République Algérienne Démocratique et Populaire
وزارة التعليم العالي و البحث العلمي
Ministère de l'enseignement supérieur et de la recherche scientifique

Université Mohamed Khider – Biskra
Faculté des Sciences et de la technologie
Département d'Architecture
Ref:………………

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كلية العلوم و التكنولوجيا
قسم الهندسة المعمارية
المرجع:................

Thèse présentée en vue de l'obtention

Du diplôme de

Doctorat LMD en : Architecture

Spécialité (Option) : Habitat et ville durables

Syntactic study of genotype and phenotype in houses layouts transformation:
Case studies from Biskra

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Dedication

I dedicate my dissertation work to my family, my friends, and my husband who encouraged me to pursue my dreams and finish my dissertation.

A special feeling of gratitude to my loving parents, whose words of encouragement and push for tenacity ring in my ears, who have always loved me unconditionally and whose good examples have taught me to work hard for the things that I aspire to achieve.

My sisters and brothers, have never left my side and are very special

I'm dedicating this work to my beloved daughter BAYANE...

BARKAT Rihane

Acknowledgements

First and foremost I amextremely grateful to my supervisors: ***Prof. BADA Yassine*** *for his invaluable advice, continuous support, and patience during my PhD study. His immense knowledge and plentiful experience have encouraged me in all the time of my academic research and daily life.*

I would also like to thank my co-supervisor ***Prof GUNEY Yassemin*** *for the guidance, and direction.*

My gratitude goes also to the member of the jury: ***Prof. BOUTABBA Hynda, Prof. BENABBAS Moussadek*** *and* ***DR. Khelil Sara*** *who accepted to examine and evaluate my work.*

Finally, I would like to express my gratitude to my parents, my husband, without their tremendous understanding and encouragement in the past few years, it would be impossible for me to complete my study. I also appreciate all the support I received from the rest of my family and my friends.

Thank you. My love for you all can never be quantified. God bless you.

BARKAT RIhane

Abstracts

Abstract

The organization of domestic space is primarily dictated by Functional needs, wellbeing (comfort) and sociocultural codes and rules that characterize a specific mode life ; a particular behavior.

This study will focus on the spatial organization of different typologies of houses in Biskra city, Algeria, from different periods of time. The spatial configuration of house layouts may be different in different periods, regions, cultures, and societies. The transformation and changeability of spatial configuration and organization of domestic space is subject to differing parameters and rules as: (lifestyle, technology, openness to other cultures…) and which evolving over time. The aim of the study is to look into the transformation of house layout in different urban fabrics of the city of Biskra, through the important period of the growth of the city (before, during and after the colonial period). Consequently, the purpose isto look for whether there is a genotype or not a for all the house typologies produced overtime.

Starting from the assumption that despite all the apparent differences spatial organizations and configurations of these typologies still follow the same rules (invariable principles) in organizing the spatial structure ; following the concept of Genotype and Phenotype.

Key words : Domestic architecture, genotype/ phenotype, space syntax, transformation, justified –graph, house layout.

Resumé

L'organisation de l’espace domestique est principalement stipulée par les besoins fonctionnels, le bien-être (le confort) et les codes et les règles socioculturels qui caractérise un mode de vie spécifique ; un comportement particulier.

La présente étude portera sur l'organisation spatiale de différentes typologies de maisons à la ville de Biskra, en Algérie, et à différentes ères. La configuration spatiale des dispositions des maisons peut être différente selon les périodes, les régions, les cultures et les sociétés. La transformation et l'évolutivité de la configuration spatiale et de l'organisation de l'espace domestique sont soumises à des paramètres et règles différents tels que : le mode de vie, la technologie, l’ouverture aux autres cultures…etc., qui évoluent dans le temps.

L'objectif de notre étude est d'examiner la transformation de l'agencement des maisons dans les différents tissus urbains de la ville de Biskra, à travers la période importante de l’élargissement de la ville (avant, pendant et après la période coloniale).

Par conséquent, il s'agit de rechercher s'il existe un génotype ou non pour toutes les typologies de maisons produites au fil du temps et ce, en partant de l'hypothèse qui dit que malgré toutes les différences apparentes, les organisations et configurations spatiales de ces typologies suivent toujours les mêmes règles (principes invariables) dans l'organisation de la structure spatiale; suivant le concept de génotype et phénotype.

Mots clés: Architecture domestique, génotype / phénotype, syntaxe de l’espace, transformation, graphe justifié, plan de maison.

ملخص

إن ما يحكم تنظيم الفضاء المنزلي هو بادئ الرأي احتياجات وظيفية ورفاهية (الراحة) وقوانين وأُسس اجتماعية وثقافية، يتسم بها نمط حياة معين، بل وسلوك معين؛

سننصب هذه الدراسة على التنظيم الفضائي لشتى أنماط السكنات على مر الأزمنة وتعددها بمدينة بسكرة – الجزائر ؛ إذ قد تتباين التشكيلة الفضائية لمخططات السكنات بتباين الأزمنة والمناطق والثقافات والمجتمعات.

يخضع كل من التحول وقابلية التوسع في التشكيلة الفضائية وتنظيم الفضاء المحلي، لمعايير وقواعد شتى نحو: أسلوب الحياة والتكنولوجيا والانفتاح على الثقافات الأخرى وهلم جرا؛ تلك القواعد التي يطالها التطور على مر الزمن؛

وتهدف الدراسة التي بين أيدينا إلى البحث في التحولات التي طرأت على مخطط السكنات من حيث الأنسجة العمرانية لمدينة بسكرة على تعددها، خلال أهم فترة نُمو شهدتها المدينة (قبل الحقبة الاستعمارية وإبانها وغداتها).

لذا، فإن الغاية المرجوة هي البحث عما إذا كان هناك نمط وراثي لكافة أنماط السكنات التي شيدت على مر الزمن أم لا؛ انطلاقا من الفرضية التي تذهب إلى أنه على الرغم من كافة الاختلافات الجلية، فإن تنظيمات هذه الأنماط وتشكيلاتها الفضائية تتبع دوما القواعد عينها (مبادئ ثابتة) في تنظيم الهيكل المكاني؛ متبعة مفهوم النمط الوراثي والنمط الظاهري.

الكلمات المفتاحية: الهندسة المعمارية المنزلية – النمط الوراثي / النمط الظاهري – التركيب المكاني – التحول – الرسم البياني المبرر – مخطط السكن.

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Introduction Chapter

1. General introduction

The term "domestic" originally meant "study of housing" or "accommodation of people" (Friedrich.R, 2003). The architecture reflects the way people behave (Kent, 1990). Domestic architecture is concerned with the creation of living spaces, and it's concerned with the connection between the use of space and the arrangement of domestic space, with "culture" being a key factor influencing this interaction. Domestic space is defined as a household's living space within an enclosed place known as a house (Iren. C, 2017), and it's utilized to decipher the symbolic meaning of the spatial configuration for the physical construction.

Houses are complex patterns of organized space, governed by rules and conventions about room size and configuration, which domestic activities go together, how the interior should be decorated and furnished, and what kinds of house hold objects are appropriate in each setting, how family members interact in different spaces, and how and where guests should be welcomed and entertained in the home (Walker. L, 2002). Although all houses fulfill the same basic needs of living, cooking and eating, entertaining, bathing, sleeping, and storing, a look at the architectural record reveals an incredible variety in how these activities are accommodated in buildings from various historical times and cultures. Every house creates a 'lifestyle' by constructing social interfaces among family members and between the inhabitants and visitors to the house, which often extends to the way rooms are decorated and house hold objects are placed within the domestic interior, and while the genotype, if it exists, will stabilize these generic cultural relations, everything else can be left to vary as circumstances dictate, which is why houses may bear little resemblance to one another (George.A , Said.Z, 2016). Instead of referring to the public space of the street or the urban space of the city as a whole, "domestic space" now refers to the private space of the house, the household, or the home (Iren. C, 2017).

Under this context, much researches has been conducted into concepts that related on domestic space as the concept of privacy and its influence on the spatial configurations of the different houses. The spatial configuration is the most important process among the influencing aspects in building design, especially in terms of function. Configuration is described as at least the relationship between two spaces in a house layout that takes into consideration a third, and at most, the relationship among spaces in a complex that takes into account all other spaces in the complex (Hanson, 1998). Additionally, the configuration of space also has a cultural significance that ties to daily living habits (Smyth, 2021). The relationships between distinct household spaces strongly influence the character of the spatial structure of the house layout in general (Hanson, 1998).

According to Rapoport (1980), The culture has two fundamental traits : one is that it is an abstract theory, and the other is that it is a collection of universal ideational notions. A method for comprehending the concept of culture is to focus on a specific aspect of it, such as worldviews, values, lifestyles, and activity systems (Thungsakul, 2001). Kent concurs that culture is complex and has numerous facets. Architecture and use of space are influenced by elements of cultures (Kent, 1990). However, human relations and social factors determine culture (Low, 1988). While there are many techniques to study culture, it makes more sense when the study focuses on how built form and human relations are interpreted. According to several studies on space and its social context, pattern in built environment may represent the social and cultural order of a particular society. The study of spatial configuration and space use is an approach that specifically examines the effects of social processes in built form (Thungsakul, 2001). Spatial configuration is a continuous process that links the built-environment with people's spatial perception and behavior (Hasgul, 2015).

The initial studies of domestic space predated our forays into configurational analysis, and at almost every point, advances in theory and research methods have been filed by pilot studies on samples of houses (Hanson, 1998). To compare spatial patterns, we must first understand what constitutes a pattern and how to distinguish one configuration from another. In this case, the term "configuration" refers to something very specific. Any form of link between two spaces constitutes a spatial relation. When the relationships between two spaces are altered as a result of how we link each to a third, or indeed to any number of spaces, configuration occurs. Configurational descriptions, rather of the more localized qualities of any individual space, deal with how a system of spaces is coupled together to generate a pattern (Hillier, 2005).

This two-way dependency between spatial and social structures is summarized by John Peponis and Jean Wineman, who state that "it is possible to identify certain underlying structures of space that are linked to observable patterns of behavior, and that these patterns, in turn, create social function, whether generative or reproductive" (Wineman & Peponis, 2010). According to Sonit Bafna, the social organization is inherently spatial and inversely, the configuration of inhabited space has a fundamentally social logic (Bafna, 2003). As a result, space syntax provides a method for investigating the relationship between built-environmental configurational patterns and their generative or reproductive social structures, as well as psychological aspects related with spatial experience.

While this background offers a theoretical framework for space syntax, its analytical approaches are divided into three steps, which have been labeled as abstraction, analysis, and interpretation, or representation, configuration, and interpretation, respectively (Hillier and Tzortzi, 2006). The first step abstracts or lowers an environment, usually an architectural plan, into a sequence of distinct components (spaces, pathways, points, or views) and their relationships. The resulting collection of interconnected components is commonly referred to as a map, but it is also referred to as a graph in mathematical terms. The map's topological qualities are visually and quantitatively analyzed in the second stage, which employs graph theory (Ostwald, 2011). As a result, graph-theoretic measurements are used to determine the majority of the relationships between spatial and social systems. The final stage involves interpreting various social or perceptual features of the original architectural plan using mathematical metrics generated from the map.

The foundation of space syntax analysis can be found in graph theory, a branch of mathematics concerned with topological interactions (Ding et al., 2022). A variety of mapping or abstraction approaches are needed to turn complex spatial situations into a set of topological relationships in order to use graph theory to design. Convex spaces, axial lines, and visibility graphs are the three most prevalent types of abstraction that occur before analysis utilizing space syntactic mathematics (Ostwald, 2011). Convex space analysis, the first of these three, works by breaking down an environment into a series of visually coherent spaces in which a straight line drawn between any two places on a room's perimeter would never overlap the perimeter in another location. The configurational relationship between rooms as described by the capacity to pass between them is graphed and investigated through convex space analysis (Hillier & Hanson, 1984).

While there have been several analytical techniques and ideas created by Space Syntax reserchers, the "justified plan graph" (JPG) is the main method of this study. Hillier and Hanson separate the analysis of the interior, which they refer to as "gamma-analysis" [1984: 147], from the syntactic analysis of urban settlements, which they refer to as "alpha-analysis" [1984: 90] (Ostwald, 2011). The descriptive methods of justified graphs, initially given by Hillier & Hanson (1984), can be used to illustrate spatial connections between neighboring areas in a layout. A justified graph traverses a convex space network from one space (root) to all others, with each convex space represented by a circle and each permeable link between two spaces represented by a line (Hanson, 1998). This method is used to test some assumptions concerning the relationship between important syntactic features of spatial configuration and social variables. Access graphs and numerical findings by using the morphological measure derived from these analyses. This study could help to develop a method for dealing with the distribution of interior areas in a home based on their amount of privacy and permeability, as well as their relationship in the house layout design process (Ding et al., 2022).

Space syntax produced techniques for identifying and describing aspects of spaces that occur in relevant repetitions throughout the many systems of a society, and drawing a linkage to social elements from them. These patterns that organize spatial configurations are classed as 'genotypes' by Space Syntax when they are observed in a consistent way in a sample of architectural situations, whilst the occurrence of these abstract patterns in distinct geometric shapes is referred to as 'phenotypes' (Hanson, 1998). While phenotype manifestations are intended to be infinitely diverse, genotype patterns are supposed to remain consistent in order to define society's abstract expression in space. Hillier and Hanson (1984) argued that "Different types of social formation need a distinctive spatial order, just as different types of spatial order require a distinct social formation to support them," (p.27) .

Genetics predicts the inheritance of gene identity through the terms genotypes and phenotypes (Flint & Mackay, 2009). Hillier and Leaman introduced the concepts of genotype and phenotype into architecture at the start of the 20th century (Sari et al., 2020). Genotypes are abstract relational models that control spatial organization and the underlying phenotypic organizing principles. The physical manifestation of genotype in the form of architectural artifacts is known as phenotype (Adam, 2013). Our research implies that some genotype characteristics can change over time and that the societal norms they reflect may have evolved through time, despite the stability of genetic traits. In this study, samples of 60 house plans that are from four periods of time are examined to uncover the Biskra house genotypes and their transformation through time. The spatial configuration of the houses is represented by the J-graphs.

2. Research question

Since domestic space is subject to various needs required due to the evolution of all the parameters related to the development of human life such as technology, lifestyle, and openness to other culture, is always in continuous changing and mutation. All these changes are projected on the architecture of the space; spatial organization and configuration.

Urban complexity of the Algerian town, in this case the city of Biskra, consisting of a compilation of different fabrics through history (old city, the colonial fabric, and the post-independence fabric), has produced several habitat types. Therefore, a variety of domestic architecture has emerged; vernacular, self-built, individual, collective, promotional houses. Houses architecture is apparently different from one type to other in organization and morphological aspect.

These typologies undergone overtime multiple transformations to meet new needs, have generated new spatial organizations and morphology; new typologies. Space syntax defines this transformation in terms of concepts genotype / phenotype architectural. Genotype is defined in terms of a set of relational and configurational stances that appear in different phenotypic arrangements (Hanson, 1998); changeable genotypic expression under the influence of other contextual factors. Some characteristics related to the socio-cultural aspect, such that the ratio between privacy (residents) and public life (visitors) or inside / inside or inside / outside, are projected on the space arrangement and spatial configuration. This is well implemented in the spatial hierarchy in traditional houses, by controlling the degree of opening and closing spaces. Therefore, integration and accessibility are the two essential parameters in the spatial configuration of the house. Nevertheless, the transformations undertaken in new houses were materialized by a new morphology and spatial configuration meeting the new requirements.

An analysis of the physical attributes of house design, which is a component of place experience, is framed by the concept of ‘genotype’ and ‘phenotype,’ which is a set of analogies that Hillier and Hanson (1984) draw from the field of Biology to describe the transformational characteristics of the spatial organization and the physical form of the dwellings.’ The patterns that structure spatial configuration, when found in a consistent way in a sample of architectural cases, are classified by space syntax as « genotype ». The occurrence of these abstract patterns in different geometric forms is referred to as « phenotype».

- The question is to know whether these transformations operated on the organization and configuration of house architecture are emerging from the same genotype. And, are there any key aspects or principles that remain unchanged and constant since the traditional house layout?

- Does the syntactic analysis reveal quantitatively the underlying spatial structure of Biskra houses? Is there any evidence that a diachronic analysis of a sequence of house plans may reveal any changes in this spatial structure that correspond to social change?

3. Hypotheses

To answer these research questions of the problematic, and according to the theoretical studies, this study is based on the following assumptions:

- All house typologies (in Biskra), despite all the apparent differences in spatial organizations and configurations, ought to follow the same rules (invariable principles) organizing the space system; according to the concept of Genotype and Phenotype.

- The examination of the sample of houses seems to be indicating that Biskra' houses have an underlying spatial structure represented in: transition space centered organization.

- The analysis of all the specimens is suggested that Biskra' houses reflects the social and cultural values that are embedded in the spatial configuration, and the significance of the exterior to the overall configuration of the houses.

Research Goals

- Looking for the existence or the inexistence of a genotype for domestic architecture in Biskra.
- Studying the changeability of genotype patterns over time by investigating on houses plans in Biskra city.
- Analyzing the socio-spatial organization of different housing types.
- Study of morphological of spatial configurations characteristics of house layouts that have a role in the distribution of interior spaces. And to examine the parameters that have a role in spatial transformation in domestic space and to what extent they influence the distribution of spaces.
- Studying the social-relations that effect on the overall spatial configuration.

4. The case studies

The selected case studies are located in the Biskra city. It's characterized by the compilation of different urban fabrics: the old city (vernacular fabric), the colonial fabric, the independent fabric, and the contemporary fabric. The selection of houses was based on a survey of eighty houses and re-drawn by the author. Each house was given a code to facilitate the analysis: "HV" refers to a vernacular house, "HC" refers to the colonial house, "HI" refers to the independent house, and "HP" refers to contemporary house. The selection criteria of these houses are based on their historical, temporal (date of construction), and architectural (structure, building materials, and architectural appearance) value where the residential fabric has adapted to its context.

5. Research methodology

This study aims to identify the underlying genotype and to highlight the similarities and differences of a sample of houses in the city of Biskra. The justified graph analysis was used to specify the structural models based on the syntactic data (Guney & Wineman, 2008). The justified graphs of these houses were embedded and analyzed both by considering the exterior as a root and by excluding it. This methodology was adopted to examine different syntactic properties such as integration values (RA and RRA), depth and BDF. This syntactic data of the spatial pattern was analysed quantitatively using the A-graph program as a tool (McLane, 2013). The program focuses on the conversion of house plans into graphs, in which the nodes represent the functional spaces and the lines represent the connection between the spaces.

These graphs were drawn according to the architectural plans of the houses, starting from the exterior (the root), and aligning the graph of all functional spaces according to their depth and distance from each other. Thus, although each node represents a functional space, several authors (Markus 1993; Hanson 1998; Dovey 1999) have chosen to consider the 'L-shaped' space as a single node (Ostwald, 2011). Whether the nature of the connection between spaces is a door or an opening, it is represented by a line. It only means that the connection exists. To discover the underlying characteristics (the genotype) a syntactic analysis was performed. The following steps were followed in this study :

a) First, the J-graphs were drawn for each of the sixty houses using the exterior as a root to indicate the permeability sequence of the constituent spaces from the entrance to the interior of the house. The analysis of the spatial configuration focuses on the functional spaces with and without their exteriors.

b) Secondly, the graph measurement includes the mathematical calculations of the spatial configurations by analyzing the different syntactic properties such as MD, by obtaining RA and BDF using the A-graph software, and by calculating RRA manually. The objective of this phase is to identify possible recurrences in the sample.

c) Thirdly, the integration values were calculated, using the A-graph program for each space of each house in the sample and comparing the integration value of each space with the other spaces of the same house. This allows the structuring mode of the domestic interior of the houses studied to be determined, while the classification of these integration values leads to a better understanding of the morphology of the spatial configuration for exploring the genotype in the sample.

d) Finally, the genotype groups were highlighted by using the space link ratio (SPL) indicator and the degree of spaceness.

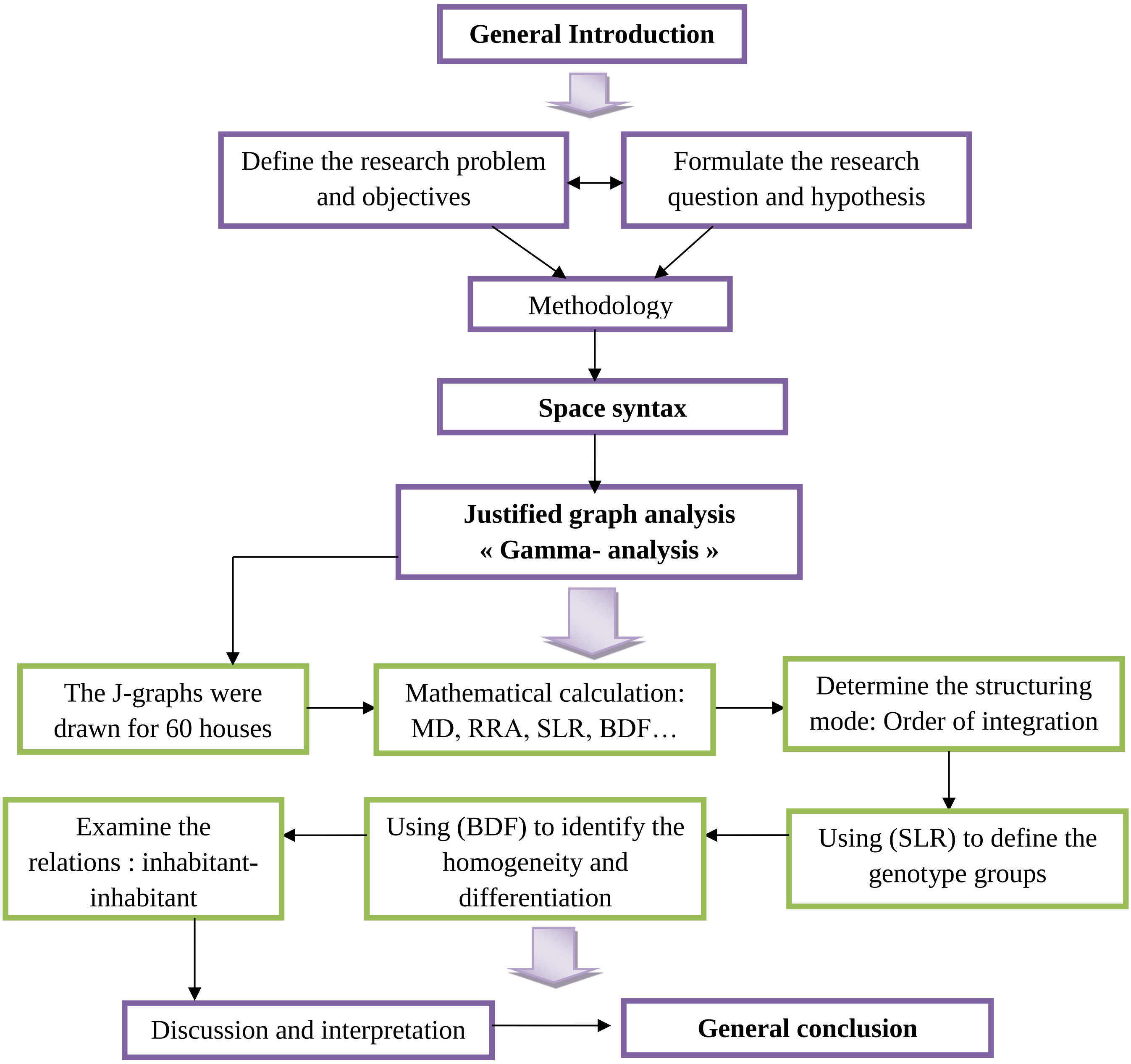


Figure 01: Flow- chart of research process

6. Thesis structure

The research work reported in this thesis is composed of two parts, a general introduction and a general conclusion. The first part, composed of three (03) chapters, entails the literature review, going through the main concepts that related to domestic space, and spatial configuration. The second part, composed from three (03) chapters, in which outlined the main steps of the analysis and chapter of the "case study presentation".

This document is organized as follow:

Part one: literature review

Chapter 01: Domestic space and transformation, theories and concepts

Explores the different definitions of the main different concepts, and that concerned the domestic architecture and the use of space, such as the house, housing, domestic space and the term of space; and the different concepts related to space such as the social space, personal space, spatial configuration. This chapter is structured to investigate the relationship between architecture and the use of space through time. And it provides an explanation to explain the transformation of the domestic space through the different period of time, by analyzing the cultural, socio-cultural, economic, and technological factors that caused physical and morphological changes and affecting on the spatial organization.

Chapter 02: The genotype and phenotype

Based on the concept of genotype and phenotype, at first, this chapter goes through the history and definition of genetic architecture. It focuses on the evolutionary theory and the underlying genetic terms, principles and concepts.

Chapter 03: Methods and analysis tools applied to domestic architecture: analysis procedure

This chapter interested about the theory and the methods that applied on domestic architecture. It's based on space syntax theory; its methods and tools: Axial line analysis, visibility graph analysis (VGA), Isovist, Convex space, and justified graph analysis. These methods presented in different measures including: the Integration, Control, Connectivity, Choice, the Depth... And the observation is considered as a tool for collecting data about people, processes, and cultures in qualitative research. And it's providing the methodoly and the procedure of the study.

Part two: Investigation

Chapter 04: case study presentation

This chapter, represent the sample of houses in the four periods (pre-colonial, colonial, independent, and contemporary), and define the urban and architectural framework to contextualize the study, and the constructive system.

Chapter 05: Abstraction of spatial configuration of the houses to justified graphs

Will provide an analysis of the j-graph of each house plan of each period, and discuss the results of the main mathematical data (RA, MD, CV) obtained from the A-graph software.

Chapter 06: The configurational analysis: application of justified graph analysis

Analyse the main syntactic parameters: RRA, SLR, BDF, …and determine the groups of genotypes, and finally identify the characteristics of the groups of genotypes.

Finally, the general conclusion will restate the main research questions and results before providing an evaluation of the limitations encountered during research and the significance of the results.

Part one:

Literature Review

Chapter I

Domestic Space and Transformation, Theories and Concepts

- Introduction

Space is an important factor when people are choosing a home, but many feel that newly built homes aren’t big enough. Architectural space can be examined in a variety of ways. The study of space's meaning and usage as a socio-cultural process is one novel approach (Lawrence, 1987). Private life's logic is incompatible with the logic of domestic space. Domestic space that support heteronormative family structures and relationships are rife with injustices and paradoxes (Galindo et al, 2022). House architecture, design, and management are a group of activities that are spatially manifested (Zolfagharzadeh et al., 2017). Religion is one of the numerous sociocultural variables that influence how the house is designed and is thought to both influence and structure interpersonal relationships (Erdoğan, 2017b). A house's fundamental components can be combined to create spaces, patterns, and outside domains in addition to other basic components (Kim, 1999).

Spaces and spatial relations are mathematically depicted in an abstract way in architecture designs where relationships are arranged and behavioral regions are established (Erman, 2017). When considering the space and its relationships to other topics, is the space's configuration—how it is made up and how it interacts with people. The definition of spatial configuration is a progressive process that links the built environment with people's spatial experiences and behaviors (Hasgul, 2015). According to Hillier & Hanson (1984), buildings are social objects by virtue of their very shape, and the arrangement of a space within one is essentially about the arrangement of relationships between people.

1- Domestic space: meaning and use

1.1. Definition of house

Our house is in our little corner of the world. The shelter gives us access to our fundamental worth as beings (Bachelard, 1994). The house Offers a living place for one or a few families, and provides the primary functions necessary for the individual, and ensures the protection of the individuals against the disorder of the outside world.

The terminology “a house” is utilized to define the physical structure that delimits and determine the space for the inhabitants. The houses are built with a range of construction material, the fact that they have different shapes and sizes, suggests that the built form of the houses are determined from various factors (Lawrence, 1987).

The house is an assemblage of organized spaces governed by rules and intricate conventions of configuration of rooms and how they connected with each other (Hanson, 1998). It defines the household who live in the house. Today, the houses are not considered only as a shelter for human beings (Esentepe, n.d, 2013), but represent a complex structure that defined by socio-cultural, cultural, economic, and demographic dimensions (Lawrence, 1987).

1.2. Definition of household

A household is a collection of people, whether related or not, who live under the same roof and are supervised by a head whose authority is respected by all members. A typical home consists of a head of household, his spouse(s), unmarried children, and possibly relatives or other unrelated individuals. A single person or a person with his children can live in the same house (Bongaarts, 1983).

Household and family notions differ by country and change throughout time. A group of individuals must meet certain standards in order to be registered as a household, including sharing (part of) a housing unit and at least some resources (such as food). In some countries, the co-residence requirement is used to define a household, whereas in others, resource sharing isused to define a household as an economic and social unit. Purchasing and preparing food together, as well as eating meals together, are common examples of resource sharing. It's not just about sharing a kitchen. The parameters used to define a household may differ depending on the data source. In housing surveys, the idea of dwelling household is commonly employed, whereas in household surveys, the concepts of food household, housekeeping unit, or consuming unit are commonly utilized (Willekens, 2016).

1.3. Defining housing

Housing is a complex concept that is difficult to describe (Ruonavaara, 2018), according to researchers and social theorists in the field of housing studies and allied fields. Because it denotes both a noun and a verb, the term "housing" is linguistically ambiguous. As a result, any definition of housing can be a noun or a verb, however it appears that housing is most commonly employed as a noun in the literature. In the literature, there does not appear to be a unified definition of housing. Various schools of thought have diverged in their definitions of housing, according to Sheibani & Havard, and they defined housing based on theoretical understandings other than political ideologies. As a result, Sheibani and Havard argue that political ideologies can influence housing definitions. They think that housing arises from man's basic material necessities, and that political ideologies influence how political systems respond to these demands. However, other studies have been conducted, particularly in developing nations, to define housing as it takes on diverse roles as a result of global events.

Housing appears to mean different things to different individuals, and its meaning is influenced by the geographical region, the dominant political ideology, and the context and purpose of use. As a result, the United Nations' Human Settlements Program has a comprehensive definition of housing: "Housing is a multi-dimensional idea that refers to the activity, process, and objects of dwellings, as well as their environment" (Allen, 2005). This definition includes dwelling as both an activity and a commodity or material object, meaning that housing has a health component. It examines not just the physical construction of the housing but also its immediate environment.

1.4. The domestic architecture

The term domestic signified commonly the study of housing ; accommodaion of people (Ragette, 2003). The architecture is a reflection of behavior (Kent, 1990). The domestic architecture concerns the creation of places for living. The house is the structure that shapes the human activities, is perceived to be a physical built dwelling for people in fixed location (Verschaffel, 2012). If the house is a reflection of how all household activities are organized and divided, then the shape of the house will change as the activities are modified or recombined (Ragette, 2003). The domestic architecture is concerned by the interaction between the uses of space and the organization of domestic space, which the "culture" is considered as an important variable that influence this interaction.

1.5. Domestic space

This term was defined as a household's living space within an enclosed place called a house (Iren.C, 2017), it's used to understand the symbolic meaning of the spatial configuration for the physical structure. The space is considered as the container of the household and actions. In anthropology, space is considered an empirical dimension and a problem or representation of culture. In architecture, the space is a theoretical and a design problem (Noel, 2011).

The domestic spatial arrangement has given importance to the gender problem and women's intimacy on the domestic interior space. In which women took care of household activities and children. The position of women inside the house and their privacy are considered as the main factors of the house form (Rappoport, 1969). The privacy of the inhabitant has been discussed as an essential component of the domestic space. And the privacy confirms the regulating of the domestic spatial configuration. Privacy as the main cultural factor is discussed in relation to a different aspects of domestic forms. The main idea of the study of domestic space is to identify the typical generative parts of domestic space configuration. In certain spatial systems, the elementary structures are related to each other. The spatial organization of the houses is based on the private and public spaces. Which the households knowledge and understanding are influenced mainly by culture and technological change (Noel, 2011).

The territoriality and concept of ambiguity are considered in constructing the meaning of domestic space which draws its meaning from beliefs that indicate its use, organization, and accessibility. Therefore, Hillier, B and Hanson, J (1984), developed a technique for analyzing domestic space which integrated the social meaning in its mode of interpretation and human relationship incorporated into the spatial organization of the built environment.

1.6. Term of space

There are many definitions on the concept of space. Hillier is opposed Le Corbusier's machine definition which is « House is a machine for live in ». Hillier asserts that the term 'space' works as a machine thus, he is related the word « machine » to « space ». Julienne Hanson set out a theory of space as an aspect of social life. The space considered as a gap which involve human relations, and it is a place where a group of persons live in.

Space is a compressive concept in general. In reality, space is an infinite chasm. It is essentially a layout that surrounds the surroundings (Tuan, 2001). On the other hand, space is more than a basic volume that surrounds architecture. It has a physical shape that can be easily decoded and defined by concrete properties like length, width, scale, geometry, as well as texture, color, and light (Figure 02). Second, it has other abstract and complicated properties, such as cave, which is termed nature (Esentepe, 2013). Humans and the built environment, according to Rapoport (1969), are in a connection. Humans differ from other living creatures in that they have the ability to think.

Architecture's shape and expression have changed throughout history. As a result, architectural spaces are similarly transformed. Technical innovations, socio-political changes, and philosophical shifts all influence architectural form and expression. However, throughout history, architectural space has changed. In fact, space is an important component of architecture that connects the past and future of building from all cultures and periods (John, 2004).

	
Shadow of Umburella defined space	Family created space by using and limiting matling
(Şensoy,1977)	

Figure 02: Creating space

Space is what makes up architecture. It's the outcome of human desires. Caves arose in response to a variety of human demands in the beginning. Caves were the first human-made shelters, as previously stated. Enclosing space causes it to occur. Shelters built of semi-open spaces, on the other hand, can be found in early civilizations such as Stone henge (figure 03). Stones were utilized to provide shelter in both vertical and horizontal directions (Esentepe, 2013).

Space is defined by architectural components, as it has been understood or analyzed since the beginning of civilization. In the built world, space is made up of four basic elements: point, line, plane, and volume. It all starts with a single point. The point is expanded into a line, which is then translated into two-dimensional pieces known as planes. Planes are extended and transformed into a volume with length and depth attributes.

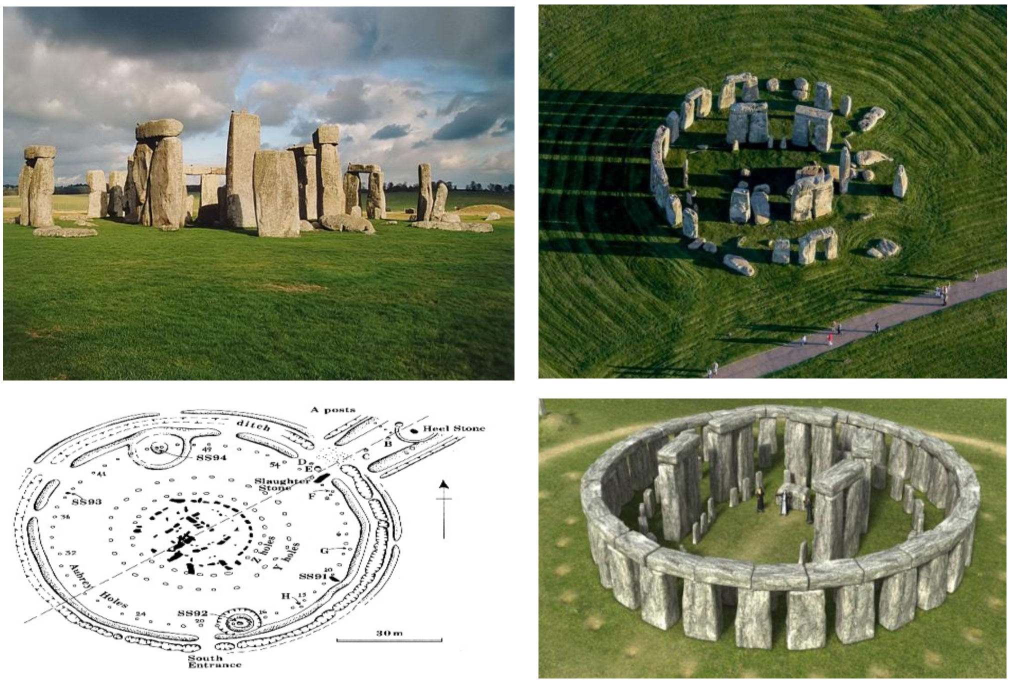


Figure 03: Vertical and horizontal natural elements are used to form space (stonehenge)

Space develops from a point, as seen in (figure 04), and evolves over time to become a three-dimensional architectural feature known as space.

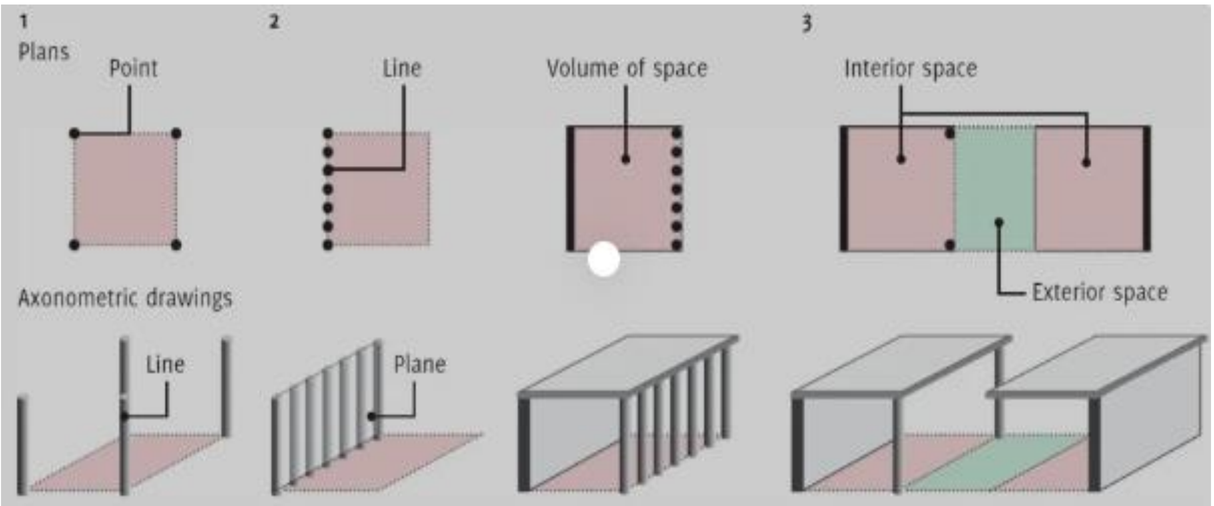


Figure 04: The Evolution of Space Process

There is no dimension to a point. As a result, it can be seen on the plan drawings. Two points are joined by a line that is described. It must be projected vertically in a linear form, such as a column or a tower, to be seen in space. The use of linear pieces gives the space more meaning. It generates a translucent space volume, defined space borders, and supports an above plane as a space structure element.

Space is only active because it is made up of areas where objects are at any given time located within a force field (Feingold 2004). Space appears “active” in a Leibnizian view because of the capabilities of events and objects occurring. Space, on the other hand, is completely dependent on the relationships that exist between the things and actions that take place in it. As a result of the relationships between the sites where events and objects occur, space exists (Antognazza, 2008).

1.7. The elements of defining space

Physical and Socio-cultural Factors are two types of spaces that are defined. These elements are also significant in the alteration of space. Factors can be rigid or movable. Fixed elements are physical elements that cannot be modified, such as vertical and horizontal elements (wall, slap, etc.). Socio-cultural factors such as family size, family economic position, and family lifestyle are examples of flexible factors.

1.7.1. Physical Factors Defined Space

As previously stated, housing is made up of physical elements such as natural elements (stones, ground) or walls, floors, slabs, windows, and so on. It is possible to state that horizontal and vertical physical elements have formed and defined space throughout history, as evidenced by the hedge stone, which is a first-age settlement (Esentepe, 2013).

Physical elements are one of the space-defining factors in architecture, and they help to shape space. Vertical and horizontal architectural features were divided into two categories by Ching (1996). Vertical linear elements (figure 05), single vertical plane, L-shape planes, parallel planes, U-shape planes, and four planes are vertical elements that defined space, whereas base plane, elevated base plane, depressed base plane, and overhead base plane are horizontal elements. While determining the character of space, each element had a crucial part.

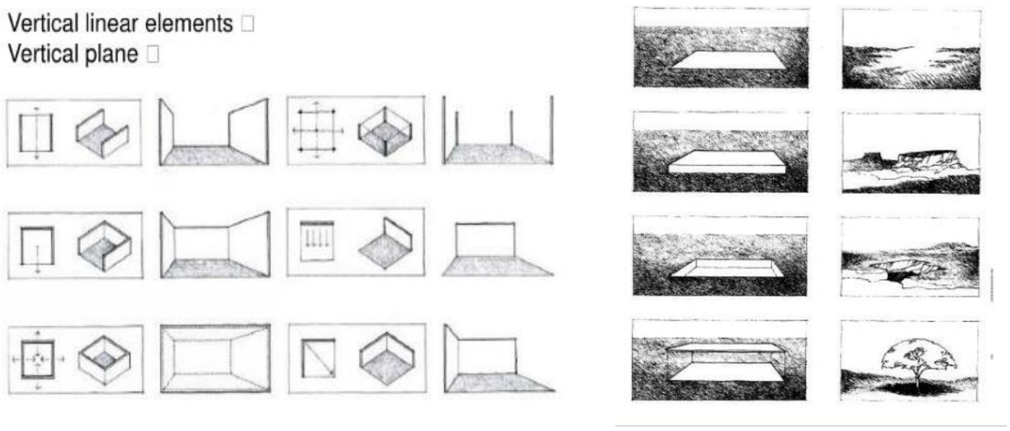


Figure 05: Horizontal and Vertical defining elements space

1.7.2. Socio-Cultural Factors Defined Space

Physical aspects aren't the only ones that give space its significance. Space is made sense of by cultural influences. According to Rapoport (1977), intangible data about space is obtained by combining shifting socio-cultural components. Civilizations can be reflected in social characteristics. As a result, it is the most crucial component in determining the impact of user profile on spaces. Due to the diverse identities of family structures, all components showed modifications. It not only influenced the architecture of the room, but it also revealed the shape of the building. As a result, there is a connection between the social factors that influence building form and the socio-cultural factors that define space.

The term "family" has a lot of different connotations. It could be a social community, a unity, or a social organization made up of systematic norms for meeting human needs (Nirun, 1994). In other words, a family is a group of people who live together and interact with one another (Sahinkaya, 1990). Although family is a global corporation, there are distinctions in terms of statuary and user responsibilities from culture to culture. Family size, family economic status, and family lifestyle all have a part in determining how much room is allocated in housing (Esentepe, 2013).

1.7.3. Family size

The size of a family is determined by the structure of the family and the size of the home. As the number of family members grows, so does the need for additional room. As a result, the shape of a building symbolizes the diversity of one family to another. According to Canan (1995), the society's world view is an important influence in determining the building's size. In Islamism, a housing scheme began with the size of the family. This demonstrates that the size of a family has an impact on housing. As seen in these instances, different civilizations develop with varying family sizes, resulting in a range of building forms (Gür, 2000). Family structure should be explored at this time. Two types of family structures exist. It's possible that it's a nucleus or a multi-nucleus family structure. Users with diverse family structures, such as nucleus or multi-nucleus, play a crucial part in determining the building design. While family structure changed, solid space and building shape (Bilen, 2004).

In addition, numerous studies on family structure have been conducted. For example, in a multi-nucleated family structure, the concept of living together is based on protection, safety, social, economic, and religious considerations (Engel, 1986). Grandparents, mother, father, uncles, aunts, cousins, and their parents and children make up the multi-nucleated family structure, which is one of the larger family structures. They shared an apartment.

As industrialisation proceeded, significant migration from rural to urban areas affected family arrangements due to job opportunities. Family structure has been impacted by rapid changes in living conditions. People who moved to industrialized areas started working and starting their own families apart from their extended relatives. As a result of these social and economic circumstances, the size of multi nucleated families shrank, and nucleus family structures emerged. As users' living situations changed, their income levels increased, and nucleus family structures surpassed multi-nucleated family structures (Aki, 2016).

1.7.4. Life Style of Family

Family life style is influenced by socio-cultural factors. It is the most comprehensive component that influences the shape of a building. Each aspect is inextricably linked to the overall way of life. The term "life style" refers to a combination of activities, interests, and opinions, or the users' way of life, as defined by their culture. It has a significant impact on our knowledge of human behavior (Wedel and Kamakura, 1998). The concept of style is a vast topic that has a considerable impact on architecture. It's also looked at from the inside. It is one of the most distinguishing features of cultural variations. In addition, social habits and customs influence one's way of life. Family life and home design are the two most essential areas for community improvement. Housing shapes are representations of a family's identity as well as its social standing. The influences of lifestyle on interior space are reflected in space organization. Different users with varied ethnic backgrounds have different housing space organization.

As previously said, human conduct is influenced by a wide range of human needs that are influenced by their society. Cultural variety is the primary reason for the observed differences in life styles traits. As a result, human requirements or needs changed. Physiological needs, safety needs, needs of love, affection, and belongingness, needs for esteem, and needs for self-actualization are all described as five groups by Maslow (1987). Housing requirements are thought to have originated from a need for protection, according to Maslow's hierarchy of needs. As a result, once a human being has fulfilled these basic wants, they begin to construct or require gaps in terms of their lifestyle.

Along with changes to the building's outward facade, people's lifestyles are taken into account in the internal areas. According to Zay (1998), socio-cultural variables have grown effective on interior spaces throughout history and at different times. As a result, numerous interpretations are made on space structure. When the Japanese hold a tea ceremony, they sit on the floor; nevertheless, when the British meet at home, they sit in chairs. Although daily tasks may be identical, people's usage of space varies depending on their cultural background.

1.8. Domestic space use

Optional activities may be conducted in the neighborhood. Within the house, we divided the activities into two groups. The activities associated to the person as an organism - actions conducted to meet fundamental, functional needs - are represented by one group, while activities relating to the person as an individual and as a social entity are represented by the other (Shahlaei & Mohajeri, 2015).

The functionalist residential unit is primarily designed for activities of the first category; there are spaces designated for sleeping, eating, washing, cooking, laundry, and storage, among other things (Waltraud, 2006). As a result, the majority of these activities were discovered to be physically tied to the dwelling's plan, and people had few options as to where they should be located. However, we believe that the desire for each family to have their own home cannot be explained solely on the basis of practical considerations.

1.8.1. Eating and cooking space

The cooking and eating spaces are considered as the most significant parts in the house design since the traditional house, its segregated, deep, and controlled spaces in the traditional courtyard houses. The kitchen now is a very important space and the main part in the building is giving new meaning, is considered as a room, part, or space of the house that uses to prepare food and also it's used as a dining area. The spatial meaning is similar to the traditional and modern houses but with newly added spaces. The eating and cooking spaces still retain the same segregation and depth value in modern houses but with additional spaces (Noel, 2011). In which the eating activity is flexible, lunch, dinner, breakfast they could take place in any place at the house such as verandah, rooms, hall, and open terrace. In new houses, the eating space is designed near the kitchen or the living room (Thungsakul, 2001). In the traditional house the eating and cooking spaces are located outside the house, contrary to the modern house the kitchen is located inside the house.

Modern architecture has developed the housing in which the kitchen became a new significant and architectural topic. The kitchen was constructed on the basis of storage need, workflow, and time-saving (Bech-Danielsen, 2012). Thus, the kitchen space has evolved over years depending on households and users' needs. Before the functions were used separately but continued their role for preparing food in a small space. In Ward War I the modern design are appeared characterized by geometric forms, absence of ornamentation and decoration, and flat surfaces, in which it's designed under cultural norms and the users' needs (Tarboush & Erçin, 2021). The kitchen is an essential space in the house design whereas, the designers provide the main functional and aesthetic characteristics by understanding the users' needs and the evolution of the users thinking (Tarboush & Erçin, 2021).

1.8.2. Sleeping space

The sleep is a primary biological necessity for humans, and satisfying this biological need is an essential element in human's daily life (Leive & Morrison, 2020). The sleeping space is a closed space located in the upper floor and the most segregated and deepest space in the house and it's not accessible for stranger or visitors. However, sleeping is importance for well-being and a way for our brain and body to recover and get rest. The sleeping space has become the comfortable part in the entire house. Sleeping spaces remain the deepest, segregated and most controlled space in the house in both type traditional and modern houses (Noel, 2011). The recent studies considered the sleeping an important social matter not only a physiological phenomenon (Leive & Morrison, 2020). The bedrooms are one of the spaces that the inhabitants spend most of their time and the bed is most furniture that used every day (Spörrle & Stich, 2010). There is several recommendation concerning the size, lighting, color, airing, and furnishing.

1.8.3. receiving space

The receiving space in the traditional houses is shallow and most integrated space, it's organized to receiving visitors and strangers (Noel, 2011). The receiving room is an important part of the interior layout and is one major area of focus for interior design. The guest room is separated from the private sector (such as bedrooms, kitchen…) is located near from the entrance. In traditional houses the guest room is multifunctional space, is used for resting, sitting, hosting guests, and sleeping. This main room should be larger and better-furnished than the other rooms. The decoration and the size of the guest room are main indicators of the statut of the family and their position in society (Erdoğan, 2017a).

1.8.4. Toilet and bathing space

In recent decades, the bathroom plays a role in the changing process of house environment, in term of aesthetic and function. It's considered as social space and become new product of global modernity (Simona Canepa, 2019). In traditional houses bathing space and toilet are located outside the house or near of the entrance. The bathroom is a place for self-care, relaxation, and well-being. The bathroom needs not to be large but must carefully designed. And the type of the fixture bathing should is preferred by the users. The bathroom is the most and least important space in the house and it used by all the inhabitants also the visitors. It is a private room; therefore culturally durty and physically clean (Lupton & Miller, 1992).

1.8.5. Verandah space

Verandah is traditional element, is located at the ground floor and acts as a transitional space between the exterior and inner space. Many activities are performed as resting, eating, and napping. Is considered as informal space for the occupants, and sometimes is used for receiving guests. The verandah provides an element of continuity along the street; it's can be shown as constant element in the historical development of traditional houses. Also it's provides therm a comfort in hot or humid climates. And it's used for differents domestic activities.

1.8.6. Courtyard

The cellular courtyard houses are one of the main characteristic of Islamic housing. In Islamic architecture the main feature is the focus on interior space, in which the spaces inside the house are arranged around the courtyard. The main role of this courtyard is social and religious therefore it used to achieve privacy. It's a place to plant trees and flowers, also a place where fountains are located. The courtyard exclude the outside for the purpose to protect the family living inside the house (Noori & Hwaish, 2015).

2. Concepts related to the space: the social dimension of space

2.1. Space and culture

Architecture is "art of space" without determining the type of space (Baessa et al., 2010). According to Caudill (1978), a space is a room that contained different spaces. Some rooms are interlocking and others are distinguishable. Some spaces are bounded with no opening and no space for circulation. A static space can be generated by closing up the opening and doors at night.

Space is a physical location where things happen and people collaborate by sharing purposes. Culture can be defined as set of thoughts, behaviors, and values, shared by the members of a society or group of individuals (C. Grantham). Space is where an object or activity is located. Is considered as the main element for social life, which known as a cultural medium. The cultural activities that people engage in render the space meaningful, whether the function of these spaces (Aucoin, 2017).

Edward & Hall (1966, 1973) studied the influence of culture on spatial perception, and focus on people's use of space as an aspect of culture. Is defined the personal space as a bubble surrounding each individual which differs in size according to the type of social relationships. Hall suggests four general types of personal space ranging from intimate to public, space. In social relations is learned an appropriate spatial variation as a feature of culture, and types vary by culture (Low, 2009). The relations between "culture" and "space" seem to be more important: spatial relations are a main factor effecting human behavior.

2.2. The social and physical space

These both terms are defined in relation to one another. Human beings are constituted through their relation to a social space. They considered as -a objects – situated in locus; which is the site where thing or an agent is situated. The spatial distribution of a population can be affecting the existing culture. The social space can be defined as the reciprocal distinction of position which comprises it; the physical space is defined as the reciprocal externality of aspects (Bourdieu, 1968). According to Bourdieu the notions of social space is connected with the physical space which provide an understanding of the structural relations between man's social environment and his physical environment. Thought the physical space is not a social space is there a clear distinction between them. The space as we live it is socially structured and clearly notable. Physical space can be considered as an abstraction site and the fact it is an appropriated space and projection of the social space.

2.3. Space and Social Relations

Hall's study provides different concepts and definitions on the culture, space, and social relations. He demonstrates that the definition of culture is vary depends on the occupied space (Hall, 1981), and according to his finding, the spatial design affects the people behavior. Thus, properties of space reflect cultural features of social relations and express behavioral conditions. Some architectural studies are concerned the influence of social structure, habit and lifestyle on the house form. The use of space differs from culture to culture according to the values and the social norms. The family's experiences that correlate with the social impact and the technology change affect the transformation of the interior space uses and its orientation (Boschetti, 1990). In the United States the domestic spatial organization appears to assure the privacy, while the domestic space of Mexican houses emphasizes the sharing and close interconnection among inhabitants.

In both Turkish and Italian cultures, the open space has been transformed into an enclosed interior space to respond to the need of privacy and security as well to adapt to the social changes and functional need. Moreover, studying the spatial organization for these two different cultures could help to identify the differences and similarities. The evaluation of previous studies indicates that spatial organization associated closely with social contents.

2.4. The spatial configuration

The spatial configuration has an important role in the social and cultural function in the domestic space. It's consists of series of elements that are spatially arranged and described as spatial relations (Godoy & Rodríguez, 2002). The notion of spatial configuration is applied to indicate to the structure of potential disposition as specified by the position of boundaries in space and by its relations between spaces that produced from the presences of boundaries (peponis, 1997). Configuration could enclose the possibility for physical and visual connections. Whereas, the human beings, and built environment are used to structure theses connections to make it controllable. There are different methods of analysis to understand spatial configurations are depends on physical, geometric and visual aspects, and the metric distances (Chdhary, Adane, and Joglekar, 2013). However, empirical studies demonstrate that the spatial configuration impacts the spatial behavior and the type of movement (kim, 1999).

The space use pattern, spatial cognition and spatial configuration, have been confirmed that they are all connected to one another. The recently studies applying the syntactic analysis to the measurement and representation of spatial configuration have revealed a connection between movement and configuration. They have analyzed the structure of networks of open public spaces, using the axial map analysis, against the possession of public spaces. Several studies are carried out by Hillier and his colleagues which assured the correlation between the configuration and movement. Peponis et al (1989) have used the space syntax approach to investigate the relationship between the morphology of Greek cities and their pedestrian movement. Whereas, the empirical studies suggest the important role of the spatial configuration of the social and cultural function of the different patterns (Kim, 1999).

The space syntax studies have become focused on the configurational modeling of architectural patterns and urban networks. Which are structured by breaking up the plan layouts and urban layout into the fewest and longest lines of sights. The statistical measurement of the configurational properties of the networks are used to produce the axial map (Dawson, 2003). It have demonstrated the features and the use of space syntax analysis ; showing the important role of spatial configuration in enhancing social life (soares, yamu, weitkamp, 2020). Whereas, this method provides the analysis of the spatial configuration both in the city and interior level. The aim of spatial configuration is fundamental to understand the social logic of groupement and settlements (Hasgul, 2015).

2.5. The privacy

Privacy involves control, freedom of option, in which it’s implies several properties; first, it permits a variety of social units in phenomena of privacy, e.g. individual- group, individual-individual. Second, it allows a bidirectional analysis of privacy. Third, the definition suggests an active regulatory process (Altman, 1976). The privacy aims to control transaction between individuals, it’s objective limiting interaction between persons and maintaining self-identity. People are involved in a dialectic relationship between privacy and social interaction.

The concept of privacy has been analyzed and studies by many researchers, Westin (1970) analyzed the term of privacy in four functions and four states. *Solitude* is the first state of privacy, where the individualize one and away from the observation of others. The second state is *intimacy* which includes the separation of groups and small group. *Anonymity* is when a person does not expect to be known, and lost in a public place. Finally, *reserve* involves the creation of abstract barriers against external factors. This analysis is indicates the different sized units that involved in privacy phenomena, and it's involves the main operation of mechanisms to attain privacy. Westin also identified four functions of privacy, including self-identity and self-independence under the term *autonomy*. Second function includes *Emotional release* which allows people to be free from social rules. This analysis of Westin suggests that people need a balance between closeness and openness, to be away from people and to be with others at different times.

Proshansky et al and their associates (1970) extended Westin's analysis which suggests that privacy maximize the freedom of option and behavioral choice (Altman, 1975). The physical environments help people needs to find privacy and characterize their Owen private territory (MUSTAFA, 2010). People use two mechanisms to regulate their need for solitude: territorial behavior and personal space. Personal territory that we attempt to have complete control, includes gardens, homes, and personal space. And it's refers to the partial control of the residents.

However, the privacy is considered as a dialectic process to regulate contact with people, and limiting interaction which is varying and dynamic, shifting from person to person and through time. In the same context to define privacy its should identify space into two types: private and public. Whereas the private space is the one constrains communication. And the public space applies no restriction and communication. The notion of privacy suggests a boundary between the self and non-self (Altman, 1970). The concept of privacy has two aspects: first one reffers to the affected person and establishing a detached space, and the second to the society and the restrictions of person's access to the other's space. These definitions comes to formulate a notion of a boundary between the person and the built environement (Renaud & Gálvez-Cruz, 2010).

2.6. Spatial behavior

Both internal and external limitations influence our social and spatial behavior (Alessandretti et al, 2018). By developing and maintaining connections in a unique and tenacious way, people are able to overcome cognitive and temporal constraints in the social arena (Dunbar,1993). New information generally suggested a link between social order and spatial behavior. As a result, sociologists who are researching interactions may be able to gather information about people's where about and movements to add to the overall image of social life, which has mostly been shaped by verbal data (Baldassare, 1978). We take advantage of the recent finding that the size of the activity space is conserved and corresponds with the size of the social circle in order to test the hypothesis that the same personality traits partially determine social and spatial behavior (Alessandrett et al, 2016).

3. House layout: the transformation of spatial organization

3.1. The term of spatial organization

While space is made up of horizontal and vertical aspects, it is also made up of order. It was self-organizing. As previously said, spaces are made up of architectural elements and multiple spaces combined to form a single entity known as a house. Each unit is put together and connected to the others. As a result, units are established. It has a unit throughout the entire procedure. Moore (Moore et al, 1974) stated that the essential sections of a house, known as space, such as rooms, can be put together in an ordered and well-organized manner to obtain a desirable structure. The most important thing is to make the space habitable and to build a meaningful pattern inside it.

Space is more than just a structural component. It is made up of dimensions, such as width, length, and height. However, this does not imply that space is used to sum up these criteria. Space is a living place in which humans dwell and meet their own needs. Although a room’s facade may appear well-organized from the outside, or a building's proportions may be appropriate in the surrounding context, this does not imply that the interior space is well-organized in and of itself. The inside is the most difficult part of the structure. When constructing or designing a structure, the internal space should come first, followed by the external area. The interior to exterior approach should be followed (Zevi, 1957).

3.2. The type of spatial organization

As previously stated units are grouped together and form the building's main form. The unit-to-whole relationship is a crucial formative concept that links units to other units, which is referred to as space. Spaces should be well-organized or self-contained. Space organization is considered at this point (Clark & Pause, 2012).

A group of spaces that form a whole space that is linked together is known as space organization. Many architects had their own ideas about how to organize space. Social (culture, way of life, religion, worldview, etc.) and physical (climate, topography, technology, etc.) factors are taken into account when organizing spaces. Social factors, in addition to physical factors, play a significant role in space organization. According to (Ching, 2007), there are five types of space organization: radial, centralized, linear, clustered, and grid. According to Ching's (1996) spatial organization, spaces join together and create primary artefacts based on physical and social elements. All classifications attempt to construct buildings that are functional and useful for human requirements (Esentepe, 2013).

3.2.1. A centralized organization

Features a focal point in the middle of the building (figure 06), with smaller spaces structured in a stable or concentrated pattern surrounding it. In order to have a balanced composition, secondary spaces might be equal in size or vary in size, depending on the purpose that they are designed to serve. Within a centralized organization, the circulation pattern can be radial, spiral, or loop, but the movement pattern should virtually and ideally end around a central location (Prerana, 2020).

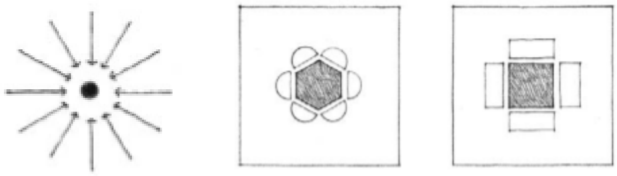


Figure 06: Centralized organization
Source: Ching, 2007

3.2.2. Linear organization

Can be designed for a single unifying element, to which other items can be attached based on their function, size, and needs. They are liner because they are organized along an axis rather than at random (figure 07), with no visual hierarchy or specific articulation, resulting in a linear volume that is dominant. Radial organization is a hybrid of centralized and linear organizations, with a central focal point from which radial linear spaces appear to emerge ; however, in radial organization, each unit appears to spread outward, whereas in centralized organization, it appears to be inward (Prerana, 2020).

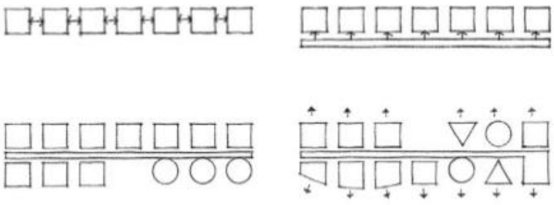


Figure 07: Linear organization
Source: Ching, 2007

3.3. Form and space

Space and form cooperate and enhance one another in architecture. The components and framework that make up a building and specify its interior space make up the structure's physical form. Our being is continually engulfed by space. We move, see forms, hear sounds, feel winds, and smell the perfumes of a flower garden in bloom through the volume of space. It's a natural material like wood or stone. It is, nonetheless, a form less vapor by definition. Its visual form, proportions and scale, and light quality are all determined by our sense of the spatial boundaries imposed by form elements. Architecture takes shape as space is grabbed, confined, molded, and structured by the elements of mass (Ching, 2007).

3.3.1. L-shaped configuration of plan

An L-shaped arrangement of vertical planes stretching outward from a field's corner is what defines it (figure 08). At the corner of the arrangement, this field is highly defined and constrained, but as it moves away, it swiftly dissipates. It shifts from being introverted to being extroverted in the inside corner of the introverted field. A building type with an L-shaped configuration can use the readings that follow. The configuration's other arm is seen as an add-on, whereas one of the arms may be a linear form that encompasses the corner inside its boundaries. The corner can also be articulated as a distinct component that joins two linear forms. L-shaped plane configurations are strong and self-supporting, which enables them to stand on their own in space. Given that they are open-ended, they are adaptable space-defining elements. To produce a variety of spaces, they can be joined with one another or with other form elements.

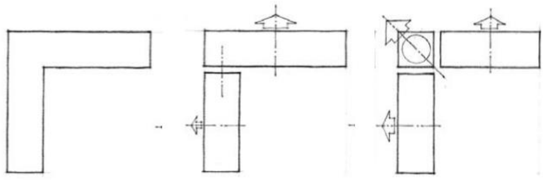


Figure 08: L-shaped configuration
Source: Ching, 2007

3.3.2. U-shaped configuration (plans)

A field of space with both an inward and outward focus is defined by a U-shaped combination of vertical planes (figure 09). The field is well defined at the closed end of the configuration. The field becomes extroverted as it approaches the open end of the arrangement. If the planes are arranged in a rectangular and oblong shape, the open end might be on either the narrow or broad side. In either instance, the open end of the spatial field will remain the primary face, and the plane opposite the open end will be the most important of the configuration's three planes.

Building forms and organizations in U-shaped configurations have the natural potential to collect and define outdoor space. Their composition appears to be primarily made up of linear forms. The configuration's corners might be articulated as separate parts or included into the linear shapes' bodies.

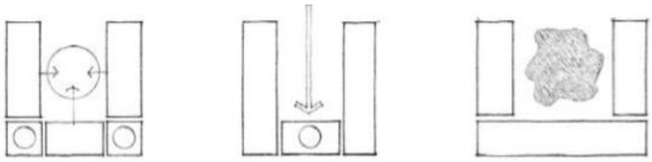


Figure 09: U-shaped plans
Source: Ching, 2007

3.4. Transformation of space

Changing user profiles has had an essential impact in the evolution of building form over time. Transformation occurs at housing units over time as a result of socio-cultural elements. Three major transformations of spaces are spatial, functional, and formal transformations.

3.5. The significance of transformation

Everything is in the process of becoming, a never-ending cycle in which one form gives way to another. Transformation is a process of changing form, according to Clark and Pause (2012). Many definitions of transformation exist in various fields such as biology, psychology, policy, and architecture, among others. The term "transformation" refers to the process of converting one item into another.

As stated by zderen (2001), change can take place in two directions: upward, by adding floors, or horizontally, by adding spaces to homes in urban settlements. As this concept indicates, change has an impact on spaces when it is combined with socio-cultural variables. Furthermore, as building forms evolve; the utilization of space (spatial organization/function) evolves as well.

3.6. Types of transformation

3.6.2 . Spatial Transformations

Until now, the reasons for the space arrangement of a building form have been explained in terms of variables. The architectural design process is a series of steps that organize space. The most significant aspect of this procedure is the strategies utilized when establishing and developing interactions between places. The space that is created should have a good geometric form that is livable for humans. As a result, geometry can be discussed in terms of spatial relationships (Esentepe, 2013).

Geometric forms are clustered and formed compositions as a result of human needs. A livable space is created as a result of geometric forms. There are various primary ways in which two or more places can be connected to one another. This relationship was divided into four categories by Evensen (1997): spatial juxtaposition/ addition, spatial integration/ penetration, spatial division, and space in a space. In line with these techniques, Ching (1996) classified space relations into four categories: space within a space, interlocking spaces, nearby spaces, and spaces linked by a common space.

3.6.2. Functional transformation

The use of space is an important issue for humans when it comes to housing. Louis Sullivan (2004), Frank Lloyd Wright's mentor, emphasized how crucial it is for architecture to put form after function. With this sentence, he emphasizes the significance of proper space utilization in dwelling. However, depending on their socio economic concerns, Different people's house configurations serve different purposes. In this instance, spaces may change to meet the needs of the household. Depending on the person's lifestyle, their use of space may differ with a diverse user profile (Esentepe, 2013). In determining the functional transformation of socio-cultural elements, housing, particularly daily life activities such as eating, sleeping, cooking habits, hosting, studding, sitting, washing, and socializing, played a key role.

People are continuously looking for more comfortable living space. As a result, houses undergo changes in order to gain appropriate space. While it is tough to modify housing in a short period of time, user and user needs can change quickly. For example, while the owner of the house may have organized his housing according to his preferences, his tenant (assuming to rent a house to someone) may alter the shape or function of the space to meet his needs. This shift in user profile signified a shift in the housing market (Berkowitz, Brownlee, Glinn, 2020).

3.6.3. Formal transformation

It's a formative concept that came forth as a result of the additive and subtractive processes. As previously stated, space is made up of architectural parts, and as a result, shapes with volume have emerged in this process. While Clark and Pause (2012) divided transformation into two categories, additive and subtractive, Ching (1996) expanded on this formative idea by include dimensional process. Additive, subtractive, and dimensional transformations are the three types of transformations, according to him. One of the most powerful transformations on the architectural form is additive transformation. New elements or forms are added to the mass or shape in additive transformation. Due to human needs, this action has designated a new space in the building.

Subspaces produced when the change takes place (Ching, 1996). The addition component of the structure could be an extension of the existing room or a space that serves a different purpose than the existing space. In addition transformation, forms are extended, but in subtractive transformation, forms are kept their original identity or altered into a different form (Ching, 1996). It may define the building's entrance, as well as creating semi-open spaces such as courtyards, inner courtyards, balconies, and terraces.

3.7. Housing transformation

Housing transformation is not a new notion, according to Nguluma (2003), as it has been explored in different quarters as essentially tries to address changes and encompass the variables of physical adjustments, extension, and maybe renewal of part or complete buildings. As a result, Tipple et al (2004), defined housing transformation as any change made by inhabitants following allotment in the form of alterations, extension, modification, or addition to the original forms, extent, and patterns of their dwellings, including their surrounding environment.

Sueca (2003) sees it as an informal housing supply approach launched by end users that could lead to improvements because it usually occurs in occupied buildings. Sueca went on to say that most public housing in developing countries is undergoing change because of the adoption of construction procedures that are familiar and convenient to those who are entitled to reside in such homes. Housing transformation is largely realized through spontaneous private efforts in underdeveloped nations. Based on the aforementioned, the term "housing transformation" as used in this study refers to the residents' physical and spatial change, addition, modification, or extension of any element of an existing residential building or its immediate surrounds for any cause. It can take the shape of materials, space changes/additions, or a combination of the two (Aduwo & Ibem, 2017).

3.8. Housing transformation process

Although there is little evidence in the literature of a universal mechanism through which occupants modify their homes. Housing transformation is usually accomplished through a variety of methods within the context of existing housing policies. The "dispersal strategy," which promotes public housing inhabitants to migrate out of huge public housing buildings and into higher-income, less-segregated areas, is one of the approaches. Residents may be given vouchers to utilize in the private market or may be required to move into public housing units in the cities. Another strategy is to utilize a "place-based redevelopment program," which focuses on razing major public housing projects and replacing them with mixed-income structures on the same site. Both approaches aim to alleviate the effects of concentrated poverty by providing residents of public housing with more resources and opportunities, such as better schools, more responsive services, better access to the workforce, and opportunities to form new social relationships with more affluent neighbors.

Salim (2002) noticed that housing transformation is highly prevalent among owner occupiers in developing nations, who remodel or enlarge their homes via personal initiative and efforts in order to improve their housing circumstances and suit their household demands. He made it obvious that the majority of changes in poor countries are carried out by small-scale contractors and single artists using locally available materials and labor, and are so extensive that the original dwelling units are difficult to distinguish. As can be seen from the above, housing transformation in both developed and developing countries attempts to improve living circumstances by meeting rising household demand, In developed countries, housing transformation appears to be a government-sponsored program carried out within the framework of existing housing policies, and thus viewed as a legal means of increasing housing supply, in developing countries, housing transformation is viewed as an illegal self-built improvement of homes and their immediate surroundings. Individuals and households organize and execute all parts of the process with their own resources, thus it does not get government help. This explains why housing transformation, particularly in public residential estates in developing countries, causes massive distortion of the estate's original plan, resulting in rapid deterioration of the neighborhood’s socio-spatial and physical attributes, with the resulting public health implications (Aduwo & Ibem, 2017).

3.9. Factors influencing housing transformation

3.9.1. Household assets

Housing transformation processes are driven by household needs and assets, according to Sheuya (2004) and Mirmoghtadaee (2009). Low-income households are compelled to modify their homes as a result of housing demands and assets available to them. The poor, according to Rakodi (2002, chap. 1), have a portfolio of assets that includes physical, human, financial, social, and natural capitals that are employed in a variety of ways to achieve livelihood goals. However, analysis of four capitals (physical, human, financial, and social) will be required for this study (faris, 2014).

In the lives of low-income households, physical assets such as housing serve as the foundation for the acquisition of other assets. Ability to invest in productive assets creates revenue, according to Rakodi (2002, chap. 1). Shelter, according to Gough, Tipple, and Napier (2003), is multifunctional in that it not only provides a roof over one's head, but also has the ability to offer rent and home-based businesses for households. Housing is a basic need for households, but it is also a valuable productive asset (faris, 2014).

Households within sufficient human and financial assets may benefit from social capital, which is built on trust and relationships with other members of the family. The ability to benefit from social capital is usually contingent on power imbalances inside and among households that are able to exchange favors. Households within sufficient resources, according to Sheuya (2004), obtain alternative capital from contacts with family, friends, and community groups. Bebbington (1999) found that the relationships between individuals, households, and organizations are often based on shared cultural identity, confrontations with other groups, and shared experiences, and that these relationships play a critical role in facilitating members' access to local resources for livelihood strategies through coordinated efforts (Avogo et al., 2017).

3.9.2. Housing needs

The desire to meet the housing demands of individual households drives housing transformation. Housing needs are determined by crowding (number of people per room, space per person), sharing of housing or multiple habitation, landlords' ability to raise rent advance, and high rents for even poor quality housing, according to the Global Report on Human Settlements (UNCHS, 1996c, cited in Tipple, 2000). In the examination of congestion, the floor area per person is a more helpful metric (UNCHS, 1996). When new families are formed and children reach adulthood, another factor of housing demands is an increase in household size due to extra children or other dependents, or the demand for separate rooms when children reach adulthood (Tipple, 2000).

The demand for extra space to accommodate expanding household members, security purposes by building fenced walls, economic activities, and the need for internal house services such as toilets and bathrooms, according to Tipple (1994, 2000), Gough et al. (2003), and Sheuya (2004), are the basic needs of households that trigger housing transformation (see also Popkin et al, 2012). Homes grow in a variety of ways, including extended family or friends from rural areas relocating to cities in search of work, weddings and the formation of new households, or high birth rates. Housing transformation procedures are an example of a livelihood approach that produces livelihood results to improve household members' well-being. In the interest to satisfy housing needs using assets available to households through housing transformation, building regulations and standards play an intermediary role in determining the success or failure of the process (Faris, 2014).

- Conclusion

Architecture is a field where space is crucial. Since the beginning of time, people have been in a world of many different settings, and these spaces have always had an impact on which they are. Recently, the tension between anthropology and "spatial" has increased. The idea of "space" has also been questioned, starting with an argument against terms constrained by geography like "culture" and "the field". Architecture occurs in space; it can functionally address a person's physical demands or go farther by addressing his spiritual wants. As a result, it transforms building construction into actual architecture, improving the quality and appeal of a person's living environment.

Because each culture has different values and social norms, the use of space varies from culture to culture. The spatial layout created by interior arrangement and a partitioning system is an important factor that has control over the inhabitant's activity. It is a controlling factor that reflects social interaction among family members as well as the relationships between domestic spaces in the household. The arrangement of the floor plan in Boschetti's historical study of Kansas farmhouses suggests that different patterns of interior spaces directly connect to social and personal values of house design across generations of family members. The transformation of interior space uses and their orientation involves the family's experience and corresponds to technological change and concurrent social impacts.

Chapter II

The Genotype and Phenotype

- Introduction

Genotypes are abstract relational models that regulate the arrangement of space and the organizing principles of the underlying phenotypes, and they are a reflection on not just spatial structure but also the nature of social and cultural patterns. Phenotype is the physical manifestation of genotype in the form of architectural objects, and it is created through a series of interactions between genotype and environment (Lewontin, 2011). The link between architecture and identity is addressed by phenotype, genotype, and environment. The problem of ostensibly typological buildings not showing expected genotypical consistency is detailed, and two ways devised to address it partially are discussed. This necessitates a rethinking of the biological foundations of the genotype-phenotype distinction, as well as the awareness that the two labels relate to distinct kinds, each defined by attributes coming from causally distinct processes (Bafna, 2012).

Buildings are cultural artifacts that hold cultural information in human habitation, according to architecture. Individual and cultural communities are represented by these structures, which are emblems of innate human attributes. Cultural structures can be carried down from generation to generation in traditional dwellings, but they cause substantial changes on a visible level. The genotype is the stable structure that underpins this, as opposed to the phenotypic, which is a variable form that may be observed.

1. Genetics:

1.1. Definition of genetics:

The first term that comes to mind when thinking of genetics is 'genes,' which is the field's foundational topic. Genetic diversity and heredity in living creatures are the subjects of other studies in this broad discipline. Despite the fact that it is generally thought to be part of the discipline of biology, it interacts with a variety of other fields, including informatics and even architecture (Winchester, 2022).

Within the 19th century, a scientist named Gregor Mendel gave birth to the terms of genetics, his main studies centered on "trait inheritance," tracing down patterns in how qualities are passed down from one generation to the next. A gene can be defined as "units of inheritance," term developed by Mendel when observing the way plant organisms transferred these traits (Gayon, 2016).

Influences of development and behavior are made based on the interaction of the organisms with the environment and the experience that it gains from it. Gene transcriptions can be active of passive based on the intracellular or extracellular environment of the cell. This means that the same genetically determined organisms can grow in different ways, adapting for survival in the medium they are placed in (Hansen, 2006).

1.2. The biological definition of genotype and phenotype:

1.2.1. The genotype:

The Genotype is a collection of genes that are responsible for a certain organism's genetic features. Genes, not attributes, are the basic information in an organism's DNA, which is referred to as genotype. The term "genotype" simply refers to the alleles carried by an organism's DNA. It can't be determined by just observation; biological testing is required. The genotype of an organism is inherited from its parents and expresses all of the organism's genetic information (Giri & Mohapatra, 2020).

If you met someone with albinism, for example, you'd know they had a mutant TYR gene, which is the most prevalent cause of albinism. Their genotype includes the mutant TYR gene. Their phenotypic includes albinism. Let's say you have brown eyes. Your phenotype is your visible eye color, but it says nothing about your genetics. Human eye color is influenced by a variety of genes, and any of them may manifest dominant or recessive qualities in your phenotype, or the particular shade of brown in your eyes (Campbell, 2020).

The allele is either brown or blue in this case, with one inherited from the mother and the other from the father. The dominant allele (B) is brown, while the recessive allele (B) is blue (b). Brown eyes are the result of a child inheriting two distinct alleles (heterozygous). The child must be homozygous for the blue eye allele to have blue eyes (Figure 10).

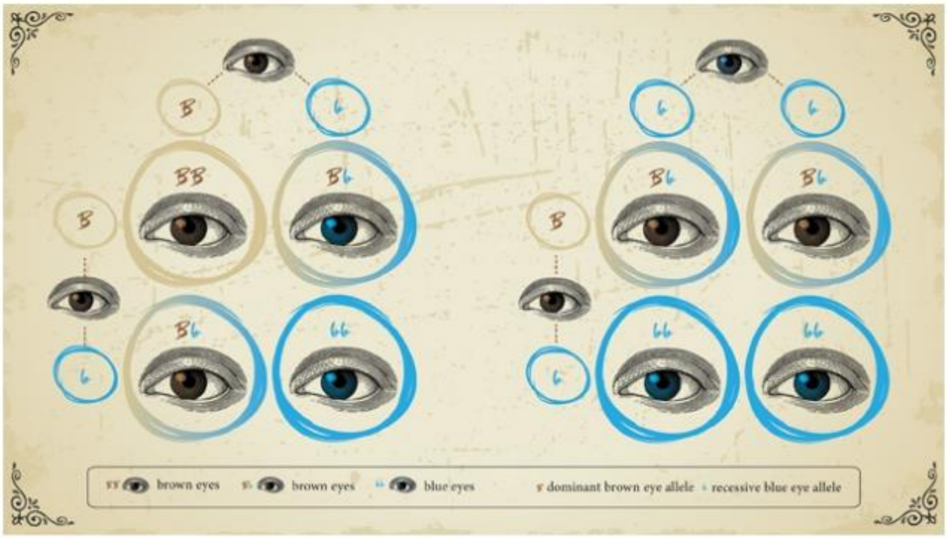


Figure 10 : Inheritance chart showing how, depending on the alleles carried by their parents, an individual may inherit blue or brown eyes, with the brown eye color allele being dominant and the blue eye color allele being recessive (Source : Campbell, 2020).

1.2.2. Phenotype:

The phenotype of an organism is the totality of its observable traits. While genotype is inherited from an organism's parents, phenotype is not. While a genotype influences phenotype, genotype and phenotype are not synonymous. The genotype, as well as other factors, influences the phenotype (Panawala, 2017).

Environmental and lifestyle influences, epigenetic changes. Nutrition, temperature, humidity, and stress are examples of environmental factors that might affect phenotypic. The phenotypic of flamingos is influenced by their surroundings (figure 11). Their native color is white, and the pink hue is generated by pigments in the creatures they eat (Campbell, 2020).

Another example is a person's skin color. Our genes determine the amount and kind of melanin we make; nevertheless, in sunny climes, UV light causes existing melanin to darken and encourages additional melanogenesis, resulting in darker skin.

Figure 11: Flamingos are naturally white, and the pigments in the creatures they eat are what give them their brilliant pink color (Source: Campbell, 2020).

1.3. The biological analogy:

Darwin's (1859) theory of evolution by natural selection has been frequently used as a framework for design, either as an explanatory analogy for our own practice (Steadman, 2008) or as a specific procedure for optimization, such as the evolutionary algorithm (Holland, 1992), but it is the subsequent development of the science of genetics that is responsible for describing a clear relationship between representation and production. From Mendel's (1965) description of the rules of heredity to Watson and Crick's (1953) discovery of the molecular structure of DNA, the process by which information is stored and conveyed has been a key contribution to our current understanding of evolution. Genetics shows a clear distinction between a hereditary germ line, or genotype, which encodes information about the structure of the organism as a digital code in DNA, and the organism itself, or phenotype, which is produced from that information through protein production and other biochemical processes. Genes are both a code for producing organism and a vehicle by which information is conveyed to the next generation, since they are inherited by children to carry the traits of their parents (Sean et al., 2011).

The encoded information can only flow in one direction, from the genotype to the phenotype, according to this method. To rule out an alternate option (Steadman, 2008) that acquired features may be inherited by offspring, Weismann (1889) advocated a separation between germ cells that could be passed on and somatic cells that could not. This has been known as the 'core dogma' of molecular biology: information can only be transferred in one direction, from genotype (the code, or DNA) to phenotype (the traits of the organism), and never the other way around (Sean, 2011).

1.4. Phenomics: From Genotype to Phenotype

The concept that a collection of genetic instructions, or genotype, interacts with the environment to form an organism's features, or phenotype, is one of biology's most fundamental ideas. Understanding how specific genotypes result in specific phenotypic features is a central goal of modern biology, because it allows for the generation of commercially viable organisms. However, given to the enormous number of genes and gene products that contributes to most phenotypes, as well as complicated and changing environmental effects (Vince, 2011), predicting phenotype from genotype is a tough challenge.

The last 20 years have seen a revolution in our understanding of genotype: while genomes are often relatively vast, with millions or billions of nucleotides, DNA's chemical simplicity allows for massive-scale research (Morgan & Herman, 2018). We can now determine genotypes in full genomes down to individual nucleotides, and entire genomes are being sequenced at ever-lower costs and faster speeds. Next-generation resequencing methods allow researchers to obtain the full genotype and epigenotype of a phylogenetic group or population, rather than only a single representative of a genus or species (Vince, 2011). The human Hap Map project pioneered high-density single nucleotide polymorphism genotyping, which has since become tractable for any organism and is now routinely applied to plants and microbes for the characterization of natural genetic variation and to support trait-driven efforts to clone and understand specific genes. As a result, genomic science is moving past the period of reference and model organisms to investigate any microbe, animal, or plant with characteristics of interest to science and society in greater depth (Kenchanmane et al, 2020)

Phenotyping is a unique field of study. Unlike a genotype, an organism's phenotype can be characterized at a variety of levels, ranging from single molecules to dynamic metabolic networks to complicated cellular developmental and physiological systems, all the way to aggregate or social behaviors of large populations (Vince, 2011). Additional levels of phenotypic complexity are created by interactions with symbionts, diseases, or competing species. Furthermore, phenotypes are dynamic, with a wide range of timescales in which they change. Consider the rapid responses of bacteria to nutrient changes (Segall et al., 1986) or the dynamic changes in photosynthesis of a leaf as a single cloud passes over the sun (Murchie and Niyogi, 2011), as opposed to the slow morphological changes in long-lived plants or even the lifelong changes in a human's outward appearance. Phenotypes rarely have a single discrete description, and most phenotypic characters are better defined as continuous functions rather than the genotype's discrete "A, C, G, T" character codes. Indeed, the phenome (the whole collection of phenotypes) can be practically infinitely complicated (Murchie and Niyogi, 2011).

2. Genetics and architecture: genotype and phenotype

2.1. Genetics architecture

The genetic architecture of several phenotypes within a species looks to be comparable, yet this similarity could not hold true when comparing species (Flint & Mackay, 2009). A description of genetic architecture can include, among other things, the number of genes and alleles, the distribution of allelic and mutational effects, and patterns of pleiotropy, dominance, and epistasis (Hansen, 2006). By the end of the 20th century, human genetic studies of complex phenotypes were failing, despite the success and predictions of genetic architecture (figure 12) from work on model species (Corder et al. 1993). Utilizing live elements, genuine genetic processes applied to architecture, and natural "software" (DNA) for "automation" natural development: construction materials, useful living places, and live organisms through genetic study (Estévez, 2010). The Genetic Barcelona Project, which is currently in the second phase of the genetic production of bioluminescent plants for urban and home usage, as demonstrated by the Biowall, Biolamp, Sporopollenin House 2, and Barcelona Genetic Pavilion (Estévez, 2009a): For the first time, geneticists are employed by architects.

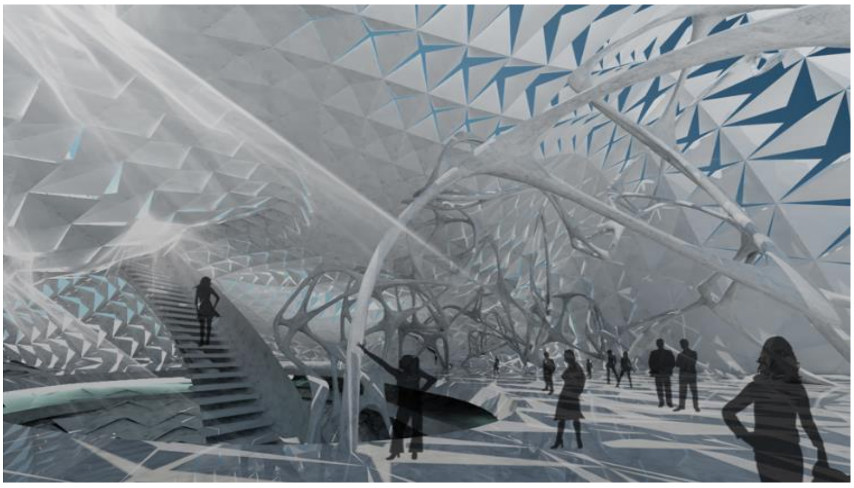


Figure 12: Genetics and biodigital architecture

2.2. Evolvability and genetic architecture

Evolvability is the capacity to change. The capacity of the genetic system to generate and preserve potentially useful genetic variants is known as evolution (Hansen, 2006). According to Wagner and Altenberg (1996), evolvability is a characteristic of the genotype-phenotype map (the genetic system), not a characteristic of the population. Because evolution is a disposition, variability is more closely tied to evolution than variation. In certain situations, the word "population evolvability" may be used for clarity. The capacity to retain variation is just as vital as the ability to produce variation. We wish to define a system's ability to evolve to include the capacity for storing and transferring genetic variation (Hansen et al. 2003b, Houle 1992). The literature on evolvability is almost entirely focused with the possibility for adaptive evolution, and I propose that we should not include a system's ability to produce unconditionally harmful mutations as a component of its evolvability (Schlichting & Murren, 2004).

2.3. Blending architecture and biology: Biomimetics

The term "biomimetics" refers to the application of natural models in technological innovation (Ripley & Bhushan, 2016). It entails biologists, physicists, chemists, and material scientists comprehending biological functions, structures, and principles of various items found in nature, and it can result in the biologically inspired design, adaption, or derivation from living nature (Bhushan, 2009). In order to build high-performance traits, nature has developed species that employ the fewest amounts of widely available materials. From the molecular to the macroscale, biological materials are highly organized at all stages, frequently in a hierarchical fashion with complex nanoarchitecture that ultimately forms a wide range of distinct functional parts (Estévez, 2005).

Bioarchitecture is a fusion of art/architecture, biomimetics, and bioinspiration. A bioinspired design is incorporated from the beginning in all components of the work at all scales (Ripley & Bhushan, 2016). It's significant to remember that mimesis encounters resistance in both art and architecture. Although completely original works are valued and emphasized in the arts, there are frequently instances of homage, inspiration, interpretation, response, or other means of combining another artist's work (Gruber, 2010). A more technical method to integration is frequently used in more recent bioinspired constructions. The advantages of the eye's iris were examined by Nouvel's Institut du Monde Arabe. With sensors to detect sunlight, the synthetic irises built into the building's skin open and close autonomously. In fact, their geometric shape and scalar duplication evoke the themes of Arabian art and architecture (Ripley & Bhushan, 2016).

2.3.1. Biomimetic architecture

Biomimetic architecture is a modern architectural ideology that explores solutions to environmental sustainability. Biomimetic know also as Bionic, bio-inspirations, and biognosis are scientific terminology that refer to the adaptation of natural processes and design to produce a new type of industrial product (Bhushan, 2009). Biomimetics is not just the copying of nature, neither materially, functionally, or creatively, but rather the understanding of natural principles to aid in the knowledge of related, technological challenges, which can subsequently be solved by the use of optimum technologies (Pohl & Nachtigall, 2015). In the architectural world, the terms biomimetic were used to describe a modern architecture style that commonly drew inspiration from nature (figure 13) for unorthodox form and, in some cases, metaphoric notion or, symbolic association (Redolfi & Khoshtinat, 2009). The goal is to use biomimetics as a design tool in architecture. There are numerous disciplines in architecture where this is applicable and required (Gruber, 2010). Architecture and structure Biomimetics can be classified into biomimetic disciplines. These subdisciplines, however, should not be strictly placed under the banner of "process biomimetics," despite the fact that they have their primary position there, because construction and design are processes (Pohl & Nachtigall, 2015).

Figure 13 : Biomimetics in structural design

2.4. Biologycal systems in architecture science

The identification of biochemical mechanisms in biological systems has been one of the driving forces behind biology's advancement over the past century. To comprehend DNA and the links between genotype and phenotype, use this biological system approach (Go, Nguyen, Harris, Lee, 2018). Genotypes give rise to phenotypes, which are distinguishable traits, at the most fundamental level of biological systems. Gene expression "interprets" the genetic information contained in DNA, and the phenotype of an organism is a result of that gene expression's characteristics (Sari et al., 2020).

In order to present all information about nodes (proteins) and edges in a biomolecular interaction network, Cytoscape's network analysis method combines a biomolecular interaction network (interactions) (Desiere, 2018). For the purpose of analyzing collective data in architecture science, the theory of variable phenotypic from genotype and environment, followed by the multi-layer biological system, will be background knowledge (Notkins, 1989).

In architecture, methods that connect spaces are frequently referred to as space syntactic analysis methods. Examine the connections or networks between several rooms. Spatial organization is the subject of space syntax (Sari et al., 2020). This is comparable to the way that biological protein networks are studied through tissue analysis. Space transforms into a node and edge in the form of interaction between spaces when using the space through justified syntactic analysis technique. Phenotypes are the output patterns of the system, whereas genotypes indicate the network management structure made up of components and their interactions (Crombach, Wotton, & Jaeger, 2016).

2.5. Genotype and Environment Interactions affect Phenotype

Although occasionally spontaneous mutations may happen that cause it to change, genotype often remains constant from one environment to another. The same genotype can, however, result in a vast variety of phenotypes when exposed to various circumstances (Baye et al., 2011). All living things are affected by the idea that phenotype is the result of interactions between genotype and environment. Environment could change how genes affect phenotypic (Garrod, 1902). The term "genotype by environment (G x E) interaction" describes the variance in how different genotypes react to various surroundings (Falconer and Mackay, 1996). A genome can adapt to significant environmental changes by selectively controlling the expression of particular genes. For instance, plants have the ability to recognize and react to particular environmental cues that influence developmental pathways and impart a variety of adaptive capacities over time (Scandalios, 1990).

Environmental influences on humans are complicated, and depending on an individual's genetic makeup, their relative importance can vary greatly. Pollutants are one type of element in the physical environment (Baye et al., 2011).

2.6. Implication of the genotype in the architectural model

New computer-based representational methods, such as parametric modeling or scripting, stress the representation's role as a generator of the architecture even more. In this context, representations play a role similar to genes in biological organism coding (Sean, 2011). The flow of information in nature is also clearly one way, from genotype to phenotype (Crick, 1970). However, in Hillier and Hanson's (1984) hypothesis of the 'inverted genotype,' the information flow is reversed. The development of new manufacturing techniques, such as off-site construction and digital fabrication, as well as industrial manufacturing of building components, needs higher precision and model attention (Gengnagel et al, 2011). In the years immediately after the biological discovery, computing methods were used to explain human mind in the nascent science of artificial intelligence. The prevailing strategy in this case centered on formal symbol systems as the foundation for intelligence (Newell and Simon, 1979). These symbols, like the underlying genetic code, represented real-world occurrences that were then controlled as abstract entities in the mind by sets of formal rules of inference to produce a specific intelligent action in the real world (Sean, 2011).

Pre-fabrication is commonly accepted in digital fabrication, contributing to the planning effort of just-in-time sourcing, production, and logistics (Gengnagel et al, 2011). Many significant phenomena, such as fluid dynamics, may be difficult or impossible to adequately replicate due to their complexity (Hanna et al, 2010). The 'primacy of the phenotype,' as Hillier and Hanson (1984) put it, is the manifestation of the structural description in the characteristics of the real world. Their descriptions of those structures are at the heart of many essential methods of 'space syntax,' but they only correspond to those structures at the level of description, and they don't explain how we actually retrieve them, or the many aspects of architectural form that fall outside the domain of space syntax (Sean, 2011).

3. Space syntax: genotype and phenotype

3.1. Space syntax analysis: Concept of genotype and phenotype

Before going into detail about the space syntax analysis, the terms genotype and phenotype will be defined. A genotype is a spatial notion that represents a set of abstract principles that phenotypes must follow (Hillier and Hanson, 2005). As a result, a phenotype is a spatial concept that depicts the genotype in physical space in the form of structures. Transtemporal linkages, or "ancestors and descendants," and transpatial links, or "contemporaneous organisms of the same sort," can exist between phenotypes (Watkins, 2021). Genotypes' set of rules can undergo either revolutionary or evolutionary changes: they can either follow a completely new set of rules or evolve from previously existing ones (Campbell, 2022). The two portions that follow will show how phenotypes and genotypes be formally understood using a space syntax analysis.

3.1.1. Phenotypes:

The main idea behind space syntax is to graphically portray bound spaces and their permeability. This is accomplished by making a justified grape that captures the spatial arrangement (Hanson, 1998). A circular node represents each area and a lined vertex represents each link (permeability) between two spaces. Two areas with this permeability are said to be contiguous. A justified network, according to Hillier, is built around a chosen root node, on top of which all other nodes align according to their topological distance from that root node (Figure 14).

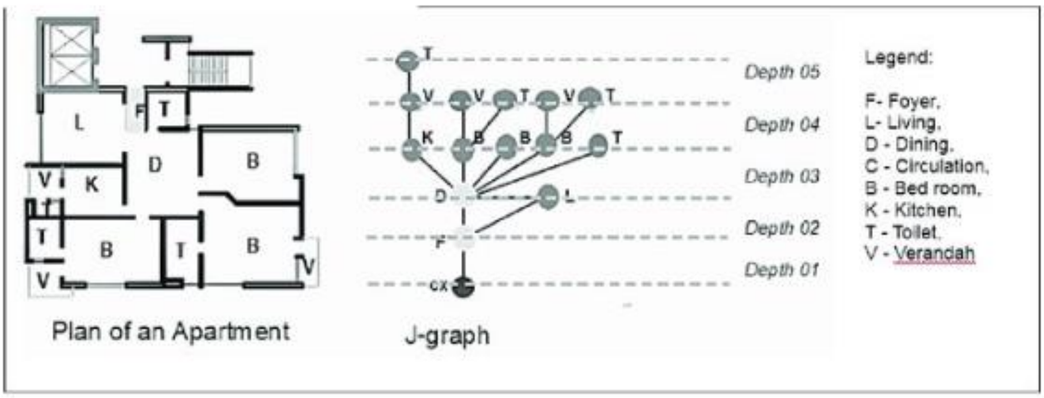


Figure 14: Example of justified graph of a house from the original root (exterior). Source : (D. Gomes, 2016)

The depth of spaces is first described in a straight forward manner using justified graph analysis. A cell's depth is determined by the number of cells passed in order to reach the cell designated by the root space (Erman, 2017). The depth might be interpreted as a spatial distance. The change in depth in justified graph analysis, which allows for topological structure analysis, alters the configuration's formal expression. With one fewer connection number than linked cell number, the justified graph can take the form of a tree (Hillier & Hanson, 1984).

