	a	3	3	3	3	0.90	0.90	0.90	0.90	0.20	0.20	0.20	0.20
Ver attach to Bedroom	c			c	4			4	0.99			0.99	0.83			0.83
Ver-Bed			a			4	4			0.63	0.63			0.50	0.50	
Circulation/ transition	c	b	b	c	3	3	3	3	1.73	1.60	1.60	1.73	2.53	2.70	2.70	2.53
Dressing	b	b	b	b	5	5	5	5	0.77	0.67	0.67	0.77	1.33	1.50	1.50	1.33
Mean					3.31	3.38	3.38	3.38	0.92	0.83	0.83	0.91				

On the other hand in the case of integration, bedrooms became more segregated in altered layout E-1 and E-2, their integration value is become lower than one for both bedrooms. The control value of foyer space become high in altered layouts to 2.20 from the original 1.20, thus allows this space more control over the other spaces of the apartment.

4.3 General Analysis of the Apartments

The apartments are very small in size and all the spaces are connected with each other very closely due to presence of one or more ring in the original layout. When one space is linked to another space with more than one link in syntactic measure it is called ring. It describes the arrangement and distribution of spaces in a building. Those spaces that share a ring can be accessed from any point of that ring. The ringy interior of these buildings allow the visitors and users to move from one space to another linked space which reduces the privacy of these buildings. Before alterations all the five apartments of case studies had ringy configuration having choice in the access (table 4.6). The ring located maximum among living-dining area; sometimes the ring connected with exterior through the foyer space and in few cases it was connected internally through the veranda or bedroom. However after alterations most of the apartment transformed into tree type layout, except C-1 and E-3 (table 4.7). With increasing privacy, a tree layout reduces the possibility of interaction and interrelationships between visitor and

occupants. Normally the tree-like shape reflects a deep and controlled spatial structure and the ring-like shape reflects interconnection and movement reducing the depth of the space layout. A tree-like justified graph has most of the nodes many steps (levels) away from the bottom node. In such a system the mean depth is high and described as deep. After alterations both apartments (C-1 & E-3) have a ring connected the dining internally with bedroom through the veranda and living.

Depth from the outside and integration within the interior are the two dimensions of the layout of a house which usually turn out to have significant social connotations. The way these underlying dimensions are configured spatially constructs an interface among the house's inhabitants and relates them to visitors to the home (Hanson, 1998). The configurational variable 'depth' has become a fundamental property of architectural space configurations to describe patterns that exist in society and mean integration expresses how shallow or deep on average spaces on the complex are from one another. The maximum depth varied between 3 to 6. The mean maximum depth of all the apartments before and after the alterations has the same value it is 3.8. The average mean depth from outside has changed from 2.37 to 2.58 which indicate the addition of more layers in the apartments layout which made the spaces more deep from outside. However the averages mean integration have transformed to 0.89 from 1.0 which also made the spaces of the layout more segregated after alterations which indicates to the degree of privacy of a space.

Table 4.6: General syntactic values (original layout)

Sl.	Sample	No of Space (k)	No of Link (L)	Space-Link Ratio	Configuration	Max Depth	Mean Depth from outside	Mean Integration 1/Mean RRA	Ring Location
1	A	8	8	1.13	Ringy	3	2.14	0.95	Foy/ Liv-Bed/ Ver/ Din-Bed
2	B	9	9	1.11	Ringy	4	2.38	0.95	Ex/ Foy/ Din/ Liv-Bed
3	C	8	8	1.13	Ringy	3	2.14	0.99	Din/ Liv-Bed/ Bed
4	D	9	11	1.33	Ringy	3	1.88	1.21	Ex/ Foy/ Liv-Bed/ Din/ Bed
5	E	14	15	1.14	Ringy	6	3.31	0.92	1.Ex/ Foy/ Liv 2. Din/ Bed1/ Ver/ Bed2/ Cr
	Mean					3.8	2.37	1.01	

Table 4.7: General syntactic values (altered layout)

Sl.	Sample	No of Space (k)	No of Link (L)	Space-Link Ratio (SLR) (L+1)/k	Configuration	Max Depth	Mean Depth from outside	Mean Integration 1/Mean RRA	Ring Location
01	A-1	8	7	1	Tree	3	2.14	0.89	-
02	A-2	8	7	1	Tree	3	2.14	0.89	-
03	A-3	8	7	1	Tree	3	2.14	0.89	-
04	B-1	9	8	1	Tree	4	2.63	0.91	-
05	B-2	9	8	1	Tree	4	2.63	0.91	-
06	B-3	9	8	1	Tree	4	2.63	0.91	-
07	C-1	9	9	1.11	Ringy	3	2.63	0.80	Foy/ Din-Bed1/ Liv-Bed/ Bed2
08	C-2	9	8	1	Tree	3	2.25	0.91	-
09	C-3	9	8	1	Tree	3	2.38	0.87	-
10	D-1	10	9	1	Tree	3	2.33	0.95	-
11	D-2	10	9	1	Tree	3	2.33	0.95	-
12	D-3	10	9	1	Tree	3	2.33	0.95	-
13	E-1	14	13	1	Tree	6	3.38	0.83	-
14	E-2	14	13	1	Tree	6	3.38	0.83	-
15	E-3	14	14	1.07	Ringy	6	3.38	0.91	Din/ Bed/ Ver/ Bed/ Cr
	Mean					3.8	2.58	0.89	

4.3.1 Spatial analysis of Distributiveness and Typology

Typology is a syntactic dimension of space syntax analysis which represents the space structural dimension based on their connections which elaborately explained on space syntax theory in section 2.7. In original layout maximum spaces were either ‘a-type’ which were approached from the one room making it isolated in the configuration or ‘c-type’ located in between a ring and the percentage was 21.18 for both (fig. 4.11). The percentage of ‘b-type’ and ‘d-type’ space was very low and they were 4.71% and 3.53% respectively which were transitional spaces and rarely present in these small apartments. On the other hand from fig. 4.11 it is seen that in altered layout maximum spaces are ‘a-type’ and ‘b-type’ so either they are located at the end of the configuration or in a transition and the percentage are 29.80 and 19.61 respectively. Although the ‘c-type’ spaces is very few only 3.53% and there are no ‘d-type’ space in the altered apartments. However from altered layout it has been seen that the presence of ring on the configuration is very rare. After alterations the overall domestic spaces have become more isolated or segregated, before alterations the spaces were located

more in between the rings even in case of the more private areas like bedroom which we have seen that they have changed in altered layout.

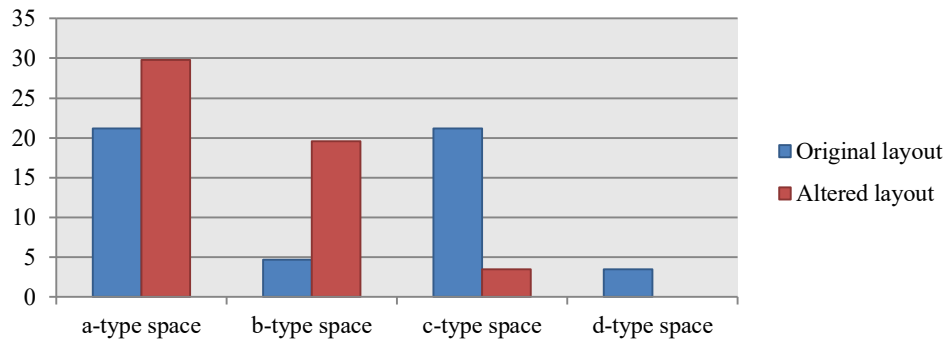


Fig 4.11: Types of spaces before and after alterations (in percentage %)

Table 4.8: Type of spaces in percentage (%); O = Original layout, A = Altered layout

Spaces	a-type space Terminal space		b-type space thoroughfares-more than one link		c-type space on a ring		d-type space on two or more rings	
	O	A	O	A	O	A	O	A
Foyer				93.33	60	6.67	20	
Living+ Bed		46.67		26.67	80	6.67	20	
Living				20				
Dining+ Bed		13.33		33.33	20	6.67		
Dining				40	60	6.67	20	
Bed1		46.67	20	33.33	60	13.33		
Bed2		26.67		13.33	20	6.67		
Kitchen	100	86.67		13.33				
C Toilet	100	100						
C Bath	80	80						
Attach toilet	20	20						
Ver (with Liv)	20	6.67						
Ver (with C. space)	20	20	20	6.67				
Ver (with bed)	20	26.67			40	6.67		
Ver+Bed		33.33						
Circulation			20	33.33	20	6.67		
Dressing			20	20				
Mean (%)	21.18	29.80	4.71	19.61	21.18	3.53	3.53	

In original graph, the foyer and the dining had the exact same quality of space, 60% was c-type and another 20% was d-type (table 4.8). Consequently they were located in the ring whether it was one or two. However after alterations 93.33% foyer is b-type so they are located on the transition of space, act as link between two areas; the semi-private and the private areas of the house and only 6.67% is c-type. On the other hand after alterations the maximum dining around 40% converted to b-type space and very few only 6.67% are till c-type space same as the foyer. 80% of living-bed were c-type space and other 20% were d-type whereas after alterations 46.67% is a-type space so

they located in the end of the circulation. Another 26.67% are b-type space so they are in transition, most of the time these circulation of bedroom end in a veranda. There are very few only 6.67% living-bed are still located in a ring. Another 20% rooms are act as only living after the alterations which are all b-type space. Before alterations there were only 20% space which were designed as dining-bed and they all were c-type space, but after alteration many users who had dedicated space for dining only they had changed their dining to dining-bed and the number is 46.67% among them 33.33% are b-type space another 13.33% are a-type and rest are d-type. However we can see that the dining or dining-bed after alterations most of them are located in a transitional tree, previously which were located in between the ring.