Convex Space Analysis (figure 15); focuses on architectural space it comprises an examination of the convex spaces' connected neighborhood, and reducing spaces to the smallest and greatest convex polygons (Watkins, 2021). These analyses include axial map analysis, which looks at the interrelationship of the longest straight lines that pass through the related gaps without being interrupted and are defined by boundaries ; isovist map analysis, which looks at visual connections ; and convex map analysis, which looks at the depth and transit relations of gaps (Erman, 2017).

A building's convex map can be evaluated from two perspectives. Strangers, in Graham's words, would oppose the natives if they were regarded to be a basic social unit. While outsiders are barred admittance into a building, a subset known as "visitors" is granted limited access. The justified graph is analyzed first with the node representing the exterior of the building - visitor-inhabitant relationship - and then without it - inhabitant-inhabitant relationship - to understand the difference between the relationship of inhabitants and the relationship between them and visitors (Watkins, 2021).

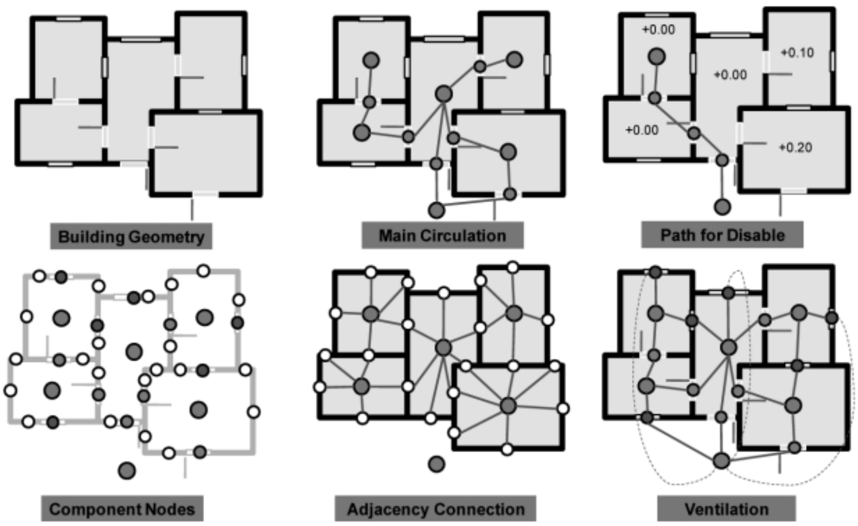


Figure 15: Example of a convex map which shows the circulation. Source: (Yongzhi et al, 2009)

Axial lines (figure 16) are the longest visible lines used to indicate separate linear spaces in urban contexts. For understanding the underlying morphology, (Hillier and Hanson 1984, Hillier 1996) uses a connectivity graph with nodes representing axial lines and linkages if the axial lines overlap. The convex map is defined as the smallest set of fattest spaces that covers the open space. According to the preceding definition, axial lines are defined as the smallest collection of such straight lines that cross through each convex space and form all axial linkages (Liu and Jiang, 2010).

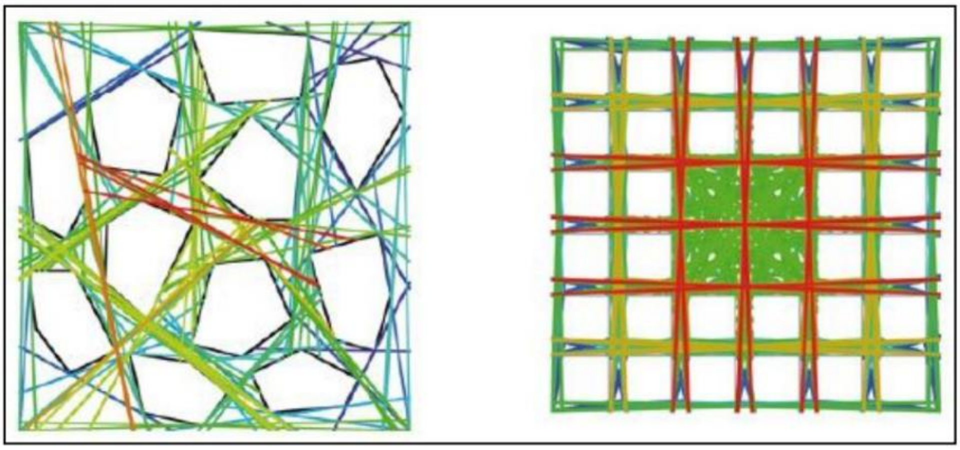


Figure 16: Example of an axial map. Source: (Araba and Mazouz, 2010)

3.1.2. Genotype:

As previously stated, once all of the phenotypes (each building) are established, the analysis can move further by identifying the abstract principles that they follow – genotypes. There are more similarities than differences in a genotype. Despite the fact that the RRA value is the most fundamental comparative value, all other available information must be taken into account (Hillier and Hanson, 1984).

The difference factor (H*), which identifies the variation of values within a certain range, is calculated to verify the defined genotypes:

$H^* = H - \ln 2 \ln 3 - \ln 2$

Where $H = -\sum [\ln (\ \ )] + [\ln (bt)] + [\ ct \ln (\ ct\ )]$

And where a = max RRA, b = mean RRA, c = min RRA

The less variance and the more similarities there are, the closer the outcome is to the value one. A value of one would indicate that there is no differentiation of spaces within a building, but a genotype or a combination of genotypes would indicate that their underlying abstract laws are comparable (Hillier and Hanson, 1984).

3.2. The genotype in space syntax literature

Space syntax developed tools for recognizing and defining elements of spaces that occur in relevant repetitions within a society's numerous systems, as well as understanding the correlation to social issues (CUNHA, 2012). Space Syntax classifies these patterns that organize spatial configurations as 'genotypes' when they are discovered in a consistent way in a sample of architectural situations, whilst the occurrence of these abstract patterns in distinct geometric shapes is referred to as 'phenotypes' (Hillier and Hanson, 1984). In the subject of spatial syntax, researchers define genotype as abstract laws underpinning spatial shapes (Rahmane & Abbaoui, 2021). When all of the spatial-functional themes are present, the dominant genotype is sometimes strongly identified. In other circumstances, when certain themes are present but others are not, these genotypes are less likely to be discovered (Hillier, Hanson and Gragam, 1987). It's worth noting that Hillier, Hanson, and Graham (1987) don't equate the graph or the rank order of spaces with the genotype ; rather, they speak of 'genotypical tendencies,' of which the rank order is one feature, and treat the spatial configuration as a device through which standard relationships between categories of inhabitants can be dynamically negotiated.

The idea of employing the 'rank order of integration values of the live functions' as a genotype indicator is now more of a practice. The term 'inequality genotype' was already in use in the space syntax literature, and Hillier, Hanson, and Peponis (1984) proposed a 'inequality genotype' in terms of 'relational differentiation of functions,' but the 1987 work gave a more straight forward operational definition :

« If numerical differences 'integration values' in functions are in a consistent order in a sample, then we can say a cultural pattern exists… This particular consistency in spatial patterning, we call inequality genotype » (Hillier, Hanson, and Graham, 1987)

« The house-by-house review suggests that although there is no obvious single house 'type' in the sample- defined perhaps as a more or less standard way of constructing the house and arranging its rooms – there is evidence of at least one functional- spatial 'genotype' – defined in terms of relational and configurational consistencies which show themselves under 'phenotypical arrangements' » (Hillier, Hanson, and Graham, 1987).

3.3. Genotypes and Phenotypes

The notions of genotype and phenotype are among the most basic in genetics, developmental biology (Mahner and Kary, 1997). We use the terms "genotype" and "phenotype" to refer to groups of organisms that meet certain genetic or phonetic criteria (Lewontin, 1992). The physical manifestation of a trait is referred to as an individual's phenotype. The genotype is the combination of alleles written in pairs to indicate the two unit components present in any individual (Klug & Cummings, 1991). ‘Genotype’ a cell's particular allelic composition, either for the entire cell or, more typically, for a specific gene or set of genes. Phenotype Some character in a specific individual takes on a specific form. A specific genotype's detectable outward manifestation (Suzuki et al, 1989).

Biologists refer to the permanent structure that underpins this as genotype, as opposed to phenotype, which is a changing shape that may be observed. According to one definition, genotypes are features or events that endure over time. Cloned from generation to generation, and stated several times. The domestic spatial genotype is a geographic pattern that occurs regularly in some cases (Sari et al., 2020). Two main methodologies are used to characterize genotype-phenotype correlations (Parnas et al 2015) : The first, which we refer to as the "perturbational" technique, connects a gene to a characteristic by analyzing the effect of a direct perturbation of the gene on the trait ; with this strategy, the causal linkages between genes and traits are clearly defined. The second strategy, known as the "observational" strategy or O-strategy, links a gene to a trait by examining the statistical correlation between gene activity and trait value across a variety of genetic or environmental backgrounds; however, because gene activity can affect trait and vice versa, the causality of the gene-trait associations defined by this strategy is not readily available (Chen et al., 2018).

- Conclusion

Phenotype variation as data for determining genotype and DNA as code in architecture. The geographical condition and resources are comprised of genotype in the form of arrangement and the principle of organizing space based on cultural and religious. In architecture, the word DNA can be used to describe an identity that is always repeated. This identity can be found in architectural types and should be traced through the classification of archetypal typologies in structures. Buildings are influenced by a variety of factors, including the availability of materials, construction technology, and the type of the site, the necessity for protection, economic, religious, and socio-cultural considerations. Biological systems processes are used to relate phenotype, genotype, environment, and locating DNA in architecture in biology scientific comparison.

Chapter III

Methods and Analysis Tools Applied to Domestic Architecture

- Introduction

Space syntax is a space theory as well as a set of analytical, quantitative, and descriptive methods for analyzing the spatial forms of houses, buildings, cities, and landscapes (Hillier and Hanson, 1988, Hillier, 2007). The relationship between humans and their occupied spaces is the focus of Space Syntax. It is thought that cultures' specific traits reside inside spatial systems, and that their knowledge is communicated through space and the structuring of places. Bill Hillier and Julienne Hanson (1988) established a collection of theories, approaches, and procedures called space syntax in the 1980s to identify links between spatial configuration and its social effects. It's been used in both architectural and urban settings. This chapter will focus on research methodology in order to determine methods that will lead to the application process. This section describes and demonstrates the steps involved in using the space syntax technique: Convex space analysis. Starting with the abstraction of a map or graph from a plan, then doing a mathematical analysis on the graph, and then interpreting the results. Space syntax provides a method for investigating the relationship between architectural configurational patterns and their generative or reproductive social systems, as well as psychological qualities related with spatial experience.

While this background provides a theoretical foundation for space syntax, its analytical approaches are divided into three stages, which have been labeled abstraction, analysis, and interpretation, and configuration and interpretation, respectively. The first stage, abstracts an environment, usually an architectural plan, into a set of distinct components and their interconnections. The resulting set of connected components is known as a map, however it is also known as a graph in mathematical terms. The topological properties of the map are visually and mathematically analyzed in the second stage using graph theory. As a result, graph-theoretic measurements are used to identify the majority of linkages between spatial and social systems. In the third stage, mathematical metrics produced from the map are utilized to interpret the original architectural plan's numerous social or perceptual aspects.

1. Observation

Before designing and performing observations, field trips are frequently scheduled to get a basic understanding of the site conditions and surrounds, to indicate critical functions or land uses in the layout, and to make early judgments on where to assign observation areas. In order to generate a quantitative description of movement behavior in the public domain, consistent and well-structured observations on site are usually planned to assess real movement and occupational behavior as well as evaluate spatial expectations (Powell, 1996).

We watch to see how much we can learn about the environment without considering people's intentions. When asked why they are going somewhere, people usually respond why they are going, not how they plan to get there or what they plan to do on the way (Bhasin, 2020). Individual intents are unaffected by communal activity within buildings or urban surroundings, which results in a pattern of use and movement that is independent of individual goals. Observations allow you to retrieve information that may be used to form an objective picture of human behavior in the built environment (Powell, 1996). However, when conducting observations, considerable caution should be exercised, particularly if the observer is considered a participant in the social sphere that occupies the geographical scene.

Our understanding of housing influences how we plan and design a house. So to understand first step observe. When it comes to space analysis, being overly reductive in your analytical procedures is something to avoid. The lived experience of the chosen space cannot be ignored while analyzing space, as the research proposes (Mcleaod, 2015). Without engaging with the experiential side of a building, it is impossible to truly comprehend its construction, function, or architectural element. This experiential link through body movement, as well as more; that is, to actually 'participate' in activities in space rather than just observe it from the outside (Grajewski & Vaughan, 2001).

Space syntax Observations are a collection of approaches for observing movement flows and patterns of space utilisation in large structures or metropolitan settings. Although these strategies were created expressly for Space syntax Research, they are similar to techniques utilized in other sciences and fields (Bhasin, 2020).

We employ a combination of methodologies to develop our research (e.g., surveys and land use maps, time-lapse photography, questionnaires, interviews, and so on) that are most appropriate for our research issue. An inquiry into social behavior can be done in a variety of ways. In the following sections, we'll go over a few of them (Grajewski & Vaughan, 2001).

2. Space syntax method

2.1.The theoretical background of the space syntax analysis

The fundamental method of space syntactic analysis was first investigated in the 1980s at University College London's Bartlett School of Architecture. An introduction to the analytical process was provided in a paper published in Environment and planning (Hillier et al., 1976). Its authors established a morphological language that used special characters to explain the fundamental characteristics of space. Hillier and Hanson (1984) first showed this idea, which is now used to investigate, predict, and assess the likely implications of design options. It is a theory and method for describing invariants in constructed spaces in particular. Relationships and interactions are contained in space (Couclelis, 1992 cited in Jiang et al., 2001). To put it another way, space is a configurable thing. The concept of spatial configuration serves as the foundation for the abstraction and integration of generic features, structures, and transformations in human settlements and civilizations in Space syntax theory (Fürstand, 2007).

The urban grid is one of the most important concepts in Space syntax theory. It's a pattern of public space that connects the buildings (Hillier, 2001). Given the importance of urban grids in the creation of living cities, their interactions with movement are frequently studied. As the powerful force that keeps the entire urban system together, urban grids are characterized as static core parts of urban systems that have a strong influence on the long-term dynamicity of urban systems and movement (Hillier, 2001). Then society's relational systems are strongly coupled space-time relational systems, with space time relations and events / activities as individual relations (Hillier & Netto, 2001).

Based on these outcomes, Space syntax theory provides its organic definition for a society as an evolutionary abstraction imposed on space-time reality. In this society, space is acted as an inverted genotype. It means that the required information to reproduce cultural patterns of space is found in the spatial configurations themselves as relations / interactions. Individuals who make up such an organic society (e.g. built areas and activities) are clearly well-defined space-time things and the spaces between individuals are filled up or overcome by the space-time relational systems. These imply movement in societies ((Hillier & Netto, 2001). Space syntax theory proposes an organic definition for a society as an evolutionary abstraction imposed on space-time reality based on these findings. Space functions as an inverted genotype in this culture. It indicates that the knowledge needed to recreate cultural patterns of space can be found in the spatial configurations themselves as relations / interactions. Individuals that make up such an organic society (for example, built places and activities) are clearly defined space-time items, and space-time relational systems fill in or overcome the gaps between them. These imply that societies are moving ((Hillier & Netto, 2001).

The rejection of space's metric qualities underpins the entire notion of space syntax. Instead, topological data isused to represent spatial configuration. Topological graphs display intrinsic traits. The representation of relationships between elements becomes the central focus of spatial analyses, which employ an urban grid to investigate social use of space (Emo et al., 2012).

There are two scales of space: large and small (Egenhofer and Mark, 1995). Small-scale space is probably greater than the human body, but can be viewed from a single vantage point, whereas large-scale space is beyond human perception and cannot be perceived from a single position (Jiang et al, 2000). Residential and cultural elements, which are variations, dominate local scale, whereas commercial and micro economic forces, which are invariants, shape global scale, according to Space syntax theory. When it comes to invariants, Space syntax theory introduces a universal pattern that maybe retrieved from global scale space-time relational systems. It's referred to as a distorted wheel pattern (Hillier, 2001). This pattern is utilized to explain movement in the first place. The impact of variants on a society is also investigated by looking at the degree of deformation in its distorted wheel pattern.

The term "space syntax analysis" refers to a theoretical and analytical collection of tools for identifying, comparing, and interpreting patterns in the spatial arrangement of space. It is a set of techniques that can capture the space configuration arrangement statistically and qualitatively and demonstrate a strong correlation with human movement and usage of space. There are three elements to Space syntax. For starters, it is a collection of tools for analyzing cities as networks of space produced by the placement, grouping, and orientation of buildings. Second, it is used to examine how these spatial networks connect to functional patterns such as mobility, land use, a real differentiation, migratory patterns, and even social well-being and malaise (Emo et al, 2012). Finally, it is a collection of ideas regarding how urban space networks in general connect to the social, economic, and cognitive elements that form and impact them. It's vital to define the term "space" in the context of Space syntax before going any farther with the theory. Voids (empty spaces) between walls, fences, and other impediments or obstructions that hinder (pedestrian) traffic and/or the visual field are classified as spaces. There are both private and public places in every human settlement. The fundamental focus of the Space syntax analysis research is the structured complex of public and private spaces, which often takes the form of a building or urban planning. The outside aspects of spaces, such as how they are related to one another, are more important than their internal measurements in meters in space syntax (Hillier, 2001). In Space syntax, topological patterns are studied. Documentary proof is less dependable than topological qualities (measuring error). They enable for a more objective investigation and comparison of settlements. The major purpose of the Space syntax application is to look into how public spaces are laid out and how they connect to private spaces (Fürstand, 2007). The way objects are connected has an effect on economic activity. The idea that humans live in a finite area of space is the foundation of space syntax. They have no choice but to seize control of the area and travel from one location to the next in order to do anything. Moving through space, interacting with other people, and even simply viewing ambient space from a point in it all have a natural and necessary spatial geometry: movement is essentially linear, interaction necessitates a convex space in which all points can see all others, and we see a variably shaped, often spiky, visual field we call an isovist from any point in space (Hillier, 2001) (Figure 17).

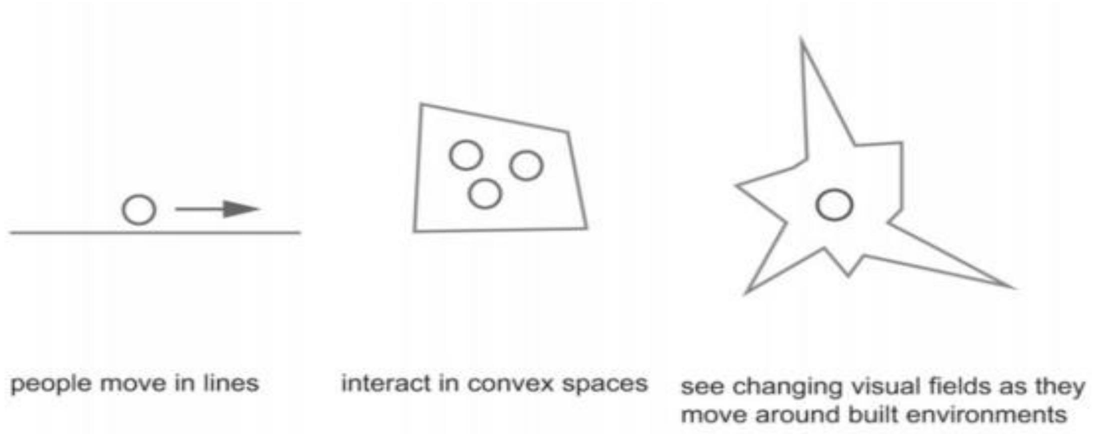


Figure 17: Relationship between space and activity: Space is an integral part of activity, not just a backdrop. (Source : Vaughan, 2007)

2.2. Application of Space Syntax in historical studies

Given its architectural roots, it's fascinating to see how many space syntax experts have opted to focus their work on historical topics or views (Griffiths, 2012). This is a test ament to Hillier and Hanson's emphasis on advocating a specifically architectural knowledge of spatial configuration that enables comparative analysis of buildings and settlements across both space and time preventing the casual projection of sociological discourses onto architectural form that might be better approached through other, less discursive, perspectives (Hillier, 1973). Given this unique contribution, it's worth considering what sort of history space syntax researchers perform and how they may contribute to urban history more broadly from a broader interdisciplinary perspective (Desyllas, 1997).

Julienne Hanson's historical work is just too diverse and important to the development of space syntax as a discipline to be fully represented here. Hanson's work is clearly divided into two sections: one pertaining to the urban scale, particularly London (Hanson 1989a, 1989b, 2000), and the other relating to the home scale, as summarized in her book Decoding Homes and Houses (1998). I'd venture to say that there's a little difference in emphasis between the two areas of employment (Griffiths, 2012). Several studies have employed computer-based spatial analysis to explore historic and prehistoric space, both domestic and ceremonial, in recent decades. In archaeology, the entire land scape has been the focus of these studies, rather than a specific urban center or construction. Archaeologists and historians are fascinated by the study of urban structures. A number of formal spatial analytical methods to the study of human interaction, experience, and socialization in the built environment are beginning to develop (Clark, 2007).

2.3. Space syntax methods and tools

2.3.1. Axial line analysis

Axial line analysis is the best approach for analyzing the street network. To analyze the urban environment, we must first build an abstracted representation of it with an emphasis on topology. It's known as a "axial map" in Space Syntax (Turner et al., 2005). The axial map of an area is produced on the basis of the open-space structure in a plan and consists of the fewest number of straight lines of sight that travel through all of the open spaces in an urban region. It is a depiction of metropolitan area in terms of the longest and shortest lines required to traverse through all public spaces (Liu & Jiang, 2010). This reduced representation may then be converted into a graph, in which a line is represented as a node and intersections between lines are represented as connections between nodes (Figur19). However, due to advancements in the program Depthmap (Turner, 2007), the most common manner of showing Axial map analysis findings is to color axial lines according to estimated values ranging from red to indigo through orange, yellow, green, and blue (Figure 20).

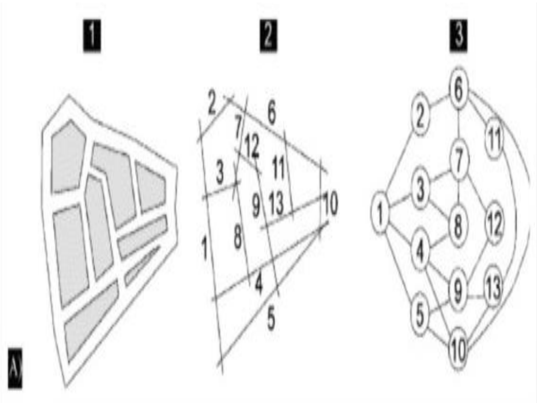


Figure 18 : Axial representation (Jiang et al, 2000) Figure 20. Axial map analysis of Vienna center

2.3.2. Visibility graph analysis (VGA)

Visibility Graph Analysisis one of the most complex techniques to space syntactic theory (VGA). This method includes a quantitative examination of visual characteristics in the built environment, as well as modeling and comprehension of how the space may be utilized and experienced by its occupants. VGA is based on a graph representation of the constructed environment's gross geometry. The space is articulated into a tiny grid to generate the representative graph (Othman et al., 2019). The grid is transformed into a graph, with the grid units represented by the vertices. If two vertices are mutually visible, the graph's edges are formed (though there can be a metric limit for a visible distance). One advantage of this visibility network is that the vertices preserve the precise geographic characteristics of their respective points. Following the construction of the graph, the common metrics of space syntax may be computed (Turner el al, 2001).

A 'global' and a 'local' graph analysis using the visibility analysis. All of the global metrics are based on calculating the shortest routes between each node and all other nodes in the visible graph. The local measurements are determined by the connections between each node and the nodes that are immediately linked to it. Because various types of visibility graphs might take significantly longer to analyze for global or local measurements, the two are separated (Li et al., 2009). Each measure is given a name that starts with the letter 'Visual' once it has been calculated. This is to separate VGA measurements from later-calculated metric and axial measurements. The graph's global metrics include' mean depth,' 'node count,' integration, and entropy.' The mean depth, like the step depth, is determined for nodes (Othman et al., 2019).

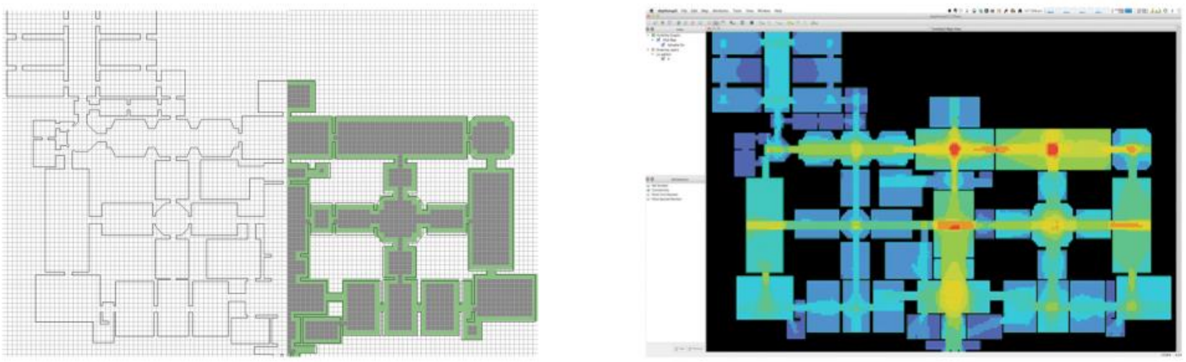
The most fundamental ones are **connectivity** and **depth**. The number of visible grid cells from a grid cell, or the number of vertices directly linked to the corresponding vertex, is the connectivity value for that grid cell. This metrical so reflects the area that may be seen from a specific location in space the shortest distance between two grid cells or graph vertices is defined by the depth (D). Step and angular are the two most common non-metric depth definitions in VGA. The number of edges between two vertices is defined as the step depth. This number represents the number of distinct straight path ways a person must take to go from one place to another in the space.

Integration' is a metric that is simply a normalized version of the mean depth, and it is significant because, as mentioned in the introduction, it has been found to correlate strongly with pedestrian movement 'gate' counts. 'Normalisation' is a method of making dissimilar systems comparable to one another by imposing a value in the 0–1 range. This is what Hillier and Hanson accomplish initially, to create the relativised asymmetry. They do, however, divide by a quantity called the d-value, which is designed to account for the fact that as axial map graphs increase, the lines intersecting them get less integrated. As a result, a small system always appears to be more integrated than a large system. Depthmap just applies the d-value to VGA graphs indiscriminately, and the result is termed 'Integration (HH)'.

Depthmap also calculates a final set of global measurements known as **entropy**. Turner (2001) goes into detail about this. The distribution of places in terms of their visual depth from a node, rather than the depth itself, is measured by entropy. If several places are visually close to a node, the visual depth from that node will be asymmetric, and the entropy will below. The entropy of a scene increases when the visual depth is spread more equally. The anticipated distribution from the node is factored into relativised entropy. The ability to specify a 'radius' for global measurements is also available. **The radius** is the same as the radius used in axial analysis. Depthmap calculates 'clustering coefficient, control, and controllability' as local metrics. Watts and Strogatz (1998) developed the clustering coefficient as a metric for determining whether a graph is a 'small world' or not. A 'small world' is one with closely concentrated groups of friends, yet a remarkably low mean depth. **The clustering** coefficient appears to indicate the 'junctionness' of locations 2, as well as how visual information changes within systems, possibly determining how a route is seen and where decision points are located within it (Turner et al. 2001).

Control is a metric proposed by Turner, whereas controllability is a measure proposed by Hillier and Hanson (1984). Control, as the name simply, identifies visually dominating regions, whereas controllability identifies areas that may be readily dominated. Controllability is considerably simpler to define: it is just the ratio of the total number of nodes up to radius 2 to the connectivity for a given place (Varoudis & Penn, 2015).

Even for modest structures, a visibility graph is generally a complex system that requires the use of a computer. As a result, color-coding grid cells is commonly used to show visibility graphs and their analysis findings. The colors reflect a measure's relative values. At the moment, depth Map is the most widely used program for VGA. Depth Map Xis the most recent iteration (Varoudis, 2014). On a low-end computer system, Depth Map provides a common platform for VGA, but depending on the geometry of the floor plan, the measurement may take a lengthy time (up to hours) (or street plan). In such instances, the lengthy analysis may slow down the research process or encourage the researcher to lower the grid resolution in order to obtain a faster but less thorough answer. These two difficulties prompted the authors to create a new, quicker tool, which they dubbed Viraph (standing for Visibility graph). While Viraph's primary objective was to speed up the VGA method, throughout the development and testing of Viraph, numerous different approaches to the raw depth data developed. Some of these options were eventually found to be valuable and relevant to the research, and were therefore integrated into the software (figure 19).



A) VGA steps: buidling the grid (left) - Filled space (right)   B) Typical VGA result - depthmapX

Figure 19: VGA with depthmapX

2.3.3. Isovist

Tandy introduced the concept of isovists into spatial analysis for landscape study, but it was Benedikt (Davis & Benedikt, 1979) who first treated isovists as a tool for architectural space analysis. Benedikt's primary contribution was the development of different measurements of isovist characteristics, such as area, perimeter, occlusivity (the fraction of the perimeter located on the solid border of the environment), and various measures of the distance from the perspective to the perimeter. Benedikt interpolated the characteristics of point isovists at a grid of places in the open space of a configuration to get 'isovist fields.' He also devised a contour map of a 'isovist field' to depict the fluctuation in these many isovist characteristics as they move across the environment. The depiction of the spatial environment was the focus of this effort. Isovists have been employed for demonstrative reasons in space syntax analysis in the form of 'convex isovists' (the union of all point isovists inside a particular convex space) because they provide a clear depiction of the strategic perspectives from a specific position. Isovists have been employed for demonstrative reasons in space syntax analysis in the form of 'convex isovists' (the union of all point isovists inside a particular convex space) because they provide a clear depiction of the strategic perspectives from a specific position (Othman et al., 2019). Despite the fact that isovists appear to offer very suggestive means of probing spatial arrangement, their use has been restricted to far. There are two primary causes for this, according to us. First, there's the challenge of producing them, which was formerly a time-consuming process. Second, despite their sensitivity to space shape, isovists give basically 'local' configuration measurements, whereas space syntax research suggests that the global characteristics of spatial configuration are crucial in defining the functional implications of design. Isovist field measurements used by Benedikt are all local, capturing the attributes of a single visual field at a single point in space, whereas Peatross and the HMSO guide utilize isovists to describe observations of behavior as being 'with insight' or 'out of sight' of a single (single) place (Turner & Penn, 1999).

2.3.3.1. Making an isovist graph

An isovist graph is a network in which each node represents a point position inside the open space of a configuration and these nodes are linked according to one of two criteria. The first rule establishes a link in the network between two nodes if they are mutually visible (Figure 20). The second criteria establishes a link if the isovist polygons from each node location intersect (Figure 21). For ease of usage, the node points are placed on a user-specified grid at a predetermined height above the ground plane (Turner & Penn, 1999).

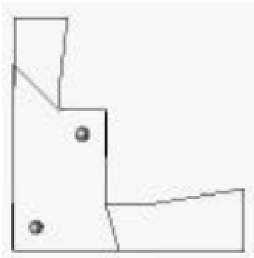


Figure 20– Direct intervisibility of nodes

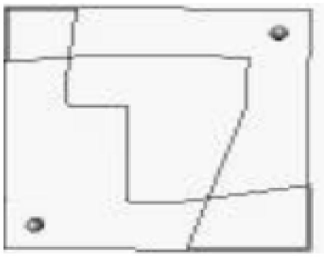


Figure 21 - Overlap of isovist polygons

2.3.3.2. Isovist Integration in building space

At the building interior scale, significant progress has been made in validating the new type of analysis, and the approaches are already being used on major retail interior projects. A study of the Tate Gallery in London was conducted to test the methodologies for anticipating pedestrian movement behavior. The Tate Gallery had previously been researched (hiller, 1996b) and provided a well-understood situation for evaluating isovist integration. The results of applying isovist integration to a Tate model are shown in (Figure 22).

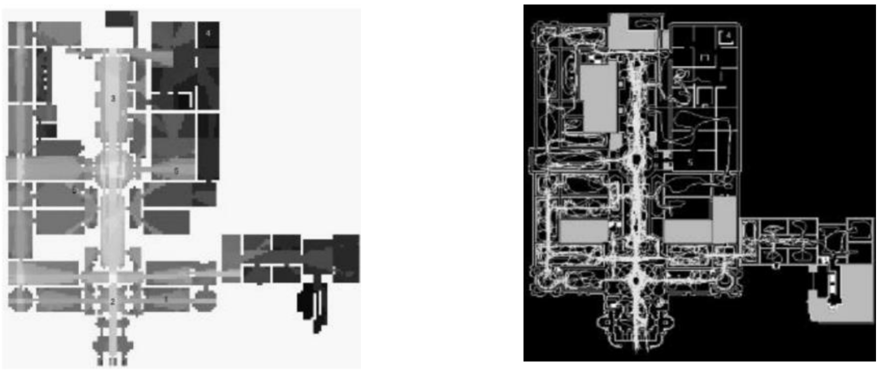


Figure 22: a-isovist integration for the Tate Gallery, Millbank b- Real people movement, first 10 minutes, in the Tate

2.3.4. Convex analysis

The study of convex space Hillier and Hanson used the term "convex space" to describe places in a system where two-dimensional organization may be found by taking the convex spaces with the best area-perimeter ratio, that is, the attest, then the next fattest, and so on, until the entire surface is covered. A convex space is split according to its topographical features, which are characterized by physical settings such as walls, entrances, windows, columns, steps, and social settings such as meeting areas, rest areas, pavilions, and halls. Convex space is produced without physical settings but with people's mobility in activities in scenarios when individuals link their social activities to a specific region of space (Kinda et al, 2014).

Convex maps are another syntactic representation of architectural space. The spatial complexity of a layout is reduced to the fewest and fattest convex spaces in a discrete convex map, which reflects adjacency connections. All pairs of points in a convex space are visible to each other. Spaces that are immediately nearby will have one step of depth between them, whereas spaces separated by at least one space will have two steps of depth between them, and so on. To put it another way, depth between two spaces is defined as the smallest number of syntactic steps –or topological distance – required to travel from one space to the other in a network (Carranza, 2013).

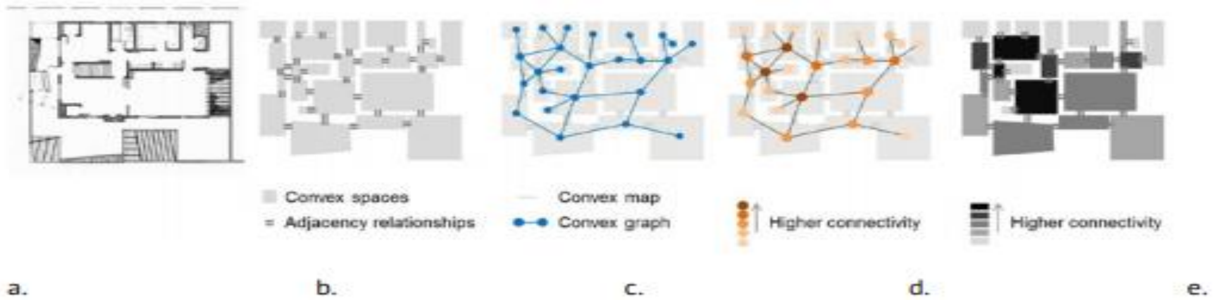


Figure 23: Space Syntax as a convex representation. The fewest and fattest convex spaces describe an architectural space (b), convex spaces are represented by a graph (c), and the graph Connectivity is highlighted in (d & e).

Figure 23 -depicts an example of using the convex space representation to decode a Frank Gehry building plan. To represent architectural space, a collection of the fewest and fattest convex spaces could be employed (a.). Where there is direct access from one place to another, these spaces are linked to form a convex map (b.). A graph is then used to depict the convex map (c.). Each vertix's various Connectivity (degree) values are then highlighted ; vertices with more connections to their immediate neighbors will have higher Connectivity values (d.) (Paul, 2011).

2.3.5. Justified graph analysis (JGP)

The descriptive methods of justified graphs, initially given by Hillier & Hanson, can be used to illustrate spatial connections between neighboring areas in a layout (1984). A justifiable graph traverses a convex space network from one space (root) to all others, with each convex space represented by a circle and each permeable link between two spaces represented by a line, as in (figure 24). All spaces one syntactic step away from a root space are leveled on the first level above the root space, all places two steps away are leveled on the second row, and so on. Depending on the connection between the root space and other spaces, a justified graph might be deep or shallow. Branching trees or looping rings are examples of spatial connections.

Figure 24: Different spatial typologies marked on a graph representing the relationships between convex spaces. The two graphs elucidated here are; a justified graph that is being laid from the point connecting the exteria to the interia of Frank Gehry's house (a.) and an adjacency graph overlaid on top of a convex map (b.).

If "A links to B "is equivalent to "B connects to A," à spatial relationship between two spaces is said to be "symmetrical". The connection is called 'asymmetrical' if it is not otherwise. The overall degree of asymmetry in a plan at each point is proportional to the mean depth from that point, which is assessed by 'relative asymmetry' (RA) (Kinda et al, 2014). The most integrated places in a spatial network are those that are geographically closest to all other locations (low RA). Because of their prominent location in the spatial network, they often allow intense traffic to pass through them. The most separated spaces are those in deeper places (high RA). The spatial network's global characteristics are integration and segmentation (Paul, 2011).

Hierarchical structures and circulation rings are frequently used in spatial design. Normally, a tree-like spatial structure represents a deep and regulated spatial structure, as well as a possible hierarchy in the social organization that fills a building. Providing interconnected movement rings in a plan, on the other hand, provides options for movement routes without lowering the depth of space. Each convex space's spatial typology is likely to change based on its relationship to movement rings.

Hillier (1996) identified four distinct sorts of spaces:

• a-types ; which are known as dead-end spaces because they link to only one other space in a network.

• b-types ; link to two or more graph spaces without being a part of any movement ring.

• c-types are generally centered on a single ring of motion.

• d-type ; The number of spaces in a shared location linking two or more rings must be the same.

The total spatial depth of a layout may be determined by the placement of a, b, c, and d types of spaces within the local and global settings of the entire network. A local increase in the number of a-type spaces combined with a global increase in d-type spaces would result in a reduced spatial depth, resulting in an integrated system, whereas a global increase in b-type spaces combined with a local increase in c-type spaces would likely result in a maximized depth, resulting in a segregated system (Oswald, 2011).

It is possible to apply the representational scheme of justified graphs to both axial and convex graphs (Kinda et al, 2014).

3. The research methodology: space syntax and techniques

The goal of Space syntax research is to develop descriptive methodologies for constructing inhabited areas in a way that articulates the underlying social meaning. This, in turn, might lead to the development of secondary theories or, more typically, practical explanations for the effects of spatial layout on various social or cultural variables. Understanding configuration space, particularly its formative process and social meaning, is a relevant issue in Space Syntax research (Bafna, 2003). The aim of the space syntax researchers was to devise a system for analyzing space that was devoid of form. This strategy necessitated a rigorous, reproducible, and rational method of studying spatial topology. Hillier and Hanson (1987) proposed a method for describing or abstracting a building's plan in such a way that its configurational or structural qualities can be visually and mathematically analyzed, and the results can then be used to understand various properties of the original design. This three-step process of abstraction, analysis, and interpretation was repeated in all early space syntax techniques. The abstraction process, which created graphs with varying architectural qualities depending on the variation utilized, was the key factor that differed between these methodologies. While the mathematical principles, techniques, and formulas remained mostly unchanged, the interpretation of the results was adjusted to study or critique the specific elements of the mapped plan.

Each of the major space syntax techniques starts with the abstraction of the plan into a map of elements and their connections, which results in a graph of nodes and edges. The convex space technique, for example, begins by abstracting the environment into the fewest number of visually coherent regions and their connections (Ostwald & Dawes, 2012). These spaces are convex in shape when derived from an architectural plan, which means that their whole perimeter is visible from any position within. This method is used to look at the configurational relationship between spaces as defined by the amount of space that can be passed between them. As a result, the map is essentially a graph of nodes (spaces) and their connections (or adjacencies) (edges).

The maps that are developed during the first stage of the spaces in an architectural design, which is a graph of room (nodes) and doors that provide access not only between rooms but also between them (edges). Controlling access not only between rooms, but also between the exterior and inside of the structure, is a major functional necessity of such a plan.

As a result, in architectural analysis, an additional node representing the outside world, denoted by a crossing circle, is usually always added. As a result, a plan's spatial structure maybe mapped using the set of rooms plus the exterior, as well as the relationships between them.

The spatial layout not only looks but is different when observed from different points of view in the layout' (Hillier 2005: 101) is an essential notion in syntactical analysis. A permeability graph can be adjusted in a variety of ways to highlight different aspects of the design in order to visualize how this difference works. For example, organizing the spaces in relation to the exterior can depict the accessibility issues that visitors confront.

The 'carrier,' which is the space at the root or foundation of the rearranged graph, is traditionally placed at the bottom of the graph, with spaces related to it positioned above it, and so on. The graph is 'justified' in relation to distinct carriers in this procedure. A graph can be justified in as many ways as there are nodes in it. The graph's topological structure is preserved while alternate intuitive readings of the plan's properties are supported (figure 25). Importantly, changing the carrier in this manner has no effect on the graph's mathematical features (Ostwald, 2011).

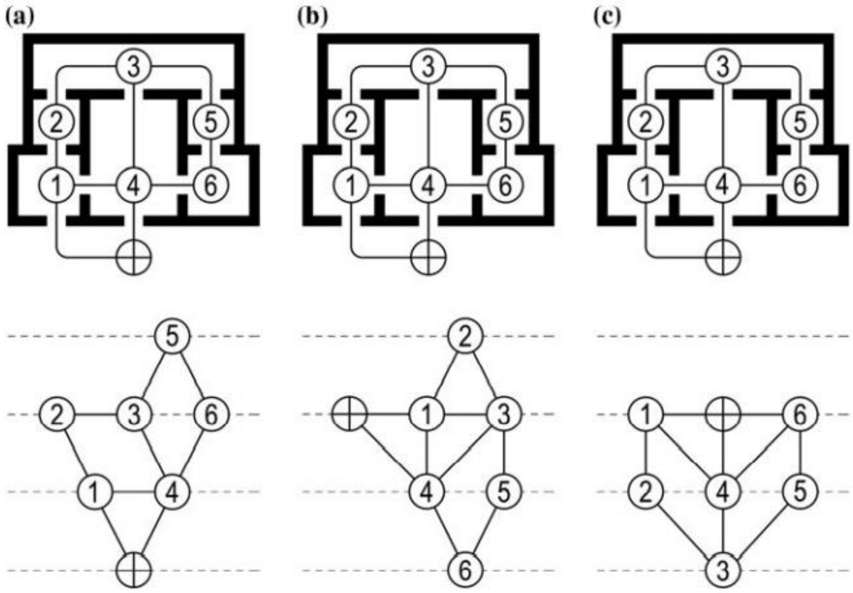


Figure 25: A visitor, an occupant in a more public space, and an occupant in a more private space are all represented by graphs of a plan justified to reflect different spatial positions: a visitor, b occupant in a more public space, and c occupant in a more private space. (Source: Ostwald & Daws, 2018)

The mathematical examination of the freshly abstracted map of spaces, pathways, or intersections is the second stage in the conventional Space Syntax approach. The study usually starts with the calculation of simple summative measures, such as the number of nodes, edges, or types of social spaces (such as "public" or "private" spaces). These can be compared to the results of other, similarly generated graphs as a percentage of the total. In most cases, the centrality or proximity of each node to all other nodes serves as the basis for comparison. Nodes' Total Depth (TD) or Mean Depth (MD) are usually determined, as well as metrics of Relative Asymmetry (RA), Control Value (CV), and integration (i). To be helpful, however, several of these indicators must be normalized in some way to allow for comparisons between graphs of different sizes. The solution proposed by Hillier and Hanson (1984) to this problem was the Real Relative Asymmetry (RRA), which is derived from a formula that normalizes relative asymmetry values against those of an idealised diamond-shaped graph is not always compelling, and many other graphs could also be used as a standard for normalization (Teklenburg et al. 1993). Of the mathematical analysis are applied to interpret a construction plan, remains a contentious topic. Khadiga Osman and Mamoun Suliman, for example, claim that the "interpretation process of numerical data remains difficult [and] subjective" (1994: 190). The explanations and methods, according to Kim Dovey (1999: 24), are "at times exceedingly difficult to follow," and the interpretation is overly reliant on imprecise terminology. Most typically, numerical results are provided and utilized to sequence or compare the values produced from various nodes in the various Space Syntax approaches, before the overall features are qualitatively defined in terms of spaces that are either' shallow' and 'integrated,' or 'deep' and' segregated.' generated values, on the other hand, can be 'related to psychological characteristics such as memorability' (Montello, 2007: iv). The parts that follow focus on the four key abstraction approaches, how they work, and how they've been utilized to understand the graph analysis results.

4. Reasons of Adopting “Space Syntax” as a Methodology

Space Syntax is a method for analyzing spatial configurations that was developed. Its goal is to describe spatial models and depict them numerically and graphically, in order to interpret them scientifically (Dursun, 2001; Dursun and Saglamer; 2003; Hanson, 2003; Asquith, 2003, 2006; Dursun, 2007; Manum, 2009). The following are the reasons for using this methodology to deal with the syntactical properties of spatial configuration:

1. This methodology is able to analyse spatial-functional systems using both physical and social variables in order to detect differences and similarities in their arrangements. This provides the way for effectively diagnosing the different features of houses‘s plan.
2. In order to comprehend the structures of various housing layouts, it uses the syntactical features of spatial arrangement (such as Symmetry – Asymmetry, Distributedness – Non-distributedness). As a result, analyzing, assessing, and comparing these varied systems become much easier.
3. The ability to assess, interprets, explain, and model a wide range of formal and spatial systems lends credibility and reality to the research.

5. Convex space analysis

One of the two original methodologies given in The Social Logic of Space is convex space analysis. This method reduces the environment to the smallest number of visually coherent areas, referred to as convex spaces. Convex spaces are sometimes referred to as an environment's "fewest and fattest spaces that cover the entire design, with the former always dominating over the latter" (Markus 1993: 14). A psychologically self-contained unit of space, a convex space is one in which every point on the perimeter is visible from every point within. It's also a place where, according to Hillier and Hanson (1984: 98), "no line drawn between any two points in the space passes outside the space." As a result, a 'L-shaped' space is not convex and must be divided into two smaller areas to satisfy the criterion (Fig. 2.6). Convex spaces are places where people can interact in a visually consistent way. A 'convex map represents the maximal units of possible reciprocal coawareness that are inferred by a given disposition of boundaries,' according to John Peponis and Tahar Bellal (2010 : 984). The most common subjects of convex space research are architectural interiors, because these environments tend to have well-defined two-dimensional spaces, as opposed to urban scale regions, which are often characterized by long streets with a lower level of visual coherence.

Visual interpretation of a convex graph, like any other spatial graph, is also possible, albeit it is necessarily more subjective. When justified with a specific carrier, the graph's shape, for example, can be used to define the graph's general features in relation to that carrier. Thus, depending on how shallow or deep the hierarchical structure is, a graph with a branching or arborescent topological structure is typically described as 'bush-like' or 'tree-like. 'Because users must travel through some critical places each time they want to reach other portions of the plan, arborescent buildings strike a compromise between flexibility and control. More linked networks have a rhizomorphous topological structure, which is frequently referred to as "looped," "ringed," or "latticed." Rhizomorphous structures give its residents a lot of freedom and flexibility in terms of how they move through space. Linear graphs with an enfilade structure, on the other hand, impose a high level of control over an occupant's spatial experience.

The use of convex space analysis to discover structural genotypes is common (Hanson et al. 1987; Conroy-Dalton and Kirsan 2008). For a specific programming type, a structural genotype is a socially sanctioned, optimal spatial configuration. A consistent investigation of a large number of functionally equivalent buildings within a specific socio-cultural setting is required to identify a genotype.

The big success of spatial syntactic analysis has been to show a social ideology inscribed in structural genetics,' says one author (1999: 24). Power interactions within institutional buildings (Markus 1987, 1993; Dovey 1999, 2010) and historic spaces (Ferguson 1996; Cooper 1997; Bustard 1999; Dawson 2001) have been studied using convex space analysis. It's also been utilized to get a glimpse into how architects think about spatial and social frameworks (Bafna 1999 ; Major and Sarris 1999; Ostwald 2011b, c). Convex space analysis has also been used to generate new layouts parametrically that imitate specified socio-spatial aspects of past designs (Yu et al. 2009).

6. The Methodology: Justified graph analysis

This section will cover the space syntax methodology's justified graph (JPG), as well as the criteria used to pick the sample and its properties. Bill Hillier and Julienne Hanson (1988) created a collection of theories, approaches, and techniques in the 1980s to identify links between spatial configuration and its social effects. It has been used in both architectural and urban settings. It entails "translating architectural blue prints into topological graphs that are mathematically and graphically evaluated and then understood in terms of their spatial and social qualities ". The justified graph analysis was used to assess the relationship between interior spaces and accessibility. It is considered as a tool to clarify the space configuration, and identify the similarities and differences between plans; this tool explores how to measure the different variables and components that related to the main features of the spatial configuration of the houses layouts. However, the justified graph has been applied to provide comparative results between the different spatial structures.

The analysis of the justified permeability graph that conducted in this study, provide physical attributes of house design, which is a component of place experience, is framed by the concept of 'genotype' and 'phenotype,' which is a set of analogies that Hillier and Hanson (1984) draw from the field of Biology to describe the transformational characteristics of the spatial organization and the physical form of the houses.' The patterns that structure spatial configuration, when found in a consistent way in a sample of architectural cases, are classified by space syntax as « genotype ». The main goal of this study is to know whether the transformation that operated on the organisation and configuration of house layouts are emerging from the same genotype, and does this syntactic analysis reveal quantitatively the underlying spatial structure of Biskra houses?

To compare the spatial pattern with one another, and to interpret their social indications, a justified graph analysis was conducted to highlight configurational differences. This method is the main tool under space syntax methodology; helps to capture important spatial arrangement aspects. Ostwald (2011) claims that the first state in creating a JPG is to convert a plan into a map of visually defined spaces, or a schematic that contains the spaces inside a plan and their linkages. This map is then converted into a graphical representation consisting solely of nodes (spaces) and lines (connections between spaces) that are placed in a hierarchy of levels beginning with 0, the root space.

According to Ostwald, visual analysis of the graph reveals a number of qualitative spatial configuration qualities, spatial hierarchy, and permeability. When a graph contains few levels, we call it shallow; this signifies that the rest of the spaces are easily accessible from the level indicated as 0. When a graph is asymmetric, it indicates that there is less spatial consistency or more deliberation in the graph. Finally, we discover that there is a spatial hierarchy when its shape is arborescent; on the other hand, when it features loops, it is dubbed ring-shaped to explain the permeability of the configuration.

The "tree" graph, which consists of spaces with no alternative means except through the original access, and the "ring" graph, which has alternative means of access to a space. According to (Hillier 1996), each space in a j-graph falls into one of four categories based on its connections, as follows: Spaces of type-A are terminal or dead end spaces. Type-B spaces are through space (transitional), serving as a link between other spaces. Type-C spaces are part of a ring sequence, whereas Type-D spaces are located on two or more rings. These categories influence the possible uses of a space, depending on the desired level of accessibility (Adeokun, 2013).

The values of the variables Total Depth (TD), Mean Depth (MD), Relative Asymmetry (RA), integration (I), Real Relative Asymmetry (RRA), and control value (CV), degree of influence that each node has on the system can then be determined by mathematical analysis of these graphs. The inscription of these values in space and subsequent translation into numbers allow us to compare the spaces inside the configuration and determine the social patterns that their disposition reveals within the configuration based on their degree of depth, integration, and base different factor. In this study the integration values (RA) calculated with and without the space outside. This enables us to analyze the interior-external relationship, which in some situations has a significant impact on the total space design, while in others it makes little difference whether the exterior relationship is included or not in the computations.

Looking at houses with and without outside ties is an important facet of configurational analysis because it helps us understand the relative importance of inhabitant-inhabitant and inhabitant-visitor relationships for home layout and organization. When there are multiple outside entrances to a home, it's also a good idea to look at how the structure unfolds as a justifiable permeability graph for each one, especially if they're functionally distinct.

The syntactical study was used to investigate the changes of the houses layouts on the sample of sixty houses from the four periods: precolonial, colonial, independence, and the contemporary period over time in Biskra city. These houses are selected according to following criteria: the historical, temporal, and architectural value (the structure, material of construction, and the architectural aspect) where the residential tissue adapted to its context. The houses are examined in term of site planning, spatial configuration, and socio-economic factors. The reason for adopting this methodology is its ability to combine the inhabitant's behavior and the socio-cultural factors in interpreting the spatial configuration and functions in order to identify the genotypical consistencies of the houses layouts. Fifteen houses were selected from each period. During the fieldwork, we conducted a semi-structured interview to better understand the modifications that had taken place in the house, as well as a survey of the house to design each person's architectural plan, all with the permission of the interviewees. One of the study's draw backs is that the residents only allowed access to the first floor and public sections of the house, restricting the scope of the investigation to this level.

Despite the fact that most studies using the JPG technique focus on architectural interiors, it was thought that it would be useful to look at attached outside spaces as well in this study. According to the interviews, many activities of the residents are carried out in these spaces on a daily basis. We decided to apply functional space analysis for interior spaces to preserve uniformity across all of the plans. We could investigate the relationship between design and social structure by focusing on functional space analysis.

7. The procedure of analysis

This study aims to identify the underlying genotype and to highlight the similarities and differences of a sample of houses in the city of Biskra. The justified graph analysis was used to specify the structural models based on the syntactic data (Guney & Wineman, 2008). The justified graphs of these houses were embedded and analysed both by considering the exterior as a root and by excluding it. This methodology was adopted to examine different syntactic properties such as integration values (RA and RRA), depth and BDF. This syntactic data of the spatial pattern was analysed quantitatively using the A-graph program as a tool (McLane, 2013). The programme focuses on the conversion of house plans into graphs, in which the nodes represent the functional spaces, and whether the nature of the connection between spaces is a door or an opening, it is represented by a line. These graphs were drawn according to the architectural plans of the houses, starting from the exterior (the root), and aligning the graph of all functional spaces according to their depth and distance from each other. Thus, although each node represents a functional space, several authors (Markus 1993; Hanson 1998; Dovey 1999) have chosen to consider the 'L-shaped' space as a single node (Ostwald, 2011).

This study reviews a number of houses layouts were conducted by the survey includes sixty houses (re-drawn by the author) from different periods of time: pre-colonial (vernacular), colonial, independent, and the contemporary period. As a starting point the selection of houses was based on the temporal and historical criteria and the architectural value, where the residential tissue adapted to its context. The strategy for sampling is to take fifteen house layouts from each period to analyze and compare, whereas the sample will analyze as a whole without grouping them to periods. To discover the underlying characteristics (the genotype) a syntactic analysis was performed. The following steps were followed in this study :

a) First, the j-graph was drawn for each of the sixty houses using the exterior as a root to indicate the permeability sequence of the constituent spaces from the entrance to the interior of the house. The analysis of the spatial configuration focuses on the functional spaces with and without their exteriors.
b) Secondly, in this step, the justified graphs are analysed without grouping them into periods, in order to see similarities and differences within the entire sample. The graph measurement includes the mathematical calculations of the spatial configurations by analysing the different syntactic properties such as MD, RA, and BDF by using the A-graph software, and RRA is calculated manually. The objective of this phase is to identify possible recurrences in the sample.
c) Thirdly, the integration values (RA) were calculated, using the A-graph program for each space of each house in the sample and comparing the integration value of each space with the other spaces of the same house. This allows the structuring mode of the domestic interior of the houses studied to be determined, while the classification of these integration values leads to a better understanding of the morphology of the spatial configuration for exploring the genotype in the sample.
d) The genotype groups were highlighted by using the space link ratio (SPL) indicator and the degree of spaceness.
e) Finally, determine the relation inhabitants- inhabitants and inhabitants – visitors using the degree of ringiness (nature of j-graphs).

- Conclusion

The space syntax makes an important contribution to the growth of environmental design research. It’s a an analytical method for quantifying, describing, and analysing building morphological patterns in order to project the social norms of their occupants. The space syntax procedure used to analyse the spatial configurations by transforming the plans into graphs of different house layouts in order to reveal the underlying characteristics and morphological structure.

Chapter IV

Case Studies Presentation

- Introduction

The majority of Algerian cities especially in the Sahara share a common path of evolution in term of their architectural typology and urban fabrics. Four major periods have been experienced by this architectural and urban mutation (Sriti & Tabet-Aoul 2004): the pre-colonial phase, the colonial phase, independence phase, and contemporary phase.

The individual housing in Biskra city passed through a number of phases from the pre-colonial period to the current period. Biskra city in pre-colonial period was dominated by vernacular architecture (traditional buildings), which characterized by compact urban form. The city was surrounded by a massive palm grove. The vernacular houses have always been able to adapt to the difficult climatic conditions. The word “vernacular house” is used to describe the buildings that have been constructed to fit the culture, the local environment and materials. The architectural buildings in Biskra underwent notable transformation as a result of French colonial rule. In the colonial period, there are houses were influenced by the classical European architecture, and others are similar to the vernacular house in term of spatial organization. They are characterized by large windows in the façades, and an extroverted spatial configuration. The independent and contemporary periods; the vernacular and colonial houses have undergone several transformations. In the new urban fabrics, the parcel limited with clearly defined boundaries, which was not the case in the vernacular fabrics, the houses were overlapping. The architecture of the independent houses are inspired from the modern colonial houses, and the modern houses are strongly inspired by the modern architecture, are features especially by the large surfaces and open to the street opposite to the vernacular house, and characterized by the use of modern construction materials as : the concrete. Modern architecture was founded on the use of new building methods, which led to the industrialization of construction and the creation of a universal style.

1. Ottoman period

1.1. Background

The city of Biskra has a very rich and ancient history, which have many abounding civilization dating back to 8000 J.C. The oldest remains were discovered in 1986 during excavations on the sites where is Biskra university center lies today and the site where the construction for the extension of contemporary city (Agli, 1988). The city had different names among which we find the name of SEKRA (Sugar) which is explained by the abundance of its famous dates called (*Deglet-Nour*) by the local name, whose this Arabic name means finger of light.

Biskra city, characterized by its geographical situation, by its hot and arid climate, its natural resources and especially agricultural lands, and its richness of water, has been one of the main roads of Sahara and major trade route to the south (Adad, Zerouala, 2002). Therefore, it has been home for many civilizations, from Romans to Arabs, until the French colonization. Thus, different urban fabrics and housing typologies have been produced within the city. The core of the city of Biskra has evolved through four main important periods: the pre-colonial (Ottoman period), the colonial, independence and the contemporary period. This paper will focus on the Ottoman period houses.

The region of Biskra was invaded by Ottoman armies ruled by Hossein Ibn Agha in the year 1541 and their occupation was only military (Agli,1988). Turkish garrison was settled in Biskra city, built a fort to be able to control the water of irrigation and expropriated the best gardens. The epidemic of 1650 gave rise to the birth of seven new settlements; M'cid, Gueddacha, Bab Dareb, Bab El Fath, Ras ElGuerria, Korra, Medjniche, scattered inside the palm grove. These seven villages compose the ancient groupings that took shape and evolved following the regulating route constituted by the irrigation canals (Côte, 2005).

The houses from the Ottoman period are scattered within the palm groves, around the old city : “It is a human work based on an autarkic economy, which has challenged the weather and the harshness of the conditions of the desert environment” (Adad & Zerouala, 2002). The houses from Ottoman period that will be referred to as vernacular houses from now on have a rural character and it’s a symbolic place which designed with respect to the environment and the ecosystem by living in harmony with all its components.

A survey has been carried out on 15 houses from three neighborhoods: M'cid, Bab dareb, and Gueddacha, during the summer 2018 as part of the doctoral research, to identify the main features and characteristics of the spaces of these vernacular houses.

The comparative study has shown that these houses share the same properties and the same spatial anatomy. Among the properties of the vernacular houses is the versatility of activities in one space. This paper will discuss the existence of a typology of Ottoman houses in Biskra city, and argue that these houses that form a part of cultural heritage of Biskra can also be interpreted as a common heritage of Ottoman history.

1.2. Ottoman era

The Ottoman Turk occupied more deeply the country; garrisons and pashas settled in various cities in the country could be divided into three regions: Oran, Medea and Constantine which is the most extensive.

Biskra invaded by the Ottomans commanded by Hossein Ibn Agha in 1541, and their occupation was only military (Agli, 1988). Turkish garrison settled down in Biskra city, where they built a fort to be able to control the market of the dates, irrigation water, and the palm grove and also to protect itself from the external danger. The fort was erected on rocky soils and elevated land for the purpose of self-defense, and also for fertile soils. The Ottoman Empire remained in the city three centuries until the French colonization in 1830.

During the Ottoman rule, in 1650, around 7000 people died because of the plague epidemic, and the rest of the inhabitants had to leave the fort and settle in groups scattered inside the palm grove organized in the form of scattered groupings around the old city. This resulted with the birth of the seven historical villages: M'cid, Bab Darb, Bab El Fath, Ras El Guerria, Korra, Gueddacha, Medjniche (figure 26). These seven villages situated in the south of the today's city still exist until today as neighborhoods with most of their houses intact. Theses vernacular neighborhoods are characterized by the compactness of their habitat for climatic reasons, its situation inside the palm grove and the existent of *saguia* (irrigation canal) which supplies palms and inhabited areas with drinking water. The palm grove and the *saguia* are considered as the important structuring elements of the urban fabric for the vernacular neighborhoods for the city of Biskra.

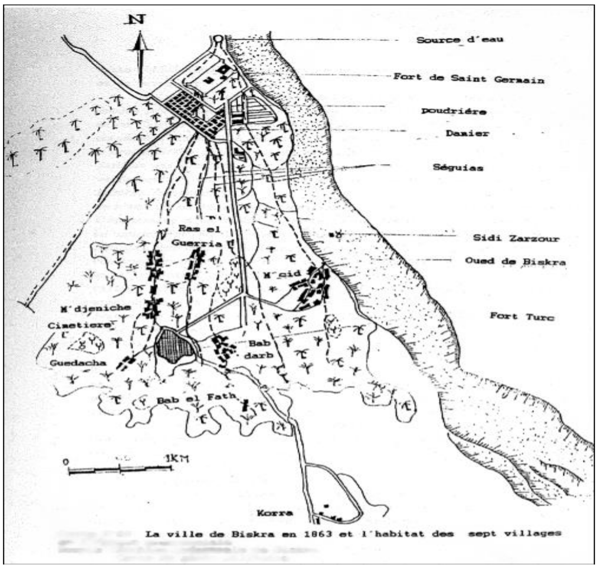


Figure 26: Map showing the seven villages in Biskra in 1863

1.3. The vernacular houses

Vernacular houses by definition have always tried to respond to diverse factors such as the climate, the religion, the socio-cultural factors, and the tradition of its community of builders (Saouli, 1989). The vernacular housing in Biskra city also is characterized by its perfect integration inside the palm grove as scattered groupings, its contact with the water stream and the palm grove has generated a specific urban structure and a typology of habitat of the vernacular nucleus. This architecture is the genie of “a human work based on an autarkic economy, which has challenged the weather and the harshness of the conditions of the desert environment” (Adad & Zerouala, 2002). The vernacular house has a rural character designed with respect to the environment and the ecosystem to live in harmony with all its components (figure 27).

Figure 27: Vernacular house in M’cid neighbrohood

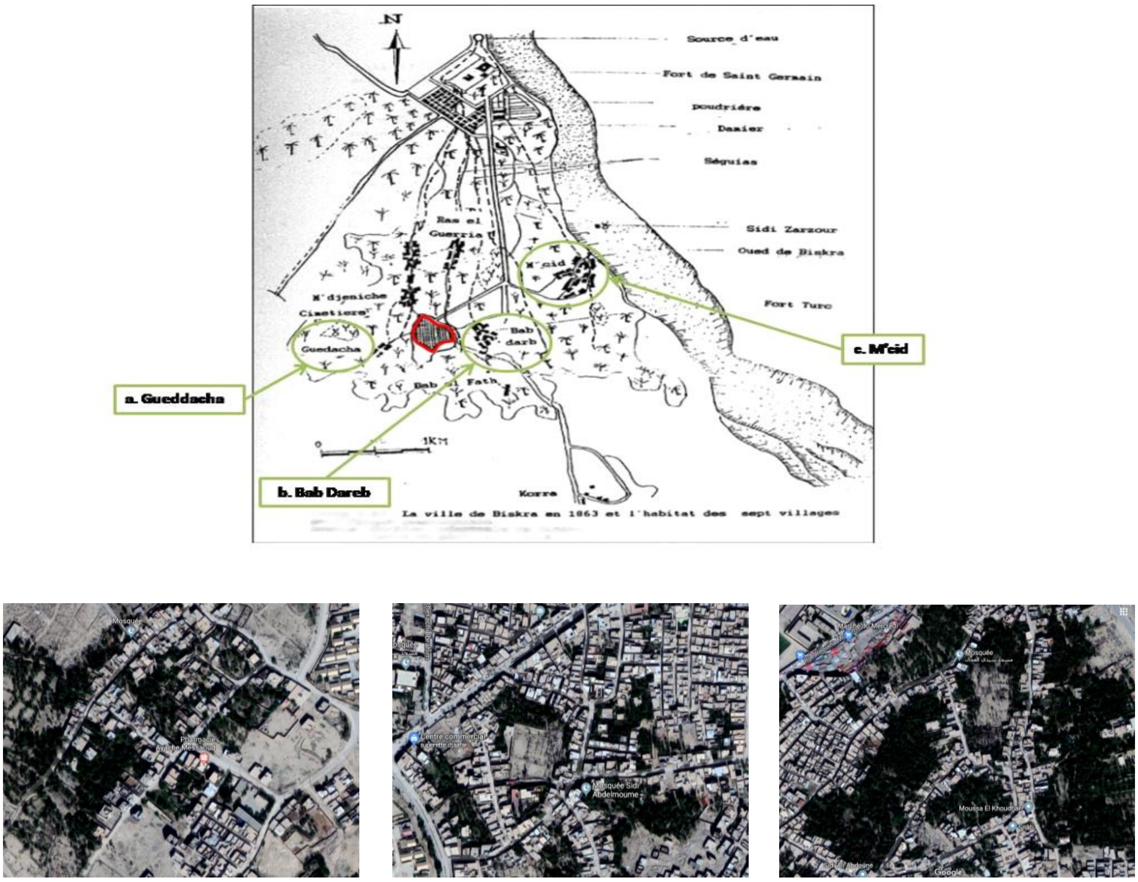
The house' spatial layout is based on some social, cultural, and religious aspects. It defines the interior as a space reserved for women. The vernacular houses in Biskra are a symbolic place, each space fulfilling its role perfectly (Adad, Zerouala, 2002). Generally each space related to economy of the household is located at the ground floor, such as: the stable for raising animals (goats, hens), and underground the *makhzen* (depot) for storage and drying dates. On the ground floor the spaces are arranged around the central space (*wasteddar*) where the daily activities take place and the family gathers in. The '*wasteddar*' is a covered space, whose considered as structuring space which articulates all spaces in the house and which are organized around it, contained an opening on the ceiling and it is the source of light and air to the house, it can be used for a variety of uses such as space for cooking meals, napping, resting, watching TV, and family meeting that could occur both during the day and night (Adad & Zerouala, 2002). It's the structuring space of the house; all the spaces are arranged around this central space. The '*sguifa*' provides the access into the house and considered as a transition and filter space. It has the role of being a screen prohibiting the direct view to the interior of the house, thus allowing the door to be left open all the time during the day (Sriti, 2012). The rooms (*bitt*) are multifunctional spaces for a number of activities: sleep (nap), rest, eat, study similar to general Ottoman houses. The additional spaces include bathroom (*hamam*), the toilet (*rmaya*), and the stable (*couri*).

1.4. The architectural survey: the case and the sample

The present study conducted includes samples from the Ottoman period houses in three neighborhoods: "Bab dareb, Mcid, and Gueddacha" situated at the southern part of Biskra city (figure 28). Being located in an arid area with hot climate, the neighborhoods are distinguished by their integration inside the palm grove and vernacular houses characteristics. The area of M'cid is about 920 ha, where 5991 inhabitants live. It contains 751 dwellings built by the mud bricks. Bab dareb is not populated as the Mcid neighborhood, 4354 inhabitants, and has an area 71,56 ha, and has only 556 dwellings. Gueddacha is the smallest one in terms of the area. Here the total number of dwellings is 407 with 2493 inhabitants.

The urban fabric of the sectors studies is characterized by their irregular urban form random, and interaction with the palm forest, the absence of a clear urban plan, and random distribution and dispersal of buildings without continuity and heterogeneity. Today most of the houses are in bad condition. The original fabric is renewed in several places by demolition and reconstruction of new houses on the site of the old ones (Sriti.L, 2012).

The houses studied are characterized by the use of local material of construction and traditional technique of construction.



a. Gueddacha b. Bab Dareb c. M'cid

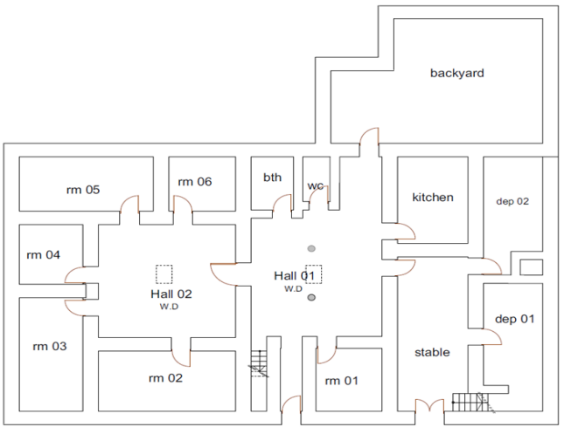
Figure 28: Situation of the three neighbrohoods M'cid, Bab Dareb, Gueddacha

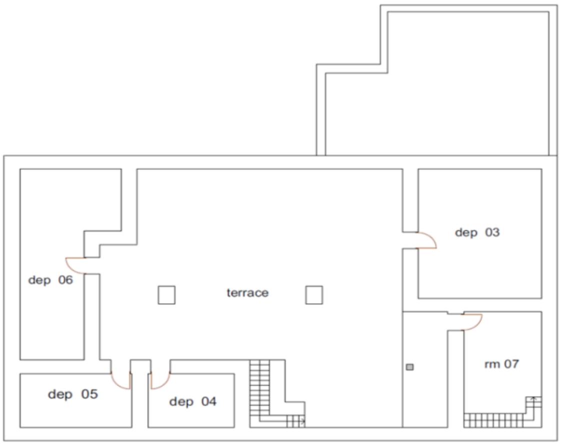
The survey was conducted in the summer of 2018 as part of the doctoral research and includes 15 houses; seven houses from Mcid neighborhood: H_{V1}, H_{V2}, H_{V3}, H_{V4}, H_{V6}, H_{V14}, H_{V15}, four houses from Bab dareb neighborhood: H_{V8}, H_{V9}, H_{V10}, H_{V13}, and four houses from Gueddacha neighborhood: H_{V5}, H_{V7}, H_{V11}, H_{V12} (Table 01). These houses were chosen according to the historical, temporal, and architectural value (the structure, materials of construction, and the architectural aspect) where the residential tissue adapted to its context. The houses are examined in term of site planning, spatial configuration, and socio-economic factors.

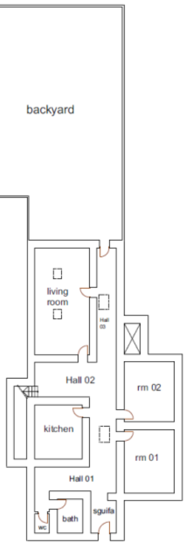
The aim of this survey is to provide a documentation of the vernacular houses to assist in examination of the spatial organization of the houses. The current state of the houses as well as existing ways of living also documented. The economic, cultural, and social aspects that related to the way of life in the original house layouts have been examined through the literature review. The survey enabled to provide the documentation for the representation of the main features of the spatial configuration and has also provided insights to the vernacular houses of the old city of Biskra. The traditional technique of the survey is used, which only needs conventional instruments. Besides, a spatial measurement of different rooms has been conducted, as well as documenting the spatial layout of the rooms, how they are organized in relation to each other. Finally, sketches were turned into plans as they are redrawn using the software Archicad (Table 01).

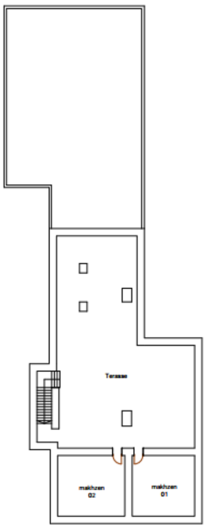
Due to the difficulty of accessing into all the houses since some of the inhabitant didn't allow strangers to disturb their privacy inside the house, a number of the plans are barrowed from the documentation of houses by second year architecture students and some plans from another doctoral research.

Table 01 : The 15 house plans used in this research.

<table>
<tr><th>Houses</th><th>Plans</th><th>Mcid neighborhood</th></tr>
<tr><td>Hv$_1$</td><td>

Ground floor


First floor</td><td></td></tr>
<tr><td>Hv$_2$</td><td>

Ground floor

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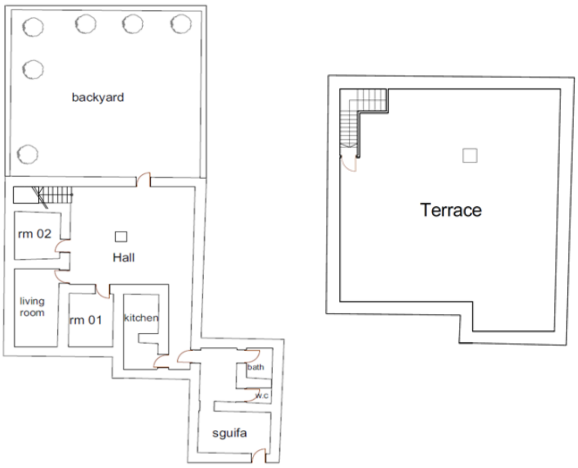
<td>Hv₃</td>
<td>

Ground floor</td>
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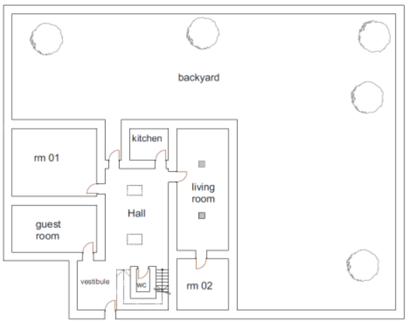
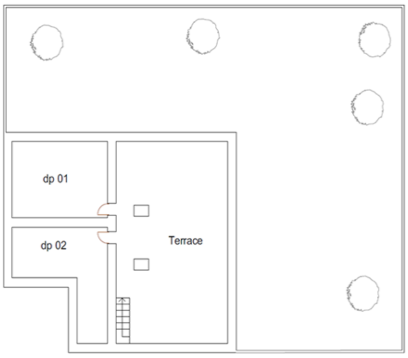
<td>Hv₄</td>
<td>

Ground floor


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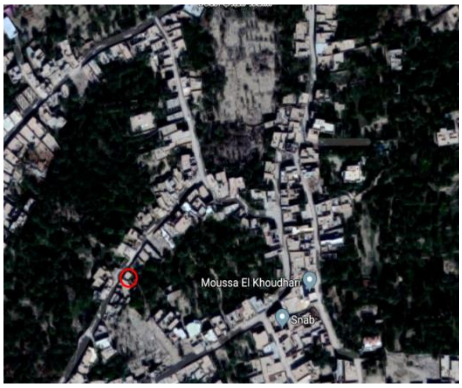
<td>
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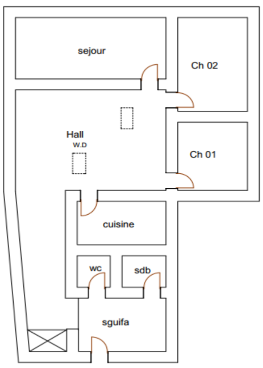
<td>Hv₆</td>
<td>

Ground floor</td>
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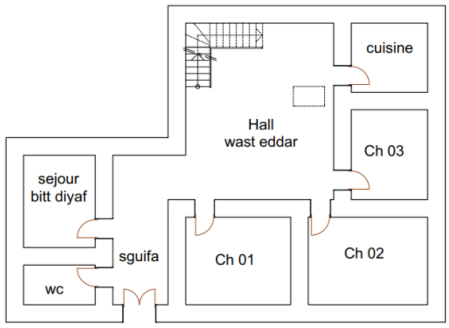
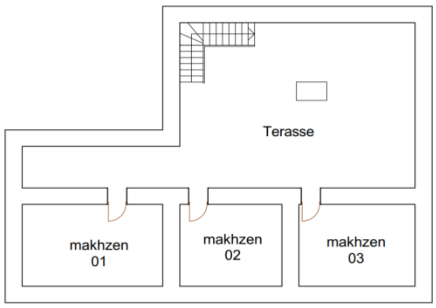
<td>

Ground floor


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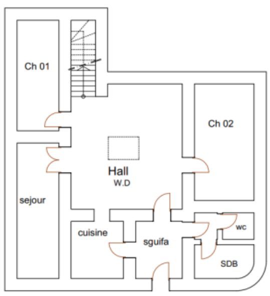
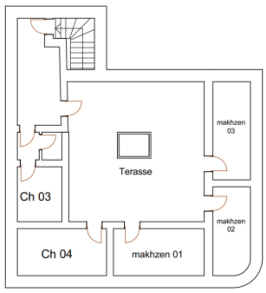
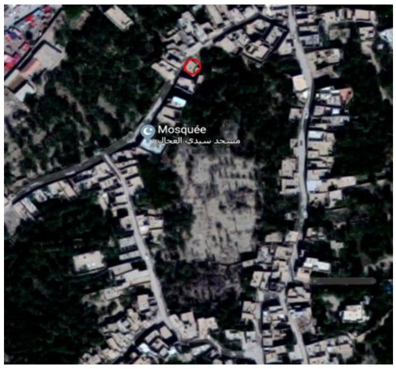
<td>



Ground floor First floor</td>
<td>
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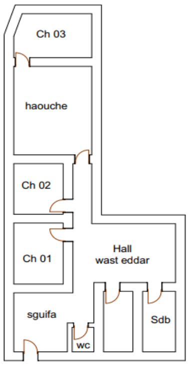
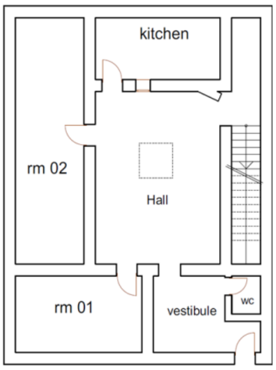
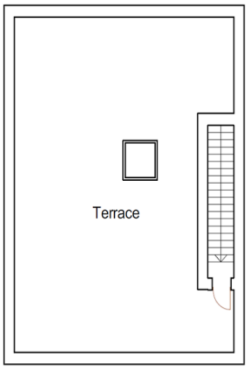
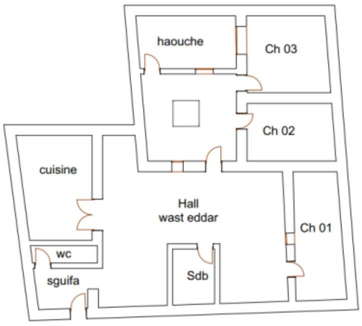
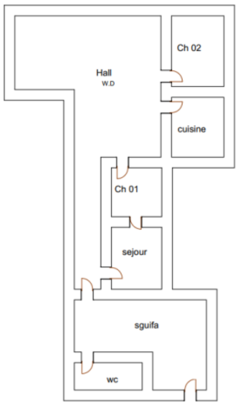
Houses	Plans	Bab dareb neighborhood
Hv$_8$	 Ground floor	
Hv$_9$	 Ground floor  First floor	
Hv$_{10}$	 Ground floor	

<table>
<tr><td>HvHv_{13}</td><td>

Ground floor</td><td>
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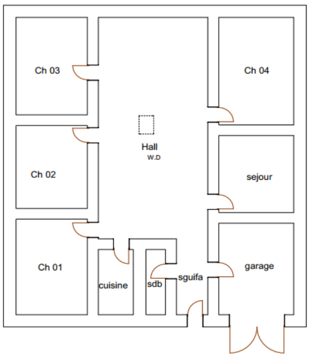
<table>
<tr><th>Houses</th><th>Plans</th><th>Gueddacha neighborhood</th></tr>
<tr><td>Hv_5</td><td>

Ground floor</td><td>
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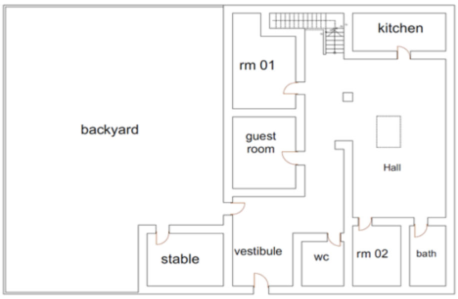
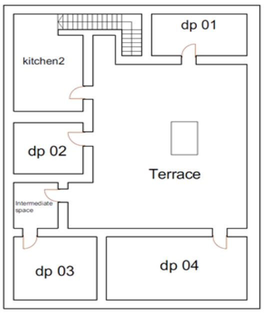
<tr><td>Hv_7</td><td>

Ground floor


First floor</td><td>
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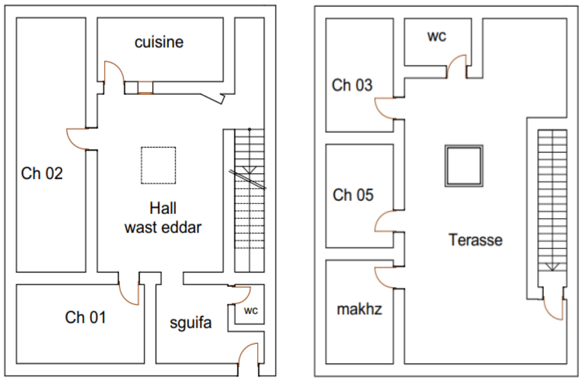
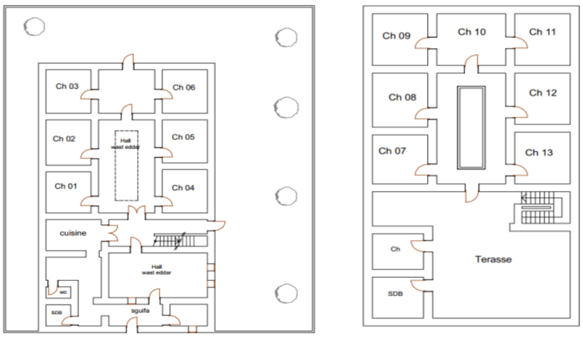
</table>

Hv$_{11}$	 Ground floor First floor	
Hv$_{12}$	 Ground floor First floor	

1.5. The urban scale

These three neighborhoods; M'cid, Gueddacha, and Bab dareb situated in the southern part in the city of Biskra, their geographic situation in contact with structure elements: the palm grove and the water stream (*saguia)* (figure 29), which supplies the palms and the inhabited areas with the drinking water in which the houses are arranged on the both side of the *saguia*.

Figure 29: The *saguia* one of the structuring elements

The urban structure of these three neighborhoods is characterized by compactness and linearity of its fabric (figure 30). For climatic reasons, their street patterns are principally made of deep, narrow and winding streets. The lack of major axes made the connectedness with the other parts of city less integrated. The rest of the roads and alleys scattered within the fabric are the paths and corridors within the palm forests and residential complexes, and is not paved and twisted and suffer from the accumulation of sand. The palm grove, embedding the house grouping, is considered as an important component of the urban fabric, by creating a microclimate to comfort inhabitants and buildings (houses) from the harsh weather i.e. summer sunrays – a real inside and outside thermal comfort of the vernacular urban fabric of the city of Biskra.

a) Gueddacha b) Mcid c) Bab Dareb

Figure 30: Maps show the compactness of the three urban fabrics

The main street served as a set of alleys that constituted secondary networkof roads. The irregularity of the road network makes the urban space less legible. One of the features of the old fabric is the hierarchy of space: street, alley and dead and threshold, with tendency to respect to respect inhabitants privacy needs.

1.6. Architectural scale

In this section, the findings obtained from the analysis of the different houses plan, are briefly discussed in terms of spatial configuration and its situation in the fabric. It is quite interesting to note that the vernacular houses of Biskra city provide an architectural heritage, and in particular they are sustainable constructions adapted to the climate and environment context.

This fact is best manifested in the construction materials and in the structural elements such as the "*rozna*" or the opening in the ceiling of the central space '*wasteddar*' that is manually operable (opening/ closing) to regulate zenith at light and ventilation according daily and seasonal comfort requirements (figure 31)**.**

Figure 31: Pictures shown the '*rozna*' on the roof in the *wasteddar* of HV_{11}, $HV_{15.}$ (Source: author)

"W*asteddar"* is considered as the main space for the most daily activities: cooking, eating, watching, napping, resting, and family gathering. It is the pivot of the movement and distribution in the house. In this space women spend their time during all day. It is the space through which the whole house is articulated. It is a regulatory space par excellence, in which the vernacular house is based on the centrality of its spatial organization. Based on the in-situ investigation, today, the functions of the "*wasteddar*" are reduced because of the adding of new spaces such as the kitchen, living room, guest room, and bed-room. This change refers to the evolution of the social life and the openness to the other cultures. It is also connected directly to the "*sguifa*" (vestibule) as the houses: $H_{V1,}$ $H_{V4,}$ $H_{V5,}$ $H_{V8,}$ $H_{V9,}$ $H_{V10,}$ $H_{V11,}$ $H_{V12,}$ $H_{V14,}$ H_{T15} shown in the table 01 above, among these houses: $H_{V9,}$ $H_{V12,}$ H_{V15} the "*wasteddar*" and "*sguifa*" are separated by a door, but the houses $H_{V2,}$ $H_{V3,}$ $H_{V5,}$ $H_{V6,}$ $H_{V7,}$ are connected to a transition space that gives to the *wasteddar* , the *sguifa* considered as a boundary between the exterior and the internal space, as well as a transition and filter space: it provides the intimacy for the inhabitant and especially for women, in which men or strangers stay in until they get the permission from the women inside the house. We notice that all the houses of the sample contain the "*sguifa*" which indicates that is one of the main structure elements of the spatial organization of the houses layout and it's imply of the important of the privacy for inhabitants inside their houses, and it is presented in different shape and size in each house in the sample.

Each house is designed based on the social life, size of the family and it needs. As well as responding on the climatic criteria, comfort, and economic state. The houses reflect the way of life suggested in that time…. Through the observation of the houses plan, we notice that the houses have different sizes, that indicate to the economic state of the household as well the size of the family (extended family), the houses H_{V1}, H_{V2}, H_{V7} , H_{V12}, H_{V11} have the highest area in the sample and have one complete ground floor and partial first floor and in some cases have a back garden as H_{V2}, H_{V3}, H_{V4}, H_{V7}, H_{V12}, and that refers to the large number of family and the economic status (rich family), the houses H_{V1}, H_{V2}, H_{V4}, H_{V7}, H_{V11}, H_{V12}, H_{V14}, H_{V15} composed from two floors linked by staircase located in the hall "*wasteddar*", and the houses H_{V3}, H_{V5}, H_{V6}, H_{V8}, H_{V9}, H_{V10}, H_{V13} have only one ground floor, small area, and less number of spaces compared by the other houses.

One of the main features in the houses is the hierarchy to the use of the spaces by visitors and inhabitants, in which the guest room (*Bitt dyaf*) located at the entry hall, as we see in houses (H_{V1}, H_{V2}, H_{V4}, H_{V7}, H_{V11}, H_{V13}, H_{V14}) because men (strangers) could not penetrate into the house, in addition women need to veil themselves front of strange man (non-muhram), the *sguifa* is the indication of that separation between visitors / inhabitants , exterior/ internal space, therefore its control the access into the house or vice-versa.

The kitchen in which women were expected to cook, mostly located in the back of the house layout, in other word is located away; to keep the privacy of women inside the house, in general the kitchen situated at the ground floor.

The ablution spaces "the toilet and the bathroom" are located at the entry hall, connected to the *sguifa* and beside the guest room in all the houses for the visitors to preserve the privacy inside the house.

1.7. Material of construction and Constructive system

The vernacular houses have been built by local materials integrating the environmental context. The inhabitants built their houses based on different conditions; climate protection, defense, introverted, and that manifested in the way the houses built in which are open towards interior, move towards the center. One of the main characteristic of the vernacular houses of Biskra is the absence of the openings on the facade, or just very small openings as the shown in the (figure b-32). The houses constructed by traditional techniques using the stone for the bedrock, the wood of palm trunks for the joinery (doors, windows) and pillars, beams, joists, the earth and mud brick for walls (figure 32**)**, in which is fortunately one of the worst heat conductors, thus, the comfort of the inhabitants inside the house depends much on the thermal properties of the walls and roof **(**Hassan, 1970**)**.

a/ material of construction **b/**open on the wall **c/** the bedrock of house

Figure 32: Show the material and technique of construction

2. The colonial period

2.1. Background

The most important colonial creations in Biskra are certainly, its checkerboard, and later the extensions which prolonged it. The colonial checkerboard was laid out in 1855, north of the current city to accommodate civilians of the French colonization. This urban colonial heritage corresponds to an establishment in the form of an orthogonal grid; "A wise checkerboard", (sriti, 2006).

During the period from 1830 to 1930, the Algerian territory experienced the first colonial grafts. It was the ex-nihilo creation of new agglomerations controlling, stifling and sometimes replacing previous establishments (dechra, medina, etc.). Overnight, these colonial settlements became the high premises of the new power in place. Very quickly, they established themselves as centers of activity and then definitively achieved the status of town centers, not only administrative but also economic (Côte, 1993).

At independence, the trends of urbanization which probably underpinned the political orientations of the time, led to the exclusion of colonial nuclei from the overall development of agglomerations. This marginalization has taken various forms and caused much damage. And if we recognize these former colonial centers today, their situation remains problematic taking into account the dangerous developments they are experiencing and which compromise their survival. The colonial checkerboard of the city of Biskra is one of the illustrations of these centers which today lie on the fringes of the city. A colonial urban and architectural heritage, the checkerboard is part of a territorial, social, economic reality and through its historical, symbolic and heritage qualities; it occupies a unique position in the city. Unfortunately, it has rarely been the subject of substantial studies, perhaps because of its own status as a "cumbersome" colonial heritage. (Sriti, 2002).

This work is based on the results of a previous study on the numerical evolution of the urban fabric of the colonial checkerboard (Boussora et al, 2001). This showed that certain aspects of the evolution of this tissue remain undetectable using an approach that took into account the morphological characteristics of the parcelaire to be studied. A morphological analysis was therefore undertaken. It consists of studying and then comparing the intrinsic formal structures (plot division) of each islet during the same period (synchronic analysis). Then it tries to explain their evolution through two chronologically different periods (diachronic analyzes). (Belakhal et al, 2002)

2.2. Genes and evolution

Like any other urban fabric, the colonial checkerboard of the city of Biskra is the result of the interweaving of two logics: the network of the roads and the resulting lots of building land. The mesh is very simple, a grid made up of orthogonal lines. The resulting blocks take on variable shapes and dimensions depending on the distances between the tracks. Different forms of islets (genera) emerge (figure 33). All of them can be reduced to a regular quadrilateral whether it is square, rectangle or square-rectangle (Belakhal et al, 2002).

It is a set of islets arranged in a chessboard pattern in the direction of the ramparts of Fort Saint Germain. In fact, the grid of the checkerboard originates in the south of the market without however worrying about the existing implantation of Ras El Ma. The islets are square, strictly identical, about 40 meters across, and extend in two strips to the limit of the Military Circle. Beyond the western limit of this Circle, the islets will be resized (approximately 25 by 30 meters) so as to blur the disturbance introduced by the market place. A third wave of implantation will complete the checkerboard.

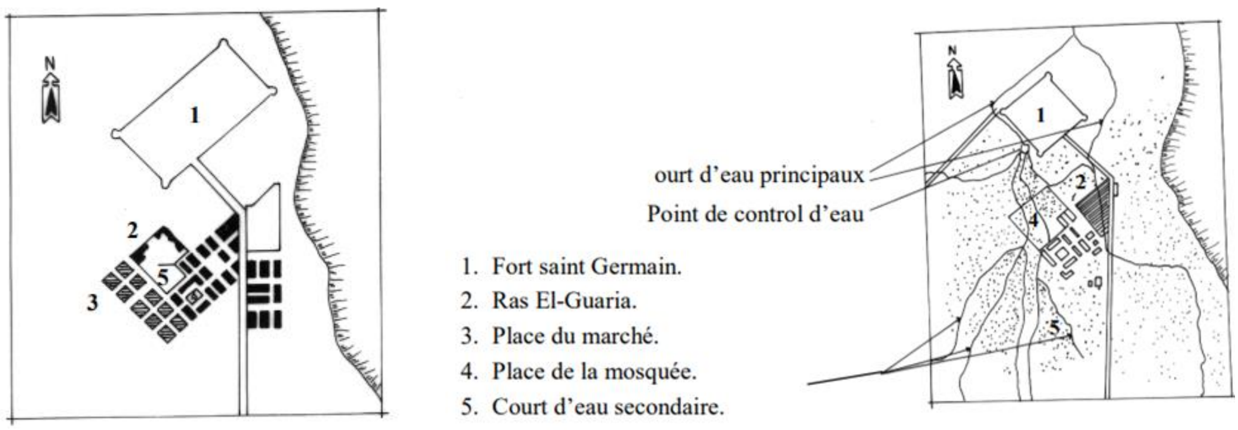


Figure 33: The resulting colonial checkerboard, Biskra 1860. Source : Agli Nadia Op Cit p55

It will take the form of a grid of 5 rows of 5 islets identical to the previous ones which will be placed in the axis of the Fort. Each islet or current block is subdivided at the rate of 4 to 5 houses per side; the interior is occupied by courtyards and gardens. It will thus represent the will of the settlers to create a new city with new urban and architectural designs and techniques. Moreover, the picturesque and touristic character of the city made Europeans come to spend their winter holidays. The city was then gaining momentum and assuming the status of a great oasis.

Later, during the post-colonial period, the city of Biskra, like all other Algerian cities, experienced extensive urban development that had already started during the years of the liberation war. This rigid and poorly controlled urbanization has mainly taken over the unoccupied areas of the city, leaving aside the colonial city center, frankly excluding it from new circuits of trade and activities (Belakhal et al, 2002). This situation has caused this urban and architectural entity to be sidelined, thus triggering its progressive decline. Today, we can only make the unfortunate observation of the consequences of ill-considered planning and management on the state of a city center which the agglomeration is trying to replace.

Various criteria were selected to measure the state and extent of this decline:

1) The centrality of the checkerboard and its relationship to the development of the urban fabric of the current city.

2) The old and current urban functions of the colonial city center.

3) Urban transport and its current impact on the colonial city center.

4) The attractive and / or repulsive characterization of places and their role in frequenting the colonial city center.

5) The state of the built environment and urban spaces of the colonial checkerboard.

Every city is heterogeneous insofar as it is made up of districts which differ from each other by their specific functional, morphological and social components. The city center is the district where the multiplicity of functions and their diversity reaches its climax. Luxury and ordinary shops, tertiary activities (administrations, banks, etc..), liberal functions (doctor's offices, lawyers, architects, etc..), leisure, culture and housing are all represented at the center. When it was created, the colonial checkerboard was first a residential area, and then it was equipped with several public facilities to give it the qualities of a true city center, namely:

institutions, market, luxury hotels (sriti, 2002). It was also enhanced by an urban development worthy of the metropolitan cities of yesteryear (monuments, squares and public garden) (figure 34). In 1890, the construction of the Caid mosque near the market gave more scope to the urban life of this city center by offering the Muslim community the opportunity to integrate there.

At the beginning of the post-colonial period, the checkerboard retained its functional importance. Algerian institutions replaced colonial ones while keeping the same premises or settling in former colonial villas. The vacant housing units were occupied by the most privileged social categories, and businesses particularly concentrated around the market place multiplied thanks to the availability of land. Various places have been able to acquire vocations relating to the activities carried out there (Belakhal et al, 2002). This is the case, for example, of the current (Rue du 24 Avril) which was dedicated to women's ready-to-wear stores and which was a place particularly popular with women.

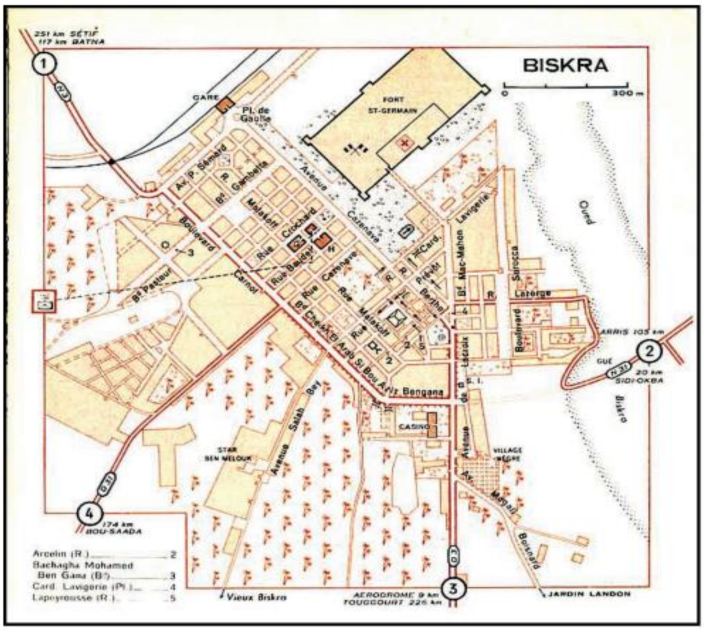


Figure 34: The development of the city center of colonial checkerboard. (Source: Cardinal lavigerie, 1956)

Then as the city grew in importance, the main poles of activity constituted by the two streets bordering the checkerboard current (Rue de la République and Boulevard Emir Abd El Kader) and the immediate surroundings of the market, saturated. This was the beginning of the scattering of activities across the city. From then on, the main public buildings, administrations, company headquarters and other buildings coming under the center were forced to set up not according to the nature of their activities but rather according to the availability of premises (apartments in ZHUNs, fitting out of offices in individual houses often far from the center, etc..). This scattering of activities was, perhaps, also maintained by the diffusion of the policy of the ZHUN, knowing that these had to contain a certain number of equipments to ensure them certain autonomy. However, it turns out that this understandable objective at the outset was exceeded when large-scale public facilities (such as certain administrative offices, banks, etc.) were installed in the ZHUNs. The situation was like these extensions competed with the city center, swallowing it up without being able to restore it elsewhere. The decline in tourist activity due to the degradation of the hotel infrastructure has led to a very significant reduction in the number of tourists and foreigners frequenting the city and its center. Finally, the establishment of the new headquarters of the wilaya outside the center, and the creation in several districts of the city, of antennas annexed to the town hall intended for the civil status services (antennas of APC), did not improve. In no way the attendance rate of the center, quite the contrary.

2.3. The colonial house

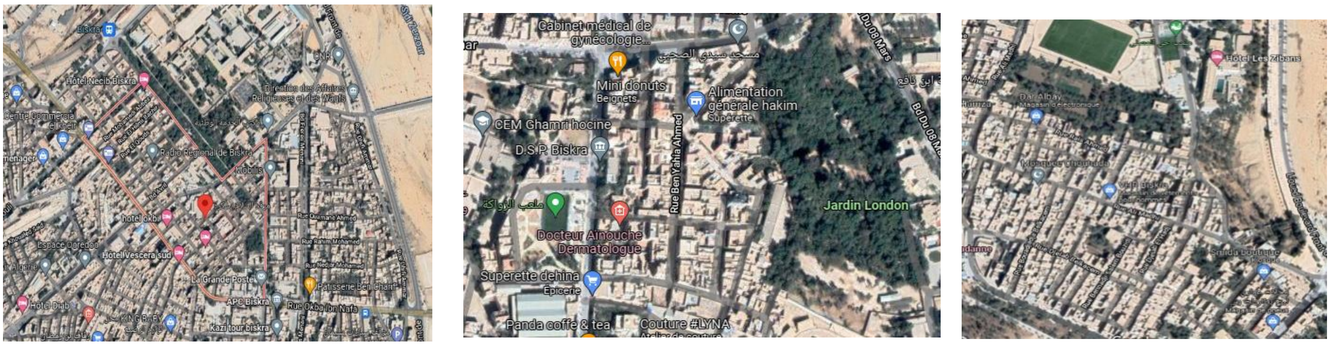
The colonial houses are of the European type. They are characterized by large openings to the outside and sloping roofs. They open directly onto the street. At the level of the current blocks (the first colonial settlement), the facades obey a symmetrical composition. The decorations, although modest (tiled roof edged with sponges or a brick ledge, cut stone base, corner treatment, treatment of the entrance, framing of stone openings, earthenware tiles or molding of plaster, wrought iron balconies, ...etc) help to give these houses a pretty appearance. On the other hand, the houses of the rural extension are devoid of any decoration, the facades are homogeneous and their treatment is rudimentary. Those in the market area, unlike the previous ones, are quite heterogeneous; there are ornate wooden or wrought iron balconies, but the decorations are also rare (figure 35). Moorish architecture such as cupolas, arches, tiled canopies, mosaic, ...etc.

The colonial house layout has some similarities with the vernacular house, whereas the hall considered as the main central space in the house, and the other spaces are arranged around this central space. The *rouzna* is the main element that provides the zenithal light and ventilation to the hall '*wasteddar*' in some houses, in which this element starts to disappear in these colonial houses. The '*sguifa*' replaced by the veranda that plays a role of a boundary between the exterior and interior space and separate the inside from the outside world. Each function and activity started to use in single rooms separately as: a guest room, living room, and bedrooms, that's means the disappearance of the multifunctional room.

Figure 35: Colonial house in la Gare neighborhood. Source: (the author)

2.4. The architectural survey: the case and the sample

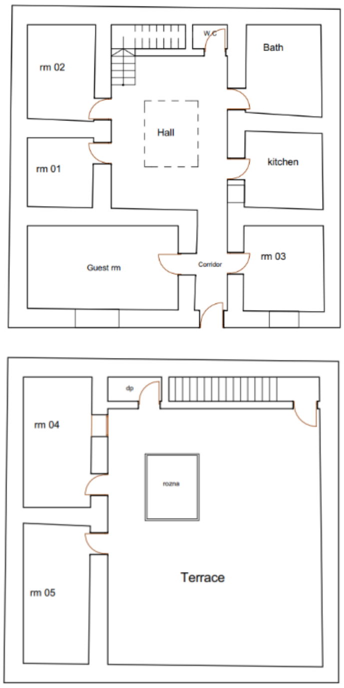
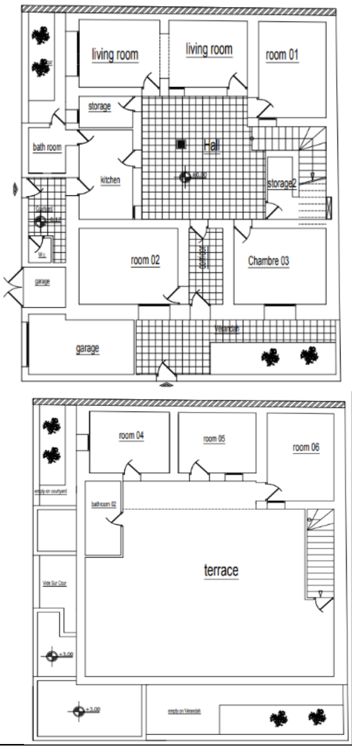
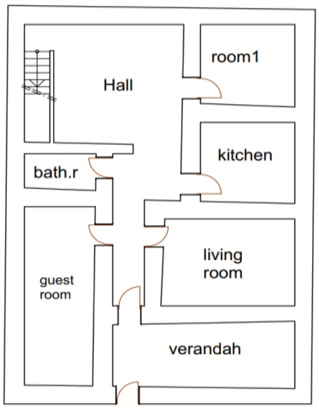
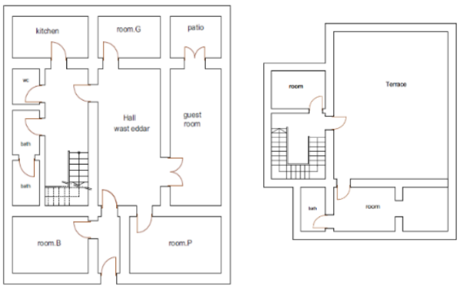
The sample consist of 15 houses from different neighborhoods constructed in the colonial period as : Chatenier, la Gare, M'sala (figure 36) … Seven houses are conducted by the survey and re-drawn by the author, and eight houses are barrowed from doctoral research by (Sriti.L, 2013) and re-drawn by the author. These houses were chosen according to the historical, temporal, and architectural criteria. Through the selection of these colonial houses we were based on the houses that have constructed for the Algerian inhabitants.



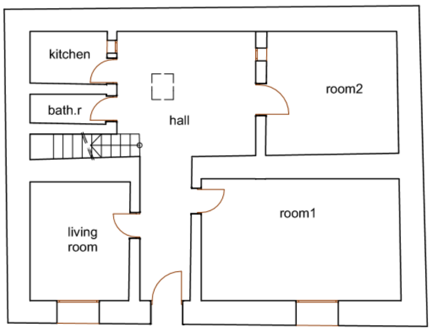
a- la Gare neighborhood b- Chatenier neighborhood c- M'sala neighborhood

Figure 36: the situation of the different neighborhoods (a- b- c) in Biskra city

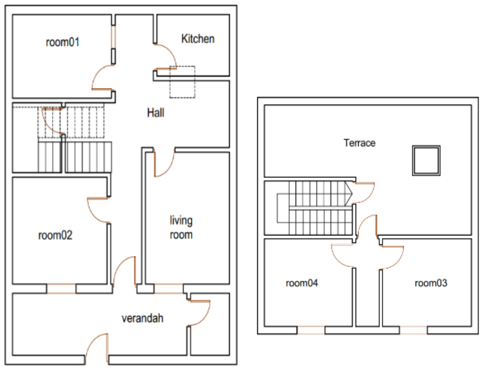
- **Table 02**: Shows the different colonial houses.

House	Plan	House	Plan
HC1		HC2	
HC3		HC4	
HC5		HC6	

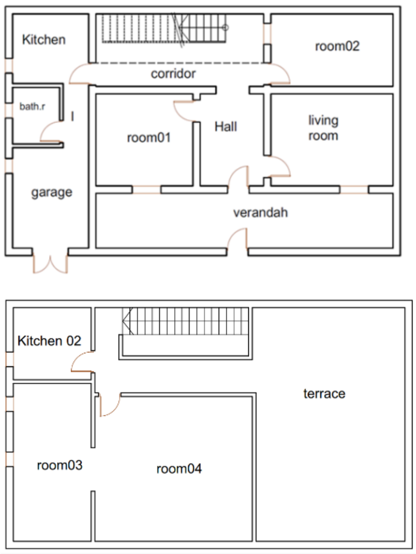
HC7



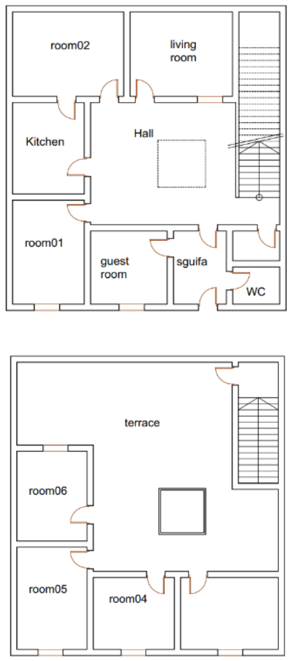
HC8



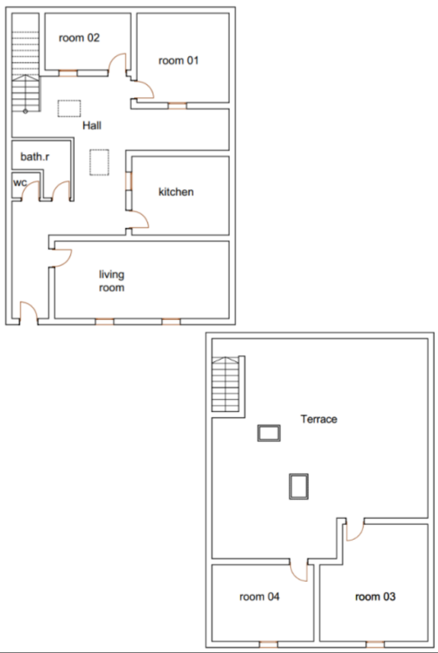
HC9



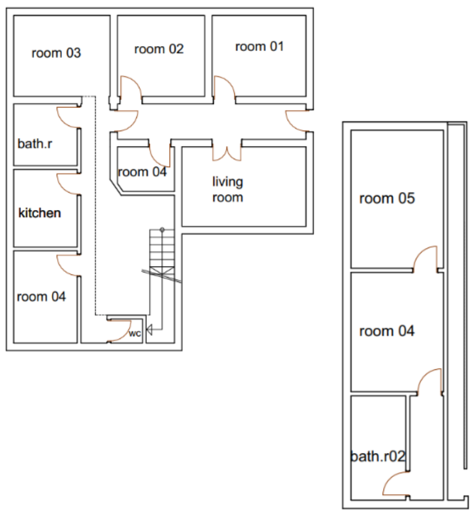
HC10

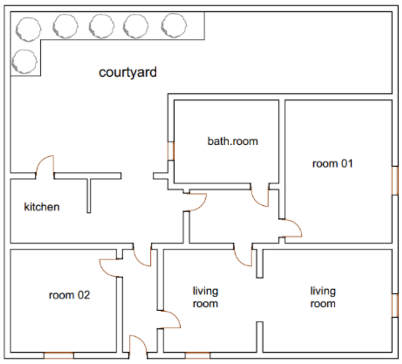
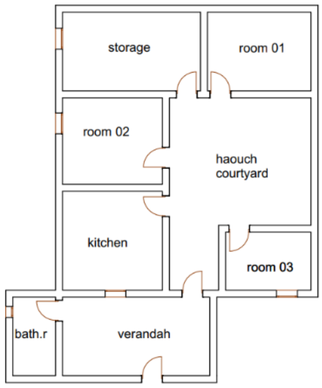
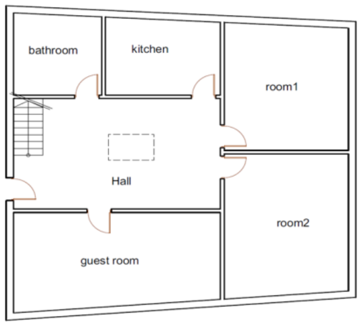
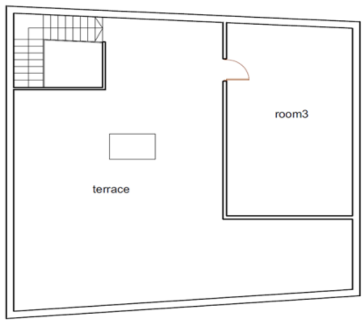


HC11



HC12



HC13		HC14	
HC15	 Ground floor  First floor		

2.5.Urban form

Morphologically, the colonial checkerboard is made up of a set of islets arranged in a chessboard pattern in the direction of the ramparts of Fort Saint Germain (figure 37). The dominant form of the islets is in the form of a square of 30 meters side (40m near the military circle), on which open individual houses (4 to 5 per side) of two levels.

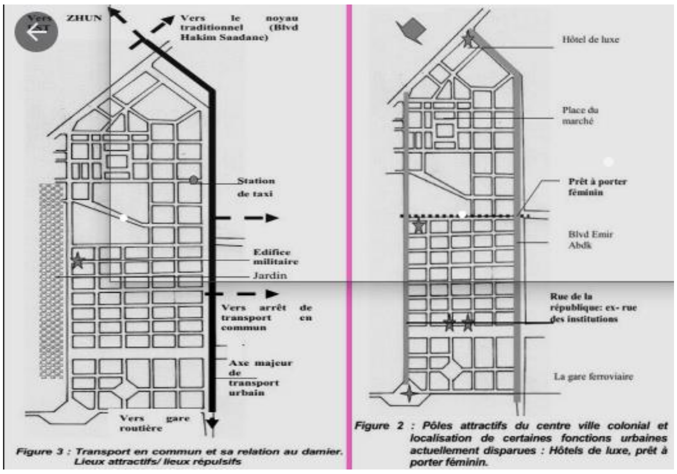


Figure 37: The regular orthogonal pattern of the checkerboard

Due to the narrowness of the plots, the houses overlook from the rear onto courtyards or gardens which occupy the center of the islet. By virtue of its vocation as a high place of the French administration, the checkerboard (le damier) brings together the majority of buildings and public services; there are also some green spaces. The rue Berthe (currently Rue El Joumhouria) which runs along the public garden and ends at the station is treated as an institutional axis. With its arcaded gallery, stone buildings and richly decorated facades, it serves as a "showcase" of the city. This is where the majority of public buildings are concentrated (banks, hotels, military circle, etc..). The so-called rural extension uses the regular orthogonal pattern of the checkerboard. The islets are nevertheless different from the current block, 1.5 to 2 times wider; therefore the island has more houses. These are modest in size and without a storey with the exception of those bordering the boulevard which was larger and more opulent. For the extension of the "market area", the orthogonal grid of the checkerboard, although taken as a whole, is deformed in several places. Thus, beyond the military circle and going east and north-east, the regularity of the grid is altered, no doubt to absorb the pre-existing urban structure of Ras El Maa (Sriti et al., 2002).

In this extension, the current block is not included. On the other hand, we are witnessing the establishment of islets each having their own shape; triangular islets are quite frequent, they are introduced to absorb the changes in direction of the orthogonal grid at its intersection with the road to the palm grove (northern extension of Salah Bey). The islets are cut into narrow and sometimes deformed plots. The market square is lined with houses generally on two levels, the ground floor of which is reserved for commerce in the form of small stalls set back from porticoes or arcades, the roofs are flat and accessible (Sriti et al., 2002). This type of habitat is maintained in the vicinity of the market, except for the arcade gallery which has disappeared; the stalls open directly onto the street.

2.6. Constructive system

The colonial house is made of local materials : earthen bricks for the walls and planks for the floor are using mixed techniques (improved traditional) where we find in particular, the use of coatings in the interior of the house and on the exterior, and rocks in the foundations (figure 38), the waterproofing of the roof ... etc. For public buildings, mud brick is replaced by stone. At the end of the 1950s, reinforced concrete was introduced in Biskra, but its use was quite limited, it is only found in a few public buildings.

Figure 38: Colonial house made of local materials **(**earthen bricks, rocks, planks)

3. Independence period

3.1. Background

It is about extensions that happened spontaneously and continued as the agglomeration developed towards the South and towards the East and which generally tended to fill the interstitial space separating the two fronts built in the city: the Checkerboard and the traditional cores (sriti, 2013). Although their appearance was in the colonial era, these extensions developed anarchically after the independence, from the 70s, the break-up of the districts Moustapha Ben Ramdane (Star Mlouk) towards the South and the South / West. And Chatenier to the South East and to the East M'Salah. The city developed during this time in an anarchic manner without any orientation or urbanization, within a framework of land speculation. This produced a precarious, anarchic urban fabric, with an urban extension towards the railway on the west side, and the palm grove on the south east side at the expense of the gardens of Bengana2. This has generated a motley fabric, formed by poorly planned habitat at the expense of the palm grove, on land sold by their owners informally, and without resorting to subdivision plans (Naija, 2014). In reality, this tissue constitutes a real urban pathology in the city of Biskra, in particular due to the lack of equipment and infrastructure like all Algerian cities which suffer from this urban pathology.

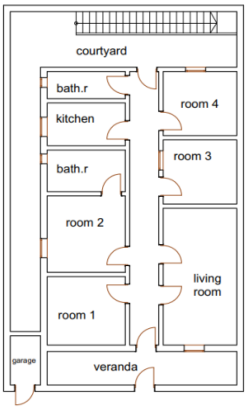
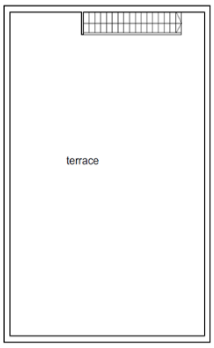
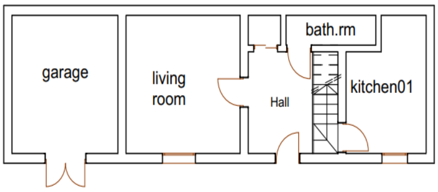
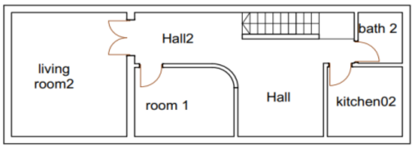
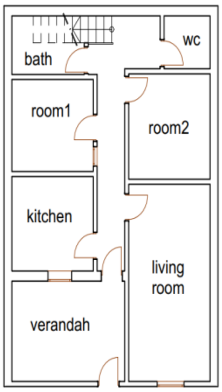
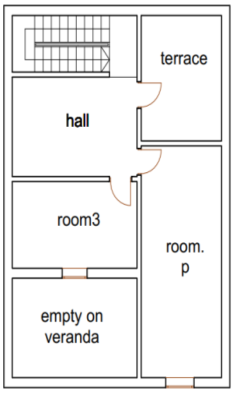
As a result, the inhabitants of the region, and of the town of Biskra, in particular, have abandoned construction with local materials (soil, and jrid), yet perpetuated from the distant past. It is the poor resistance of local materials to bad weather, and their aging that have led residents to regard them as a sign of poverty (Alkama.DJ, 1995). These are in serious competition with other industrialized concrete-based materials, widely used in the north of the country. And supported by excessive marketing by the state which sells them at ridiculous prices.

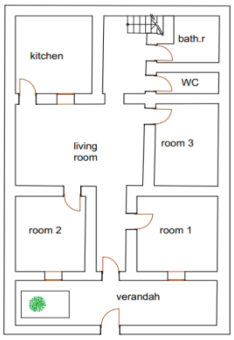
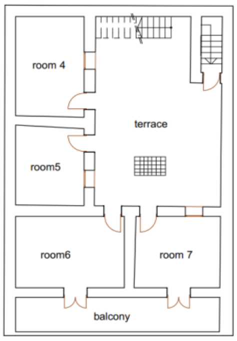
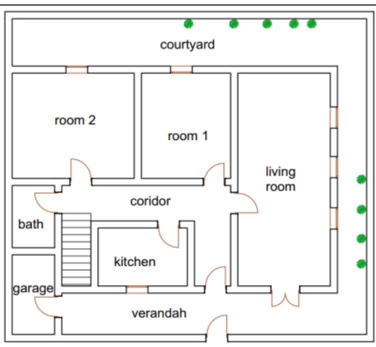
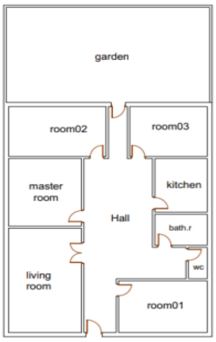
Overall, we remember that the city of Biskra almost hibernated this decade. As a result, it had not known any urbanization program besides the remarkable lack in urban management, in the pattern of extension and in the morphogenesis of the city.

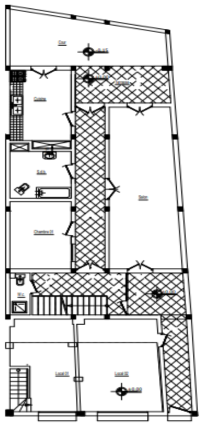
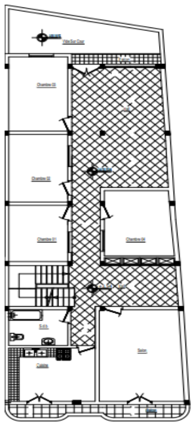
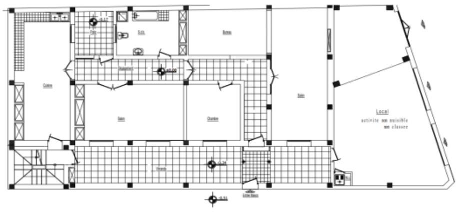
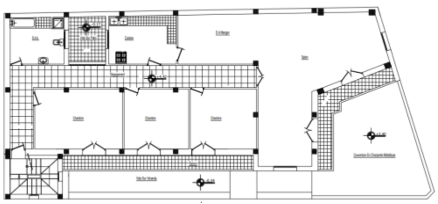
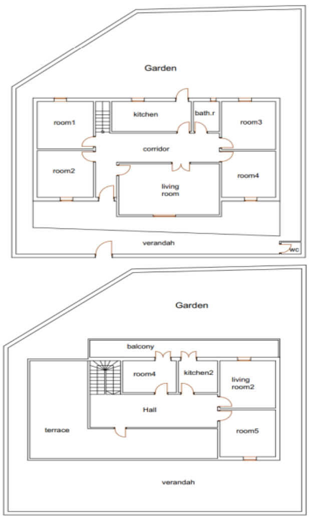
3.2.The architectural survey: case and the sample

A survey has been carried out on 15 houses from different neighborhoods in Biskra city, and re-drawn by the author in the table below. Except for four houses (HI07, HI08, HI14, and HI15) are taken from an architecture office. These houses are chosen according to temporal, historical, and architectural values. The houses are examined in term of: spatial configuration, socio-economic factors, and architectural aspect.

- **Table 03:** The house plans from the independence period

Houses	Plans	Situation
HI01	  Ground floor First floor	
HI02	 Ground floor  First floor	
HI03	  Ground floor first floor	

HI04	 Ground floor First floor	
HI05	 Ground floor	
HI06	 Ground floor	

<table>
<tr><td>HI07</td><td>
Ground floor

First floor</td><td></td></tr>
<tr><td>HI08</td><td>
Ground floor

First floor</td><td></td></tr>
<tr><td>HI09</td><td>
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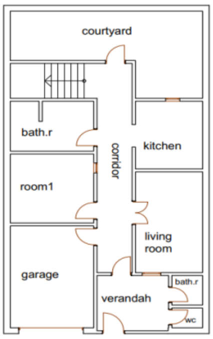
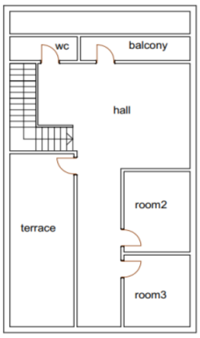
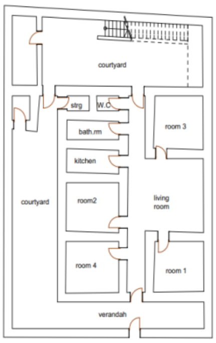
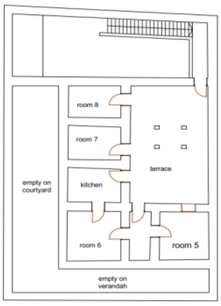
<td>



Ground floor First floor</td>
<td></td>
</tr>
<tr>
<td>HI11</td>
<td>



Ground floor First floor</td>
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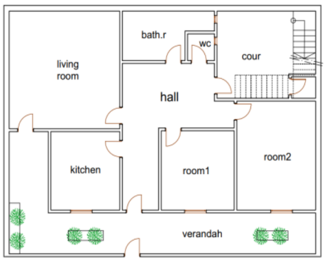
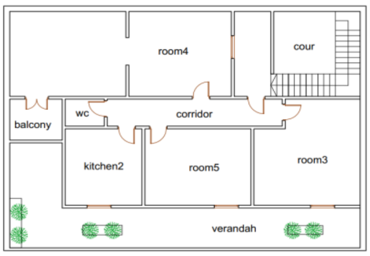
<td>

Ground floor


First floor</td>
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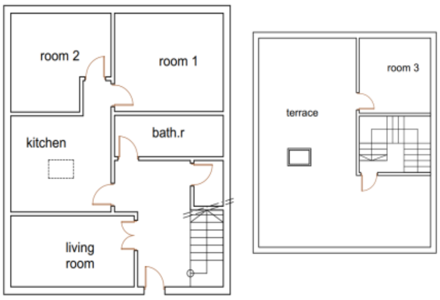
<td>
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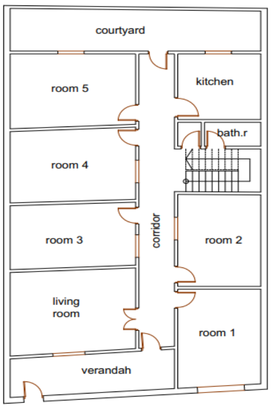
<td>

Ground floor</td>
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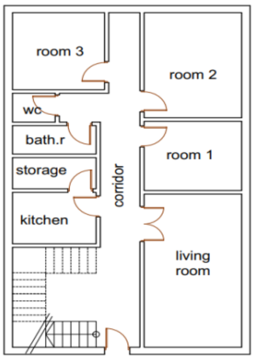
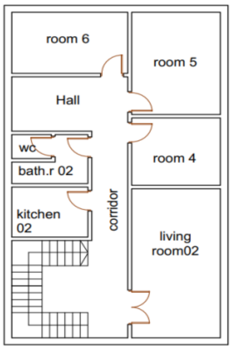
<tr>
<td>HI15</td>
<td>



Ground floor First floor</td>
<td></td>
</tr>
</table>

3.3.Urban form

The urban structure is summarily orthogonal, with the exception of the nuclei dating from the colonial era, which have an urban morphology close to that of traditional fabrics. The islets are distributed along a secondary road that begins on a major axis of the city (Zaatcha, Hakim Saadane). The plot is tight, it sometimes deforms depending on the layout of the road. The dense fabric thus formed is distinguished by certain continuity due to frequent jointing, the absence of green spaces, and the narrowness of the network of streets and alleys.

In the popular neighborhoods created at independence or during the colonial era (neighborhoods for natives), two fabric configurations can be distinguished: one is subject to a more or less regular orthogonal grid, and presents a geometric road network. Rectangular island support; the other is part of a rather traditional urban logic and deploys an arborescent network characterized by the presence of dead ends. In other words, it is not excluded that the two configurations come together in the same portion of urban space; they can also partially overlap or become entangled.

3.4.Self-built housing

In the interior organization of the domestic space of this first decade of independence, there are many similarities with traditional housing (introversion, centrality, organization around wasteddar, public-private / front-back polarity, ... etc ..). This does not exclude some changes : in particular, the addition from the entrance of an end of the corridor to wasteddar induces a mixed spatial distribution (linear + central), the disappearance of the vegetable garden adjoining the house, the appearance of new spaces (kitchen, reception room, etc.) (Figure 39). While these transformations are indicative of an evolution in lifestyles, the renewal of living models has barely begun; the use of the premises is dictated by the traditional model.

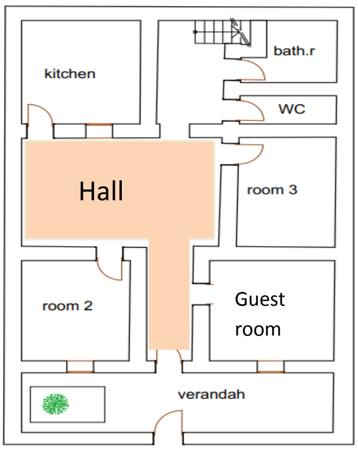


Figure 39: Space organization of house plan from the independence period. (Source : Author,2019)

3.5.Construction system

Initially (in the 1960s), the house in the popular neighborhoods was made from local materials: earthen bricks for the walls and planks for the floor; certain improvements have nevertheless been introduced, in particular, the use of coatings inside the house and outside, the waterproofing of the roof, etc. In 1969, torrential rains and the flooding of the Oued caused the destruction of a large number of earthen dwellings, which led to popular disenchantment with earthen bricks and their use, even though ancestral.

From this date, there was a marked decline in the use of the traditional construction system, which now preferred new materials - agglomerated concrete, cement and reinforced concrete - which were considered more resistant. Gradually, soil-based construction methods were abandoned in favor of cement and reinforced concrete, which definitively established themselves as exclusive and absolute building materials.

3.6. Architectural scale

The facade, with its rudimentary and bare appearance, is the most characteristic exterior element of this habitat. In popular neighborhoods of spontaneous creation, the facades are particularly modest and morphologically resemble those of traditional houses. However, they are no longer blind, and on the contrary open to the outside through small openings. The exterior coating based on cement mortar is becoming widespread. In the districts of colonial creations, obviously, under the influence of the architectural language expressed in the Checkerboard, the windows are of large dimension and they are arranged according to a symmetrical composition, the presence of the veranda (garden arranged in the front part of the plot) is required, which gives an elegant appearance to the facades. The latter are also embellished by the presence of certain decorative elements such as cornices, ceramic, mosaic or plaster wall friezes, window frames, treatment of the front door ; their job remains, all the same, timid.

4. The contemporary period

4.1. Background

The urban characteristics of the residential fabrics produced during this period are similar to those developed in the Independence. This period is, in fact, marked by the densification of housing estates and cooperatives created in the 80s, without forgetting the new housing areas developed on the outskirts of the agglomeration at the extension of East and West zones. The types of housing produced are mainly dominated by collective housing (social or promotional) and single-family houses.

Architecturally, the modern house in Biskra offers several points of similarity with the housing estate of the 80s (production methods, construction system, evolutionary character), but it differs from it in terms of external appearance.

In the early 1980s, Biskra was experiencing planned housing estates for the first time. Land in the East and West zones acquired, as part of the application of the 1974 ordinance related to the constitution of municipal land reserves, were subdivided, serviced and sold to individuals or cooperatives.

Today the urbanizable surface of these extensions (East and West zones) has reached saturation, but their extension continues. It is now part of a process of densification as the plots defined by the subdivision plans.

4.2.Urban form

The city of Biskra witnessed the appearance of a very rapid urbanization (figure 40). The management of the habitat as a primordial need, and local development tool became a reality and this by the promulgation of certain laws, and tools of urbanization, and realization. This gave rise to of this city, a (P.M.U, and a P.U.D). It was only then that Biskra began to experience a new era of urban growth, in a systematic way (Niadja, 2014). By using the zonings that are generally defined, from a quantitative approach within the framework of the (Z.H.U.N), by applying the guidelines of a national development policy for the urban sector, the city is determined by its' urban composition.

Figure 40: The urban form of the city of Biskra

The urban unit of this type of habitat is formed by the simple juxtaposition of rectangular plots in two rows without any search for composition. The islets are dense because the plots are fully built-up. Very little importance is given to green space.

4.3.Typology and external appearance of the dwellings

The analysis of this type of fabric presents a great variety in the treatment of the facades of dwellings. The architectural plan is abandoned in favour of the ideas of the user. However, the typological elements are the same taken from the Western architecture of the sixties. These include balconies, large rectangular openings, cornices, projecting spaces (Adad & Zerouala, 2002). These elements are combined without regard to the principles of composition to constitute often unfinished urban facades. In this context, for financial reasons the often-unfinished floor plays the role of an accessible terrace in the hope of converting it into living space. Also, the exposed beamrebars are there for a possible vertical extension.

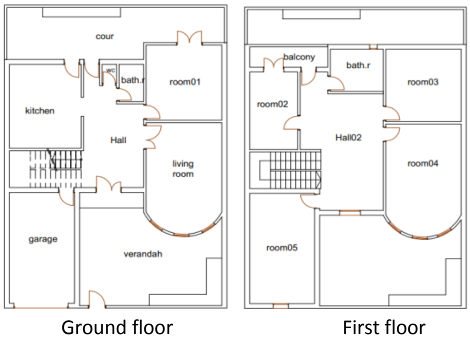
4.4.The architectural aspect

The facade of the contemporary single house appears in the form of an amalgam of elements of various styles (Moorish, classic, modern...) and the reliefs of the volume (balconies, veranda, cornices, parapets, stairwell, frame doors and windows) are all systems of architectural ornamentation (Sriti, 2013). The materials used are very varied, to the point where often on the same facade, solid brick, cut stone, wrought iron, tile, marble, mosaic, plaster columns, and many other elements raised only with the aim of confirming the facade in its role as an object of social distinction.

4.5.The architectural survey: case and the sample

The fifteen house plans of this sample are designed and drawn by an architectural firm in Biskra city, most of houses in the contemporary period are designed by different architects opposite of the previous periods. Are chosen according to the: temporal and architectural values. These houses are characterised by its size, different access, different levels... and that refer to the improvement of economic, and social level of life conditions comparing to the pre- colonial, colonial, and independence periods. The table below show the different plans with their situation in Biskra city.

Table 04: The house plans from the contemporary period and their situation

<table>
<tr><th>Houses</th><th>Plans</th><th>Situation</th></tr>
<tr><td>HP01</td><td>
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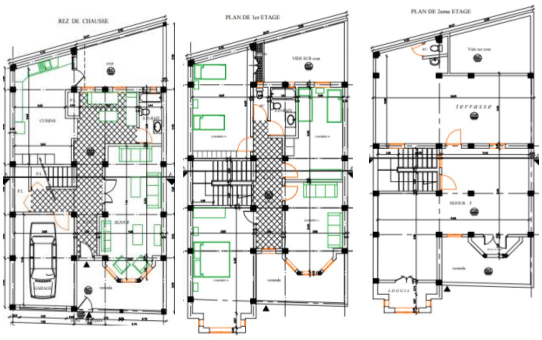
<tr><td>HP02</td><td></td><td></td></tr>
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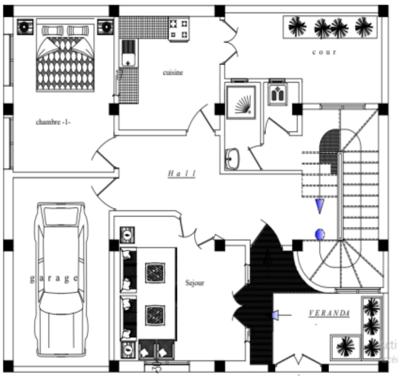
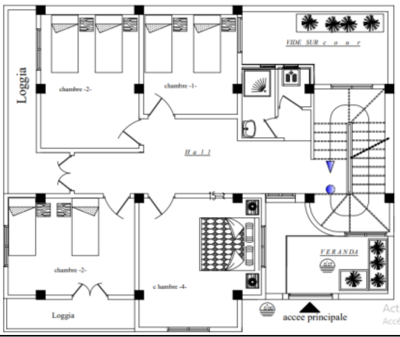
<td>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<td></td>
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<tr>
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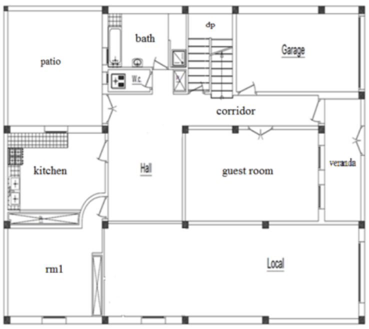
<td>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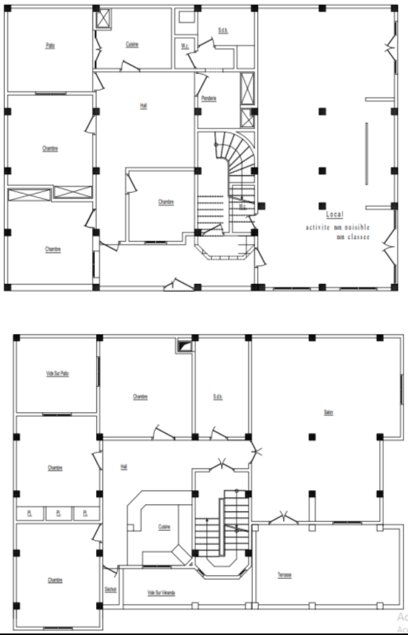
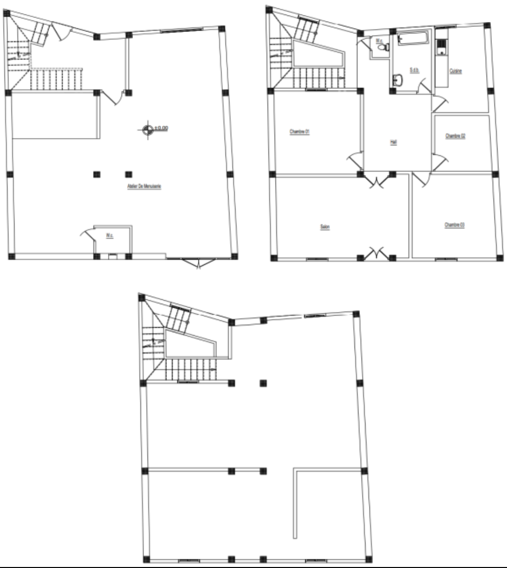
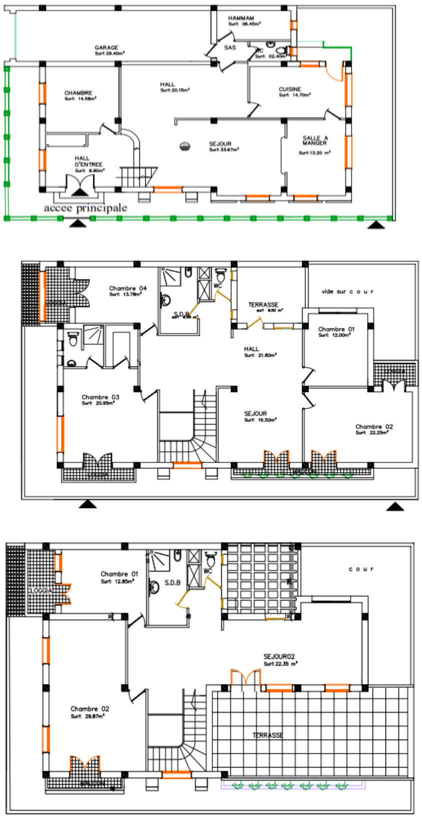
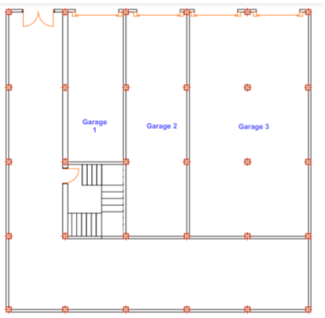
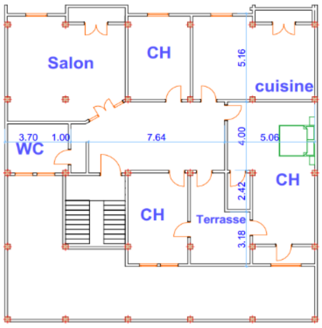
HP06		
HP07		
HP08		

HP09	 H A L L S alon sdb local activite non nuisible non classee chambre -1- CUISINE chambre -3- chambre -2- balcon TERRASSE ACCESSIBLE	 Hôtel Les Zibans Rue Hasnaoui Aissa Hopital Hakim Saadane Institut National de Formation Supérieure Vulcanisateur ACHRAF
HP10	 GARAGE HAMMAM SAS CHAMBRE HALL CUISINE SEJOUR SALLE A MANGER HALL D'ENTREE accee principale Chambre 04 TERRASSE vide sur c o u r Chambre 01 Chambre 03 Chambre 02 S.D.B c o u r SEJOUR02	 Bd Emir Abdelkader

<table>
<tr><td>HP11</td><td>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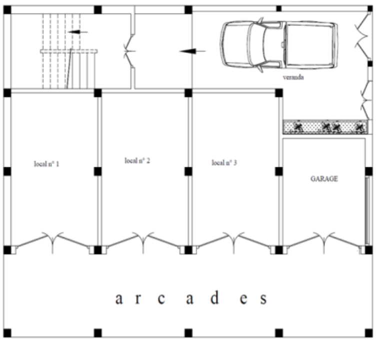
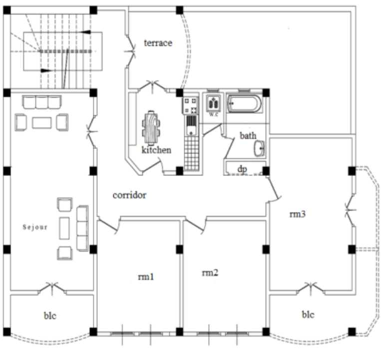
<tr><td>HP12</td><td>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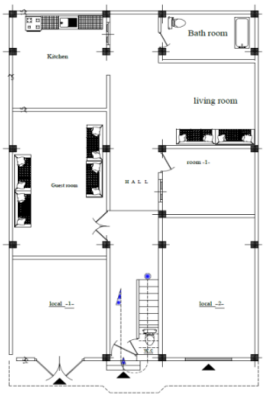
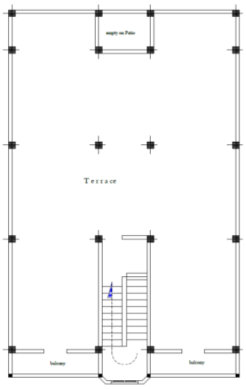
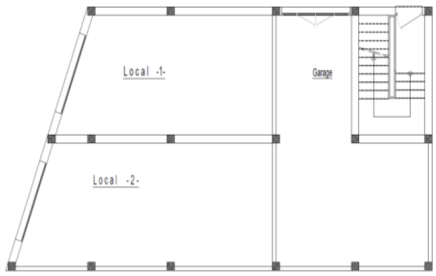
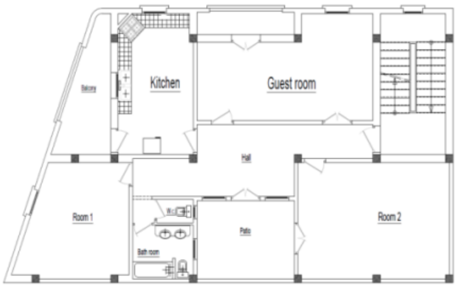
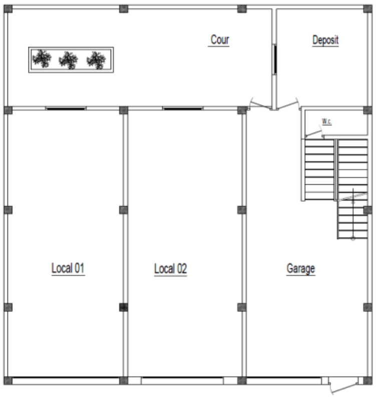
HP13	Kitchen Bath room living room Guest room HALL room -1- local -1- local -2- Terrace 	Superette Hidaya Centre commercial MosqueeHudhayfah ibn al-Yaman CEM Hammoudi Mohamed Seghir Rue N 43 Rue N 62 Docteur Tadj Salim Rue Athmania Mohamed Djamoui
HP14	Local -1- Local -2- Garage Kitchen Guest room Hall Room 1 Room 2 Patio	Cabinet Cardiologie Dr. ABBASSI AMIRA Zoo Biskra Unité secondaire de la protection civile CEM Madani Rahmoun Directorate of Education Musée Régional de la Sixième Wilaya PALACE BISKRA Cour de Biskra

HP15	 Cour Deposit W.c Local 01 Local 02 Garage  Empty on Cour Terrace Bath room Room 01 Kitchen Corridor living room Room 02 Room 03 Guest room	 HAI IBN BADIS HAI EL IZDIHAR

- Conclusion

Biskra houses have undergone several transformations over the different periods, are manifested in the new typology that appeared from the introverted spatial configuration with a central space “Hall” with an open on the roof called “*Rouzna*” and the chican entry “*sguifa*” to the extroverted house type open to outside, with a corridor, and locals in the ground floor for commercial reason, in addition the disappearance of the “*sguifa*”, which was considered as transition space between the outside and the inner space (public and private realm).

The significance of the vernacular spatial configuration continues to define the contemporary spatial organization. The colonization and modernization have an impact on houses form and impose a foreign typologies and urban forms. The houses in Biskra city are adapted to the modern and contemporary needs, but nonetheless continue to express the basic traditional requirements of daily needs.

Chapter V

Abstraction of Spatial Configuration of the Houses to Justified Graphs

- Introduction

In a graphical and mathematical context, justified plan graph is a method for the scientific examination of the space syntactic attitude. In fact, this technique just considers the space hierarchy, not the size or dimensions of the spaces. The architectural plans of the desired houses are primarily investigated in order to quantitatively evaluate the justified plan graphs. (Atikeh et al, 2019).

After establishing the spatial relationship of a building in convex map form, a justified plan graph will be created. In which, the convex map is used to convert an architectural plan into a diagram that depicts the configuration of the plan's selected properties (Ostwald, 2011). To create the justified plan graph, one space is used as the basis, which is shown by a crossover circle. The building spaces are then leveled in relation to the base space, with the entrance being level 0 and the places directly connected to it being level 1, with the relationship depicted by a line. The sixty house plans were analysed with their justified graphs. In this analysis, each functional space in the spatial organisation is treated as a cell, and is indicated by a circle, and the relationship between the cells is indicated by a line that refers to the transition (Erman, 2017).

A j-graph can be shallow or deep. A shallow j-graph implies that a space is directly linked to most of the other spaces in the configuration, but a deep j-graph implies that a space is indirectly related to other spaces via intermediate spaces, forming a tree structure (Gadsiah and al, 2020). The 'tree' graph, which consists of spaces with no alternative means of exit except through the original access, and the 'ring' graph, which consists of spaces with alternate methods of exit other than the original access, were both identified in all the samples. According to Hillier (1996), every space in a J-graph would fall into one of four types of groups based on their connections: Terminal or dead-end spaces are spaces of type A. Type-B spaces are transitional, constituting part of a series that leads to other spaces, Type-C spaces are ring sequences, and Type-D spaces are on two or more rings. Depending on the intended level of accessibility, these categories influence the potential uses of a location (Adeokun and al, 2013).

The J-graphs of the sampled houses revealed the following spatial properties: symmetry and asymmetry, depth, distributedness and non-distributedness, integration, relative asymmetry and control. Asymmetry occurs when a space must be moved in order to get access to a third space, whereas symmetry happens when spaces have identical reciprocal ties to each other and no space limits access to any other space unilaterally. Non-distributedness evaluates whether there is a ring, suggesting alternative pathways, and distributedness evaluates whether there is a single sequence of spaces. Control examines how well a given space admits or restricts access to other spaces within the overall system. Integration is described as the average depth of the network formed for the vertex to all other vertices in the system, from most integrated to most separated, a system's vertices can be ranked. Relative asymmetry (RA) is a metric that can be used to measure integration (Adeokun and al, 2013).

In this chapter (section), the first step is to investigate the morphological structure of these houses’s spatial arrangements in order to decompose them into their convex configuration and convert them into justified graphs using a “house by house” method. The justified graphs are constructed for the sixty houses from the four periods (pre-colonial, colonial, independent, and contemporary).

1. The coding of different spaces in the spatial arrangement

The code is described as a system of symbols intended to represent and transfer information from a source to a destination point by prior convention. The code can be linguistic, in which case it is represented by a language, or non-linguistic, documentary, in which case it allows for the identical presentation of all analogous phenomena in a corpus, allowing for information condensation and homogenization in order to submit the same corpus to statistical and computer analysis.

As a result, the code is essential for deciphering any communication as well as rebuilding the object using hints obtained from its coded encryption (Boutabba, 2013).

The graphs and their plans for the sample (60 houses) are represented in the Appendix A.

Table 05: Coding of the different constituent spaces

Espace	Code	Espace	Code	Espace	Code
Exterior	ext	**Hall** *wast eddar*	Hl	**Vestibule** *sguifa*	Vs
Living room	lvrm	**Corridor**	crd	**Bed room**	rm
Deposit makhzen	dp	**Garage**	gr	**Parents room**	prm
Staircase	str	**Guestroom**	Grm	**patio**	pt

Back yard	Byr	**Kitchen**	ktch	**Receiving room**	rcvrm
Local	L	**Courtyard**	cor	**Terrace**	trs
Hall	H	**Veranda**	vr	**Toilet**	Wc
Intermediate space	I	**Bathroom**	bth	**Buanderie**	bdr
Balcony	blc	**Dinner room**	dnrm	**wardrobe**	wrd

2. Abstraction of the graphs

2.1. The vernacular houses (HV):

2.1.1. Analysis of the vernacular House 01(HV01):

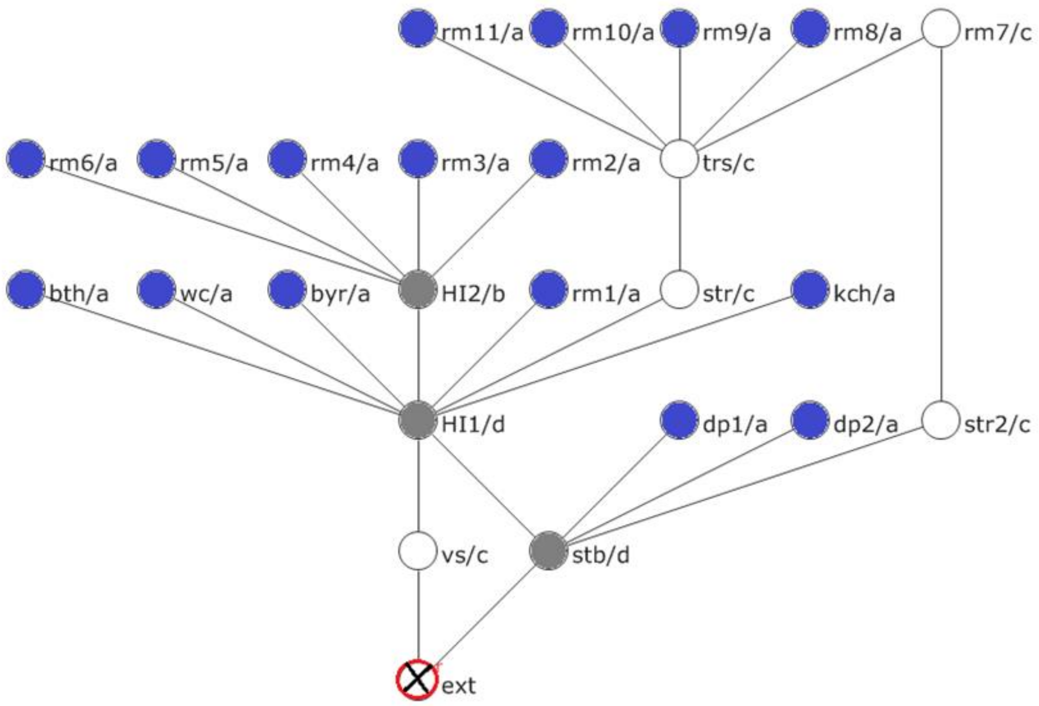


Figure-41: The justified graph of the vernacular house 01 (HV_1)

The graph of the house was constructed using the exterior as a root and represent a ringy structure, which makes it tend to distributedness in a part of the system. In other words, the depth within the house's layout increases, with 26 links and 25 spaces, the inferior part shows the existence of two rings; one is an inner ring formed of six nodes and the second one is an outer ring formed of four nodes. The graph shows an asymmetric order, and composed from the typological space a, b, c and d. the a-type space represents 66%, the b-type 4% from all the system, while the c-type has 24%, and the d-type space has 8%, constituting the results of the four types. The a-type is the most appropriate for the task where there is no through movement, this type includes each of the rooms (rm) that are considered as multifunctional spaces that tend to the private use, the kitchen (ktch), the bathroom (bath), the toilet (wc) these ablution spaces destined to the common use (resident and visitors), and the deposit (dp) were used for the storage of the dates, wheat and barley…etc. These spaces are arranged as dead-end spaces. The b-type spaces suggest that there is no choice of movement in the system, as the Hall (Hl2) "*wasteddar*" it takes directly to the rooms; it is the pivot of the movement, the c-type spaces include; the vestibule "*sguifa*" it is shallow from the exterior; it is considered as the boundary between the exterior and the internal space, and it is also the point of penetration inside the house. The stairs (str, str2) are the only space that connect between the two levels, the room (rm7), and the terrace (trs), where they offer more choice of circulation around the house. The d-type spaces fall in two rings which make them offer more choice of movement and circulation within the house.

Table 06: Hv_1.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	**ext**	78	3,25	0,19	5,11	0,70
1	**vs**	65	2,70	0,14	6,73	0,61
2	**Hl1**	44	1,83	0,07	13,80	6,36
3	**Hl2**	57	2,37	0,11	8,36	5,11
4	**wc**	67	2,79	0,15	6,41	0,11
5	**bth**	67	2,79	0,15	6,41	0,11
6	**rm1**	67	2,79	0,15	6,41	0,11
7	**str**	55	2,29	0,11	8,90	0,27
8	**ktch**	67	2,79	0,15	6,41	0,11
9	**byr**	67	2,79	0,15	6,41	0,11
10	**rm3**	80	3,33	0,20	4,92	0,16
11	**rm2**	80	3,33	0,20	4,92	0,16
12	**rm4**	80	3,33	0,20	4,92	0,16
13	**rm5**	80	3,33	0,20	4,92	0,16
14	**rm6**	80	3,33	0,20	4,92	0,16
15	**trs**	66	2,75	0,15	6,57	5,00
16	**rm9**	89	3,70	0,23	4,24	0,16
17	**rm8**	89	3,70	0,23	4,24	0,16
18	**rm7**	79	3,29	0,19	5,01	0,66
19	**rm10**	89	3,70	0,23	4,24	0,16
20	**rm11**	89	3,70	0,23	4,24	0,16
21	**stb**	57	2,37	0,11	8,36	3,11
22	**dp1**	80	3,33	0,20	4,92	0,20
23	**dp2**	80	3,33	0,20	4,92	0,20
24	**str2**	68	2,83	0,15	6,27	0,70
	Min	44,00	1,83	0,07	4,24	0,11
	Mean	**72,80**	**3,03**	**0,17**	**6,10**	**1,00**
	Max	89,00	3,70	0,23	13,80	6,36

Hv_1.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	**vs**	64	2,78	0,16	6,17	0,11
1	**Hl1**	42	1,82	0,07	13,31	6,91
2	**Hl2**	54	2,34	0,12	8,16	5,11
3	**wc**	64	2,78	0,16	6,17	0,11
4	**bth**	64	2,78	0,16	6,17	0,11
5	**rm1**	64	2,78	0,16	6,17	0,11
6	**str**	52	2,26	0,11	8,72	0,27
7	**ktch**	64	2,78	0,16	6,17	0,11
8	**byr**	64	2,78	0,16	6,17	0,11
9	**rm3**	76	3,30	0,20	4,77	0,16
10	**rm2**	76	3,30	0,20	4,77	0,16
11	**rm4**	76	3,30	0,20	4,77	0,16
12	**rm5**	76	3,30	0,20	4,77	0,16
13	**rm6**	76	3,30	0,20	4,77	0,16
14	**trs**	62	2,69	0,15	6,48	5,00
15	**rm9**	84	3,65	0,24	4,14	0,16
16	**rm8**	84	3,65	0,24	4,14	0,16
17	**rm7**	76	3,30	0,20	4,77	0,66
18	**rm10**	84	3,65	0,24	4,14	0,16
19	**rm11**	84	3,65	0,24	4,14	0,16
20	**stb**	56	2,43	0,13	7,66	2,61
21	**dp1**	78	3,39	0,21	4,60	0,25
22	**dp2**	78	3,39	0,21	4,60	0,25
23	**str2**	66	2,86	0,16	5,88	0,75
	Min	42,00	1,82	0,07	4,14	0,11
	Mean	**69,33**	**3,01**	**0,18**	**5,90**	**1,00**
	Max	84,00	3,65	0,24	13,31	6,91

The data in the table above shows the results of the Relative asymmetry (RA). The Hall (Hl1) "*wasteddar"* is considered as the most integrated space in the system with the value of 0.07 with and without exterior, whereas the Hall (Hl2) the stable, and the staircase (str) are the second integrated spaces with the value of 0.11 when the exterior is included, and 0.12 for the

Hall when the exterior is not included, while the vestibule "*sguifa*" has the value of RA 0.14 with exterior included, and 0.16 when the exterior is not included. Then, the ablution spaces (the bathroom and the toilet), the kitchen, the backyard, the staircase (str2), and the terrace with the value of 0.15 when the exterior is included and rise in some spaces when it is not. The exterior has the value of 0.19. Whereas the other spaces such as the rooms and the deposits are considered as the most segregated spaces in the system with values arrange between them 0.20, 0.23. Thus, the low value of integration (RA) indicates more accessibility of some spaces of Hv_1, the distribution of the Relative asymmetry throughout the system arranges the interaction between the inhabitants themselves and between the inhabitants and visitors.

2.1.2. Analysis of the vernacular House (HV02):

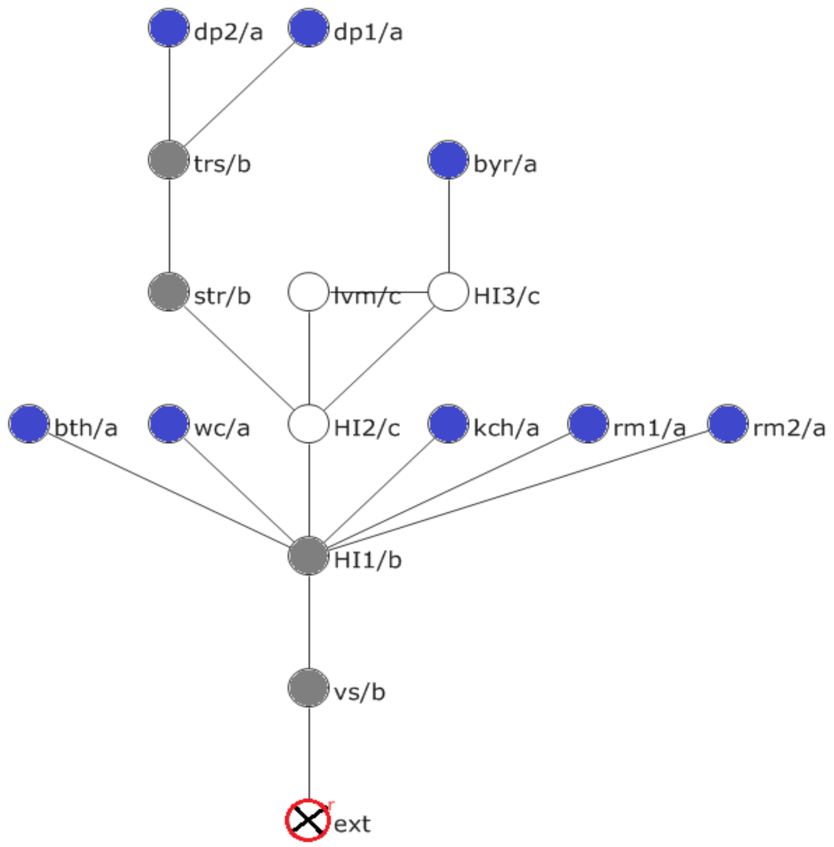


Figure -42: The justified graph of the vernacular house 02 (HV_2)

The justified graph shows a tree-like structure that has three branches, the first one is external and takes the exterior as a root, its more deep from the exterior and it contains 17 nodes and 17 links with the presence of an inner ring which passes through the living room (lvrm), the hall (Hl2), and the "*wasteddar*" (HL) in spite the existence of an inner ring, but it tend to lack in distributedness in all the system, which manifests in the high number of space of the types "a" and "b". The inferior part of the graph is in asymmetric order whereas the spaces are arranged in a linear sequence away from the root, whiles the superior part is in symmetric order. The a-type spaces represent 53% from all the spaces, the b-type spaces have 28%, and the c-type have 18% from all the system. The vestibule "*sguifa*" is the point of penetration into the house, considered as the filter between the external world and the interior; it gives directly to the Hall the pivot of the movement it directly distributes to the occupation spaces: the kitchen (ktch), the rooms (rm1, rm2), and the ablution spaces (bath, wc) arranged as dead-end spaces of a-type spaces.

Table 07: Hv_2.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	0	55	3,66	0,38	2,62	0,50
1	vs	41	2,73	0,24	4,03	1,14
2	Hl1	29	1,93	0,13	7,50	5,75
3	Hl2	29	1,93	0,13	7,50	1,47
4	ktch	43	2,86	0,26	3,75	0,14
5	rm1	43	2,86	0,26	3,75	0,14
6	wc	43	2,86	0,26	3,75	0,14
7	bth	43	2,86	0,26	3,75	0,14
8	rm2	43	2,86	0,26	3,75	0,14
9	lvr	41	2,73	0,24	4,03	0,58
10	Hl3	40	2,66	0,23	4,20	1,75
11	str	37	2,46	0,20	4,77	0,58
12	byr	54	3,60	0,37	2,69	0,33
13	trs	47	3,13	0,30	3,28	2,50
14	dp1	61	4,06	0,43	2,28	0,33
15	dp2	61	4,06	0,43	2,28	0,33
	Min	29,00	1,93	0,13	2,28	0,14
	Mean	**44,37**	**2,95**	**0,27**	**3,99**	**1,00**
	Max	61,00	4,06	0,43	7,50	5,75

Hv_2.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	vs	40	2,85	0,28	3,50	0,14
1	Hl1	27	1,92	0,14	7,00	6,25
2	Hl2	26	1,85	0,13	7,58	1,47
3	ktch	40	2,85	0,28	3,50	0,14
4	rm1	40	2,85	0,28	3,50	0,14
5	wc	40	2,85	0,28	3,50	0,14
6	bth	40	2,85	0,28	3,50	0,14
7	rm2	40	2,85	0,28	3,50	0,14
8	lvr	37	2,64	0,25	3,95	0,58
9	Hl3	36	2,57	0,24	4,13	1,75
10	str	33	2,35	0,20	4,78	0,58
11	byr	49	3,50	0,38	2,60	0,33
12	trs	42	3,00	0,30	3,25	2,50
13	dp1	55	3,92	0,45	2,21	0,33
14	dp2	55	3,92	0,45	2,21	0,33
	Min	26,00	1,85	0,13	2,21	0,14
	Mean	**40,00**	**2,85**	**0,28**	**3,91**	**1,00**
	Max	55,00	3,92	0,45	7,58	6,25

The table above shows the data of the quantitative values, the integration values (RA) are given in both cases when the exterior is included and when it is not. The results indicate the RA values become more integrated when the exterior is not included; in this case the exterior plays an important role in bringing the layout together. The transition spaces are the most integrated spaces in the house layout as the Halls (Hl1, Hl2) with equal value to 0.13, then the staircase with the value of 0.20, the hall (Hl3) 0.23, and the vestibule 0.24 are from the topological space of b-type and Hl3 from c-type because it's a part from the inner ring. The rooms, the kitchen, the bathroom, the toilet have an equal value to 0.26, and the most segregated spaces are the backyard at depth five and the deposits at depth six with the value of 0.37, 0.43. In term of control, the Hl1 has the highest degree in the house's layout with the value of 5.75.

2.1.3. Analysis of the vernacular House (HV03):

The graph represents a tree-like structure with two connections, the spaces are deep from the exterior, is in symmetric from the inferior part and symmetric in the superior part in the graph and it's contained 11 nodes and 12 links that connect the structure together. Two topological types of spaces are structured in the house's layout, 61% of a-type and 41%of b-type. The vestibule (vs) situated at the first depth is shallow from the exterior and allows the access into the house, it's of b-type space that has a direct view on an intermediate space which distributes to the toilet (wc) and the bathroom (bath), those are at depth three from a-type spaces arranged as dead-end spaces, which are destined to mix use visitors / residents, and the

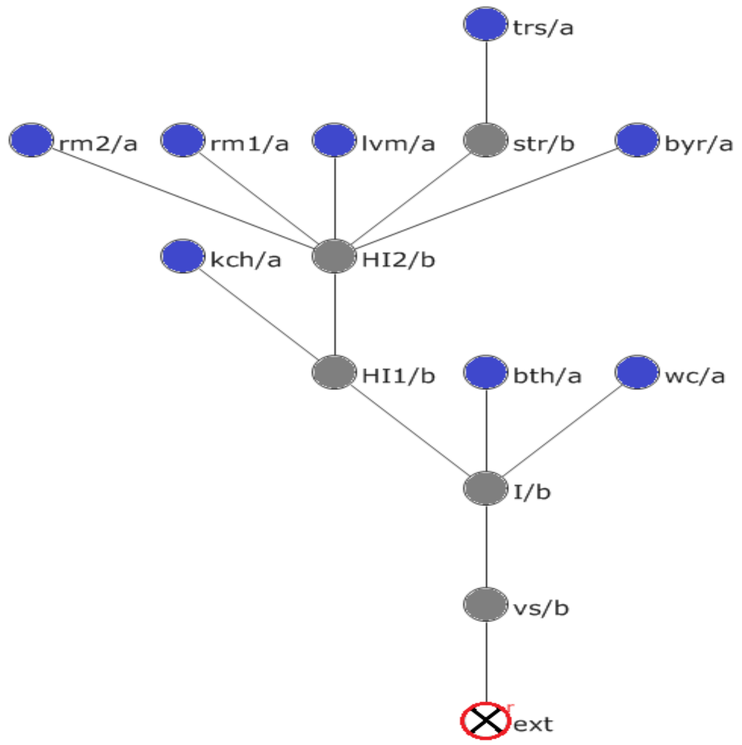


Figure - 43: The justified graph of the vernacular house 03 (HV_3)

corridor (cor) which is the space that separate the female space from the public zone, is of b-type space considered as a through space, it takes to the kitchen that is arranged as a dead-end space and to the Hall (Hl2) which is the main central space from b-type, which also suggests no choice of movement whereas there is no mobility to and from this space, it is a through space, where all the living spaces arranged around this central space are from the a-type spaces such as; the rooms (rm1,rm2), the living room, backyard and the staircase that takes to the terrace.

The data indicates the results of integration (RA) for each space for both cases; with and without exterior, the corridor (cor) and the hall (Hl2) are the most integrated space in the system with an equal value of RA 0.15 despite their situation in different levels, the order of integration is the same when the exterior is not included. The transition spaces considered as the most integrated spaces, which play an important role in the circulation and the distribution within the house. The intermediate space (In) is the second integrated space with the value of 0.20, the vestibule (v), then the staircase (str). Each of the kitchen, the rooms, the backyard, and the living room are culminated at the top of the graph, have the same value of integration. The ablution spaces, the bathroom (bath) and the toilet (wc) have a high value of integration which are segregated from the exterior despite the fact that they are located at the depth three, whereas the terrace is the most segregated space in the system.

Table 08: Hv_3.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	ext	51	3,92	0,48	2,05	0,50
1	vs	39	3,00	0,33	3,00	1,25
2	In	29	2,23	0,20	4,87	2,83
3	bth	41	3,15	0,35	2,78	0,25
4	cor	25	1,92	0,15	6,50	1,41
5	wc	41	3,15	0,35	2,78	0,25
6	ktch	37	2,84	0,30	3,25	0,33
7	Hl2	25	1,92	0,15	6,50	4,83
8	lvr	37	2,84	0,30	3,25	0,16
9	rm1	37	2,84	0,30	3,25	0,16
10	str	35	2,69	0,28	3,54	1,16
11	byr	37	2,84	0,30	3,25	0,16
12	rm2	37	2,84	0,30	3,25	0,16
13	trs	47	3,61	0,43	2,29	0,50
	Min	25,00	1,92	0,15	2,05	0,16
	Mean	**37,00**	**2,84**	**0,30**	**3,61**	**1,00**
	Max	51,00	3,92	0,48	6,50	4,83

Hv_3.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	vs	38	3,16	0,39	2,53	0,25
1	In	27	2,25	0,22	4,40	3,33
2	bth	38	3,16	0,39	2,53	0,25
3	cor	22	1,83	0,15	6,60	1,41
4	wc	38	3,16	0,39	2,53	0,25
5	ktch	33	2,75	0,31	3,14	0,33
6	Hl2	21	1,75	0,13	7,33	4,83
7	lvr	32	2,66	0,30	3,30	0,16
8	rm1	32	2,66	0,30	3,30	0,16
9	str	30	2,50	0,27	3,66	1,16
10	byr	32	2,66	0,30	3,30	0,16
11	rm2	32	2,66	0,30	3,30	0,16
12	trs	41	3,41	0,43	2,27	0,50
	Min	21,00	1,75	0,13	2,27	0,16
	Mean	**32,00**	**2,66**	**0,30**	**3,71**	**1,00**
	Max	41,00	3,41	0,43	7,33	4,83

2.1.4. Analysis of the vernacular House (HV04):

The graph represents a tree-like structure; it is deep from the exterior. It shows an asymmetric order and a non-distributedness in all the system. The two topological types ‘a’ and ‘b’ are characterized by this tree-like structure, 61% from a-type space and 33% from b-type space. The graph started with one space of b-type space; the vestibule (*sguifa*), which is the point of penetration within the house that takes to the guest room (Grm), it is shallow from the exterior and of a-type space arranged as dead-end space, it is destined to the visitors especially man to not penetrate inside the house and to keep the privacy for women.

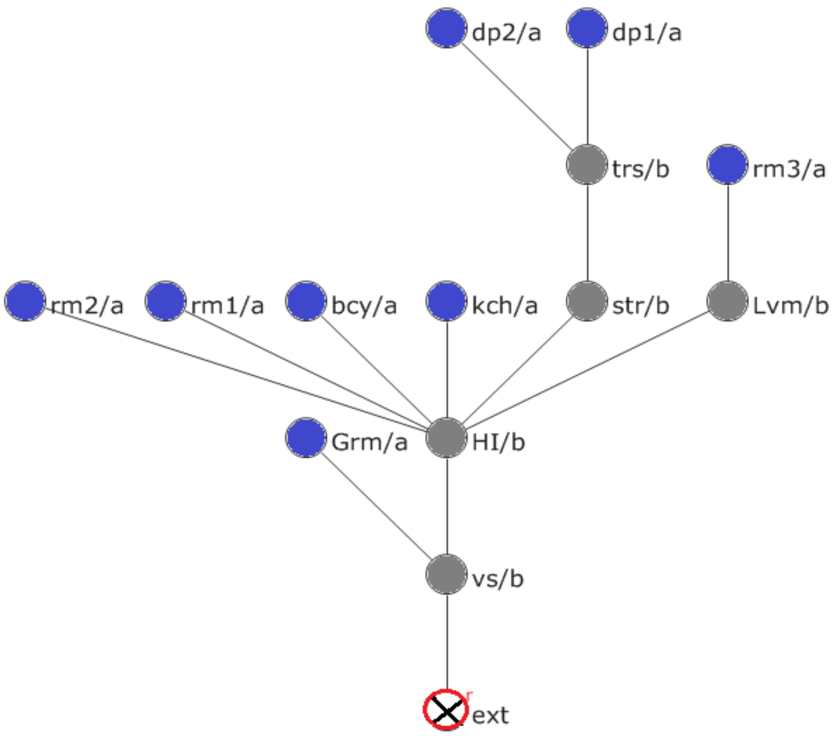


Figure - 44: The justified graph of the vernacular house 04 (HV_4)

The hall (Hl) is of b-type, it is the pivot of circulation inside the house and directly serves to the occupation spaces; the rooms (rm1, rm2), the kitchen, the living room, and the backyard, are of a-type space which is located at the same depth. The Hall is the most integrated space in the house with the value of 0.10, and the second integrated space is the staircase (str) with the value of 0.17, then the vestibule 0.20, although they are situated at different levels in the graph and they are considered as through and transition spaces.

The kitchen, the room1, room2, the backyard and the living room have the same value of integration. The terrace has the value of 0.28. Moreover, the order of integration preserves the same rank of integration when the exterior is not taken into account. The exterior and guest-room are segregated despite their opposite depth (they are located at the first and second depth). The most segregated spaces are the deposits and the room3 with the value of 0.43

which are located at the last depth in the graph. The Hall has the height value of control in the house with the value of 5.50.

Table 09: Hv_4.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	ext	45	3,21	0,34	2,93	0,33
1	vs/b	32	2,28	0,19	5,05	2,14
2	Grm/a	45	3,21	0,34	2,93	0,33
3	Hl/b	23	1,64	0,09	10,11	4,83
4	kch/a	36	2,57	0,24	4,13	0,14
5	l/b	34	2,42	0,21	4,55	1,14
6	str/b	30	2,14	0,17	5,68	0,47
7	rm1/a	36	2,57	0,24	4,13	0,14
8	Lvm/b	34	2,42	0,21	4,55	1,14
9	rm2	47	3,35	0,36	2,75	0,50
10	trs/b	39	2,78	0,27	3,64	2,50
11	dp1/a	52	3,71	0,41	2,39	0,33
12	dp2/a	52	3,71	0,41	2,39	0,33
13	byr/a	47	3,35	0,36	2,75	0,50
14	wc/a	36	2,57	0,24	4,13	0,14
	Min	23,00	1,64	0,09	2,39	0,14
	Mean	**39,20**	**2,80**	**0,27**	**4,14**	**1,00**
	Max	52,00	3,71	0,41	10,11	4,83

Hv_4.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	vs/b	31	2,38	0,23	4,33	1,14
1	Grm/a	43	3,30	0,38	2,60	0,50
2	Hl/b	21	1,61	0,10	9,75	5,00
3	kch/a	33	2,53	0,25	3,90	0,14
4	l/b	31	2,38	0,23	4,33	1,14
5	str/b	27	2,07	0,17	5,57	0,47
6	rm1/a	33	2,53	0,25	3,90	0,14
7	Lvm/b	31	2,38	0,23	4,33	1,14
8	rm2	43	3,30	0,38	2,60	0,50
9	trs/b	35	2,69	0,28	3,54	2,50
10	dp1/a	47	3,61	0,43	2,29	0,33
11	dp2/a	47	3,61	0,43	2,29	0,33
12	byr/a	43	3,30	0,38	2,60	0,50
13	wc/a	33	2,53	0,25	3,90	0,14
	Min	21,00	1,61	0,10	2,29	0,14
	Mean	**35,57**	**2,73**	**0,28**	**3,99**	**1,00**
	Max	47,00	3,61	0,43	9,75	5,00

2.1.5. Analysis of the vernacular House (HV05)

The graph was constructed in a tree-like structure using the exterior as a root, it's shallow from the exterior. The presence of an outer ring offers more than one access into the house. The graph tend to non-distributedness in global manifested by the topological spaces of a-type and b-type where are in symmetric order. The graph opens on a row of two topological spaces of c-type as the the vestibule (*sguifa*) is located at depth one which takes to the bathroom (sdb) at depth two where it is arranged as dead-end of a-type space, and the garage (gr) of c-type space at depth one forming a ring with the vestibule, and the Hall (*wast eddar*) of the topological space of b-type "through space" is located at depth two, and it's the main central space in the house whereas it is the pivot of the circulation that serves to a multitude of a-type spaces such as; the kitchen (ktch), the living room (lvrm), the bedrooms (rm1, rm2,rm3, rm4) which are the spaces that favor the intimacy.

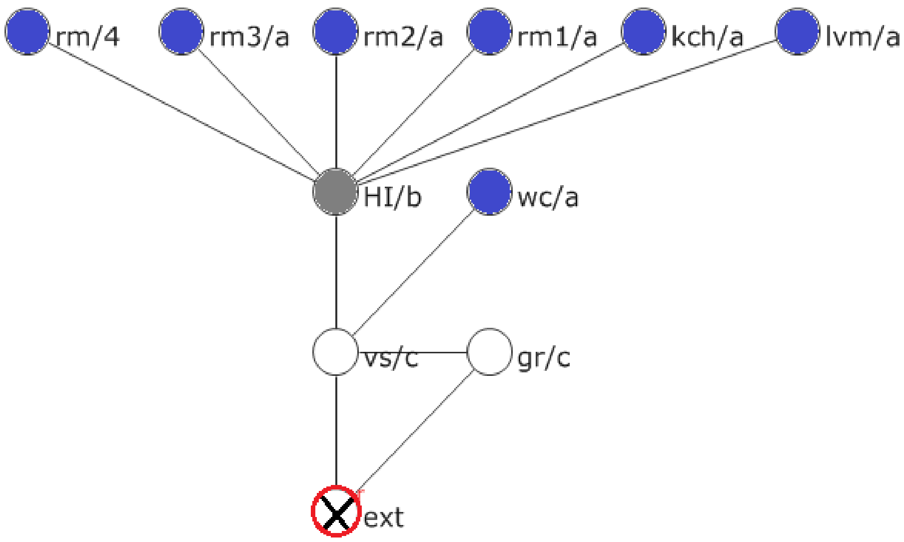


Figure -45: The justified graph of the vernacular house 05 (HV_5)

Table 10: Hv_5.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	vs	16	1,60	0,13	7,50	2,14
1	gr	24	2,40	0,31	3,21	0,75
2	ext	24	2,40	0,31	3,21	0,75
3	Hl	13	1,30	0,06	15,00	6,25
4	wc	25	2,50	0,33	3,00	0,25
5	rm2	22	2,20	0,26	3,75	0,14
6	rm1	22	2,20	0,26	3,75	0,14
7	rm3	22	2,20	0,26	3,75	0,14
8	rm4	22	2,20	0,26	3,75	0,14
9	ktch	22	2,20	0,26	3,75	0,14
10	lvr	22	2,20	0,26	3,75	0,14
	Min	13,00	1,30	0,06	3,00	0,14
	Mean	**21,27**	**2,12**	**0,25**	**4,94**	**1,00**
	Max	25,00	2,50	0,33	15,00	6,25

Hv_5.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	vs	15	1,66	0,16	6,00	2,14
1	gr	23	2,55	0,38	2,57	0,33
2	Hl	11	1,22	0,05	18,00	6,33
3	wc	23	2,55	0,38	2,57	0,33
4	rm2	19	2,11	0,27	3,60	0,14
5	rm1	19	2,11	0,27	3,60	0,14
6	rm3	19	2,11	0,27	3,60	0,14
7	rm4	19	2,11	0,27	3,60	0,14
8	ktch	19	2,11	0,27	3,60	0,14
9	lvr	19	2,11	0,27	3,60	0,14
	Min	11,00	1,22	0,05	2,57	0,14
	Mean	**18,60**	**2,06**	**0,26**	**5,07**	**1,00**
	Max	23,00	2,55	0,38	18,00	6,33

By reviewing the quantitative data, the Hall (*wast eddar*) has the lowest value of RA 0.06, which means that it is the most integrated space and the space that shows a high accessibility in the house's layout, and the second integrated space is the vestibule 0.13. The spaces which have a mediocre value of integration are the staircase 0.19, the kitchen, the living room, the bedrooms (rm1, rm2, rm3, rm4) 0.22, and the segregated spaces are the garage 0.28, the bathroom 0.30, the terrace 0.36.the spaces of transition have always the hight value of integration.

2.1.6. Analysis of the vernacular House (HV06)

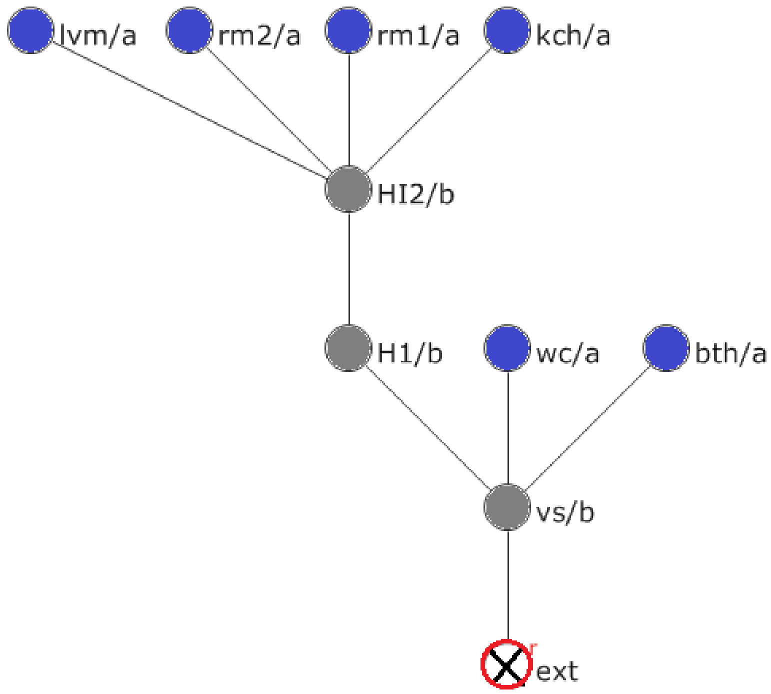


Figure -46: The justified graph of the vernacular house 06 (HV_6)

The graph opens on the vestibule (*sguifa*) of the topological space of b-type which is a through space and the shallower space in the system and it is the boundary between the exterior and the interior of the house, it even controls the penetration of visitors into the house , it takes to the ablution spaces (bathroom and the toilet) of a-type space at depth two which are arranged as dead-end spaces, and the corridor (H1) is of b-type space and considered as transition space that leads directly to the main Hall (wast eddar) at depth three of the topological space of b-type which is the pivot of the circulation in the house layout serving to a multitude of topological spaces of a-type at depth four as; the kitchen (ktch), the living room (lvrm), the bedrooms (rm1, rm2) are arranged as dead-end spaces away from the original space (root space) which are appropriate for the inhabitants where there is no through movement therefore they due for the daily private use.

Table 11: Hv_6.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	**ext**	26	2,88	0,47	2,11	0,25
1	**vs**	18	2,00	0,25	4,00	3,50
2	**bth**	26	2,88	0,47	2,11	0,25
3	**wc**	26	2,88	0,47	2,11	0,25
4	**H1**	16	1,77	0,19	5,14	0,45
5	**Hl2**	16	1,77	0,19	5,14	4,50
6	**ktch**	24	2,66	0,41	2,40	0,20
7	**rm1**	24	2,66	0,41	2,40	0,20
8	**rm2**	24	2,66	0,41	2,40	0,20
9	**lvr**	24	2,66	0,41	2,40	0,20
	Min	16,00	1,77	0,19	2,11	0,20
	Mean	**22,40**	**2,48**	**0,37**	**3,02**	**1,00**
	Max	26,00	2,88	0,47	5,14	4,50

Hv_6.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	**vs**	17	2,12	0,32	3,11	2,50
1	**bth**	24	3,00	0,57	1,75	0,33
2	**wc**	24	3,00	0,57	1,75	0,33
3	**H1**	14	1,75	0,21	4,66	0,53
4	**Hl2**	13	1,62	0,17	5,60	4,50
5	**ktch**	20	2,50	0,42	2,33	0,20
6	**rm1**	20	2,50	0,42	2,33	0,20
7	**rm2**	20	2,50	0,42	2,33	0,20
8	**lvr**	20	2,50	0,42	2,33	0,20
	Min	13,00	1,62	0,17	1,75	0,20
	Mean	**19,11**	**2,38**	**0,39**	**2,91**	**1,00**
	Max	24,00	3,00	0,57	5,60	4,50

Through the analysis of the quantitative data, the spaces of the last depth four; the kitchen, the living room, the bedrooms (rm1,rm2) with the value (0.41), and the spaces of the depth two; the bathroom, the toilet have the highest value of RA (0.47); which means that they are the most segregated spaces in the house layout, despite the different level of depth of the spaces, whereas the Hall (*wast eddar*) and the corridor (H1) have the same lowest value of RA (0,19) which means that they are the most integrated spaces in the system, and the vestibule (*sguifa*) has a mediocre value of integration (0,25).

In terms of control, the Hall (Hl2) has the highest degree of control (4,50), then the vestibule with the value (2.50) which means that it controls the access to the house.

2.1.7. Analysis of the vernacular House (HV07)

The graph was constructed using the exterior as a root, and represents a tree-like structure with two branches, Contained 09 nodes linked by 08 links, and is in asymmetric order. It's tending to lack of distributedness which manifested by the topological spaces of a-type and b-type spaces. The vestibule (*sguifa*) constitutes the point of penetration into the house formed of space of b-type, whereas the spaces of b-type represent the spaces of the transition and the movement around the house "through spaces" such as : the vestibule at depth one is shallow from the exterior, the corridor (H) at depth two which is takes to the Hall at depth three (*wast eddar*) where it is the pivot of the circulation, these spaces of b-type are offered a great control to the spaces of a-type. The spaces of a-type are favored by the inhabitants for its privacy; the toilet at depth two is shallow from the original space and that for private and public use (visitors and inhabitants), the living room (lvrm) at depth three and it's used for receiving guests, and each of the kitchen (ktch), and the bedrooms (rm1,rm2), are arranged at the last depth and arranged as dead end spaces, are the deepest and more private spaces in the house.

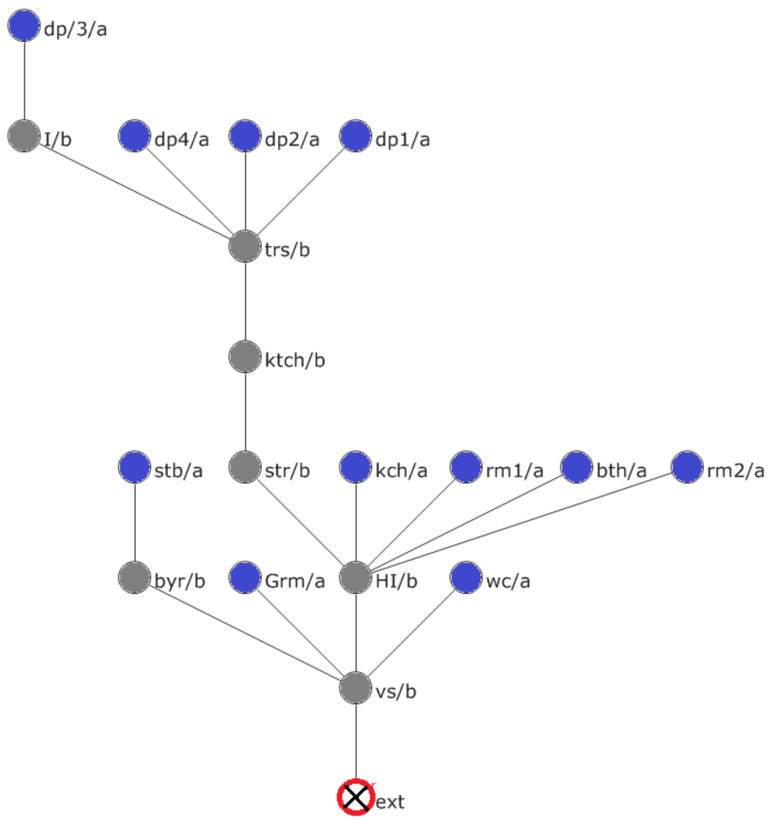


Figure -47: The justified graph of the vernacular house 07 (HV_7)

From the data, the hall (Hl) that is located at depth two and connects between the private and public zone, has the lowest value of RA (0,16) which means that it is the most integrated space in the system, and the second integrated space is the staircase (str) with value of RA (0,18), then the vestibule "*sguifa*" (0,20), the kitchen2 (0,21), the terrace (0,26), the rooms (rm1, rm2), the bathroom, have the same value of integration (0,27), despite the guest room and the toilet are situated at depth two are less integrated with value (0,32) and they are destined to the public use (for visitors) to not penetrate inside the house, the exterior has the same value with the last (0,32). The deposits (dp1,dep2, dp3, dep4),the stable (stb), the intermediate space (I) , are the most segregated spaces in the house. The hall and the terrace have the highest degree of control in the system with values: 4.70, 4.00 respectively.

Table 12: Hv_7.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	ext	67	3,72	0,32	3,12	0,20
1	vs/b	50	2,77	0,20	4,78	3,66
2	Hl/b	43	2,38	0,16	6,12	4,70
3	wc/a	67	3,72	0,32	3,12	0,20
4	Grm/a	67	3,72	0,32	3,12	0,20
5	kch/a	60	3,33	0,27	3,64	0,16
6	rm1/a	60	3,33	0,27	3,64	0,16
7	str/b	46	2,55	0,18	5,46	0,66
8	bth/a	60	3,33	0,27	3,64	0,16
9	ktch/b	51	2,83	0,21	4,63	0,70
10	byr/b	65	3,61	0,30	3,25	1,20
11	rm2/a	60	3,33	0,27	3,64	0,16
12	stb/a	82	4,55	0,41	2,39	0,50
13	trs/b	58	3,22	0,26	3,82	4,00
14	dp4/a	75	4,16	0,37	2,68	0,20
15	dp2/a	75	4,16	0,37	2,68	0,20
16	I/b	73	4,05	0,35	2,78	1,20
17	dp1/a	75	4,16	0,37	2,68	0,20
18	dp3/a	90	5,00	0,47	2,12	0,50
	Min	43,00	2,38	0,16	2,12	0,16
	Mean	**64,42**	**3,57**	**0,30**	**3,54**	**1,00**
	Max	90,00	5,00	0,47	6,12	4,70

Hv_7.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	vs/b	49	2,88	0,23	4,25	2,66
1	Hl/b	41	2,41	0,17	5,66	4,75
2	wc/a	65	3,82	0,35	2,83	0,25
3	Grm/a	65	3,82	0,35	2,83	0,25
4	kch/a	57	3,35	0,29	3,40	0,16
5	rm1/a	57	3,35	0,29	3,40	0,16
6	str/b	43	2,52	0,19	5,23	0,66
7	bth/a	57	3,35	0,29	3,40	0,16
8	ktch/b	47	2,76	0,22	4,53	0,70
9	byr/b	63	3,70	0,33	2,95	1,25
10	rm2/a	57	3,35	0,29	3,40	0,16
11	stb/a	79	4,64	0,45	2,19	0,50
12	trs/b	53	3,11	0,26	3,77	4,00
13	dp4/a	69	4,05	0,38	2,61	0,20
14	dp2/a	69	4,05	0,38	2,61	0,20
15	I/b	67	3,94	0,36	2,72	1,20
16	dp1/a	69	4,05	0,38	2,61	0,20
17	dp3/a	83	4,88	0,48	2,06	0,50
	Min	41,00	2,41	0,17	2,06	0,16
	Mean	**60,55**	**3,56**	**0,32**	**3,36**	**1,00**
	Max	83,00	4,88	0,48	5,66	4,75

2.1.8. Analysis of the vernacular House (HV08):

The j-graph represents a tree-like structure, that tend to non-distributedness in the system, and it is in symmetric order and its deep from the exterior, the non-distributedness is manifested in the topological spaces of a-type (6 spaces) and b-type (4 spaces) in which the spaces of a-type in symmetric order and the spaces of b-type in asymmetric order.

The vestibule (*sguifa*) is situated at depth one of b-type space, represents the boundary between the exterior and the internal spaces, where it's shallow from the exterior, and it has a view to the Hall (*wast eddar*) of b-type space, it's the pivot of the circulation and connected to all the spaces in the house, such as the spaces of a-type: the kitchen, the bathroom, and the bedroom, they are arranged as dead-end spaces, and has a direct view to a bedroom arranged at last depth. The spaces of a-type are suitable for the occupation, and b-type spaces are the spaces of movement and circulation.