In original layout the bedrooms were either b-type or c-type space but in altered layout most of the bedrooms are a-type space but there are also some b-type space and the c-type space though which are very few in number. The verandas were three type of space and they were a, b and c; and their percentages were 60, 20 and 40 respectively. However after alterations most of them are a-type space (53.34%) and very few are b and c-type space and the percentage is 6.67. Another 33.33% veranda has transformed into veranda-bed which all are a-type. After alterations by blocking the ring to control the access users altered most of the verandas into a-type space or terminal space; which were located into the ring in original plan. Before alterations 100% kitchen were a-type whereas after alterations 13.33% transformed into b-type; this is because these kitchen were actually the veranda which has transformed into kitchen after alterations. In case of transitional space or the circulation space previously they were b-type and c-type; the percentage was 20 for both because of the presence of ring. However after alterations most of them are b-type space (33.33%) and rest of them (6.67%) are c-type.

Considering the significant changes found from the syntactic data of distributiveness and typology, the total layout is discussed below-

- After alteration most of the apartments become tree-like configurations however in original layout all of them were ringy type. This indicates to have more choices in the access to the domestic space in original layout but controlled and limited in altered layout. Thus convert more space to a-type or b-type in altered layout instead of c-type or d-type which are on original layout. Thus make the rooms more segregated which increase the privacy.

- Foyer, dining and dining-bed became thoroughfare space, connected only with two spaces. Whereas in original layout they were more permeable space located among a ring with more interconnected space. Dining space acts as a node and distributes movement to the inner spaces in the house in altered layout.
- Around 50% living-bed became terminal space in altered layout so they can maintain the privacy of bedroom whereas in original layout most of living-bed was in between a ring. Rest of the living-bed becomes thoroughfare spaces because they are connected to a veranda. Thus living-bed and veranda can also create a group of spaces to make it as a terminal space with maximum privacy and segregation that can be approached from foyer space.
- In original layout there were no bedroom which is terminal space, maximum were located among a ring or connected to a veranda which hamper the privacy. However after the alterations maximum bedroom is transformed into terminal space. Among the rest of the bed, very few are still located between the ring and others are in transitional space.

4.3.2 Spatial analysis of Depth

The syntactic value of depth represents the spatial position or location of a particular space in the configuration of the house with respect to a space of the house in the justified graph analysis. In this study the carrier/root is the exterior lobby of the studied apartments from where the depth values of all other spaces of the configuration are measured. In most cases the apartments are 3 to 4 steps deep; very few are up-to the 6 steps deep (appendix F.3). If we see the mean depth of the apartments we can see that after alteration all the apartments becoming deeper; their mean depth increases from 0.3 to 0.4 in some cases (table 4.9). The mean depth of individual function is also increased (table 4.10). Therefore the inner spaces or functions become deeper from outside.

If we compare the mean depth of the entire apartment before and after alterations we can find that either they are remaining the same or the mean depth has increased. Here we can see that unless case study group 'A', the mean depth value has increased in all the other samples. The group 'A' samples has remains same mean depth value of 2.14 but in case of other samples the value has increased (table 4.9).

Table 4.9: Comparison of mean depth of all the samples

	Original	Altered		
Sample	A	A-1	A-2	A-3
Mean Depth	2.14	2.14	2.14	2.14
Sample	B	B-1	B-2	B-3
Mean Depth	2.38	2.63	2.63	2.63
Sample	C	C-1	C-2	C-3
Mean Depth	2.14	2.38	2.33	2.38
Sample	D	D-1	D-2	D-3
Mean Depth	1.88	2.33	2.33	2.33
Sample	E	E-1	E-2	E-3
Mean Depth	3.31	3.38	3.38	3.38

According to table no 4.10 the depth of foyers are remain same the ‘one’ before and after the alterations. On the contrary most of the functions/ spaces obtain more depth value meaning the spaces are getting more distance from the outside. Before alterations the living-bed and the dining were located comparatively near the entry, usually on depth one and two. From table we can see 60% living-bed located on depth 1 and 40% were located on two but after alterations 6.67% living-bed are shifted to a depth four and also there are no living-bed are located on depth one; moreover 53.33% living-bed are located on depth two and other 20% are located on depth three. On the other hand no more dining is located in depth one whereas before alterations there were 20% dining located on depth one. All the current dining and dining-bed are located on depth two and three; they become more deep function, far from the entry. On the other hand service functions like kitchen, toilet, and veranda also get more depth so they are transforming into more private function after alterations.

From the table 4.10 we can see that in almost every space the mean depth increase except the second bed. The major spaces like living, dining, bed, kitchen all this spaces have increased mean depth value meaning these spaces becoming more deep function. The most increased mean depth value have the living or living-bed spaces, before alteration there was no living, the value of liv-bed was 1.4., whereas after alteration they become 2.33 and 2.42 respectively. The mean value of veranda which is located with the living have also achieved a very high value from 2 to 3. On contrary in some apartments they have a second bed room only in that case these spaces lose its mean depth value from 4 to 3.29. On the other hand the mean depth of foyer, kitchen, common bath, attach toilet, dressing and circulation of toilet remain the same.

Table 4.10: Depth of different major spaces (in percentage %);

O = Original layout, A = Altered layout.

Space	Depth 1		Depth 2		Depth 3		Depth 4	
	O	A	O	A	O	A	O	A
Foyer	80	100						
Liv-bed	60		40	53.33		20		6.67
Living				13.33		6.67		
Din-bed			20	40		13.33		
Dining	20		60	46.67				
Bed 1			40	40	40	60		
Bed 2						33.33	20	13.33
Kitchen			40	40	60	60		
C Toilet			40	26.67	40	53.33	20	20
C Bath			20	20	40	40	20	20
Ver (with Living)			20			6.67		
Ver(with C space)			20	6.67	20	20		
Ver (with Bed)					20	6.67	40	26.67
Ver-bed						26.67		13.33

Analysing the depth of the studied apartments it is seen that when the occupants started staying there and make some alterations, all the apartments become deeper therefor the inner spaces or functions become more segregated from outside. The mean depth of individual spaces is also increased. From all the data found from space syntax shows that all the spaces have increased their depth in altered samples. The most significant changes has found on the living-bed, dining, bed and veranda.

- In original layout the depth of living-bed and dining was 1 and 2 but after alteration they have shifted to 2 and 3. This shift in depth value has occurred due to two reasons; one is for closing the direct door to living room from the outside and second is to ensure the foyer after entry. Very few living-bed have shifted in depth 4, this is happened mainly due to the shift of activity to a different room explained in chapter 3.
- In case of the new bedrooms, which are created by giving partition to the large living-bedroom all of them are located on depth 3. However the number of bedroom in depth 3 has increased.
- The depth of the verandas has also increased. In original layout the veranda were in depth 2, 3 and sometimes in 4 also. After alterations very few veranda has left in depth 2. Maximum veranda is in depth 3 and 4. Those which verandas are used as bed also all of them are in depth 3 and 4.