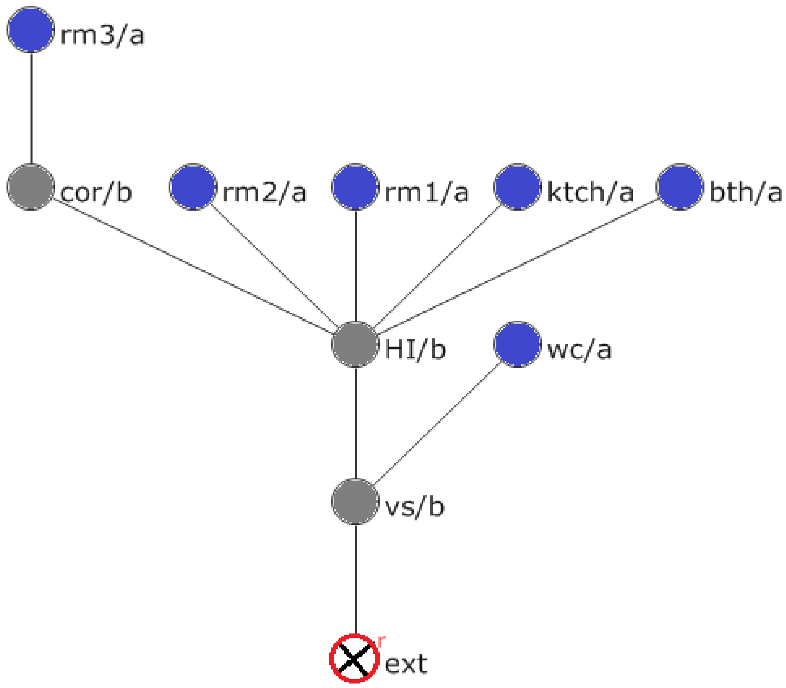


Figure -48: The justified graph of the vernacular house 08 (HV_8)

Table 13: Hv_8.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	ext	24	2,66	0,41	2,40	0,33
1	vs	16	1,77	0,19	5,14	2,16
2	Hl	12	1,33	0,08	12,00	4,83
3	wc	24	2,66	0,41	2,40	0,33
4	rm1	20	2,22	0,30	3,27	0,16
5	ktch	20	2,22	0,30	3,27	0,16
6	bth	20	2,22	0,30	3,27	0,16
7	rm2	20	2,22	0,30	3,27	0,16
8	cor	18	2,00	0,25	4,00	1,16
9	rm3	26	2,88	0,47	2,11	0,50
	Min	12,00	1,33	0,08	2,11	0,16
	Mean	**20,00**	**2,22**	**0,30**	**4,11**	**1,00**
	Max	26,00	2,88	0,47	12,00	4,83

Hv_8.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	vs	15	1,87	0,25	4,00	1,16
1	Hl	10	1,25	0,07	14,00	5,00
2	wc	22	2,75	0,50	2,00	0,50
3	rm1	17	2,12	0,32	3,11	0,16
4	ktch	17	2,12	0,32	3,11	0,16
5	bth	17	2,12	0,32	3,11	0,16
6	rm2	17	2,12	0,32	3,11	0,16
7	cor	15	1,87	0,25	4,00	1,16
8	rm3	22	2,75	0,50	2,00	0,50
	Min	10,00	1,25	0,07	2,00	0,16
	Mean	**16,88**	**2,11**	**0,31**	**4,27**	**1,00**
	Max	22,00	2,75	0,50	14,00	5,00

The data in the table above, shows the results of the relative asymmetry (RA), in which the lowest value is (0.08) for the Hall "*wast eddar*" located at depth two, that means that it is the most integrated space in the system, and second highest integrated space is the vestibule "*sguifa*" with the value (0,19), the courtyard has the value (0,25), then the kitchen (ktch), the bathroom (bath) and the bedrooms (rm1, rm2) have the value of integration (0,30), the exteriorand the toilet are segregated spaces with the value (0,41), then the bedroom (rm3) has the value (0,47), the rank order of integration of the house staysthe same when the exterior is not included.

2.1.9. Analysis of the vernacular House (HV09):

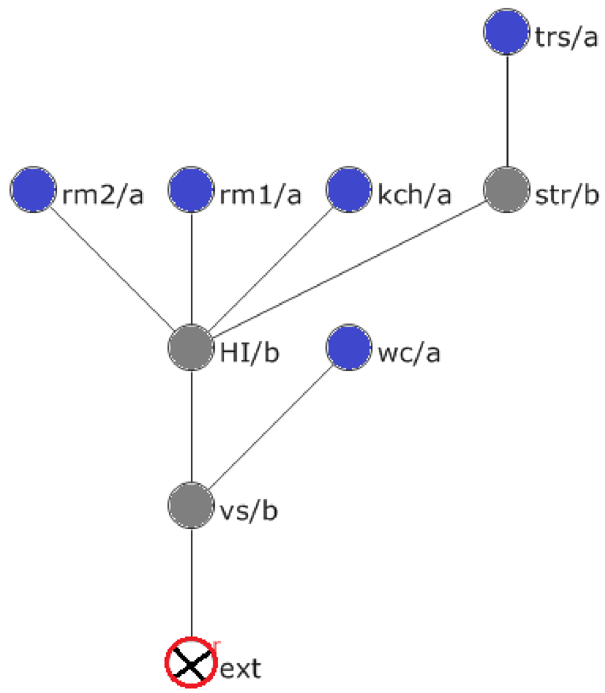


Figure -49: The justified graph of the vernacular house 09 (HV_9)

The graph has a striking resemblance to the previous graph of Hv09; it was constructed using the exterior as a root, contained 09 nodes and 08 links. The non-distributedness is manifested on the topological spaces 'a' and 'b' types; 62% of a-type and 42% of b-type space in which a-type in symmetric order and b-type in asymmetric order. Like the previous houses, the vestibule "*sguifa*" represents the only access into the house, it is of b-type space which is considered as a through space that takes to the toilet of a-type space arranged as dead-end space located at depth two and shallow from the exterior, and to the Hall "*wasteddar*" of b-type space the main central space in the house that gives to the rooms (rm1, rm2). The kitchen is from a-type space, and the staircase from b-type space which is also a through space that takes directly to the terrace in the second level.

Table 14: Hv_9.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	**ext**	21	2,62	0,46	2,15	0,33
1	**vs**	14	1,75	0,21	4,66	2,20
2	**Hl**	11	1,37	0,10	9,33	3,83
3	**wc**	21	2,62	0,46	2,15	0,33
4	**rm1**	18	2,25	0,35	2,80	0,20
5	**ktch**	18	2,25	0,35	2,80	0,20
6	**rm2**	18	2,25	0,35	2,80	0,20
7	**str**	16	2,00	0,28	3,50	1,20
8	**trs**	23	2,87	0,53	1,86	0,50
	Min	11,00	1,37	0,10	1,86	0,20
	Mean	**17,77**	**2,22**	**0,34**	**3,56**	**1,00**
	Max	23,00	2,87	0,53	9,33	3,83

Hv_9.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	**vs**	13	1,85	0,28	3,50	1,20
1	**Hl**	9	1,28	0,09	10,50	4,00
2	**wc**	19	2,71	0,57	1,75	0,50
3	**rm1**	15	2,14	0,38	2,62	0,20
4	**ktch**	15	2,14	0,38	2,62	0,20
5	**rm2**	15	2,14	0,38	2,62	0,20
6	**str**	13	1,85	0,28	3,50	1,20
7	**trs**	19	2,71	0,57	1,75	0,50
	Min	9,00	1,28	0,09	1,75	0,20
	Mean	**14,75**	**2,10**	**0,36**	**3,60**	**1,00**
	Max	19,00	2,71	0,57	10,50	4,00

From the tables, the hall "*wast eddar*" has the lowest value of RA (0.10) that refers to the high degree of integration of that space. The second integrated space is the vestibule "*sguifa"* with value (0.21), and then comes the staircase (0.28). The transition spaces have the lowest degree of integration and the highest values of control in the house. The terrace, the toilet (wc) and the exterior (ext) have the highest degree of integration (0.53, 0.46) which means that they are segregated spaces, even though they are situated at the first levels in the graph and shallow from the exterior. The kitchen and the rooms (rm1, rm2) have an equal value of integration (0.35) which is considered as segregated spaces.

2.1.10. Analysis of the vernacular House (HV10):

The graph was constructed using the exterior as a root; it represents a tree-like structure. The topological spaces of a- and b-type indicate to the non-distributedness in the system (70% of a-type and 33% of b-type spaces), the graph is in asymmetric order. The penetration into the house is through the vestibule "*sguifa*" at depth one, it is of the topological space b-type, and gives directly to the hall "*wast eddar*". The toilet from a-type at depth two which is shallow from the exterior destined for public use, the kitchen, the room, the bathroom and the hall2 are arranged around the "*wast eddar*", they are from the topological space a-type except the hall2 which is from b-type space, considered as the second main space in the house where all the daily activities take place. The last depth is situated in the bed-rooms (rm2, rm3) and the courtyard which are arranged as dead end spaces from the topological space of a-type.

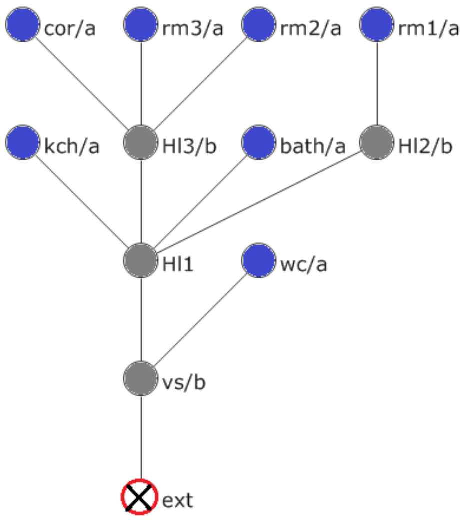


Figure -50: The justified graph of the vernacular house 10 (HV$_{10}$)

Table 15: Hv$_{10}$.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	ext	33	3,00	0,40	2,50	0,33
1	vs/b	23	2,09	0,21	4,58	2,20
2	Hl1	17	1,54	0,10	9,16	3,08
3	wc/a	33	3,00	0,40	2,50	0,33
4	Hl3/b	21	1,90	0,18	5,50	3,20
5	bath/a	27	2,45	0,29	3,43	0,20
6	Hl2/b	25	2,27	0,25	3,92	1,20
7	kch/a	27	2,45	0,29	3,43	0,20
8	rm1/a	35	3,18	0,43	2,29	0,50
9	rm3/a	31	2,81	0,36	2,75	0,25
10	cor/a	31	2,81	0,36	2,75	0,25
11	rm2/a	31	2,81	0,36	2,75	0,25
	Min	17,00	1,54	0,10	2,29	0,20
	Mean	**27,83**	**2,53**	**0,30**	**3,79**	**1,00**
	Max	35,00	3,18	0,43	9,16	3,20

Hv$_{10}$.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	vs/b	22	2,20	0,26	3,75	1,20
1	Hl1	15	1,50	0,11	9,00	3,25
2	wc/a	31	3,10	0,46	2,14	0,50
3	Hl3/b	18	1,80	0,17	5,62	3,20
4	bath/a	24	2,40	0,31	3,21	0,20
5	Hl2/b	22	2,20	0,26	3,75	1,20
6	kch/a	24	2,40	0,31	3,21	0,20
7	rm1/a	31	3,10	0,46	2,14	0,50
8	rm3/a	27	2,70	0,37	2,64	0,25
9	cor/a	27	2,70	0,37	2,64	0,25
10	rm2/a	27	2,70	0,37	2,64	0,25
	Min	15,00	1,50	0,11	2,14	0,20
	Mean	**24,36**	**2,43**	**0,31**	**3,70**	**1,00**
	Max	31,00	3,10	0,46	9,00	3,25

The hall1 (Hl1) has the lowest degree of RA (0.10) that indicates to the high integration of that space, when the exterior is not included the order of integration remains the same, then the hall3 (Hl3) has the second high degree of integration with value (0.18), next, the vestibule "*sguifa*" with value of integration (0.21). The hall2 (Hl2) is integrated space with value (0.25), the kitchen, and the bathroom have an equal value (0.29) , the bedrooms (rm2, rm3) and the courtyard show a degree of segregation in the house with value (0.36), whereas the room1 has the highest degree of integration in the house with value (0.43). The exterior and the toilet are segregated spaces with high value of integration (0.40). Moreover, the halls (Hl1 and Hl2) have a high degree of control 3.75, 3.20 respectively.

2.1.11. Analysis of the House V11 (Hv_{11})

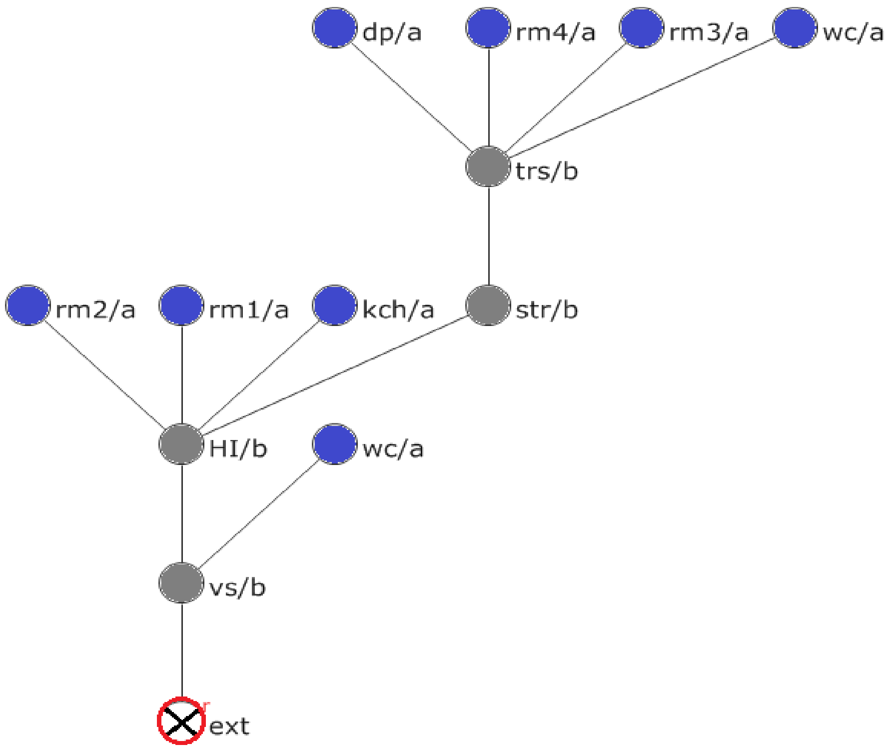


Figure -51: The justified graph of the vernacular house 11 (HV_{11})

The graph of the vernacular house11 has a steady resemblance to the previous houses, it represents a tree-like structure with two brunches, the graph is in symmetric order, and tends to the non-distributedness that manifested in the topological spaces of a-type 66% and b-type 36%. It is deep from the exterior (the root space). The penetration into the house from the vestibule of the topological space of b-type takes to the hall and the toilet which is destined to common use visitors and inhabitants; they are located at depth two and shallow from the exterior. The hall is the main central space where all the spaces are arranged around it. As for the bedrooms (rm1, rm2) and the kitchen they are from the a-type spaces. The staircase of the topological space b-type takes directly to the next floor to the terrace of b-type where it is considered as transition space. And the last depth is situated in each of the bedrooms (rm3 and rm4) and the toilet, a deposit which are arranged as dead-end spaces.

The transition spaces such as the hall, the staircase, the terrace and the vestibule are the most integrated spaces and that are shown in the low value of RA of each space 0.16, 0.18, 0.22

and 0.27, respectively. When the exterior is not included, the rank order of integration remains the same in the system. The kitchen and the bedrooms (rm1, rm2) have the same value of RA 0.33, the deposit, the bedrooms (rm3, rm4), and the toilet are situated at the last depth, they are segregated spaces. The exterior has the high value of RA 0.49, thus, is the most segregated space in the house. The terrace has the highest degree of control with value 4.50 because it controls the access to the other spaces, next comes the hall with value 4.00.

Table 16: Hv_{11}.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	ext	41	3,41	0,43	2,27	0,33
1	vs	30	2,50	0,27	3,66	2,20
2	wc	41	3,41	0,43	2,27	0,33
3	Hl	23	1,91	0,16	6,00	3,83
4	rm1	34	2,83	0,33	3,00	0,20
5	ktch	34	2,83	0,33	3,00	0,20
6	rm2	34	2,83	0,33	3,00	0,20
7	str	24	2,00	0,18	5,50	0,40
8	trs	27	2,25	0,22	4,40	4,50
9	dp	38	3,16	0,39	2,53	0,20
10	rm4	38	3,16	0,39	2,53	0,20
11	rm3	38	3,16	0,39	2,53	0,20
12	wc	38	3,16	0,39	2,53	0,20
	Min	23,00	1,91	0,16	2,27	0,20
	Mean	**33,84**	**2,82**	**0,33**	**3,32**	**1,00**
	Max	41,00	3,41	0,43	6,00	4,50

Hv_{11}.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	vs	29	2,63	0,32	3,05	1,20
1	wc	39	3,54	0,50	1,96	0,50
2	Hl	21	1,90	0,18	5,50	4,00
3	rm1	31	2,81	0,36	2,75	0,20
4	ktch	31	2,81	0,36	2,75	0,20
5	rm2	31	2,81	0,36	2,75	0,20
6	str	21	1,90	0,18	5,50	0,40
7	trs	23	2,09	0,21	4,58	4,50
8	dp	33	3,00	0,40	2,50	0,20
9	rm4	33	3,00	0,40	2,50	0,20
10	rm3	33	3,00	0,40	2,50	0,20
11	wc	33	3,00	0,40	2,50	0,20
	Min	21,00	1,90	0,18	1,96	0,20
	Mean	**29,83**	**2,71**	**0,34**	**3,23**	**1,00**
	Max	39,00	3,54	0,50	5,50	4,50

2.1.12. Analysis of the vernacular House (HV12):

The graph was constructed using the exterior as a root; it represents a tree-like structure in the superior part and ringy configuration in the inferior part. The graph is deep from the exterior and is in symmetric order in general. It’s contained 29 nodes and 30 links, the graph shows a distributedness in the inferior part manifested in two rings which offer a high flexibility in the movement and offer a choice of circulation around the house. The a-type space represents 60%, b-type represents 14%, c-type 24%, and d-type 3%, its notable that the configuration constructed by the four typological spaces (a,b,c,d types). The vestibule is considered as the point of penetration into the house it’s from c-type space in which is part from the inner ring that formed by: the vestibule (vs), the hall (HL), the intermediate space (I), and the kitchen (ktch), whereas the vestibule is the filter that separate between the inner space and the outside world, the "*sguifa*" takes directly to three spaces: the deposit (dp) of a-type at depth two which arranged as dead-end space, the hall (Hl1) and the intermediate space (I) of c-type space. Each of the toilet (wc) and the bathroom (bath) are arranged as dead-end spaces.

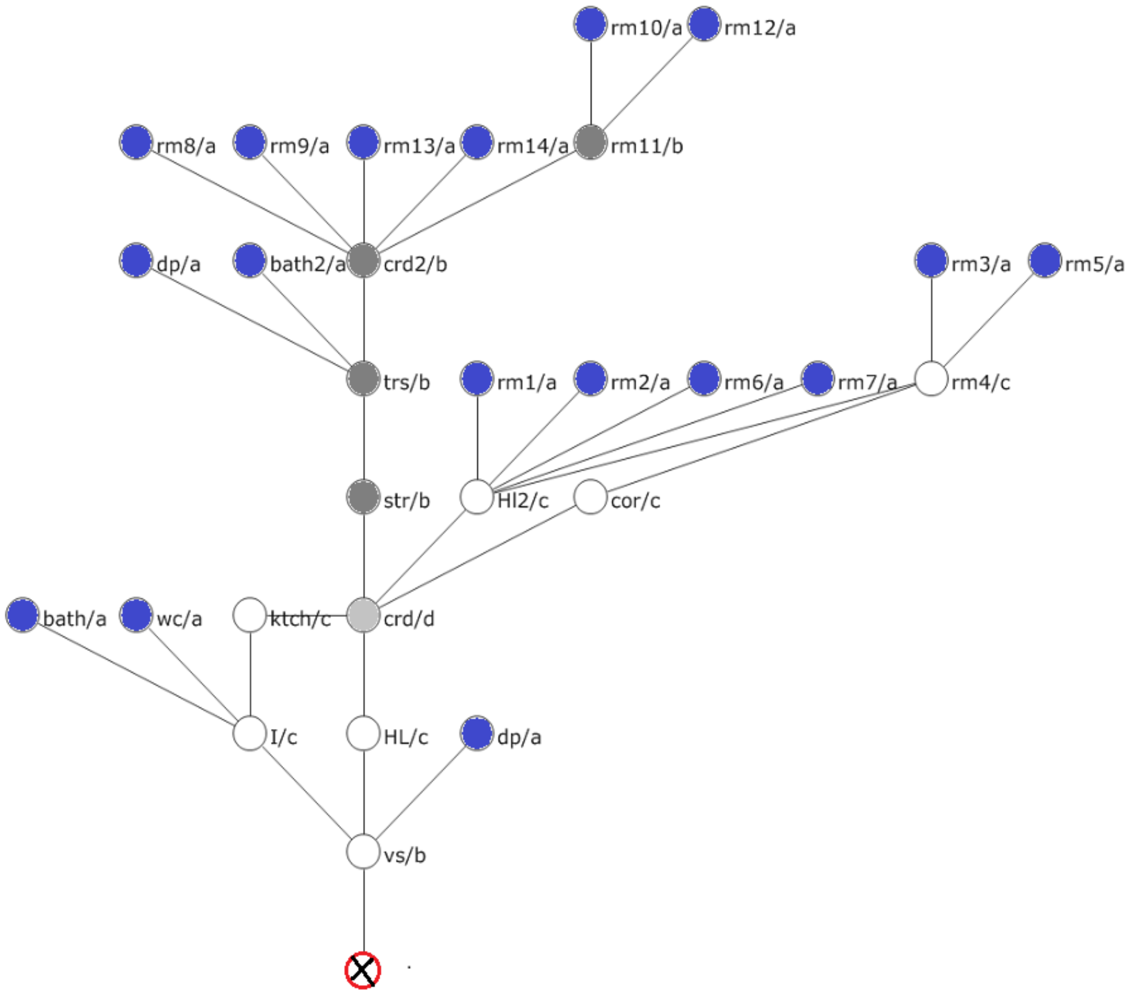


Figure - 52: The justified graph of the vernacular house 12 (HV_{12})

The second hall (Hl2) from d-type space and part of two rings is the pivot of movement within the house in which is distribute to a number of bedrooms of a-type space (rm1, rm2, rm6, and rm7) whereas the rm4 of c-type space has an access to the bedrooms (rm3, rm5). The staircase opens to the terrace of b-type space which has an access a deposit (dp), and bathroom (bth) whereas these two spaces arranged as dead-end spaces at depth six, and to a corridor (crd) of b-type space which is a through space that open to the bedrooms (rm8, rm9, rm13, and rm14) of a-type spaces, and the bedroom (rm11) of b-type has an access to two rooms (rm10, and rm12) which arranged as dead-end space in the last depth in the graph.

The data in the tables below show that the transition spaces (through spaces) have the lowest values of RA, in which the corridor (crd) is the most integrated space with value (0.12), the hall (HL2) and the terrace (trs) are the second integrated spaces with an equal value (0.15), followed by the hall (HL) and the kitchen (ktch) with the same value (0.16), then the courtyard (cor) with value (0.17), and the second corridor (cor2) with value (0.18). the vestibule (vs), the intermediate space (I) and the room (rm4) have an equal value of integration (0.20). The bedrooms (rm10, and rm12) are the most segregated spaces which have the highest value of integration (0.31) which are situated at last depth. The other spaces have a moderate value varied between (0.22) and (0.27). It's notable, when the exterior is not included the rank order of integration remain the same in the system. The corridor (crd2) and the hall (HL2) have the highest value of control (4.58) and (4.45) respectively. The vestibule has a high control (2.75), these spaces control the access to the most spaces in the houses.

Table 17: Hv_{12}.agx_summary. Exterior included **Hv_{12}.agx_summary. Exterior not included**

		TDn	MDn	RA	i	CV
0	ext	142	4,89	0,27	3,59	0,25
1	vs/b	114	3,93	0,20	4,77	2,75
2	HL/c	97	3,34	0,16	5,97	0,45
3	dp/a	142	4,89	0,27	3,59	0,25
4	I/c	114	3,93	0,20	4,77	2,75
5	crd/d	78	2,68	0,12	8,28	2,16
6	ktch/c	97	3,34	0,16	5,97	0,45
7	wc/a	142	4,89	0,27	3,59	0,25
8	batha	142	4,89	0,27	3,59	0,25
9	str/b	84	2,89	0,13	7,38	0,45
10	Hl2/c	92	3,17	0,15	6,44	4,45
11	cor/c	100	3,44	0,17	5,71	0,45
12	rm1/a	120	4,13	0,22	4,46	0,16
13	trs/b	92	3,17	0,15	6,44	2,66
14	crd2/b	106	3,65	0,18	5,27	4,58
15	bath2/a	120	4,13	0,22	4,46	0,25
16	dp/a	120	4,13	0,22	4,46	0,25
17	rm2/a	120	4,13	0,22	4,46	0,16
18	rm6/a	120	4,13	0,22	4,46	0,16
19	rm7/a	120	4,13	0,22	4,46	0,16
20	rm4/c	114	3,93	0,20	4,77	2,66
21	rm3/a	142	4,89	0,27	3,59	0,25
22	rm5/a	142	4,89	0,27	3,59	0,25
23	rm13/a	134	4,62	0,25	3,86	0,16
24	rm14/a	134	4,62	0,25	3,86	0,16
25	rm11/b	130	4,48	0,24	4,01	2,16
26	rm9/a	134	4,62	0,25	3,86	0,16
27	rm8/a	134	4,62	0,25	3,86	0,16
28	rm10/a	158	5,44	0,31	3,14	0,33
29	rm12/a	158	5,44	0,31	3,14	0,33
	Min	78,00	2,68	0,12	3,14	0,16
	Mean	**121,40**	**4,18**	**0,22**	**4,66**	**1,00**
	Max	158,00	5,44	0,31	8,28	4,58

		TDn	MDn	RA	i	CV
0	vs/b	113	4,03	0,22	4,44	1,75
1	HL/c	95	3,39	0,17	5,64	0,53
2	dp/a	140	5,00	0,29	3,37	0,33
3	I/c	112	4,00	0,22	4,50	2,83
4	crd/d	75	2,67	0,12	8,04	2,16
5	ktch/c	94	3,35	0,17	5,72	0,45
6	wc/a	139	4,96	0,29	3,40	0,25
7	bath/a	139	4,96	0,29	3,40	0,25
8	str/b	80	2,85	0,13	7,26	0,45
9	Hl2/c	88	3,14	0,15	6,30	4,45
10	cor/c	96	3,42	0,17	5,55	0,45
11	rm1/a	115	4,10	0,23	4,34	0,16
12	trs/b	87	3,10	0,15	6,40	2,66
13	crd2/b	100	3,57	0,19	5,25	4,58
14	bath2/a	114	4,07	0,22	4,39	0,25
15	dp/a	114	4,07	0,22	4,39	0,25
16	rm2/a	115	4,10	0,23	4,34	0,16
17	rm6/a	115	4,10	0,23	4,34	0,16
18	rm7/a	115	4,10	0,23	4,34	0,16
19	rm4/c	109	3,89	0,21	4,66	2,66
20	rm3/a	136	4,85	0,28	3,50	0,25
21	rm5/a	136	4,85	0,28	3,50	0,25
22	rm13/a	127	4,53	0,26	3,81	0,16
23	rm14/a	127	4,53	0,26	3,81	0,16
24	rm11/b	123	4,39	0,25	3,97	2,16
25	rm9/a	127	4,53	0,26	3,81	0,16
26	rm8/a	127	4,53	0,26	3,81	0,16
27	rm10/a	150	5,35	0,32	3,09	0,33
28	rm12/a	150	5,35	0,32	3,09	0,33
	Min	75,00	2,67	0,12	3,09	0,16
	Mean	**115,79**	**4,13**	**0,23**	**4,57**	**1,00**
	Max	150,00	5,35	0,32	8,04	4,58

2.1.13. Analysis of the vernacular House (HV13):

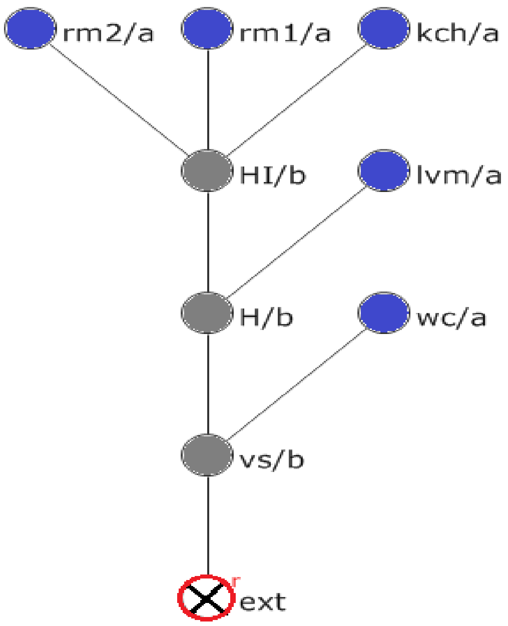


Figure -53: The justified graph of the vernacular house 13 (HV_{13})

The graph is representing an arborescent configuration in general; it's linear and asymmetrical order in the inferior part and in tree-like structure and symmetric order in the superior part. is contained 9 nodes and 8 links, the high degree of a- and b-type (62% of a-type, 42% of b-type) leads to the non-distributedness in the system. As the previous houses, the « *sguifa* » is the only point that allow the penetration into the house, is from b-type space situated at depth one, it takes to the toilet at depth two which destined to the common use visitors / inhabitants, and to the hall (H) of b-type space, it's playing a role of separation because it leads to the living room (guest room for visitors) and to the main central hall (Hl) where the daily activities take a place. At last depth are situated the bedrooms and the kitchen from a-type space, which are the most private spaces in the house.

From the quantitative data in the table above, the transition spaces have always the low value of RA or the high degree of integration, as in the house V_{13} the hall (H) is the most integrated space (0.17), then the hall (Hl) the main central space with value (0.21), and the vestibule with value (0.28). When the exterior is not included the H and Hl have the same value of integration (0.19). The exterior and the toilet have the highest degree of RA (0.53) which means are the most segregated spaces in the system. Whereas the bedrooms and the kitchen have (0.46) show a high segregation, and the living room has a value of (0.42) is show a mediocre segregation. The hall (Hl) is the most controlled space in the house with value of (3.33) then the (H) and the vestibule.

Table 18: Hv_{13}.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	ext	23	2,87	0,53	1,86	0,33
1	vs	16	2,00	0,28	3,50	2,33
2	H	13	1,62	0,17	5,60	1,58
3	wc	23	2,87	0,53	1,86	0,33
4	Hl	14	1,75	0,21	4,66	3,33
5	lvr	20	2,50	0,42	2,33	0,33
6	rm1	21	2,62	0,46	2,15	0,25
7	ktch	21	2,62	0,46	2,15	0,25
8	rm2	21	2,62	0,46	2,15	0,25
	Min	13,00	1,62	0,17	1,86	0,25
	Mean	**19,11**	**2,38**	**0,39**	**2,92**	**1,00**
	Max	23,00	2,87	0,53	5,60	3,33

Hv_{13}.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	vs	15	2,14	0,38	2,62	1,33
1	H	11	1,57	0,19	5,25	1,75
2	wc	21	3,00	0,66	1,50	0,50
3	Hl	11	1,57	0,19	5,25	3,33
4	lvr	17	2,42	0,47	2,10	0,33
5	rm1	17	2,42	0,47	2,10	0,25
6	ktch	17	2,42	0,47	2,10	0,25
7	rm2	17	2,42	0,47	2,10	0,25
	Min	11,00	1,57	0,19	1,50	0,25
	Mean	**15,75**	**2,25**	**0,41**	**2,87**	**1,00**
	Max	21,00	3,00	0,66	5,25	3,33

2.1.14. Analysis of the vernacular House (HV14):

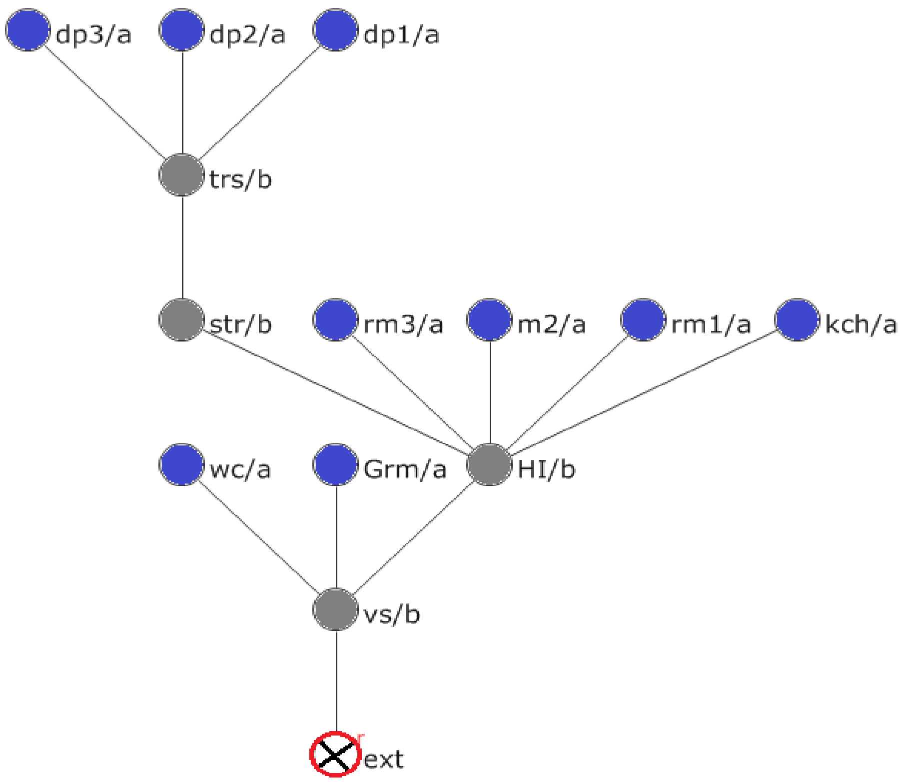


Figure -54: The justified graph of the vernacular house 14 (HV_{14})

The graph is constructed using the exterior as a root, represents an arborescent configuration (tree-like structure), in symmetric order. The graph composed from two topological spaces the a-type has 69% and the b-type has 33% that manifested in the non-distributedness in the house layout. The b-type spaces are for the circulation and distribution they suggest that there is no choice of movement. As for the vestibule, the only point of penetration into the house which gives to the toilet (wc) and guest room (Grm), they are shallow from the exterior and are destined for common use visitors / inhabitants. The hall (Hl) which is the main central space gives to the rooms (rm1, rm2, rm3) and the kitchen that are arranged as dead-end spaces. The staircase is the space that connects between the two levels; it takes directly to the terrace.

From the quantitative data from the table, the hall is considered as the most integrated space (0.12) even though itis the most controlled space with value (4.75). The staircase is the second integrated space with value (0.17), then the vestibule (0.20), and it has a high value of control (3.16) because it controls the access to the house. The terrace has a good integration (0.25), it controls the access to the spaces in the second floor, its value of control is (3.50). The rooms (rm1, rm2, and rm3) have a high value of integration which means, the segregation of these spaces. The most segregated spaces are the deposits that are situated at the last depth with value (0.41).

Table 19: Hv_{14}.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	ext	41	3,15	0,35	2,78	0,25
1	1	29	2,23	0,20	4,87	3,16
2	Grm	41	3,15	0,35	2,78	0,25
3	Hl	23	1,76	0,12	7,80	4,75
4	wc	41	3,15	0,35	2,78	0,25
5	rm2	35	2,69	0,28	3,54	0,16
6	rm3	35	2,69	0,28	3,54	0,16
7	rm1	35	2,69	0,28	3,54	0,16
8	ktch	35	2,69	0,28	3,54	0,16
9	str	27	2,07	0,17	5,57	0,41
10	trs	33	2,53	0,25	3,90	3,50
11	dp2	45	3,46	0,41	2,43	0,25
12	dp1	45	3,46	0,41	2,43	0,25
13	dp3	45	3,46	0,41	2,43	0,25
	Min	23,00	1,76	0,12	2,43	0,16
	Mean	**36,42**	**2,80**	**0,30**	**3,71**	**1,00**
	Max	45,00	3,46	0,41	7,80	4,75

Hv_{14}.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	vs	28	2,33	0,24	4,12	2,16
1	Grm	39	3,25	0,40	2,44	0,33
2	Hl	21	1,75	0,13	7,33	4,83
3	wc	39	3,25	0,40	2,44	0,33
4	rm2	32	2,66	0,30	3,30	0,16
5	rm3	32	2,66	0,30	3,30	0,16
6	rm1	32	2,66	0,30	3,30	0,16
7	ktch	32	2,66	0,30	3,30	0,16
8	str	24	2,00	0,18	5,50	0,41
9	trs	29	2,41	0,25	3,88	3,50
10	dp2	40	3,33	0,42	2,35	0,25
11	dp1	40	3,33	0,42	2,35	0,25
12	dp3	40	3,33	0,42	2,35	0,25
	Min	21,00	1,75	0,13	2,35	0,16
	Mean	**32,92**	**2,74**	**0,31**	**3,53**	**1,00**
	Max	40,00	3,33	0,42	7,33	4,83

2.1.15. Analysis of the vernacular House (HV15):

The graph has a striking resemblance to the previous graphs, it was constructed using the exterior as a root, and the graph shows a tree-like structure with two brunches, it is in symmetric order in general. It contains 18 nodes and 18 links, with the presence of an inner ring in the inferior part passing by the vestibule « *sguifa* », the kitchen, and the hall « *wast eddar* », despite the presence of a ring; the graph shows a non-distributedness in global which appears in the high degree of a- and b-type spaces: 58% a-type, 25% b-type and 16% of c-type spaces. The vestibule (vs) is situated at depth one, it is shallow from the exterior from c-type space which represents the point of penetration into the house and provides a choice of circulation into the house. The vestibule is connected to the bathroom and the toilet via an intermediate space (I) of b-type and the ablution spaces (the bathroom and toilet) are arranged as dead-end spaces.

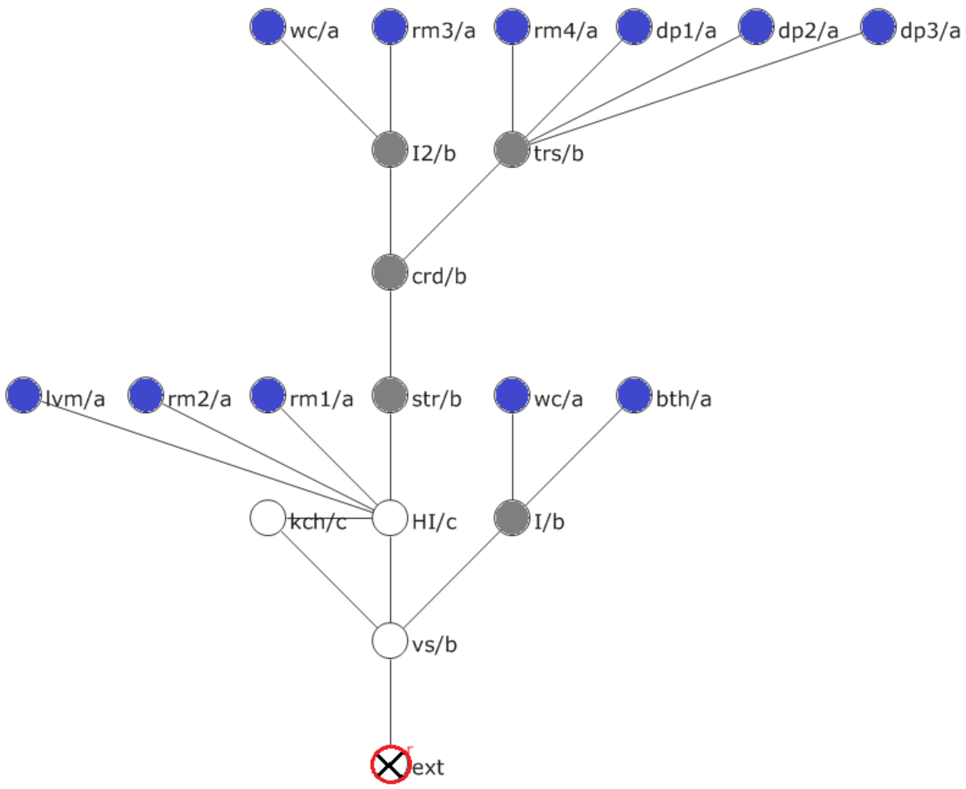


Figure -55: The justified graph of the vernacular house 15 (HV_{15})

The Hall (Hl) is the pivot of circulation and the point of distribution within the house and it is of c-type space; it has an access to the living room, the rooms (rm1, rm2), and the staircase that takes directly to the next floor; to an intermediate space (I2) of b-type space which is a transition space. The bedroom (rm3) has a private access and isolated from the other spaces, which is arranged as dead-end space. The bedroom (rm4) and the deposits (dp1, dp2, dp3) have an access to the terrace of b-type space and they are arranged at the last depth in the graph as dead-end spaces.

Table 20: Hv_{15}.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	ext	69	4,05	0,38	2,61	0,25
1	vs	53	3,11	0,26	3,77	2,66
2	Hl	42	2,47	0,18	5,44	4,25
3	I	69	4,05	0,38	2,61	0,25
4	ktch	55	3,23	0,27	3,57	0,41
5	rm2	58	3,41	0,30	3,31	0,16
6	str	40	2,35	0,16	5,91	0,50
7	lvr	58	3,41	0,30	3,31	0,16
8	rm1	58	3,41	0,30	3,31	0,16
9	I2	40	2,35	0,16	5,91	1,03
10	trs	48	2,82	0,22	4,38	4,33
11	I3	52	3,05	0,25	3,88	2,33
12	rm3	68	4,00	0,37	2,66	0,33
13	wc	68	4,00	0,37	2,66	0,33
14	rm4	64	3,76	0,34	2,89	0,20
15	dp1	64	3,76	0,34	2,89	0,20
16	dp2	64	3,76	0,34	2,89	0,20
17	dp3	64	3,76	0,34	2,89	0,20
	Min	40,00	2,35	0,16	2,61	0,16
	Mean	**57,44**	**3,37**	**0,29**	**3,61**	**1,00**
	Max	69,00	4,05	0,38	5,91	4,33

Hv_{15}.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	vs	52	3,25	0,30	3,33	1,66
1	Hl	40	2,50	0,20	5,00	4,33
2	I	67	4,18	0,42	2,35	0,33
3	ktch	53	3,31	0,30	3,24	0,50
4	rm2	55	3,43	0,32	3,07	0,16
5	str	37	2,31	0,17	5,71	0,50
6	lvr	55	3,43	0,32	3,07	0,16
7	rm1	55	3,43	0,32	3,07	0,16
8	I2	36	2,25	0,16	6,00	1,03
9	trs	43	2,68	0,22	4,44	4,33
10	I3	47	2,93	0,25	3,87	2,33
11	rm3	62	3,87	0,38	2,60	0,33
12	wc	62	3,87	0,38	2,60	0,33
13	rm4	58	3,62	0,35	2,85	0,20
14	dp1	58	3,62	0,35	2,85	0,20
15	dp2	58	3,62	0,35	2,85	0,20
16	dp3	58	3,62	0,35	2,85	0,20
	Min	36,00	2,25	0,16	2,35	0,16
	Mean	**52,70**	**3,29**	**0,30**	**3,51**	**1,00**
	Max	67,00	4,18	0,42	6,00	4,33

The calculations show that the intermediate space (I2) and the staircase (str) are the most integrated space in the house with the same value (0.16) and have low control (1.03 and 0.50) respectively, in which these spaces control the access into first floor. The hall (Hl) is the second integrated space (0.18), and has high control (4.25) whereas its control the circulation and the access into the house. The terrace (trs) is an integrated space with value (0.22) which is has the highest value of control (4.33). The vestibule has a moderate value of integration (0.26) and control (2.66), this space control the access into the house and considered as a boundary between the interior and the exterior. The deposits, the toilet, the Livingroom, the kitchen, and the bedrooms are segregated spaces and have low value of control.

- Discussion

In this section, the findings obtained from the analysis of the different houses plan, are briefly discussed in terms of spatial configuration and its situation in the fabric. It is quite interesting to note that the vernacular houses of Biskra city provide an architectural heritage, and in particular they are sustainable constructions adapted to the climate and environment context. This fact is best manifested in the construction materials and in the structural elements such as the “*rozna*” or the opening in the ceiling of the central space ‘*wasteddar*’ that is manually operable (opening/ closing) to regulate zenith at light and ventilation according to the daily and seasonal comfort requirements.

“W*asteddar”* is considered as the main space for most of the daily activities; cooking, eating, watching, napping, resting, and family gathering. It is the pivot of the movement and distribution in the house. In this space women spend their time during all day. Based on the in-situ investigation, today, the functions of the “*wasteddar*” are reduced because of the adding of new spaces such as the kitchen, living room, guest room, and bed-room. This change refers to the evolution of the social life and the openness to the other cultures.

The method of justified graph analysis allowed identifying the patterning of these vernacular houses. Regarding the analysis of the different syntactic properties and the graphs, the house plans share common characteristics; the spatial organisation of the houses is structured around transition spaces such as the hall (*wasteddar*) and the corridor. The hall is the main central space of the vernacular house; it is a b-type topological space where most of the daily domestic activities take place; in terms of integration values, it is considered as the most integrated space in the house plans. The hall is the pivot of the movement and distribution in the house. In this space women spend their time during all day. Based on the in-situ investigation, today, the functions of the “*wasteddar*” are reduced because of the adding of new spaces such as the kitchen, living room, guest room, and bed-room. This change refers to the evolution of the social life and the openness to the other cultures.

The vestibule (*sguifa*) is located at depth1 in all houses; it is shallow from the root space (exterior). Moreover, it is one of the specific spaces that characterize the vernacular house in Biskra city. It is the boundary between the exterior space and the interior space that provides visual privacy inside the house. The *sguifa* is the point of entry of visitors into the house; whereas the access is regulated by socio-cultural rules. The bedrooms are the most segregated spaces, they are located at the end of the graphs; they are suitable for inhabitants who tend towards private use. It should be noted that the guest room is shallow from the exterior because it is specific for strangers.

The observation of the sample graphs shows a strong similarity between spatial configurations, while the results of the in-depth analysis show that the deeper one goes into the structure, the more private the spaces become, such as private spaces (bedrooms, storage spaces) and service spaces (kitchen, bathroom), while the transitional spaces (hall, vestibule, corridors) are the most integrated spaces in the houses, which provide a degree of control within the house. House layouts become more segregated when the exterior is included in the analysis. However, for houses with weak relationships with the exterior space and classified as 'introverted houses', the exterior is always on the segregated side, when integration values are considered.

2.2. The colonial houses (HC):

2.2.1. Analysis of the colonial House (HC01):

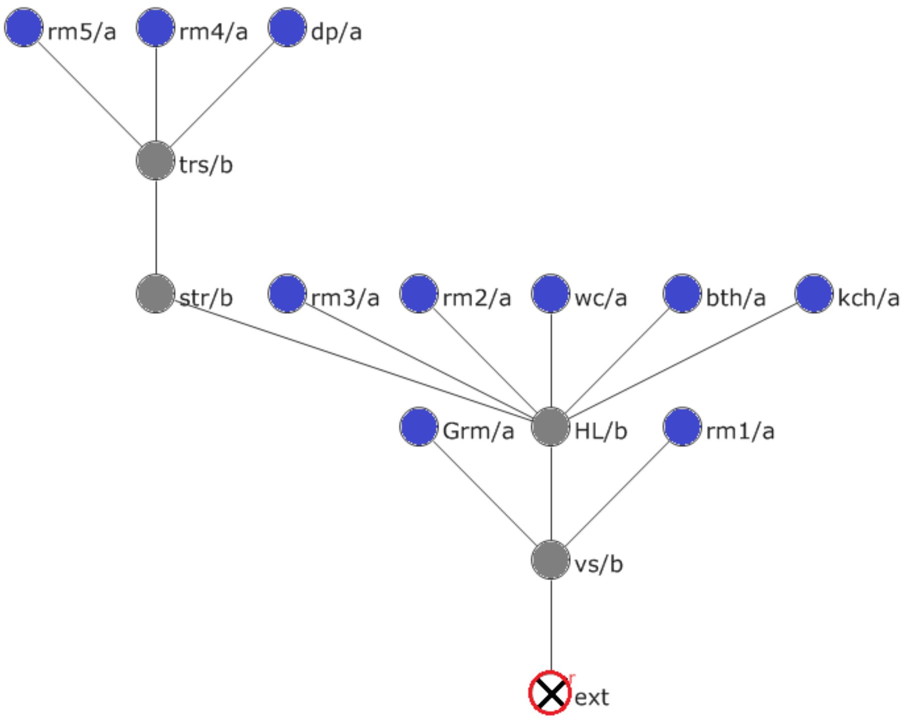


Figure -56: The justified graph of the colonial house 01 (HC1)

The graph was using the exterior as a root, it shows a tree-like structure with two brunches, there are 10 spaces of a-type which means 71%, 4 spaces of b-type 30%, and these degrees refer to the non-distributedness of the system. The penetration into the house is from a cell of b-type « *the sguifa* » it gives brunches to three spaces; two of a-type and one space of b-type. The guest room (Grm) and the rm1 are destined to strangers/ visitors, and the hall (HL) is destined to the inhabitants, it is considered as the main space which contains the most important activities in the house and distributes to the spaces of a-type: the kitchen, the bathroom, the toilet, and the bedrooms. It also gives to the staircase of b-type space that takes to the next levels and to the terrace; these two spaces are playing an important role of transition. At the last depth an arrangement of a-type spaces: the rooms (rm4, rm5) and the deposit; are destined to private use « residence ».

From the table below, the hall (HL) constitutes the nucleus of private circulation, it controls the access to five spaces of occupation and one of transition, thus, and it is the most integrated space (0.10) and has the highest degree of control (5.75). The staircase at depth three has a low value of RA (0.18) which refers to the high degree of integration and very low of control on the spaces, then the vestibule has a high integration degree with low value of RA (0.18), and its value of control is (3.14) thus, the vestibule plays an important role in controlling the access into the house. The terrace has a high value of control (3.50) but an average value of integration (0.24). The toilet, the bathroom, the kitchen, and the bedrooms have the same value. The order of integration of the spaces remains the same when the exterior is not included. The deposit, the rooms (rm4, rm5) are the most segregated spaces in the system then the exterior, the guest room and the (rm1) despite they are shallow from the exterior, which refers to the high privacy of these spaces for the inhabitants.

Table 21: HC01.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	0	44	3,14	0,32	3,03	0,25
1	vs	31	2,21	0,18	5,35	3,14
2	Grm	44	3,14	0,32	3,03	0,25
3	HL	24	1,71	0,10	9,10	5,75
4	rm1	44	3,14	0,32	3,03	0,25
5	wc	37	2,64	0,25	3,95	0,14
6	rm2	37	2,64	0,25	3,95	0,14
7	bth	37	2,64	0,25	3,95	0,14
8	rm3	37	2,64	0,25	3,95	0,14
9	ktch	37	2,64	0,25	3,95	0,14
10	str	29	2,07	0,16	6,06	0,39
11	trs	36	2,57	0,24	4,13	3,50
12	rm5	49	3,50	0,38	2,60	0,25
13	rm4	49	3,50	0,38	2,60	0,25
14	dp	49	3,50	0,38	2,60	0,25
	Min	24,00	1,71	0,10	2,60	0,14
	Mean	**38,93**	**2,78**	**0,27**	**4,08**	**1,00**
	Max	49,00	3,50	0,38	9,10	5,75

HC01.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	vs	30	2,30	0,21	4,58	2,14
1	Grm	42	3,23	0,37	2,68	0,33
2	HL	22	1,69	0,11	8,66	5,83
3	rm1	42	3,23	0,37	2,68	0,33
4	wc	34	2,61	0,26	3,71	0,14
5	rm2	34	2,61	0,26	3,71	0,14
6	bth	34	2,61	0,26	3,71	0,14
7	rm3	34	2,61	0,26	3,71	0,14
8	ktch	34	2,61	0,26	3,71	0,14
9	str	26	2,00	0,16	6,00	0,39
10	trs	32	2,46	0,24	4,10	3,50
11	rm5	44	3,38	0,39	2,51	0,25
12	rm4	44	3,38	0,39	2,51	0,25
13	dp	44	3,38	0,39	2,51	0,25
	Min	22,00	1,69	0,11	2,51	0,14
	Mean	**35,42**	**2,72**	**0,28**	**3,91**	**1,00**
	Max	44,00	3,38	0,39	8,66	5,83

2.2.2. Analysis of the colonial House (HC02):

The graph was constructed using the exterior as a root, the graph shows a quite strong asymmetry, a distributedness is observed in the inferior part of the graph which is formed by two rings; one is external, it passes by the exterior and the veranda of c-type space, the second ring is internal, it passes by hall of d-type space and the living room of b-type space.

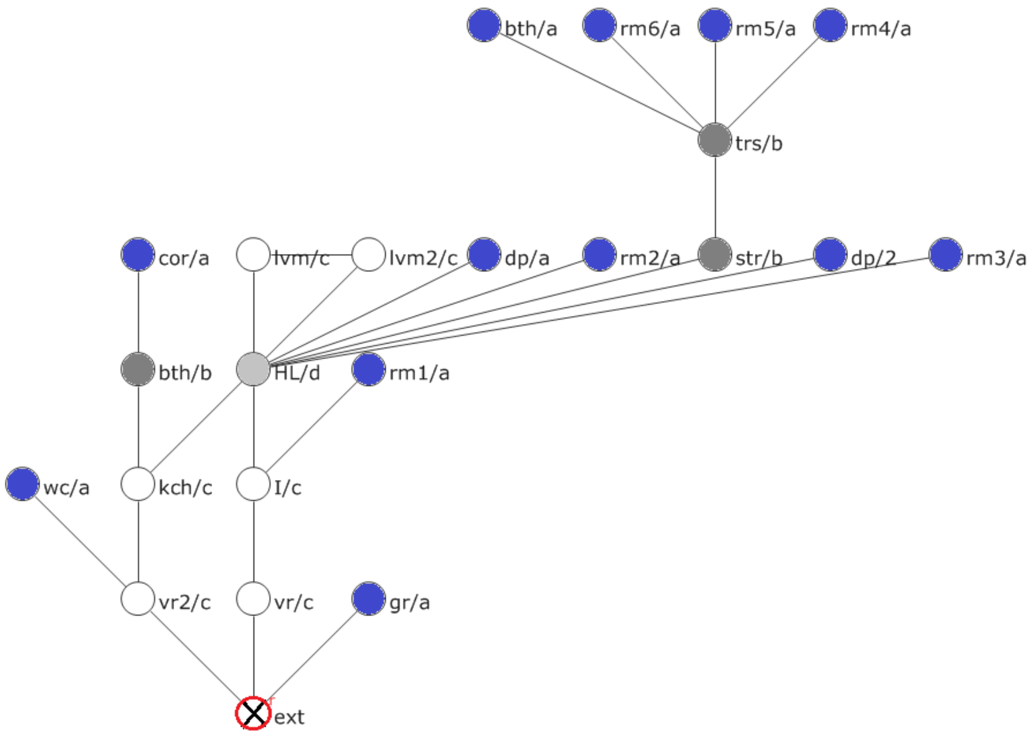


Figure -57: The justified graph of the colonial house 02 (HC02)

Four topological types are distinguished in the graph, whereas the access into the house by two points of penetrations the verandas (vrd and vrd2), both of c-type, they offer a choice of movement around the house. Both verandas give to the kitchen and an intermediate space which is an alternative passage to get to the hall « *wasteddar* », the main central space of d-type space, where it distributes to all the spaces in the system and is considered as the pivot of the movement. Each of the bedrooms, the deposits, the staircase and the living room are connected directly to the hall, from a-type space arranged as dead-end at depth four in the graph, the staircase plays an important role of transition from the ground floor to the next level it takes to the terrace of b-type space which all the spaces at the last depth: the bedrooms (rm4, rm5, rm6) and the bathroom are arranged around it. The veranda2 takes to the kitchen then the bathroom and this later has no direct contact with the hall or all the rest of the spaces in the house, and the bathroom takes to the courtyard where they are arranged in linear sequence.

Table 22: HC02.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	0	79	3,59	0,24	4,05	1,83
1	vrd	70	3,18	0,20	4,81	0,66
2	I	57	2,59	0,15	6,60	1,61
3	rm1	78	3,54	0,24	4,12	0,33
4	HL	44	2,00	0,09	10,50	6,16
5	gr	100	4,54	0,33	2,96	0,33
6	ktch	53	2,40	0,13	7,45	0,94
7	wc	87	3,95	0,28	3,55	0,33
8	bath	72	3,27	0,21	4,62	1,33
9	cor	93	4,22	0,30	3,25	0,50
10	vrd2	66	3,00	0,19	5,25	1,66
11	lvrm	64	2,90	0,18	5,50	0,61
12	lvrm2	64	2,90	0,18	5,50	0,61
13	dp	65	2,95	0,18	5,37	0,11
14	rm2	65	2,95	0,18	5,37	0,11
15	str	55	2,50	0,14	7,00	0,31
16	dp2	65	2,95	0,18	5,37	0,11
17	rm3	65	2,95	0,18	5,37	0,11
18	trs	68	3,09	0,19	5,02	4,50
19	fm5	89	4,04	0,29	3,44	0,20
20	rm4	89	4,04	0,29	3,44	0,20
21	rm6	89	4,04	0,29	3,44	0,20
22	bath2	89	4,04	0,29	3,44	0,20
	Min	44,00	2,00	0,09	2,96	0,11
	Mean	**72,43**	**3,29**	**0,21**	**5,02**	**1,00**
	Max	100,00	4,54	0,33	10,50	6,16

HC02.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	vrd	93	4,42	0,34	2,91	0,33
1	I	74	3,52	0,25	3,96	2,11
2	rm1	93	4,42	0,34	2,91	0,33
3	HL	59	2,80	0,18	5,52	6,16
4	gr	462	22,00	2,10	0,47	0,00
5	ktch	70	3,33	0,23	4,28	1,11
6	wc	106	5,04	0,40	2,47	0,50
7	bath	87	4,14	0,31	3,18	1,33
8	cor	106	5,04	0,40	2,47	0,50
9	vrd2	87	4,14	0,31	3,18	1,33
10	lvrm	77	3,66	0,26	3,75	0,61
11	lvrm2	77	3,66	0,26	3,75	0,61
12	dp	78	3,71	0,27	3,68	0,11
13	rm2	78	3,71	0,27	3,68	0,11
14	str	68	3,23	0,22	4,46	0,31
15	dp2	78	3,71	0,27	3,68	0,11
16	rm3	78	3,71	0,27	3,68	0,11
17	trs	79	3,76	0,27	3,62	4,50
18	fm5	98	4,66	0,36	2,72	0,20
19	rm4	98	4,66	0,36	2,72	0,20
20	rm6	98	4,66	0,36	2,72	0,20
21	bath2	98	4,66	0,36	2,72	0,20
	Min	59,00	2,80	0,18	0,47	0,00
	Mean	**101,90**	**4,85**	**0,38**	**3,30**	**0,95**
	Max	462,00	22,00	2,10	5,52	6,16

In terms of quantitative value, the highest value of RA (integration) is recorded by the hall (HL) (0.09) situated at the third depth, then followed by the kitchen at depth two (0.13) and the intermediate space (I) (0.15) at the same depth. The staircase has value (0.14) and situated at depth four. These transition spaces form the heart of the circulation within the house. The garage has the highest value of integration (0.33) that refers to the highest segregation of that space, despite the fact that it is not situated at the top of the graph but at depth one. When the exterior is not included; the vestibule becomes more segregated. The living rooms (lvrm, lvrm2), the deposits (dep, dep2), and the bed-rooms (rm2, rm3) have the same integration (0.18). The toilet and the terrace are segregated with almost the same values (0.28) and (0.29) respectively, but they are situated at different levels. The exterior is segregated with value (0.24), also the courtyard is shallow from the exterior and have a high value of integration (0.30).

2.2.3. Analysis of the colonial House (HC03):

The graph is in asymmetrical order in general, it was constructed using the exterior as a root space, and shows a non-distributedness in the system, manifested in the topological spaces of a- and b-type (54% of a-type, 50% of b-type).

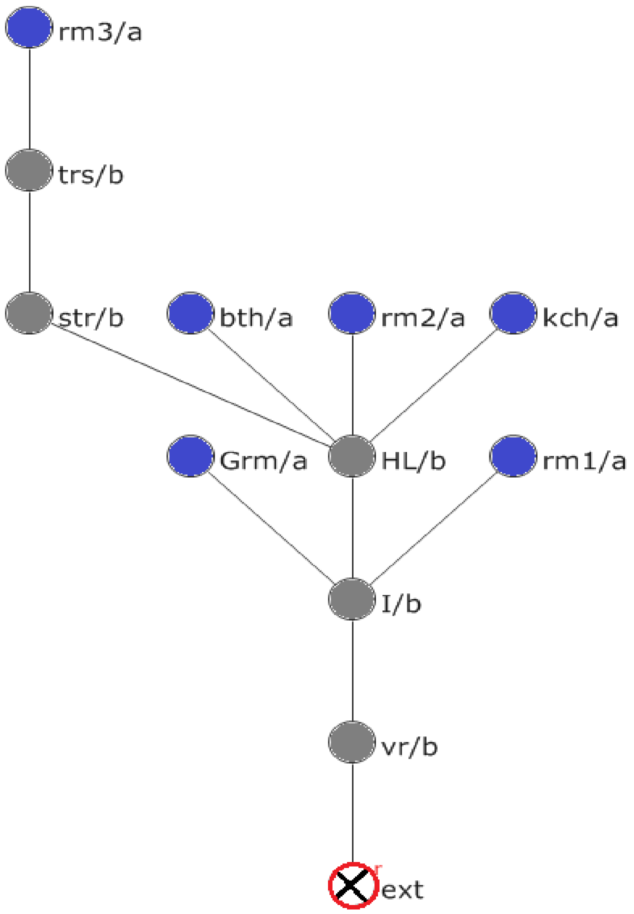


Figure -58: The justified graph of the colonial house 03 (HC03)

The penetration into the house from only one point: the veranda of b-type space where there is no choice of movement, it gives to the intermediate space (I) of b-type space where it distributes to the hall the main central space of b-type, the guest room, and the bedroom (rm1) which are from a-type space, arranged at depth three, they are dedicated to the visitors/ strangers, and shallow from the exterior.

The hall is considered as the main space for the daily activities in the house where all the family is gathered, it gives directly to three spaces of a-type: the kitchen, the bathroom, and a bedroom, and one space of b-type: the staircase; that gives access to the terrace and to the bedroom (rm3) at last depth.

The quantitative data indicates that the order of integration stays the same when the exterior is not included. The hall has the lowest value of integration (RA) (0.14), meaning it is the most integrated space followed by the intermediate space with value (0.18), then the staircase (0.25). The most segregated spaces are the bedroom (rm3), the exterior and the terrace with values (0.58), (0.50), and (0.40) respectively. The bathroom, the kitchen and the bedroom (rm2) have the same value of integration (0.32), the guest room and the bedroom (rm1) have (0.36). The hall has the highest degree of control (3.75) followed by the intermediate space (2.70) and the veranda (1.25). In conclusion, the transition spaces are the most controlled and integrated spaces in the system.

Table 23: HC03.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	ext	39	3,54	0,50	1,96	0,50
1	vrd	29	2,63	0,32	3,05	1,25
2	I	21	1,90	0,18	5,50	2,70
3	rm1	31	2,81	0,36	2,75	0,25
4	HL	19	1,72	0,14	6,87	3,75
5	Grm	31	2,81	0,36	2,75	0,25
6	rm2	29	2,63	0,32	3,05	0,20
7	ktch	29	2,63	0,32	3,05	0,20
8	bath	29	2,63	0,32	3,05	0,20
9	str	25	2,27	0,25	3,92	0,70
10	trs	33	3,00	0,40	2,50	1,50
11	rm3	43	3,90	0,58	1,71	0,50
	Min	19,00	1,72	0,14	1,71	0,20
	Mean	**29,83**	**2,71**	**0,34**	**3,35**	**1,00**
	Max	43,00	3,90	0,58	6,87	3,75

HC03.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	vrd	28	2,80	0,40	2,50	0,25
1	I	19	1,90	0,20	5,00	3,20
2	rm1	28	2,80	0,40	2,50	0,25
3	HL	16	1,60	0,13	7,50	3,75
4	Grm	28	2,80	0,40	2,50	0,25
5	rm2	25	2,50	0,33	3,00	0,20
6	ktch	25	2,50	0,33	3,00	0,20
7	bath	25	2,50	0,33	3,00	0,20
8	str	21	2,10	0,24	4,09	0,70
9	trs	28	2,80	0,40	2,50	1,50
10	rm3	37	3,70	0,60	1,66	0,50
	Min	16,00	1,60	0,13	1,66	0,20
	Mean	**25,45**	**2,54**	**0,34**	**3,38**	**1,00**
	Max	37,00	3,70	0,60	7,50	3,75

2.2.4. Analysis of the colonial House (HC04):

The justified graph of the house (HC04) represents a weak symmetry order; it was constructed using the exterior as a root. The graph contained 18 nodes linked by 17 lines; the non-distributedness is clearly expressed by the high number of the topological spaces of a- and b-type; 52% of a-type and 50% of b-type space. The graph opens on a space of b-type the vestibule « *sguifa* » which gives to the room (rm1) of a-type is destined to visitors, and to the hall the main central space of b-type, it takes directly to: the courtyard, rm3 of a-type, and the guest room (rm2) of b-type space, those considered as through spaces.

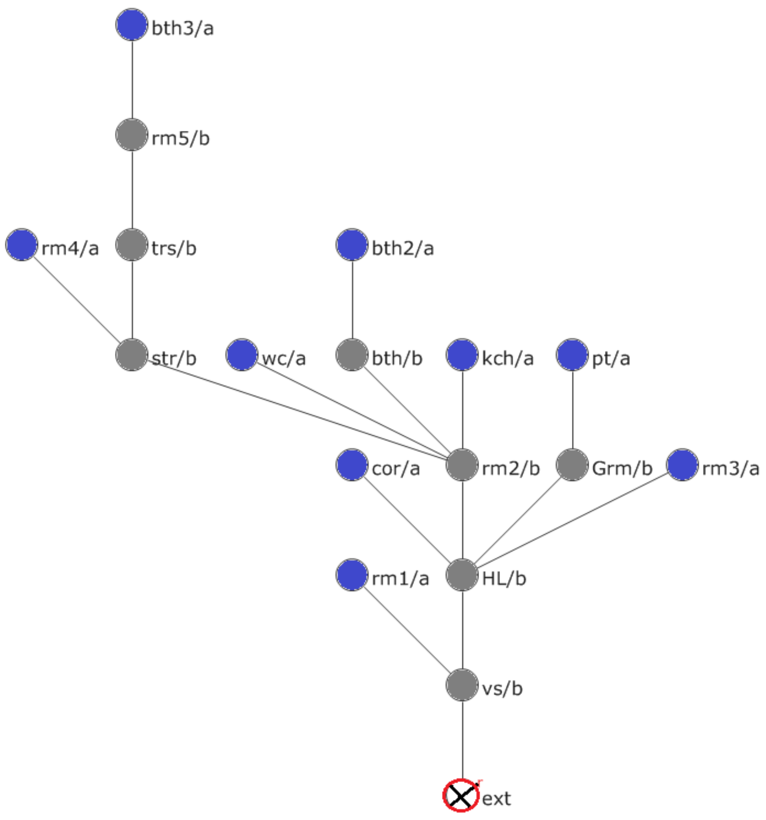


Figure -59: The justified graph of the colonial house 04 (HC04)

The kitchen, the bathroom, the toilet from a-type and the staircase from b-type are arranged around room number two, where this space is considered as the most important space and the pivot of mobility in the house, a through space that takes to the next level to the terrace and the room4where there is no choice of circulation and from this space (str). The terrace gives to room number five which has a private bathroom; it is arranged as the last space in the graph.

Room number two is the most integrated space (0.13) in the house located at depth three followed by the hall with value (0.14) at depth two despite the differences in their levels, they both have the highest value of control, the hall (3.20) and room number two (3.03). The staircase, which takes to the first floor, has a good integration (0.19), the transition spaces have the highest degree of integration. The spaces which have a low integration like the vestibule (0.23) but it is located at depth two and it is shallow from the exterior, the bathroom has the same value of integration with the vestibule despite the fact that it doesn't has the same depth. Located at depth four, the guest room, bathroom number two, and the kitchen have the same value (0.25), then room number three, the courtyard (0.26), and the terrace (0.27). The segregated spaces are the bedrooms (rm4, rm5), the exterior and the bathroom (bath2) have the same value (0.35) and they are located at different depths. In thiscase, the spaces that are situated at last depth are the most segregated spaces in the system except the exterior.

Table 24: HC04.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	ext	65	3,82	0,35	2,83	0,33
1	vs	49	2,88	0,23	4,25	2,20
2	HL	37	2,17	0,14	6,80	3,03
3	rm1	65	3,82	0,35	2,83	0,33
4	rm2	35	2,05	0,13	7,55	3,03
5	Grm	51	3,00	0,25	4,00	1,20
6	cor	53	3,11	0,26	3,77	0,20
7	bath	49	2,88	0,23	4,25	1,20
8	ktch	51	3,00	0,25	4,00	0,20
9	wc	51	3,00	0,25	4,00	0,20
10	str	43	2,52	0,19	5,23	1,70
11	pt	67	3,94	0,36	2,72	0,50
12	trs	55	3,23	0,27	3,57	0,83
13	bath2	65	3,82	0,35	2,83	0,50
14	rm3	53	3,11	0,26	3,77	0,20
15	rm4	59	3,47	0,30	3,23	0,33
16	rm5	69	4,05	0,38	2,61	1,50
17	bth3	85	5,00	0,50	2,00	0,50
	Min	35,00	2,05	0,13	2,00	0,20
	Mean	**55,66**	**3,27**	**0,28**	**3,90**	**1,00**
	Max	85,00	5,00	0,50	7,55	3,03

HC04.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	vs	48	3,00	0,26	3,75	1,20
1	HL	35	2,18	0,15	6,31	3,20
2	rm1	63	3,93	0,39	2,55	0,50
3	rm2	32	2,00	0,13	7,50	3,03
4	Grm	48	3,00	0,26	3,75	1,20
5	cor	50	3,12	0,28	3,52	0,20
6	bath	45	2,81	0,24	4,13	1,20
7	ktch	47	2,93	0,25	3,87	0,20
8	wc	47	2,93	0,25	3,87	0,20
9	str	39	2,43	0,19	5,21	1,70
10	pt	63	3,93	0,39	2,55	0,50
11	trs	50	3,12	0,28	3,52	0,83
12	bath2	60	3,75	0,36	2,72	0,50
13	rm3	50	3,12	0,28	3,52	0,20
14	rm4	54	3,37	0,31	3,15	0,33
15	rm5	63	3,93	0,39	2,55	1,50
16	bth3	78	4,87	0,51	1,93	0,50
	Min	32,00	2,00	0,13	1,93	0,20
	Mean	**51,29**	**3,20**	**0,29**	**3,79**	**1,00**
	Max	78,00	4,87	0,51	7,50	3,20

2.2.5. Analysis of the colonial House (HC05):

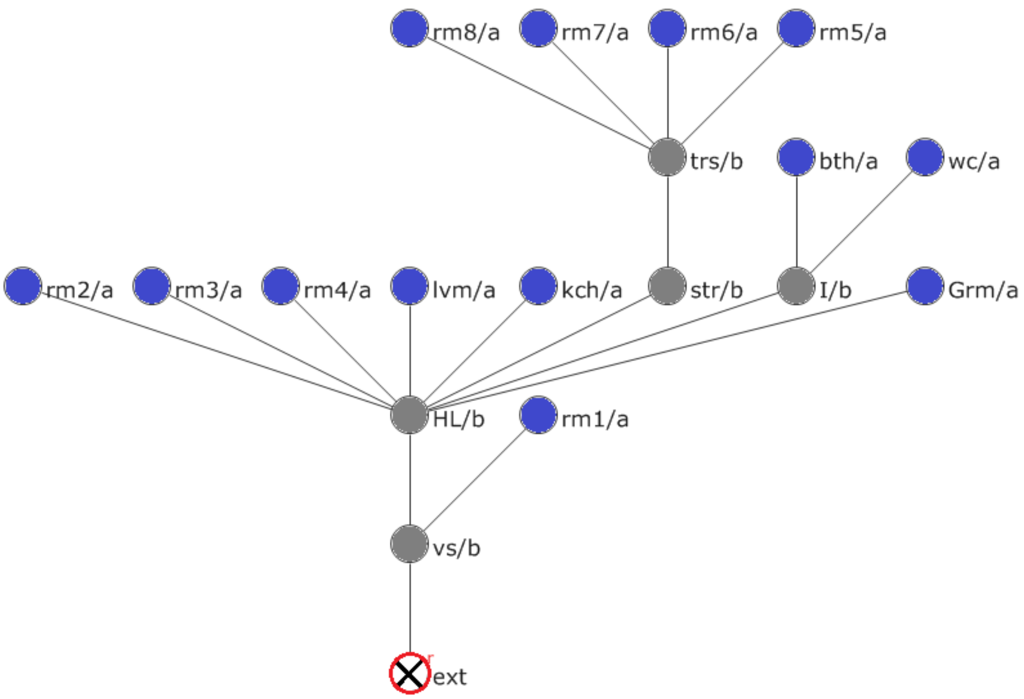


Figure -60: The justified graph of the colonial house 05 (HC05)

The graph represents a tree-like structure with two brunches, it had 19 nodes and 18 links. The graph shows a symmetric order and non-distributedness manifested in the high number of the topological spaces of a- and b-type spaces 61% of a-type and 29% of b-type. The entrance into the house from the b-type space ; the vestibule (*sguifa*) that represents the point of penetration into the house dedicated to stranger's circulation and gives to room number oneof a-type space is arranged as dead-end space at depth two which is destined to the strangers / visitors, and gives to the hall the main central space of b-type space the pivot of the circulation and offers more flexibility of movement, it distributes to the guest room, the kitchen, the living room, the bedrooms (rm2, rm3, rm4) of a-type space are suitable for the occupation. And to the staircase which takes to the next floor and to the terrace of b-type space, itis the main transition space which distributes to the bedrooms: rm5, rm6, rm7, rm8 situated at the last depth in the graph they are the most private spaces in the house, and to the intermediate spaces of b-type space which are through spaces where there is no choice of circulation and gives to the bathroom and the toilet at depth four.

Table 25: HC05.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	0	61	3,38	0,28	3,55	0,33
1	vs	44	2,44	0,16	5,88	2,11
2	HL	31	1,72	0,08	11,76	7,16
3	rm1	61	3,38	0,28	3,55	0,33
4	kitch	48	2,66	0,19	5,10	0,11
5	str	38	2,11	0,13	7,65	0,31
6	lvrm	48	2,66	0,19	5,10	0,11
7	rm4	48	2,66	0,19	5,10	0,11
8	rm3	48	2,66	0,19	5,10	0,11
9	I	44	2,44	0,16	5,88	2,11
10	rm2	48	2,66	0,19	5,10	0,11
11	Grm	48	2,66	0,19	5,10	0,11
12	trs	47	2,61	0,18	5,27	4,50
13	rm7	64	3,55	0,30	3,32	0,20
14	rm6	64	3,55	0,30	3,32	0,20
15	rm5	64	3,55	0,30	3,32	0,20
16	rm8	64	3,55	0,30	3,32	0,20
17	bath	61	3,38	0,28	3,55	0,33
18	wc	61	3,38	0,28	3,55	0,33
	Min	31,00	1,72	0,08	3,32	0,11
	Mean	**52,21**	**2,90**	**0,22**	**4,97**	**1,00**
	Max	64,00	3,55	0,30	11,76	7,16

HC05.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	vs	43	2,52	0,19	5,23	1,11
1	HL	29	1,70	0,08	11,33	7,33
2	rm1	59	3,47	0,30	3,23	0,50
3	kitch	45	2,64	0,20	4,85	0,11
4	str	35	2,05	0,13	7,55	0,31
5	lvrm	45	2,64	0,20	4,85	0,11
6	rm4	45	2,64	0,20	4,85	0,11
7	rm3	45	2,64	0,20	4,85	0,11
8	I	41	2,41	0,17	5,66	2,11
9	rm2	45	2,64	0,20	4,85	0,11
10	Grm	45	2,64	0,20	4,85	0,11
11	trs	43	2,52	0,19	5,23	4,50
12	rm7	59	3,47	0,30	3,23	0,20
13	rm6	59	3,47	0,30	3,23	0,20
14	rm5	59	3,47	0,30	3,23	0,20
15	rm8	59	3,47	0,30	3,23	0,20
16	bath	57	3,35	0,29	3,40	0,33
17	wc	57	3,35	0,29	3,40	0,33
	Min	29,00	1,70	0,08	3,23	0,11
	Mean	**48,33**	**2,84**	**0,23**	**4,84**	**1,00**
	Max	59,00	3,47	0,30	11,33	7,33

The hall is considered as the pivot of the circulation in the house and controls the access to six spaces of occupation and two of transition. Indeed, it represents the most controlled space with value (7, 16). It serves to the most important space which makes it the most integrated space with value (0.08). The vestibule and the intermediate space have the same values of integration (0.16) despite their different depth in the graph. The terrace has a value of (0.18).

These transition spaces are the most integrated spaces because they control the circulation around the house layout. The kitchen, the living room, the rooms (rm2, rm3, rm4), and the guest room have the same integration (0.19). The exterior, the bathroom, and the toilet are shallow from the root and have a high value of integration which means they are segregated. The spaces that are located at last depth are the most segregated spaces.

2.2.6. Analysis of the colonial House (HC06):

The graph represents a tree-like structure with two brunches and it is shallow from the exterior, the spatial configuration of the house (HC06) indicates a lack in ditributedness showing in the absence of the rings in the graph and the high number of the topological spaces of a-type. The graph constituted from the topological spaces a- and b-type. Whereas, the a-type spaces represent 76% of the total number, and the spaces of b-type represent 25%.

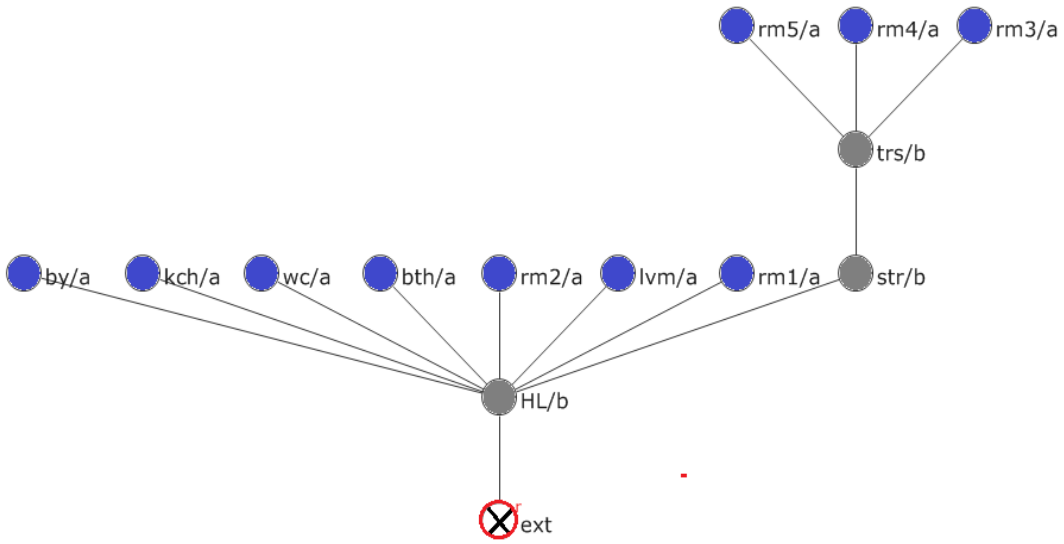


Figure -61: The justified graph of the colonial house 06 (HC06)

The penetration into the house is through the « Hall », the pivot of circulation which controls access to other spaces in the house. The hall connects to the kitchen, bathroom, bedrooms, backyard, living room, and staircase. The staircase reaches to the first floor. The configuration shows that the end-points and the deepest spaces are generally the bedrooms they are the most private spaces also the kitchen where the domestic activities occur. The hall, staircase and terrace are considered as transition spaces from b-type space.

With regard to quantitative values, it is noticeable that the results don't vary when the exterior is included or not, which means that the spatial configuration structures the relationships between residents. The graph is segregated from the exterior, whereas the bedrooms (rm3, rm4, rm5) in last depth are the most segregated spaces with value (0.37), followed by the rooms (rm1, rm2), the living room, the kitchen, the bathroom, the toilet, the exterior, and the backyard that are situated at depth three with value (0.24). Theses segregated spaces constitute the topological space a-type. The most integrated space in the house is the hall (0.08) which allows some control of circulation and provides access to occupancy spaces. Then the staircase has the value of integration (0.14) and the terrace (0.21), these spaces of topological space b-type are the transition spaces.

Table 26: HC06.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	ext	32	2,46	0,24	4,10	0,11
1	HL	20	1,53	0,08	11,14	8,50
2	rm2	32	2,46	0,24	4,10	0,11
3	lvrm	32	2,46	0,24	4,10	0,11
4	rm1	32	2,46	0,24	4,10	0,11
5	bath	32	2,46	0,24	4,10	0,11
6	wc	32	2,46	0,24	4,10	0,11
7	str	24	1,84	0,14	7,09	0,36
8	ktch	32	2,46	0,24	4,10	0,11
9	byd	32	2,46	0,24	4,10	0,11
10	trs	30	2,30	0,21	4,58	3,50
11	rm4	42	3,23	0,37	2,68	0,25
12	rm3	42	3,23	0,37	2,68	0,25
13	rm5	42	3,23	0,37	2,68	0,25
	Min	20,00	1,53	0,08	2,68	0,11
	Mean	**32,57**	**2,50**	**0,25**	**4,55**	**1,00**
	Max	42,00	3,23	0,37	11,14	8,50

HC06.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	HL	19	1,58	0,10	9,42	7,50
1	rm2	30	2,50	0,27	3,66	0,12
2	lvrm	30	2,50	0,27	3,66	0,12
3	rm1	30	2,50	0,27	3,66	0,12
4	bath	30	2,50	0,27	3,66	0,12
5	wc	30	2,50	0,27	3,66	0,12
6	str	22	1,83	0,15	6,60	0,37
7	ktch	30	2,50	0,27	3,66	0,12
8	byd	30	2,50	0,27	3,66	0,12
9	trs	27	2,25	0,22	4,40	3,50
10	rm4	38	3,16	0,39	2,53	0,25
11	rm3	38	3,16	0,39	2,53	0,25
12	rm5	38	3,16	0,39	2,53	0,25
	Min	19,00	1,58	0,10	2,53	0,12
	Mean	**30,15**	**2,51**	**0,27**	**4,13**	**1,00**
	Max	38,00	3,16	0,39	9,42	7,50

With regard to quantitative values, it is noticeable that the results don't vary when the exterior is included or not, which means that the spatial configuration structures the relationships between residents. The graph is segregated from the exterior, whereas the bedrooms (rm3, rm4, rm5) in last depth are the most segregated spaces with value (0.37), followed by the rooms (rm1, rm2), the living room, the kitchen, the bathroom, the toilet, the exterior, and the backyard that situated at depth three with value (0.24).Theses segregated spaces constitute the topological space a-type. The most integrated space in the house is the hall (0.08) which allows some control of circulation and provides access to occupancy spaces. Then the staircase has value of integration (0.14) and the terrace (0.21), these spaces of topological space b-type are the transition spaces.

2.2.7. Analysis of the colonial House (HC07):

The configuration represents a tree-like structure and symmetric system, and non-distributedness manifested in the topological spaces a- and b-type. The graph is shallow from the exterior and constituted of 10 nodes and 09 links. The penetration into the house is through “the corridor” which is of b-type space and distributes to the living room (lvrm), the bedroom (rm) and the hall (HL). Whereas the bedroom (rm1) and living room (lvrm) are arranged as dead-end spaces of topological space a-type.

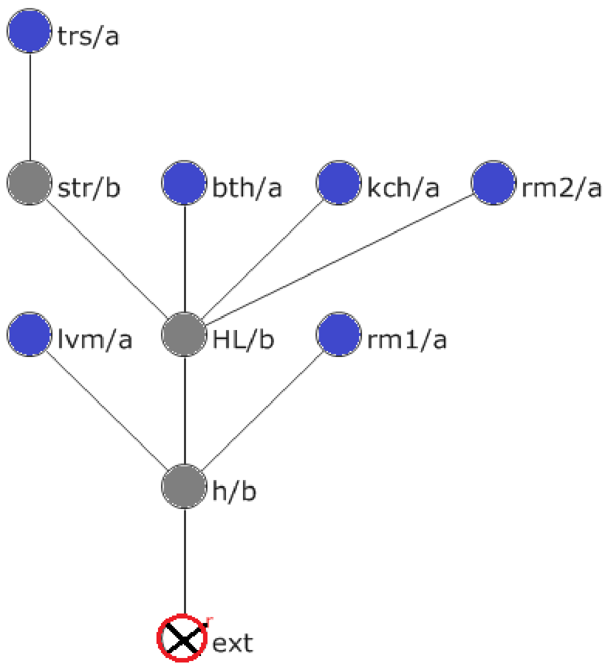


Figure -62: The justified graph of the colonial house 07 (HC07)

The living room (lvrm) is destined to the mix use, for receiving guests and for family gathering. The hall situated at depth three takes to service spaces of topological space a-type such as: the kitchen, and the bathroom plus the bedroom (rm2), also its takes to the staircase of topological space of b-type which takes directly to the terrace at last depth. In this case the corridor controls the access into the house and the hall plays an important role to isolate the women area where the domestic activities occur.

Table 27: HC07.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	ext	23	2,55	0,38	2,57	0,25
1	h	15	1,66	0,16	6,00	3,20
2	Lvrm	23	2,55	0,38	2,57	0,25
3	HL	13	1,44	0,11	9,00	3,75
4	rm1	23	2,55	0,38	2,57	0,25
5	str	19	2,11	0,27	3,60	1,20
6	bth	21	2,33	0,33	3,00	0,20
7	ktch	21	2,33	0,33	3,00	0,20
8	rm2	21	2,33	0,33	3,00	0,20
9	trs	27	3,00	0,50	2,00	0,50
	Min	13,00	1,44	0,11	2,00	0,20
	Mean	**20,60**	**2,28**	**0,32**	**3,73**	**1,00**
	Max	27,00	3,00	0,50	9,00	3,75

HC07.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	h	14	1,75	0,21	4,66	2,20
1	Lvrm	21	2,62	0,46	2,15	0,33
2	HL	11	1,37	0,10	9,33	3,83
3	rm1	21	2,62	0,46	2,15	0,33
4	str	16	2,00	0,28	3,50	1,20
5	bth	18	2,25	0,35	2,80	0,20
6	ktch	18	2,25	0,35	2,80	0,20
7	rm2	18	2,25	0,35	2,80	0,20
8	trs	23	2,87	0,53	1,86	0,50
	Min	11,00	1,37	0,10	1,86	0,20
	Mean	**17,77**	**2,22**	**0,34**	**3,56**	**1,00**
	Max	23,00	2,87	0,53	9,33	3,83

The order of integration (Relative asymmetry) of different cells remains extremely similar, whether or not the exterior is included. The most integrated cell is recorded by the main Hall (HL) with value (0.11), followed closely by the secondary hall or corridor (h) with value (0.16), then the staircase (str) with value (0.27). Despite the fact that, the living room (lvrm), exterior (ext), and bedroom (rm1) are located at depth two, they are more segregated than the kitchen (ktch), the bathroom (bth), the bedroom (rm2) that are located at depth three. The terrace is the most segregated space in the system with value (0.50) which is situated at last depth in the graph. The hall (HL) is the most controlled space in the house followed by the corridor (h) and the staircase.

2.2.8. Analysis of the colonial House (HC08):

The graph HC08 represents a tree-like structure and symmetric system in global. The topological space of a-type represents 53% and the topological space of b-type represents 50%, which makes the system tend to non-distributedness. The graph opens with succession of two spaces of b-type: the verandah (vr) and the corridor (crd). The corridor (crd) distributes to the guest room (grm) and bathroom (bath) from topological space of a-type arranged as dead-end spaces in depth three, and to the hall (HL) and staircase (str) from topological space b-type. The hall (HL) opens on the kitchen (ktch), and the bedrooms (rm1, rm2), they are arranged as dead-end spaces at depth four, these spaces are more isolated than the other spaces, they are suitable for the inhabitants and not destined to private use, contrary to the guest room which is shallow from the exterior and destined to receive the visitors. The staircase of b-type space takes to the next floor, in the terrace of b-type that has access to two rooms (rm3, rm4) by an intermediate space (I) of b-type.

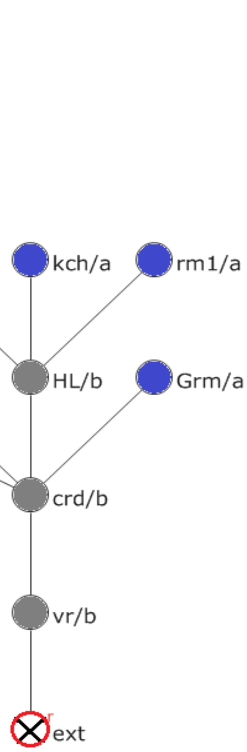


Figure -63: The justified graph of the colonial house 08 (HC08)

Table 28: HC08.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	ext	48	3,69	0,44	2,22	0,50
1	vr	36	2,76	0,29	3,39	1,20
2	crd	26	2,00	0,16	6,00	3,25
3	HL	32	2,46	0,24	4,10	3,20
4	Grm	38	2,92	0,32	3,12	0,20
5	bath	38	2,92	0,32	3,12	0,20
6	kitch	44	3,38	0,39	2,51	0,25
7	rm1	44	3,38	0,39	2,51	0,25
8	rm2	44	3,38	0,39	2,51	0,25
9	str	30	2,30	0,21	4,58	0,70
10	trs	36	2,76	0,29	3,39	0,83
11	I	44	3,38	0,39	2,51	2,50
12	rm4	56	4,30	0,55	1,81	0,33
13	rm3	56	4,30	0,55	1,81	0,33
	Min	26,00	2,00	0,16	1,81	0,20
	Mean	**40,85**	**3,14**	**0,35**	**3,11**	**1,00**
	Max	56,00	4,30	0,55	6,00	3,25

HC08.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	vr	35	2,91	0,34	2,86	0,20
1	crd	24	2,00	0,18	5,50	3,75
2	HL	29	2,41	0,25	3,88	3,20
3	Grm	35	2,91	0,34	2,86	0,20
4	bath	35	2,91	0,34	2,86	0,20
5	kitch	40	3,33	0,42	2,35	0,25
6	rm1	40	3,33	0,42	2,35	0,25
7	rm2	40	3,33	0,42	2,35	0,25
8	str	27	2,25	0,22	4,40	0,70
9	trs	32	2,66	0,30	3,30	0,83
10	I	39	3,25	0,40	2,44	2,50
11	rm4	50	4,16	0,57	1,73	0,33
12	rm3	50	4,16	0,57	1,73	0,33
	Min	24,00	2,00	0,18	1,73	0,20
	Mean	**36,61**	**3,05**	**0,37**	**2,97**	**1,00**
	Max	50,00	4,16	0,57	5,50	3,75

The quantitative data show the values of RA in both cases when the exterior is included and when it is excluded, the order of integration remains similar whether or not the exterior is included. The most integrated space is the corridor (crd) with value of RA (0.16), followed by the staircase as the second integrated space with value (0.21), then the hall (HL) with value (0.24). The veranda (vr) has a moderate value of integration (0.29). The other spaces have high value of integration, they are segregated spaces; the guest room and the bathroom have the same value (0.32), the kitchen, the bedrooms (rm1, rm2), and the intermediate space have same value (0.39), the most segregated spaces are the exterior (0.44), and the bedrooms (rm4, rm5) with value (0.55).

In term of control, the most controlled space is the corridor (3.25), then the hall (3.20), followed by the intermediate space (2.50) and the veranda by control value (1.20).

2.2.9. Analysis of the colonial House (HC09):

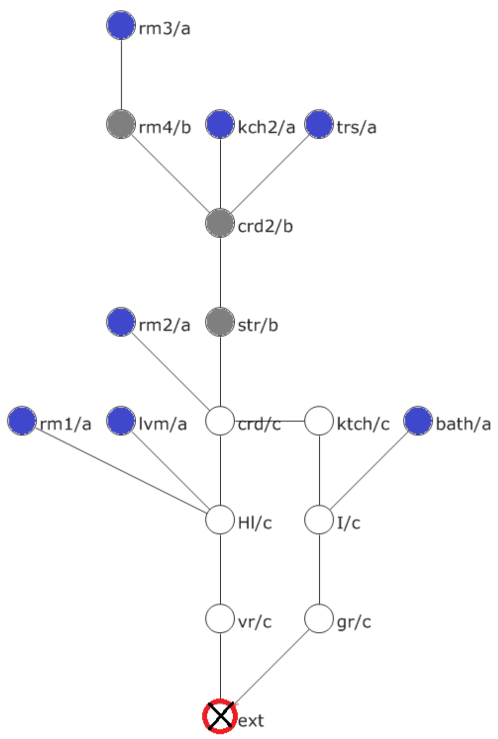


Figure-64: The justified graph of the colonial house 09 (HC09)

The configuration of the HC09 represents an asymmetric, distributed system in the inferior part and non-distributedness in the superior part, and in symmetric order in the superior part. It is a tree- like structure and deep from the exterior, constituted of 17 nodes and 17 links.

There are four topological spaces in the graph: the a-type space represents 53% from all the system, the topological space of b-type 50%, and the c-type: 25%. The penetration into the house from an outer ring formed by: the exterior, the veranda, the garage, the hall, the corridor, the kitchen and the intermediate space. The veranda and the garage are the two points to access into the house and where they fall in a ring; which provides a choice of mobility and flexibility of circulation, thus less control in the entrance of the house. The hall (Hl) have an access to spaces of a-type: the bedroom (rm1), the living room (lvrm), they are arranged as dead-end spaces at depth three, and to the corridor of c-type and part of an outer ring is the pivot of circulation and the main distributed space in the spatial configuration, it takes to the kitchen, the bedroom (rm2), and the staircase (str) of b-type space, which takes to the next floor to the second corridor (crd2), the main central space and the pivot of circulation in this first floor, which also takes to the terrace, the second kitchen (ktch2), and the bedroom (rm3) that has an access to another bedroom (rm4) of a-type space arranged as dead-end space in the last depth in the spatial configuration.

The quantitative data show that the order of integration remains similar whether the exterior is included or not. The most integrated space in the house is the corridor (crd) with the lowest value (0.16), then the second integrated space is the staircase (str) with value (0.20), followed by the hall (Hl) with value (0.21) and the kitchen with value (0.23), and the second corridor (crd2) is integrated space with value (0.26). The bedroom (rm2) has a moderate value of integration (0.29). The exterior is segregated spaces which have high value of RA (0.35) and the veranda (0.29), followed by the living room (lvrm) and the bedroom (rm1), the toilet and the bedroom (rm3) have the highest value of RA (0.50) it’s the most segregated space in the house, the terrace and the kitchen (ktch2) (0.39).

In term of control, the second corridor (crd2) is the most controlled space with value (3.00), followed by the hall (Hl) with value (2.70), and the corridor (crd) (2.25), then the intermediate space (2.00).