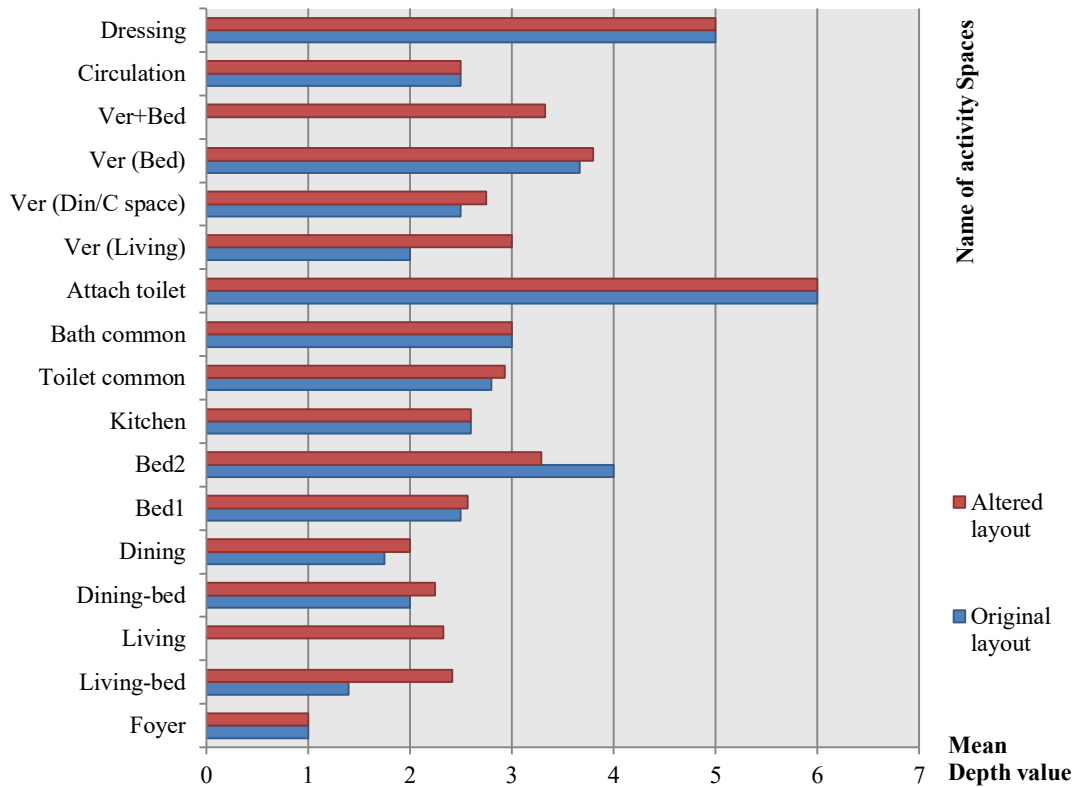


Fig 4.12: Mean depth of different spaces (original and altered layout)

4.3.3 Spatial Analysis of Integration

An important configurational property is integration, a measure of the minimum number of intervening spaces that must be crossed in order to reach all spaces in the spatial configuration. Integration of a space expresses the degree to which it is integrated or segregated within a configuration. The more a space is integrated the more it pulls all other spaces in the complex closer to it. An integrated space in the house allows more direct access to the rest of the house than a less integrated space (Hillier, 1996; Hillier and Hanson, 1984). In case of mean integration value, before alteration they all are around 1; however after alteration there are no such apartments which have a mean integration value of 1 or more than 1; all the value is below 1 (table 4.11). The highest mean integration value before alteration is 1.21 and the lowest is 0.92 whereas after alteration the highest value is 0.95 and the lowest one is 0.80. It means that after alterations the apartments become less integrated; where many functions have become more segregated.

Table 4.11: Comparison of mean integration of all the samples

	Original	Altered		
Sample	A	A-1	A-2	A-3
Mn. Integration	0.95	0.89	0.89	0.89
Sample	B	B-1	B-2	B-3
Mn. Integration	0.95	0.91	0.91	0.91
Sample	C	C-1	C-2	C-3
Mn. Integration	0.99	0.80	0.91	0.87
Sample	D	D-1	D-2	D-3
Mn. Integration	1.21	0.95	0.95	0.95
Sample	E	E-1	E-2	E-3
Mn. Integration	0.92	0.83	0.83	0.91

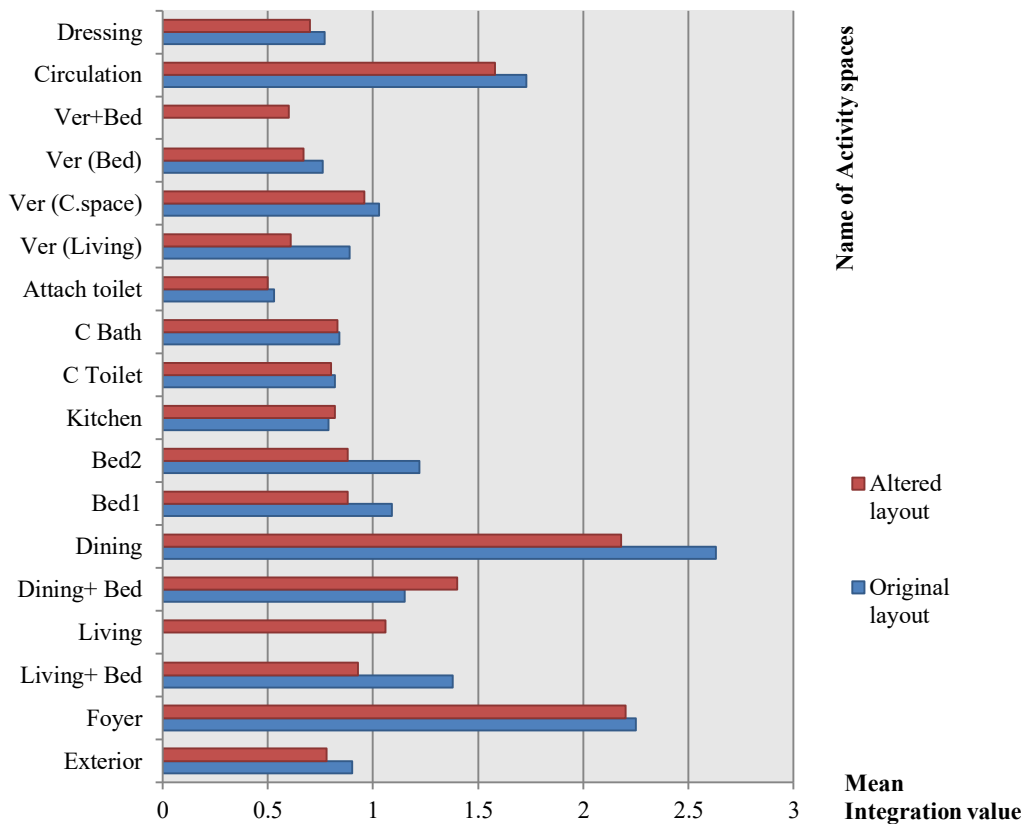


Fig 4.13: Mean integration of different spaces (original and altered layout)

Integration values of the different spaces of the studied apartments show that mean integration of different spaces follows a pattern. From the studies it has been seen that the more integrated activities are the social ones. The segregated activities are the personal ones. From the data found from space syntax analysis it shows that after alterations, the integration value of all the apartments and also almost all the individual spaces of the apartments have decreased except the dining-bed and kitchen (fig. 4.13).

Two significant changes have happened after the alterations.

- In case of individual spaces/ functions like living-bed, bedrooms and veranda (with living) all these spaces have decreased their integration value. However all these spaces are used as bed also, so the occupants have changed the layout such a way that these spaces get more privacy by segregation.
- On the other hand, in original layout dining spaces are designed for dining purpose only but in altered layout due to shortage of space maximum occupants are using this space as dining-bed. However if we can see the integration value of dining and dining-bed we can see that both the spaces have decreased its value to 2.18 and 1.14 respectively against the original 2.63 integration value of dining.

4.3.4 Spatial analysis of Control

Control value is a dynamic local measure. It measures the degree to which a space controls access to its immediate neighbours taking into account the number of alternative connections that each of these neighbours has. Control measures how well a particular space permits or restricts accessibility to other spaces within the overall system. Within the overall system taking into account the number of alternative connections that each of these neighbours has.

From the analysis it has seen that there are two distinct types found in the configuration which are-

- The semi-public spaces like foyer, dining, dining-bed or circulation corridor etc. has higher control value after the alteration which means the more a strong control over the accessibility to its neighbouring spaces.
- Living-bed and other bedrooms has less control value after the alterations which proves that, these spaces have high segregating quality as they are the private activity spaces.
- Another observation has found from the syntactic data of control that whether in original layout or the altered layout, the control value of dining and dining-bed is always high. This syntactic measure is the characteristics to represent the dining area as a space where visitor inhabitant relation took place.

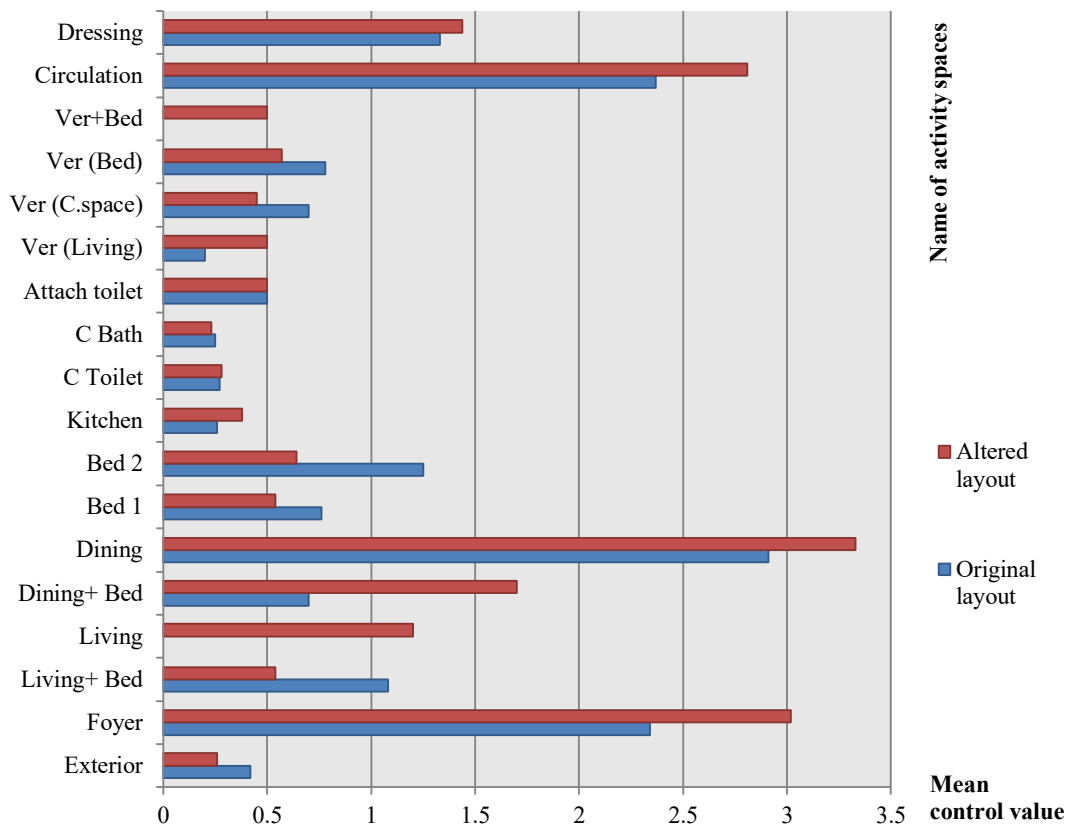


Fig 4.14: Mean control value of different spaces (original and altered layout)

4.4 Conclusion

If we compare the mean integration value with the mean control value there is a significant relation between them. In the case of foyer, dining, circulation corridor the mean integration value has decreased of that spaces but their mean control value has increased so they became less connected with their surrounding but in some place they are the only way to reach their surrounding spaces. As the altered configurations are less ringy, they are more tree like configuration as a result they become segregated space and at the same time their control over their neighbouring space has increased. Moreover in dining-bed, the mean integration value and mean control value have increased. Therefore it proves that they become highly integrated space of the configuration. On the other hand in case of living-bed and the bedrooms the syntactic value of integration and control for both has decreased so it can be easily said that in their cases these spaces become highly segregated one.

CHAPTER 05 CONCLUSION

5.1 Introduction

This research has focused on the user preferences about the morphology of dwelling space in relation to the functional and social need of the lower middle income govt. employees in the context of Dhaka. To find out the morphology of domestic space through spatial analysis this study also identifies the morphological changes due to alterations with the consequences. Space syntax provides an approach to understand the relationship between people and buildings by establishing the formal spatial properties of building. From survey findings the issues responsible for the alterations in lower middle income houses have been defined in this chapter, which conclude this research with some major recommendations.

5.2 Research Findings and Discussion

The economic condition of a family had a significant effect on their lifestyle. The insufficiency of affordability forced lower middle income families to take over their living style and space requirements and at the same time required to preserve their family standards and social norms discussed in chapter two. They are in a struggle for maintaining balance of the both as they are the first or second generation city dweller in most of the case.

5.2.1 Spatial organisation of lower middle income apartments in Dhaka

The analysis of this study deals with the morphological characteristics of domestic space of the lower middle income group focusing the alterations. As the study focused on only lower middle income families so all of the respondents have almost similar economic condition. The apartments are selected from the govt. staff housing on Dhaka. All the apartments are of such employees' whose salary grade ranges from eleven to twenty according to Bangladesh national pay scale. Among the respondents most of them are extended family with a household number of five to six. The apartments are originally designed by architects. Before alterations all the five apartments of case studies had ringy configuration having choice in the access. The ring located mostly among living-dining area; sometimes the ring connected with

exterior through the foyer space and in few cases it was connected internally through the veranda or bedroom. The ringy interior of these buildings allow the visitors to move from one space to another linked space which reduces the privacy of these apartments. However after alterations most of the apartments transformed into tree like configuration except two. The tree-like shape reflects a controlled spatial structure and the ring-like shape reflects interconnection and movement reducing the depth of the layout. The average mean depth from outside has changed from 2.37 to 2.58 which indicate the addition of more layers in the apartments layout which made the spaces more deep from outside. However the averages mean integration have transformed to 0.89 from 1.01 after alteration which also made the spaces more segregated indicates that the degree of privacy is increased.

5.2.1.1 Components of Domestic Space

The houses are mainly composed of the basic functional spaces like living, dining, kitchen, one or two bedrooms, verandas, bath and toilets. Some major changes have found from the analysis of the case study apartments which are briefly described below in three broad categories of domestic components; entry and circulation, major activity spaces and services which are discussed in chapter three.

Entry and circulation

Foyer is a very important space for an apartment as it is a place in movement which maintains the segregation between the inhabitants and the visitors of a domestic space. It allows the inhabitants to have a choice in access either to the living area or to the inner function holding rooms. In original layout two types of entry have observed among the samples. When they have two entries from outside, one directly entered to the living-bed and another in a foyer space. The second one when there is only one entry, which directly enters to a common space either foyer or dining. However the first one is more commonly observed in studied apartments. After alterations all the apartments have ensured the use of foyer space by closing the direct entry to living-bed. Who don't have any foyer in original layout also create a foyer by giving a partition in the dining area. In original layout foyer was most permeable space in between one or more interconnected ring (c or d type space). Whereas in altered layout it became a definite transitional space which helps occupants entered to the inside of the apartment.

The common circulation like foyer, corridor etc. has higher control value after the alteration express strong control over the accessibility to its neighbouring spaces.

Major activity spaces

In local culture living is used mainly for the outsiders and guests. Besides living, the dining and bedrooms are also used to entertain the female guest. Dining is mainly used for eating and doing other household works. However besides their typical use, living and dining in the studied apartments both were used as bedroom also due to shortage of bedroom in the apartment. Dining and the TV room (either bedroom or living) act as a common shared space. From the spatial analysis of this study the major activity spaces like living, dining, bedrooms all of them are found as multifunctional spaces holding many activities in the same place but different time.

Around 50% living-beds became dead-end space in altered layout so they can maintain the privacy of bedroom whereas in original layout they were in between a ring. In original layout the depth of living-bed was 1 and 2 but after alteration they have shifted to 2 and 3. Living-bed has less control value after the alterations which prove that, these spaces have high segregating quality as they have contains private activity e.g. sleeping. Dining space acts as a node and distributes movement to the inner spaces in the house in altered layout. Dining and dining-bed became transitional space connected with two spaces which help occupants to enter the deeper part of the apartment. However in original layout they were more permeable space within a ring of interconnected spaces. Again in original layout the depth of dining was 1 or 2 but after alteration they have shifted to 2 or 3. However if we can see the integration value of dining and dining-bed we can see that both the spaces have decreased its value to 2.18 and 1.14 respectively against the original integration value 2.63 of dining. After the alteration the semi-public spaces e.g. dining, dining-bed etc. has higher control value which means the more a strong control over the accessibility to its neighbouring spaces. Another observation has found from the syntactic data of control that whether in original layout or the altered layout, the control value of dining and dining-bed is always high. This syntactic measure represent that dining always acts as a major transitional space of residence in terms of privacy and accessibility. In original layout there were no bedroom which is terminal space, maximum were located among a ring which hamper the privacy. However after the alterations maximum bedroom is

transformed into dead-end type spaces but ensured interaction within family. All the apartments become deeper therefore the inner spaces or functions (private functions e.g. bedrooms) become more segregated from outside. All the bedrooms have less control value after the alterations which proves that, these spaces have high segregating quality as they are the private activity spaces.

Service

The veranda has a significant impact in these apartments. Most of the veranda becomes dead-end space and converted to its activity as a multifunctional space used also as a bed room for occasional use. Some other veranda used for kitchen purpose. However before alteration many of them are located in between a ring. The depth of the verandas has also increased and integration value decreased. In original layout the veranda were in depth 2, 3 and sometimes in 4 also. After alterations very few veranda has left in depth 2. Maximum veranda is in depth 3 and 4. Those which verandas are used as bed also all of them are in depth 3 and 4. These apartments have separate bath and toilet to enhance the functional usability.

5.2.1.2 Space use Pattern through Activity analysis

According to activity pattern analysis all the activities are categorized according to three broad group; semi-public, private and service activities. From analysis it has been found that major private activity sleeping is the key factor for all the alterations. Due to shortage of bedroom maximum changes have taken place. However after all the changes have taken place, they have a mixed pattern of space use for their daily domestic activity. Almost all the spaces e.g. living, dining, veranda and sometimes kitchen also used for the sleeping activity besides their original activity during different time on different case. On the other hand for some activities like reading, family gathering they don't usually have any specific space, they used any space for these activities if it is suitable for that time. On a different case entertaining guest is a problem as they have all the spaces as multifunctional so during the time of entertaining guest the other activities of that place is being disturbed.