Table 29: HC09.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	ext	59	3,68	0,35	2,79	1,00
1	vr/c	51	3,18	0,29	3,42	0,75
2	Hl/c	42	2,62	0,21	4,61	2,75
3	crd/c	36	2,25	0,16	6,00	2,25
4	lvm/a	57	3,56	0,34	2,92	0,25
5	str/b	41	2,56	0,20	4,80	0,50
6	rm2/a	51	3,18	0,29	3,42	0,25
7	crd2/b	48	3,00	0,26	3,75	3,00
8	trs/a	63	3,93	0,39	2,55	0,25
9	kch2/a	63	3,93	0,39	2,55	0,25
10	rm4/b	61	3,81	0,37	2,66	1,25
11	rm3/a	76	4,75	0,50	2,00	0,50
12	rm1	57	3,56	0,34	2,92	0,25
13	gr/c	60	3,75	0,36	2,72	0,83
14	I/c	52	3,25	0,30	3,33	2,00
15	ktch/c	44	2,75	0,23	4,28	0,58
16	bath/a	67	4,18	0,42	2,35	0,33
	Min	36,00	2,25	0,16	2,00	0,25
	Mean	**54,58**	**3,41**	**0,32**	**3,36**	**1,00**
	Max	76,00	4,75	0,50	6,00	3,00

HC09.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	vr/c	55	3,66	0,38	2,62	0,25
1	Hl/c	41	2,73	0,24	4,03	3,25
2	crd/c	33	2,20	0,17	5,83	2,25
3	lvm/a	55	3,66	0,38	2,62	0,25
4	str/b	37	2,46	0,20	4,77	0,50
5	rm2/a	47	3,13	0,30	3,28	0,25
6	crd2/b	43	2,86	0,26	3,75	3,00
7	trs/a	57	3,80	0,40	2,50	0,25
8	kch2/a	57	3,80	0,40	2,50	0,25
9	rm4/b	55	3,66	0,38	2,62	1,25
10	rm3/a	69	4,60	0,51	1,94	0,50
11	rm1/a	55	3,66	0,38	2,62	0,25
12	gr/c	65	4,33	0,47	2,10	0,33
13	I/c	51	3,40	0,34	2,91	2,50
14	ktch/c	41	2,73	0,24	4,03	0,58
15	bath/a	65	4,33	0,47	2,10	0,33
	Min	33,00	2,20	0,17	1,94	0,25
	Mean	**51,62**	**3,44**	**0,34**	**3,14**	**1,00**
	Max	69,00	4,60	0,51	5,83	3,25

2.2.10. Analysis of the colonial House (HC10):

The graph represents a tree-like structure with two brunches; it shows a distributedness in a part of the system manifested in the existence of two inner rings. The topological space of a-type represents 50%, the topological space of b-type 13%, c-type represents 23% of all the system, and d-type 5%.

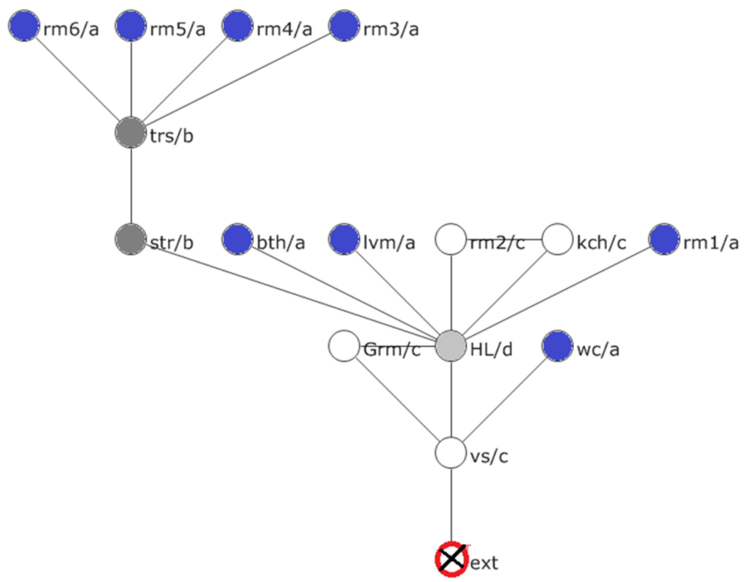


Figure -65: The justified graph of the colonial house 10 (HC10)

The vestibule (vs) is the point of penetration into the house where it is a part of an inner ring that includes each of the hall and the guest room (Grm) which is destined to receive visitors, whereas the second ring includes each of the hall (HL), the kitchen (ktch), and the bedroom (rm2). The hall (HL) of d-type space which is part of the two inner rings and provides more flexibility of movement within the house, it distributes to three types of topological space the a-type as: the guest room (Grm), bedroom (rm1), living room (lvrm), and bathroom (bath), they are arranged as dead-end spaces. The c-type spaces such as: the kitchen (ktch) and bedroom (rm2), and the b-type space like the staircase (str) that takes to the first floor. The terrace of b-type space distributes to the bedrooms (rm3, rm4, rm5, rm6), they are situated at the last depth in the graph which make them isolated and tend to the private use.

The quantitative data shows that the order of integration remains similar when the exterior in included or not. The hall is the most integrated space in the house with value (0.09), followed

Table 30: HC10.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	0	52	3,25	0,30	3,33	0,25
1	vs	37	2,31	0,17	5,71	2,61
2	wc	52	3,25	0,30	3,33	0,25
3	Hl	27	1,68	0,09	10,90	6,25
4	Grm	39	2,43	0,19	5,21	0,36
5	rm2	41	2,56	0,20	4,80	0,61
6	kch	41	2,56	0,20	4,80	0,61
7	rm1	42	2,62	0,21	4,61	0,11
8	lvrm	42	2,62	0,21	4,61	0,11
9	bath	42	2,62	0,21	4,61	0,11
10	str	32	2,00	0,13	7,50	0,31
11	dp	42	2,62	0,21	4,61	0,11
12	trs	39	2,43	0,19	5,21	4,50
13	rm5	54	3,37	0,31	3,15	0,20
14	rm4	54	3,37	0,31	3,15	0,20
15	rm6	54	3,37	0,31	3,15	0,20
16	rm3	54	3,37	0,31	3,15	0,20
	Min	27,00	1,68	0,09	3,15	0,11
	Mean	**43,76**	**2,73**	**0,23**	**4,81**	**1,00**
	Max	54,00	3,37	0,31	10,90	6,25

HC10.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	vs	36	2,40	0,20	5,00	1,61
1	wc	50	3,33	0,33	3,00	0,33
2	Hl	25	1,66	0,09	10,50	6,33
3	Grm	37	2,46	0,20	4,77	0,44
4	rm2	38	2,53	0,21	4,56	0,61
5	kch	38	2,53	0,21	4,56	0,61
6	rm1	39	2,60	0,22	4,37	0,11
7	lvrm	39	2,60	0,22	4,37	0,11
8	bath	39	2,60	0,22	4,37	0,11
9	str	29	1,93	0,13	7,50	0,31
10	dp	39	2,60	0,22	4,37	0,11
11	trs	35	2,33	0,19	5,25	4,50
12	rm5	49	3,26	0,32	3,08	0,20
13	rm4	49	3,26	0,32	3,08	0,20
14	rm6	49	3,26	0,32	3,08	0,20
15	rm3	49	3,26	0,32	3,08	0,20
	Min	25,00	1,66	0,09	3,00	0,11
	Mean	**40,00**	**2,66**	**0,23**	**4,68**	**1,00**
	Max	50,00	3,33	0,33	10,50	6,33

by the staircase (0.13) and vestibule with value (0.17), the guest room and the terrace with same value (0.19), the bedroom (rm2) and the kitchen have the same integrated value (0.20). These spaces: the bathroom, the living room, the bedroom (rm1), and the deposit have an equal value of integration (0.21) in which they have integrated systems. The most segregated spaces are: the bedrooms (rm3, rm4, rm5, rm6) with value (031), and the exterior is segregated space with value (0.30). the hall is the most controlled space with value (6.25), followed by the terrace (4.50) and the vestibule (2.61).

2.2.11. Analysis of the colonial House (HC11):

The graph is constructed using the exterior as a root, it represents an arborescent structure and in symmetric order in general. The graph is constituted of 13 nodes and 13 links. The system tends to the lack in distributedness in general which is manifested by the topological spaces of a-type that represents 58% of all the spaces, 18% of b-type space, and 23% of c-type spaces. The presence of an inner ring provides a kind of flexibility of movement which is formed by three topological spaces of c-type the vestibule (vs), the guest room (Grm) and the hall (HL). The hall of c-type distributes to the kitchen, bathroom, toilet, bedrooms (rm1, rm2) of topological space of a-type arranged at depth three as dead-end spaces, and to the staircase (str) of b-type that takes directly to the terrace (trs) which gives an access to the most segregated spaces in the system the bedrooms (rm3, and rm4) of topological space a-type arranged as dead-end space, these two bedrooms are destined for private use.

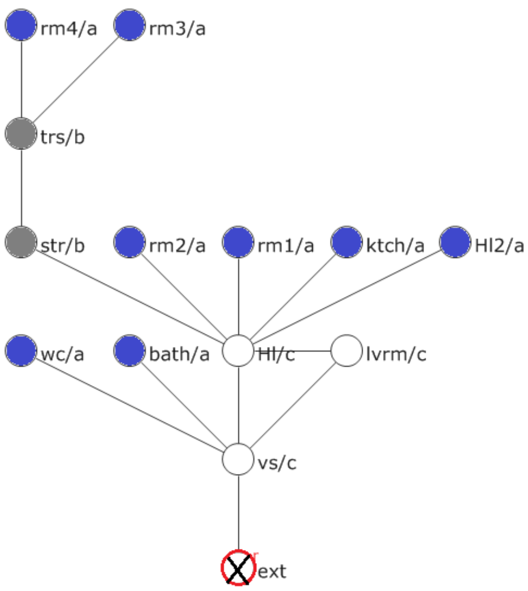


Figure-66: The justified graph of the colonial house 11 (HC11)

In term of quantitative data, the order of integration remains similar whether the exterior is included or not, from the table there are some values of RA that remain similar in both cases when the exterior is included or not such as: the hall, the staircase, and the terrace. The most integrated space in the house is the hall (Hl) with low value of RA (0.10) which is the most accessible space, and the second integrated space is the vestibule with value (0.16) followed by the staircase (0.17), then the living room (0.20). Each of the kitchen, second hall, and the bedrooms (rm1, rm2) has the same value of integration (0.25), they are considered as segregated spaces .The terrace is also a segregated space with value (0.27). The most segregated spaces are the exterior, the bathroom and the toilet with the same value (0.32) and the bedrooms (rm3, rm4) with high value of RA (0.43). The most controlled space is the hall (5.20) and the vestibule (3.64).

Table 31: HC11.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	ext	38	2,92	0,32	3,12	0,20
1	vs/c	26	2,00	0,16	6,00	3,64
2	Hl/c	21	1,61	0,10	9,75	5,20
3	lvrm/c	29	2,23	0,20	4,87	0,34
4	bath/a	38	2,92	0,32	3,12	0,20
5	wc/a	38	2,92	0,32	3,12	0,20
6	rm1/a	33	2,53	0,25	3,90	0,14
7	ktch/a	33	2,53	0,25	3,90	0,14
8	Hl2/a	33	2,53	0,25	3,90	0,14
9	rm2/a	33	2,53	0,25	3,90	0,14
10	sr/b	27	2,07	0,17	5,57	0,47
11	trs/b	35	2,69	0,28	3,54	2,50
12	rm4/a	47	3,61	0,43	2,29	0,33
13	rm3/a	47	3,61	0,43	2,29	0,33
	Min	21,00	1,61	0,10	2,29	0,14
	Mean	**34,14**	**2,62**	**0,27**	**4,23**	**1,00**
	Max	47,00	3,61	0,43	9,75	5,20

HC11.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	vs/c	25	2,08	0,19	5,07	2,64
1	Hl/c	19	1,58	0,10	9,42	5,25
2	lvrm/c	27	2,25	0,22	4,40	0,39
3	bath/a	36	3,00	0,36	2,75	0,25
4	wc/a	36	3,00	0,36	2,75	0,25
5	rm1/a	30	2,50	0,27	3,66	0,14
6	ktch/a	30	2,50	0,27	3,66	0,14
7	Hl2/a	30	2,50	0,27	3,66	0,14
8	rm2/a	30	2,50	0,27	3,66	0,14
9	sr/b	24	2,00	0,18	5,50	0,47
10	trs/b	31	2,58	0,28	3,47	2,50
11	rm4/a	42	3,50	0,45	2,20	0,33
12	rm3/a	42	3,50	0,45	2,20	0,33
	Min	19,00	1,58	0,10	2,20	0,14
	Mean	**30,92**	**2,57**	**0,28**	**4,03**	**1,00**
	Max	42,00	3,50	0,45	9,42	5,25

2.2.12. Analysis of the Colonial House (HC12):

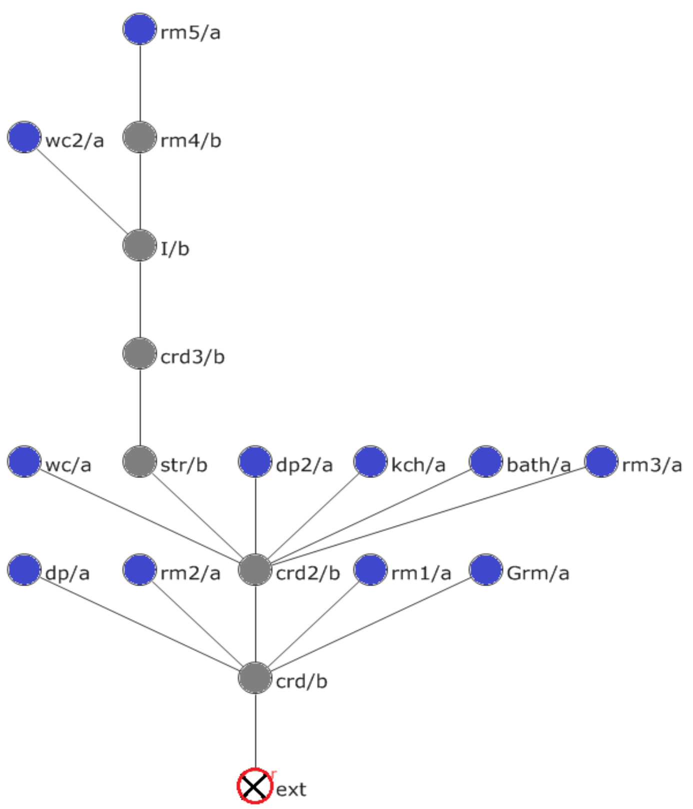


Figure -67: The justified graph of the colonial house 12 (HC12)

The graph was constructed using the exterior as a root; it represents an arborescent configuration and deep from the exterior. Have a symmetric order in the inferior part and an asymmetric order in the superior part. The non-distributedness is manifested in the topological space of a-type 64%, and the topological space of b-type 37%. The point of penetration by b-type space the corridor (crd) which takes directly to guest room (grm), deposit (dp), bedrooms (rm, rm2) of topological space of a-type whereas the guest room is dedicated to the visitors, it is shallow from the exterior in purpose to keep strangers away from the private area of the inhabitants. In addition, the corridor (crd) takes to a second corridor (crd2) in depth two of b-type space, it distributes to topological spaces of a-type such as: the kitchen (ktch), bedroom (rm3), bathroom (bath), deposit (dp2), toilet (wc), and of topological space of b-type such as: staircase. The corridor provides high control within the house which is the pivot of movement and circulation. The corridor (crd3) at depth four of topological space b-type take to the bedrooms (rm4, rm5) and the toilet passing by an intermediate space (I) which provide more intimacy for these spaces that are more segregated spaces in the system. The bedrooms, kitchen, bathroom… of topological space of a-type are the most suitable spaces for inhabitants because there is no through movement. But the spaces of b-type are specific for circulation and transition within the house.

Table 32: HC12.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	**ext**	57	3,35	0,29	3,40	0,16
1	**crd**	41	2,41	0,17	5,66	5,14
2	**crd2**	35	2,05	0,13	7,55	5,66
3	**rm1**	57	3,35	0,29	3,40	0,16
4	**rm2**	57	3,35	0,29	3,40	0,16
5	**dp**	57	3,35	0,29	3,40	0,16
6	**Grm**	57	3,35	0,29	3,40	0,16
7	**dp2**	51	3,00	0,25	4,00	0,14
8	**ktch**	51	3,00	0,25	4,00	0,14
9	**bath**	51	3,00	0,25	4,00	0,14
10	**str**	41	2,41	0,17	5,66	0,64
11	**wc**	51	3,00	0,25	4,00	0,14
12	**rm3**	51	3,00	0,25	4,00	0,14
13	**crd3**	49	2,88	0,23	4,25	0,83
14	**I**	59	3,47	0,30	3,23	2,00
15	**wc2**	75	4,41	0,42	2,34	0,33
16	**rm4**	73	4,29	0,41	2,42	1,33
17	**rm5**	89	5,23	0,52	1,88	0,50
	Min	35,00	2,05	0,13	1,88	0,14
	Mean	**55,66**	**3,27**	**0,28**	**3,89**	**1,00**
	Max	89,00	5,23	0,52	7,55	5,66

HC12.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	**crd**	40	2,50	0,20	5,00	4,14
1	**crd2**	33	2,06	0,14	7,05	5,70
2	**rm1**	55	3,43	0,32	3,07	0,20
3	**rm2**	55	3,43	0,32	3,07	0,20
4	**dp**	55	3,43	0,32	3,07	0,20
5	**Grm**	55	3,43	0,32	3,07	0,20
6	**dp2**	48	3,00	0,26	3,75	0,14
7	**ktch**	48	3,00	0,26	3,75	0,14
8	**bath**	48	3,00	0,26	3,75	0,14
9	**str**	38	2,37	0,18	5,45	0,64
10	**wc**	48	3,00	0,26	3,75	0,14
11	**rm3**	48	3,00	0,26	3,75	0,14
12	**crd3**	45	2,81	0,24	4,13	0,83
13	**I**	54	3,37	0,31	3,15	2,00
14	**wc2**	69	4,31	0,44	2,26	0,33
15	**rm4**	67	4,18	0,42	2,35	1,33
16	**rm5**	82	5,12	0,55	1,81	0,50
	Min	33,00	2,06	0,14	1,81	0,14
	Mean	**52,23**	**3,26**	**0,30**	**3,66**	**1,00**
	Max	82,00	5,12	0,55	7,05	5,70

Examination of the quantitative data shows similarities in order of integration whether or not the exterior taken into account, with the exception of the corridor (crd) which is becoming more segregated. The spatial configuration of the house HC12 tends to strengthen the interface of relations between residents. The most integrated space is the corridor (crd2) that is situated at depth two which displays very low value 0.13, followed by the staircase (str) and the corridor (crd) with same value of integration 0.17. The guest room (grm), the bedrooms (rm1, rm2), the deposit (dp) and the exterior have similar value of integration 0.29 which are segregated even though they are situated at depth two. Whereas, the kitchen (ktch), the bathroom (bath), the deposit (dep2), the toilet (wc), and the bedroom (rm3) are situated at depth three and have value of integration of 0.25. The corridor (crd3) has value of integration of 0.23 despite the fact that it is situated at depth four, followed by the intermediate space with value 0.29. The most segregated spaces are: the bedroom (rm4), the toilet (wc2), and the bedroom (rm5) with values: 0.41, 0.42, and 0.52 respectively. The corridor (crd2) is the most controlled space 5.66, followed by the corridor (crd) 5.14 and the intermediate space (I) 2.00.

2.2.13. Analysis of the Colonial House (HC13):

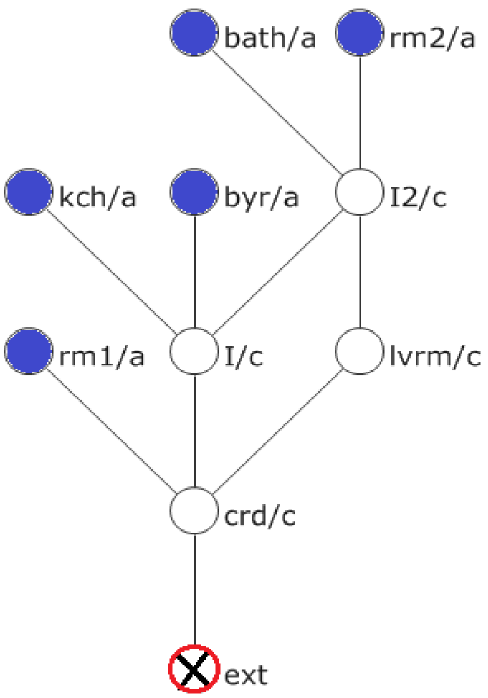


Figure -68: The justified graph of the colonial house 13 (HC13)

The spatial configuration was constructed using the exterior as a root; it represents a tree-like structure and in asymmetric order. In spite of the existence of an inner ring that is formed by four topological spaces of c-type the configuration shows lack of distributedness. The penetration into the house is done according to a point of c-type, the corridor (crd) which is falling in a ring that offers a choice of circulation around the house. The topological spaces of a-type represent 55%, and the topological spaces of c-type 40% of all the system. The inner ring includes the spaces of transition and circulation like the corridor (crd), the intermediate space (I), and the second intermediate space (I2), also the living room (lvrm), which provides more flexibility of movement and low control. The kitchen (ktch), the bedrooms (rm1, rm2), the backyard (byr), and the bathroom (bath) from a-type space are arranged as dead-end spaces.

When the exterior is excluded from the calculations, viewing the quantitative values reveals some variation. The order of integration remains in the same order with the expectation of the corridor (crd), it becomes more segregated and the intermediate space (I2) tends to be more integrated. The intermediate space (I) is the most integrated space in the system with value 0.13, followed by the corridor (crd) and the second intermediate space (I2) with similar value 0.19. The living room (lvrm) and the bedroom (rm1) are situated at the same second depth but they have different values of integration 0.25 and 0.41 respectively, whereas the living room is more integrated than the bedroom. The kitchen and the backyard have the same value 0.36. The bathroom (bath) and the bedroom (rm2) are situated at the last depth in the graph, they are considered as segregated spaces with value of integration 0.41 the same as the bedroom (rm1) that is situated at the depth two, these spaces are considered suitable for the inhabitants according to their private use. The corridor (crd) and the intermediate space (I2) have the most value of control 2.75, followed by the intermediate space (I) with value 2.50.

Table 33: HC13.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	**ext**	24	2,66	0,41	2,40	0,25
1	**crd**	16	1,77	0,19	5,14	2,75
2	**I**	14	1,55	0,13	7,20	2,50
3	**lvrm**	18	2,00	0,25	4,00	0,50
4	**rm1**	24	2,66	0,41	2,40	0,25
5	**byr**	22	2,44	0,36	2,76	0,25
6	**ktch**	22	2,44	0,36	2,76	0,25
7	**I2**	16	1,77	0,19	5,14	2,75
8	**rm2**	24	2,66	0,41	2,40	0,25
9	**bath**	24	2,66	0,41	2,40	0,25
	Min	14,00	1,55	0,13	2,40	0,25
	Mean	**20,40**	**2,26**	**0,31**	**3,66**	**1,00**
	Max	24,00	2,66	0,41	7,20	2,75

HC13.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	**crd**	15	1,87	0,25	4,00	1,75
1	**I**	12	1,50	0,14	7,00	2,58
2	**lvrm**	16	2,00	0,28	3,50	0,58
3	**rm1**	22	2,75	0,50	2,00	0,33
4	**byr**	19	2,37	0,39	2,54	0,25
5	**ktch**	19	2,37	0,39	2,54	0,25
6	**I2**	13	1,62	0,17	5,60	2,75
7	**rm2**	20	2,50	0,42	2,33	0,25
8	**bath**	20	2,50	0,42	2,33	0,25
	Min	12,00	1,50	0,14	2,00	0,25
	Mean	**17,33**	**2,16**	**0,33**	**3,53**	**1,00**
	Max	22,00	2,75	0,50	7,00	2,75

Analysis of the Colonial House (HC14):

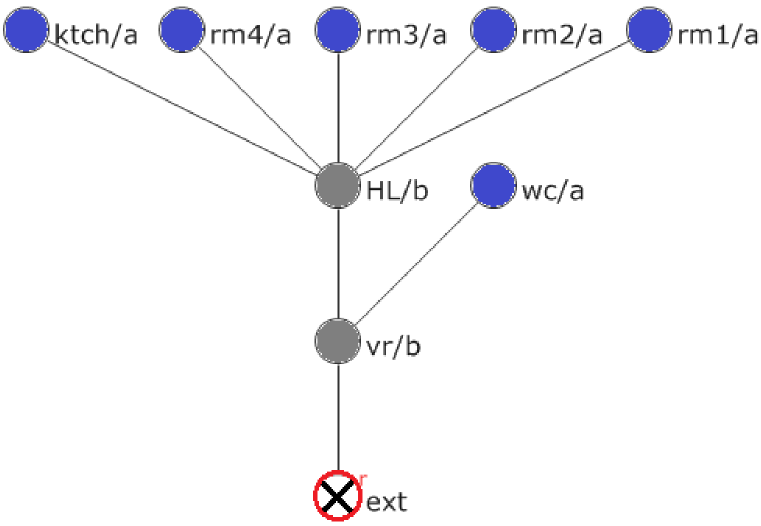


Figure -69: The justified graph of the colonial house 29 (HC29)

The configuration represents an arborescent structure, and a symmetric order, its shallow from the exterior. The graph has 75% from the topological space of a-type and 28% of b-type space which tend to the non-distributedness. The point of penetration of b-type space; the veranda (vr) which takes to the toilet which is arranged as dead-end space, and to the hall (HL) of b-type the pivot of circulation within the house, it controls the access into all the spaces: the kitchen (ktch) and the bedrooms (rm1, rm2, rm3, rm4) that are situated at the last depth as the most private spaces.

Table 34: HC14.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	ext	20	2,50	0,42	2,33	0,33
1	vr	13	1,62	0,17	5,60	2,16
2	wc	20	2,50	0,42	2,33	0,33
3	HL	10	1,25	0,07	14,00	5,33
4	rm3	17	2,12	0,32	3,11	0,16
5	rm2	17	2,12	0,32	3,11	0,16
6	rm1	17	2,12	0,32	3,11	0,16
7	rm4	17	2,12	0,32	3,11	0,16
8	ktch	17	2,12	0,32	3,11	0,16
	Min	10,00	1,25	0,07	2,33	0,16
	Mean	**16,44**	**2,05**	**0,30**	**4,42**	**1,00**
	Max	20,00	2,50	0,42	14,00	5,33

HC14.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	vr	12	1,71	0,23	4,20	1,16
1	wc	18	2,57	0,52	1,90	0,50
2	HL	8	1,14	0,04	21,00	5,50
3	rm3	14	2,00	0,33	3,00	0,16
4	rm2	14	2,00	0,33	3,00	0,16
5	rm1	14	2,00	0,33	3,00	0,16
6	rm4	14	2,00	0,33	3,00	0,16
7	ktch	14	2,00	0,33	3,00	0,16
	Min	8,00	1,14	0,04	1,90	0,16
	Mean	**13,50**	**1,92**	**0,30**	**5,26**	**1,00**
	Max	18,00	2,57	0,52	21,00	5,50

The quantitative data shows that the order of integration remains similar whether the exterior is included or not. With expectation, the veranda (vr) becomes more segregated. The Hall is the most integrated space with value 0.07, followed by the veranda (vr) 0.17. The exterior and the toilet are the most segregated spaces. The kitchen (ktch), and the bedrooms (rm1, rm2, rm3, rm4) are segregated with value 0.32. The hall (HL) has the highest degree of control 5.33, it controls the access within the house and the circulation, the veranda (vr) has value of control 2.16, it controls the access into the house.

2.2.14. Analysis of the Colonial House (HC15):

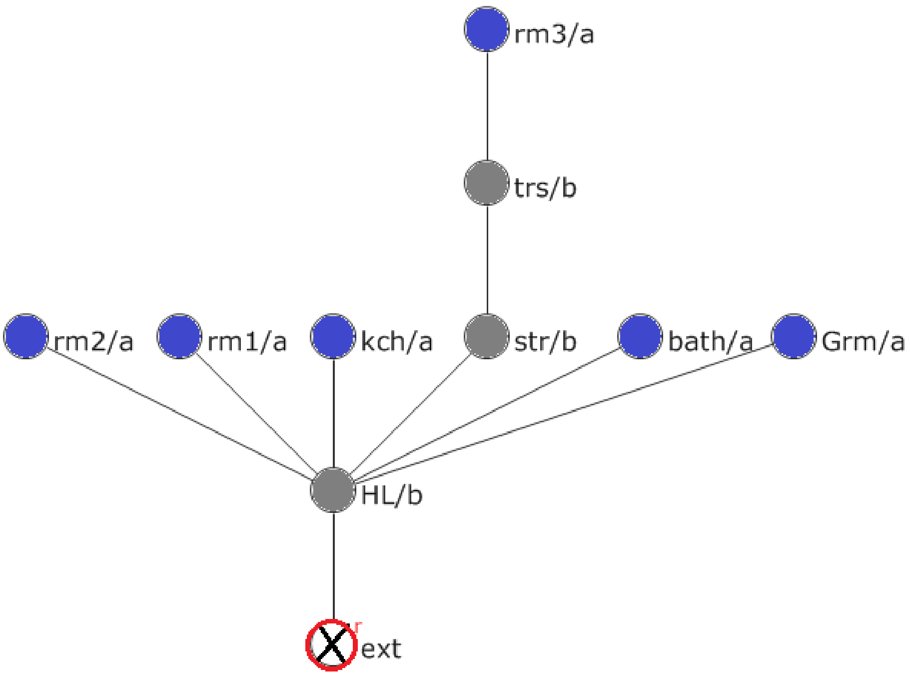


Figure -70: The justified graph of the colonial house 15 (HC15)

The configuration has a striking resemblance to the previous graph HC14. The graph has a symmetric order in the inferior part and asymmetric order in the superior part. It is shallow from the exterior. The non-distributedness is manifested in the topological space of a-type 66% and 37% of b-type. The hall (HL) of b-type is the point of penetration into the house, it is the pivot of circulation and distributes to: the kitchen (ktch), the bathroom (bath), the guestroom (grm), the bedrooms (rm1, rm2) from a-type space and arranged as dead-end spaces, and the staircase (str) of b-type space which takes directly to the terrace (trs) that has an access to a bedroom (rm3) of a-type at the last depth in the graph and arranged as dead-end space.

Table 35: HC15.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	ext	20	2,22	0,30	3,27	0,14
1	HL	12	1,33	0,08	12,00	6,50
2	str	16	1,77	0,19	5,14	0,64
3	ktch	20	2,22	0,30	3,27	0,14
4	rm1	20	2,22	0,30	3,27	0,14
5	rm2	20	2,22	0,30	3,27	0,14
6	bath	20	2,22	0,30	3,27	0,14
7	Grm	20	2,22	0,30	3,27	0,14
8	trs	22	2,44	0,36	2,76	1,50
9	rm3	30	3,33	0,58	1,71	0,50
	Min	12,00	1,33	0,08	1,71	0,14
	Mean	**20,00**	**2,22**	**0,30**	**4,12**	**1,00**
	Max	30,00	3,33	0,58	12,00	6,50

HC15.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	HL	11	1,37	0,10	9,33	5,50
1	str	14	1,75	0,21	4,66	0,66
2	ktch	18	2,25	0,35	2,80	0,16
3	rm1	18	2,25	0,35	2,80	0,16
4	rm2	18	2,25	0,35	2,80	0,16
5	bath	18	2,25	0,35	2,80	0,16
6	Grm	18	2,25	0,35	2,80	0,16
7	trs	19	2,37	0,39	2,54	1,50
8	rm3	26	3,25	0,64	1,55	0,50
	Min	11,00	1,37	0,10	1,55	0,16
	Mean	**17,77**	**2,22**	**0,34**	**3,56**	**1,00**
	Max	26,00	3,25	0,64	9,33	5,50

As in the majority of the other graphs, the quantitative values and the hierarchy they induce in terms of integration remain constant whether or not the exterior is included in the calculation. The hall (HL) has the lowest degree of integration 0.08 which means that it is the most integrated space in the system followed by the staircase (str) with value 0.19. The most segregated spaces are the terrace (trs) 0.36 and the bedroom (rm3) 0.58, they are both situated at the last depth. The kitchen, the guest room, the bathroom, the exterior, and the bedrooms (rm1, rm2) have the same degree of integration 0.30 which make them segregated in the system. The Hall has the highest degree of control 6.50 followed by the terrace 1.50.

- Discussion:

The findings from the analysis of the various colonial house plans are briefly discussed in terms of spatial configuration and its location in the fabric. The spatial configuration of the colonial houses shows some similarities with the vernacular houses. The justified graphs show that the spatial configuration characterized by its arborescent structure (tree-like) and represent lack in distributedness or in other word, have non-distributed system in general. The colonial houses are influenced from the vernacular architecture, whereas the spatial configuration is organized around the hall "*wast eddar*" that contained an opening in theceilingfor the ventilation and the over heading lighting. And are opened on the vestibule "*sguifa*" which controls the access into the house and which is also considered as a boundary between the exterior and the interior. The colonial houses are regulated by some criteria: each house must have at least one ground floor, a first floor and uses local materials. These colonial constructions had no balconies, no projections, awnings, or blinds.

The veranda is the main space that characterizes the colonial house, which replaced the vestibule "*sguifa*", in addition, it's notable that some houses have no vestibule or veranda, they are opened directly to a hall or corridor which are the pivot of circulation and movement around the house. From analyzing the sample, the two houses (HC2 and HC9) have two entrances into the house the second one from the garage. From the quantitative analysis, the transition spaces are the most integrated spaces in all the houses, and the most controlled, where the bedrooms and service area are segregated spaces. The guest room is generally shallow from the exterior because it is destined to receive visitors.

3.2. Analysis the houses from the independence period (HI)

3.2.1. Analysis of the House 01 (HI01):

The graph has a striking resemblance to the previous graphs of the pre-colonial and colonial periods; it represents a tree-like structure, it shows a symmetric order and non-distributedness. The topological spaces of a-type represent 64% of the total number of spaces and 38% of the topological spaces of b-type. The graph starts by the topological space of b-type which is the veranda, it is considered as the point of penetration into the house, it gives to the corridor the main space of transition in the house of b-type; it is a through space where there is no choice of movement. Each of: the kitchen, the bathroom, the bedrooms (rm1, rm2, rm3, rm4), and the guest room are arranged around the corridor which controls the access to these spaces of a-type, the room2 has a private bathroom arranged as a dead-end space in the graph. The staircase of b-type is a transition space that takes to the terrace situated at the last depth in the graph. The garage is of a-type space at depth one, it has a direct access from the exterior and has no relationship with inside the house.

In term of quantitative value, taking into account the exterior or not in the calculation of the data, the results show a negligible influence. The corridor and the veranda are at different depth but have a strong integration with an equal value of RA (0.17); the veranda is considered as a boundary between the exterior and the internal space, it gives to the corridor.

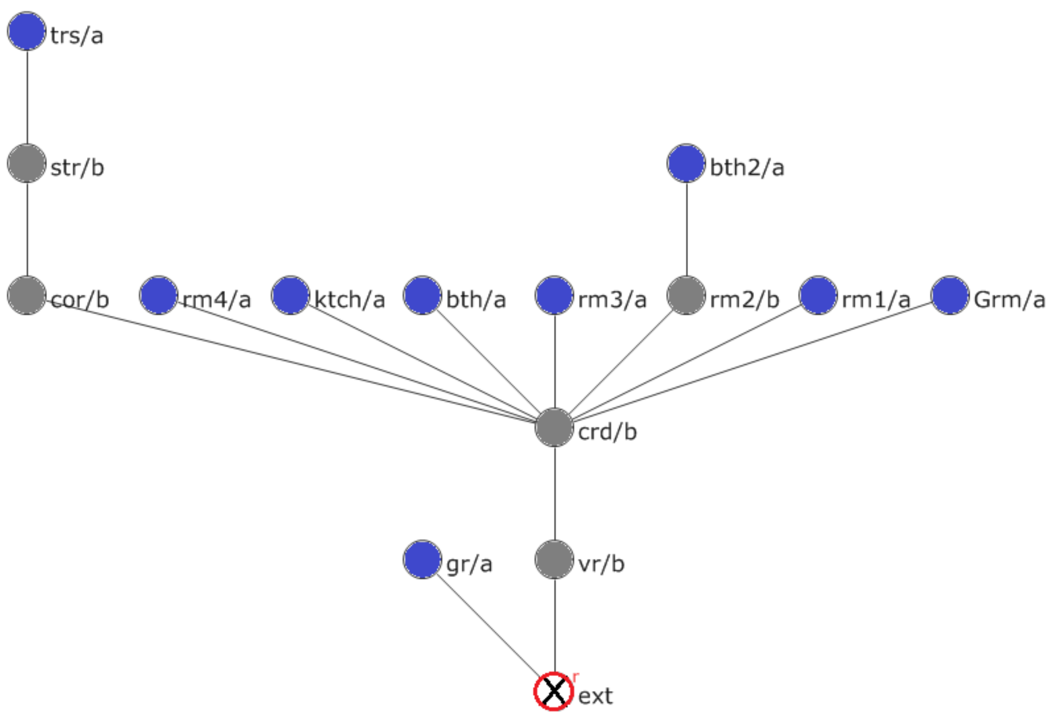


Figure -71: The justified graph of the house HI01

The corridor has the lowest value of RA (0.07), it is the most integrated space in the house which gives access to the all the spaces and has the highest degree of control (7.50), it controls the circulation around the house. The bedrooms (rm1, rm3, and rm4), the guest room, the bathroom and the kitchen are situated at the same depth and have an equal value of integration (0.21). The exterior has the same value with the staircase (0.17) despite their different depth in the graph. The most segregated spaces are the terrace and the garage (0.43).

Table 36: HI01.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	**ext**	41	2,92	0,29	3,37	1,50
1	**vr**	30	2,14	0,17	5,68	0,61
2	**crd**	21	1,50	0,07	13,00	7,50
3	**gr**	54	3,85	0,43	2,27	0,50
4	**rm3**	34	2,42	0,21	4,55	0,11
5	**rm2**	32	2,28	0,19	5,05	1,11
6	**rm1**	34	2,42	0,21	4,55	0,11
7	**bath**	34	2,42	0,21	4,55	0,11
8	**ktch**	34	2,42	0,21	4,55	0,11
9	**Grm**	34	2,42	0,21	4,55	0,11
10	**rm4**	34	2,42	0,21	4,55	0,11
11	**cor**	30	2,14	0,17	5,68	0,61
12	**bth2**	45	3,21	0,34	2,93	0,50
13	**str**	41	2,92	0,29	3,37	1,50
14	**trs**	54	3,85	0,43	2,27	0,50
	Min	21,00	1,50	0,07	2,27	0,11
	Mean	**36,80**	**2,62**	**0,25**	**4,73**	**1,00**
	Max	54,00	3,85	0,43	13,00	7,50

HI01.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	**vr**	41	3,15	0,35	2,78	0,11
1	**crd**	30	2,30	0,21	4,58	8,00
2	**gr**	182	14,00	2,16	0,46	0,00
3	**rm3**	41	3,15	0,35	2,78	0,11
4	**rm2**	39	3,00	0,33	3,00	1,11
5	**rm1**	41	3,15	0,35	2,78	0,11
6	**bath**	41	3,15	0,35	2,78	0,11
7	**ktch**	41	3,15	0,35	2,78	0,11
8	**Grm**	41	3,15	0,35	2,78	0,11
9	**rm4**	41	3,15	0,35	2,78	0,11
10	**cor**	37	2,84	0,30	3,25	0,61
11	**bth2**	50	3,84	0,47	2,10	0,50
12	**str**	46	3,53	0,42	2,36	1,50
13	**trs**	57	4,38	0,56	1,77	0,50
	Min	30,00	2,30	0,21	0,46	0,00
	Mean	**52,00**	**4,00**	**0,50**	**2,64**	**0,92**
	Max	182,00	14,00	2,16	4,58	8,00

3.2.2. Analysis of the House HI02:

The graph of HI02 represents a symmetric order, and non-distributedness manifested in the high number of spaces nine of a-type (69%) and three of b-type (27%). The graph opens on a space of b-type, the hall that guarantees high control around the house.

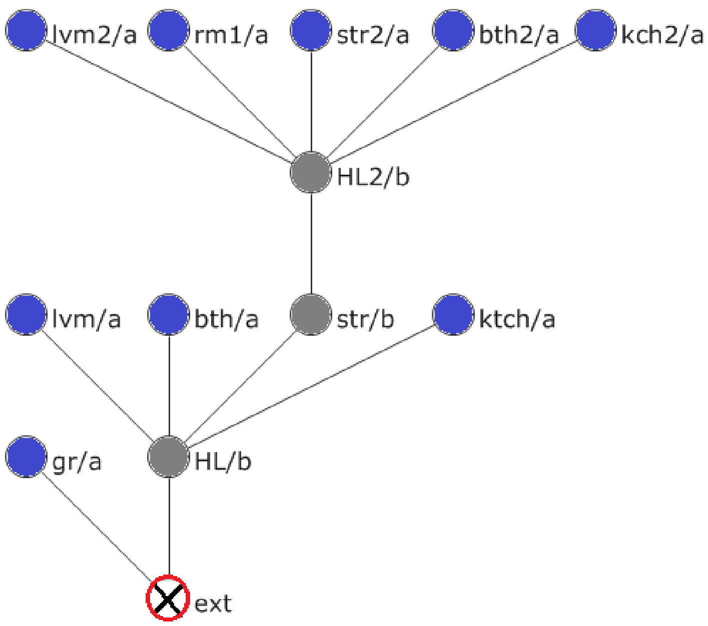


Figure -72: The justified graph of the house HI02

It gives an access to the spaces of daily use: the living room, the bathroom, and the kitchen, are from a-type, and space of transition: the staircase of b-type that articulate the two levels of the house. The hall (Hl2) of b-type space at depth three is the pivot of circulation and articulation at the first floor; it controls the spaces at this level. The living room (lvrm2), the bedroom (rm1), the kitchen (ktch2), the bathroom (bath2) and the staircase (str2) are of a-type space arranged as dead-end spaces at last depth in the graph.

The data shows that the hall (Hl, and HL2) have the highest degree of control in the house (4.00, and 5.50 respectively), and have a strong integration with an equal value (0.18) despite their position, they are situated at different depths. The staircase has the highest degree of integration with value (0.16). The rest of the spaces in the house in both levels have the same degree of segregation (0.34) except the exterior which has (0.31), they are the most private spaces in the house.

Table 37: HI02.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	ext	33	2,75	0,31	3,14	1,20
1	HL	24	2,00	0,18	5,50	4,00
2	str	23	1,91	0,16	6,00	0,36
3	bath	35	2,91	0,34	2,86	0,20
4	lvrm	35	2,91	0,34	2,86	0,20
5	ktch	35	2,91	0,34	2,86	0,20
6	gr	44	3,66	0,48	2,06	0,50
7	HL2	24	2,00	0,18	5,50	5,50
8	bth2	35	2,91	0,34	2,86	0,16
9	str2	35	2,91	0,34	2,86	0,16
10	rm1	35	2,91	0,34	2,86	0,16
11	lvrm2	35	2,91	0,34	2,86	0,16
12	ktch2	35	2,91	0,34	2,86	0,16
	Min	23,00	1,91	0,16	2,06	0,16
	Mean	**32,92**	**2,74**	**0,31**	**3,47**	**1,00**
	Max	44,00	3,66	0,48	6,00	5,50

HI02.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	HL	33	3,00	0,40	2,50	3,50
1	str	30	2,72	0,34	2,89	0,41
2	bath	42	3,81	0,56	1,77	0,25
3	lvrm	42	3,81	0,56	1,77	0,25
4	ktch	42	3,81	0,56	1,77	0,25
5	gr	132	12,00	2,20	0,45	0,00
6	HL2	29	2,63	0,32	3,05	5,50
7	bth2	38	3,45	0,49	2,03	0,16
8	str2	38	3,45	0,49	2,03	0,16
9	rm1	38	3,45	0,49	2,03	0,16
10	lvrm2	38	3,45	0,49	2,03	0,16
11	ktch2	38	3,45	0,49	2,03	0,16
	Min	29,00	2,63	0,32	0,45	0,00
	Mean	**45,00**	**4,09**	**0,61**	**2,03**	**0,91**
	Max	132,00	12,00	2,20	3,05	5,50

3.2.3. Analysis of the House HI03:

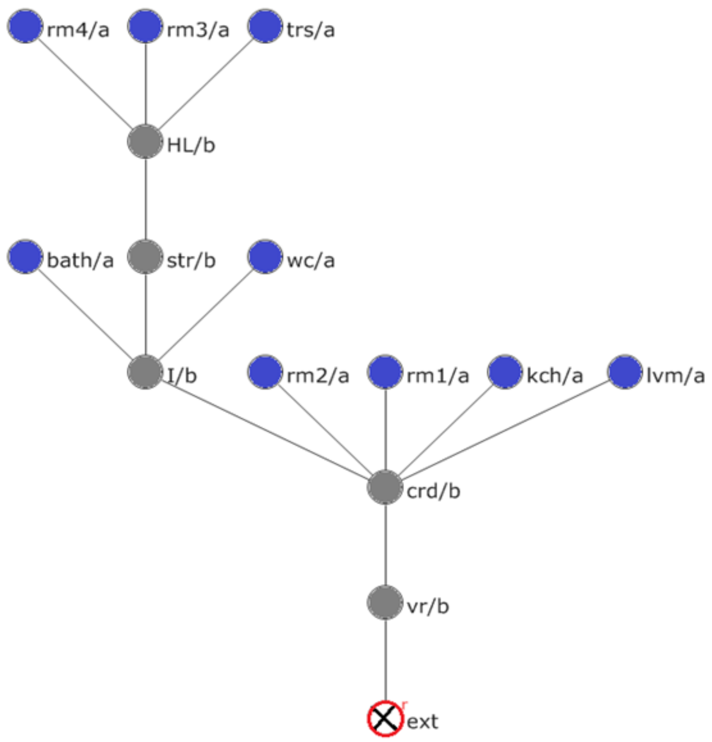


Figure -73: The justified graph of the house HI03

The graph HI03 represents a tree-like structure; it shows a symmetric order and non-distributedness. The graph opens on a space of b-type: the veranda which is considered as the filter between the exterior and the interior space, the veranda controls the access into the house. It gives to the corridor the main space of transition and movement of b-type. The bedrooms (rm1, and rm2), the kitchen, the intermediate space, and the living room: are arranged around the corridor, these spaces of occupation are suitable for the inhabitants. The intermediate space of b-type; it is a transition space that takes to the ablution spaces the bathroom and the toilet are of a-type arranged as dead-end spaces, and to the staircase of b-type, it serves directly to the next floor; to the hall of b-type, it deserves to the bedrooms (rm3, and rm4), and the terrace.

The order of integration (RA) remains practically the same when the exterior is included or not, thus, the spatial configuration favors the relationships between the residents. The intermediate space (I) is the most integrated space in the house's layout with value (0.15) with a strong control (2.66), and the corridor is the second integrated space with (0.16), it is the most controlled space with the highest degree of control (4.75) in the house. The veranda and the hall have an equal value of integration (0.28), despite the fact that they are situated at different depths, then, the ablution spaces: the bathroom and the toilet have a low degree of integration (0.29). The most segregated spaces are the spaces of occupation: the terrace and the bedrooms (rm3 and rm4) situated at the last depth with value (0.42), thus the exterior shares the same value despite the different depths. The bedrooms (rm1 and rm2), the kitchen, and the living room have a strong segregated with value (0.30).

Table 38: HI03.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	ext	53	3,78	0,42	2,33	0,50
1	vr	40	2,85	0,28	3,50	1,16
2	crd	29	2,07	0,16	6,06	4,75
3	rm1	42	3,00	0,30	3,25	0,16
4	ktch	42	3,00	0,30	3,25	0,16
5	lvrm	42	3,00	0,30	3,25	0,16
6	rm2	42	3,00	0,30	3,25	0,16
7	I	28	2,00	0,15	6,50	2,66
8	str	33	2,35	0,20	4,78	0,50
9	wc	41	2,92	0,29	3,37	0,25
10	bath	41	2,92	0,29	3,37	0,25
11	HL	40	2,85	0,28	3,50	3,50
12	trs	53	3,78	0,42	2,33	0,25
13	rm3	53	3,78	0,42	2,33	0,25
14	rm4	53	3,78	0,42	2,33	0,25
	Min	28,00	2,00	0,15	2,33	0,16
	Mean	**42,13**	**3,00**	**0,30**	**3,56**	**1,00**
	Max	53,00	3,78	0,42	6,50	4,75

HI03.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	vr	39	3,00	0,33	3,00	0,16
1	crd	27	2,07	0,17	5,57	5,25
2	rm1	39	3,00	0,33	3,00	0,16
3	ktch	39	3,00	0,33	3,00	0,16
4	lvrm	39	3,00	0,33	3,00	0,16
5	rm2	39	3,00	0,33	3,00	0,16
6	I	25	1,92	0,15	6,50	2,66
7	str	29	2,23	0,20	4,87	0,50
8	wc	37	2,84	0,30	3,25	0,25
9	bath	37	2,84	0,30	3,25	0,25
10	HL	35	2,69	0,28	3,54	3,50
11	trs	47	3,61	0,43	2,29	0,25
12	rm3	47	3,61	0,43	2,29	0,25
13	rm4	47	3,61	0,43	2,29	0,25
	Min	25,00	1,92	0,15	2,29	0,16
	Mean	**37,57**	**2,89**	**0,31**	**3,49**	**1,00**
	Max	47,00	3,61	0,43	6,50	5,25

3.2.4. Analysis of the House HI04:

The graph of house (HI04) represents a tree-like structure; it is deep from the exterior "the root space". The graph shows an asymmetric order in general, and it tends to lack in distributedness, in turn of means the increase in the depth within the house layout.

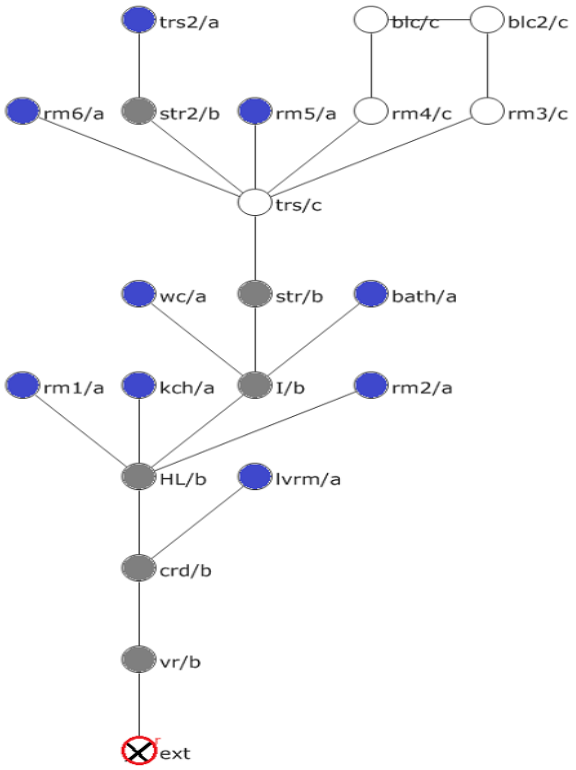


Figure -74: The justified graph of the house HI04

The graph composed from three types of topological spaces; 9 spaces of a-type: 45%, 6 spaces of b-type: 31%, 5 spaces of c-type: 24%. It contains 21 nodes and 21 links, with the presence of an inner ring in the superior part in the graph formed of five nodes, it passes by the topological spaces of c-type: the terrace, room3, room4, balcony, and balcony number two. The access to the house by the topological space of b-type: the veranda the filter between the external word and the interior, it takes to the corridor of b-type that distributes to the living room (or guest room) which is destined to visitors/ strangers, and to the hall the main central space where the daily activities take place. All the spaces, like the bedrooms (rm1, and rm2), the kitchen, and the intermediate space are arranged around the hall. The intermediate space at depth four where the ablution spaces (the bathroom, and the toilet) are situated, and it has the role ofan articulation and transition from the ground floor to the first floor, it takes directly to the terrace of b-type which is a transition space that distribute to the spaces of occupation such as: the bedrooms (rm3, rm4, rm5, and rm6), and to a staircase that leads to another private staircase situated at the last depth in the graph.

Table 39: HI04.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	ext	105	5,25	0,44	2,23	0,50
1	vr	86	4,30	0,34	2,87	1,33
2	crd	69	3,45	0,25	3,87	1,70
3	HL	56	2,80	0,18	5,27	3,58
4	lvrm	88	4,40	0,35	2,79	0,33
5	ktch	75	3,75	0,28	3,45	0,20
6	I	51	2,55	0,16	6,12	2,70
7	rm1	75	3,75	0,28	3,45	0,20
8	rm2	75	3,75	0,28	3,45	0,20
9	str	52	2,60	0,16	5,93	0,41
10	bath	70	3,50	0,26	3,80	0,25
11	wc	70	3,50	0,26	3,80	0,25
12	trs	55	2,75	0,18	5,42	4,00
13	rm5	74	3,70	0,28	3,51	0,16
14	rm4	71	3,55	0,26	3,72	0,66
15	rm3	71	3,55	0,26	3,72	0,66
16	str2	72	3,60	0,27	3,65	1,16
17	rm6	74	3,70	0,28	3,51	0,16
18	trs2	91	4,55	0,37	2,67	0,50
19	blc	87	4,35	0,35	2,83	1,00
20	blc2	87	4,35	0,35	2,83	1,00
	Min	51,00	2,55	0,16	2,23	0,16
	Mean	**74,00**	**3,70**	**0,28**	**3,76**	**1,00**
	Max	105,00	5,25	0,44	6,12	4,00

HI04.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	vr	85	4,47	0,38	2,59	0,33
1	crd	67	3,52	0,28	3,56	2,20
2	HL	53	2,78	0,19	5,02	3,58
3	lvrm	85	4,47	0,38	2,59	0,33
4	ktch	71	3,73	0,30	3,28	0,20
5	I	47	2,47	0,16	6,10	2,70
6	rm1	71	3,73	0,30	3,28	0,20
7	rm2	71	3,73	0,30	3,28	0,20
8	str	47	2,47	0,16	6,10	0,41
9	bath	65	3,42	0,26	3,71	0,25
10	wc	65	3,42	0,26	3,71	0,25
11	trs	49	2,57	0,17	5,70	4,00
12	rm5	67	3,52	0,28	3,56	0,16
13	rm4	64	3,36	0,26	3,80	0,66
14	rm3	64	3,36	0,26	3,80	0,66
15	str2	65	3,42	0,26	3,71	1,16
16	rm6	67	3,52	0,28	3,56	0,16
17	trs2	83	4,36	0,37	2,67	0,50
18	blc	79	4,15	0,35	2,85	1,00
19	blc2	79	4,15	0,35	2,85	1,00
	Min	47,00	2,47	0,16	2,59	0,16
	Mean	**67,20**	**3,53**	**0,28**	**3,79**	**1,00**
	Max	85,00	4,47	0,38	6,10	4,00

The examination of quantitative data shows that the order of integration remains the same when the exterior is not included. The most integrated spaces are: the intermediate space and the staircase with the same value (0.16), then the hall and the terrace with an equal value (0.18) despite the fact that they are situated at different depths in the graph. The corridor has a strong integration (0.24). The veranda is shallow from the exterior at depth one, it represents a strong segregation, but the most segregated space is the exterior with (0.44). The bathroom, the toilet, the rm1, and rm2are integrated spaces that have the same value (0.26), the living room, the kitchen and the balconies show a strong segregation in the house. The terrace shows a high value of control (4.00), and then the hall is the second controlled space in the house (3.58), followed by the intermediate space (2.70) and the corridor (1.70).

3.2.5. Analysis of the House HI05:

The graph is composed from the four topological spaces a-, b-, c-, and d-type: 50% of a-type, 11% of b-type, 36% of c-type, and 9% of d-type. The access to the house is done according to one node of the topological space d-type: the veranda, which provides flexibility in term of movement and low control, gives to the living room which is destined to the common useby inhabitants or visitors. And to the corridor the main central space for circulation and distribution, it distributes to the spaces of a-type space such as: the kitchen, the bathroom and the bedrooms (rm1, and rm2), they are arranged as dead-end spaces, and the staircase of b-type which takes to the terrace. The corridor offers a high degree of control on the house which provides a controlled access to the private zone.

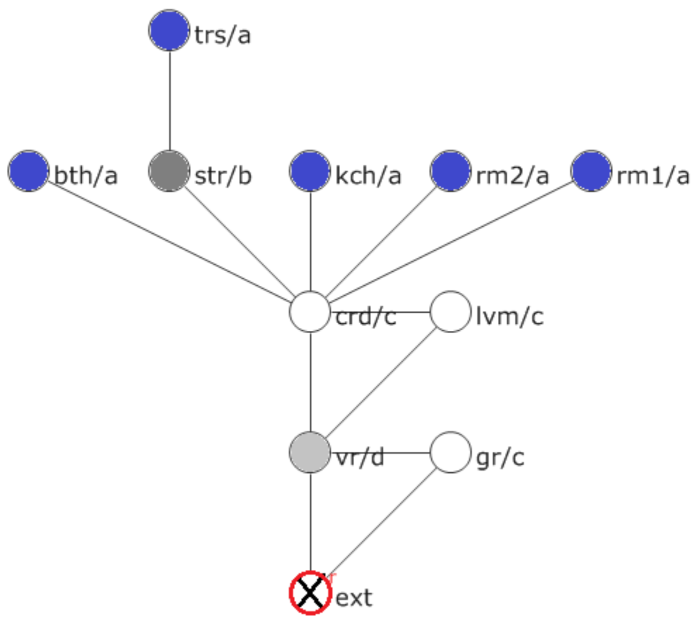


Figure -75: The justified graph of the house HI05

The corridor is considered as the most integrated space (0.06), and it provides a high control in the house, it plays an important role to control the access to the private zone; it contains the occupation and service spaces. The veranda has a strong integration with value (0.15), and a high value of control (1.65), it controls the access to the house and guides the movement of visitors and strangers.

The living room and the staircase have a low value of integration which means that they are integrated spaces with values (0.20), (0.22) respectively. Where the staircase is represents a high value of control (1.14). The garage has a strong integration and shares the same value with the exterior (0.33), thus materializing the non-permeability of the graph (HI05). The kitchen, the bedrooms (rm2, and rm1), and the bathroom are located at the same depth which means, they culminate with the same value (0.26) and show a low integration capacity, Whereas the terrace is considered as the most segregated space in the system.

Table 40: HI05.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	ext	25	2,50	0,33	3,00	0,75
1	vr	17	1,70	0,15	6,42	1,64
2	crd	13	1,30	0,06	15,00	5,25
3	gr	25	2,50	0,33	3,00	0,75
4	lvrm	19	1,90	0,20	5,00	0,39
5	ktch	22	2,20	0,26	3,75	0,14
6	rm2	22	2,20	0,26	3,75	0,14
7	str	20	2,00	0,22	4,50	1,14
8	bath	22	2,20	0,26	3,75	0,14
9	rm1	22	2,20	0,26	3,75	0,14
10	trs	29	2,90	0,42	2,36	0,50
	Min	13,00	1,30	0,06	2,36	0,14
	Mean	**21,45**	**2,14**	**0,25**	**4,93**	**1,00**
	Max	29,00	2,90	0,42	15,00	5,25

HI05.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	vr	16	1,77	0,19	5,14	1,64
1	crd	11	1,22	0,05	18,00	5,33
2	gr	24	2,66	0,41	2,40	0,33
3	lvrm	17	1,88	0,22	4,50	0,47
4	ktch	19	2,11	0,27	3,60	0,14
5	rm2	19	2,11	0,27	3,60	0,14
6	str	17	1,88	0,22	4,50	1,14
7	bath	19	2,11	0,27	3,60	0,14
8	rm1	19	2,11	0,27	3,60	0,14
9	trs	25	2,77	0,44	2,25	0,50
	Min	11,00	1,22	0,05	2,25	0,14
	Mean	**18,60**	**2,06**	**0,26**	**5,11**	**1,00**
	Max	25,00	2,77	0,44	18,00	5,33

3.2.6. Analysis of the House HI06:

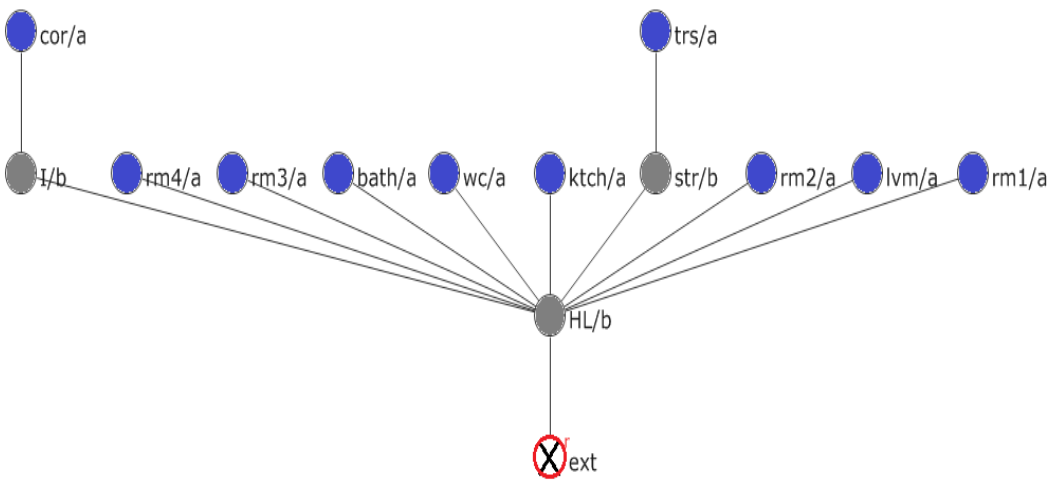


Figure -76: The justified graph of the house HI06

The graph represents an arborescent structure, it is in symmetric order. The non-distributedness manifested by the high number of a-type that represents 76% from all the cells, and 25% of b-type spaces. The hall is the point of penetration from b-type space, it allows direct access to all the bedrooms (rm1, rm2, rm3, rm4), the kitchen (ktch), the bathroom (bath), the toilet (wc), and the living room (lvrm), they are arranged as dead-end spaces, and indirectly through b-type space (staircase and intermediate space), to the terrace and courtyard.

The quantitative value of the configuration remains in the same order whether the exterior is included or not. As in most of the cases previously studied, this would tend to highlight the importance of the interface of relations between residents. The hall (HL) has the lowest degree of integration 0.02 which that it is the most integrated space in the system, followed by the staircase (str) and the intermediate space (I) with the same value 0.15. The courtyard (cor), and the terrace (trs) are the most segregated spaces with value 0.30. Whereas the rest of the spaces: the kitchen, the bathroom, the toilet, the living room, the bedrooms (rm1, rm2, rm3, and rm4) has a moderate degree of integration 0.17, they are situated at the same depth in the system. The hall has the highest degree of control 10.00, followed by the staircase and the intermediate space 1.09, in which the transition spaces control the circulation within the house and the access into the spaces.

Table 41: HI06.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	ext	27	2,07	0,17	5,57	0,09
1	HL	15	1,15	0,02	39,00	10,00
2	ktch	27	2,07	0,17	5,57	0,09
3	str	25	1,92	0,15	6,50	1,09
4	rm2	27	2,07	0,17	5,57	0,09
5	wc	27	2,07	0,17	5,57	0,09
6	bath	27	2,07	0,17	5,57	0,09
7	rm3	27	2,07	0,17	5,57	0,09
8	lvrm	27	2,07	0,17	5,57	0,09
9	rm4	27	2,07	0,17	5,57	0,09
10	rm1	27	2,07	0,17	5,57	0,09
11	I	25	1,92	0,15	6,50	1,09
12	cor	37	2,84	0,30	3,25	0,50
13	trs	37	2,84	0,30	3,25	0,50
	Min	15,00	1,15	0,02	3,25	0,09
	Mean	**27,28**	**2,09**	**0,18**	**7,76**	**1,00**
	Max	37,00	2,84	0,30	39,00	10,00

HI06.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	HL	14	1,16	0,03	33,00	9,00
1	ktch	25	2,08	0,19	5,07	0,10
2	str	23	1,91	0,16	6,00	1,10
3	rm2	25	2,08	0,19	5,07	0,10
4	wc	25	2,08	0,19	5,07	0,10
5	bath	25	2,08	0,19	5,07	0,10
6	rm3	25	2,08	0,19	5,07	0,10
7	lvrm	25	2,08	0,19	5,07	0,10
8	rm4	25	2,08	0,19	5,07	0,10
9	rm1	25	2,08	0,19	5,07	0,10
10	I	23	1,91	0,16	6,00	1,10
11	cor	34	2,83	0,33	3,00	0,50
12	trs	34	2,83	0,33	3,00	0,50
	Min	14,00	1,16	0,03	3,00	0,10
	Mean	**25,23**	**2,10**	**0,20**	**7,04**	**1,00**
	Max	34,00	2,83	0,33	33,00	9,00

3.2.7. Analysis of the House HI07:

The graph was constructed using the exterior as a root, it shows a tree-like and deep configuration. The graph is in asymmetric order and appears as a distributive structure. Penetration into the building takes place at three points: the corridor (crd) as well as the garage (gr1) which forms an outer ring, and the garage (gr2) arranged as dead-end space at depth one. These two access points are characterized by spatial flexibility while circumscribing the movements in a well determined circuit. The corridor (cor) of d-type space is part of two rings, which offers a choice of circulation within the house, this inner ring formed by three topological spaces of d-type space as the corridor (crd), the living room (lvrm), and the corridor (crd2). Each of the living room (lvrm), the corridor (crd2), the kitchen (ktch), and the veranda (vr) are of d-type spaces, they are connected with each other forming two inner rings. The bathroom (bath1) arranged as dead-end space at depth two. The bathroom (bath2) and bedroom (rm1) situated at depth three of a-type space arranged as dead-end spaces.

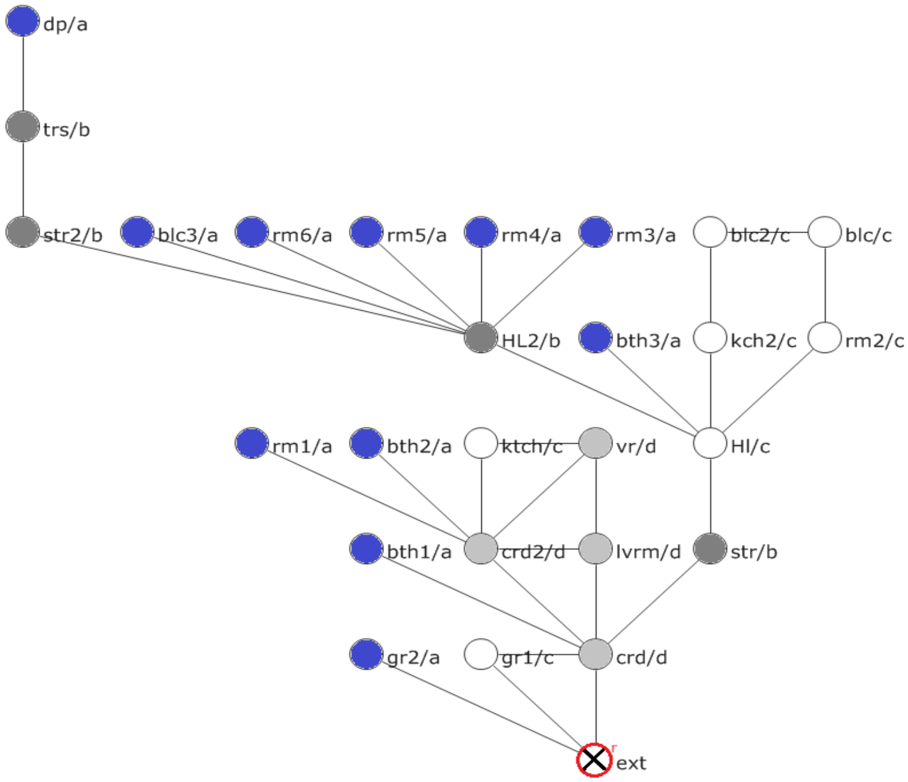


Figure -77: The justified graph of the house HI07

The staircase (str) arranged at depth two distributes directly to a hall (HL)of c-type space at depth three it is a part of an inner ring, formed by kitchen (ktch2), bedroom (rm2), balcony (blc1, and balc2) which suggests a choice of movement. And it distributes to the bathroom (bath2) which is arranged as dead-end space, and to the staircase (str) of b-type space that takes directly to the terrace (trs) and deposit (dp), both situated at last depth in the graph. The second Hall (HL2) of b-type space distributes to most of the bedrooms (rm2, rm3, rm4, rm5) and the balcony (blc3).

The quantitative results show that the data becomes segregated when the exterior is included. The value of integration of the exterior is lower (0.21) than some spaces in the house, and with the existence of an outer ring, the configuration places as much emphasis on the relationships between visitors and residents as those between residents. The Hall (HL) and the staircase (str) have the lowest degree of integration 0.12 whereas they are considered as the most integrated spaces in the system, followed by the hall (HL2) and the corridor (crd), the kitchen (ktch2) and room (rm2) have the same value of integration 0.18, the corridor (crd2) and bathroom (bath3) have the same value 0.19. The most segregated spaces are the deposit, the terrace and the garage (gr2) with value (0.36, 0.28 respectively). The rest of the spaces have moderate value of integration distributed in different levels in the graph. The hall (HL2) is the most controlled space with value 5.70, followed by the corridor (crd) 2.83, then the hall (HL) 2.64.

Table 42: HI07.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	ext	95	3,65	0,21	4,71	1,66
1	crd	73	2,80	0,14	6,91	2,83
2	grl	96	3,69	0,21	4,64	0,50
3	gr2	120	4,61	0,28	3,45	0,33
4	lvrm	92	3,53	0,20	4,92	0,66
5	str	68	2,61	0,12	7,73	0,36
6	crd2	89	3,42	0,19	5,15	3,33
7	bath1	98	3,76	0,22	4,51	0,16
8	vr	112	4,30	0,26	3,77	1,00
9	ktch	113	4,34	0,26	3,73	0,50
10	bath2	114	4,38	0,27	3,69	0,16
11	rm1	114	4,38	0,27	3,69	0,16
12	Hl	65	2,50	0,12	8,33	2,64
13	ktch2	87	3,34	0,18	5,32	0,70
14	rm2	87	3,34	0,18	5,32	0,70
15	bath3	90	3,46	0,19	5,07	0,20
16	blc2	109	4,19	0,25	3,91	1,00
17	blc	109	4,19	0,25	3,91	1,00
18	HL2	74	2,84	0,14	6,77	5,70
19	rm4	99	3,80	0,22	4,45	0,14
20	rm3	99	3,80	0,22	4,45	0,14
21	rm5	99	3,80	0,22	4,45	0,14
22	rm6	99	3,80	0,22	4,45	0,14
23	blc3	99	3,80	0,22	4,45	0,14
24	str2	95	3,65	0,21	4,71	0,64
25	trs	118	4,53	0,28	3,53	1,50
26	dp	143	5,50	0,36	2,77	0,50
	Min	65,00	2,50	0,12	2,77	0,14
	Mean	**98,37**	**3,78**	**0,22**	**4,77**	**1,00**
	Max	143,00	5,50	0,36	8,33	5,70

HI07.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	crd	96	3,84	0,23	4,22	3,00
1	grl	119	4,76	0,31	3,19	0,20
2	gr2	650	26,00	2,08	0,48	0,00
3	lvrm	113	4,52	0,29	3,40	0,70
4	str	89	3,56	0,21	4,68	0,40
5	crd2	110	4,40	0,28	3,52	3,36
6	bath1	119	4,76	0,31	3,19	0,20
7	vr	131	5,24	0,35	2,83	1,00
8	ktch	132	5,28	0,35	2,80	0,50
9	bath2	133	5,32	0,36	2,77	0,16
10	rm1	133	5,32	0,36	2,77	0,16
11	Hl	84	3,36	0,19	5,08	2,64
12	ktch2	104	4,16	0,26	3,79	0,70
13	rm2	104	4,16	0,26	3,79	0,70
14	bath3	107	4,28	0,27	3,65	0,20
15	blc2	124	4,96	0,33	3,03	1,00
16	blc	124	4,96	0,33	3,03	1,00
17	HL2	91	3,64	0,22	4,54	5,70
18	rm4	114	4,56	0,29	3,37	0,14
19	rm3	114	4,56	0,29	3,37	0,14
20	rm5	114	4,56	0,29	3,37	0,14
21	rm6	114	4,56	0,29	3,37	0,14
22	blc3	114	4,56	0,29	3,37	0,14
23	str2	110	4,40	0,28	3,52	0,64
24	trs	131	5,24	0,35	2,83	1,50
25	dp	154	6,16	0,43	2,32	0,50
	Min	84,00	3,36	0,19	0,48	0,00
	Mean	**135,69**	**5,42**	**0,36**	**3,32**	**0,96**
	Max	650,00	26,00	2,08	5,08	5,70

3.2.8. Analysis of the House HI08:

The graph represents an arborescent structure, it is in symmetric order. The topological space of a-type represents 38%, the b-type 5%, the c-type 45%, the d-type 9%, in which the configuration represents a distributedness structure manifested by the existence of inner and outer rings. The penetration into the house is by two points of c-type space; the veranda (vr) and the garage (gr). The veranda (vr) of d-type is apart from the inner ring that is formed by: the corridor (crd), the staircase (str), the corridor (crd2), and the kitchen (ktch). These spaces of transition provide more spatial flexibility and suggest choice of movement around the house and offer less control.

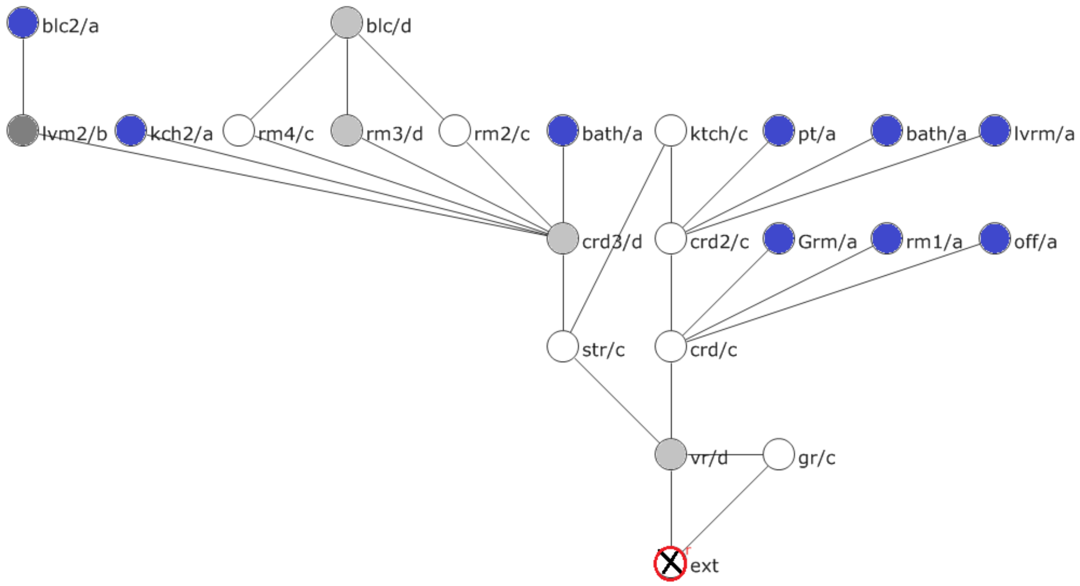


Figure -78: The justified graph of the house HI08

The corridor (crd) at depth two distributes to the guest room (grm), bedroom (rm1), and office (off). The corridor (crd2) at depth three distributes to the living room (lvrm), the bathroom (bath), and patio (pt), they are arranged as dead-end spaces. The corridor (crd3) of d-type spaceis part from two inner rings the first one formed by: the corridor (crd3), the bedrooms (rm2, rm3), and balcony (blc). The second ring includes the corridor (crd3), balcony (blc), and the bedrooms (rm3, rm4). In addition, it distributes to the kitchen (ktch2) and living room (lvrm) that has an access to the balcony (blc2).

The data shows that the calculations remain similar whether or not the exterior is included. The staircase (str) is the most integrated space 0.12, followed by the veranda (vr) and the corridor (crd3) with the same value 0.14, the corridor (crd) and kitchen 0.16, then the corridor (crd2) 0.17. the exterior (ex), the kitchen (ktch2), the living room (lvrm2), the bedrooms (rm2, rm3, rm4), the bathroom (bath), and the garage; these spaces despite their difference in depth they have similar value of integration (0.22, 0.23). The balconies show the highest value of integration 0.32 which make them the most segregated spaces. The guest room (grm), the office (off), the bedroom (rm1), the patio, the bathroom (bath), and the living room (lvrm) has a moderate value of integration they tend to be segregated, even though they are destined to receive visitors and strangers like the guestroom. The corridor (crd3) is the most controlled space, followed by the corridor (crd2) and corridor (crd3).

Table 43: HI08.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	ext	70	3,33	0,23	4,28	0,75
1	vr	51	2,42	0,14	7,00	1,53
2	gr	70	3,33	0,23	4,28	0,75
3	crd	56	2,66	0,16	6,00	3,45
4	str	47	2,23	0,12	8,07	0,89
5	crd2	58	2,76	0,17	5,67	3,70
6	Grm	76	3,61	0,26	3,81	0,20
7	rml	76	3,61	0,26	3,81	0,20
8	off	76	3,61	0,26	3,81	0,20
9	ktch	55	2,61	0,16	6,17	0,53
10	pt	78	3,71	0,27	3,68	0,20
11	bath	78	3,71	0,27	3,68	0,20
12	lvrm	78	3,71	0,27	3,68	0,20
13	crd3	51	2,42	0,14	7,00	4,33
14	bath	71	3,38	0,23	4,20	0,14
15	rm2	69	3,28	0,22	4,37	0,47
16	rm3	69	3,28	0,22	4,37	0,47
17	rm4	69	3,28	0,22	4,37	0,47
18	ktc2	71	3,38	0,23	4,20	0,14
19	lvm2	69	3,28	0,22	4,37	1,14
20	blc	85	4,04	0,30	3,28	1,50
21	blc2	89	4,23	0,32	3,08	0,50
	Min	47,00	2,23	0,12	3,08	0,14
	Mean	**68,72**	**3,27**	**0,22**	**4,69**	**1,00**
	Max	89,00	4,23	0,32	8,07	4,33

HI08.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	vr	50	2,50	0,15	6,33	1,53
1	gr	69	3,45	0,25	3,87	0,33
2	crd	54	2,70	0,17	5,58	3,53
3	str	45	2,25	0,13	7,60	0,97
4	crd2	55	2,75	0,18	5,42	3,70
5	Grm	73	3,65	0,27	3,58	0,20
6	rml	73	3,65	0,27	3,58	0,20
7	off	73	3,65	0,27	3,58	0,20
8	ktch	52	2,60	0,16	5,93	0,53
9	pt	74	3,70	0,28	3,51	0,20
10	bath	74	3,70	0,28	3,51	0,20
11	lvrm	74	3,70	0,28	3,51	0,20
12	crd3	48	2,40	0,14	6,78	4,33
13	bath	67	3,35	0,24	4,04	0,14
14	rm2	65	3,25	0,23	4,22	0,47
15	rm3	65	3,25	0,23	4,22	0,47
16	rm4	65	3,25	0,23	4,22	0,47
17	ktc2	67	3,35	0,24	4,04	0,14
18	lvm2	65	3,25	0,23	4,22	1,14
19	blc	80	4,00	0,31	3,16	1,50
20	blc2	84	4,20	0,33	2,96	0,50
	Min	45,00	2,25	0,13	2,96	0,14
	Mean	**65,33**	**3,26**	**0,23**	**4,47**	**0,99**
	Max	84,00	4,20	0,33	7,60	4,33

3.2.9. Analysis of the House HI09:

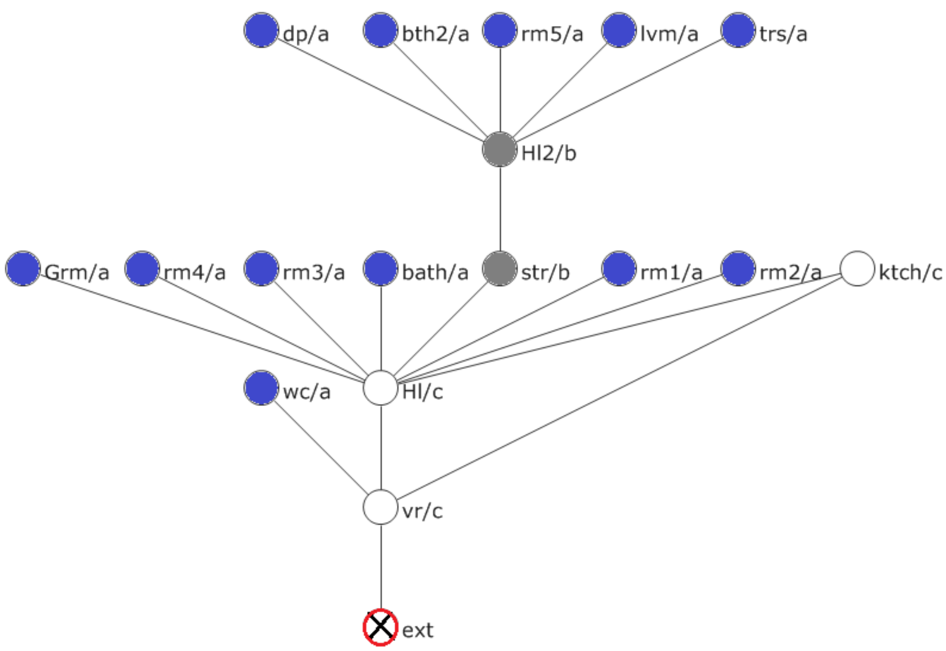


Figure -79: The justified graph of the house HI09

The configuration has a tree-like structure; it is in symmetric order and shows a non-distributedness in general, whereas the topological space of a-type represents 70%, b-type

12%, and c-type 16%. The structure has 18 nodes and 18 links. The penetration into the house from c-type space the verandah (vr) which is part from the inner ring that is formed by: the hall (HL), and the kitchen (ktch), which offers flexibility of movement within the house. The veranda (vr) takes to the toilet (wc) that is situated at depth two and arranged as dead-end space.The hall is the pivot of movement and has some control within the house whereas it connects all the intimate spaces, which distribute directly to the bedrooms (rm1, rm2, rm3, and rm4), the guest room (grm) that is destined to receive strangers and visitors, the bathroom (bath), the kitchen (ktch), and the staircase (str). The secondary hall (HL2) at depth four distributes to the most private area that includes each of bedroom (rm5), the living room (lvrm) which is used to family gathering, the terrace (trs), the bathroom (bath2), and deposit (dp) which are situated at last depth and arranged as dead-end space.

Table 44: HI09.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	ext	57	3,35	0,29	3,40	0,25
1	vr	41	2,41	0,17	5,66	2,61
2	Hl	30	1,76	0,09	10,46	7,25
3	bath	46	2,70	0,21	4,68	0,11
4	str	34	2,00	0,12	8,00	0,27
5	rm1	46	2,70	0,21	4,68	0,11
6	rm3	46	2,70	0,21	4,68	0,11
7	rm4	46	2,70	0,21	4,68	0,11
8	Grm	46	2,70	0,21	4,68	0,11
9	rm2	46	2,70	0,21	4,68	0,11
10	ktch	43	2,52	0,19	5,23	0,36
11	wc	57	3,35	0,29	3,40	0,25
12	Hl2	40	2,35	0,16	5,91	5,50
13	rm5	56	3,29	0,28	3,48	0,16
14	lvrm	56	3,29	0,28	3,48	0,16
15	trs	56	3,29	0,28	3,48	0,16
16	bath2	56	3,29	0,28	3,48	0,16
17	dp	56	3,29	0,28	3,48	0,16
	Min	30,00	1,76	0,09	3,40	0,11
	Mean	**47,66**	**2,80**	**0,22**	**4,86**	**1,00**
	Max	57,00	3,35	0,29	10,46	7,25

HI09.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	vr	40	2,50	0,20	5,00	1,61
1	Hl	28	1,75	0,10	10,00	7,33
2	bath	43	2,68	0,22	4,44	0,11
3	str	31	1,93	0,12	8,00	0,27
4	rm1	43	2,68	0,22	4,44	0,11
5	rm3	43	2,68	0,22	4,44	0,11
6	rm4	43	2,68	0,22	4,44	0,11
7	Grm	43	2,68	0,22	4,44	0,11
8	rm2	43	2,68	0,22	4,44	0,11
9	ktch	41	2,56	0,20	4,80	0,44
10	wc	55	3,43	0,32	3,07	0,33
11	Hl2	36	2,25	0,16	6,00	5,50
12	rm5	51	3,18	0,29	3,42	0,16
13	lvrm	51	3,18	0,29	3,42	0,16
14	trs	51	3,18	0,29	3,42	0,16
15	bath2	51	3,18	0,29	3,42	0,16
16	dp	51	3,18	0,29	3,42	0,16
	Min	28,00	1,75	0,10	3,07	0,11
	Mean	**43,76**	**2,73**	**0,23**	**4,74**	**1,00**
	Max	55,00	3,43	0,32	10,00	7,33

The data remain at the same order of integration whether or not the exterior is included. The hall (Hl) is the most integrated space with value 0.09, followed by the staircase (str) 0.12, the second hall (Hl2) 0.16, then the veranda (vr) 0.17. The most segregated spaces are the most private spaces: the bedroom (rm5), the living room, the terrace, the bathroom (bath2), the deposit with value 0.28. Each of the bedroom (rm1, rm2, rm3, and rm4), the guest room, the bathroom, and the staircase has the same value of integration 0.21 whereas the kitchen, which is part of the inner ring, is integrated with value 0.19.

3.2.10. Analysis of the House HI10:

The configuration was constructed using the exterior as a root, it shows a tree-like structure and an arborescent structure with two brunches, the graph is in symmetric order. The configuration is continued only of a-type and b-type spaces; the a-type represents 72% and b-type 29% which make it a non-distributedness system. The penetration into the house is by a row of b-type spaces; the veranda (vr) and the corridor (crd). The veranda takes directly to the ablutions spaces: the bathroom (bath), and the toilet (wc).

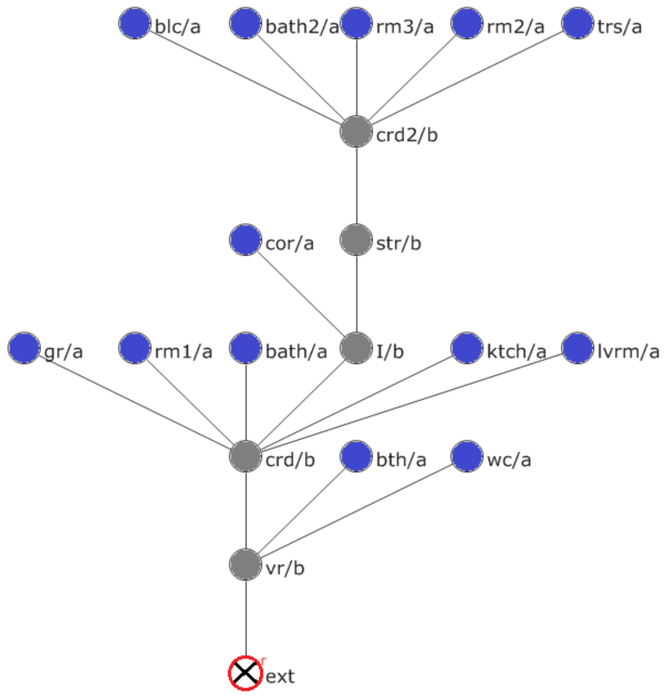


Figure -80: The justified graph of the house HI10

The corridor (crd) which offers high potential for movement control, it distributes directly to the occupation spaces: the kitchen (kthc), the living room (lvrm), the bathroom (bath), the room (rm1), the garage (gr), they are of a-type spaces situated at depth three. And to the intermediate space (I) of b-type space that takes to the rest of spaces: the courtyard (cor) arranged as dead-end space, and the staircase (str) that takes indirectly through the corridor (crd2) of b-type space to the most private spaces: the bedrooms (rm2, rm3), the terrace (trs), the bathroom (bath2), and the balcony (blc), which is arranged as dead-end spaces at last depth in the graph, whereas the corridor (crd2) is the pivot of circulation and controls the access into the spaces.

The quantitative calculations are in the same order of integration when the exterior is included or not. The absence of variations in the data reinforces the relationships between residents. The corridor (crd) is the most integrated space 0.14, followed by the intermediate space (I) 0.15, then the staircase (str) 0.18. The transition spaces play an important role in the distribution and guide the sequence of circulation within the house. The ablutions space: the bathroom and the toilet that are situated at depth two, are also shallow from the exterior, they have a high value of integration 0.32 that means that they are segregated. The kitchen (ktch), the living room (lvrm), the room (rm), the bathroom (bath1), and the garage (gr); have the same moderate value of integration 0.25, whereas the second corridor (crd2) has a value 0.22, and the courtyard (cor) 0.26. The most segregated spaces are the bedrooms (rm2, rm3), the terrace (trs), the bathroom (bath2), the balcony (blc) have the same value 0.33. In which the exterior is segregated with the value 0.32. The space that has the highest value of control is the corridor (crd) 0.58, then the Second corridor (crd2) 5.50, followed by the veranda (vr) 3.14 and the intermediate space (I) 1.64.

Table 45: HI10.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	ext	68	3,77	0,32	3,06	0,25
1	vr	51	2,83	0,21	4,63	3,14
2	crd	40	2,22	0,14	6,95	5,58
3	bath	68	3,77	0,32	3,06	0,25
4	wc	68	3,77	0,32	3,06	0,25
5	bath	57	3,16	0,25	3,92	0,14
6	ktch	57	3,16	0,25	3,92	0,14
7	rm1	57	3,16	0,25	3,92	0,14
8	gr	57	3,16	0,25	3,92	0,14
9	lvrm	57	3,16	0,25	3,92	0,14
10	str	46	2,55	0,18	5,46	0,50
11	crd2	53	2,94	0,22	4,37	5,50
12	rm3	70	3,88	0,33	2,94	0,16
13	rm2	70	3,88	0,33	2,94	0,16
14	trs	70	3,88	0,33	2,94	0,16
15	bath2	70	3,88	0,33	2,94	0,16
16	blc	70	3,88	0,33	2,94	0,16
17	I	41	2,27	0,15	6,65	1,64
18	cor	58	3,22	0,26	3,82	0,33
	Min	40,00	2,22	0,14	2,94	0,14
	Mean	**59,36**	**3,29**	**0,27**	**3,96**	**1,00**
	Max	70,00	3,88	0,33	6,95	5,58

HI10.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	vr	50	2,94	0,24	4,12	2,14
1	crd	38	2,23	0,15	6,47	5,66
2	bath	66	3,88	0,36	2,77	0,33
3	wc	66	3,88	0,36	2,77	0,33
4	bath	54	3,17	0,27	3,67	0,14
5	ktch	54	3,17	0,27	3,67	0,14
6	rm1	54	3,17	0,27	3,67	0,14
7	gr	54	3,17	0,27	3,67	0,14
8	lvrm	54	3,17	0,27	3,67	0,14
9	str	42	2,47	0,18	5,44	0,50
10	crd2	48	2,82	0,22	4,38	5,50
11	rm3	64	3,76	0,34	2,89	0,16
12	rm2	64	3,76	0,34	2,89	0,16
13	trs	64	3,76	0,34	2,89	0,16
14	bath2	64	3,76	0,34	2,89	0,16
15	blc	64	3,76	0,34	2,89	0,16
16	I	38	2,23	0,15	6,47	1,64
17	cor	54	3,17	0,27	3,67	0,33
	Min	38,00	2,23	0,15	2,77	0,14
	Mean	**55,11**	**3,24**	**0,28**	**3,83**	**1,00**
	Max	66,00	3,88	0,36	6,47	5,66

3.2.11. Analysis of the House HI11:

The graph represents an arborescent structure; it is deep from the exterior. The configuration shows a lack of distributedness, which has three types of topological spaces: a-type 59%, the b-type space 4%, and c-type 30%, with the existence of two inner rings. The penetration into the house by row of c-type spaces formed an inner ring: the veranda (vr), the corridor (crd), the hall (HL) and the courtyard (cor), which offers a flexibility of movement and choice of mobility around the house. The veranda has an access to the toilet (wc1) and a deposit (dp); they are shallow from the exterior and arranged as dead-end spaces. And the corridor (crd) that takes to a bedroom (rm1) and to the hall (Hl) which distributes to the occupation spaces in the house: the living room (lvrm), the kitchen (ktch), the bedroom (rm1, rm2), the bathroom (bath), the toilet (wc2), and to the courtyard (cor). Whereas the living room is used for family gathering and for receive visitors and guests.

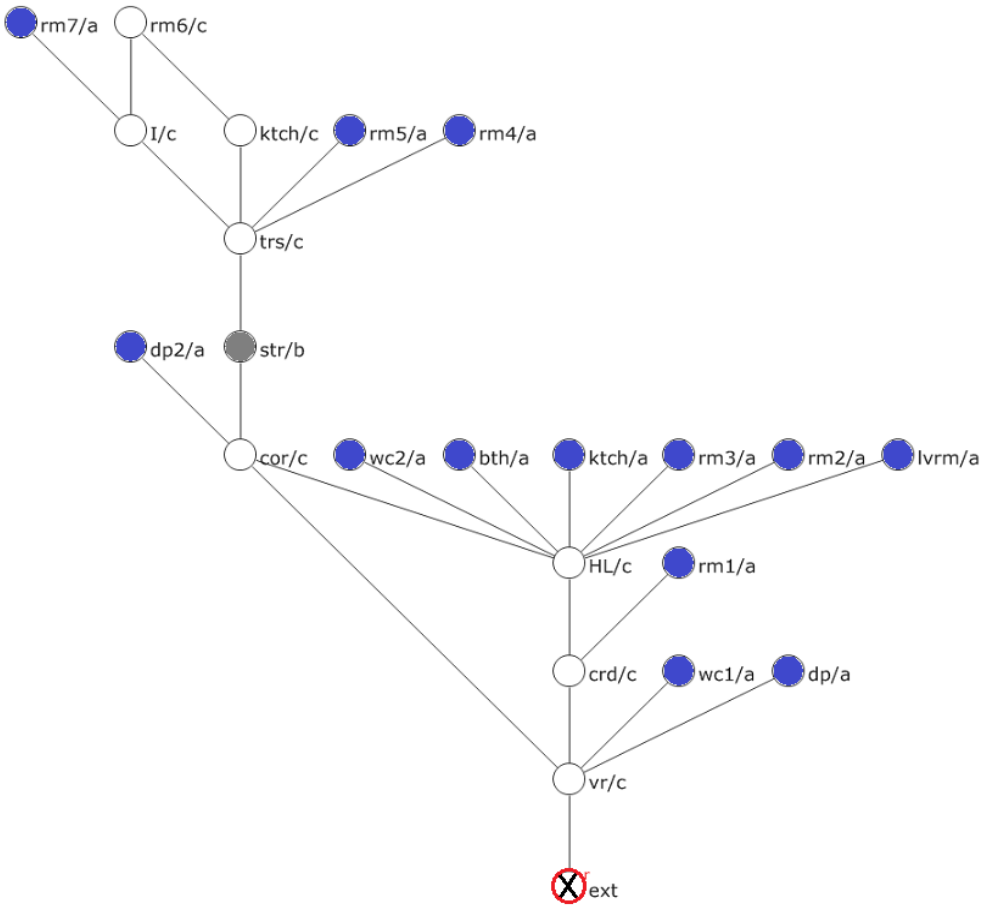


Figure -81: The justified graph of the house HI11

The courtyard (cor) takes indirectly to the rest of spaces which is considered as the most private. The staircase of c-type space, the transition space that takes to terrace that has an access to the bedrooms (rm4, rm5), and the second kitchen (ktch2). The bedroom (rm7) has an access through the intermediate space (I). The terrace, the kitchen, the bedroom (rm6) and the intermediate space are opened on each other, which formed an inner ring that offers a choice of circulation, where the bedrooms are suitable for the inhabitants.