5.2.2 Categories and Reasons of the Alterations

The components of the original layout are altered by the occupants on the current layout in which they are live in. During field study some major alterations are found in the apartments which have transformed the original layout of the apartments to a new one. However the alterations which are made by the occupants can finally divided in three major groups-

- Increase the usability of spaces by controlling access
- Compartmentalization by using partition
- Conversion of space use by relocating activity

In general, there are two evident categories of alterations. The first one is only by converting the function/ activity or multiple use of space by remaining the layout of apartment almost same. Another is when the original layout of the apartment is changed to fulfil users' preference by giving the partition or controlling the access. Without changing the original planning layout of the apartments the prominent alteration which the users' have made is making the spaces multifunctional. All the major spaces e.g. living, dining or veranda has additional uses mostly as bedroom besides their original use according to time. The major alterations have found on the case studies which have changed the original layout of the apartments all of them are happened by bellow three techniques.

Control of access

After alterations all the occupants has ensure the use of foyer avoiding the direct entry to living-bed from the outside. Due to this the control of foyer and corridor is higher than original layout which allows them the control of access to their neighbouring space. They become the transitional space connected with more than one link and acting as a node from which the circulation is distributed to other spaces. By avoiding the direct entry to living-bed usability of the space is also enhanced. The circulation space for the access/ door can be used for furniture placement in altered layout. However in original layout most of the major activity spaces are connected with a ring thus easily permeable for the visitors. After alteration they become tree by controlling the interconnection between the rooms due to privacy and the functionality of the room. The dining are becoming the transitional spaces and the living-bed, bed etc. become dead-end space. The control of dining area is becoming higher; this space can control

the access to the surrounding spaces. The major activity spaces are located at the end of the branch as dead-end spaces so their control value is also become less except the dining area.

Use of partition

The main reason of using the partition is to make more room dividing the existing large one for the need of extra room. Many have used the new rooms as a separate living, bed etc. or one as a combined living-bed and give another one as sublet for the economic benefit. To ensure the privacy of dining or living-bed sometimes they also use curtain or furniture as a partition. Thus the users sometimes preferred to make compartment in their domestic space to increase the number of functional space ensuring the privacy. Moreover due to partition the functionality of space has increased mostly as the users can utilize the space by placing furniture alongside the partition. All the major activity space becomes deeper from the outside due to this partition and compartmentalization of layout. Also their integration value is decreased thus making the overall apartment more segregated and enhance the privacy.

Relocation of activity

The conversion of the use of space to another one has observed in the case study samples which are actually not designed for. As an example veranda is used for cooking activity and thus found a separated space/ room (kitchen) for sleeping activity. All these alterations occurred in the domestic space for the need of extra rooms mostly bedrooms.

From the above mentioned discussion, there is a pattern found from the alterations. After alteration most of the apartments become tree-like configurations however in original layout all of them were ringy configuration. This indicates to have more choices in the access to the domestic space in original layout but limited in altered layout. The original layouts are more distributive including alternative routes. Whereas the altered layouts are less distributive, a single sequence of spaces creates one or two branches afterwards. The major activity spaces are changing their typology from a ring or junction that provides choice to a thoroughfare-with more than one link- where movement is highly directed leading to a terminal space. Integration value is decreasing whereas depth and control is increasing. This indicates that the occupants need more

privacy and layering between spaces and segregation in domestic spaces from the outside and visitors. From the study it has also seen that besides enhancing functionality of space all the alterations and changes have made in the apartments; privacy is a major reason behind them.

5.3 Conclusion and Recommendation

Although the spaces cannot accommodate all the activities; time adjustment and space zoning increased functionality. In this way, spaces have high value in terms of functionality when they can accommodate many kinds of activities in the same space. Although functionality of a space also means there are no disturbances among activities which not fully satisfied here.

This study's findings show that even though initial space function of the house had been determined, there are some additional points need to be taken into consideration. A Space is merely a container of activities where any activity may occur and even though it has not been determined previously. In other words, multi-functionality of space is highly necessary, especially for lower middle income houses. Space should be designed in such a way that can hold many activities at the same time.

This study has also reported the findings which allow the user to personalize; making the house to adapt their needs and lifestyle. As the families live in these apartments for a long period of time so they have tried to solve the emerging spatial needs. by making some alterations in their existing dwellings they have to adapt the space as their changing needs. Through the alterations, residents are able to cope with the inadequacy of their home, since they lack the economic power to shift their dwelling to a bigger or more adequate one. By understanding the trends and the reasons of the alterations will help the concern authorities to re-evaluate the design of houses and housing in the future.

5.4 Scope of Future Research

One of the major problems of these apartments is attending the guest due to the limited space. If anyone has come to stay at night, they don't have any extra room to accommodate the guest. Thus the low sociability was conceivable as a trait of these residents. This study has also shown that as this is not currently address properly but

like family privacy, intra-family privacy has also become more important among the family members. Though some respondents have said, they don't have much problem of privacy whether it is about guest-occupants, child-adult or the male-female but from the study findings it has seen that privacy acts as a major deterrents of the alterations of these residence. More investigation is needed to understand these phenomenons properly. On the other hand the study focuses only on the govt. staff housing of Dhaka means the public sector not the private sector housing for easy access to data collection and surveying of researcher. However, the research scope can be extended by investigating the private sector housing also for more generalizing findings. Moreover a comparative study with other cities of Bangladesh is recommended to understand the cultural change and housing use, design and adaptation elsewhere.

The current study covers the housing area which are mostly designed by architects, besides that the current housing shows an incompatibility towards their spatial configuration of domestic space. It seems that the designer does not able to understand the users need and aspirations. The current process of mass housing production is in such a way that 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). Houses are often designed with typical user, with typical abilities in mind, for the typical needs for today, without considering the future changes of the user (Baldwin & Tomita, 2007). This study is raising the question of how to adequately address the need by developing adaptable house design.

The research findings support the end-users involvement in the housing design process in the early stage of decision making as well as at later stages of adaptation and transformations which could offer a higher possibility of housing design better attuned to current actual needs. Exploring the possibilities of the end-users involvement in early stages of housing design can be a useful research focus. The research findings support a positive attitude towards user transformations of housing in developing countries. With this knowledge, the gap between architects' and users' needs would be narrowed.

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APPENDIX A: SAMPLE QUESTIONNAIRE

TITLE: A STUDY ON MORPHOLOGICAL CHARACTERS OF DOMESTIC SPACES FOCUSING THEIR ALTERATIONS IN THE APARTMENTS OF LOWER MIDDLE INCOME GROUP IN DHAKA

This survey is a part of a post graduate research project undertaken at the Department of Architecture, Bangladesh University of Engineering and Technology, Dhaka. All information collected will be utilized for academic purpose only and shall be kept confidential. Your cooperation in this regard will be highly appreciated.

Dilruba Yasmin
Assistant Professor
Department of Architecture
Dhaka University of Engineering & Technology, Gazipur.

Questionnaire number: _____
 Time (interview began): HR. _____ MIN. _____
 Address: Flat no. _____ House No. _____

Section I USER CHARECTERISTICS

Socio-demographic Data *The following background information is needed about respondent for classification purposes. Please indicate the classifications which best describe the respondent.*

Respondent Profile

Name: _____
 Age: _____ Gender: _____
 Education (*highest level completed*) _____
 Status in household: _____ Profession: _____

Household Profile

01. How long have you lived in this apartment? -

02. What is the number of household? -

Sl.	Name	Relation	Gender	Age	Occupation
1					
2					
3					
4					
5					
6					

04. Do you share this space with any other out of your own household? - Yes/ No

05. If yes, with how many member? -

Sl.	Name	Relation	Gender	Age	Occupation
1					
2					
3					

Section II PLAN INVESTIGATION (ALTERATIONS)

This section is about plan investigation to examine the alterations/modifications/adaptations made by dwellers and why these changes are made. Researcher has to sketch the layout of room and location of furniture; also required to mark the activities in each room and veranda within the layout of rooms.

06. Type of Alterations in the apartment (Mark on plan, address by researcher)

i. Wall _____ ii. Door _____
 iii. Window _____ iv. Size of room _____
 v. Addition of room _____ vi. Furniture layout _____
 vii. Curtains _____ viii. _____

07. Reason of alterations

i. Privacy/Security/Functional/others

ii. Privacy/Security/Functional/others

iii. Privacy/Security/Functional/others

iv. Privacy/Security/Functional/others

v. Privacy/Security/Functional/others

vi. Privacy/Security/Functional/others

08. Use of space in a different way that is not designed for (Mark on plan, address by researcher)

i. Living

ii. Dining

iii. Veranda

iv. Kitchen

v. Bed

vi.

09. Reasons of Changes

i. Privacy/Security/Functional/others

ii. Privacy/Security/Functional/others

iii. Privacy/Security/Functional/others

iv. Privacy/Security/Functional/others

v. Privacy/Security/Functional/others

vi. Privacy/Security/Functional/others

Section III ACTIVITY ANALYSIS

This section examines the space use and activity pattern with respect to user and space to understand the way of living and space use pattern.

10. Space-use according to activity (multifunctional space use) and their aspiration

Zoning	Kind of activity	Space			
		Male	Female	Adult	Children
Private	Sleeping				
	Reading				
	Changing dress				
Semi public	Preparing food				
	Cooking				
	Dining				
	Drying				
	Take care of children/elderly				
	family gathering				
	Watching tv				
Entertaining guest					

10. Overall suggestion regarding the apartment plan/ layout

Section V USER CHARECTERISTICS

Socio-economic Data *The following background information is needed about respondent for classification purposes. Please indicate the classifications which best describe the respondent.*

11. Total earning member of the family-
12. Monthly expenditure approx.-
13. Salary grade in Pay Scale-
14. House rent -

Time interview end: _____ **HR.** _____ **MIN.**

Date:

APPENDIX B: COMPONENTS OF DOMESTIC SPACE

B.1 Percentage of space in original and altered samples

Percentage of spaces		
Spaces	Before alterations	After alterations
Foyer	80	100
Living-Bed	100	80
Living	0	20
Dining-Bed	20	53.3
Dining	80	46.7
Bed	80	93.3
Kitchen	100	100
Toilet	100	100
Bath	80	80
Attach toilet	20	20
Veranda-Bed	0	40
Veranda	80	60
Corridor	40	40
Dressing	20	20

B.2 Number of spaces in original samples

Numbers of spaces (Original Plan)						
Sample	A	B	C	D	E	% of Space
Area (sq. ft.)	425	530	580	690	800	
Foyer	1	1		1	1	80
Living-Bed	1	1	1	1	1	100
Living						0
Dining-Bed	1					20
Dining		1	1	1	1	80
Bed		1	1	1	2	80
Kitchen	1	1	1	1	1	100
Toilet	1	1	1	1	1	100
Bath		1	1	1	1	80
Attach toilet					1	20
Veranda-Bed						0
Veranda	2	1		1	2	80
Corridor			1		1	40
Dressing					1	20
Total No of Space	7	8	7	8	13	

B.3 Number of spaces in altered samples

Numbers of spaces _ Altered Plan																
Area (sq. ft.)	425			530			580			690			800			% of Space
Sample	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	
Foyer	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
Living-Bed	1	1	1	1	1	1	1	1	1	1			1		1	80
Living											1	1		1		20
Dining-Bed	1	1	1	1			1	1	1	1						53.3
Dining					1	1					1	1	1	1	1	46.7
Bed				1	1	1	1	1	1	2	2	2	2	2	2	80
Kitchen	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
Toilet	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
Bath				1	1	1	1	1	1	1	1	1	1	1	1	80
Attach toilet													1	1	1	20
Veranda-Bed	1		1							1	1		1	1		40
Veranda	1	1		1	1	1						1	1	1	2	60
Corridor							1	1	1				1	1	1	40
Dressing													1	1	1	20
Total No of Space	7	7	7	8	8	8	8	8	8	9	9	9	13	13	13	

APPENDIX C: ACTIVITY ANALYSIS IN SAMPLE CASES _ Multifunctional space use

Sl.	Type	Activity	Space	No of cases	%	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		
01	Private	Sleeping	Living-Bed	12 /15	80	√	√	√	√	√	√	√	√	√	√			√		√		
			Dining	05 /15	33.3				√				√	√	√	√						
			Veranda (optional)	06 /15	40	√		√									√	√		√	√	
			Kitchen (used as bed)	02 /15	13.3		√	√														
			Bed	15 /15	100	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
		Reading	Living-Bed	02 /12	16.7										√	√						
			Bed	06 /12	50						√	√	√	√			√			√	√	
		No Fix space	04 /12	33.3			√	√							√				√			
02	Semi Private	Family gathering	Living-Bed	04 /15	26.7				√		√	√	√									
			Dining-Bed	01 /15	6.7											√						
			Bed	09 /15	60	√	√	√	√	√				√		√			√	√		
			No Fix space	04 /15	26.7											√		√	√			
		Watching TV	Living	02 /15	13.3												√	√				
			Living-bed	06 /15	40		√		√	√	√	√								√		
			Din-Bed	05 /15	33.3	√	√	√								√					√	
			Bed	04 /15	26.7					√					√		√				√	
			Entertaining guest	Living-bed	12 /15	80	√	√	√	√	√	√	√	√	√	√	√			√		√
		Dining	Living	03 /15	20												√	√			√	
			Dining	03 /15	20											√	√				√	
			Dining-Bed	07 /15	46.7	√	√	√	√					√		√	√					
			Bed/ no fixed space	01 /15	6.7										√							
		Dining	07 /15	46.7					√	√					√	√		√	√	√		
03	Service	Preparing food	Kitchen	11 /15	73.3	√			√	√	√	√	√	√		√		√	√	√		
			Veranda	04 /15	26.7		√	√											√		√	
			Bed	02 /15	13.3		√	√														
			Dining	02 /15	13.3												√		√			
		Cooking	Kitchen	13 /15	86.7	√			√	√	√	√	√	√	√	√	√	√	√	√	√	
			Veranda	02 /15	13.3		√	√														
		Drying	Veranda	08 /12	66.7	√	√		√	√	√						√				√	√
			Outside the building	03 /15	20													√	√	√		
			Outside of Window	03 /15	20									√	√	√						
			Front Stair	01 /15	6.7			√														

█ Apartments those are not included on the calculation because they don't have the described facility.

APPENDIX D: ALTERATIONS IN CASE STUDY SAMPLES

D.1 Alterations in plan layout

Plan Investigation _ Alterations in plan layout																							
Sl.	Alterations		Reasons	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	No of cases	% of alterations	Total % of alterations		
01	Use of Partition	Reducing room size by wall	i. Privacy of din-bed							√		√							2/15	13.3	33.33 %		
			ii. For extra bedroom											√						1/15		6.7	
			iii. For individual living & bed												√	√				2/15		13.3	
		Use of Curtain	i. Privacy									√		√					√	3/15	20	20 %	
02	Control of access by closing the some door permanently	Between living and exterior	i. Functional				√		√								√		√	4/9	44.4	100 %	
			ii. Security /maintenance					√						√	√	√			√	5/9	55.6		
		Between Ver and bed	i. Functional	√	√	√												√	√	5/6	83.3	83.3 %	
			ii. No Change																	√	1/6		16.7
		Between two bed rooms	i. Privacy-functional										√	√	√	√	√				5/6	83.3	83.3 %
			ii. No Change									√									1/6	16.7	

■ Apartments those are not included on the calculation because they don't have the described facility.

D.2 Alterations in Space use

Sl.	Original Use	Reasons	Altered Use	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	No of Cases	Percentage (%)	% of Alterations		
01	Living-bed	Lack of Bedroom Economic (rent)	Bed								√					√	√		3/15	20	20		
			No Change	√	√	√	√	√	√	√			√	√	√	√			√	12/15		80	
02	Dining	Lack of Bedroom Economic (rent)	Din-Bed				√			√			√							3/15	20	33.4	
			Liv-Bed								√										1/15		6.7
			Bed									√									1/15		6.7
			No Change	√	√	√		√	√						√	√	√	√	√	√	10/15		66.6
03	Bed	Lack of Bedroom	Din-Bed								√	√								2/15	13.3	26.7	
			Liv-Bed														√				1/15		6.7
			Liv															√			1/15		6.7
			No Change	√	√	√	√	√	√	√				√	√	√			√		11/15		73.3
04	Kitchen	Lack of Bedroom	Bed		√	√														2/15	13.3	13.3	
			No Change	√			√	√	√	√	√	√	√	√	√	√	√	√	√	√	√		√
05	Veranda 1	Lack of Bedroom	Bed	√	√	√							√	√		√	√			7/12	58.3	58.3	
			No Change				√	√	√							√			√		5/12		41.7
06	Veranda 2	Lack of Bedroom	Kitchen		√	√														2/6	33.3	33.3	
			No Change	√													√	√	√		4/6		66.7

■ Apartments those are not included on the calculation because they don't have the described facility.