The quantitative data remains similar, whether the exterior is taken into account or not. The courtyard (cor) 0.11, the hall (HL) 0.13, the staircase (str) 0.14, the veranda (vr) 0.16, and the corridor (crd) 0.18; are the most integrated spaces in the house. The bedroom (rm1) is shallow from the exterior situated at depth three; it has the same value of integration 0.27 with the bedrooms (rm4, rm5) that are situated at depth seven in the graph and that means that these three bedrooms tend to privacy. Each of the bedrooms (rm2, rm3), the kitchen (ktch), the living room (lvrm), the bathroom (bath), and the toilet (wc2) have the same moderate value ofintegration 0.22., whereas the most integrated spaces are the bedroom6 and bedroom7 with values 0.34 and 0.35 respectively. The Hall is the most controlled space 6.58, followed by the veranda 3.58, the terrace 3.33, and the courtyard 1.82.

Table 46: HI11.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	ext	81	3,68	0,25	3,91	0,20
1	vr	60	2,72	0,16	6,07	3,58
2	crd	65	2,95	0,18	5,37	1,32
3	HL	54	2,45	0,13	7,21	6,58
4	ktch	75	3,40	0,22	4,35	0,12
5	bath	75	3,40	0,22	4,35	0,12
6	rm3	75	3,40	0,22	4,35	0,12
7	rm2	75	3,40	0,22	4,35	0,12
8	wc2	75	3,40	0,22	4,35	0,12
9	lvrm	75	3,40	0,22	4,35	0,12
10	cor	49	2,22	0,11	8,55	1,82
11	str	56	2,54	0,14	6,79	0,45
12	dp2	70	3,18	0,20	4,81	0,25
13	rm1	86	3,90	0,27	3,60	0,33
14	wc1	81	3,68	0,25	3,91	0,20
15	dp	81	3,68	0,25	3,91	0,20
16	trs	65	2,95	0,18	5,37	3,33
17	ktch	84	3,81	0,26	3,72	0,70
18	rm5	86	3,90	0,27	3,60	0,20
19	I	82	3,72	0,25	3,85	1,70
20	rm4	86	3,90	0,27	3,60	0,20
21	rm6	101	4,59	0,34	2,92	0,83
22	rm7	103	4,68	0,35	2,85	0,33
	Min	49,00	2,22	0,11	2,85	0,12
	Mean	**75,65**	**3,43**	**0,23**	**4,62**	**1,00**
	Max	103,00	4,68	0,35	8,55	6,58

HI11.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	vr	59	2,80	0,18	5,52	2,58
1	crd	63	3,00	0,20	5,00	1,37
2	HL	51	2,42	0,14	7,00	6,58
3	ktch	71	3,38	0,23	4,20	0,12
4	bath	71	3,38	0,23	4,20	0,12
5	rm3	71	3,38	0,23	4,20	0,12
6	rm2	71	3,38	0,23	4,20	0,12
7	wc2	71	3,38	0,23	4,20	0,12
8	lvrm	71	3,38	0,23	4,20	0,12
9	cor	47	2,23	0,12	8,07	1,87
10	str	53	2,52	0,15	6,56	0,45
11	dp2	67	3,19	0,21	4,56	0,25
12	rm1	83	3,95	0,29	3,38	0,33
13	wc1	79	3,76	0,27	3,62	0,25
14	dp	79	3,76	0,27	3,62	0,25
15	trs	61	2,90	0,19	5,25	3,33
16	ktch	79	3,76	0,27	3,62	0,70
17	rm5	81	3,85	0,28	3,50	0,20
18	I	77	3,66	0,26	3,75	1,70
19	rm4	81	3,85	0,28	3,50	0,20
20	rm6	95	4,52	0,35	2,83	0,83
21	rm7	97	4,61	0,36	2,76	0,33
	Min	47,00	2,23	0,12	2,76	0,12
	Mean	**71,72**	**3,41**	**0,24**	**4,44**	**1,00**
	Max	97,00	4,61	0,36	8,07	6,58

3.2.12. Analysis of the House HI12:

The graph was constructed using the exterior as a root. The spatial configuration of the house HI12 is both linear and symmetrical; it features an arborescent structure with two brunches. The graph shows a non-distributedness in general despite the existence of two inner rings. The non-distributedness is manifested in the high number of the topological spaces of a- andb-types; a-type: 57%, b-type: 22%. In which the topological space of c- and d-types have an equal number: 10% of the total numbers. The penetration into the house from the topological space d-type, the veranda (vr) which is a part from an inner ring that is formed by the corridor (crd) ,the guestroom (Grm), and the hall (Hl); that offer a choice of circulation into the house. The guest room has an access to the veranda, the hall, and the corridor, it is the space where the inhabitants receive the visitors and the strangers, it is situated at depth two and it is shallow from the exterior.

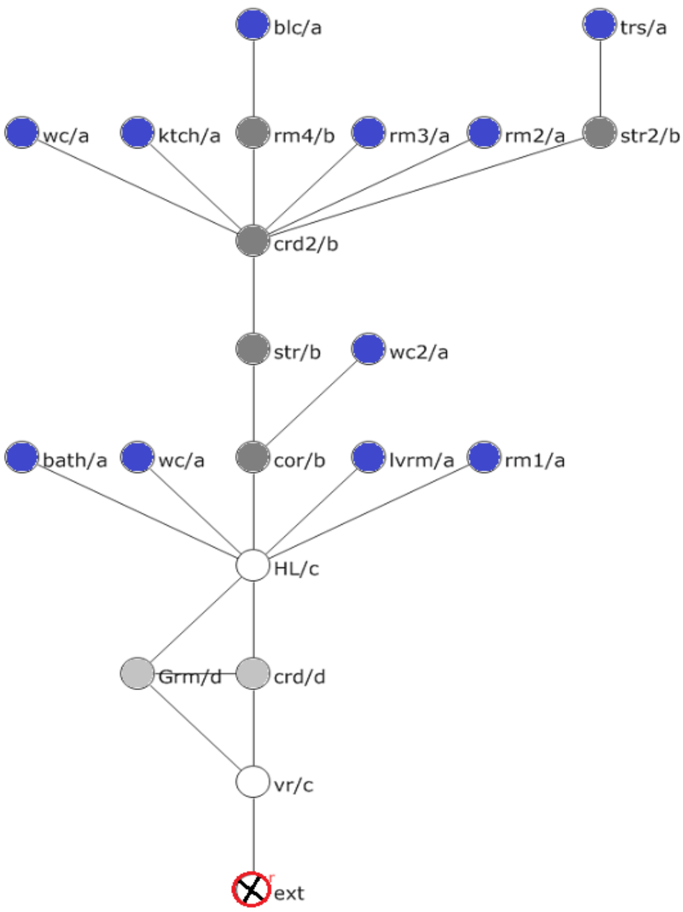


Figure -82: The justified graph of the house HI12

The kitchen situated at depth three as dead-end space. The hall (Hl) is a c-type space, considered as the pivot of the movement, it distributes to the most spaces such as; bedrooms (rm1, rm2), the guest room, the bathroom, the toilet which are from a-type space and the courtyard of b-type space. The second space of b-type the staircase (str) which takes to the intermediate space that controls the access into the spaces in the first floor: the bedrooms (rm3, rm4, rm5), the kitchen (ktch2) and the toilet, which are spaces of a-type arranged as dead-end spaces in the last depth in the graph. The deepest spaces in the graph are considered as the most private spaces.

Whether or not the exterior is included, the quantitative data remains the same. With the high integration value of the exterior (0.43), which leads us to assume that the spatial configuration of house HI12 emphasis on the relationships between visitors and residents as those between residents.

The hall (Hl) and the courtyard (cor) have the lowest value of integration (0.18) even though, they the most integrated spaces in the house. The staircase has the second lowest value (0.20), followed by the intermediate space (I) (0.23), the corridor (0.24), and the guest room (0.25). Despite the fact that they have different depths, they are considered as integrated spaces in the house.

Table 47: HI12.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	0	94	4,94	0,43	2,28	0,33
1	vr	76	4,00	0,33	3,00	1,58
2	Grm	62	3,26	0,25	3,97	0,72
3	crd	61	3,21	0,24	4,07	1,80
4	Hl	50	2,63	0,18	5,51	4,91
5	ktch	79	4,15	0,35	2,85	0,25
6	bath	68	3,57	0,28	3,48	0,14
7	rm2	68	3,57	0,28	3,48	0,14
8	wc	68	3,57	0,28	3,48	0,14
9	cor	50	2,63	0,18	5,51	1,64
10	rm1	68	3,57	0,28	3,48	0,14
11	str	54	2,84	0,20	4,88	0,83
12	wc2	68	3,57	0,28	3,48	0,33
13	I	60	3,15	0,23	4,17	0,66
14	crd2	68	3,57	0,28	3,48	5,50
15	rm5	86	4,52	0,39	2,55	0,16
16	rm4	86	4,52	0,39	2,55	0,16
17	rm3	86	4,52	0,39	2,55	0,16
18	ktch	86	4,52	0,39	2,55	0,16
19	wc3	86	4,52	0,39	2,55	0,16
	Min	50,00	2,63	0,18	2,28	0,14
	Mean	**71,20**	**3,74**	**0,30**	**3,49**	**1,00**
	Max	94,00	4,94	0,43	5,51	5,50

HI12.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	vr	75	4,16	0,37	2,68	0,58
1	Grm	60	3,33	0,27	3,64	0,89
2	crd	59	3,27	0,26	3,73	1,97
3	Hl	47	2,61	0,18	5,27	4,91
4	ktch	76	4,22	0,37	2,63	0,25
5	bath	64	3,55	0,30	3,32	0,14
6	rm2	64	3,55	0,30	3,32	0,14
7	wc	64	3,55	0,30	3,32	0,14
8	cor	46	2,55	0,18	5,46	1,64
9	rm1	64	3,55	0,30	3,32	0,14
10	str	49	2,72	0,20	4,93	0,83
11	wc2	63	3,50	0,29	3,40	0,33
12	I	54	3,00	0,23	4,25	0,66
13	crd2	61	3,38	0,28	3,55	5,50
14	rm5	78	4,33	0,39	2,55	0,16
15	rm4	78	4,33	0,39	2,55	0,16
16	rm3	78	4,33	0,39	2,55	0,16
17	ktch	78	4,33	0,39	2,55	0,16
18	wc3	78	4,33	0,39	2,55	0,16
	Min	46,00	2,55	0,18	2,55	0,14
	Mean	**65,05**	**3,61**	**0,30**	**3,45**	**1,00**
	Max	78,00	4,33	0,39	5,46	5,50

The bedrooms (rm1, rm2), the bathroom (bath), the toilets (wc, wc2), and the corridor (crd2) have the same value (0.28) even though, they are situated at different depths. The most segregated spaces are the veranda (0.33) followed by the kitchen (0.35) and they are situated at depth two and three in the graph, respectively. The bedrooms (rm3, rm4, rm5), the kitchen (ktch2), the toilet (wc3) have a high value of integration (0.39) where they are segregated from the exterior.

In term of control of value; the corridor (crd2) has the highest value of control (5.50), and the hall with a value of (4.91).

3.2.13. Analysis of the House HI13:

The graph of the house (HI13) represents a tree-like configuration, in symmetric order in general and non-distributedness system. Indeed, it does not present any node of topological type "c" or "d" and therefore no ring. However, there is an important number of a-type space 60%, and b-type space 44%. The penetration into the house by the topological space of b-type the hall which provides a strong control within the house, it is the pivot of the movement and it distributes to: the bathroom, the toilet, the living room, which are of a-type space, and to the kitchen of b-type space which has an access to the bedrooms (rm1, and rm2). And also, to the staircase of b-type which takes to the terrace that has an access to a bedroom (rm3) that is arranged as dead-end space in the graph. It is notable that the bedrooms are situated at the last depth in the graph, which indicates that these spaces are more suitable for occupation where there is no through movement, while circulation is for b-type space (the transition spaces).

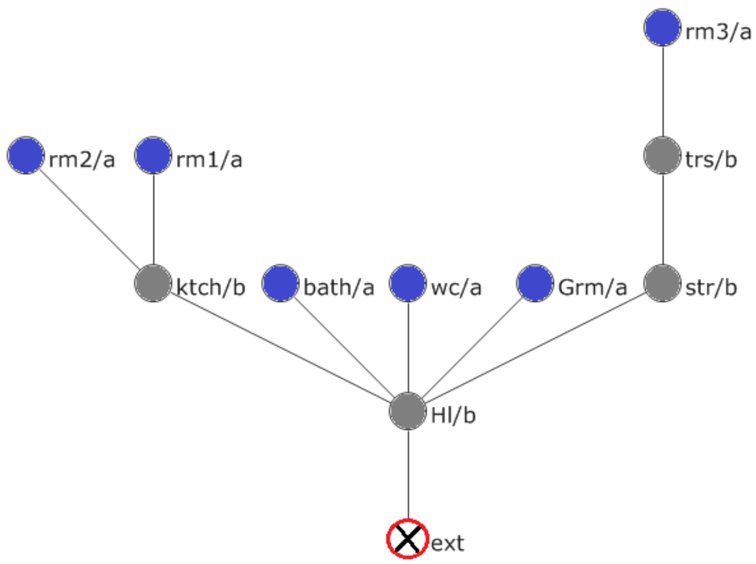


Figure -83: The justified graph of the house HI13

The quantitative data shows that the order of integration of the spaces remains similar when the exterior is included or not. The hall is the most integrated space in the house with low value of integration (0.11), followed by the kitchen and the staircase with the same value (0.22). The exterior, the bathroom, the toilet, and the living room, have a moderate value 0.31. The most segregated spaces are: the terrace (0.37), the bedrooms (0.42), and the bedroom3 (0.57) that is situated at last depth. The hall (Hl) has the highest value of control (4.83).

Table 48: HI13.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	0	24	2,40	0,31	3,21	0,16
1	Hl	15	1,50	0,11	9,00	4,83
2	ktch	20	2,00	0,22	4,50	2,16
3	bath	24	2,40	0,31	3,21	0,16
4	wc	24	2,40	0,31	3,21	0,16
5	lvrm	24	2,40	0,31	3,21	0,16
6	str	20	2,00	0,22	4,50	0,66
7	rm2	29	2,90	0,42	2,36	0,33
8	rm1	29	2,90	0,42	2,36	0,33
9	trs	27	2,70	0,37	2,64	1,50
10	rm3	36	3,60	0,57	1,73	0,50
	Min	15,00	1,50	0,11	1,73	0,16
	Mean	**24,72**	**2,47**	**0,32**	**3,63**	**1,00**
	Max	36,00	3,60	0,57	9,00	4,83

HI13.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	Hl	14	1,55	0,13	7,20	3,83
1	ktch	18	2,00	0,25	4,00	2,20
2	bath	22	2,44	0,36	2,76	0,20
3	wc	22	2,44	0,36	2,76	0,20
4	lvrm	22	2,44	0,36	2,76	0,20
5	str	18	2,00	0,25	4,00	0,70
6	rm2	26	2,88	0,47	2,11	0,33
7	rm1	26	2,88	0,47	2,11	0,33
8	trs	24	2,66	0,41	2,40	1,50
9	rm3	32	3,55	0,63	1,56	0,50
	Min	14,00	1,55	0,13	1,56	0,20
	Mean	**22,40**	**2,48**	**0,37**	**3,17**	**1,00**
	Max	32,00	3,55	0,63	7,20	3,83

3.2.14. Analysis of the House HI14:

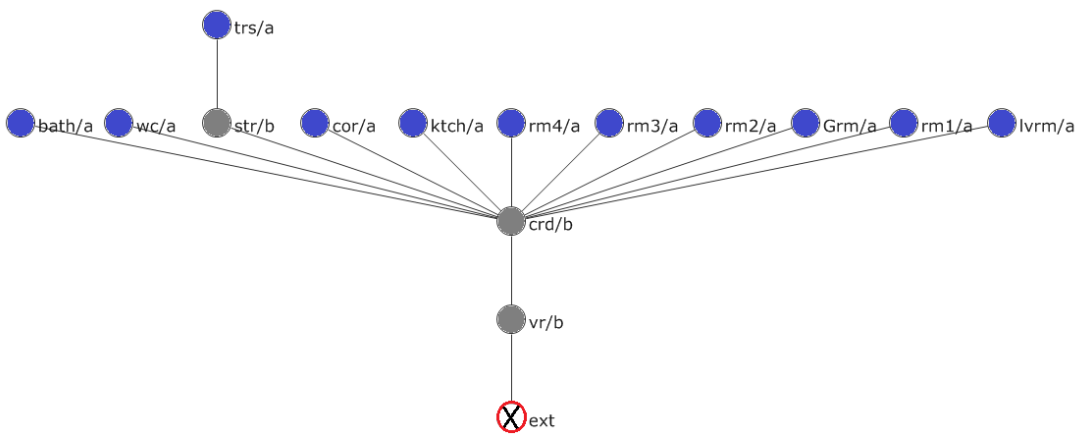


Figure -84: The justified graph of the house HI14

The configuration represents a tree-like structure and symmetric order. The graph has two topological spaces the a-type and b-type. The a-type represents 84% and b-type 25%. Which indicates that the graph tends to the non-distributedness. The penetration into the house from two pints of b-type: the veranda (vr) and the corridor (crd). The veranda is the space that separate the outside from the interior space and takes directly to the corridor while the corridor (crd) is the pivot of circulation and the space that distribute to all the spaces in the house; the bedrooms (rm1, rm2, rm3,rm4), the living room (lvrm), the guest room (grm), the bathroom (bath), the toilet (wc), the kitchen (ktch), the courtyard (cor), and the staircase (str) which takes to the terrace (trs).

The quantitative data and order of integration remains the same when the exterior is included or not, with exception of the corridor (crd), which becomes more integrated when the exterior is not taken into account. The veranda (vr) and the staircase (str) have the same value of integration 0.14 and they are integrated from the exterior. The terrace (trs) and the exterior (ex) are the most segregated spaces with value 0.28. The rest of the space has similar value of integration 0.16. The most controlled space is the corridor with high value of control 11.00, followed by the veranda and the staircase with value 1.08.

Table 49: HI14.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	ext	40	2,85	0,28	3,50	0,50
1	vr	27	1,92	0,14	7,00	1,08
2	crd	16	1,14	0,02	45,50	11,00
3	rm4	29	2,07	0,16	6,06	0,08
4	rm3	29	2,07	0,16	6,06	0,08
5	Grm	29	2,07	0,16	6,06	0,08
6	rm2	29	2,07	0,16	6,06	0,08
7	ktch	29	2,07	0,16	6,06	0,08
8	cor	29	2,07	0,16	6,06	0,08
9	str	27	1,92	0,14	7,00	1,08
10	wc	29	2,07	0,16	6,06	0,08
11	rm1	29	2,07	0,16	6,06	0,08
12	lvrm	29	2,07	0,16	6,06	0,08
13	bath	29	2,07	0,16	6,06	0,08
14	trs	40	2,85	0,28	3,50	0,50
	Min	16,00	1,14	0,02	3,50	0,08
	Mean	**29,33**	**2,09**	**0,16**	**8,47**	**1,00**
	Max	40,00	2,85	0,28	45,50	11,00

HI14.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	vr	26	2,00	0,16	6,00	0,08
1	crd	14	1,07	0,01	78,00	11,50
2	rm4	26	2,00	0,16	6,00	0,08
3	rm3	26	2,00	0,16	6,00	0,08
4	Grm	26	2,00	0,16	6,00	0,08
5	rm2	26	2,00	0,16	6,00	0,08
6	ktch	26	2,00	0,16	6,00	0,08
7	cor	26	2,00	0,16	6,00	0,08
8	str	24	1,84	0,14	7,09	1,08
9	wc	26	2,00	0,16	6,00	0,08
10	rm1	26	2,00	0,16	6,00	0,08
11	lvrm	26	2,00	0,16	6,00	0,08
12	bath	26	2,00	0,16	6,00	0,08
13	trs	36	2,76	0,29	3,39	0,50
	Min	14,00	1,07	0,01	3,39	0,08
	Mean	**25,71**	**1,97**	**0,16**	**11,03**	**1,00**
	Max	36,00	2,76	0,29	78,00	11,50

3.2.15. Analysis of the House HI15:

The graph was constructed using the exterior as a root. The spatial configuration represents an arborescent structure with two bushes. The configuration is in symmetric order and non-distributedness system. It contains from 20 nodes and 19 links. There are two topological spaces a-type 73%, and b-type 27%. The point of penetration is the corridor of b-type space which is a through space where there is no choice of mobility to and from this space, which is the pivot of circulation in which it distributed to the most spaces in the house; the bathroom, the toilet, the living room, the bedrooms (rm1, rm2, rm3), of a-type spaces and they are arranged as dead-end space at depth two, the kitchen and the staircase of b-type space; the kitchen has an access into the storage (stg), and the staircase (str) takes directly to the second corridor (crd2) that distributed to a multitude spaces of a-type: the kitchen, the living room, the hall, the bedrooms (rm4, rm5, rm6), and the bathroom from b-type space has an access to a toilet that is situated at last depth in the graph. However, the spaces of b-type have a strong control and movement management.

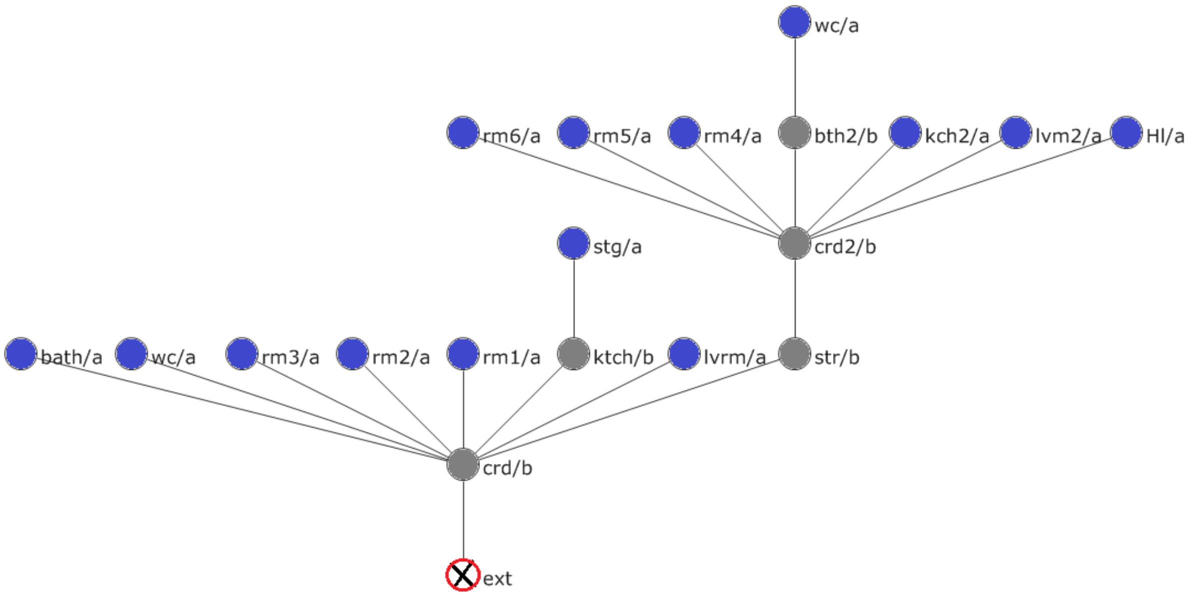


Figure -85: The justified graph of the house HI15

In term of quantitative data, the order of integration remains similar when the exterior is included or not. The transition spaces the corridor (crd), the staircase (str), and the second corridor (crd2) have the lowest value of integration (0.11) and (0.12) which means that they are the most integrated spaces in the house. The exterior has a moderate value of integration (0.21) and equal to the living room, the bedrooms (rm1, rm2, and rm3), the bathroom, and the toilet. The kitchen is an integrated space with value (0.20). The spaces at depth four have the same value (0.22); the living room (lvm2), the kitchen (kch2), the hall, and the bedrooms (rm4, rm5, rm6), and the bathroom (bath2). The most segregated spaces are the storage at depth three and the toilet at last depth five with value (0.30) and (0.32) respectively.

In term of control, the most controlled space is the corridor (8.00), followed by the second corridor at depth three with value (7.00).

Table 50: HI15.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	0	56	2,94	0,21	4,62	0,11
1	crd	38	2,00	0,11	9,00	8,00
2	rm1	56	2,94	0,21	4,62	0,11
3	ktch	54	2,84	0,20	4,88	1,11
4	lvrm	56	2,94	0,21	4,62	0,11
5	str	38	2,00	0,11	9,00	0,23
6	rm2	56	2,94	0,21	4,62	0,11
7	rm3	56	2,94	0,21	4,62	0,11
8	wc	56	2,94	0,21	4,62	0,11
9	bath	56	2,94	0,21	4,62	0,11
10	stg	72	3,78	0,30	3,22	0,50
11	crd2	40	2,10	0,12	8,14	7,00
12	ktch2	58	3,05	0,22	4,38	0,12
13	lvrm2	58	3,05	0,22	4,38	0,12
14	bath	56	2,94	0,21	4,62	1,12
15	rm4	58	3,05	0,22	4,38	0,12
16	rm5	58	3,05	0,22	4,38	0,12
17	Hl	58	3,05	0,22	4,38	0,12
18	rm6	58	3,05	0,22	4,38	0,12
19	wc	74	3,89	0,32	3,10	0,50
	Min	38,00	2,00	0,11	3,10	0,11
	Mean	**55,60**	**2,92**	**0,21**	**5,03**	**1,00**
	Max	74,00	3,89	0,32	9,00	8,00

HI15.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	crd	37	2,05	0,12	8,05	7,00
1	rm1	54	3,00	0,23	4,25	0,12
2	ktch	52	2,88	0,22	4,50	1,12
3	lvrm	54	3,00	0,23	4,25	0,12
4	str	36	2,00	0,11	8,50	0,25
5	rm2	54	3,00	0,23	4,25	0,12
6	rm3	54	3,00	0,23	4,25	0,12
7	wc	54	3,00	0,23	4,25	0,12
8	bath	54	3,00	0,23	4,25	0,12
9	stg	69	3,83	0,33	3,00	0,50
10	crd2	37	2,05	0,12	8,05	7,00
11	ktch2	54	3,00	0,23	4,25	0,12
12	lvrm2	54	3,00	0,23	4,25	0,12
13	bath	52	2,88	0,22	4,50	1,12
14	rm4	54	3,00	0,23	4,25	0,12
15	rm5	54	3,00	0,23	4,25	0,12
16	Hl	54	3,00	0,23	4,25	0,12
17	rm6	54	3,00	0,23	4,25	0,12
18	wc	69	3,83	0,33	3,00	0,50
	Min	36,00	2,00	0,11	3,00	0,12
	Mean	**52,63**	**2,92**	**0,22**	**4,76**	**1,00**
	Max	69,00	3,83	0,33	8,50	7,00

- Discussion:

The syntactic analysis of the series of houses covering the independent period, the findings show the disappearance of the vestibule “*sguifa*” and its replacement by the veranda as an intermediate space between the inner and outer space thus represents a boundary to control the access into the house. The veranda is considered as the point of penetration into the house; in some cases, the corridor and the hall represent the point of penetration.

The houses have an underlying spatial structure that is based on the importance of transition spaces, which separate and link different spaces and areas. The hall started to disappear from the spatial organization of independent period houses and the corridor was taking over as an important spatial place in these houses. It is the pivot of circulation and distributed space, where the hall became a space for family gathering, eating, resting… most the houses have the main hall or the corridor as the most integrated spaces.

From the justified graphs of the sample, the spatial configurations have a distributed system generally manifested in the inner and outer rings, four topological spaces are characterized in the spatial configurations: a-type, b-type, c-type and d-type, whereas the c- and d-type spaces offer a flexibility of movement and choice of circulation within the house, thus decrease the privatization. The most segregated are the bedrooms and the service area. The balconies and the patio are the main addition to the spatial organization of these houses, whereas the houses became more open to the exterior. The guest rooms were not used by the family and are not allowed for the member of family especially children to enter to these spaces except when they receive guests, because it is supposed to be always clean. From the graphs, it is notable that some houses have more than one entrance, such as the garages and locals of a- and b-type spaces.

4. Analysis the houses from the contemporary period (HP)

4.2.1. Analysis of the House HP01:

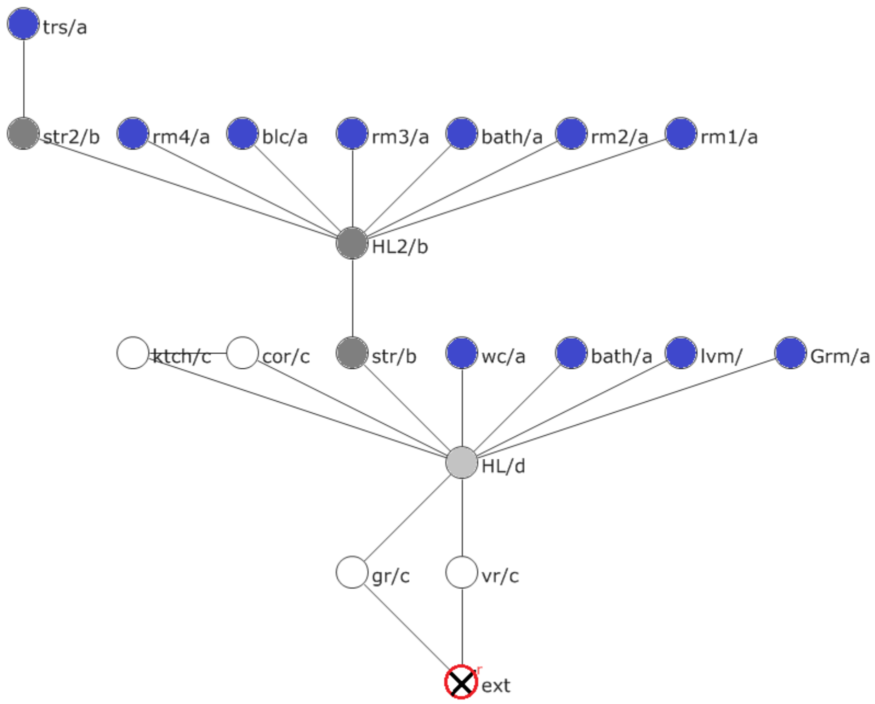


Figure -86: The justified graph of the modern House (HP01)

The graph was constructed using the exterior as a root; it is deep from the original space and represents a tree-like structure with two brunches. And it is in symmetric order and shows a lack in distributedness in general in the system. It is characterized by two rings: an inner and external one, where the circulation in the inferior part of the graph is articulated. The graph composed from the four topological spaces: 58% of a-type, 16% of b-type, 25% of c-type, and 5% of d-type. The graph has two different points of penetration into the house: the veranda and the garage from the c-type are part from the external ring. These both spaces lead to the hall the main central space and the pivot of the movement and transition; it is of d-type which provides more flexibility and choice of movement around the house. The guest room, living room, and the ablution space (the toilet, and the bathroom) are from a-type are arranged around the hall. Each of the kitchen and the courtyard are a part from the inner ring passing by the hall. The staircase of b-type is the point of transition to the next level. The hall (Hl2) is the pivot the circulation and it distributes to all the spaces as: the bedrooms (rm1, rm2, rm3, and rm4), the bathroom, the balcony theses spaces are from a-type, and to the staircase that leads to the terrace that is arranged as dead-end space in the last depth in the graph.

Table 51: HP01.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	ext	70	3,68	0,29	3,35	1,00
1	vr	54	2,84	0,20	4,88	0,61
2	gr	54	2,84	0,20	4,88	0,61
3	HL	38	2,00	0,11	9,00	6,50
4	wc	56	2,94	0,21	4,62	0,11
5	bath	56	2,94	0,21	4,62	0,11
6	lvrm	56	2,94	0,21	4,62	0,11
7	str	38	2,00	0,11	9,00	0,23
8	cor	55	2,89	0,21	4,75	0,61
9	ktch	55	2,89	0,21	4,75	0,61
10	Grm	56	2,94	0,21	4,62	0,11
11	HL2	40	2,10	0,12	8,14	7,00
12	rm3	58	3,05	0,22	4,38	0,12
13	bath	58	3,05	0,22	4,38	0,12
14	rm2	58	3,05	0,22	4,38	0,12
15	blc	58	3,05	0,22	4,38	0,12
16	rm4	58	3,05	0,22	4,38	0,12
17	rm1	58	3,05	0,22	4,38	0,12
18	str2	56	2,94	0,21	4,62	1,12
19	trs	74	3,89	0,32	3,10	0,50
	Min	38,00	2,00	0,11	3,10	0,11
	Mean	**55,30**	**2,91**	**0,21**	**5,06**	**1,00**
	Max	74,00	3,89	0,32	9,00	7,00

HP01.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	vr	53	2,94	0,22	4,37	0,11
1	gr	53	2,94	0,22	4,37	0,11
2	HL	36	2,00	0,11	8,50	7,50
3	wc	53	2,94	0,22	4,37	0,11
4	bath	53	2,94	0,22	4,37	0,11
5	lvrm	53	2,94	0,22	4,37	0,11
6	str	35	1,94	0,11	9,00	0,23
7	cor	52	2,88	0,22	4,50	0,61
8	ktch	52	2,88	0,22	4,50	0,61
9	Grm	53	2,94	0,22	4,37	0,11
10	HL2	36	2,00	0,11	8,50	7,00
11	rm3	53	2,94	0,22	4,37	0,12
12	bath	53	2,94	0,22	4,37	0,12
13	rm2	53	2,94	0,22	4,37	0,12
14	blc	53	2,94	0,22	4,37	0,12
15	rm4	53	2,94	0,22	4,37	0,12
16	rm1	53	2,94	0,22	4,37	0,12
17	str2	51	2,83	0,21	4,63	1,12
18	trs	68	3,77	0,32	3,06	0,50
	Min	35,00	1,94	0,11	3,06	0,11
	Mean	**50,84**	**2,82**	**0,21**	**5,00**	**1,00**
	Max	68,00	3,77	0,32	9,00	7,50

The most integrated spaces are: the hall (HL), and the staircase (str) that share the same value (0.11), followed by the hall (HL2) with value (0.12). Then, the veranda (vr) and the garage (gr) with the same value (0.20). They are situated at different levels of depth. The terrace has the highest value of integration (0.32) which means that it is the most segregated space in the system, situated at the last depth. The exterior has a strong segregation with value (0.29). Each of: the toilet (wc), the bathroom (bath), living room (lvrm), courtyard (cor), the kitchen (ktch), the guestroom (Grm), and the staircase (str2) have a strong segregation with value (0.21), followed by the rooms (rm1, rm2, rm3, rm4), the bathroom, and the balcony with the value (0.22). The halls (HL2 and Hall) have the highest degree of control in the system (7.00, and 6.50) respectively, they control the circulation around the house.

4.2.2. Analysis of the House HP02:

The graph represents a strong asymmetry, and lack in distributedness especially in the superior part and shows an asymmetric in global. The graph contained 21 nodes and 21 links, with an outer ring passing by the veranda, the exterior, the garage, and the corridor which are from the c-type. A three topological space are distinguished in the graph; 55% of a-type, 31% of b-type, and 19% of c-type. The point of penetration into the house is from two spaces of c-type: the veranda and the garage where they fall in a ring, they offer a choice of movement in the house.

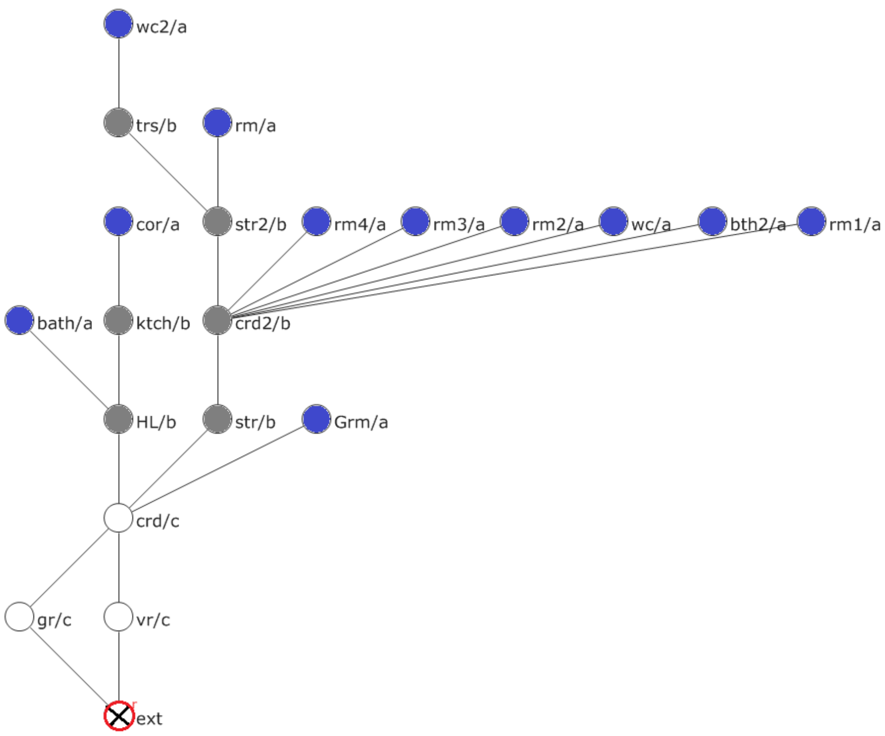


Figure -87: The justified graph of the modern House (HP02)

The corridor is considered as the space of distribution which takes to the hall "*wasteddar*" the main central space and the pivot of the movement that gives an access to the bathroom and the kitchen; they are arranged in linear sequence that ends by the courtyard of a-type. The staircase gives directly to the corridor in the next level where this space distributes to all the spaces in that level such as: the bedrooms (rm1, rm2, rm3, and rm4), the bathroom, the toilet that are arranged as dead end spaces and the staircase of b-type that takes to the terrace and big room in the last depth in the graph.

From the table above, the data shows that the corridor (crd2) in the first level has the lowest value of integration (RA) (0.13) which refers to the high degree of integration in the house also it is the most controlled space with value (6.83), followed by the staircase (str) (0.14) and the corridor (crd) (0.15) they are considered as integrated spaces in the system. The hall and the staircase (str2) show a good integration with value (0.22) and (0.20) respectively. The bedrooms (rm1, rm2, rm3, and rm4), the bathroom (bath2), and the toilet have the same value of integration (0.23). Taking into account or not the exterior which has no impact on the calculations and the relative asymmetry but they changed only minimally. Despite the fact that the veranda and the garage are shallow from the exterior at depth one, they have an equal value of integration (0.24). The most segregated spaces are the toilet (wc2) with value (0.39) that situated at last depth, followed by the exterior with value (0.33) in spite of their differentiation.

Table 52: HP02.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	vr	67	3,35	0,24	4,04	0,70
1	gr	67	3,35	0,24	4,04	0,70
2	crd	50	2,50	0,15	6,33	2,83
3	HL	63	3,15	0,22	4,41	1,70
4	str	47	2,35	0,14	7,03	0,32
5	Grm	69	3,45	0,25	3,87	0,20
6	ktch	80	4,00	0,31	3,16	1,33
7	bath	82	4,10	0,32	3,06	0,33
8	cor	99	4,95	0,41	2,40	0,50
9	crd2	46	2,30	0,13	7,30	6,83
10	str2	59	2,95	0,20	4,87	1,62
11	rm4	65	3,25	0,23	4,22	0,12
12	rm3	65	3,25	0,23	4,22	0,12
13	rm2	65	3,25	0,23	4,22	0,12
14	wc	65	3,25	0,23	4,22	0,12
15	bath2	65	3,25	0,23	4,22	0,12
16	rm1	65	3,25	0,23	4,22	0,12
17	rm	78	3,90	0,30	3,27	0,33
18	trs	76	3,80	0,29	3,39	1,33
19	wc2	95	4,75	0,39	2,53	0,50
20	ext	84	4,20	0,33	2,96	1,00
	Min	46,00	2,30	0,13	2,40	0,12
	Mean	**69,14**	**3,45**	**0,25**	**4,19**	**1,00**
	Max	99,00	4,95	0,41	7,30	6,83

HP02.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	vr	66	3,47	0,27	3,63	0,20
1	gr	66	3,47	0,27	3,63	0,20
2	crd	48	2,52	0,16	5,89	3,83
3	HL	60	3,15	0,23	4,17	1,70
4	str	44	2,31	0,14	6,84	0,32
5	Grm	66	3,47	0,27	3,63	0,20
6	ktch	76	4,00	0,33	3,00	1,33
7	bath	78	4,10	0,34	2,89	0,33
8	cor	94	4,94	0,43	2,28	0,50
9	crd2	42	2,21	0,13	7,43	6,83
10	str2	54	2,84	0,20	4,88	1,62
11	rm4	60	3,15	0,23	4,17	0,12
12	rm3	60	3,15	0,23	4,17	0,12
13	rm2	60	3,15	0,23	4,17	0,12
14	wc	60	3,15	0,23	4,17	0,12
15	bath2	60	3,15	0,23	4,17	0,12
16	rm1	60	3,15	0,23	4,17	0,12
17	rm	72	3,78	0,30	3,22	0,33
18	trs	70	3,68	0,29	3,35	1,33
19	wc2	88	4,63	0,40	2,47	0,50
	Min	42,00	2,21	0,13	2,28	0,12
	Mean	**64,20**	**3,37**	**0,26**	**4,12**	**1,00**
	Max	94,00	4,94	0,43	7,43	6,83

4.2.3. Analysis of the House HP03:

The graph represents a tree-like structure using the exterior as a root, despite the presence of four rings: one external and the others are internal; the system tends to lack in distributedness that manifests in the topological spaces: of a-type that represents 37,5 %, the b-type 21,7%, the c-type 32%, the d-type 8%. The penetration into the house is from two points from the external ring; the veranda and the garage which provide a choice of movement and are shallow from the original space “the root”. The veranda of d-type space has an important role in the house which offers a choice of circulation, where is the point of distribution that takes directly to the guest room, it is destined to the visitors/ strangers. The intermediate spaces which are from c-type space, the both spaces give to the hall “*wast eddar*” these last spaces (the veranda, the guest room, the intermediate space and the hall) are falling in an inner ring which makes them offer a choice of circulation around the house.

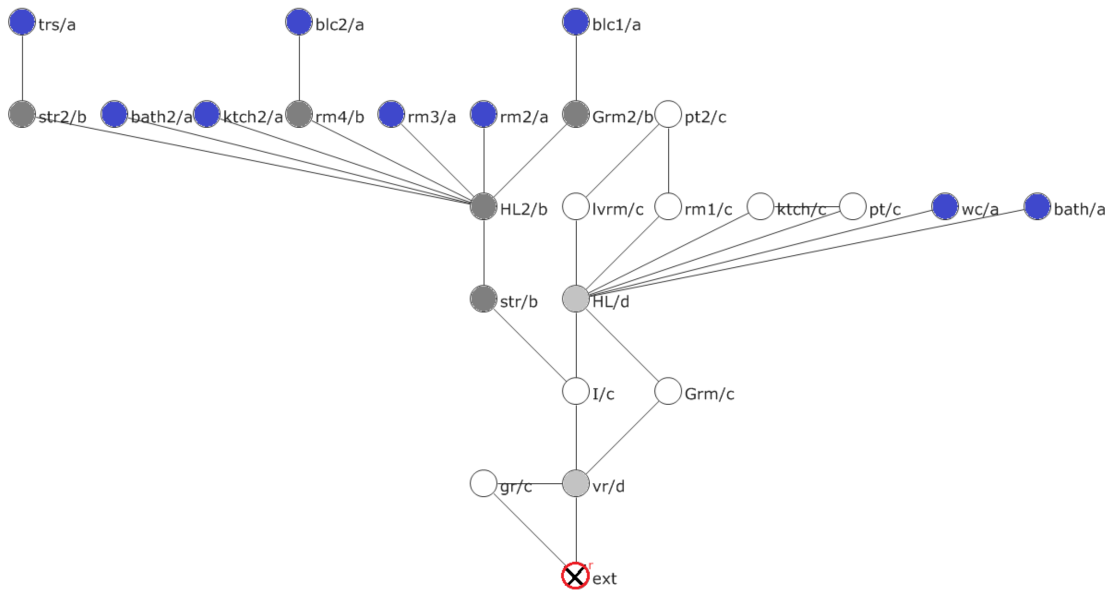


Figure -88: The justified graph of the modern House (HP03)

The intermediate space distributes to the staircase and the hall “*wast eddar*” which is the most important space in the house where all the family gather in and it is considered as the pivot of the movement. Each of the living room, the bedroom (rm1), the kitchen, the patio, the ablution spaces (the bathroom, and the toilet) are arranged around the hall, whereas the patio the kitchen and the hall form an inner ring and provide a flexibility of movement within the house. The staircase of b-type takes directly to the next floor to the hall02 that gives to: the guest room02, the bedrooms (rm2, rm3, and rm4), the kitchen2, the staircase, the bathroom and the toilet. The terrace and the balconies from a-type are arranged as dead-end spaces in the graph situated at the last depth.

Table 53: HP03.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	ext	98	4,08	0,26	3,72	0,75
1	vr	76	3,16	0,18	5,30	1,83
2	gr	98	4,08	0,26	3,72	0,75
3	I	59	2,45	0,12	7,88	0,87
4	HL	66	2,75	0,15	6,57	4,83
5	str	60	2,50	0,13	7,66	0,45
6	Grm	83	3,45	0,21	4,67	0,37
7	lvrm	87	3,62	0,22	4,38	0,62
8	rm1	87	3,62	0,22	4,38	0,62
9	ktch	88	3,66	0,23	4,31	0,62
10	pt	88	3,66	0,23	4,31	0,62
11	wc	89	3,70	0,23	4,24	0,12
12	bath	89	3,70	0,23	4,24	0,12
13	HL2	63	2,62	0,14	7,07	6,00
14	pt2	108	4,50	0,30	3,28	1,00
15	Grm2	84	3,50	0,21	4,60	1,12
16	rm2	86	3,58	0,22	4,45	0,12
17	rm3	86	3,58	0,22	4,45	0,12
18	rm4	84	3,50	0,21	4,60	1,12
19	ktch2	86	3,58	0,22	4,45	0,12
20	bath2	86	3,58	0,22	4,45	0,12
21	str2	84	3,50	0,21	4,60	1,12
22	trs	107	4,45	0,30	3,32	0,50
23	blc2	107	4,45	0,30	3,32	0,50
24	blc1	107	4,45	0,30	3,32	0,50
	Min	59,00	2,45	0,12	3,28	0,12
	Mean	**86,24**	**3,59**	**0,22**	**4,69**	**1,00**
	Max	108,00	4,50	0,30	7,88	6,00

HP03.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	vr	75	3,26	0,20	4,86	1,83
1	gr	97	4,21	0,29	3,41	0,33
2	I	57	2,47	0,13	7,44	0,95
3	HL	63	2,73	0,15	6,32	4,83
4	str	57	2,47	0,13	7,44	0,45
5	Grm	81	3,52	0,22	4,36	0,45
6	lvrm	83	3,60	0,23	4,21	0,62
7	rm1	83	3,60	0,23	4,21	0,62
8	ktch	84	3,65	0,24	4,14	0,62
9	pt	84	3,65	0,24	4,14	0,62
10	wc	85	3,69	0,24	4,08	0,12
11	bath	85	3,69	0,24	4,08	0,12
12	HL2	59	2,56	0,14	7,02	6,00
13	pt2	103	4,47	0,31	3,16	1,00
14	Grm2	79	3,43	0,22	4,51	1,12
15	rm2	81	3,52	0,22	4,36	0,12
16	rm3	81	3,52	0,22	4,36	0,12
17	rm4	79	3,43	0,22	4,51	1,12
18	ktch2	81	3,52	0,22	4,36	0,12
19	bath2	81	3,52	0,22	4,36	0,12
20	str2	79	3,43	0,22	4,51	1,12
21	trs	101	4,39	0,30	3,24	0,50
22	blc2	101	4,39	0,30	3,24	0,50
23	blc1	101	4,39	0,30	3,24	0,50
	Min	57,00	2,47	0,13	3,16	0,12
	Mean	**81,66**	**3,55**	**0,23**	**4,56**	**1,00**
	Max	103,00	4,47	0,31	7,44	6,00

The order of integration remains the same when the exterior is not taken into account. The intermediate space (I) is the most integrated space at the house with value 0.12, followed by the staircase (str) 0.13, the second hall (HL2) 0.14, and the main hall (HL) 0.15. We noticed that the intermediate space plays an important role in distribution, which takes to the main hall (*wast eddar*) and guest room where the spaces of occupation are arranged around. And it takes to the staircase to the next floor where the most private spaces are. The veranda has a value of integration 0.18; it is integrated from the exterior. The guest rooms (grm and grm2) despite the fact that they have different levels, they are integrated and have similar value of integration 0.21, and they are destined to the visitors and strangers. The living room (lvrm), the bedrooms (rm1, rm2, rm3, and rm4), the kitchens (ktch, ktch2), the bathrooms, and the toilet; have the same value of integration (0.22, 0.23), they are situated at depth four and five and segregated from the exterior. The garage has the same value with the exterior 0.26. The segregated spaces are the balconies, the patio, and the terrace with value 0.30. The second hall (HL2) is the most controlled space 6.00, the first hall 4.83, and the verandah 1.83.

4.2.4. Analysis of the House HP04:

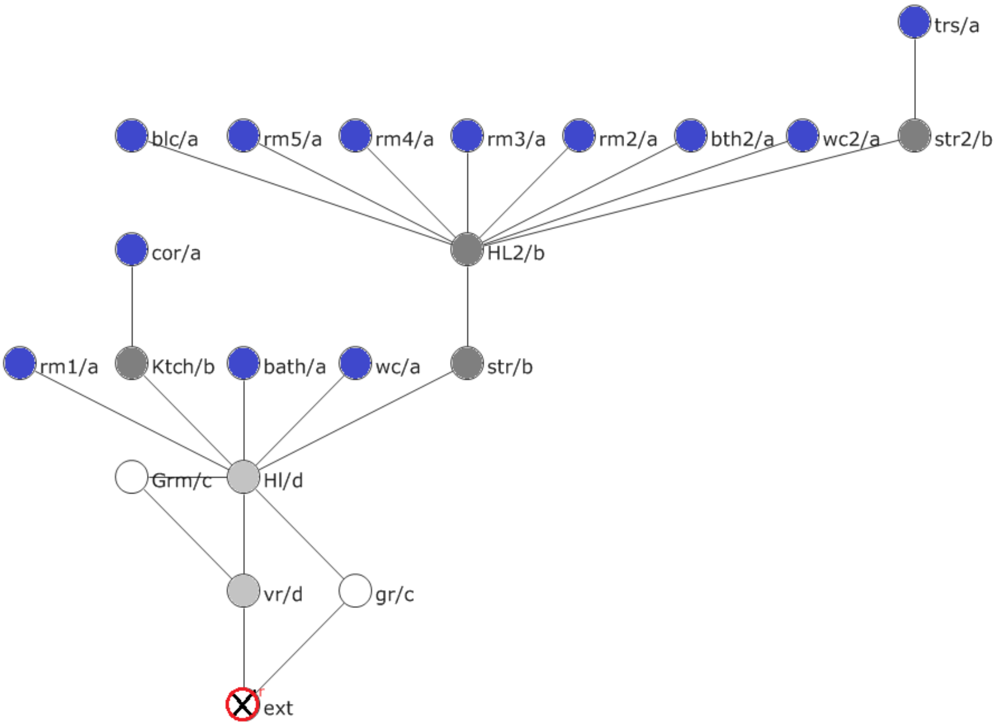


Figure -89: The justified graph of the modern House (HP04)

The graph represents a tree-like structure with two brunches; it shows distributedness in the inferior part, and non- distributedness in the superior part. The distributedness is manifested by the existence of the topological spaces of c- and d-type that formed an outer and inner ring. The penetration into the house from row of topological spaces of d-type: the veranda (vr) and the hall (Hl). The garage (gr) is the second access where it is part from the outer ring with the veranda and the hall. The second inner ring formed by the veranda, the hall and the guest room, offer a flexibility of circulation around the house, whereas, the veranda has an access to the spaces that are destined to strangers / visitors. The hall (Hl) is the pivot of circulation where it distributes to: the bathroom (bath), the toilet (wc), the room (rm1), they are from a-type space that is arranged as dead-end space. The staircase (str), and the kitchen (ktch), are from b-type space. The kitchen has an access to the courtyard arranged as dead-end space. In addition, the staircase takes indirectly to the next spaces through the hall (Hl2), the main central space which permit to distribute to occupancy spaces; the bedrooms (rm2, rm3, rm4, rm5), the ablution spaces (the bathroom, and the toilet), which are arranged as dead-end spaces. And to the staircase that takes directly to the terrace, situated at the last depth.

Table 54: HP04.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	ext	75	3,75	0,28	3,45	0,83
1	vr	58	2,90	0,20	5,00	1,12
2	Hl	42	2,10	0,11	8,63	5,33
3	Grm	59	2,95	0,20	4,87	0,45
4	gr	59	2,95	0,20	4,87	0,62
5	bath	61	3,05	0,21	4,63	0,12
6	wc	61	3,05	0,21	4,63	0,12
7	ktch	59	2,95	0,20	4,87	1,12
8	rm1	61	3,05	0,21	4,63	0,12
9	str	41	2,05	0,11	9,04	0,23
10	cor	78	3,90	0,30	3,27	0,50
11	HL2	42	2,10	0,11	8,63	8,00
12	rm3	61	3,05	0,21	4,63	0,11
13	rm2	61	3,05	0,21	4,63	0,11
14	bath2	61	3,05	0,21	4,63	0,11
15	rm4	61	3,05	0,21	4,63	0,11
16	rm5	61	3,05	0,21	4,63	0,11
17	blc	61	3,05	0,21	4,63	0,11
18	wc2	61	3,05	0,21	4,63	0,11
19	str2	59	2,95	0,20	4,87	1,11
20	trs	78	3,90	0,30	3,27	0,50
	Min	41,00	2,05	0,11	3,27	0,11
	Mean	**60,00**	**3,00**	**0,21**	**5,10**	**1,00**
	Max	78,00	3,90	0,30	9,04	8,00

HP04.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	vr	57	3,00	0,22	4,50	0,62
1	Hl	40	2,10	0,12	8,14	6,00
2	Grm	57	3,00	0,22	4,50	0,62
3	gr	58	3,05	0,22	4,38	0,12
4	bath	58	3,05	0,22	4,38	0,12
5	wc	58	3,05	0,22	4,38	0,12
6	ktch	56	2,94	0,21	4,62	1,12
7	rm1	58	3,05	0,22	4,38	0,12
8	str	38	2,00	0,11	9,00	0,23
9	cor	74	3,89	0,32	3,10	0,50
10	HL2	38	2,00	0,11	9,00	8,00
11	rm3	56	2,94	0,21	4,62	0,11
12	rm2	56	2,94	0,21	4,62	0,11
13	bath2	56	2,94	0,21	4,62	0,11
14	rm4	56	2,94	0,21	4,62	0,11
15	rm5	56	2,94	0,21	4,62	0,11
16	blc	56	2,94	0,21	4,62	0,11
17	wc2	56	2,94	0,21	4,62	0,11
18	str2	54	2,84	0,20	4,88	1,11
19	trs	72	3,78	0,30	3,22	0,50
	Min	38,00	2,00	0,11	3,10	0,11
	Mean	**55,50**	**2,92**	**0,21**	**5,04**	**1,00**
	Max	74,00	3,89	0,32	9,00	8,00

The quantitative calculations show that the order of integration and the values of most spaces remain similar when the exterior is not taken into account that means that the spaces are less affected by the exclusion of the exterior. The transition spaces; both halls (Hl, and HL2) and the staircase (str) are the most integrated spaces with the same value 0.11. The veranda, the kitchen, the guest room, the second staircase, and the garage; have the same value of integration (0.20) despite the fact that they are situated at different levels of depth. The most segregated spaces are the terrace and the courtyard 0.30 and the exterior 0.28. The rest of spaces have the same moderate space of integration 0.21. The most controlled space is the second hall (Hl2) with value 8.00, and followed by first hall 5.33.

4.2.5. Analysis of the House HP05:

The graph was constructed using the exterior as a root, they are constituted from three bushes; the inferior part shows a distributedness which exist in an outer ring, and the two bushes represent a non-distributedness. The graph has three types of topological spaces; the a-type represents 73%, the b-type 18%, and the c-type 12%. The penetration into the house from the outer ring which offers a choice of circulation, the local has a separate access from the house, the veranda (vr) and the garage (gr) are considered as two points of access that take to the corridor (crd).

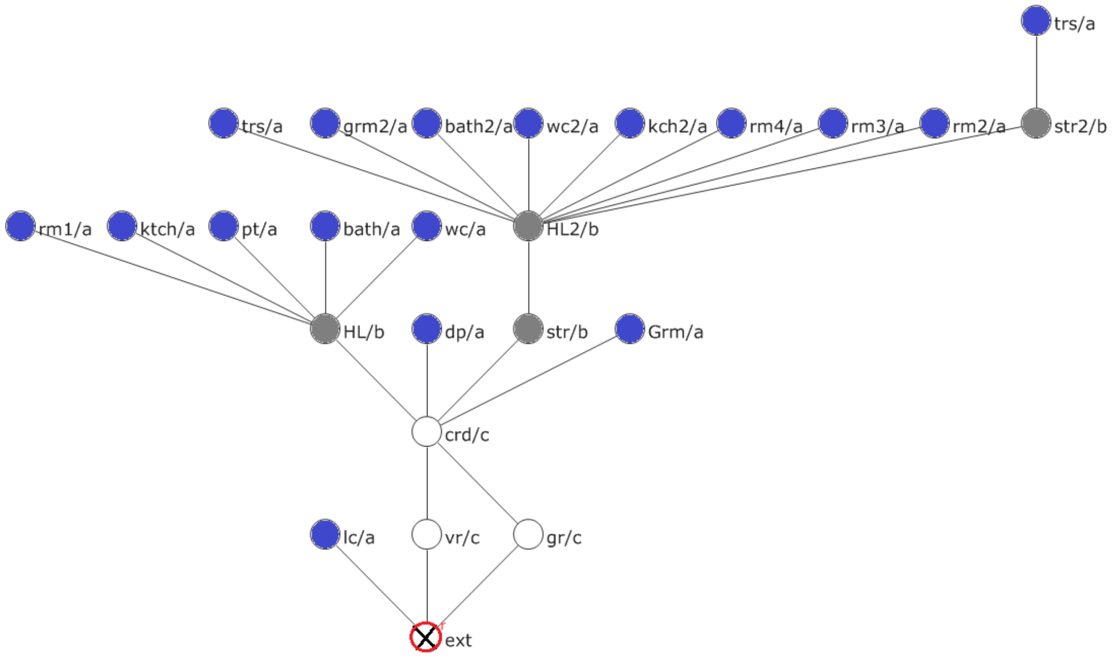


Figure -90: The justified graph of the modern House (HP05)

The corridor (crd) has an access to the staircase, the hall and the guest room (grm) which is separated from the occupancy spaces because it is destined to receive visitors and strangers. The hall (HL) takes directly to the patio (pt), the ablution spaces (bath, wc), the kitchen (ktch), the room (rm1). The hall (HL2) at depth four which distributes to the most private spaces such as: the bedrooms (rm2, rm3, rm4), the guest room (grm2), the kitchen (ktch2), the terrace (trs), the bathroom and toilet, they are all arranged as dead-end spaces in the last depth.

The quantitative data marks a certain change on the values of relative asymmetry (integration value) in which the spaces become more segregated and the order of integration remains similar when the exterior is not taken into account. The represented spatial configuration tends to emphasize the relationship between residents and visitors as well. The corridor is the most integrated spaces with value 0.10, followed by the staircase (str) 0.11, the second hall (HL2), and the first hall (Hl) 0.15. The garage (gr), and the veranda (vr) have a moderate value of integration 0.17. The deposit (dp), the guest room (grm), and the second staircase have similar value of integration despite the fact that they are situated at different depths. The most segregated spaces: are the local, the terrace, and the exterior. The rest of spaces are segregated from the exterior according to their private use, whereas they are suitable for the residents. The second hall (Hl2) is the most controlled space 9.00, then the first hall (Hl) 5.16, the corridor 3.66, and the exterior 2.00.

Table 55: HP05.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	ext	92	3,83	0,24	4,05	2,00
1	gr	73	3,04	0,17	5,63	0,50
2	vr	73	3,04	0,17	5,63	0,50
3	lc	115	4,79	0,32	3,03	0,33
4	crd	54	2,25	0,10	9,20	3,66
5	dp	77	3,20	0,19	5,20	0,16
6	str	55	2,29	0,11	8,90	0,26
7	HL	67	2,79	0,15	6,41	5,16
8	Grm	77	3,20	0,19	5,20	0,16
9	bath	90	3,75	0,23	4,18	0,16
10	wc	90	3,75	0,23	4,18	0,16
11	pt	90	3,75	0,23	4,18	0,16
12	ktch	90	3,75	0,23	4,18	0,16
13	rm1	90	3,75	0,23	4,18	0,16
14	HL2	58	2,41	0,12	8,11	9,00
15	wc2	81	3,37	0,20	4,84	0,10
16	kch2	81	3,37	0,20	4,84	0,10
17	rm4	81	3,37	0,20	4,84	0,10
18	rm3	81	3,37	0,20	4,84	0,10
19	grm2	81	3,37	0,20	4,84	0,10
20	trs	81	3,37	0,20	4,84	0,10
21	rm2	81	3,37	0,20	4,84	0,10
22	str2	79	3,29	0,19	5,01	1,10
23	trs	102	4,25	0,28	3,53	0,50
24	bath2	81	3,37	0,20	4,84	0,10
	Min	54,00	2,25	0,10	3,03	0,10
	Mean	**80,80**	**3,36**	**0,20**	**5,18**	**1,00**
	Max	115,00	4,79	0,32	9,20	9,00

HP05.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	gr	94	4,08	0,28	3,56	0,16
1	vr	94	4,08	0,28	3,56	0,16
2	lc	552	24,00	2,09	0,47	0,00
3	crd	73	3,17	0,19	5,06	4,66
4	dp	94	4,08	0,28	3,56	0,16
5	str	72	3,13	0,19	5,16	0,26
6	HL	84	3,65	0,24	4,14	5,16
7	Grm	94	4,08	0,28	3,56	0,16
8	bath	105	4,56	0,32	3,08	0,16
9	wc	105	4,56	0,32	3,08	0,16
10	pt	105	4,56	0,32	3,08	0,16
11	ktch	105	4,56	0,32	3,08	0,16
12	rm1	105	4,56	0,32	3,08	0,16
13	HL2	73	3,17	0,19	5,06	9,00
14	wc2	94	4,08	0,28	3,56	0,10
15	kch2	94	4,08	0,28	3,56	0,10
16	rm4	94	4,08	0,28	3,56	0,10
17	rm3	94	4,08	0,28	3,56	0,10
18	grm2	94	4,08	0,28	3,56	0,10
19	trs	94	4,08	0,28	3,56	0,10
20	rm2	94	4,08	0,28	3,56	0,10
21	str2	92	4,00	0,27	3,66	1,10
22	trs	113	4,91	0,35	2,81	0,50
23	bath2	94	4,08	0,28	3,56	0,10
	Min	72,00	3,13	0,19	0,47	0,00
	Mean	**113,00**	**4,91**	**0,35**	**3,52**	**0,95**
	Max	552,00	24,00	2,09	5,16	9,00

4.2.6. Analysis of the House HP06:

The house was constructed using the exterior as root; the spatial configuration represents a tree-like structure with three bushes. The graph tends to lack of distributedness in a part of the system, in turn of means the increase in the depth within the house layout, the configuration is deep from the exterior. Three topological spaces exist in the spatial configuration; the a-type space represents 60% which are the spaces that are suitable for inhabitants where there is no through movement. The b-type space represents 15% which is through space and in general they are the transition spaces. The c-type space represents: 26% in which these spaces offer a choice of circulation within the house.

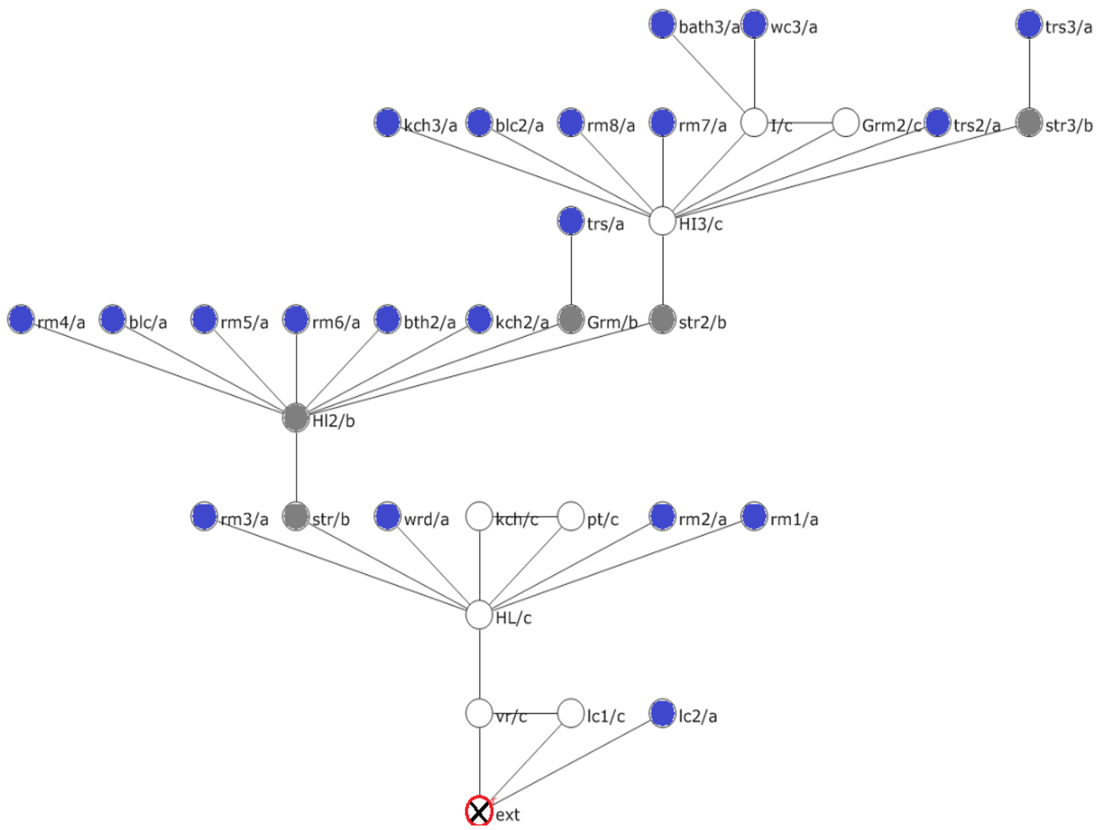


Figure -91: The justified graph of the modern House (HP06)

The graph is characterized by the existence of inner and outer rings. The penetration into the house is from an outer ring which is composed by the exterior (ext), the veranda (vr), and the local (lc1). The veranda takes directly to the hall (Hl) which is part from an inner ring formed by: the hall, the kitchen, and the patio. It provides a flexibility of movement and low control in the house. The hall is the pivot of circulation and distribution space. Each of the bedrooms (rm1, rm2, and rm3), the patio, the kitchen, the wardrobe, and the staircase are arranged around this central space (HL). The staircase of b-type space takes to the spaces in first floor. The rooms (rm4, rm5, and rm6), the bathroom, the balcony, the kitchen, the guest room and the staircase are arranged around the second hall (Hl2) which is the pivot of circulation and a distribution space by excellence. The staircase (str2) takes to another level; the hall (HL3) is part from an inner ring formed by the guest room and an intermediate space that takes to the ablution spaces (the bathroom, and the toilet). The spaces: the bedrooms (rm7, rm8), the kitchen (ktch3), the terrace, the balcony, are from a-type space are arranged around the hall (HL3) and are situated at last depth in the graph as dead-end spaces, the staircase from b-type space takes to the terrace in the last depth in the graph.

Table 56: HP06.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	ext	162	4,90	0,24	4,09	1,83
1	vr	133	4,03	0,18	5,28	0,95
2	lc1	163	4,93	0,24	4,06	0,66
3	lc2	194	5,87	0,30	3,27	0,33
4	HL	107	3,24	0,14	7,13	5,83
5	kch	138	4,18	0,19	5,02	0,62
6	pt	138	4,18	0,19	5,02	0,62
7	rm2	139	4,21	0,20	4,98	0,12
8	wrd	139	4,21	0,20	4,98	0,12
9	str	95	2,87	0,11	8,51	0,23
10	rm1	139	4,21	0,20	4,98	0,12
11	rm3	139	4,21	0,20	4,98	0,12
12	Hl2	85	2,57	0,09	10,15	7,50
13	rm6	117	3,54	0,15	6,28	0,11
14	bath2	117	3,54	0,15	6,28	0,11
15	kch2	117	3,54	0,15	6,28	0,11
16	rm5	117	3,54	0,15	6,28	0,11
17	blc	117	3,54	0,15	6,28	0,11
18	rm4	117	3,54	0,15	6,28	0,11
19	Grm	115	3,48	0,15	6,43	1,11
20	str2	93	2,81	0,11	8,80	0,22
21	trs	147	4,45	0,21	4,63	0,50
22	Hl3	103	3,12	0,13	7,54	6,75
23	rm7	135	4,09	0,19	5,17	0,11
24	I	130	3,93	0,18	5,44	2,61
25	Grm2	132	4,00	0,18	5,33	0,36
26	rm8	135	4,09	0,19	5,17	0,11
27	blc2	135	4,09	0,19	5,17	0,11
28	kch3	135	4,09	0,19	5,17	0,11
29	trs2	135	4,09	0,19	5,17	0,11
30	str3	133	4,03	0,18	5,28	1,11
31	wc3	162	4,90	0,24	4,09	0,25
32	bath3	162	4,90	0,24	4,09	0,25
33	trs3	165	5,00	0,25	4,00	0,50
	Min	85,00	2,57	0,09	3,27	0,11
	Mean	**132,05**	**4,00**	**0,18**	**5,63**	**1,00**
	Max	194,00	5,87	0,30	10,15	7,50

HP06.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	vr	163	5,09	0,26	3,78	1,12
1	lc1	193	6,03	0,32	3,08	0,50
2	lc2	1056	33,00	2,06	0,48	0,00
3	HL	135	4,21	0,20	4,81	6,00
4	kch	164	5,12	0,26	3,75	0,62
5	pt	164	5,12	0,26	3,75	0,62
6	rm2	165	5,15	0,26	3,72	0,12
7	wrd	165	5,15	0,26	3,72	0,12
8	str	121	3,78	0,17	5,57	0,23
9	rm1	165	5,15	0,26	3,72	0,12
10	rm3	165	5,15	0,26	3,72	0,12
11	Hl2	109	3,40	0,15	6,44	7,50
12	rm6	139	4,34	0,21	4,63	0,11
13	bath2	139	4,34	0,21	4,63	0,11
14	kch2	139	4,34	0,21	4,63	0,11
15	rm5	139	4,34	0,21	4,63	0,11
16	blc	139	4,34	0,21	4,63	0,11
17	rm4	139	4,34	0,21	4,63	0,11
18	Grm	137	4,28	0,21	4,72	1,11
19	str2	115	3,59	0,16	5,97	0,22
20	trs	167	5,21	0,27	3,67	0,50
21	Hl3	123	3,84	0,18	5,45	6,75
22	rm7	153	4,78	0,24	4,09	0,11
23	I	148	4,62	0,23	4,27	2,61
24	Grm2	150	4,68	0,23	4,20	0,36
25	rm8	153	4,78	0,24	4,09	0,11
26	blc2	153	4,78	0,24	4,09	0,11
27	kch3	153	4,78	0,24	4,09	0,11
28	trs2	153	4,78	0,24	4,09	0,11
29	str3	151	4,71	0,23	4,16	1,11
30	wc3	178	5,56	0,29	3,39	0,25
31	bath3	178	5,56	0,29	3,39	0,25
32	trs3	181	5,65	0,30	3,32	0,50
	Min	109,00	3,40	0,15	0,48	0,00
	Mean	**178,54**	**5,57**	**0,29**	**4,16**	**0,96**
	Max	1056,00	33,00	2,06	6,44	7,50

The quantitative data shows that the integration value becomes more segregated when the exterior in not included, which means that the exterior play an important role in bringing the layout together when it is included. The second hall (HL2) has the lowest value of integration (0.09) which is the most integrated space in the system. Followed by the staircase (str, str2) with value (0.11), and the hall (HL3, HL2) with value (0.13) and (0.14) respectively. The rooms (rm4, rm5, rm6), the kitchen (kch2), the balcony, the bathroom (bath2), the guest room (Grm), are integrated spaces with the same value (0.15) followed by the intermediate space (I) and the second guest room, the veranda, and the staircase (str3) with the same value of integration (0.18) in which it is notable that these spaces have different depths in the graph but the same value of integration. The kitchen (ktch), the patio, the kitchen (ktch3), the balcony (blc2) the terrace (trs2) and the room (rm2) have the same value (0.19). The most segregated spaces are the local (lc2) with value (0.30), followed by the terrace (trs3) with the value (0.25), and the exterior (ext), the local (lc1), the bathroom (bath3) and the toilet (wc3) have the same value (0.24) and are segregated from the exterior.

In term of control, the most controlled space in the system is the hall (HL2) with value 7.50, then the hall (HL3) with value (6.75), the hall (HL) (5.83). The intermediate space (I) has a low value of control (2.61), and the exterior (1.83).

4.2.7. Analysis of the House HP07:

The graph has a linear structure and asymmetric order in the inferior part, and a tree-like structure and symmetric order in the superior part. The spatial configuration shows a non-distributedness in general, the penetration into the house from an outer ring formed by: the exterior (ext), the garage (gr), and the veranda (vr), which provides a flexibility of movement.

Three topological types of space characterize this spatial configuration; the a-type space represents 47%, the b-type space represents 40%, the c-type space represents 12%. The graph opens on a string of spaces of type "b" type: the corridor (h), the staircase (str), the hall (Hl). In which, the house has four accesses: the veranda (vr), and the garage (gr) takes directly into the house, and the both locals (lc, lc2) have no access into the house.

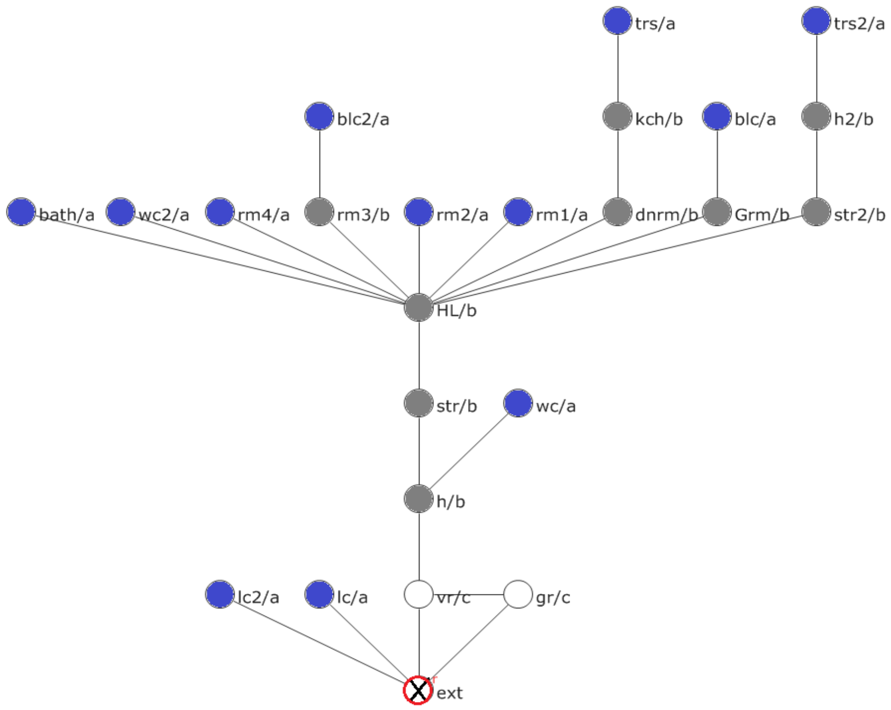


Figure -92: The justified graph of the modern House (HP07)

The hall (Hl) of b-type space is the pivot of circulation and the main central space in the house which distributes to spaces of a-type such as: the bathroom, the toile, the bedrooms (rm1, rm2, rm4). And spaces of b-type such as: room3, the dining room, the guest room, and the staircase that takes indirectly to the terrace passing by a corridor (h) of a-type space arranged as dead-end space in the last depth in the graph. The dining room opens on the kitchen which has an access to a terrace, where they are arranged in linear sequence formed by b-type spaces.

Table 57: HP07.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	ext	99	4,30	0,30	3,32	2,83
1	gr	101	4,39	0,30	3,24	0,58
2	vr	82	3,56	0,23	4,28	1,08
3	lc	121	5,26	0,38	2,58	0,25
4	lc2	121	5,26	0,38	2,58	0,25
5	h	68	2,95	0,17	5,62	1,83
6	str	58	2,52	0,13	7,22	0,43
7	wc	90	3,91	0,26	3,77	0,33
8	HL	50	2,17	0,10	9,37	7,50
9	rm2	72	3,13	0,19	5,16	0,10
10	rm1	72	3,13	0,19	5,16	0,10
11	dnrm	68	2,95	0,17	5,62	0,60
12	Grm	70	3,04	0,18	5,38	1,10
13	rm3	70	3,04	0,18	5,38	1,10
14	rm4	72	3,13	0,19	5,16	0,10
15	wc2	72	3,13	0,19	5,16	0,10
16	bath	72	3,13	0,19	5,16	0,10
17	str2	68	2,95	0,17	5,62	0,60
18	kch	88	3,82	0,25	3,89	1,50
19	blc	92	4,00	0,27	3,66	0,50
20	blc2	92	4,00	0,27	3,66	0,50
21	trs	110	4,78	0,34	2,90	0,50
22	h2	88	3,82	0,25	3,89	1,50
23	trs2	110	4,78	0,34	2,90	0,50
	Min	50,00	2,17	0,10	2,58	0,10
	Mean	**83,58**	**3,63**	**0,23**	**4,61**	**1,00**
	Max	121,00	5,26	0,38	9,37	7,50

HP07.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	gr	142	6,45	0,51	1,92	0,50
1	vr	123	5,59	0,43	2,28	1,33
2	lc	506	23,00	2,09	0,47	0,00
3	lc2	506	23,00	2,09	0,47	0,00
4	h	106	4,81	0,36	2,75	2,00
5	str	93	4,22	0,30	3,25	0,43
6	wc	125	5,68	0,44	2,24	0,33
7	HL	82	3,72	0,25	3,85	7,50
8	rm2	101	4,59	0,34	2,92	0,10
9	rm1	101	4,59	0,34	2,92	0,10
10	dnrm	97	4,40	0,32	3,08	0,60
11	Grm	99	4,50	0,33	3,00	1,10
12	rm3	99	4,50	0,33	3,00	1,10
13	rm4	101	4,59	0,34	2,92	0,10
14	wc2	101	4,59	0,34	2,92	0,10
15	bath	101	4,59	0,34	2,92	0,10
16	str2	97	4,40	0,32	3,08	0,60
17	kch	114	5,18	0,39	2,51	1,50
18	blc	118	5,36	0,41	2,40	0,50
19	blc2	118	5,36	0,41	2,40	0,50
20	trs	133	6,04	0,48	2,08	0,50
21	h2	114	5,18	0,39	2,51	1,50
22	trs2	133	6,04	0,48	2,08	0,50
	Min	82,00	3,72	0,25	0,47	0,00
	Mean	**143,91**	**6,54**	**0,52**	**2,52**	**0,91**
	Max	506,00	23,00	2,09	3,85	7,50

The quantitative data above shows that the spaces become more segregated when the exterior is included. The hall (HL) is the most integrated space with value (0.10), the staircase (str) is the second integrated space with value (0.13). The corridor (h), the dining room (dnrm), and the staircase (str2) are integrated spaces; they have the same value of integration (0.17). The guest room and the room (rm3) have the same value (0.18), they are integrated spaces and have some control. The rooms (rm1, rm2, and rm4), the bathroom (bath), and the toilet (wc2) are integrated spaces with value (0.19). Even though the veranda (vr) is shallow from the exterior, it is a segregated space with value (0.23). The corridor (h2), and the toilet (wc) are segregated spaces with value (0.25) and (0.26) respectively. The balconies have the same value (0.27). The most segregated spaces are: the exterior (ext), the garage have the same value (0.30), both terraces (0.34) and both locals (lc, lc2) are shallow from the exterior and have the highest value of integration (0.38).

4.2.8. Analysis of the House HP08:

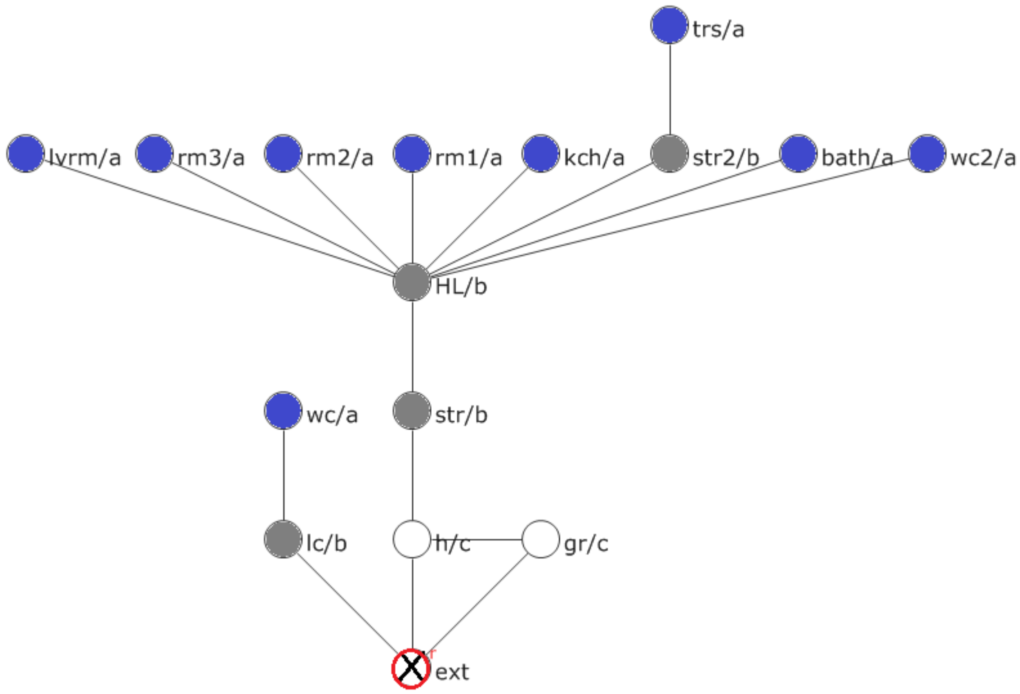


Figure -93: The justified graph of the modern House (HP08)

The graph has a striking resemblance to the previous graph of HP07, it was constructed using the exterior as a root, and it contained 16 nodes and 16 links. The spatial configuration is in symmetric order in the superior part and asymmetric order in the inferior part. The presence of an outer ring offers more than one access into the house, the house has three entrances: the garage, the corridor, and the veranda. The graph tends to -non-distributedness in global manifested by the topological spaces of a-type represents 60%. In which the configuration has three topological space a-type 60%, b-type 28%, and the c-type 20%. The graph opens on a row of two topological spaces of c-type: the garage and the corridor situated at the same depth one, and two topological spaces of b-type: the staircase (str) at depth two and the hall (HL) situated at depth three, which is a through space considered as the pivot of movement in the house that serves to a multitude of a-type spaces such as: the living room, the kitchen, the bathroom, the toilet, and the bedrooms (rm1, rm2, rm3) which are no through spaces arranged as dead-end spaces in the graph. Finally, the staircase of b-type space takes to the terrace directly.

By reviewing the quantitative data, the order of integration remains similar when the exterior is included or not. But it is notable that the value of integration increased when the exterior is not included which means that the spaces become more segregated. The hall (HL) has the lowest value of RA (0.12); it is the most integrated space and the space that shows a high accessibility in the house, and the second integrated space is the staircase (str) (0.16), followed by the corridor which has a mediocre value of RA (0.21) and the second staircase (0.23). The living room, the kitchen, the bathroom, the toilet, the bedrooms (rm1, rm2, and rm3) is segregated spaces with the same value of RA (0.25). The most segregated spaces are: the exterior (0.30), the garage (0.32), the terrace (0.37), and the local (0.41).

In term of control, the hall has the highest value of control (8.00) followed by the garage, the exterior, and the local with the same value (1.33).

Table 58: HP08.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	ext	47	3,13	0,30	3,28	1,33
1	h	38	2,53	0,21	4,56	1,33
2	gr	49	3,26	0,32	3,08	0,66
3	lc	59	3,93	0,41	2,38	1,33
4	str	32	2,13	0,16	6,17	0,44
5	wc	73	4,86	0,55	1,81	0,50
6	HL	28	1,86	0,12	8,07	8,00
7	rm1	42	2,80	0,25	3,88	0,11
8	kch	42	2,80	0,25	3,88	0,11
9	str2	40	2,66	0,23	4,20	1,11
10	bath	42	2,80	0,25	3,88	0,11
11	rm2	42	2,80	0,25	3,88	0,11
12	rm3	42	2,80	0,25	3,88	0,11
13	lvrm	42	2,80	0,25	3,88	0,11
14	wc2	42	2,80	0,25	3,88	0,11
15	trs	54	3,60	0,37	2,69	0,50
	Min	28,00	1,86	0,12	1,81	0,11
	Mean	**44,62**	**2,97**	**0,28**	**3,96**	**1,00**
	Max	73,00	4,86	0,55	8,07	8,00

HP08.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	h	62	4,42	0,52	1,89	1,50
1	gr	73	5,21	0,64	1,54	0,50
2	lc	196	14,00	2,00	0,50	1,00
3	str	53	3,78	0,42	2,33	0,61
4	wc	196	14,00	2,00	0,50	1,00
5	HL	46	3,28	0,35	2,84	8,00
6	rm1	57	4,07	0,47	2,11	0,11
7	kch	57	4,07	0,47	2,11	0,11
8	str2	55	3,92	0,45	2,21	1,11
9	bath	57	4,07	0,47	2,11	0,11
10	rm2	57	4,07	0,47	2,11	0,11
11	rm3	57	4,07	0,47	2,11	0,11
12	lvrm	57	4,07	0,47	2,11	0,11
13	wc2	57	4,07	0,47	2,11	0,11
14	trs	66	4,71	0,57	1,75	0,50
	Min	46,00	3,28	0,35	0,50	0,11
	Mean	**76,40**	**5,45**	**0,68**	**1,89**	**1,00**
	Max	196,00	14,00	2,00	2,84	8,00

4.2.9. Analysis of the House HP09:

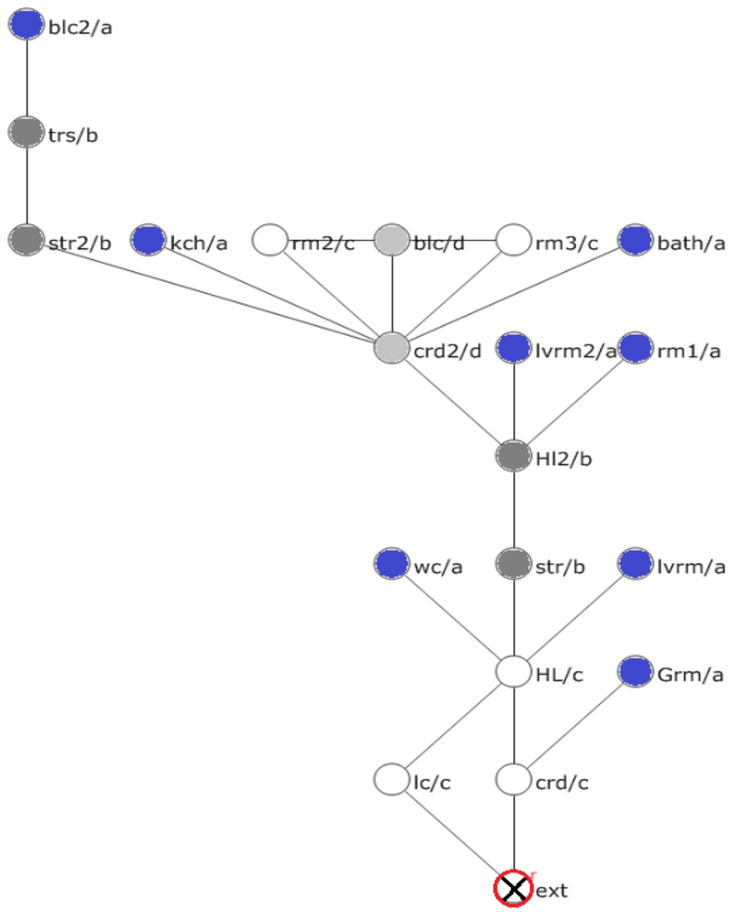


Figure -94: The justified graph of the modern House (HP09)

The configuration of the HP09 represents a symmetric order and a distributedness system. The graph is a tree- like structure and deep from the exterior, it is constituted of 20 nodes and 22 links. The graph was constructed using the exterior as a root; it represents a tree-like structure. It is characterized by the presence of outer and inner rings. The spatial configuration has four topological spaces: a-type: 42%, b-type: 22%, c-type: 30%, d-type: 10% the penetration into the house takes place at two points: the corridor (crd), and the local (lc) which form an outer ring with the hall (Hl). These three points are characterized by spatial flexibility while circumscribing the movement in a well determined circuit. The corridor has an access into the guest room which is destined to receive visitors and strangers; for that reason, it is shallow from the exterior and situated at depth two as dead- end space, where it is isolated from the other spaces in the house. The hall (HL) takes to the toilet, living room, are of a-type space and the staircase of b-type space takes directly to a hall (Hl2) that distributes to another living room (lvrm2) and a bedroom (rm1) of a-type space arranged as dead-end spaces at depth five. The corridor (crd2), the bedroom (rm3), the balcony (blc), and the bedroom (rm4) are connected with each other forming two inner rings whereas the balcony and the corridor of c-type space, provide a choice of mobility within the house and offer low control, these spaces are situated at depth six and they are deep from the exterior. The kitchen and the bathroom of a-type space arranged at depth six are no through spaces. The staircase (str2) of b-type space a through space takes to the terrace (trs) of b-type space that has an access to a balcony.

The quantitative results show that the order of integration remains similar when the exterior is included or not. The hall (HL2) has the lowest value of RA (0.15), it is also the most integrated space, followed by the corridor (crd2) with value (0.16) and the staircase (str) with value (0.17), they are both integrated spaces. The hall (HL) is an integrated space with value of RA (0.21). The staircase (str2) shows a moderate value of RA (0.24). The balcony (blc), the bedroom (rm1), and the living room (lvrm) have the same value of integration (0.25). The bathroom, the kitchen, and the bedrooms (rm2, rm3) have the same value (0.26). The living room and the guest are shallow from the exterior but they are segregated space with high value of RA (0.31) and (0.33) respectively. The corridor (crd) situated at the first depth has a high value of RA (0.29). The most segregated space is the balcony (blc2) with value (0.44), the exterior (0.38), and the terrace (0.33).

Table 59: HP09.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	ext	85	4,47	0,38	2,59	0,83
1	crd	69	3,63	0,29	3,42	1,70
2	lc	71	3,73	0,30	3,28	0,70
3	HL	55	2,89	0,21	4,75	3,33
4	Grm	87	4,57	0,39	2,51	0,33
5	lvrm	73	3,84	0,31	3,16	0,20
6	str	49	2,57	0,17	5,70	0,45
7	wc	73	3,84	0,31	3,16	0,20
8	Hl2	45	2,36	0,15	6,57	2,64
9	rm1	63	3,31	0,25	3,88	0,25
10	lvrm2	63	3,31	0,25	3,88	0,25
11	crd2	47	2,47	0,16	6,10	4,08
12	blc	63	3,31	0,25	3,88	1,14
13	rm3	64	3,36	0,26	3,80	0,47
14	rm2	64	3,36	0,26	3,80	0,47
15	kch	65	3,42	0,26	3,71	0,14
16	str2	61	3,21	0,24	4,07	0,64
17	bath	65	3,42	0,26	3,71	0,14
18	trs	77	4,05	0,33	2,94	1,50
19	blc2	95	5,00	0,44	2,25	0,50
	Min	45,00	2,36	0,15	2,25	0,14
	Mean	**66,70**	**3,51**	**0,27**	**3,86**	**1,00**
	Max	95,00	5,00	0,44	6,57	4,08

HP09.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	crd	68	3,77	0,32	3,06	1,20
1	lc	70	3,88	0,33	2,94	0,20
2	HL	53	2,94	0,22	4,37	4,00
3	Grm	85	4,72	0,43	2,28	0,50
4	lvrm	70	3,88	0,33	2,94	0,20
5	str	46	2,55	0,18	5,46	0,45
6	wc	70	3,88	0,33	2,94	0,20
7	Hl2	41	2,27	0,15	6,65	2,64
8	rm1	58	3,22	0,26	3,82	0,25
9	lvrm2	58	3,22	0,26	3,82	0,25
10	crd2	42	2,33	0,15	6,37	4,08
11	blc	57	3,16	0,25	3,92	1,14
12	rm3	58	3,22	0,26	3,82	0,47
13	rm2	58	3,22	0,26	3,82	0,47
14	kch	59	3,27	0,26	3,73	0,14
15	str2	55	3,05	0,24	4,13	0,64
16	bath	59	3,27	0,26	3,73	0,14
17	trs	70	3,88	0,33	2,94	1,50
18	blc2	87	4,83	0,45	2,21	0,50
	Min	41,00	2,27	0,15	2,21	0,14
	Mean	**61,26**	**3,40**	**0,28**	**3,84**	**1,00**
	Max	87,00	4,83	0,45	6,65	4,08

4.2.10. Analysis of the House HP10:

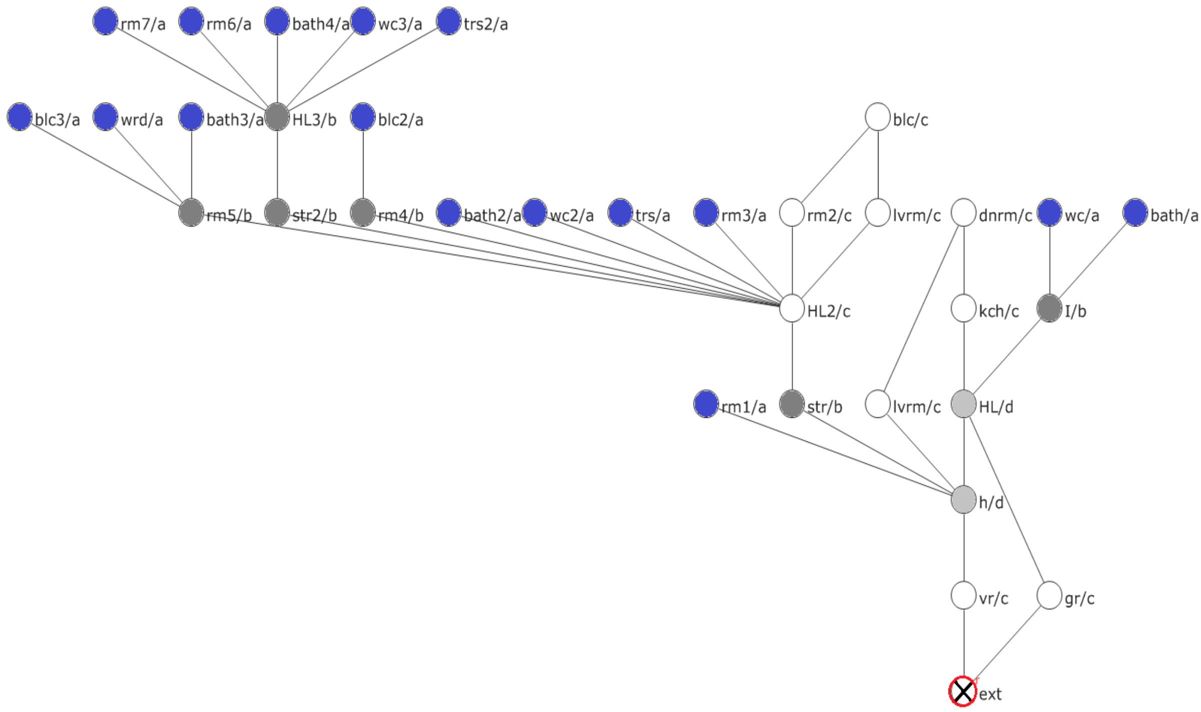


Figure -95: The justified graph of the modern House (HP10)

The graph represents an arborescent structure; it is in symmetric order and deep from the exterior. It is characterized by the presence of the four topological spaces the a-type: 48%, b-type: 18%, c-type: 29%, d-type: 6%, which makes the spatial configuration tend to the distributedness that is manifested by the existence of inner and outer rings. The penetration into the house by a range of spaces of c- and d-type which offer a choice of mobility and flexibility of movement within the house, and tend to decrease the control of; the veranda (vr) and the garage (gr) these two points permit to accede into the house. The first outer ring formed by: the exterior, the corridor (h), the garage (gr), and the hall (Hl), the second ring formed by: the corridor (h), the hall (Hl), the kitchen (kch), the dining room (dnrm), and the living room (lvrm), this ring contains the spaces that have a functional relationship. The hall takes to an intermediate space (I) where the ablution spaces are. The bathroom and the toilet of a-type space are arranged as dead-end spaces. This part of the graph represents the ground floor where there is strong flexibility and accessibility within the house and less control which makes it less private area. The corridor (h) takes to the staircase (str) of b-type a through space that serve to the second hall (Hl2) in the first floor which is part from an inner ring that is formed by: living room (lvrm2), the balcony, the hall (Hl2), and the bedroom (rm2). The hall (Hl2) is a main space that distributes to spaces of a-type: the bedroom (rm3), the bathroom, the toilet (wc), and the (trs) are arranged as dead end-spaces, which are suitable for the inhabitants. It also distributes to spaces of b-type where there are through spaces: the room4 has an access to a balcony (bc2), the room5 has access to a bathroom, wardrobe and a balcony; this room is destined to the parents. In addition, the staircase (str3) that takes to another level more private where we can find spaces of a-type: bedrooms (rm6, rm7), the terrace (trs2), the bathroom (bath4), and the toilet (wc3) are arranged around the hall (Hl3) in the last depth in graph.