APPENDIX E: SUMMARIZED SYNTACTIC DATA OF ALL SAMPLE CASES

E.1 Typology in original samples

Sl.	Spaces	a-type space Dead end	b-type space Transition tree	c-type space between ring	d-type space between 2 ring	Total (%)
1	Foyer			A/ B/ E (60)	D (20)	80
2	Living-Bed			A/ B/ C/ E (80)	D (20)	80
3	Living					
4	Dining-Bed			A (20)		20
5	Dining			B/ C/ E (60)	D (20)	80
6	Bed 1		B (20)	C/ D/ E (60)		80
7	Bed 2			E (20)		20
8	Kitchen	A/ B/ C/ D/ E				100
9	Toilet common	A/ B/ C/ D/ E				100
10	Bath common	B/ C/ D/ E (80)				80
11	Attach toilet	E (20)				20
12	Veranda (With Living)	D (20)				20
13	Veranda (With Din/ Com space)	E (20)	A (20)			40
14	Veranda (With bed)	B (20)		A/E (40)		60
15	Veranda-Bed					
16	Corridor		C (20)	E (20)		40
17	Dressing		E (20)			20
	Mean (%)	21.18	4.71	21.18	3.53	

E.2 Typology in altered samples

Sl.	Out of 15 (%)	a-type space Dead end	b-type space Transition tree	c-type space	d-type space	Total (%)
1	Foyer		A-1/A-2/A-3/B-1/B-2/B-3/C-2/C-3/D-1/D-2/D-3/E-1/E-2/E-3 93.33	C-1 6.67		100
2	Living-Bed	A-1/A-2/A-3/B-1/B-2/B-3/E-3 46.67	C-2/C-3/D-1/E-1 26.67	C-1 6.67		80
3	Living		D-2/D-3/E-2 20			20
4	Dining-Bed	C-2/ C-3 13.33	A-1/A-2/A-3/B-1/D-1 33.33	C-1 6.67		46.67
5	Dining		B-2/B-3/D-2/D-3/E-1/E-2 40	E-3 6.67		46.67
6	Bed 1	A-2/A-3/D-1/D-2/D-3/E-1/E-2 46.67	B-1/B-2/B-3/ C-2/ C-3 33.33	C-1/E-3 13.33		93.33
7	Bed 2	C-2/D-1/D-2/D-3 26.67	E-1/E-2 13.33	E-3 6.67		46.67
8	Kitchen	A-1/B-1/B-2/B-3/ C-1/ C-2/ C-3/D-1/D-2/D-3/E-1/E-2/E-3 86.67	A-2/A-3 13.33			100
9	Common Toilet	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				100
10	Common Bath	B-1/B-2/B-3/ C-1/ C-2/ C-3/D-1/D-2/D-3/E-1/E-2/E-3 80				80
11	Attach toilet	E-1/E-2/E-3 20				20
12	Veranda (with Living)	D-3 6.67				6.67
13	Veranda (with Dining/ Common space)	E-1/E-2/E-3 20	A-1 6.67			26.67
14	Veranda (with bed)	A-2/B-1/B-2/B-3 26.67		E-3 6.67		33.33
15	Veranda-Bed	A-1/ A-3/D-1/D-2/E-2 33.33				40
16	Corridor		C-1/ C-2/ C-3/E-1/E-2 33.33	E-3 6.67		40
17	Dressing		E-1/E-2/E-3 20			20
	Mean (%)	29.80	19.61	3.53	-	

E.3 Depth of the different spaces in original samples in percentage

Sl.	Spaces	Depth 1	Depth 2	Depth 3	Depth 4	Depth 5	Depth 6
1	Foyer	A/ B/ D/ E 80%					
2	Living-Bed	B/ D/ E 60%	A/ C 40%				
3	Living						
4	Dining-Bed		A 20%				
5	Dining	C 20%	B/ D/ E 60%				
6	Bed 1		C/ D 40%	B/ E 40%			
7	Bed 2				E 20%		
8	Kitchen		A/ B 40%	C/ D/ E 60%			
9	Toilet common		C/ D 40%	A/ B 40%	E 20%		
10	Bath common		D 20%	B/ C 40%	E 20%		
11	Attach toilet						E 20%
12	Veranda (With Living)		D 20%				
13	Veranda (With Din/ Com. space)		A 20%	E 20%			
14	Veranda (With bed)			A 20%	B/ E 40%		
15	Veranda-Bed						
16	Corridor		C 20%	E 20%			
17	Dressing					E 20%	

E.4 Depth of the different spaces in altered samples in percentage

Sl.	Spaces	Depth 1	Depth 2	Depth 3	Depth 4	Depth 5	Depth 6
1	Foyer	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/ 100%					
2	Living-Bed		A-1/A-2/A-3/C-1/C-2/C-3/D-1/E-3/ 53.33%	B-1/B-2/B-3/ 20%	E-1/ 6.67%		
3	Living		D-2/D-3/ 13.33%	E-2/ 6.67%			
4	Dining-Bed		A-1/A-2/A-3/B-1/C-1/D-1/ 40%	C-2/ C-3/ 13.33%			
5	Dining		B-2/B-3/D-2/D-3/E-1/E-2/E-3/ 46.67%				
6	Bed 1		A-2/A-3/C-2/C-3/E-1/E-2/ 40%	B-1/B-2/B-3/C-1/D-1/D-2/D-3/E-3/ 60%			
7	Bed 2			C-2/D-1/D-2/D-3/E-1 33.33%	E-2/E-3 13.33%		
8	Kitchen		A-1/A-2/A-3/B-1/B-2/B-3/ 40%	C-1/C-2/C-3/D-1/D-2/D-3/E-1/E-2/E-3/ 60%			
9	Common Toilet		C-2/D-1/D-2/D-3/ 6.67%	A-1/A-2/A-3/B-1/B-2/B-3/C-1/C-3/ 53.33%	E-1/E-2/E-3/ 20%		
10	Common Bath		D-1/D-2/D-3/ 20%	B-1/B-2/B-3/C-1/C-2/C-3/ 40%	E-1/E-2/E-3/ 20%		
11	Attach toilet						E-1/E-2/E-3/ 20%
12	Veranda (with Living)			D-3/ 6.67%			
13	Veranda (with Dining/ Common space)		A-1/ 6.67%	E-1/E-2/E-3/ 20%			
14	Veranda (with bed)			A-2/ 6.67%	B-1/B-2/B-3/E-3 26.67%		
15	Veranda-Bed			A-1/A-3/D-1/D-2/ 6.67%	E-1/E-2/ 13.33%		
16	Corridor		C-1/C-2/C-3/ 20%	E-1/E-2/E-3/ 20%			
17	Dressing					E-1/E-2/E-3/ 20%	

E.5 Comparison of Depth on different spaces in percentage

Sl.	Space	Depth 1 (%)		Depth 2 (%)		Depth 3 (%)		Depth 4 (%)		Depth 5 (%)		Depth 6 (%)	
		Original	Altered	Original	Altered	Original	Altered	Original	Altered	Original	Altered	Original	Altered
1	Foyer	80	100										
2	Living-bed	60		40	53.33		20		6.67				
3	Living				13.33		6.67						
4	Dining-bed			20	40		13.33						
5	Dining	20		60	46.67								
6	Bed 1			40	40	40	60						
7	Bed 2						33.33	20	13.33				
8	Kitchen			40	40	60	60						
9	Common Toilet			40	26.67	40	53.33	20	20				
10	Common Bath			20	20	40	40	20	20				
11	Attach toilet											20	20
12	Veranda (Living)			20			6.67						
13	Veranda (Common space/ Dining)			20	6.67	20	20						
14	Veranda (Bed)					20	6.67	40	26.67				
15	Veranda-bed						26.67		13.33				
16	Corridor			20	20	20	20						
17	Dressing									20	20		

E.6 Depth and mean depth of different spaces in original samples

Sl.		Sample A	Sample B	Sample C	Sample D	Sample E	Mean Depth
1	Foyer	1	1		1	1	1.00
2	Living-bed	2	1	2	1	1	1.40
3	Living						-
4	Dining-bed	2					2.00
5	Dining		2	1	2	2	1.75
6	Bed 1		3	2	2	3	2.50
7	Bed 2					4	4.00
8	Kitchen	2	2	3	3	3	2.60
9	Toilet common	3	3	2	2	4	2.80
10	Bath common		3	3	2	4	3.00
11	Attach toilet					6	6.00
12	Veranda (With Living)				2		2.00
13	Veranda (Dining/ Com space)	2				3	2.50
14	Veranda (With bed)	3	4			4	3.67
15	Veranda-Bed						-
16	Corridor			2		3	2.50
17	Dressing					5	5.00
	Mean Depth	2.14	2.38	2.14	1.88	3.31	2.84

E.7 Depth and mean depth of different spaces in altered samples

Sample Space	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 D
Foyer	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1.00
Living-bed	2	2	2	3	3	3	2	2	2	2			4		2	2.42
Living											2	2		3		2.33
Dining-bed	2	2	2	2			2	3	3	2						2.25
Dining					2	2					2	2	2	2	2	2.00
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	2.60
Common Toilet	3	3	3	3	3	3	3	2	3	2	2	2	4	4	4	2.93
Common Bath				3	3	3	3	3	3	2	2	2	4	4	4	3.00
Attach toilet													6	6	6	6.00
Veranda (with Liv)												3				3.00
Veranda (Com. space)	2												3	3	3	2.75
Veranda (with bed)		3		4	4	4									4	3.80
Veranda-Bed	3		3							3	3		4	4		3.33
Corridor							2	2	2				3	3	3	2.50
Dressing													5	5	5	5.00
Mean Depth	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