Table 60: HP10.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	ext	153	4,63	0,22	4,40	1,00
1	vr	128	3,87	0,17	5,55	0,70
2	gr	148	4,48	0,21	4,59	0,75
3	h	99	3,00	0,12	8,00	2,75
4	HL	119	3,60	0,16	6,13	1,53
5	kch	148	4,48	0,21	4,59	0,75
6	dnrm	153	4,63	0,22	4,40	1,00
7	lvrm	128	3,87	0,17	5,55	0,70
8	str	89	2,69	0,10	9,42	0,30
9	rm1	131	3,96	0,18	5,38	0,20
10	I	147	4,45	0,21	4,63	2,25
11	HL2	81	2,45	0,09	11,00	6,75
12	wc	179	5,42	0,27	3,61	0,33
13	bath	179	5,42	0,27	3,61	0,33
14	rm2	111	3,36	0,14	6,76	0,60
15	lvrm	111	3,36	0,14	6,76	0,60
16	rm3	113	3,42	0,15	6,60	0,10
17	trs	113	3,42	0,15	6,60	0,10
18	wc2	113	3,42	0,15	6,60	0,10
19	bath2	113	3,42	0,15	6,60	0,10
20	rm4	111	3,36	0,14	6,76	1,10
21	str2	101	3,06	0,12	7,76	0,26
22	rm5	107	3,24	0,14	7,13	3,10
23	bath3	139	4,21	0,20	4,98	0,25
24	wrd	139	4,21	0,20	4,98	0,25
25	HL3	123	3,72	0,17	5,86	5,50
26	blc	141	4,27	0,20	4,88	1,00
27	blc2	143	4,33	0,20	4,80	0,50
28	blc3	139	4,21	0,20	4,98	0,25
29	bath4	155	4,69	0,23	4,32	0,16
30	wc3	155	4,69	0,23	4,32	0,16
31	rm6	155	4,69	0,23	4,32	0,16
32	trs2	155	4,69	0,23	4,32	0,16
33	rm7	155	4,69	0,23	4,32	0,16
	Min	81,00	2,45	0,09	3,61	0,10
	Mean	**131,58**	**3,98**	**0,18**	**5,72**	**1,00**
	Max	179,00	5,42	0,27	11,00	6,75

HP10.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	vr	128	4,00	0,19	5,16	0,20
1	gr	148	4,62	0,23	4,27	0,25
2	h	97	3,03	0,13	7,63	3,25
3	HL	117	3,65	0,17	5,83	2,03
4	kch	145	4,53	0,22	4,38	0,75
5	dnrm	149	4,65	0,23	4,23	1,00
6	lvrm	125	3,90	0,18	5,33	0,70
7	str	86	2,68	0,10	9,18	0,30
8	rm1	128	4,00	0,19	5,16	0,20
9	I	144	4,50	0,22	4,42	2,25
10	HL2	77	2,40	0,09	11,02	6,75
11	wc	175	5,46	0,28	3,46	0,33
12	bath	175	5,46	0,28	3,46	0,33
13	rm2	106	3,31	0,14	6,70	0,60
14	lvrm	106	3,31	0,14	6,70	0,60
15	rm3	108	3,37	0,15	6,52	0,10
16	trs	108	3,37	0,15	6,52	0,10
17	wc2	108	3,37	0,15	6,52	0,10
18	bath2	108	3,37	0,15	6,52	0,10
19	rm4	106	3,31	0,14	6,70	1,10
20	str2	96	3,00	0,12	7,75	0,26
21	rm5	102	3,18	0,14	7,08	3,10
22	bath3	133	4,15	0,20	4,91	0,25
23	wrd	133	4,15	0,20	4,91	0,25
24	HL3	117	3,65	0,17	5,83	5,50
25	blc	135	4,21	0,20	4,81	1,00
26	blc2	137	4,28	0,21	4,72	0,50
27	blc3	133	4,15	0,20	4,91	0,25
28	bath4	148	4,62	0,23	4,27	0,16
29	wc3	148	4,62	0,23	4,27	0,16
30	rm6	148	4,62	0,23	4,27	0,16
31	trs2	148	4,62	0,23	4,27	0,16
32	rm7	148	4,62	0,23	4,27	0,16
	Min	77,00	2,40	0,09	3,46	0,10
	Mean	**126,36**	**3,94**	**0,19**	**5,64**	**1,00**
	Max	175,00	5,46	0,28	11,02	6,75

The data shows that the calculations remain similar whether or not the exterior is included. The second hall (Hl2) the most integrated space with low value of RA (0.09), followed by the staircase (0.10), the corridor (h), and the second staircase (str2) have the same value (0.12). the bedrooms (rm2, rm4, rm5), and the living room (lvrm2) are integrated spaces with low value of RA (0.14), the bedroom (rm3), the bathroom (bath2), the toilet (wc2), and the terrace (trs) have the same value of integration (0.15). The hall (HL) has value of integration (0.16), the veranda, the living room, and the third hall (HL3) that situated at second floor have the same value (0.17) despite the fact that they are situated at different levels and it refers to the accessibility of these spaces. The balconies have the same value (0.20), the exterior and the dining room are segregated spaces with the same value (0.22), even though they are situated at different depths. The garage (21) is segregated space. The most segregated spaces are the bathroom and the toilet with value (0.27).

In term of control, the second hall (HL2) has the highest value of control (6.75), then the hall (HL3) (5.50), the bedroom5 (3.10), the corridor (h) (2.75), and the intermediate space (I) (2.25).

4.2.11. Analysis of the House HP11:

The graph represents an arborescent structure; it is in symmetric order and non-distributedness system. The graph characterized by two inner rings. Has four topological spaces of a-type, it represents 56%, the b-type 26%, the c-type 20%, and the d-type 17%. The penetration into the house is from four points; three of them of a-type spaces: the garages (gr, gr1, and gr2), and in which they are arranged as dead-end spaces in the graph and have no access into the house.

In addition, a point of b-type space: the courtyard (cor) which takes to the staircase (str); and to the hall (HL) in the first floor, which is the pivot of movement and circulation. The hall distributes to two spaces of a-type which are no through spaces: the bathroom (bath), and the bedroom (rm1), two spaces of b-type: the kitchen (ktch) and the receiving room (rcvrm) which they have an access to balconies (blc1, and blc2) respectively, three spaces of c- and d-type where they part of the inner rings: the bedrooms (rm2, and rm3) the (rm2) has an access to a toilet and a balcony, and the terrace (trs).

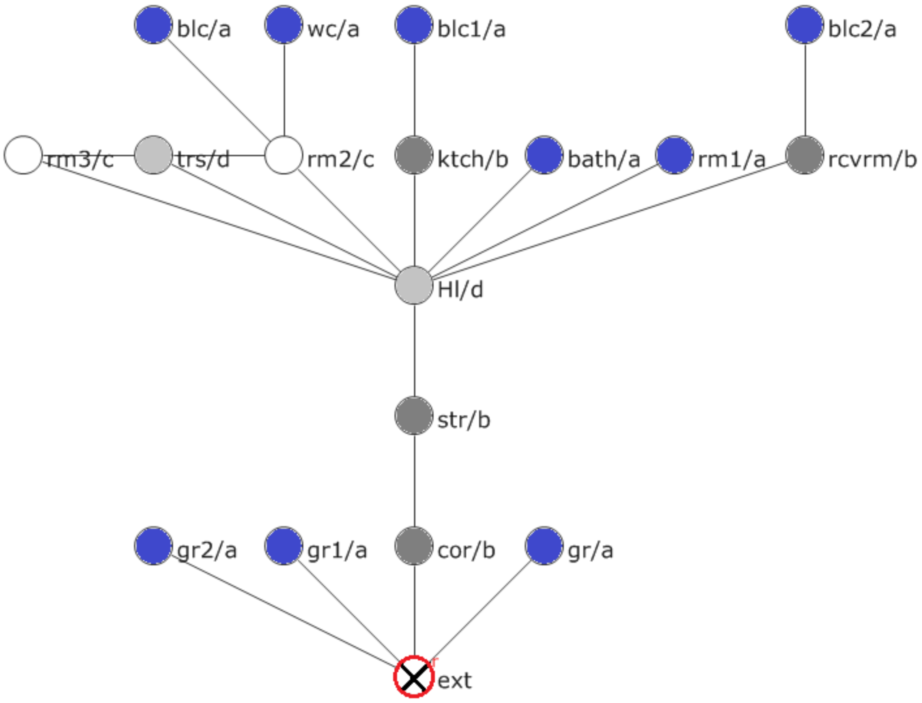


Figure -96: The justified graph of the modern House (HP11)

Table 61: HP11.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	ext	57	3,35	0,29	3,40	3,50
1	cor	47	2,76	0,22	4,53	0,75
2	gr1	73	4,29	0,41	2,42	0,25
3	gr	73	4,29	0,41	2,42	0,25
4	gr2	73	4,29	0,41	2,42	0,25
5	str	39	2,29	0,16	6,18	0,62
6	Hl	33	1,94	0,11	8,50	4,58
7	ktch	47	2,76	0,22	4,53	1,12
8	bath	49	2,88	0,23	4,25	0,12
9	rm1	49	2,88	0,23	4,25	0,12
10	rm2	44	2,58	0,19	5,03	2,45
11	trs	45	2,64	0,20	4,85	0,87
12	rm3	48	2,82	0,22	4,38	0,45
13	rcvrm	47	2,76	0,22	4,53	1,12
14	wc	60	3,52	0,31	3,16	0,25
15	blc	60	3,52	0,31	3,16	0,25
16	blc1	63	3,70	0,33	2,95	0,50
17	blc2	63	3,70	0,33	2,95	0,50
	Min	33,00	1,94	0,11	2,42	0,12
	Mean	**53,88**	**3,16**	**0,27**	**4,11**	**1,00**
	Max	73,00	4,29	0,41	8,50	4,58

HP11.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	cor	91	5,68	0,62	1,60	0,50
1	gr1	272	17,00	2,13	0,46	0,00
2	gr	272	17,00	2,13	0,46	0,00
3	gr2	272	17,00	2,13	0,46	0,00
4	str	79	4,93	0,52	1,90	1,12
5	Hl	69	4,31	0,44	2,26	4,58
6	ktch	79	4,93	0,52	1,90	1,12
7	bath	81	5,06	0,54	1,84	0,12
8	rm1	81	5,06	0,54	1,84	0,12
9	rm2	76	4,75	0,50	2,00	2,45
10	trs	77	4,81	0,50	1,96	0,87
11	rm3	80	5,00	0,53	1,87	0,45
12	rcvrm	79	4,93	0,52	1,90	1,12
13	wc	88	5,50	0,60	1,66	0,25
14	blc	88	5,50	0,60	1,66	0,25
15	blc1	91	5,68	0,62	1,60	0,50
16	blc2	91	5,68	0,62	1,60	0,50
	Min	69,00	4,31	0,44	0,46	0,00
	Mean	**115,64**	**7,22**	**0,83**	**1,59**	**0,82**
	Max	272,00	17,00	2,13	2,26	4,58

The quantitative data shows that the order of integration remains similar, but the spaces tend to be more segregated when the exterior is not included. The most integrated space is the hall (0.11), and then the staircase which is the second integrated space (0.16), followed by bedroom (rm2) with value (0.19) and the terrace (0.20). Each of the kitchen, the courtyard, the bedroom (rm3), and the receiving room has the same integration value (0.22). The bathroom, the bedroom (rm1), and the exterior have moderate value of integration. The most segregated spaces are: the balconies, and the garages with values (0.33, 0.41) respectively. The hall is the most controlled space with value (4.58), followed by the exterior with value (3.50).

4.2.12. Analysis of the House HP12:

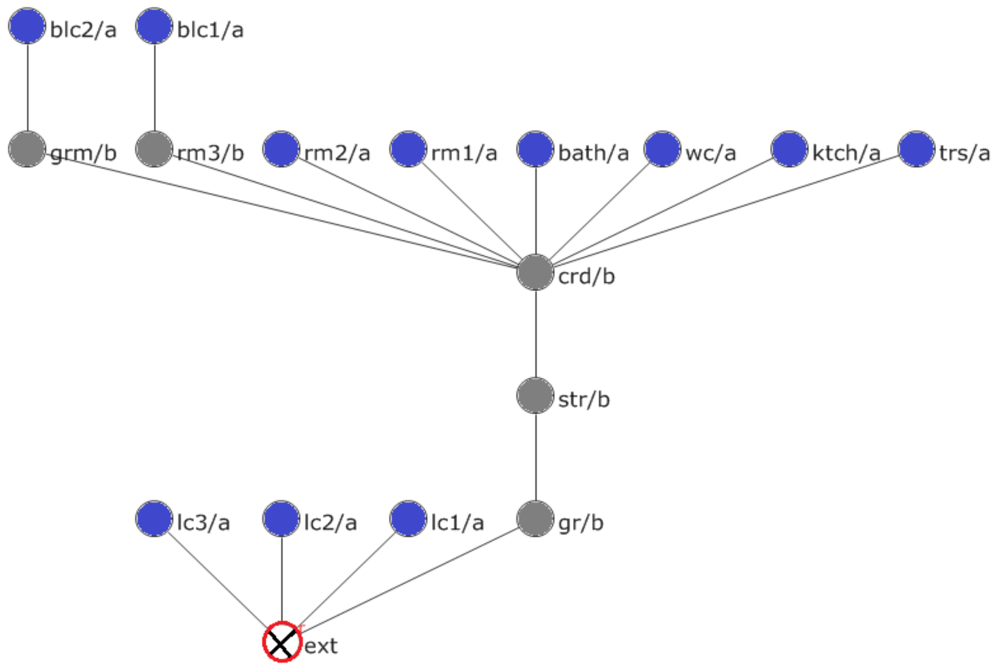


Figure -97: The justified graph of the modern House (HP12)

The graph is constructed using the exterior as a root, the configuration represents an arborescent structure, it is in symmetric order and non-distributedness system manifested in the absence of rings and the high number of the topological spaces of a-type and b-type, whereas the a-type represents 68%, and the b-type: 33 %. There are four spaces connected with the exterior: three of them of a-type space: locals (lc1, lc2, lc3) arranged as dead-end spaces at depth one and have no access into the house, and a space of b-type: the garage (gr) which is the point of penetration into the house it takes directly to the corridor (crd) of b-type; itis a through space where there is no choice of circulation and it is also the pivot of movement, it distributes to a multitude of a-type spaces: the bedrooms (rm1, rm2), the bathroom, the toilet, the kitchen, and the terrace; they are arranged as dead-end spaces at depth four. Moreover, it distributes to spaces of b-type: the guest room and bedroom (rm3) which have access to balconies.

Table 62: HP12.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	**ext**	51	3,18	0,29	3,42	3,50
1	**lc2**	66	4,12	0,41	2,40	0,25
2	**lc1**	66	4,12	0,41	2,40	0,25
3	**lc3**	66	4,12	0,41	2,40	0,25
4	**gr**	42	2,62	0,21	4,61	0,75
5	**str**	35	2,18	0,15	6,31	0,61
6	**crd**	30	1,87	0,11	8,57	7,50
7	**bath**	45	2,81	0,24	4,13	0,11
8	**rm1**	45	2,81	0,24	4,13	0,11
9	**rm2**	45	2,81	0,24	4,13	0,11
10	**rm3**	43	2,68	0,22	4,44	1,11
11	**wc**	45	2,81	0,24	4,13	0,11
12	**ktch**	45	2,81	0,24	4,13	0,11
13	**trs**	45	2,81	0,24	4,13	0,11
14	**grm**	43	2,68	0,22	4,44	1,11
15	**blc2**	58	3,62	0,35	2,85	0,50
16	**blc1**	58	3,62	0,35	2,85	0,50
	Min	30,00	1,87	0,11	2,40	0,11
	Mean	**48,70**	**3,04**	**0,27**	**4,09**	**1,00**
	Max	66,00	4,12	0,41	8,57	7,50

HP12.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	**lc2**	255	17,00	2,28	0,43	0,00
1	**lc1**	255	17,00	2,28	0,43	0,00
2	**lc3**	255	17,00	2,28	0,43	0,00
3	**gr**	86	5,73	0,67	1,47	0,50
4	**str**	75	5,00	0,57	1,75	1,11
5	**crd**	66	4,40	0,48	2,05	7,50
6	**bath**	77	5,13	0,59	1,69	0,11
7	**rm1**	77	5,13	0,59	1,69	0,11
8	**rm2**	77	5,13	0,59	1,69	0,11
9	**rm3**	75	5,00	0,57	1,75	1,11
10	**wc**	77	5,13	0,59	1,69	0,11
11	**ktch**	77	5,13	0,59	1,69	0,11
12	**trs**	77	5,13	0,59	1,69	0,11
13	**grm**	75	5,00	0,57	1,75	1,11
14	**blc2**	86	5,73	0,67	1,47	0,50
15	**blc1**	86	5,73	0,67	1,47	0,50
16	16	-	-	-	-	-
	Min	66,00	4,40	0,48	0,43	0,00
	Mean	**111,00**	**7,40**	**0,91**	**1,45**	**0,81**
	Max	255,00	17,00	2,28	2,05	7,50

In term of quantitative data, the order of integration remains similar, but the spaces tend to be more segregated when the exterior is not included. The corridor (crd) is the most integrated space with low value of RA (0.11), followed by the staircase (str) with value (0.15). The garage is an integrated space with value (0.21). The guest room and the bedroom3 have the same integrated value (0.22). Each of the bathroom, the bedrooms (rm1, rm3), the kitchen, the terrace, and the toilet has a moderate value of integration (0.24). The segregated spaces are the exterior with value (0.29), the balconies (0.35), and three locals are the most segregated spaces (0.41). The corridor is the most controlled space (7.50), then the exterior with value (3.50).

4.2.13. Analysis of the House HP13:

The graph is constructed using the exterior as a root, itis deep from the exterior and it represents an arborescent structure with two bushes, the configuration is in symmetric order and non-distributedness system. The graph is contains from 23 nodes and 22 links.

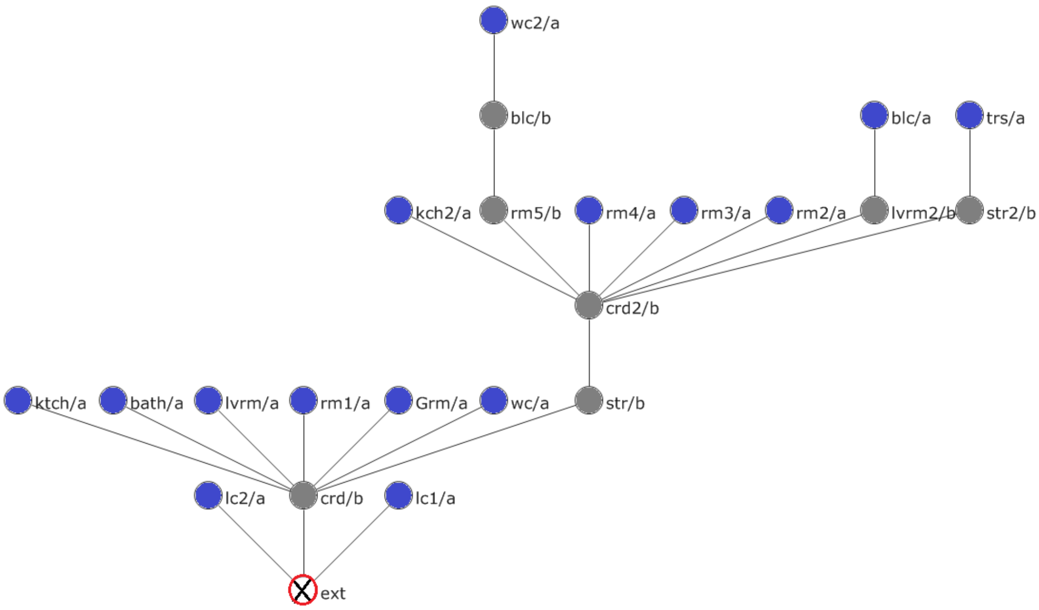


Figure -98: The justified graph of the modern House (HP13)

The topological spaces of a-type represent: 68%, and b-type: 28%. The configuration has three different point of penetration into the house: the both locals (lc1, lc2) of a-type space arranged as dead end space at depth one and have no access into the house, and the corridor of b-type space a through space and the pivot of circulation, in which it distributes to a multitude spaces of a-type: the kitchen, the bathroom, the living room, the guest room, the toilet, and the bedroom (rm1), and to a staircase of b-type which takes to the next floor; to the second corridor (crd2) of b-type that distributes to other spaces of a-type: the kitchen (ktch2), the bedrooms (rm2, rm3, rm4), and b-type: living room (lvrm2) has an access to a balcony, the staircase (str2) takes to the terrace, and bedroom (rm5) has an access to a balcony and a toilet.

From the quantitative data, the values of integration become more segregated when the exterior is not included, and the order of integration remains similar in both cases. The most integrated spaces are the staircase (str) and the second corridor (crd2) with value (0.11), followed by the first corridor (crd) in the ground floor with value (0.12), the bedroom (rm5) integrated with value (0.18), followed by the staircase (str2) and the living room (lvrm2) in the first floor with value (0.19). Each of the bedrooms (rm2, rm3, and rm4), the exterior, and the kitchen (ktch2) are integrated spaces with value of RA (0.20). Each of the bedroom (rm1), the guest room, the bathroom, the toilet, the living room, and the kitchen has a moderate value of integration (0.22). The balconies and the terrace are segregated with value (0.26) and (0.28), both locals are segregated with value (0.29), and the most segregated space is the toilet with value (0.35) which is situated at last depth. Both corridors have the highest value of control (6.83), (6.00), followed by the exterior with value (2.12).

Table 63: HP13.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	ext	69	3,13	0,20	4,91	2,12
1	crd	52	2,36	0,12	7,70	6,83
2	Lc1	90	4,09	0,29	3,39	0,33
3	lc2	90	4,09	0,29	3,39	0,33
4	rm1	73	3,31	0,22	4,52	0,12
5	Grm	73	3,31	0,22	4,52	0,12
6	wc	73	3,31	0,22	4,52	0,12
7	lvrm	73	3,31	0,22	4,52	0,12
8	bthm	73	3,31	0,22	4,52	0,12
9	str	49	2,22	0,11	8,55	0,25
10	kch	73	3,31	0,22	4,52	0,12
11	11	48	2,18	0,11	8,88	6,00
12	rm3	69	3,13	0,20	4,91	0,12
13	rm4	69	3,13	0,20	4,91	0,12
14	rm5	65	2,95	0,18	5,37	0,62
15	rm2	69	3,13	0,20	4,91	0,12
16	lvrm2	67	3,04	0,19	5,13	1,12
17	str2	67	3,04	0,19	5,13	1,12
18	ktch2	69	3,13	0,20	4,91	0,12
19	trs	88	4,00	0,28	3,50	0,50
20	blc	88	4,00	0,28	3,50	0,50
21	blc	84	3,81	0,26	3,72	1,50
22	wc2	105	4,77	0,35	2,78	0,50
	Min	48,00	2,18	0,11	2,78	0,12
	Mean	**72,86**	**3,31**	**0,22**	**4,90**	**1,00**
	Max	105,00	4,77	0,35	8,88	6,83

HP13.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	crd	91	4,33	0,33	3,00	6,50
1	Lc1	462	22,00	2,10	0,47	0,00
2	lc2	462	22,00	2,10	0,47	0,00
3	rm1	109	5,19	0,41	2,38	0,14
4	Grm	109	5,19	0,41	2,38	0,14
5	wc	109	5,19	0,41	2,38	0,14
6	lvrm	109	5,19	0,41	2,38	0,14
7	bthm	109	5,19	0,41	2,38	0,14
8	str	85	4,04	0,30	3,28	0,26
9	kch	109	5,19	0,41	2,38	0,14
10	10	81	3,85	0,28	3,50	6,00
11	rm3	99	4,71	0,37	2,69	0,12
12	rm4	99	4,71	0,37	2,69	0,12
13	rm5	95	4,52	0,35	2,83	0,62
14	rm2	99	4,71	0,37	2,69	0,12
15	lvrm2	97	4,61	0,36	2,76	1,12
16	str2	97	4,61	0,36	2,76	1,12
17	ktch2	99	4,71	0,37	2,69	0,12
18	trs	115	5,47	0,44	2,23	0,50
19	blc	115	5,47	0,44	2,23	0,50
20	blc	111	5,28	0,42	2,33	1,50
21	wc2	129	6,14	0,51	1,94	0,50
	Min	81,00	3,85	0,28	0,47	0,00
	Mean	**135,90**	**6,47**	**0,54**	**2,40**	**0,90**
	Max	462,00	22,00	2,10	3,50	6,50

4.2.14. Analysis of the House HP14:

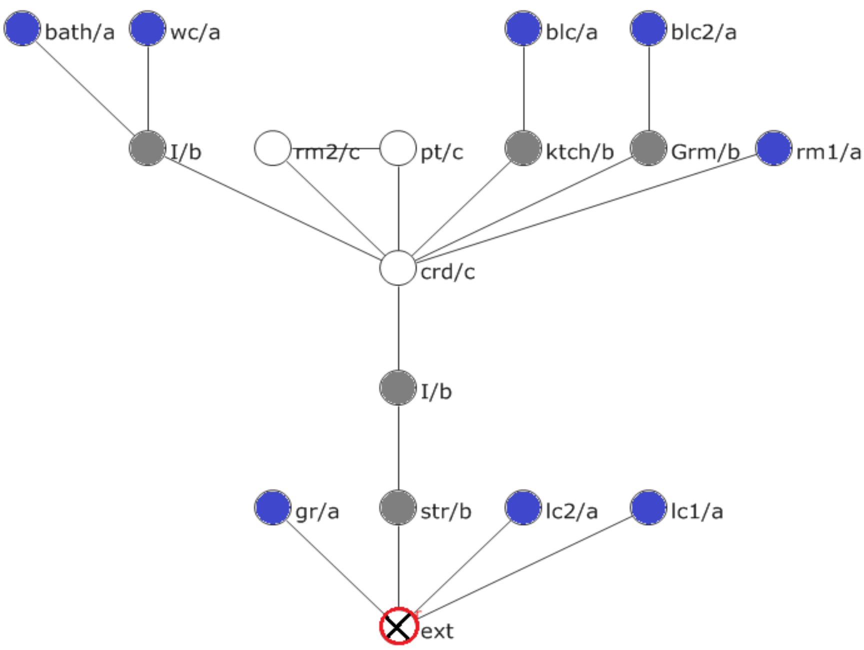


Figure -99: The justified graph of the modern House (HP14)

The configuration represents an arborescent structure. The graph is in symmetric order, and lack in distributedness system. The existence of an inner ring in the superior part in the graph provides some flexibility of movement. The graph is characterized by three topological types, the a-type: 50%, the b-type: 33%, and the c-type: 17%. The penetration into the house from four points; three of a-type: the garage (gr), and the both local (lc1, lc2) where they have no access into the house, and space of b-type: is the staircase (str) that takes to another space of b-type an intermediate space (I), this intermediate space takes to the corridor the main space in the house and distributes to all the spaces, of c-type and it is part of an inner ring formed by the patio and the bedroom (rm2) where there is a choice of mobility. The ablution spaces; the bathroom and the toilet are isolated from the other spaces and are arranged as dead-end spaces in the last depth in the graph. The bedroom (rm1) of a-type space, the kitchen and the guest room are of b-type spaces they have access to two balconies.

Table 64: HP14.agx_summary. Exterior included **HP14.agx_summary. Exterior not included**

		TDn	MDn	RA	i	CV
0	ext	53	3,31	0,30	3,24	3,50
1	gr	68	4,25	0,43	2,30	0,25
2	str	44	2,75	0,23	4,28	0,75
3	lc1	68	4,25	0,43	2,30	0,25
4	lc2	68	4,25	0,43	2,30	0,25
5	I	37	2,31	0,17	5,71	0,64
6	crd	32	2,00	0,13	7,50	3,83
7	pt	46	2,87	0,25	4,00	0,64
8	ktch	45	2,81	0,24	4,13	1,14
9	Gstrm	45	2,81	0,24	4,13	1,14
10	rm2	46	2,87	0,25	4,00	0,64
11	i	43	2,68	0,22	4,44	2,14
12	rm1	47	2,93	0,25	3,87	0,14
13	blc	60	3,75	0,36	2,72	0,50
14	wc	58	3,62	0,35	2,85	0,33
15	bath	58	3,62	0,35	2,85	0,33
16	blc2	60	3,75	0,36	2,72	0,50
	Min	32,00	2,00	0,13	2,30	0,14
	Mean	**51,64**	**3,22**	**0,29**	**3,73**	**1,00**
	Max	68,00	4,25	0,43	7,50	3,83

		TDn	MDn	RA	i	CV
0	gr	240	16,00	2,14	0,46	0,00
1	str	85	5,66	0,66	1,50	0,50
2	lc1	240	16,00	2,14	0,46	0,00
3	lc2	240	16,00	2,14	0,46	0,00
4	I	74	4,93	0,56	1,77	1,14
5	crd	65	4,33	0,47	2,10	3,83
6	pt	75	5,00	0,57	1,75	0,64
7	ktch	74	4,93	0,56	1,77	1,14
8	Gstrm	74	4,93	0,56	1,77	1,14
9	rm2	75	5,00	0,57	1,75	0,64
10	i	72	4,80	0,54	1,84	2,14
11	rm1	76	5,06	0,58	1,72	0,14
12	blc	85	5,66	0,66	1,50	0,50
13	wc	83	5,53	0,64	1,54	0,33
14	bath	83	5,53	0,64	1,54	0,33
15	blc2	85	5,66	0,66	1,50	0,50
	Min	65,00	4,33	0,47	0,46	0,00
	Mean	**107,87**	**7,19**	**0,88**	**1,46**	**0,81**
	Max	240,00	16,00	2,14	2,10	3,83

The data show that the calculations remain similar whether or not the exterior is included. The spaces become more segregated when the exterior is not included. The corridor is the most integrated space (0.13), then the intermediate space (I) with value (0.17), the staircase integrated with value (0.23), the kitchen and the guestroom (0.24). The patio and the bedroom1 have a moderate integration value (0.25). The exterior is segregated with value (0.30), the most segregated spaces are: the bathroom and the toilet (0.35), the balconies

(0.36), the garage and both locals have the same high value (0.43). The corridor is the most controlled space with value (3.83).

4.2.15. Analysis of the House HP15:

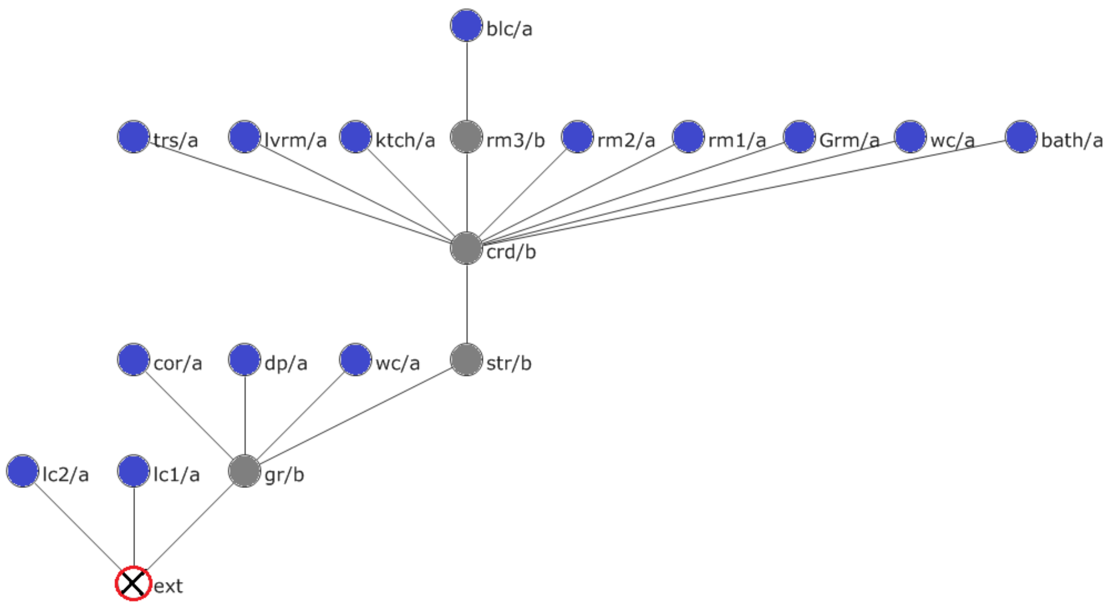


Figure -100: The justified graph of the modern House (HP15)

The configuration was constructed using the exterior as a root; it represents an arborescent structure and deep from the exterior. The graph is in symmetric order and non- distributedness system manifested in the topological spaces a-type and b-type; the a-type spaces represent: 77%, and b-type: 24%. The penetration into the house from three points; two of them of a-type the locals (lc1, lc2) where they have no access into the house, and the third space of b-type: the garage which is connected to a toilet, courtyard, deposit these spaces of a-type arranged as dead-end spaces at depth two, and to a staircase of b-type that leads to the first floor where we find the habitable spaces. The staircase takes to the corridor (crd) of b-type space the main space in the house that offer more accessibility and distribution to a multitude space of a-type as: the terrace, the living room, the kitchen, the guest room, the bathroom, the toilet, and the bedrooms (rm1, rm2) these spaces are suitable for the inhabitants because there is no through circulation. The bedroom (rm3) of b-type space has an access to a balcony, which is arranged in the last depth in the graph.

The quantitative data shows that the spaces become more segregated when the exterior is not included; the order of integration remains similar whether or not the exterior is included. The most integrated space in the house is the corridor (crd) with value (0.10) and it is the most accessible space, the staircase (str) is the second integrated space with value (0.12), followed by the garage (0.15). The bedroom (rm5) has a moderate value (0.20) it is an integrated space. The kitchen, the living room, the guest room, the bathroom, the toilet, the terrace, and the bedrooms (rm1, rm2), have a moderate segregation with value (0.21). The exterior is segregated space with value (0.24), the toilet, the courtyard, and the deposit are segregated with value (0.26) even though they are shallow from the exterior. The balcony and the both locals show the high value of integration, they are the most segregated spaces in the house with value (0.31) (0.35) respectively.

In term of control, the corridor is the most controlled space (9.00), the garage is the second controlled space (3.30), then the exterior (2.20).

Table 65: HP15.agx_summary. Exterior included

		TDn	MDn	RA	i	CV
0	**ext**	55	3,05	0,24	4,13	2,20
1	**lc1**	72	4,00	0,35	2,83	0,33
2	**gr**	42	2,33	0,15	6,37	3,83
3	**lc2**	72	4,00	0,35	2,83	0,33
4	**dp**	59	3,27	0,26	3,73	0,20
5	**cor**	59	3,27	0,26	3,73	0,20
6	**wc**	59	3,27	0,26	3,73	0,20
7	**str**	37	2,05	0,12	8,05	0,30
8	**crd**	34	1,88	0,10	9,56	9,00
9	**rm3**	49	2,72	0,20	4,93	1,10
10	**ktch**	51	2,83	0,21	4,63	0,10
11	**lvrm**	51	2,83	0,21	4,63	0,10
12	**trs**	51	2,83	0,21	4,63	0,10
13	**rm2**	51	2,83	0,21	4,63	0,10
14	**rm1**	51	2,83	0,21	4,63	0,10
15	**Gsrm**	51	2,83	0,21	4,63	0,10
16	**wc**	51	2,83	0,21	4,63	0,10
17	**bth**	51	2,83	0,21	4,63	0,10
18	**blc**	66	3,66	0,31	3,18	0,50
	Min	34,00	1,88	0,10	2,83	0,10
	Mean	**53,26**	**2,95**	**0,23**	**4,74**	**1,00**
	Max	72,00	4,00	0,35	9,56	9,00

HP15.agx_summary. Exterior not included

		TDn	MDn	RA	i	CV
0	**lc1**	306	18,00	2,12	0,47	0,00
1	**gr**	73	4,29	0,41	2,42	3,50
2	**lc2**	306	18,00	2,12	0,47	0,00
3	**dp**	87	5,11	0,51	1,94	0,25
4	**cor**	87	5,11	0,51	1,94	0,25
5	**wc**	87	5,11	0,51	1,94	0,25
6	**str**	65	3,82	0,35	2,83	0,35
7	**crd**	59	3,47	0,30	3,23	9,00
8	**rm3**	71	4,17	0,39	2,51	1,10
9	**ktch**	73	4,29	0,41	2,42	0,10
10	**lvrm**	73	4,29	0,41	2,42	0,10
11	**trs**	73	4,29	0,41	2,42	0,10
12	**rm2**	73	4,29	0,41	2,42	0,10
13	**rm1**	73	4,29	0,41	2,42	0,10
14	**Gsrm**	73	4,29	0,41	2,42	0,10
15	**wc**	73	4,29	0,41	2,42	0,10
16	**bth**	73	4,29	0,41	2,42	0,10
17	**blc**	85	5,00	0,50	2,00	0,50
	Min	59,00	3,47	0,30	0,47	0,00
	Mean	**100,55**	**5,91**	**0,61**	**2,17**	**0,88**
	Max	306,00	18,00	2,12	3,23	9,00

- Discussion

From the analysis of the selected contemporary houses in Biskra city, the constructed justified plan graphs followed by mathematical analysis are characterized by an arborescent and deep configuration, the graphs have a symmetric order in global. From the calculation of the integration value (RA) of the spatial configuration of all the spaces in each house and from the sample, the transition spaces are the most integrated spaces: for most houses the main halls are the central space and the pivot of circulation within the house, and the corridors which appeared in the independence period, take place as main central space. These houses are characterized by the presence of inner and outer rings, which offer more flexibility, less control that manifested in the topological spaces c- and d-type where they provide a choice of mobility; this features the modern houses, which are open to the exterior word and renounce the idea of introverted houses. For that, the disappearance of the vestibule « *sguifa* » that provides privacy and controls the access into the house is notable, now it is replaced by the veranda: an open space, which represents the boundary between the exterior and inner space. In addition, the social and economic life changed over time, the inhabitants started to build their houses according to their needs, budgets and economic statutes. From the justified graphs of each house, we notice that there is more than one entrance (between two and four entrances) from the exterior; some houses have locals at the ground floor destined to economic use.

The multifunctional space has disappeared and several spaces appeared such as: the dining room, the guest room, the wardrobe, the balconies, the patio, the parent room…etc. In which the guest room is shallow from the exterior because it is destined to the visitors and strangers to keep them away from the private spaces within the house, the penetration of the different users into the house is constrained and regulated by cultural and social principles. The living area became open and flexible by creating a connection between the living room, the hall, the patio, the balcony, and the terrace. The spatial interface between inhabitants and strangers is one of the notable issues in every culture for every house.

The house plans reflect a pattern of social life which has changed since the vernacular houses, the size of the family determines the size of each house, the absence of the architectural identity is observable in these houses.

- Conclusion

The examination of the 60 house plans from the four periods in Biskra city: pre-colonial (vernacular), colonial, independent, and contemporary, indicate that these houses have an underlying spatial structure. The findings of this study suggest that justified graph analysis can be used in a diachronic perspective to investigate changes in spatial layout over time. The approach to diachronicity of this study does not examine the changes in the same house plan over time, but rather the changes in the spatial organization of different houses over time. The analysis of this sample of houses from the four periods indicated that the transition spaces centred the spatial organization from the vernacular houses to the modern houses, whereas the corridor appeared in the beginning of 1970 in the independent period, in which the central organization has transformed into a linear sequence. The vestibule « *sguifa* » was the point of penetration in the vernacular houses until the colonial period, and then it disappeared and has been replaced by the veranda. The latest houses from the independent and contemporary houses have more than one entrance from the exterior. Another finding is the importance of the exterior to the overall layouts and configuration of the houses.

The goal of this study is to express lifestyle through patterns of continuity and change in spatial configurations. The change in family and social structure cannot be thought as a separate thing from the house layouts design; one can assure that these changes affect directly the spatial organization and the use of domestic space.

Chapter VI

The configurational Analysis: Application of Justified Graph Analysis

- Introduction

To understand the spatial structure of space, Bill Hillier and Julien Hansen established the theory of spatial configuration, which they used to investigate the connection between the configuration of space and human behavior. Spatial configuration analysis is concerned with how spaces are positioned next to each other and how they interact (Siadatian & Pourjafar, 2015). To comprehend and describe the spatial configuration, an appropriate method that responds to environmental variables must be sought. The syntax method of space is the primary approach for comprehending spatial configuration. In this method, the relations are presented as mathematical data so that we may comprehend the interrelationships between the space configuration and the behavior of its users by examining this data. The spatial configuration is analysed using the main measurements: the Mean depth (MD), Real relative asymmetry (RRA), the Based different factor (BDF)… The results are explained in this section.

1. The configurational analysis and genotype exploration

In order to understand space as cultural data (primali, 2013), at first phase conversion the house plans into justified graphs (previous chapter), and the calculation of the fundamental syntactic data, in this analysis, each functional space in the spatial organization is treated as a cell, and is indicated by a circle, and the relationship between the cells in indicated by a line that refers to the transition (Erman, 2017). The abstraction of the graphs distinguishes between the living space, the transition space and the other constituent spaces of the system. The JPG was chosen to develop a graphical and mathematical analysis of the spatial configuration, the graphs are visually analysed to reveal a series of quantitative spatial configuration properties such as: mean depth (MD), permeability, integration (relative asymmetry RA, and real relative asymmetry RRA), base difference factor (BDF) that describe how the house is spatially experienced in a rigorous and repeatable format (Elizondo, 2021).This quantitative analysis was performed using the A-graph program. These parameters: MD, RRA, and BDF were analysed using the exterior as a root and excluding it to understand the relationship between inhabitants- inhabitants and inhabitants – visitors.

The table 01 below contains the basic syntactic data for each house. The first examination of house plans is based on the j-graphs generated for each house. In order to see similarities and differences across the entire sample, the j-graphs are analysed first without being divided into decades.

- **Table 66:** The syntactic data for all the houses in the sample. MD: mean depth, SPL: space link ratio, BDF: base difference factor, RRA: real relative symmetry.

House N°	SLR	MD	Integration (RRA) (with exterior)			BDF with ext	Integration (RRA) (without exterior)			BDF without ext
			min	mean	max		min	mean	max	
Hv01	1.08	3.03	0.36	0.89	1.17	0.88	0.36	0.89	1.17	0.86
Hv02	1.06	2.95	0.53	1.11	1.74	0.55	0.50	1.10	1.74	0.51
Hv03	1.00	2.84	0.57	1.15	1.82	0.45	0.49	1.10	0.59	0.44
Hv04	1.00	2.71	0.38	1.06	1.44	0.51	0.38	1.08	1.64	0.46
Hv05	1.09	2.12	0.22	0.84	1.13	0.42	0.18	0.87	1.27	0.37
Hv06	1.00	2.48	0.63	1.21	1.54	0.26	0.56	1.25	1.80	0.18
Hv07	1.00	3.57	0.65	1.13	1.67	0.67	0.59	1.15	1.77	0.62
Hv08	1.00	2.22	0.27	0.99	1.54	0.32	0.22	1.00	1.57	0.27
Hv09	1.00	2.22	0.33	1.10	1.23	0.23	0.29	1.12	1.74	0.18
Hv10	1.00	2.53	0.37	1.05	1.43	0.37	0.36	1.05	1.27	0.28
Hv11	1.00	2.82	0.60	1.20	1.59	0.44	0.63	1.20	1.79	0.35
Hv12	1.06	4.18	0.69	1.22	1.78	0.93	0.69	1.22	1.81	0.93
Hv13	1.00	2.38	0.56	1.25	1.69	0.19	0.58	1.27	2.03	0.07
Hv14	1.00	2.80	0.48	1.12	1.54	0.51	0.49	1.15	1.54	0.46
Hv15	1.05	3.37	0.71	1.25	1.61	0.65	0.68	1.25	1.74	0.60
Total	**-**	**2.78**	**0.49**	**1.10**	**1.52**	**0.51**	**0.46**	**1.11**	**1.56**	**0.43**
HC01	1.00	2.62	0.59	1.06	1.42	0.46	0.39	1.01	1.41	0.52
HC02	1.08	2.74	0.45	1.04	1.65	0.79	0.87	1.86	14.63	0.45
HC03	1.00	3.00	0.52	1.26	2.17	0.35	0.48	1.24	2.18	0.30
HC04	1.00	3.70	0.54	1.10	1.49	0.41	0.54	1.19	2.09	0.40
HC05	1.00	2.14	0.36	0.96	1.30	0.73	0.33	0.95	1.26	0.69
HC06	1.00	2.09	0.29	0.89	1.34	0.52	0.35	0.96	1.36	0.46
HC07	1.00	3.78	0.44	1.28	1.99	0.28	0.41	1.42	2.07	0.23
HC08	1.00	3.27	0.54	1.16	1.80	0.47	0.57	1.18	1.82	0.41
HC09	1.00	2.80	0.85	1.43	2.06	0.54	1.63	2.77	7.24	0.50
HC10	1.06	3.29	0.31	0.77	1.08	0.65	0.34	0.81	1.14	0.60
HC11	1.00	2.62	0.33	0.92	1.43	0.45	0.33	0.93	1.33	0.40
HC12	1.00	3.27	0.44	0.96	1.80	0.59	0.46	0.98	1.80	0.55
HC13	1.10	2.26	0.61	1.00	1.31	0.28	0.43	1.01	1.52	0.18
HC14	1.00	2.05	0.24	1.02	1.45	0.29	0.15	1.01	1.72	0.22
HC15	1.00	2.22	0.28	1.03	1.98	0.27	0.35	1.14	2.10	0.19
Total	**-**	**2.84**	**0.45**	**1.05**	**1.61**	**0.47**	**0.50**	**1.23**	**2.91**	**0.40**
HI01	1.00	2.62	0.27	0.93	1.66	0.54	0.78	1.89	8.09	0.27
HI02	1.00	2.74	0.60	1.13	1.75	0.40	1.40	2.16	7.71	0.18
HI03	1.00	3.00	0.57	1.16	1.62	0.53	0.57	1.16	1.61	0.49
HI04	1.09	3.70	0.72	1.26	2.00	0.69	0.71	1.23	1.68	0.69
HI05	1.18	2.14	0.25	0.86	1.58	0.37	0.20	0.96	1.61	0.34
HI06	1.00	2.09	0.10	0.58	1.29	0.58	0.12	0.61	1.36	0.53
HI07	1.18	3.78	0.39	0.72	1.18	0.84	0.62	1.16	1.36	0.52
HI08	1.13	3.27	0.39	0.71	1.02	0.75	0.40	0.77	1.72	0.72
HI09	1.05	2.80	0.32	0.76	0.99	0.69	0.32	0.75	1.06	0.63
HI10	1.00	3.29	0.45	0.85	1.07	0.69	0.47	0.85	1.10	0.65
HI11	1.08	3.43	0.47	0.78	1.18	0.78	0.40	0.79	1.18	0.75
HI12	1.10	3.74	0.77	1.30	1.86	0.68	0.75	1.21	1.64	0.67
HI13	1.00	2.47	0.39	0.99	2.06	0.32	0.45	1.08	2.21	0.25
HI14	1.00	2.09	0.07	0.61	1.04	0.63	0.03	0.56	1.05	0.60
HI15	1.00	2.92	0.47	0.90	1.38	0.69	0.46	0.88	1.39	0.66
Total	**-**	**2.93**	**0.41**	**0.90**	**1.44**	**0.61**	**0.51**	**1.07**	**2.31**	**0.48**
HP01	1.10	2.91	0.48	0.92	1.42	0.69	0.47	0.89	1.38	0.65
HP02	1.04	3.45	0.59	1.14	1.77	0.70	0.48	0.96	1.49	0.67
HP03	1.16	3.59	0.60	1.10	1.50	0.83	0.63	1.10	1.46	0.80
HP04	1.04	3.00	0.47	0.86	1.29	0.73	0.46	0.83	1.35	0.69
HP05	1.04	3.36	0.55	0.99	1.60	0.80	0.92	1.72	10.19	0.47
HP06	1.08	4.00	0.35	0.70	1.14	0.96	0.56	1.07	1.17	0.59
HP07	1.04	3.63	0.45	1.03	1.63	0.80	1.02	2.14	8.56	0.54
HP08	1.06	2.97	0.40	0.92	1.80	0.51	1.11	2.16	6.30	0.35
HP09	1.15	3.51	0.48	0.88	1.40	0.67	0.47	0.86	1.38	0.64
HP10	1.08	3.98	0.30	0.63	0.93	0.99	0.29	0.62	0.94	0.97
HP11	1.11	3.16	0.34	0.84	1.29	0.65	1.34	2.53	6.49	0.45
HP12	1.00	3.04	0.39	0.92	1.41	0.61	1.59	3.01	7.60	0.42
HP13	1.00	3.31	0.46	0.91	1.47	0.76	1.14	2.12	8.60	0.51

HP14	1.12	3.22	0.44	0.99	1.45	0.61	1.53	2.87	6.99	0.42
HP15	1.00	2.95	0.31	0.67	1.10	0.67	0.91	1.76	6.46	0.43
Total	**-**	**3.33**	**0.39**	**0.90**	**1.41**	**0.40**	**0.86**	**1.64**	**4.69**	**0.45**

1.1. The mean depth (MD)

The table above sets out the values of the mean depth (MD) for the sample of houses is an indication of the layering of different spaces in the system (Primali.P, 2013). Whereas, all the spaces that have the same value are placed on the same line in the graph. From the data its notable that the contemporary houses have the highest value of mean depth (3.04); they the deepest houses in the sample and have segregated systems, whereas the house HP06 has the highest value of MD (4.00) followed by HP10 (3.98) and HI08 (3.78). The vernacular houses have the lowest value of MD (2.82) they shallow from the original space (the root). The house HC14 has the lowest value and it’s the most integrated house in the system (2.05), then the house HC06 (2.09), followed by the house HV5 (2.12) and HC5, HI05 with same value (2.14).

On the other hand, the average depth of the houses shows no correlations with integration of their global systems from the exterior. However, we note that there are some houses with high depth and permeable system.

Analysing the houses indicate ; that the vernacular houses have the lowest value of mean depth that refers to the small surface of these houses in this period, the increase of mean depth through time due to the decrease of number of spaces.

1.2. The permeability

This indicator investigates the exterior's integration value and compares it to the complex's average or maximum value. The more permeable the building is, the lower the exterior's integration capability with relation to the building, i.e. the closer the exterior is to all of the constituent cells. The greater this value, the further the exterior is from the interior of the building. To evaluate the outcomes of the investigation of all the specimens in the corpus, a comparison of these distinct integration values will be required. The houses that have a permeable system represent 55% from all the sample which mean they integrated from the exterior, and the non-permeable system represent 44% whereas theses houses are segregated (Table 02).

- **Table 67:** The Permeability of all the houses in the sample.

N°	Houses	The values of Relative asymmetry RA (Integration) from the exterior	Permeable system	Non- permeable system
01	HV01	0.19	X	
02	HV02	0.38		X
03	HV03	0.48		X
04	HV04	0.35		X
05	HV05	0.13	X	
06	HV06	0.47		X
07	HV07	0.32		X
08	HV08	0.41		X
09	HV09	0.46		X
10	HV10	0.42		X
11	HV11	0.43		X
12	HV12	0.26	X	
13	HV13	0.53		X
14	HV14	0.35	X	
15	HV15	0.38		X
16	HC01	0.32	X	
17	HC02	0.24	X	
18	HC03	0.50		X
19	HC04	0.28		X
20	HC05	0.28	X	
21	HC06	0.24	X	
22	HC07	0.38		X
23	HC08	0.44		X
24	HC09	0.40	X	
25	HC10	0.20	X	
26	HC11	0.37	X	
27	HC12	0.29	X	
28	HC13	0.32	X	
29	HC14	0.42		X
30	HC15	0.30	X	

31	HI01	0.29	X	
32	HI02	0.31	X	
33	HI03	0.42		X
34	HI04	0.44		X
35	HI05	0.33		X
36	HI06	0.17	X	
37	HI07	0.21	X	
38	HI08	0.23	X	
39	HI09	0.29		X
40	HI10	0.32		X
41	HI11	0.25	X	
42	HI12	0.30		X
43	HI13	0.32	X	
44	HI14	0.16		X
45	HI15	0.21	X	
46	HP01	0.29		X
47	HP02	0.24	X	
48	HP03	0.26	X	
49	HP04	0.28		X
50	HP05	024	X	
51	HP06	0.24	X	
52	HP07	0.30		X
53	HP08	0.30	X	
54	HP09	0.38		X
55	HP10	0.22	X	
56	HP11	0.29	X	
57	HP12	0.29	X	
58	HP13	0.22	X	
59	HP14	0.29	X	
60	HP15	0.23	X	

1.3. The real relative asymmetry RRA (Integration)

Refers to how connected and closed a space is to all other different types of spaces. In other words, it describes the extent to which the space is accessible from all spaces in the system. The integration values give a quantitative indication of the permeability of the system (Guney & Wineman, 2008) and the degree of overall integration of the building. The lower the integration value and closer to 0, the more integrated the system is, the more connected the spaces are to each other in the system, and the spaces tend to be more isolated and private. Thus, the higher value of integration which tends towards 1 and above means the segregation of the system, and the spaces will be more accessible and less private. There are two values of integration (RRA) are given for each house in the sample in Table 02; one of them when the exterior is included, and the other when it is not part of the system. The purpose to look at the values of integration with and without exterior is to understand the significance of the exterior to the overall configuration of each house. When the exterior is included, the configuration becomes more integrated, indicating that the exterior is crucial in bringing the layout together. An extraverted or outward looking is the term used to describe a house layout in this case. The layout is regarded as inward looking or introverted as the configuration becomes more segregated with the exterior (Guney & Wineman, 2008).

- **Table 68:** Shows the values of Integration (RRA) of all the sample

House N°	MD	Integration (RRA) (with exterior)			Integration (RRA) (without exterior)		
		min	mean	max	min	mean	Max
Hv01	3.03	0.36	0.89	1.17	0.36	0.89	1.17
Hv02	2.95	0.53	1.11	1.74	0.50	1.10	1.74
Hv03	2.84	0.57	1.15	1.82	0.49	1.10	0.59
Hv04	2.71	0.38	1.06	1.44	0.38	1.08	1.64
Hv05	2.12	0.22	0.84	1.13	0.18	0.87	1.27
Hv06	2.48	0.63	1.21	1.54	0.56	1.25	1.80
Hv07	3.57	0.65	1.13	1.67	0.59	1.15	1.77
Hv08	2.22	0.27	0.99	1.54	0.22	1.00	1.57
Hv09	2.22	0.33	1.10	1.23	0.29	1.12	1.74
Hv10	2.40	0.37	1.05	1.43	0.36	1.05	1.27
Hv11	2.82	0.60	1.20	1.59	0.63	1.20	1.79
Hv12	4.18	0.69	1.22	1.78	0.69	1.22	1.81
Hv13	2.38	0.56	1.25	1.69	0.58	1.27	2.03
Hv14	2.80	0.48	1.12	1.54	0.49	1.15	1.54
Hv15	3.37	0.71	1.25	1.61	0.68	1.25	1.74

Total	**2.78**	**0.49**	**1.10**	**1.52**	**0.46**	**1.11**	**1.56**
HC01	2.62	0.59	1.06	1.42	0.39	1.01	1.41
HC02	2.74	0.45	1.04	1.65	0.87	1.86	14.63
HC03	3.00	0.52	1.26	2.17	0.48	1.24	2.18
HC04	3.70	0.54	1.10	1.49	0.54	1.19	2.09
HC05	2.14	0.36	0.96	1.30	0.33	0.95	1.26
HC06	2.09	0.29	0.89	1.34	0.35	0.96	1.36
HC07	3.78	0.44	1.28	1.99	0.41	1.42	2.07
HC08	3.27	0.54	1.16	1.80	0.57	1.18	1.82
HC09	2.80	0.85	1.43	2.06	1.63	2.77	7.24
HC10	3.29	0.31	0.77	1.08	0.34	0.81	1.14
HC11	2.62	0.33	0.92	1.43	0.33	0.93	1.33
HC12	3.27	0.44	0.96	1.80	0.46	0.98	1.80
HC13	2.26	0.61	1.00	1.31	0.43	1.01	1.52
HC14	2.05	0.24	1.02	1.45	0.15	1.01	1.72
HC15	2.22	0.28	1.03	1.98	0.35	1.14	2.10
Total	**2.84**	**0.45**	**1.05**	**1.61**	**0.50**	**1.23**	**2.91**
HI01	2.62	0.27	0.93	1.66	0.78	1.89	8.09
HI02	2.74	0.60	1.13	1.75	1.40	2.16	7.71
HI03	3.00	0.57	1.16	1.62	0.57	1.16	1.61
HI04	3.70	0.72	1.26	2.00	0.71	1.23	1.68
HI05	2.14	0.25	0.86	1.58	0.20	0.96	1.61
HI06	2.09	0.10	0.58	1.29	0.12	0.61	1.36
HI07	3.78	0.39	0.72	1.18	0.62	1.16	1.36
HI08	3.27	0.39	0.71	1.02	0.40	0.77	1.72
HI09	2.80	0.32	0.76	0.99	0.32	0.75	1.06
HI10	3.29	0.45	0.85	1.07	0.47	0.85	1.10
HI11	3.43	0.47	0.78	1.18	0.40	0.79	1.18
HI12	3.74	0.44	0.96	1.80	0.75	1.21	1.64
HI13	2.47	0.61	1.00	1.31	0.45	1.08	2.21
HI14	2.09	0.24	1.02	1.45	0.03	0.56	1.05
HI15	2.92	0.28	1.03	1.98	0.46	0.88	1.39
Total	**2.98**	**0.41**	**0.88**	**1.44**	**0.51**	**1.07**	**2.31**
HP01	2.91	0.48	0.92	1.42	0.47	0.89	1.38
HP02	3.45	0.59	1.14	1.77	0.48	0.96	1.49
HP03	3.59	0.60	1.10	1.50	0.63	1.10	1.46
HP04	3.00	0.47	0.86	1.29	0.46	0.83	1.35
HP05	3.36	0.55	0.99	1.60	0.92	1.72	10.19
HP06	4.00	0.35	0.70	1.14	0.56	1.07	1.17
HP07	3.63	0.45	1.03	1.63	1.02	2.14	8.56
HP08	2.97	0.40	0.92	1.80	1.11	2.16	6.30
HP09	3.51	0.48	0.88	1.40	0.47	0.86	1.38

HP10	3.98	0.30	0.63	0.93	0.29	0.62	0.94
HP11	3.16	0.34	0.84	1.29	1.34	2.53	6.49
HP12	3.04	0.39	0.92	1.41	1.59	3.01	7.60
HP13	3.31	0.46	0.91	1.47	1.14	2.12	8.60
HP14	3.22	0.44	0.99	1.45	1.53	2.87	6.99
HP15	2.95	0.31	0.67	1.10	0.91	1.76	6.46
Total	**3.33**	**0.39**	**0.90**	**1.41**	**0.86**	**1.64**	**4.69**

There are two integration values presented in the Table 02: one with the exterior being part of the system and the other when it is not. The purpose of using the two integration values (RRA) with and without the exterior is to see how the system has treated the exterior and its significance on the entire house configuration, or to investigate the exterior- interior relation and its effect on the spatial configuration of each house.

From the data in the Table above ; there are 31 houses have low values of RRA in which are integrated from the root space : HV01, HV05, HV08, HC05, HC06, HC10, HC11, HC12, HI01,HI05, HI06, HI07, HI08, HI09, HI10, HI11, HI13, HI14, HI15 HP01, HP4, HP05, HP06, HP08, HP09, HP10, HP11, HP12, HP13, HP14, HP15. Their graphs are shallow from the exterior. The most integrated house is HI06 with value (0.58), followed by HP10 with value 0.63, HI08 (0.71) and HI07 (0.72). It is notable that, when the exterior is included the configuration become more integrated, in this case the house layouts described as extraverted or outward looking. 29 houses have segregated configuration. The most segregated house is HC09 with value (1.43) followed by HC07 with value (1.28). The configurations become more segregated when the exterior is included which they described as introverted houses or more inward looking.

It's notable that, the majority of segregated houses from the vernacular and colonial houses where they have the highest values of integration, and the majority of integrated houses from the contemporary and independence period which have the lowest values of integration, that refer to the easier accessibility into the houses in these periods, contrary to the vernacular and colonial houses.

When the exterior is omitted, the value of integration (RRA) increases in some houses in the sample such as : HV4, HV5, HV6, HV7, HV8, HV9, HV13, HV14 , HC2, HC4, HC6, HC7,HC8, HC9, HC10, HC11, HC12, HC13, HC15, HI1, HI2, HI5, HI6, HI7, HI8, HI11, HI12, HI13, HP5, HP6, HP7, HP8, HP9, HP11, HP12, HP13, HP14, HP15, which become more segregated, where the configuration is strongly affected by the secluded of the exterior, but the rank order of the values of integration (RRA) of each space from the most integrated to the most segregated is unchanged in each house. Fifteen houses become more integrated when the exterior is omitted: HV02, HV03, HC01, HC03, HC05, HC14, HI04, HI09, HI14, HI15, HP01, HP02, HP4, HP09, HP10.The houses: HV01, HV10, HV11, HV12, HV15, HI03, HI10, HP03 have the same value of integration when the exterior is included or not; which mean that the spaces are less affected by the exclusion of the exterior. The absence of variations in the data reinforces the relationships between residents.

Analysis the integration values with and without the exterior allows to investigate the exterior -interior relation, which has an important effect on the spatial configuration whilst, in some cases there is no impact to the overall space configuration whether the relation to the space outside is included or not. This step helps us to understand the relation inhabitant- inhabitant and inhabitant -visitors.

By comparing the mean integration values (RRA) for each period, it's notable that the RRA for the vernacular houses have the highest values which mean the vernacular houses are the most segregated houses, followed by the colonial houses which show a high value of RRA, then the values of integration (RRA) increase in the independent and contemporary period, whereas the contemporary houses considered as the most integrated spaces in the sample.

1.4. The space link ratio (SLR)

This indicator is used to assess the distributedness and non-distributedness properties to each space and the house layout, if there is only one non-intersecting route from a space to another in a system is said to be non-distributedness, if there are more than one non-intersecting route for any two spaces in the system here we talk about a distributed system. It is realized via a mathematical formula that relates the total number of nodes in a complex to the number of links raised by one: $L + 1 / K = SLR$ (L: number of links, K: total number of nodes). If the complex only offers a guided path with no other options, the SLR report shows a value of 01; if the value is more than unity, the system has many circulation options and closed circuits. Table 04 shows the results of the SLR of each house from the sample.

- **Table 69:** Show the SLR values for each house

Vernacular houses	SLR	Colonial houses	SLR	Independent houses	SLR	Contemporary houses	SLR
Hv01	1.08	HC01	1.00	HI01	1.00	HP01	1.10
Hv02	1.06	HC02	1.08	HI02	1.00	HP02	1.04
Hv03	1.00	HC03	1.00	HI03	1.00	HP03	1.16
Hv04	1.00	HC04	1.00	HI04	1.04	HP04	1.09
Hv05	1.09	HC05	1.00	HI05	1.09	HP05	1.04
Hv06	1.00	HC06	1.00	HI06	1.00	HP06	1.05
Hv07	1.00	HC07	1.00	HI07	1.18	HP07	1.04
Hv08	1.00	HC08	1.00	HI08	1.18	HP08	1.06
Hv09	1.00	HC09	1.00	HI09	1.11	HP09	1.15
Hv10	1.00	HC10	1.06	HI10	1.00	HP10	1.05
Hv11	1.00	HC11	1.00	HI11	1.04	HP11	1.11
Hv12	1.06	HC12	1.00	HI12	1.10	HP12	1.00
Hv13	1.00	HC13	1.10	HI13	1.00	HP13	1.00
Hv14	1.00	HC14	1.00	HI14	1.00	HP14	1.12
Hv15	1.05	HC15	1.00	HI15	1.00	HP15	1.00

From the data in the Table 04, twenty seven houses show distributed system with high value more than 1 of SLR: HV01, HV02, HV05, HV12, HV15, HC02, HC10, HC13, HI04, HI05, HI07, HI08, HI09, HI11, HI12, HP01, HP02, HP03, HP04, HP05, HP06, HP07, HP8, HP09, HP10, HP11, HP14, thus; these houses offer an alternative and choice of movement within the house. Whereas thirty three from the entire sample show a non-distributedness system: HV03, HV04, HV06, HV07, HV08, HV09, HV10, HV11, HV13, HV14, HC01, HC03, HC04, HC05, HC06, HC07, HC08, HC09, HC11, HC12, HC14, HC15, HI01, HI02, HI03, HI06, HI10, HI13, HI14, HI15, HP12, HP13, HP15 which these house have a value of 1.00, while the system offer a guided path with no alternative circulation within the house.

From the analysis of the sample, we see that the colonial houses have the lowest value of SLR where there are three houses have a value high than 1.00: HC02, HC10, HC13. Followed by the vernacular houses, with ten houses have the value of (1.00). Whereas the majority of contemporary houses have a value more than 1.00 which refers to the distributedness system except the house HP12, HP13, HP15 has a non-distributedness system. The independence houses have seven houses with a distributedness system and eight houses with non-distributedness system.

The distributedness reflects the existence of rings in the system, and more than one intersecting path from the root to other spaces in the system which indicates the flexibility of movement.

In conclusion, the contemporary houses have distributed system where there is an alternative route within the house which means easier accessibility and less control, followed by the independence houses. Whereas the colonial and vernacular houses have non-distributed system, therefore, the paths are guided and controlled.

1.5. The base difference factor BDF:

BDF Is used to provide a measure of the degree of differentiation between the spaces in terms of integration (Mustafa, 2016). When the value of BDF tends towards 0, it indicates a strong differentiation and the system need to be more structured. When the value tends towards 1, it means that there is a small difference between the spaces. Table 05 bellow shows the values of difference factor when the exterior is included or not.

- **Table 70:** Show the values of the based difference factor (H) and (H*)

N°	Houses	The difference factor H		The relative difference factor H*	
		With ext	**Without ext**	**With ext**	**Without ext**
01	**HV01**	0.33	0.34	0.88	0.86
02	**HV02**	0.46	0.48	0.55	0.51
03	**HV03**	0.50	0.51	0.45	0.44
04	**HV04**	0.48	0.50	0.51	0.46
05	**HV05**	0.52	0.54	0.42	0.37
06	**HV06**	0.58	0.61	0.26	0.18
07	**HV07**	0.42	0.43	0.67	0.62
08	**HV08**	0.56	0.58	0.32	0.27
09	**HV09**	0.59	0.61	0.23	0.18
10	**HV10**	0.53	0.57	0.37	0.28
11	**HV11**	0.51	0.55	0.44	0.35
12	**HV12**	0.31	0.32	0.93	0.91
13	**HV13**	0.61	0.66	0.19	0.07
14	**HV14**	0.48	0.50	0.51	0.46

15	**HV15**	0.42	0.44	0.65	0.60
16	**HC01**	0.47	0.48	0.56	0.52
17	**HC02**	0.52	0.61	0.79	0.45
18	**HC03**	0.47	0.49	0.35	0.30
19	**HC04**	0.41	0.40	0.60	0.57
20	**HC05**	0.54	0.55	0.73	0.69
21	**HC06**	0.45	0.47	0.52	0.46
22	**HC07**	0.34	0.48	0.28	0.23
23	**HC08**	0.38	0.39	0.47	0.41
24	**HC09**	0.41	0.43	0.51	0.35
25	**HC10**	0.40	0.42	0.60	0.55
26	**HC11**	0.37	0.38	0.46	0.40
27	**HC12**	0.45	0.46	0.59	0.55
28	**HC13**	0.57	0.61	0.28	0.18
29	**HC14**	0.57	0.59	0.29	0.22
30	**HC15**	0.58	0.61	0.27	0.19
31	**HI01**	0.47	0.58	0.54	0.27
32	**HI02**	0.52	0.61	0.40	0.18
33	**HI03**	0.47	0.49	0.53	0.49
34	**HI04**	0.41	0.40	0.69	0.69
35	**HI05**	0.54	0.55	0.37	0.34
36	**HI06**	0.45	0.47	0.58	0.53
37	**HI07**	0.34	0.48	0.84	0.52
38	**HI08**	0.38	0.39	0.75	0.72
39	**HI09**	0.41	0.43	0.69	0.63
40	**HI10**	0.40	0.42	0.69	0.65
41	**HI11**	0.37	0.38	0.78	0.75
42	**HI12**	0.41	0.41	0.68	0.67
43	**HI13**	0.56	0.59	0.32	0.25
44	**HI14**	0.43	0.44	0.63	0.60
45	**HI15**	0.41	0.42	0.69	0.66
46	**HP01**	0.41	0.42	0.69	0.65

47	**HP02**	0.40	0.42	0.70	0.67
48	**HP03**	0.35	0.36	0.83	0.80
49	**HP04**	0.39	0.41	0.73	0.69
50	**HP05**	0.36	0.50	0.80	0.47
51	**HP06**	0.50	0.45	0.96	0.59
52	**HP07**	0.36	0.80	0.80	0.54
53	**HP08**	0.48	0.54	0.51	0.35
54	**HP09**	0.42	0.43	0.67	0.64
55	**HP10**	0.28	0.29	0.99	0.97
56	**HP11**	0.42	0.65	0.50	0.45
57	**HP12**	0.44	0.52	0.61	0.42
58	**HP13**	0.38	0.48	0.76	0.51
59	**HP14**	0.44	0.51	0.61	0.42
60	**HP15**	0.41	0.51	0.67	0.43

The difference factor (BDF) is an excellent predictor of spatial ordering strength since it is utilized to determine the degree of variance in integration values. All the houses in the sample show a low values of BDF, in which the highest values is 0.61 for the house HV13, and the lowest value 0.28 for the house HP10. These low values of BDF indicate to the strong differentiation, in other word have a strong functional structure.

In this case the difference factor allows us to clarify the degree of consistency and solidity of a spatial configuration, and indicates whether distinct activities are spatially connected or separated. Low values indicate a strong structure and the arrangement of a structure encourages functional separation of the spaces that compose it. On the contrary, vigorous values translate a weakness of it; indicate that the spatial configuration tends to argue in favor of a functional confusion of these constituent spaces.

1.6. The degree of spaceness:

The JPG technique allows the type of space in the system to be categorised. Hillier (1996) distinguished four topological spaces: a-type, which has one link, b-type, which connects to two or more spaces, c-type, which lies on a ring and has more than one connection, and d-type, which lies on at least two rings and has more than two connections. Private (bedrooms), social (living room) and service (kitchen and bathrooms) spaces are a-type spaces; transition spaces (hall, corridor, staircase, and intermediate spaces) are b-type spaces. To compute the degree of a-ness of each house, the total number of convex spaces minus one is divided by the number of a-type spaces, the degree of b-ness is calculated by dividing the total number of convex spaces minus two by the number of b-type spaces in a house, the degree of c-ness and d-ness is calculated by dividing the total number of convex spaces in the graph by the number of c-type or d-type spaces.

The graphs in (the previous chapter) shows a tree and ringy structures characterised by the existence of four topological spaces : a-type space, which is the appropriate space for occupancy, and topological b-type spaces, which are transition spaces, suggesting that there is no mobility choice in the system, the c-type with the d-type spaces offering choice of circulation and movement around the house that refer to the existence of rings which affect directly the topological nature of spaces within the house (Guney, 2008). The table (06) below presents the calculation of the degree of: a-ness, b-ness, c-ness and d-ness for each house in the sample. They give an insight into the use of space in the spatial configuration.

From these results, it can be noticed that a-type spaces represent the highest percentage in the whole sample (63%). This type includes each of the private, social and service spaces such as bedrooms, kitchen, bathroom, storage, and the living spaces where daily activities take place. The a-type space creates segregation as results of the increase in depth. While the transition area such as halls, corridors, vestibules (*sguifa*), veranda, terrace, and stairs are the transitional b-type spaces represent (30%) of the sample suggesting that there is no choice of mobility to and from this space. These are pass-through spaces, while all houses have an average percentage of b-type space. The c-type spaces represent (20%) of the sample and fall in a ring suggesting a choice of movement around the houses and offer more flexibility of circulation. The d-type spaces have the lowest degree (8%) of the sample offer alternative of movement when moving around the houses, the existence of rings tends to decrease the control and privacy within the house.

- **Table 71:** Degree of space-ness indicator of the space type (Authors, 2021)

Houses	The degree of spaceness (space type)			
	a-ness	**b-ness**	**c-ness**	**d-ness**
HV1	0.66	0.04	0.24	0.08
HV2	0.53	0.28	0.18	0.00

HV3	0.61	0.41	0.00	0.00
HV4	0.61	0.33	0.00	0.00
HV5	0.70	0.11	0.27	0.00
HV6	0.66	0.37	0.00	0.00
HV7	0.61	0.27	0.00	0.00
HV8	0.66	0.37	0.00	0.00
HV9	0.62	0.42	0.00	0.00
HV10	0.70	0.33	0.00	0.00
HV11	0.66	0.36	0.00	0.00
HV12	0.60	0.14	0.23	0.03
HV13	0.62	0.42	0.00	0.00
HV14	0.69	0.33	0.00	0.00
HV15	0.58	0.25	0.16	0.00
Total	**0.63**	**0.29**	**0.08**	**0.007**
HC1	0.71	0.30	0.00	0.00
HC2	0.54	0.09	0.30	0.04
HC3	0.54	0.50	0.00	0.00
HC4	0.58	0.50	0.00	0.00
HC5	0.72	0.29	0.00	0.00
HC6	0.76	0.25	0.00	0.00
HC7	0.66	0.37	0.00	0.00
HC8	0.53	0.50	0.00	0.00
HC9	0.46	0.21	0.25	0.12
HC10	0.56	0.13	0.23	0.05
HC11	0.58	0.18	0.23	0.00
HC12	0.64	0.37	0.00	0.00
HC13	0.55	0.00	0.40	0.00
HC14	0.75	0.28	0.00	0.00
HC15	0.77	0.37	0.00	0.00
Total	**0.62**	**0.28**	**0.09**	**0.014**
HI1	0.71	0.38	0.00	0.00
HI2	0.81	0.27	0.00	0.00
HI3	0.64	0.38	0.00	0.00
HI4	0.45	0.36	0.23	0.00
HI5	0.50	0.11	0.36	0.09
HI6	0.76	0.25	0.00	0.00
HI7	0.42	0.16	0.29	0.14
HI8	0.47	0.05	0.31	0.13
HI9	0.70	0.12	0.16	0.00

HI10	0.72	0.29	0.00	0.00
HI11	0.59	0.04	0.34	0.00
HI12	0.57	0.22	0.10	0.10
HI13	0.60	0.44	0.00	0.00
HI14	0.78	0.23	0.00	0.00
HI15	0.73	0.27	0.00	0.00
Total	**0.63**	**0.23**	**0.25**	**0.11**
HP1	0.57	0.16	0.25	0.05
HP2	0.55	0.31	0.19	0.00
HP3	0.37	0.21	0.36	0.08
HP4	0.60	0.21	0.14	0.09
HP5	0.70	0.17	0.16	0.00
HP6	0.60	0.12	0.26	0.00
HP7	0.52	0.40	0.12	0.00
HP8	0.60	0.28	0.18	0.00
HP9	0.36	0.22	0.30	0.10
HP10	0.48	0.18	0.29	0.05
HP11	0.56	0.26	0.11	0.11
HP12	0.68	0.33	0.00	0.00
HP13	0.68	0.33	0.00	0.00
HP14	0.50	0.33	0.17	0.00
HP15	0.77	0.23	0.00	0.00
Total	**0.57**	**0.24**	**0.16**	**0.03**

According to the data of the space-ness indicator of the sample in the Table, the a-type space has the highest degree in all the houses (63%), while the d-type has the lowest degree (8%). The both houses HV01 and HV12 in the vernacular houses have all four topological spaces with the following value: HV01: a-ness 0.66, b-ness 0.04, c-ness 0.24, d-ness 0.08, and HV12: a-ness 0.60, b-ness 0.14, c-ness 0.23, d-ness 0.03. In the colonial period four houses have four topological types; HC2 (a-ness 0.54, b-ness0.09, c-ness 0.30, d-ness 0.04), HC9 (a-ness 0.46, b-ness 0.21, c-ness 0.25, d-ness 0.12), HC10 (a-ness 0.56, b-ness 0.13, c-ness 0.23, d-ness 0.05). The independent period has four houses with following values: HI5 (a-ness 0.50, b-ness 0.11, c-ness 0.36, d-ness 0.09), HI7 (a-ness 0.42, b-ness 0.16, c-ness 0.29, d-ness 0.14), HI8 (a-ness 0.47, b-ness 0.05, c-ness 0.31, d-ness 0.13), HI12 (a-ness 0.57, b-ness 0.22, c-ness 0.10, d-ness 0.10). And the contemporary period have six houses : HP1 (a-ness 0.57, b-ness 0.16, c-ness 0.25, d-ness 0.05), HP3 (a-ness 0.37, b-ness 0.21, c-ness 0.36, d-ness 0.08), HP4 (a-ness 0.60, b-ness 0.21, c-ness 0.14, d-ness 0.09), HP9 (a-ness 0.36, b-ness 0.22, c-ness 0.30, d-ness 0.10), HP10 (a-ness 0.48, b-ness 0.18, c-ness 0.29, d-ness 0.05) HP11 (a-ness 0.56, b-ness 0.26, c-ness 0.11, d-ness 0.11).

The results reveal the presence of a-type and b-type spaces in 100% of the sample, which refer to private, social and service spaces. The private and social spaces represent the separate spaces in the system such as bedrooms, halls, living room and guest room. There is no penetration into these spaces which provide a high degree of control due to their nature as spaces for specific functions such as sleeping, resting and eating. While the c- and d-type space are part from the rings, the presence of these two types indicate to the flexibility and fluidity of circulation within the house, where the control of movement decreases inside the house because they offer a choice of circulation, these types of spaces increase in the independence and contemporary houses

2. The order of integration of each house in the sample: the mode of structure

To define the genotype, other syntactic parameters are highlighted in this study, expressed by the order of integration. The domestic interior of the house layouts was analysed; each space in each house was compared to other spaces in the same house in the sample according to its degree of integration (RRA). This ordering could provide a better understanding of the morphology of the spatial configuration. If this ordering remains in a consistent order across a sample, then there is evidence of a cultural pattern (genotype). Tables (7.a, 7.b, 7.c, 7.d) present the order of integration of the houses in each period.

Table (72.a, 72.b, 73.c, 74.d) presents the ranking order of the integration values (relative asymmetry RA) of all the interior "functional spaces" in each house. The ranking order, from the most integrated space to the most separated space, shows that the hall (Hl) is the most integrated space in every house in the entire sample, except for houses HV12, HC13, HI3, HI4, HP3, where the intermediate space (I) is the most integrated space, in the house HC8, HC9, HC12, HI1, HI5, HI10, HI15, HP2, HP5, HP12, HP13, HP14, HP15 the corridor (crd) is the most integrated space, the houses HI2, HI8; the staircase (str) represent the most integrated space, the house HI11 where the courtyard (cor) is the most integrated space in the house. While, these integrated spaces (Hl, crd, str..) are the transitional spaces of the topological space b-type considered as through space. The hall provides access to all the spaces in the house and is the pivot of the movement and circulation within the houses. The bedrooms, bathroom, toilet, storage spaces are the most separated spaces in the whole sample which all belong to the topological a-type space.

The results in the Tables show a clear recurrence in the mode of spatial structuring as most of the houses are structured around the hall in the sample; it is demonstrating the existence of underlying characteristics in the spatial pattern of the sample, as Hillier and Hanson (1987) state: "*the cultural pattern exists*". Recurrence in syntactic properties may be an indication of genotype.

Five distinct groups are identified, the first group where the hall is the most integrated space. In the vernacular houses the vestibule (*sguifa*) is the point of entrance into the houses which takes directly to the main central hall that has an access to the most spaces in the house as: the kitchen, the bedrooms, the bathroom, the toilet, the storage spaces… These halls are large enough to serve as both transition spaces and functional spaces such as guest reception areas. In the colonial houses the vestibule started to disappear and replaced by the veranda which considered as the boundary between the exterior and the interior spaces and the point of entrance into the house which takes to the hall the main central space. Later in the independence and contemporary period this central hall begins to contract in size and transforms into a corridor.

When all 60 houses are examined together, the transition spaces are the most integrated space. According to the findings, significant architectural characteristics to govern the relationships of the public and private realms of the house include transition spaces that simultaneously link and separate various spatial sections (Guney, 2008).

The examination of the order of integration of each house in the four periods, indicate another significant in the spatial configuration; the placement of the kitchen whereas is almost the second integrated functional space after the transition spaces in all the periods, which refers to the accessibility of this space, until the contemporary period the guest room and living room start to be more integrated and the kitchen tend to the segregation in some houses. The bedrooms are segregated spaces in all the periods. And the vestibule is integrated space after the hall in the vernacular houses especially and the colonial houses then it are disappearing in the both periods the independence and contemporary houses.

Table 72.a: The order of integration of living function of each house of vernacular houses

N°	RA: mean	Houses	Order of integration (with exterior)
01	0.17	Hv01	Hl1<Hl2=str=stb<vs<wc=bth=rm1=ktch=byr=trs=str2<ext=rm7<rm3=rm2=rm4=rm5=rm6=dp1=dp2<rm9=rm8=rm10=rm11
02	0.27	Hv02	Hl1=Hl2<str<Hl3<lvr<ktch=rm1=wc=bth=rm2<trs<byr<ext<dp1=dp2
03	0.30	Hv03	Hl1<Hl2<In<ktch=lvr=rm1=byr=rm2<vs<bth<trs<ext
04	0.28	Hv04	Hl<str<vs<lvr<ktch=byr=rm1=rm2<trs<grm=ext<rm3<dp1=dp2
05	0.30	Hv05	Hl<vs<rm2=rm1=rm3=rm4=ktch=lvr<gr=ext<wc
06	0.25	Hv06	Hl=Hl2<vs<ktch=rm1=rm2=lvr<ext=bth=wc
07	0.34	Hv07	Hl<str<vs<trs<rm2=ktch=rm1=bth<byr=I<ext=wc=grm=dp3<dp2=dp1=kch tr<cr=dp4
08	0.24	Hv08	Hl<vs<cor<rm1=ktch=bth=rm2<ext=wc<rm3
09	0.39	Hv09	Hl<vs<str<rm1=ktch=rm2<ext<trs
10	0.30	Hv10	Hl<Hl2<vs<ktch=bth=rm1<rm2=rm3=cor<wc=ext
11	0.31	Hv11	Hl<str<trs<vs<rm1=ktch=rm2<dp=rm4=rm3=wc2<wc=ext
12	0.22	Hv12	crd<str<trs<HL=kch<cor<crd2<vs=I=rm4<rm1=bath2=dp=rm2=rm6=rm7<rm11<rm13=rm14=rm8=rm9<ext=dp=wc=bath=rm3=rm5=<rm10=rm12
13	0.29	Hv13	H<Hl<vs<lvr<rm1=ktch=rm2<wc=ext
14	0.37	Hv14	Hl<str<I<trs<rm2=rm3=rm1=ktch<ext=grm=wc<dp1=dp2=dp3
15	0.26	Hv15	Hl=str<I2<trs<I3<vs<ktch<rm2=lvr=rm1<rm4=dp1=dp2=dp3<rm3=wc<ext

Table 72.b: The order of integration of living function of each house of colonial houses

N°	RA: mean	Houses	Order of integration (with exterior)
01	0.27	HC01	Hl<str<vs<trs<bth=rm2= wc=ktch= rm3<ext<rm5 =rm4=dp
02	0.21	HC02	Hl<ktch<str<I<lvrm=lvrm2=rm3=dp=rm2=dp2<trs=vrd2<vrd<Bth<rm1=ext<wc<rm5=rm4=rm6=bth2<cor<gr
03	0.34	HC03	Hl<I<str<vrd=rm2=ktch=bath<rm1=Grm<trs<ext<rm3
04	0.28	HC04	Hl>rm2>str>vs=bath>ktch=wc=grm>rm3>trs>rm4>ext=rm1=bath2>rm5>bath3
05	0.22	HC05	Hl<str<vs<trs<rm3=rm4=ktch=lvrm=rm2=grm<ext=rm1=bath=wc<rm7=rm6=rm5=rm8
06	0.25	HC06	Hl<str<trs<ktch=rm1=rm2=lvrm=ext=bth=wc=byd<rm4=rm3=rm5
07	0.32	HC07	Hl<h<str<bth=ktch=rm2<ext=rm1<trs
08	0.35	HC08	crd<str<HL<vr=trs<Grm=bth=<ktch=rm1=rm2=I<ext<rm4=rm3
09	0.38	HC09	Crd<Hl<str<I=vr<rm2=ktch<rm1=lvrm<ext<rm3<trs=ktch2<gr<rm4<wc

10	0.23	HC10	Hl<str<vs<Grm=trs<rm2=kch<rm1=lvrm=bth=dp<ext=wc<rm5=rm 4=rm6=rm3
11	0.29	HC11	HL<str<trs<vs<bath=ktch=rm1=rm2<trs<grm=ext<rm3=rm4
12	0.28	HC12	Crd2<crd=str<crd3<dp2=ktch=bath=wc=rm3<ext=rm1=rm2=dp= grm<I<rm4<wc2<rm5
13	0.31	HC13	I<crd=I2<lvrm<byr=ktch<ext=rm1=rm2=bath
14	0.30	HC14	Hl<vr<rm3=rm2=rm1=rm4=ktch<wc=ext
15	0.30	HC15	HL<str<ext=ktch=rm1=rm2=bath=Grm<trs<rm3

Table 73.c: The order of integration of living function of each house of independence houses

N°	RA: mean	Houses	Order of integration (with exterior)
01	0.25	HI01	crd<vr=cor<rm2<rm3=rm1=bath=ktch=Grm=rm4<ext=str<bth2< gr=trs
02	0.31	HI02	Str<Hl=Hl2<bath=lvrm=ktch=bth2=str2=rm1=lvrm2=ktch2<gr
03	0.30	HI03	I<crd<str<vr=HL<wc=bath<rm1=ktch=lvrm=rm2<ext=trs=rm3rm4
04	0.28	HI04	I=str<HL=trs<crd<bath=wc=rm4=rm3<str2<ktch=rm1=rm2=rm5=r m6<vr<lvrm=blc=blc2<trs2<ext
05	0.25	HI05	Crd<vr<lvrm<str<ktch=rm2=bath=rm1<ext=gr<trs
06	0.18	HI06	Hl<str=I <ext=ktch=rm2=wc=bath=rm3=lvrm=rm4=rm1<cor=trs
07	0.22	HI07	Hl=str<crd=Hl2<ktch2=rm2<crd2=bath3<lvrm<ext=gr1=str2< bth1=rm4=rm3=rm5=rm6=blc3<blc=blc2<vr=ktch<bth2=rm1<trs=gr 2<dp
08	0.22	HI08	Str<vr=crd3<crd=ktch<crd2<rm2=rm3=rm4=lvrm2<ktch3=bth=gr=e xt= ktch2<grm=rm1=off<pt=bth=lvrm<blc=blc2
09	0.22	HI09	Hl<str<Hl2<vr<ktch<bath=rm1=rm3=rm4=grm=rm2<rm5= lvrm=trs= bath2=dp<ext
10	0.27	HI10	Crd<I<str<vr<crd2<bath=ktch=rm1=gr=lvrm<cor<ext=bath=wc<rm 3=rm2=trs=bath2=blc
11	0.23	HI11	Cor<HL<str<vr<crd=trs<dp2<ktch=bth=rm3=rm2=wc2=lvrm<ext= wc1=dp=I=<rm1=rm5=rm4=<rm6<rm7
12	0.30	HI12	HL=cor<str<I<crd<Grm<bth=rm2<wc=rm1=wc2=crd2<vr<ktch<rm 5=rm4< rm3=ktch2=wc3<ext
13	0.32	HI13	HL<ktch=str<ext=bath=wc=lvrm<trs< rm2=rm1
14	0.30	HI14	Hl<vr<rm3=rm2=rm1=rm4=ktch<wc=ext
15	0.16	HI15	Crd<vr=str<rm4=rm3=grm=rm2=ktch=cor=wc=rm1=lvrm=bth<ext= trs

Table 74.d: The order of integration of living function of each house of contemporary houses

N°	RA: mean	Houses	Order of integration (with exterior)
01	0.21	HP01	HL=str<Hl2<vr=gr<wc=bath=lvrm=cor=ktch=Grm=str2<rm3= bath= rm2=blc=rm4=rm1<ext<trs

02	0.25	HP02	Crd2<str<crd<str2<HL<rm4=rm3=rm2=wc=bth2=rm1<vr=gr<Grm<trs<rm<ktch<bath<ext<wc2<cor
03	0.22	HP03	I<str<HL2<HL<vr<Grm=Grm2=str2=rm4<lvrm=rm1=rm2=rm3=bath2<ktch=pt=wc=bath<gr=ext<pt2=trs=blc2=blc1
04	0.21	HP04	Hl=str=Hl2<vr=gr=ktch=str2<bth=wc=rm1=rm3=rm2=bth2= rm4=rm5=blc=wc2<ext<trs
05	0.20	HP05	Crd<str<Hl2<Hl<vr=gr<grm=str2=dp<wc2=kch2=rm4=rm3= grm2=trs=rm2=bth2<bth=wc=pt=ktch=rm1<ext<trs<lc
06	0.16	HP06	Hl2<str=str2<Hl3<Hl<rm6=bth2=kch2=rm5=blc=rm4=grm<vr= I=grm2=str3<ktch=pt=rm7=rm8=blc2=kch3=trs2<rm2=wrd=rm1=rm3<ext=lc=wc3=bth3<trs3<lc2
07	0.23	HP07	Hl<str<h=dnrm=str2<Grm=rm3<rm2=rm1=rm4=wc2=bath<vr<h2=kch<wc<blc=blc2<ext=gr<trs=trs2<lc=lc2
08	0.28	HP08	HL<str<h<str2<rm1=kch=bath=rm2=rm3=lvrm=wc2<ext<gr<trs<lc<wc
09	0.27	HP09	Hl2<crd2<str<HL<str2<rm1=lvrm2=blc<rm3=rm2=kch=bath<crd<lc <lvrm=wc<trs<ext<grm<blc2
10	0.18	HP10	HL2<str<h=str2<rm5=rm4=lvrm=rm2<rm3=trs=wc2=bth2<HL<vr=lvrm=HL3<rm1<bth3=wrd=blc=blc2=blc3<gr=kch=I<ext= dnrm<bth4=wc3=trs2=rm7<wc=bath
11	0.27	HP11	HL<str<rm2<trs<cor=ktch=rm3=rcvrm=bath=rm1<ext<wc=blc<blc1 =blc2<gr1=gr=gr2
12	0.27	HP12	Crd<str<gr<rm3=grm<bath=rm1=rm2=wc=ktch=trs<ext<blc= blc2<lc2=lc1=lc3
13	0.22	HP13	Crd2=str<crd<rm5<lvm=str2<ktch2=ext=rm3=rm4=rm2<rm1= Grm=wc=lvrm=bath=kch<blc<blc2=trs<lcl=lcl2<wc2
14	0.29	HP14	Crd<I<I<Grm=kch<pt=rm2=rm1=ext<wc=bth<blc=blc2<gr=lcl= lcl2
15	0.23	HP15	Crd<str<gr<rm<ktch=lvrm=trs=rm2=rm1=Grm=wc=bath<ext<dp=cor=wc<blc<lcl=lcl2

This step leads to discover consistent pattern features the different house plans; five groups are classified based on the structuring mode which represented in the transition spaces (the hall, the courtyard, the staircase, and the intermediate space), except the group E whereas the courtyard is the most integrated space.