E.8 Comparison of mean depth on different spaces in original and altered samples

Sl.		Mean Depth	
		Original	Altered
1	Foyer	1.00	1.00
2	Living-bed	1.40	2.42
3	Living		2.33
4	Dining-bed	2.00	2.25
5	Dining	1.75	2.00
6	Bed 1	2.50	2.57
7	Bed 2	4.00	3.29
8	Kitchen	2.60	2.60
9	Toilet common	2.80	2.93
10	Bath common	3.00	3.00
11	Attach toilet	6.00	6.00
12	Veranda (With Living)	2.00	3.00
13	Veranda (With Din/ Com space)	2.50	2.75
14	Veranda (With bed)	3.67	3.80
15	Veranda-Bed	-	3.33
16	Corridor	2.50	2.50
17	Dressing	5.00	5.00

E.9 Integration and mean integration of different spaces in original samples

Sl.		Sample A	Sample B	Sample C	Sample D	Sample E	Mean Integration
1	Exterior	0.86	0.81	0.86	1.27	0.69	0.90
2	Foyer	3.45	1.48		2.96	1.10	2.25
3	Living-Bed	1.15	1.11	0.99	2.96	0.69	1.38
4	Living						-
5	Dining-Bed	1.15					1.15
6	Dining		2.96	3.45	2.22	1.89	2.63
7	Bed 1		1.11	0.99	1.11	1.16	1.09
8	Bed 2					1.22	1.22
9	Kitchen	0.86	0.68	0.69	0.81	0.90	0.79
10	Toilet common	0.57	0.89	0.86	0.89	0.87	0.82
11	Bath common		0.89	0.69	0.89	0.87	0.84
12	Attach toilet					0.53	0.53
13	Veranda (With Living)				0.89		0.89
14	Veranda (With C. space)	1.15				0.90	1.03
15	Veranda (With bed)	0.69	0.59			0.99	0.76
16	Veranda-Bed						-
17	Corridor			1.72		1.73	1.73
18	Dressing					0.77	0.77
	Mean Integration	0.95	0.95	0.99	1.21	0.92	

E.10 Integration and mean integration of different spaces in altered samples

Sl.		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 I
1	Exterior	0.86	0.86	0.86	0.68	0.68	0.68	0.68	0.89	0.81	0.92	0.92	0.92	0.67	0.67	0.67	0.78
2	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	1.10	1.10	1.10	2.20
3	Living-Bed	0.86	0.86	0.86	0.89	0.89	0.89	0.99	1.11	0.99	1.10			0.99		0.67	0.93
4	Living											1.10	1.10		0.99		1.06
5	Dining-Bed	1.15	1.15	1.15	2.96			0.99		0.55	1.83						1.40
6	Dining					2.96	2.96					1.83	1.83	1.89	1.89	1.89	2.18
7	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
8	Bed 2								0.59		0.79	0.79	0.79	0.99	0.99	1.22	0.88
9	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	0.90	0.90	0.90	0.82
10	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	0.80
11	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
12	Attach toilet													0.48	0.48	0.53	0.50
13	Veranda (with Liv)												0.61				0.61
14	Veranda (C. space)	1.15												0.90	0.90	0.90	0.96
15	Veranda (with bed)		0.57		0.59	0.59	0.59									0.99	0.67
16	Veranda-Bed	0.57		0.57							0.61	0.61		0.63	0.63		0.60
17	Corridor							1.27	1.48	1.77				1.60	1.60	1.73	1.58
18	Dressing													0.67	0.67	0.77	0.70
	Mean Integration	0.89	0.89	0.89	0.91	0.91	0.91	0.80	0.91	0.87	0.95	0.95	0.95	0.83	0.83	0.91	

E.11 Comparison of mean integration on different spaces in original and altered samples

Sl.		Mean Integration	
		Original	Altered
1	Exterior	0.90	0.78
2	Foyer	2.25	2.20
3	Living-Bed	1.38	0.93
4	Living	-	1.06
5	Dining-Bed	1.15	1.40
6	Dining	2.63	2.18
7	Bed 1	1.09	0.88
8	Bed 2	1.22	0.88
9	Kitchen	0.79	0.82
10	Common Toilet	0.82	0.80
11	Common Bath	0.84	0.83
12	Attach toilet	0.53	0.50
13	Veranda (with Living)	0.89	0.61
14	Veranda (with Common space)	1.03	0.96
15	Veranda (with bed)	0.76	0.67
16	Veranda-Bed	-	0.60
17	Corridor	1.73	1.58
18	Dressing	0.77	0.70

E.12 Control and mean control value of different spaces in original samples

Sl.		Sample A	Sample B	Sample C	Sample D	Sample E	Mean CV
1	Exterior	0.20	0.83	0.20	0.04	0.83	0.42
2	Foyer	3.50	1.70		2.95	1.20	2.34
3	Living-Bed	0.70	0.70	0.70	2.45	0.83	1.08
4	Living						-
5	Dining-Bed	0.70					0.70
6	Dining		3.33	3.33	1.90	3.08	2.91
7	Bed 1		1.20	0.70	0.45	0.70	0.76
8	Bed 2					1.25	1.25
9	Kitchen	0.20	0.33	0.33	0.25	0.20	0.26
10	Toilet common	0.50	0.20	0.20	0.20	0.25	0.27
11	Bath common		0.20	0.33	0.20	0.25	0.25
12	Attach toilet					0.50	0.50
13	Veranda (Living)				0.20		0.20
14	Veranda (C. space)	1.20				0.20	0.70
15	Veranda (Bed)	1.00	0.50			0.83	0.78
16	Veranda-Bed						-
17	Corridor			2.20		2.53	2.37
18	Dressing					1.33	1.33

E.13 Control and mean control value of different spaces in altered samples

Sl.		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 CV
1	Exterior	0.20	0.20	0.20	0.33	0.33	0.33	0.25	0.20	0.25	0.20	0.20	0.20	0.33	0.33	0.33	0.26
2	Foyer	4.00	4.00	4.00	2.20	2.20	2.20	2.25	3.83	2.75	3.75	3.75	3.75	2.20	2.20	2.20	3.02
3	Living-Bed	0.20	0.20	0.20	0.20	0.20	0.20	0.50	1.20	1.25	1.20			0.75		0.33	0.54
4	Living											1.20	1.20		1.20		1.20
5	Dining-Bed	1.20	1.20	1.20	3.83			0.75		0.50	3.20						1.70
6	Dining					3.83	3.83					3.20	3.20	3.08	3.08	3.08	3.33
7	Bed 1		0.20	0.20	1.20	1.20	1.20	1.00	0.20	0.25	0.25	0.25	0.25	0.33	0.33	0.70	0.54
8	Bed 2								0.50		0.25	0.25	0.25	1.20	0.75	1.25	0.64
9	Kitchen	0.20	1.20	1.20	0.33	0.33	0.33	0.25	0.33	0.25	0.25	0.25	0.25	0.20	0.20	0.20	0.38
10	Common Toilet	0.50	0.50	0.50	0.20	0.20	0.20	0.25	0.20	0.25	0.20	0.20	0.20	0.25	0.25	0.25	0.28
11	Common Bath				0.20	0.20	0.20	0.25	0.33	0.25	0.20	0.20	0.20	0.25	0.25	0.25	0.23
12	Attach toilet													0.50	0.50	0.50	0.50
13	Veranda (Living)												0.50				0.50
14	Veranda (C. space)	1.20												0.20	0.20	0.20	0.45
15	Veranda (Bed)		0.50		0.50	0.50	0.50									0.83	0.57
16	Veranda-Bed	0.50		0.50							0.50	0.50		0.50	0.50		0.50
17	Corridor							3.50	2.20	3.25				2.70	2.70	2.53	2.81
18	Dressing													1.50	1.50	1.33	1.44

E.14 Comparison of mean control on different spaces in original and altered samples

Sl.		Mean Control value	
		Original	Altered
1	Exterior	0.42	0.26
2	Foyer	2.34	3.02
3	Living-Bed	1.08	0.54
4	Living	-	1.20
5	Dining-Bed	0.70	1.70
6	Dining	2.91	3.33
7	Bed 1	0.76	0.54
8	Bed 2	1.25	0.64
9	Kitchen	0.26	0.38
10	Common Toilet	0.27	0.28
11	Common Bath	0.25	0.23
12	Attach toilet	0.50	0.50
13	Veranda (Living)	0.20	0.50
14	Veranda (C. space)	0.70	0.45
15	Veranda (Bed)	0.78	0.57
16	Veranda-Bed	-	0.50
17	Corridor	2.37	2.81
18	Dressing	1.33	1.44