Table 75: Shows the structuring mode of each group

Table75.a. Group A structured around the HL

Group	The houses Structuring around the Hall (HL)	BDF (H*)
	HV01	0.88
	HV02	0.55
	HV03	0.45

Table 75.b. Group B structured around the Cor

Group	The houses Structuring around the Corridor (crd)	BDF (H*)
	HC08	0.38
	HC09	0.41
	HC12	0.45

A	HV04	0.51
	HV05	0.42
	HV06	0.26
	HV07	0.67
	HV08	0.32
	HV09	0.59
	HV10	0.37
	HV11	0.44
	HV13	0.19
	HV14	0.51
	HV15	0.65
	HC01	0.47
	HC02	0.52
	HC03	0.47
	HC04	0.41
	HC05	0.54
	HC06	0.45
	HC07	0.34
	HC10	0.40
	HC11	0.37
	HC14	0.57
	HC15	0.58
	HI06	0.45
	HI07	0.34
	HI09	0.41
	HI12	0.41
	HI13	0.56
	HI14	0.43
	HP01	0.41
	HP04	0.39
	HP06	0.50
	HP07	0.36
	HP08	0.48
	HP09	0.42
	HP10	0.28
	HP11	0.65

B	HV12	0.93
	HI01	0.47
	HI05	0.54
	HI10	0.40
	HI15	0.41
	HP02	0.40
	HP05	0.36
	HP12	0.44
	HP13	0.38
	HP14	0.44
	HP15	0.41

Table 75.c. Group C structured around the (I)

Group	The houses Structuring around the Intermediate space (I)	BDF (H*)
C	HC13	0.57
	HI03	0.47
	HI04	0.41
	HP03	0.35

Table 75.d. Group D structured around the (str)

Group	The houses Structuring around the Staircase (str)	BDF (H*)
D	HI02	0.52
	HI08	0.38

Table 75.e. Group E structured around (cor)

Group	The houses Structuring around the Courtyard (cor)	BDF (H*)
E	HI11	0.37

The group A; represent the first dominant group, the number of houses that structured around the Hall (HL) is important according to the other groups therefore stands at 36 houses (60%) more than half the whole sample. It's notable that most the group from the vernacular houses except the house HV12 and the colonial houses except the houses HC08, HC09, HC12, HC13 from the other groups. The base difference factor (BDF) shows low values varied between 0.19 and 0.88 in which the house HV13 has the lowest value of BDF and the house HV01 has the highest value, the low values of BDF indicating the strongest differentiation and structured spatial configuration. The group B; the second group that structured around the corridor (crd) contained 14 houses from the four periods: precolonial, colonial, independence, and contemporary period. By observing the BDF it represents a low value differed between 0.38 and 0.93, in which the house HV12 has the highest degree (0.93) which means strong differentiation of spatial ordering. The third group C structured around the intermediate space (I) have four houses from whole the sample from the four periods, its characterised also by its low value of BDF, in general this group represent a strong differentiation and structured spatial configuration. The group D which structured around the staircase contained only from two houses from the independent period, and have a low value of BDF. The last group E that structured around the courtyard (cor) contained from one house from the independence period HI11 and has a low value of BDF (0.37) indicating the strongest differentiation.

By examining these five groups, one can observe an underlying characteristic of the spatial configuration. One of the significant can observed is the structuring around the transition spaces over the four periods.

3. Refinement of genotype groups using the space link ratio

Based on mode of structuring, five groups are identified. The first dominant group is structuring around the hall (HL) contained of 39 houses, the second group; is structuring around the corridor (Cor) and contained 14 houses, third group structured around the intermediate space (I) which contained of 04 houses, fourth group is structuring around the staircase (str) contained of two houses, the last one; we cannot considered as a group because contained only from one house, is not a part from any group.

The recurrence of specific structural elements of the specimens is seen to be the index of genotype. Whilst the diversity of observed architectural compositions is thought of as the phenotypes (Boutaba, 2013). But we will not be able to talk about genotype in this stage, to refine the groups of genotype for the sample; we must review all the groups by other syntactic parameters: the space link ratio SLR which provides details of the itinerary. If there is only a guided path available at the complex and no other options, the SLR report shows a value of 1. If this number is greater than 1, the system has closed circuits and multiple options for circulation. The results shown in the table below;

Table 76: The SLR for each house from the five groups (A, B, C, D, and E)

Houses of G.A	SLR	Houses of G. B	SLR	Houses of G. C	SLR	Houses of G. D	SLR	Houses of G. E	SLR
HV01	1.08	HV12	1.06	HC13	1.10	HI02	1.00	HI11	1.04
HV02	1.06	HC08	1.00	HI03	1.00	HI08	1.13		
HV03	1.00	HC09	1.00	HI04	1.09				
HV04	1.00	HC12	1.00	HP03	1.16				
HV05	1.09	HI01	1.00						
HV06	1.00	HI05	1.08						
HV07	1.00	HI10	1.00						
HV08	1.00	HI15	1.00						
HV09	1.00	HP02	1.04						
HV10	1.00	HP05	1.04						

HV11	1.00	HP12	1.00
HV13	1.00	HP13	1.00
HV14	1.00	HP14	1.12
HV15	1.05	HP15	1.00
HC01	1.00		
HC02	1.08		
HC03	1.00		
HC04	1.00		
HC05	1.00		
HC06	1.00		
HC07	1.00		
HC10	1.06		
HC11	1.00		
HC14	1.00		
HC15	1.00		
HI06	1.00		
HI07	1.18		
HI09	1.05		
HI12	1.10		
HI13	1.00		
HI14	1.00		
HP01	1.10		
HP04	1.04		
HP06	1.08		
HP07	1.04		
HP08	1.06		
HP09	1.15		
HP10	1.08		
HP11	1.11		

From the Table 09, it is notable that there are no recurrences in the SLR in each group whereas all the groups' subdivided into two subgroups, in the group « A » most of houses (22 houses) have non-distrubuted system that features an arborescent justified graphs. The rest of houses (17 houses) have distributed system and ringy graphs. From this group, it's distinguished two subgroups of houses: first one; the houses structured around the hall with tree structure, where there is only one route for any two points in a spatial configuration it's said non-distributed system. The second; houses structured around the hall with ringy configuration, means distributed system which reflects the existence of more than one non-intersecting route between two given points in a system. The group « B » has nine houses structured around the corridor with non-distributed system; tree-structure, and five houses with ringy structure. The group « c » which structured around the intermediate space; one house with tree- like structure and non-distributed system, and three houses has ringy system which tends to distributedness. The group « D » contained two houses one of them have haracteriz system, and the other non-distrbuted. The last group « E » has only one house haracterized by its ringy system and the distributedness. The table 10 showed the classified groups.

Table 77: classified the groups of genotypes

Genotype A01	G. A Distributed system	HV01- HV02- HV05 – HV15- HC02 – HC10 –HC11– HI07 – HI09 – HI12 – HP01- HP04 – HP06 – HP07- HP08- HP09- HP10- HP11.
Genotype A02	G. A Non-Distributed system	HV03 – HV04 – HV06- HV07- HV08 – HV09 – HV10 – HV11 – HV13 – HV14 – HC01 – HC03 – HC04 – HC05 – HC06 – HC07 – HC14 – HC15 – HI06 – HI13 – HI14.
Genotype B01	G. B Distributed system	HV12 – HI05 – HP02 – HP05 – HP14
Genotype B02	G. B Non-Distributed system	HC08 – HC09 – HC12- HI01 – HI10 – HI15 – HP12 – HP¨13- HP15
Genotype C01	G. C Distributed system	HC13- HI04 – HP03
Genotype C02	G. C Non-Distributed system	HI03
Genotype D01	G. D Distributed system	HI08
Genotype D02	G. D Non-Distributed system	HI02
GenotypeE	G. E Distributed system	HI11

The analysis of these specimens according to SLR, it suggests that there are six underlying spatial-functional 'genotype' (A01, A02, B01, B02, C01, C02) defined under configurational consistencies that showed under different ‘phenotypes’ (Hillier, Hanson, Graham, 1987). In which the first groups (A01 and A02) can be demonstrated as dominant genotype (the first type), and other groups considered as secondary genotypes. The genotype represented in: transition-space-centered-organization. Which these transition spaces are defined as a link between different enclosed spaces, and these transitional and circulation spaces are one of the essential elements in the architectural design. As the last step, the base difference factors were used to identify the strength and the homogeneity of genotypes. The BDF was explored for the second time to check the solidity of the genotype groups shown in Table 11 below:

Table 78 (a, b, c, d): BDF for each genotype groups

Table 78.a. Values of BDF for the genotype A

Genotype A01	BDF	Genotype A02	BDF
HV01	0.88	HV03	0.45
HV02	0.55	HV04	0.51
HV05	0.42	HV06	0.26
HV07	0.67	HV08	0.32
HV15	0.65	HV09	0.59
HC02	0.52	HV10	0.37
HC10	0.40	HV11	0.44
HI07	0.34	HV13	0.19
HI09	0.41	HV14	0.51
HI12	0.41	HC01	0.47
HP01	0.41	HC03	0.47
HP04	0.39	HC04	0.41
HP06	0.50	HC05	0.54
HP07	0.36	HC06	0.45
HP08	0.48	HC07	0.34
HP09	0.42	HC11	0.37
HP10	0.28	HC14	0.57
HP11	0.65	HC15	0.58
		HI06	0.45
		HI13	0.56
		HI14	0.43

Table 78.b. Values of BDF for the genotype B

Genotype B01	BDF	Genotype B02	BDF
HV12	0.93	HC08	0.38
HI05	0.54	HC09	0.41
HP02	0.40	HC12	0.45
HP05	0.36	HI01	0.47
HP14	0.44	HI10	0.40
		HI15	0.41
		HP12	0.44
		HP13	0.38
		HP15	0.41

Genotype C01	BDF	Genotype C02	BDF
HC13	0.57	HI03	0.47
HI04	0.41		

Genotype D01	BDF	Genotype D02	BDF	Genotype E	BDF
HI08	0.38	HI02	0.52	HI11	0.37

HP03	0.35

The groups of genotype are divided based on the qualitative characteristic: the itinerary. Based on the BDF from the (Table 78) the groups of genotype show low value of BDF for all the groups, there by indicate to the strong differentiation and homogeneity for the spatial configuration. In which, in the first group G.A01 the values of BDF varied between 0.28 as the lowest value for HP10 and 0.88 as the highest value of BDF for HV01. The second group G.A02 has closed values of BDF; 0.19 as the minimum value for HV13 and 0.59 as maximum value for HV09. The group G.B01 the values varied between 0.36 as minimum value for HP05 and 0.93 as maximum value for HV12. The group G.B02 has very closed values between 0.38 the lowest value (HC08, HP13) and 0.47 (HI01) as the highest value. The group G.C01 contained three houses: HP03 has the lowest value 0.35 and HC13 has the highest value 0.57. The group G.C02 contained one house HI03 (0.47).

4. Discussion and interpretation

After analysing the different spatial arrangement of 60 houses from different periods, the results were examined which indicate that there is an underlying spatial structure within the sample based on the justified graphs analysis by looking for recurrences within the houses. The examination of RRA indicates the important role of the exterior to bring the layouts together in which the houses become more integrated when the exterior is included and that leads to the significant of the exterior to the overall spatial configurations for all the periods (Barkat.R, 2020). The analysis of houses demonstrates that the integration value increase when the exterior is included, which means that all the houses share the inward-looking. In the case of vernacular and colonial houses, the most of houses are segregated which mean more private and more controlled, the houses of independent and contemporary houses are more integrated which mean less private and more accessible.

The results indicate important features for this sample of houses. The mean depth (MD) measurement show that the vernacular houses are shallow from the exterior and from the data the configuration become deeper through time, and the contemporary houses have the deepest spatial arrangement within the complex. Thereby this result may due to the increase of the number of spaces and that refer to the improvement of the economic status of inhabitants and to the development of social life.

After the examination of the order of integration and the different indicator as to the base different factor (BDF) and the space-link ratio (SLR) for whole the sample; six groups of structuring modes are identified, the first dominant group is structured around the hall '*wasteddar*' of b-type space which is the main central space and has a strong functional-efficiency of spaces and more structured, based on SLR this dominant group is subdivided into two sub-groups: Group A01 shows a ring-shaped spatial configuration that offers alternative movement within a part of the house and the second sub-group A02 that features an arborescent justified graphs and non-distributed system. In the second group (B) where the corridor of b-type space is the structured space which is a linear element that considered as the pivot of circulation, when using the SLR the group (B) is subdivided into two sub-groups: B01 with distributed system and ringy graph which offer a choice of mobility within the house, and B02 characterised by an arborescent graphs and non-distributed system. The third group structured around the intermediate space subdivided into two sub-groups: C01 features by ringy graphs and C01 with tree-like structure which tends to the non-distributedness. The fourth minimal group structured around the staircase have only two houses one with ringy graph and the other with an arborescent structure. The last group structured around the courtyard contained only one house; therefore, it's can't form a group. Comprising of BDF values for all the groups indicates that each group has a low value of BDF, so the configuration tends to favour functional differentiation and it's more structured and homogeneous.

These results confirm the existence of the genotype which manifested in several phenotypes. From the quantitative approach that used in this study such as the real relative asymmetry (RRA), space link-ratio, degree of spaceness and permeability… the houses are regulated by socio-cultural factors such as "intimacy" which is considered a vital and sacred rule to preserve family members. Space syntax expresses the meanings of the social factors and lifestyle in the spatial system. It allows comparing the spatial arrangements of a sample of houses through different time that formed under the influence of the same cultural factors.

In the following part of analysis, we will analyse and investigate how social relation expresses themselves through spatial organisation of the house. And investigate the exterior -interior relation, which has an important effect on the spatial configuration whilst, in some cases there is no impact to the overall space configuration whether the relation to the space outside is included or not. This step helps us to understand the relation inhabitant- inhabitant and inhabitant -visitors.

5. Examine the underlying structure of social relations:

The quantitative indicators have been examined in the first part of the analysis, shedding light on discovering the genotype and the underlying characteristics of the houses layouts of Biskra city over time; in the first stage we demonstrate the groups of genotypes through the indicator: space link ratio (SLR). In this second part of interpretation we will focus on examining the social logic of the spatial configuration by discovering the constituent parts and connections that make up the spatial pattern (Hanson, 1998).

The investigation of interior-exterior relation based on integration values by taking in consideration including or omitting the space outside, in which in some cases this last has a significant effect on the spatial configuration whereas in others, doesn't make any different (Hanson, 1998). "Integration is the key through which we can demonstrate how locations and buildings work on a collective level and grasp the social substance of architecture" (Hanson, 1998). The list below shows the effect of omitting the exterior on the houses that become more integrated or segregated.

-- The houses that become more integrated when the exterior is not included : HV02, HV03, HC01, HC03, HC05, HC14, HI04, HI09, HI14, HI15, HP01, HP02, HP04, HP09, HP10.

-- The houses that become more segregated when the exterior is not included : HV04, HV05, HV06, HV07, HV08, HV09, HV12, HV13, HV14, HC02, HC04, HC06, HC07, HC08, HC09, HC10, HC11,HC12, HC13, HC15, HI01, HI02, HI05, HI06, HI07, HI08, HI11, HI12, HI13, HP05, HP06, HP07, HP08, HP11, HP12, HP13, HP14, HP15.

- The houses that didn't affected by omitting the exterior : HV01, HV10, HV11, HV15, HI03, HI10, HP03.

Figure 101: Flowchart identifies the segregated, integrated, and not affected houses by omitting the exterior. (Source: author)

Most of the houses (38 houses) become more segregated when the exterior is omitted, and fifteen houses become more integrated, thus, it refers to the important role of the space outside on the overall configuration of houses. Seven houses didn’t affected by the omitting of the exterior.

6. Explore the social logic of spatial configuration by decryption the arborescent and ringy graphs

According to the book of Social logic of space, Hillier and Hanson (1989) establish a fundamental method called Gamma – analysis (justified graph) is that building transmits social information through their internal structures, through both general variations in the fundamental syntactic parameters. According to how the complex is viewed syntactically from a certain space, we can define a space in terms of syntax. Thus, social information is carried more by interior structures than by external relationships. Additionally, the approach demonstrates how a structure interfaces the relationship between individuals who enter as guests and those who reside there (inhabitants).

A new dimension is added to the relationship between social solidarity and space by the duality of inside and outside. Solidarity will be transpatial to the extent that it strengthens and homogenizes the interior organization of space and, concurrently, emphasizes the interior's discreteness by exerting tight control over the boundary. In order to protect the inside structure from uncontrolled intrusion, such a solidarity needs the boundary's separating function (Hillier and Hanson, 1989).

This section offers a study of the relationships between the internal and external relations of the building (house) as part of a general theory of the social logic of space, and it introduces the method of syntactic analysis (justified graph) of interior structures. It also develops a number of hypotheses about the relation between the major syntactic parameters and social variables.

The interactions of inhabitants with inhabitants and inhabitants with visitors will produce genotypes, but the more regulated interfaces will articulate distinctions and similarities in social solidarity forms with better precision and higher differentiation. Since all buildings, parametrize the syntactic dimensions or symmetry-asymmetry and distributedness-non-distributedness to map relationships between residents and between residents and visitors, all structures share the same abstract genotype (Hillier and Hanson, 1989).

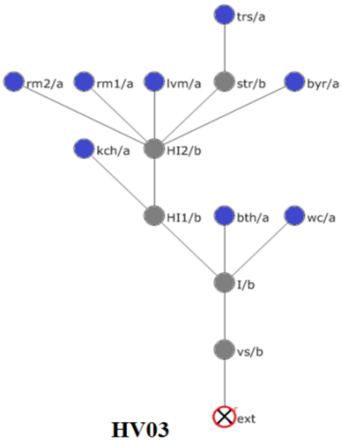
This part of the interpretation will focus on the identification of the genotypes by defining the spatial specifies of the interior organization and establishing the social logic underlying the spatial configuration. Starting by analysing the degree of ringiness one of the fundamental properties of the space of whole the sample, in which allow to classify the configurations in two categories:

- Arborescent graphs
- Ringy graphs

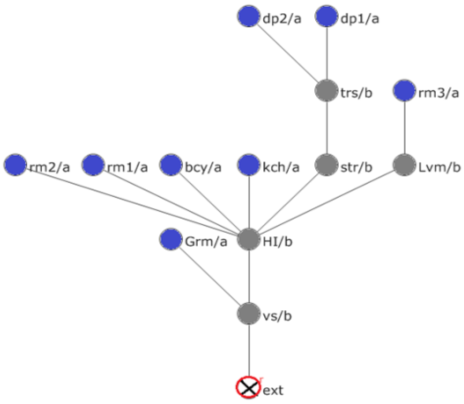
6.1. The arborescent graphs

The arborescent graphs represent the major category of spatial layout. They are features by a sequence of spaces of b-type that serving to the spaces of a-type. The movement within the house is controlled and guided whereas the spaces of a-type are dead-end space and b-type suggests no choice of mobility to and from this space, it's a through space. From the sample the arborescent graphs represent 50% from whole the sample most of them from the vernacular and colonial houses. Thirty one houses from the sample have the arborescent graph: HV03, HV04, HV06, HV07, HV08, HV09, HV10, HV11, HV13, HV14, HC01, HC03, HC04, HC05, HC06, HC07, HC08, HC12, HC14, HC15, HI01, HI02, HI03, HI06, HI10, HI13, HI14, HI15, HP12, HP13, and HP15.

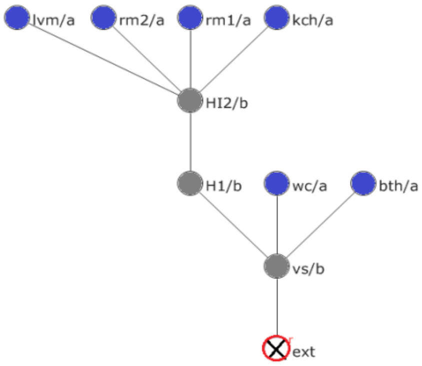
The graphs are deep from the carrier (exterior) and in symmetric order (Figure 102). The justified graphs are drawn from point of view of a visitor who is unfamiliar with the interior of the house, but is seeking to map every space connected to the first room (guest room) entered from : the veranda, vestibule or outside (Ostwald, 2011). But the inhabitant who is familiar with the house will use different paths to achieve a specific space within the house. From the graphs, a boundary between the exterior and inner space is existed represented in two spaces: the vestibule (*sguifa*) in the vernacular houses, and the veranda which appeared in the colonial period. Whereas, the inferior part of the graphs is asymmetric, except the houses: HC06, HC15, HI06, HI02, HI13, HI15.



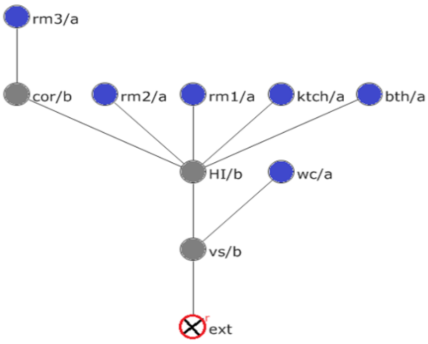
HV03



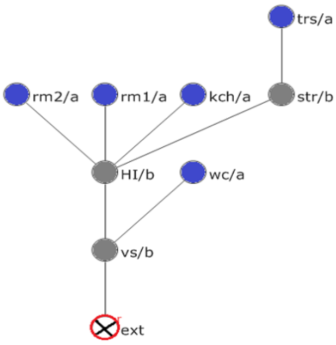
HV04



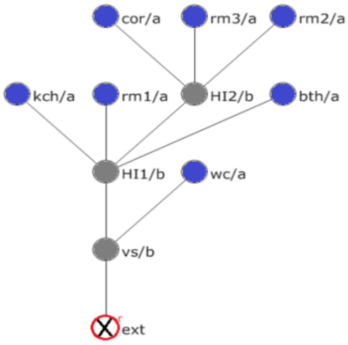
HV06



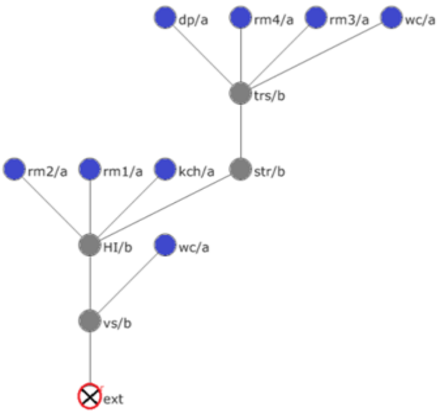
HV08



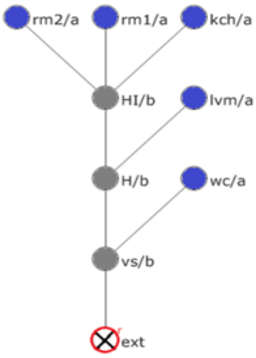
HV09



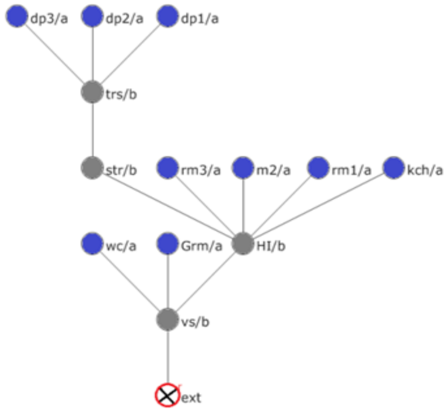
HV10



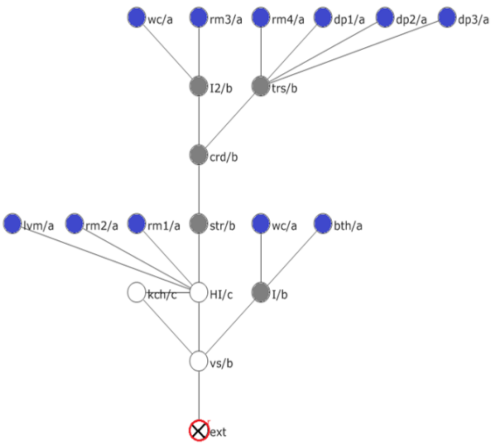
HV11



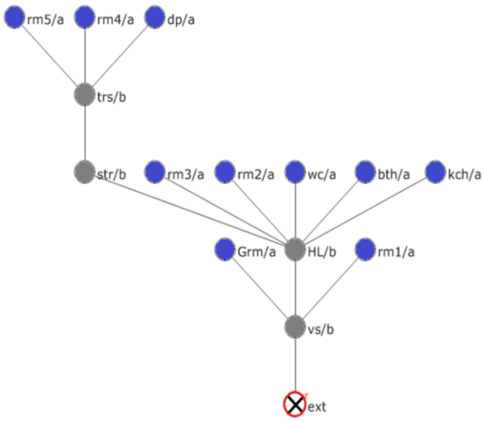
HV13



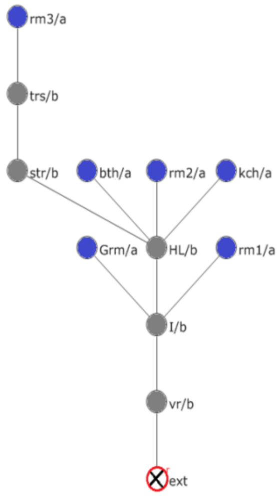
HV14



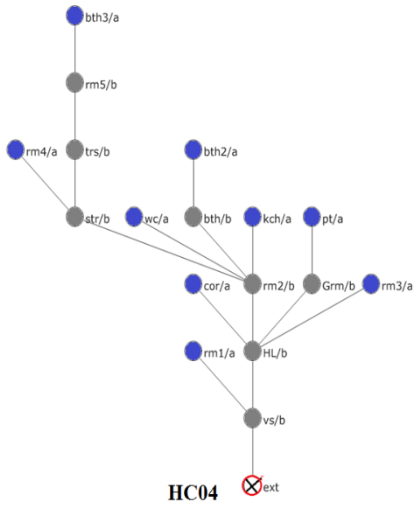
HV15



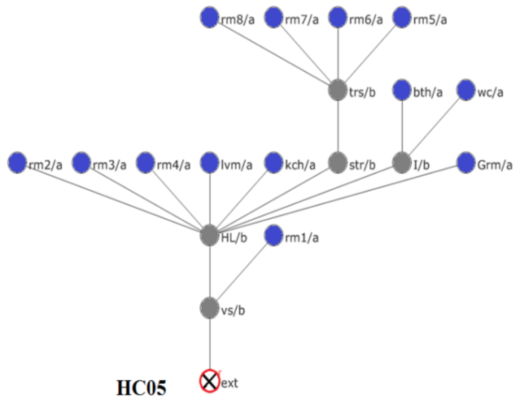
HC01



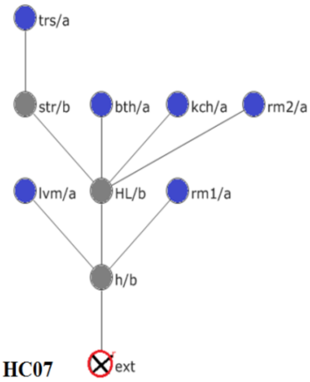
HC03



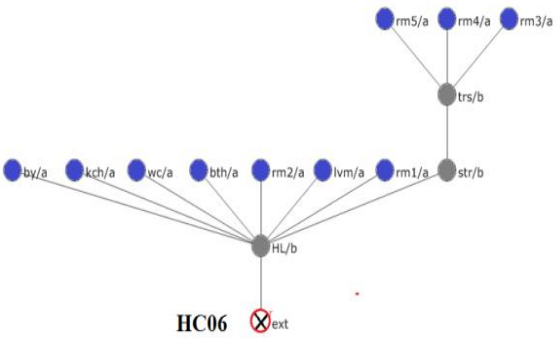
HC04



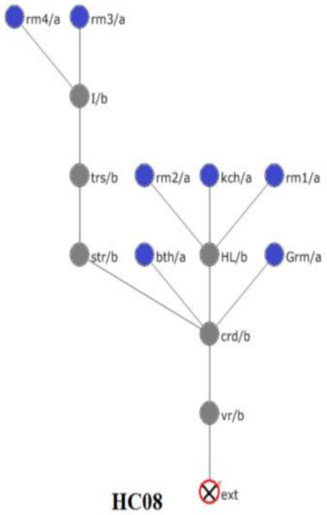
HC05



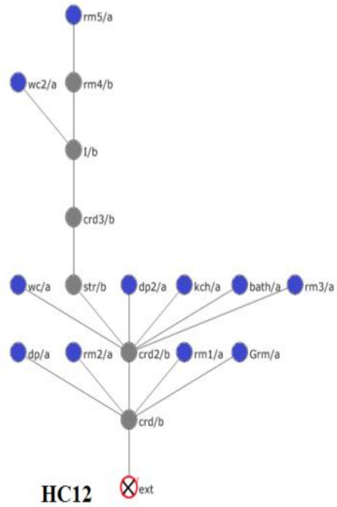
HC07



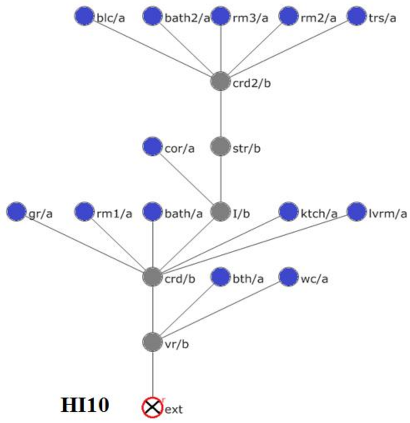
HC06



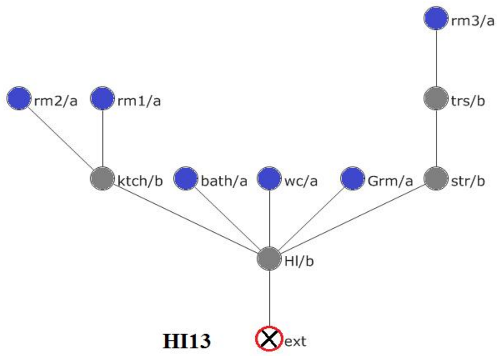
HC08



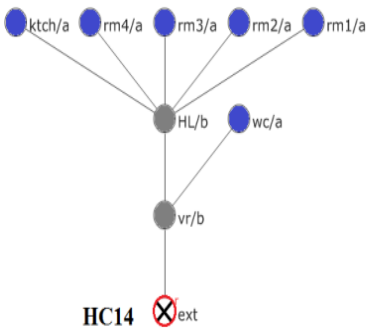
HC12



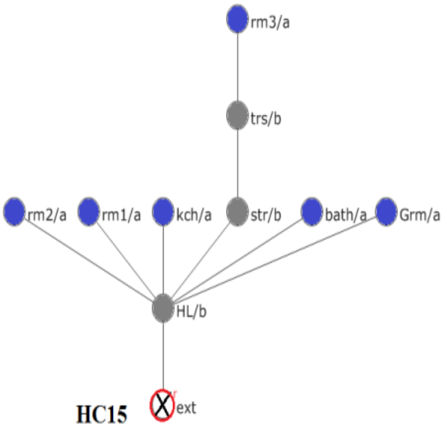
HI10



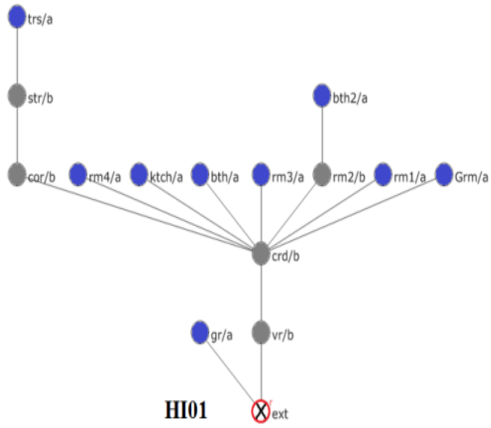
HI13



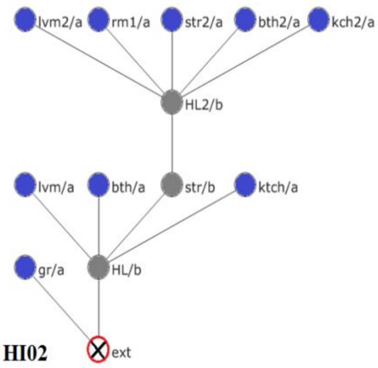
HC14



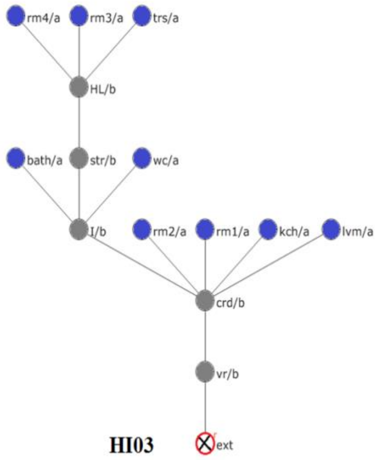
HC15



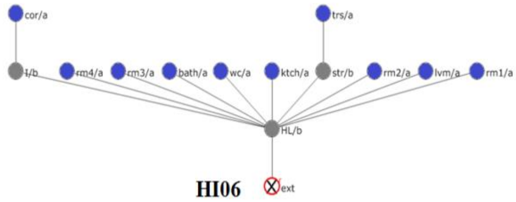
HI01



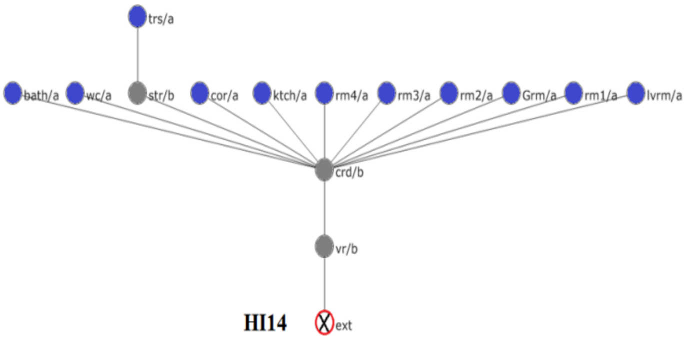
HI02



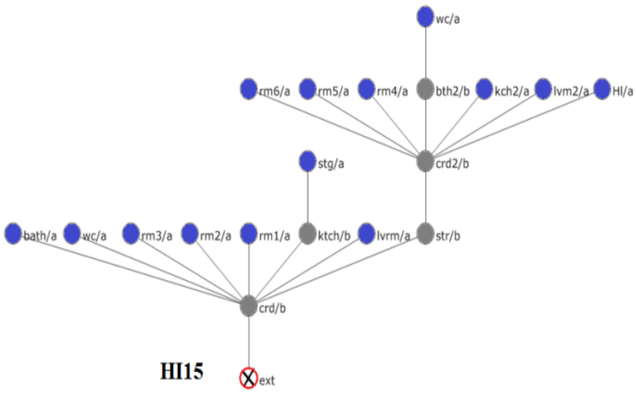
HI03



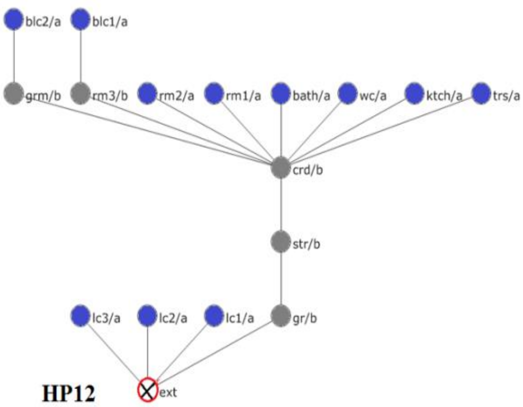
HI06



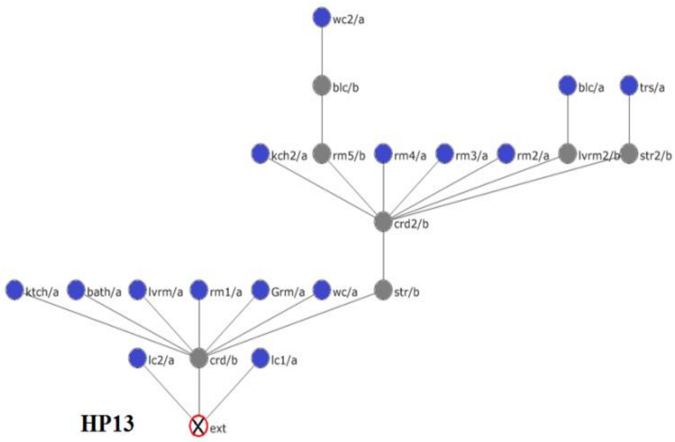
HI14



HI15



HP12



HP13

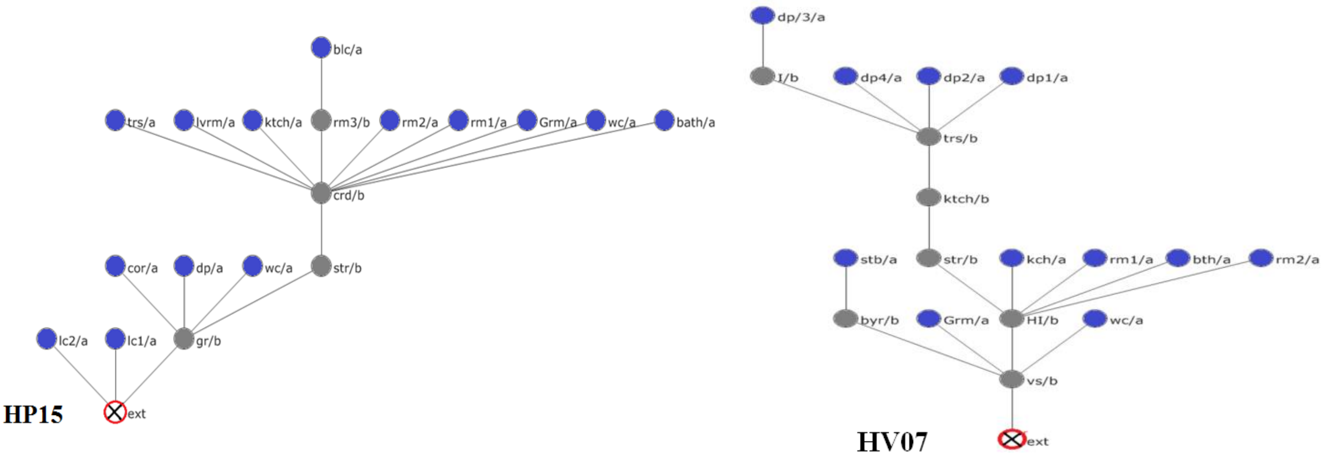


Figure 102: The arborescent graphs from the four periods

6.2. The Ringy graphs

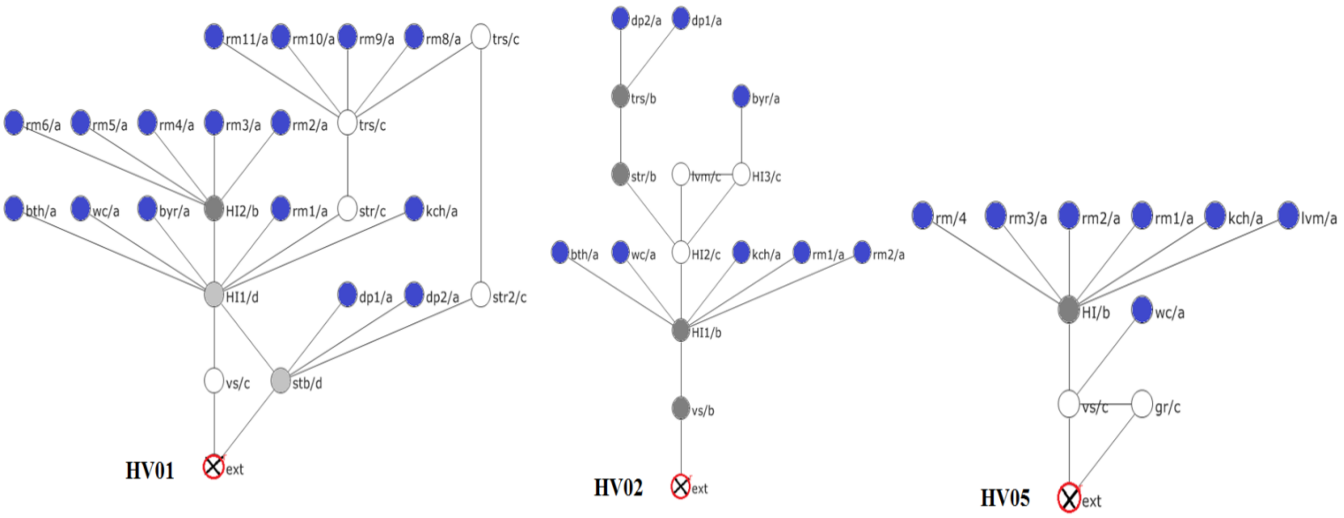
The ringy graphs represent the second category of spatial configuration; it provides a high flexibility and choice of movement. These ringy graphs add extra permeability, thus, it refer to a distributed system. In addition to topological spaces of a- and b- type, it exist c-type or d-type or both of them. It distinguished from the graphs that there are two types of rings: inner rings and outer rings.

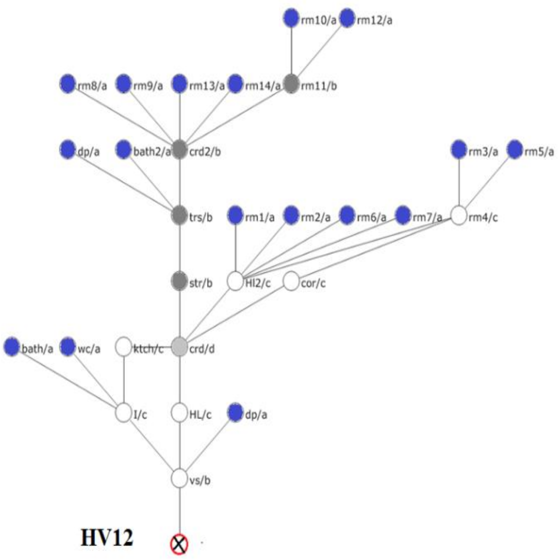
The inner rings: include the ring that formed by interior spaces.

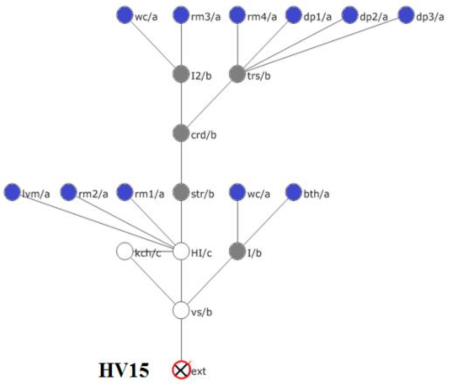
The outer rings: include the rings that formed by the exterior and inner spaces.

From the figure (103) below, the ringy graphs offer high flexibility, permeability and less control within the house, the existence of inner rings articulate the relations between residents, in which these rings have an important role in the interior distributedness. Twenty nine ringy graphs from the sample most of them from the contemporary period : HV01, HV02, HV05, HV12, HV15, HC02, HC09, HC10, HC11, HC13, HI04, HI05, HI07, HI08, HI09, HI11, HI12, HP01, HP02, HP03, HP04, HP05, HP06, HP07, HP08, HP09, HP10, HP11, HP14.

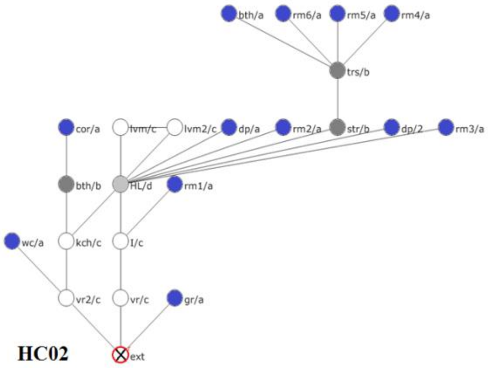
The inner rings offer a certain choice of mobility for the inhabitants within the houses, in which are formed in the most graphs by : the kitchen (kch), the hall (HL), the vestibule (vs), the veranda (vr), the living room (lvrm), the guest room (Grm), the corridor (crd), rooms (rm), and balcony (blc) ; such as : (vs, kch, hl), (Hl, lvrm, crd), (crd, kch vr), (vr Hl, kch), (Hl, kch, pt), (crd, rm, balcony), (vr, crd, kch, str), (vr, grm, hl, rm)… these spaces with such a passageway quality shape the everyday domestic life. Both the vestibule and the veranda are equally important as a filter spaces for dividing public from private areas. The outer rings include each of: exterior, the veranda, the vestibule, the garage, locals, corridor, are considered as entrance spaces. The penetration of visitors into the house is controlled by specific socio-cultural- religious codes. The gradient of intimacy is found in these houses at varying degrees from the public, or semi- private to the most private spaces.



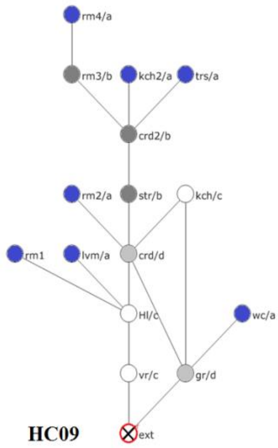




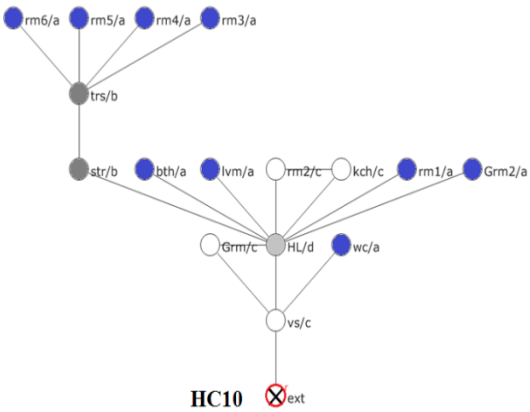
HV15



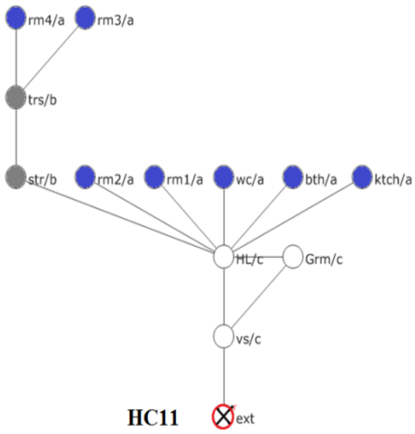
HC02



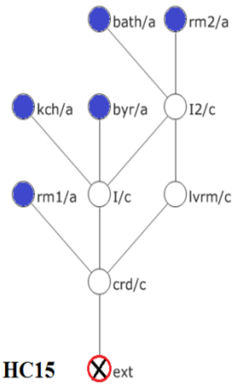
HC09



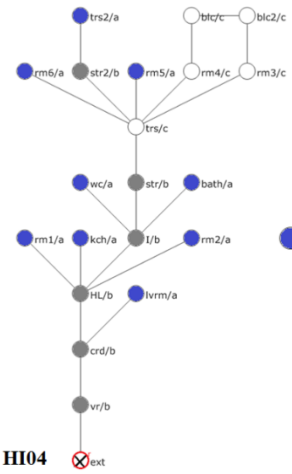
HC10



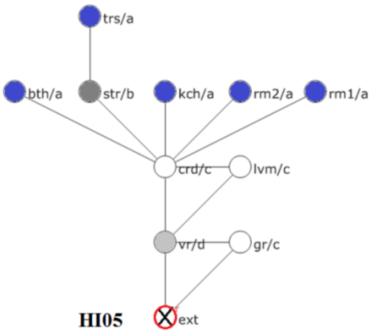
HC11



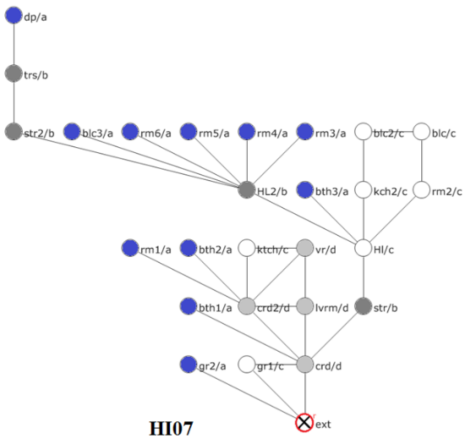
HC15



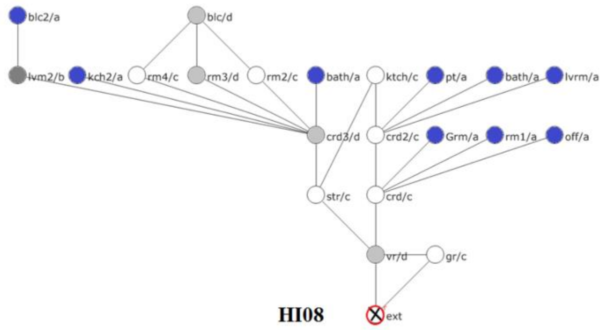
HI04



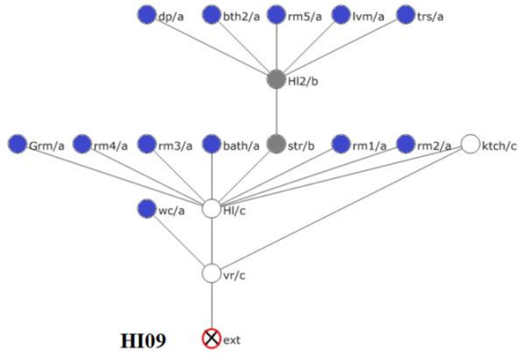
HI05



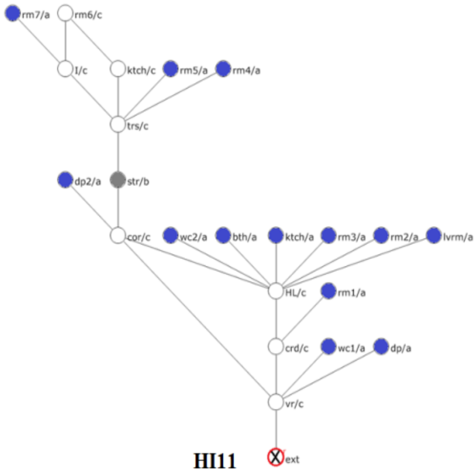
HI07



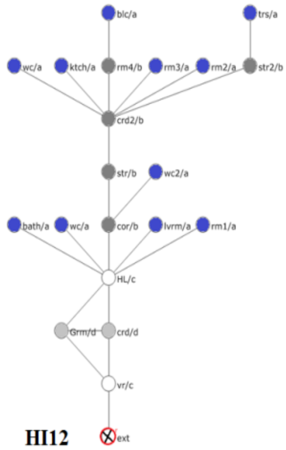
HI08



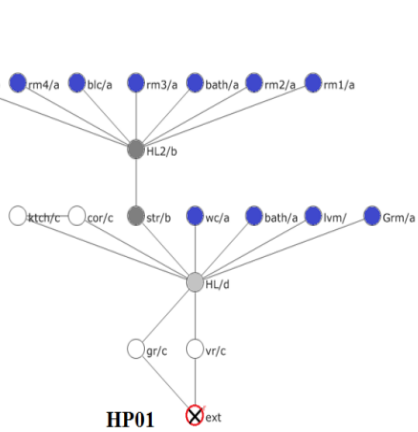
HI09



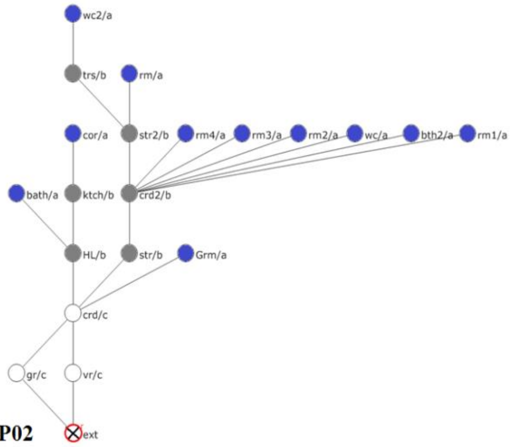
HI11



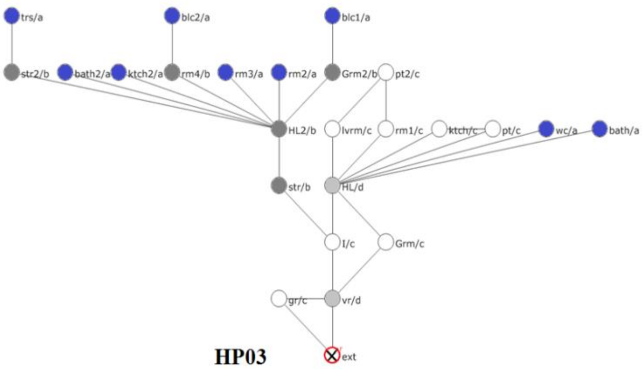
HI12



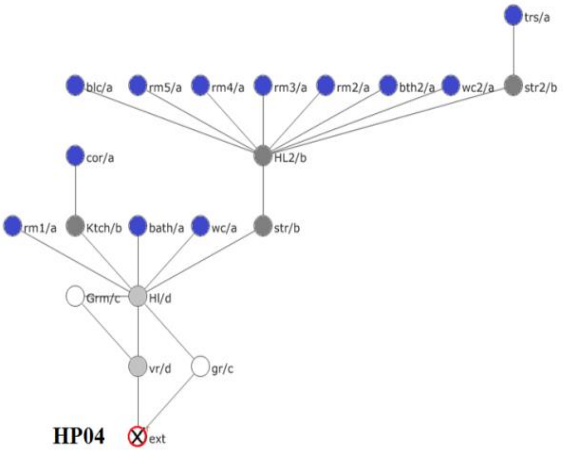
HP01



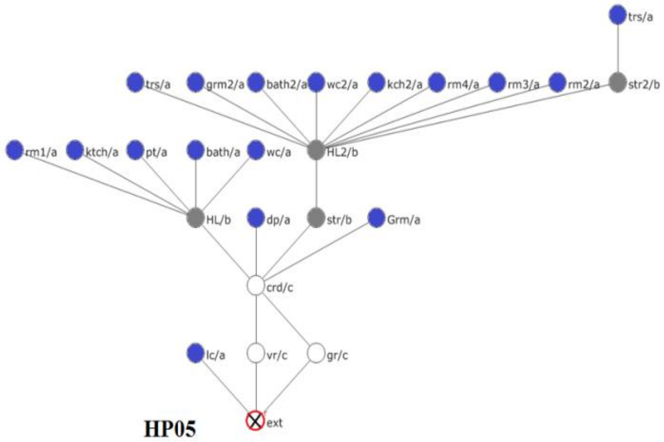
HP02



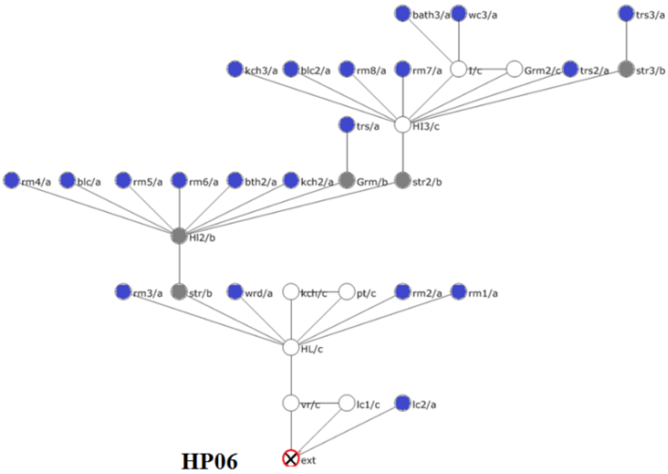
HP03



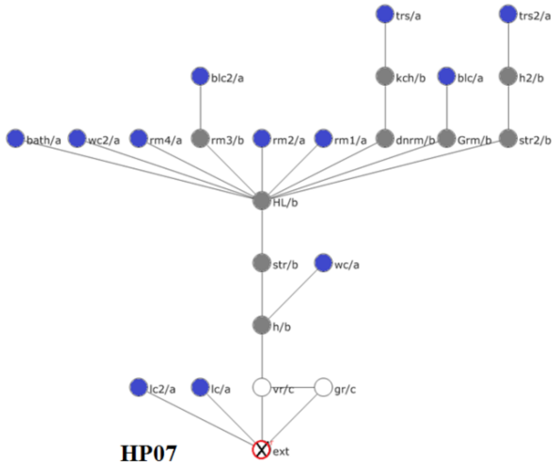
HP04



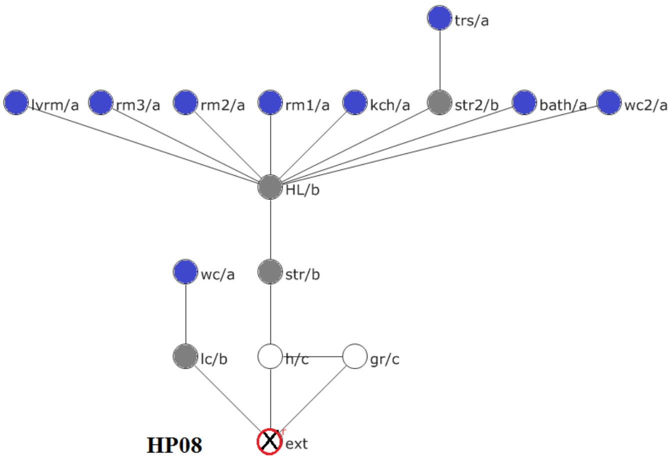
HP05



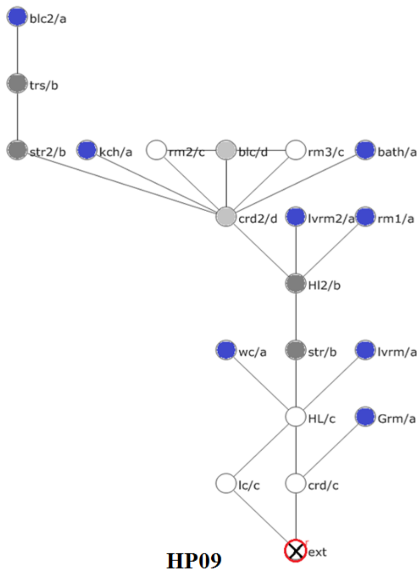
HP06



HP07



HP08



HP09

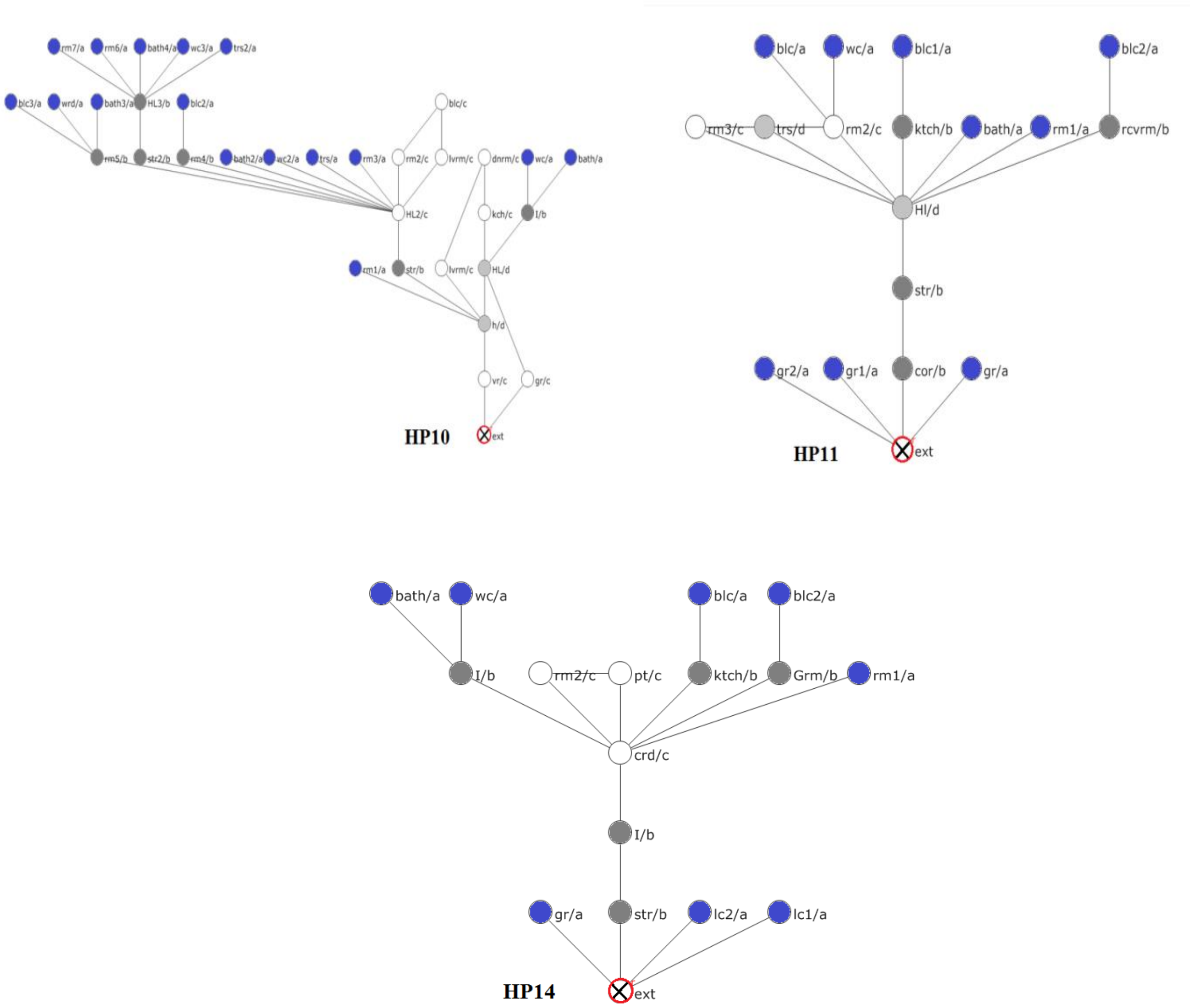
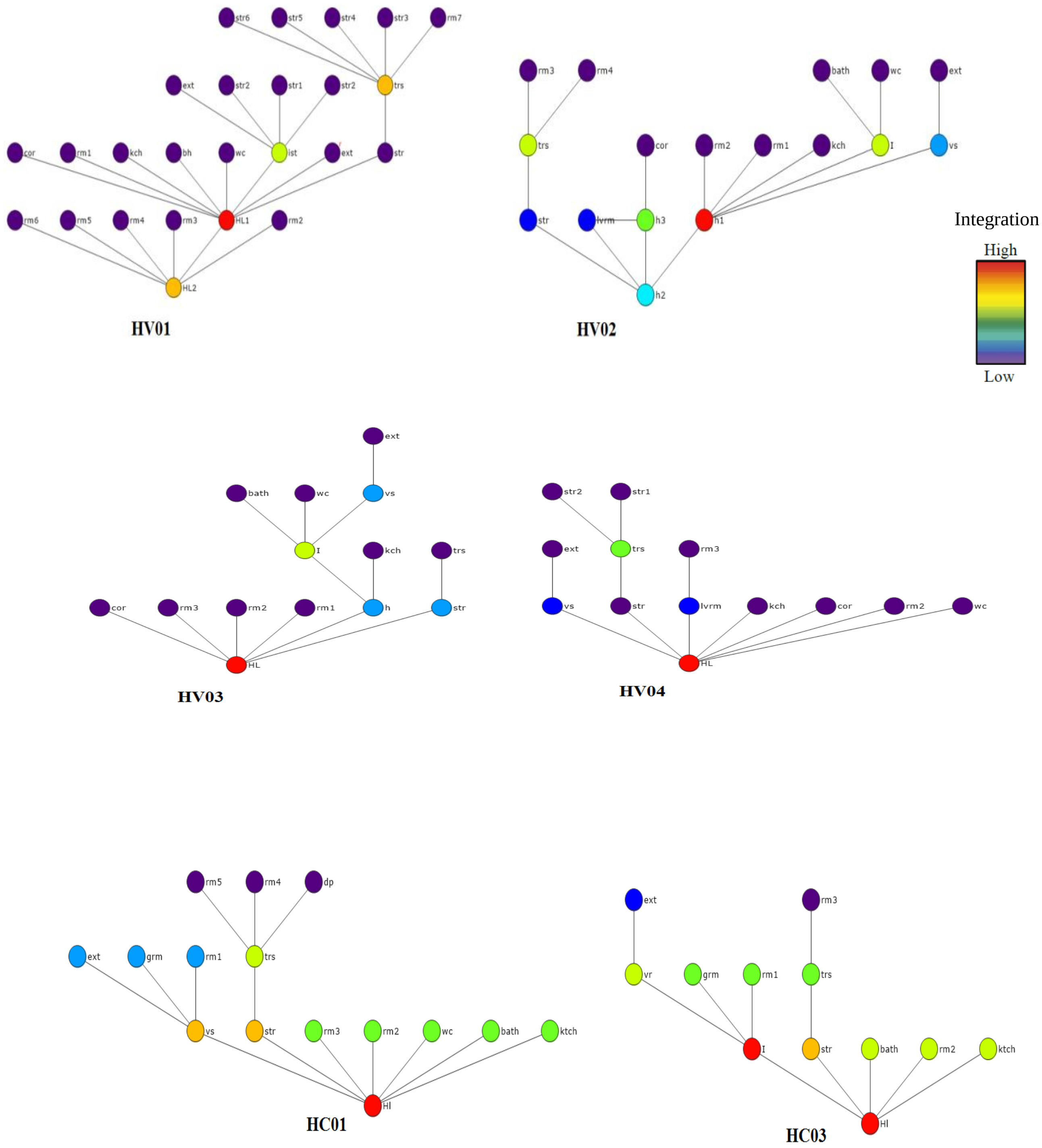


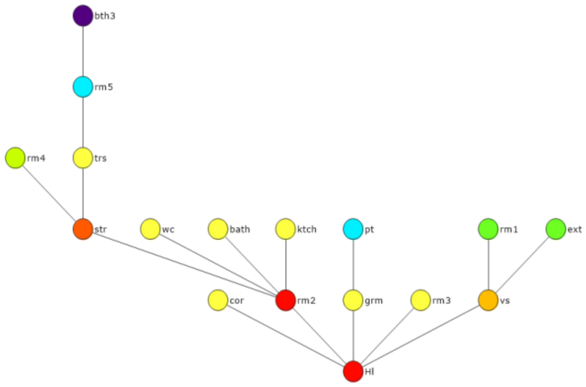
Figure 103: The ringy graphs (inner and outer rings)

7. The spatial configuration in point of view of inhabitants / visitors

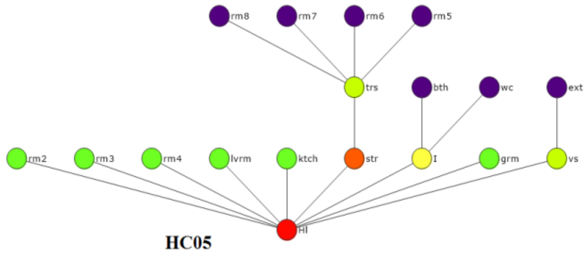
The figures (102, 103) show the graphs in point of view of a visitor, in which enter from the outside through an intermediate spaces considered as a boundary between the inner space and outside, such as: the vestibule (vs) one of the main element in the spatial organization of the vernacular houses, the veranda (vr) appeared in the colonial houses, and in some cases the corridor (crd).

The guest room is shallow from the exterior, whereas a stranger could not enter into the house, it is notable that a visitor has a guided path, and the inhabitant has different paths to pass from a space to another. In the figure (104) below show different graphs from the four periods from point of view of an inhabitant, in which it’s started by the hall ; the main central spaces and the pivot of the movement within the houses.

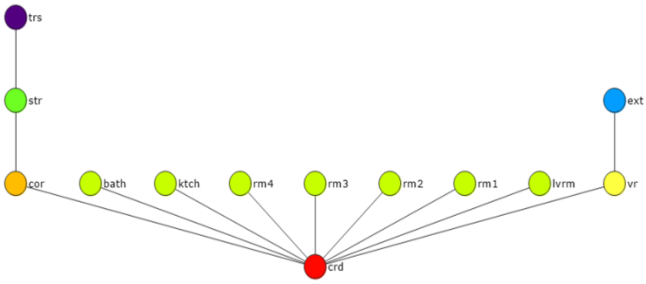




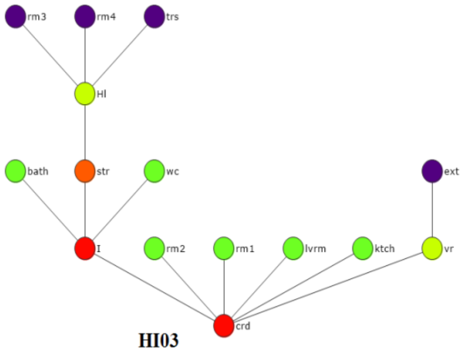
HC04



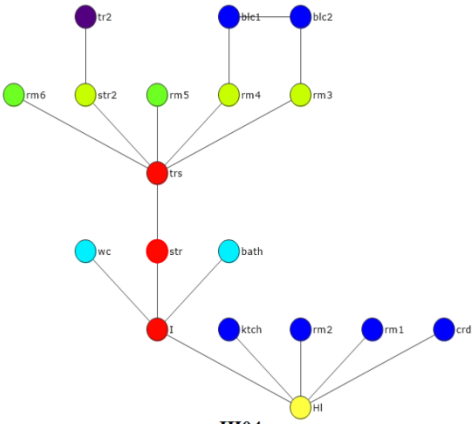
HC05



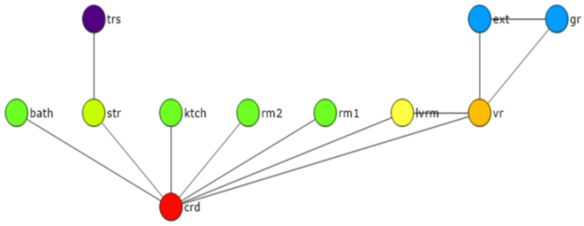
HI01



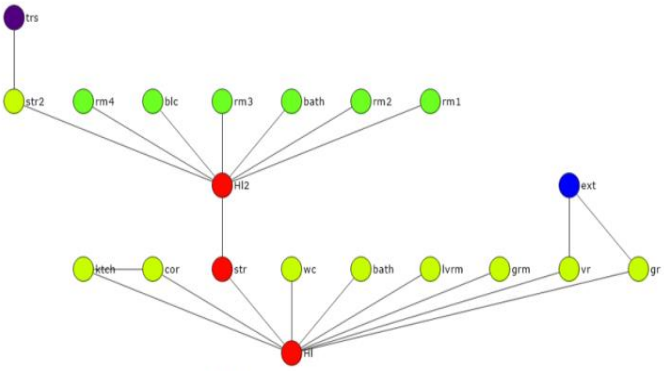
HI03



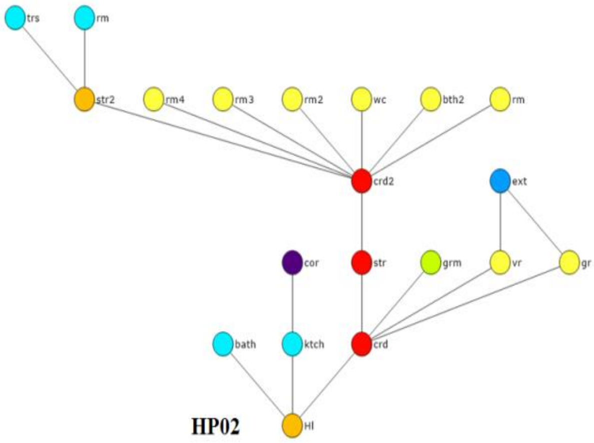
HI04



HI05



HP01



HP02

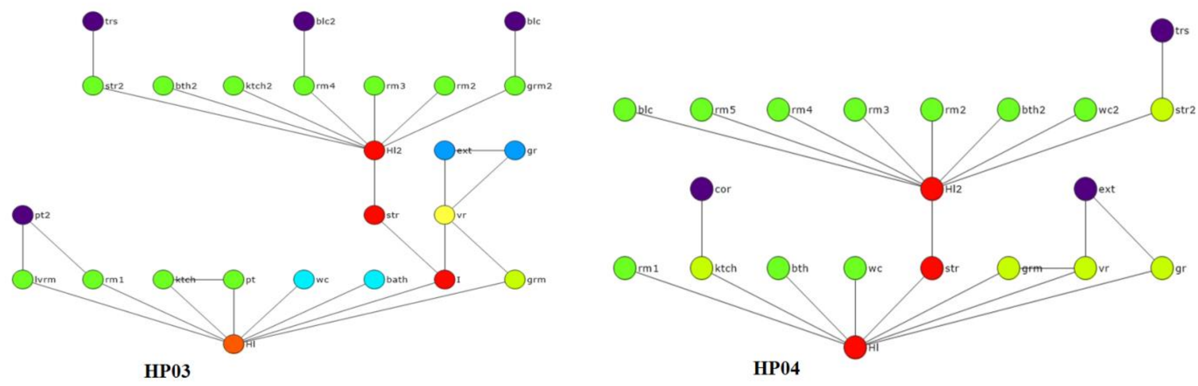


Figure 104: Show different graphs from the four periods from point of view of an inhabitant

The graphs represent an arborescent structure with the Hall as a carrier, from the point of an inhabitant who is a familiar with the house, which use different paths to progress through a space. The graph from point of view of an inhabitant is less linear, symmetrical, and less deep. Therefore, of point of view of a visitor which is unfamiliar with the inside of the house, and who is try to locate and map every space in relation to the first room entered from the exterior. In this case, the graph is linear, deep, and more asymmetrical. Hillier and Hanson (1984) suggest that there two types of social relations revealed in the J-graphs : inhabitants – visitors relations can be effectively expressed in a JPEG using the exterior as the carrier, and inhabitants – inhabitants relations are more complicated, necessitating the examination of numerous additional JPG.

8. Examine the interior- exterior relations: social- characteristics of genotype groups

In the sense that what is realized in every interior is already a particular mode of organizing experience and a certain way of representing in space the peculiarities of a cultural identity, when we move from the outside to the inside, we do so from the arena of encounter probabilities to a domain of social knowledge.

The relationship between social solidarity and space is given a new depth by the duality of inside and outside. Solidarity will provide an internal space structuring that is stronger and more consistent while also emphasizing the interior's discreteness by exerting tight control over the boundary.

Transpatial solidarity typically indicates a spatial layout that prioritizes the inhabitant-inhabitant interface. A transpatial entity is an inhabitant. Spatial solidarity is a sign of inhabitant-visitors relationship.

According to Hanson (1998), Explore the interior-exterior relation, which, in some cases, significantly affects the overall space configuration while, in other cases, it barely affects the results of the calculations whether the relationship to the outside is included or excluded. From the previous results of the graphs analysis and the integration values with and without the exterior, we deduce that the arborescent graphs and the graphs that have inner rings are principally organized so as to structure interior relations, thus the inhabitant –inhabitant interface.

In the ringy graphs, the exterior has an important role to forming outer rings through the configuration, at least as much as the relations among its inhabitant, the inhabitant-visitor interface are important to understanding this building's sociogram.

In the Table -12 demonstrate the five genotype groups with their nature of justified graph : arborescent (AR), inner ring (IR), outer ring (ER), complex ring (CR).

Table 79 . The genotype groups and their justified graphs nature.

Table 79.a. Genotype A01 and A02

Genotype A01	JG	Genotype A02	JG
HV01	CR	**HV03**	AR
HV02	IR	**HV04**	AR
HV05	ER	**HV06**	AR
HV15	IR	**HV08**	AR
HC02	CR	**HV09**	AR
HC10	IR	**HV10**	AR
HI07	CR	**HV11**	AR
HI09	IR	**HV13**	AR
HI12	IR	**HV14**	AR
HP01	CR	**HC01**	AR
HP04	CR	**HC03**	AR
HP06	CR	**HC04**	AR
HP07	ER	**HC05**	AR
HP08	ER	**HC06**	AR
HP09	CR	**HC07**	AR
HP10	CR	**HC11**	IR
HP11	IR	**HC14**	AR
		HC15	AR
		HI06	AR

Table 79.b. Genotype B01 and B02

Genotype B01	JG	Genotype B02	JG
HV12	IR	**HC08**	AR
HI05	CR	**HC09**	CR
HP02	ER	**HC12**	AR
HP05	ER	**HI01**	AR
HP14	IR	**HI10**	AR
		HI15	AR
		HP12	AR
		HP13	AR
		HP15	AR

HI13	AR
HI14	AR
HV07	AR

Table 79.c. Genotype C01 and C02

Genotype C01	JG	Genotype C02	JG
HC13	IR	**HI03**	AR
HI04	IR		
HP03	CR		

Table 79.d. Genotype C0, C02 and E

Genotype D01	JG	Genotype D02	JG	Genotype E	JG
HI08	CR	**HI02**	AR	**HI11**	IR

9. Discussion and interpretation

This study has demonstrated that the domestic spatiality of Biskra' houses reveal several underlying relationships, by analysing the nature of the justified graphs according to their degree of ringiness whether they: arborescent (AR), inner rings (IR), external rings (ER), and complex rings (CR), they split to 14 subgroups that share the same specificities, i.e. the mode of structuring of the spatial organization, and the base difference factor (BDF). From the Table (12) the group **G.A01** which structured around the Hall shows that the j-graphs have different types of rings: complex rings (CR), outer rings (ER) and inner rings (IR), hence, the **G.A01** have three subgroups. First group; **G.A01.ER**, contained three houses « HV05, HP07, HP08 » characterized by the existence of outer rings and a strong basic difference factor. The spatial configuration that formed this genotype is essentially structures external relations and highlights the significance of **inhabitants - visitors** interface. The second group; **G.A01.IR,** have seven houses with qualitative nature is internal annular: « HV02, HV15, HC01, HC10, HI09, HI12, HP11 » and display strong BDF. The configurations structures internal relations that developed by syntactic means into a certain kind of interface between **inhabitants - inhabitants**. The third group; **G.A01.CR**, whose justified graphs belong to a complex ringiness, that contained of eight houses: « HV01, HC02, HI07, HP01, HP04, HP06, HP09, HP10 » with strong BDF. It is essentially structures the exterior – interior relations, this relation serves to highlight **inhabitants - visitors** interface. Visitors are people who are allowed to temporarily access the building, but whose social identity is not mapped onto the facility's spatial organization (Hanson, 1998).

The group **G.A02.AR** is structured around the Hall whose justified graphs are arborescent ' tree-like' structure with guided path. Comprise twenty one houses « HV03, HV04, HV06, HV07, HV08, HV09, HV10, HV11, HV13, HV14, HC01, HC03, HC04, HC05, HC06, HC07, HC14, HC15, HI06, HI13, HI14 ». The spatial configurations structure internal relations and highlight the supremacy of **inhabitants – inhabitants** interface.

The group **G.B01** consists of three subgroups, structured around the corridor and share the same specifies, whose justified graphs show internal, external, and complex ringiness, and display strong BDF. The first subgroup; **G. B01.IR** contained two houses « HP14, and HV12 » with low value of BDF indicating strong functional structure. The configuration articulates interior relations and structures the **inhabitants – inhabitants** interface. The second group; **G.B01.ER** contained two houses: « HP02, HP05 » with strong differentiation, whose j-graphs are of external ringiness nature. These rings add extra permeability to the configuration, thus, articulate the relation of the boundary, and highlight the significance of **inhabitants - visitors** interface. The last group **G.B01.CR** whose j-graphs are of external ringiness nature, consist of two houses « HI05, HC09 ». These rings add extra permeability to the configuration, thus, articulate the relation of the boundary, and highlight the significance of **inhabitants - visitors** interface.

The group **G.B02.AR** is structured around the courtyard, and consist of nine houses « HC08, HC09, HC12, HI01, HI10, HI15, HP12, HP13, HP15 » show a low value of BDF indicate a strong differentiation, the j-graphs have an arborescent 'tree-like' structure, thus, articulate interior relations and highlights the significance of **inhabitants – inhabitants** interface.

The group **G.C01** is structured around the intermediate space (I), composed from two subgroups with common characteristics, but differs by the existence of two natures of j-graphs: inner rings, and complex rings. The first group **G.C01.IR** contained two houses « HC13, HI04 » features by existence the inner rings and low values of BDF indicating the strong differentiation. The spatial configuration structures essentially internal relations by highlighting the supremacy of the **inhabitants - inhabitants** interface. The second group **G.C01.CR** has only one house « HP03 » features by the existence of both inner and outer rings. The relations between **inhabitants – visitors** are structured in this genotype. The Group **G.C02.AR** is structured around the intermediate space (I) has one house « HI03 » whose j-graph is of tree-like nature with guided path and without any circuit. The relations between inhabitants – inhabitants are highlighted in the configuration.

The group **G.D01** which structured around the staircase (str), has one subgroup **G.D01.CR** composed from one house « HI08 » whose j-graph belong to a complex ringiness with inner and outer rings, that structured the relations between inhabitants - visitors. The group **G.D02.AR** composed from one house « HI02 » whose j-graph is of arborescent 'tree-like' nature, and with low values of BDF, articulate interior relations and highlights the significance of **inhabitants – inhabitants** interface.

The group **G.E.IR** consists of one house « HI11 » structured around the courtyard, has a low value of BDF, whose j-graph shows internal ringiness, and highlights the significance of **inhabitants – inhabitants** interface. The table (80) below represent these results.

Table 80 (a, b, c, d, and e): shows the different genotype subgroups

Table 80.a: The four genotype subgroup (A) structured around the hall

G.A01.ER	G.A01.IR	G.A01.CR	G.A02.AR
•HV05	•HV02	•HV01	•HV03
•HP07	•HV07	•HC02	•HV04
•HP08	•HV15	•HI07	•HV06
	•HC01	•HP01	•HV07
	•HC10	•HP04	•HV08
	•HI09	•HP06	•HV09
	•HI12	•HP09	•HV10
	•HP11	•HP10	•HV11
			•HV13
			•HV14
			•HC01
			•HC03
			•HC04
			•HC05
			•HC06
			•HC07
			•HC14

Table 80.b: The four genotype subgroup (B) structured around the corridor

G.B01.ER	G.B01.IR	G.B01.CR	G.B02.AR
•HP02	•HV12	•HI05	•HC08
•HP05	•HP14	•HC09	•HC09
			•HC12
			•HI01
			•HI10
			•HI15
			•HP12
			•HP13
			•HP15

Table 80.c: The three genotype subgroup (C) structured around the intermediate space

G.C01.IR	G.C01.CR	G.C02.AR
•HC13 •HI14	•HP03	•HI03

Table 80.d: The two genotype subgroup (D) structured around the staircase

G.D01.CR	G.D02.AR
•HI08	•HI02

Table 80.e: The genotype group (E) structured around the courtyard

G.E.IR
•HI11

10.Conclusion

The research demonstrates that the spatial organization of Biskra houses is governed by a consistent genotype: transition-space-centred-organization. The relationship between the public and private realms of the house can be regulated with the use of transition spaces, which simultaneously link and divide various spatial areas. The transition spaces organisations started in the vernacular houses (pre-colonial period) and have continued through the colonial, independent, and contemporary period. Most of the houses examined had the hall (HL) the main central space as their most integrated space, followed by the corridor (crd), the intermediate space (I), and the staircase (str); these transition spaces have the lowest degree of integration, which means that they are the most integrated spaces but they are also considered as the pivot of the movement within the house. They control spaces for the interior and exterior-interior relations. The bedrooms, storage spaces are considered as the most segregated spaces, the kitchen and the living rooms are integrated spaces. After preparing the convex maps, and the justified graphs for the different plans, a configurational analysis (syntactic analysis) has been conducted to reveal the similarities and differences between the spatial configurations in different periods.

The MD shows that the depth of the houses increases through the periods of time and that refers to the increasing in the number of spaces, whereas the family status and economic status has developed over time. Analysing the integration values (RRA) uncover the significance of the exterior to the overall configurations of the houses. It is demonstrated that most of the houses have low values of integration which mean are integrated when the exterior is included, in other words, the houses share the outward-looking configuration in the independent and contemporary periods. The houses from the pre-colonial and colonial periods have segregated system, which means share the inward-looking configurations. The intimacy was one of the main features of the houses especially in the vernacular and colonial houses, whereas the houses become more accessible through time. From analysing the different graphs, the guest room is shallow from the exterior which is isolated from the other spaces as: the kitchen, living room, and the bedrooms, in which maintaining the home's privacy is important. The vestibule "*sguifa*" is one of the main elements in the vernacular houses, it's considered as a filter between the exterior and inner space, through time, started from the colonial period it's replaced by the veranda. The analysis also demonstrate that the houses have different entrances: houses which have one entrance, houses have two entrances one of them is a garage, houses have multiple entrances such as: locals, garages and an entrance into the house.

Another finding, the majority of houses from pre-colonial and colonial periods have non-distributed systems with no alternative routes, whereas the houses from the contemporary and independent periods have distributed systems. There is a distinct transformation from the tree-like structures to the ringy structures. The presence of a-type and b-type spaces indicate to privacy and provide high degree of control within the houses, whereas, the c-type and d-type which part of the rings offer more flexibility and choice of mobility hence less control and more accessibility. The transformation of the spatial organisation over time reflects cultural and social changes; this study describes the socio-spatial transformation of Biskra domestic culture from four periods of time.

The syntactical analysis of a series of Biskra houses from different periods of time enables us to uncover the underlying characteristics, and also the significant transformations in the spatial configurations. The results imply that the spatial organization of different houses reflects cultural and social factors. The genotype reflects the social and cultural values that are embedded in the spatial configuration. The findings demonstrate the existing of five genotypes that features the spatial organisation of Biskra houses classified by their mode of structuring: GA01, GA02; are structured around the Hall; G.B01, G.B02; are structured around the corridor, G.C01, G.C02; are structured around the intermediate space, G.D01, G.D02; are structured around the staircase, G.E is structured around the courtyard. These genotypes groups were divided according to their graph natures (degree of ringiness): arborescent, inner ring, exterior ring, and complex rings, whereas this examination allows to interpret the sociologic significance of the spatial configurations, that of identifying the relations inhabitants – inhabitants and inhabitants – visitors which are the fundamental social generators of houses. There is no internal structure that separates different categories of inhabitants, but the exterior- interior dimension distinguishes inhabitants from visitors through an intermediary threshold space. While the interior divides people from things, the exterior acts as a point of contact between inhabitants and visitors.

- **General conclusion**

The concepts of "genotype" and "phenotype" are a set of analogies that Hillier and Hanson (1984) draw from the field of biology to describe the transformational characteristics of the spatial organization and the physical form of the dwellings. These concepts are used to frame an analysis of the physical attributes of house design, which is a component of place experience. When patterns that structure spatial arrangement are discovered consistently in a sample of architectural instances, space syntax designates these patterns as having a "genotype." In genetics, the terms genotypes and phenotypes are used to predict gene identity inheritance. Around the turn of the century, Hillier and Leaman (1974) adopted the terms genotype and phenotype from biology and applied them to architecture. The genotype is defined as an abstract rules underpinning spatial shapes, and it is an abstract relational models that govern the spatial arrangement and the organizing principles of the underlying phenotypes, and they reflect not just spatial structure but also the character of social and cultural patterns. The phenotype is defined as the physical manifestation of the active genes and their degree of activation, in other word; "phenotype" refers to the appearance of these abstract patterns in various geometrical forms. When all of the spatial-functional themes are present, the dominant genotype can be strongly detected.

The finding of this research, would allow us to understand both the configuration of the different houses (phenotype) and the underlying characteristics of spatial arrangement (genotype). This study aims to investigate whether the transformations on the organization and configuration of house architecture are emerging from the same genotype, how social relation expresses themselves through spatial configuration of the Biskra' houses, and if the exterior -interior relations effect on the spatial configuration. To answer to this research questions different assumptions are suggested ; that despite all the apparent differences spatial organizations and configurations of these typologies still follow the same rules (invariable principles) in organizing the spatial structure ; according to the concept of Genotype and Phenotype. The analysis of all the specimens is suggested that Biskra' houses reflect the social and cultural values that are embedded in the spatial configuration. And the significance of the exterior to the overall configuration of the houses.

A gamma analysis was conducted to sample of 60 houses from different periods (pre-colonial, colonial, independent, and contemporary periods) in Biskra city, in which they were chosen according to temporal and architectural criteria. Based on the justified graph analysis. The J-graph allows demonstrating the configurational properties of house planes, and provides a graphical and mathematical model to analyse the spatial configuration of buildings. It is a permeability structure where each functional space of the system is identified in terms of its relationship to every other space, showing the relational logic of the parts to the whole. This numerical method allowed illustrating house plans in the form of graphs. First, it focused on the abstraction of house plans into graphs and explored their configurational properties. Then, it relied on the AGRAPH software to carry out the different parameters considered in this analysis: the mean depth (MD), the real relative asymmetry (RRA), the base different factor (BDF), the space link-ratio (SLR) and the degree of spaceness. The findings reveal the existence of a genotype patterns for the spatial configurations of Biskra houses. House layouts' spatial configurations may vary throughout different periods, culture, and societies.

Configuration might be regarded as the most important concept in space syntax theory. Accordingly, the first section of the thesis is composed of definitions of the main concepts and theories that related to domestic space. Hillier (2007) argues that buildings have the ability to both collect and return information to society through spatial layout. The analysis of the literature on space reveals the continuity and necessity between the built environment's objectivity and subjectivity in how people perceive and experience space. Spatial configuration has an impact on spatial behavior and human navigational patterns, according to studies by Hilier (1993). The spatial configuration of the environment and society both influence one another. Understanding spatial layout is important for identifying and comprehending the relationships between areas in residential architecture. Spatial configuration, in general, refers to the relationship between the spaces and how they are positioned next to one another. In 'Space is the Machine', B. Hillier describes space as a void and function as what we do in it, and it is incorporated into the forms themselves. The relation between space and social life is found in the interactions between human and spatial configuration. The space syntax method reveals and leads to understand the social logic of the space configuration. This study concerns the spatial structure of domestic space, it introduced a syntactic analysis ‘ justified graph analysis’, which allows to analyse the layouts of 60 houses from Biskra city to generate spatial configurations and identify patterns of space referred to as architectural genotype.

Individual housing in Biskra city went through several periods from the pre-colonial to the contemporary period. The vernacular houses have been able of adapting to the difficult climatic conditions. Whereas, the colonial house is similar to the vernacular one in term of spatial organisation, but we find other colonial houses influenced by the classical European architecture. The independent and modern houses are characterized by the large surface, open to the Street, and use of modern materials of construction opposite to the vernacular and colonial houses, the houses were overlapping. Thus, Biskra houses have undergone different transformation over time, are represented in the new typology that emerged from the introverted spatial arrangement with a central space "Hall" with an open on the roof called "Rouzna" and the chican entry "*sguifa*" to the extroverted house type open to the exterior with a corridor and locals on the ground level. The significance of vernacular spatial configurations continues to determine contemporary spatial organization. Colonialization and modernisation have an impact on housing form and impose alien typologies and urban patterns. A survey has been carried out on 60 houses from different fabrics through the four periods, to identify the main features and characteristics of the spaces of these houses. The comparative study of theses sample of houses from the four periods describe the convex dimension, and examining the interaction between cultural characteristics and spatial organisation using the method of justified graph analysis. The results have shown that these houses share the same underlying characteristics and the same spatial anatomy.

The findings of this study imply that justified graph analysis can be employed in a diachronic perspective to explore changes in spatial layout over time. This study's approach to diachronicity does not investigate changes in the same house plan across time, but rather Variations in the spatial organization of different houses through time. The analysis of this sample of houses revealed that transition spaces centered the spatial organization from vernacular houses to modern houses, whereas the corridor appeared in the early 1970s in the independent period, where the central organization transformed into a linear sequence. And the results show the importance of the exterior to the overall layouts and configuration of the houses. Changes in family and social structure cannot be considered apart from the design of house layouts; these changes have a direct impact on the spatial organization and usage of domestic space.

The J-graph analysis was chosen to develop the mathematical analysis of the spatial configuration; the graphs are analyszed to reveal a series of quantitative spatial configuration properties such as: mean depth (MD), permeability, integration (RRA), Space link ratio (SLR), and Base different factor (BDF), these parameters: MD, RRA, and BDF were analysed using the exterior as a root and excluding it to understand the relationship between inhabitants- inhabitants and inhabitants – visitors. The examination of these parameters indicates that there is an underlying spatial structure within the sample. The examination of integration values (RRA) indicates the important role of the exterior to bring the layouts together in which the houses become more integrated when the exterior is included and that leads to the significant of the exterior to the overall spatial configurations for all the periods. The vernacular and colonial houses are segregated, which means they are more private and more controlled, whereas independent and contemporary houses are more integrated, which means they are less private and more accessible. The mean depth (MD) measurement reveals that vernacular houses are shallow from the outside, and based on the data, the configuration becomes deeper over time, with contemporary houses having the deepest spatial arrangement inside the complex.

After the examination the order of integration, BDF, and SLR; six groups of structuring modes are identified, the first dominant group is structured around the hall '*wasteddar*' of b-type space which is the main central space and has a strong functional-efficiency of spaces, based on SLR this dominant group is subdivided into two sub-groups: Group A01 shows a ring-shaped spatial configuration, and the second group A02 that features an arborescent justified graphs and non-distributed system. The second group, the corridor of b-type space is the structured space which is a linear element, and using the SLR is subdivided into two sub-groups: B01 with distributed system and ringy graph, and B02 characterised by an arborescent graphs and non-distributed system, and B02 characterised by an arborescent graphs and non-distributed system. The fourth minimal group structured around the staircase have only two houses one with ringy graph and the other with an arborescent structure. The last group are structured around the courtyard one house. These findings support the presence of a genotype that manifested in a variety of phenotypes.

The investigation exterior -interior relation has an important effect on the spatial configuration whilst, in some cases there is no impact to the overall space configuration whether the relation to the space outside is included or not. The relations inhabitants – inhabitants and inhabitants – visitors are the fundamental social generators of houses. There is no internal structure that separates different categories of inhabitants, but the exterior- interior dimension distinguishes inhabitants from visitors through an intermediary threshold space. Inside-outside duality offers a new dimension to the relationship between social solidarity and space.

In conclusion, the spatial configuration of these sample of houses are regulated and controlled by socio-cultural factors, such as “intimacy”, which is considered a vital and sacred rule to preserve family members. The obtained results have affirmed the hypothesis for the research questions. Based on the first hypothesis; there is an organising principle of spatial configuration as there are similarities between the socio-spatial patterns of the sample in Biskra city, whereas, the existence of the genotype is confirmed using the order of integration and the SLR, which manifested in several phenotypes. According to the second hypothesis; the analysis of the spatial configuration of whole the sample indicates that the houses structured around transitional spaces represented in: the Hall (*waseteddar*), the Corridor, the Intermediate space, and the Staircase. Which these transition spaces are defined as a link between different enclosed spaces, and these transitional and circulation spaces are one of the essential elements in the architectural design.

The last hypothesis is confirmed ; The examination of interior-exterior relation based on integration values by taking in consideration including or omitting the exterior space, in which in some cases this last has a significance effect on the spatial configuration whereas in others, doesn't make any differences. The houses from the pre-colonial and colonial periods have segregated system, which means they share the inwared-looking configurations, in the independent and contemporary periods the houses share the outward-looking configuration. The finding indicates that the houses in the independent and contemporary periods become more accessible and open to the exterior world opposite to the houses in the pre-colonial and colonial period.

The justified graph analysis was applied as an effective tool to explore the underlying characteristics as: genotype/phenotype, in addition to identify the social - relations of the spatial patterns of Biskra’houses, and allows demonstrating the configurational properties of house planes, and provides a graphical and mathematical model to analyse the spatial configuration of buildings. This method has provided physical attributes of house design, which is a component of place experience (genotype and phenotype). The findings of this research would provide new insight about residential design, related the social and cultural aspects, and temporal transformation, for better houses’ layout design responding to people needs.

Recommendations :

According to the obtained results in this study, the following recommendations are suggested for further studies:

- The size of the sample and selection criteria: a small sample of houses could be taken into account, to facilitate the comparison between the samples and explore more characteristics, similarities and differences. Chose the houses according to: the economic and social values, size of family, regions, climate, rural and urban character, and considering contemporary houses designed by architects.
- In term of methodology: considering space use investigation, behavior mapping, questionnaires, and Isovist.
- Using the visibility graph analysis (VGA).

Limititation of the study :

The following research limitations affect the results of this study:

- The size of the case study, as it is large; it requires a larger amount of time and surveyor.
- Due to the poor building condition of some house, that are abandoned and uninhabited; it is difficult to get information related to their use.
- Some difficulties in carrying out the survey inside the houses, reticence of the inhabitants, furthermore the covid period restrictions made it harder.
- In terms of methodology, it would have been interesting if a behavior mapping of the houses space use had been carried out, besides questionnaires about the use and spatial perception. But most of the inhabitants do not allow strangers to get inside their houses, or stay for a long time.

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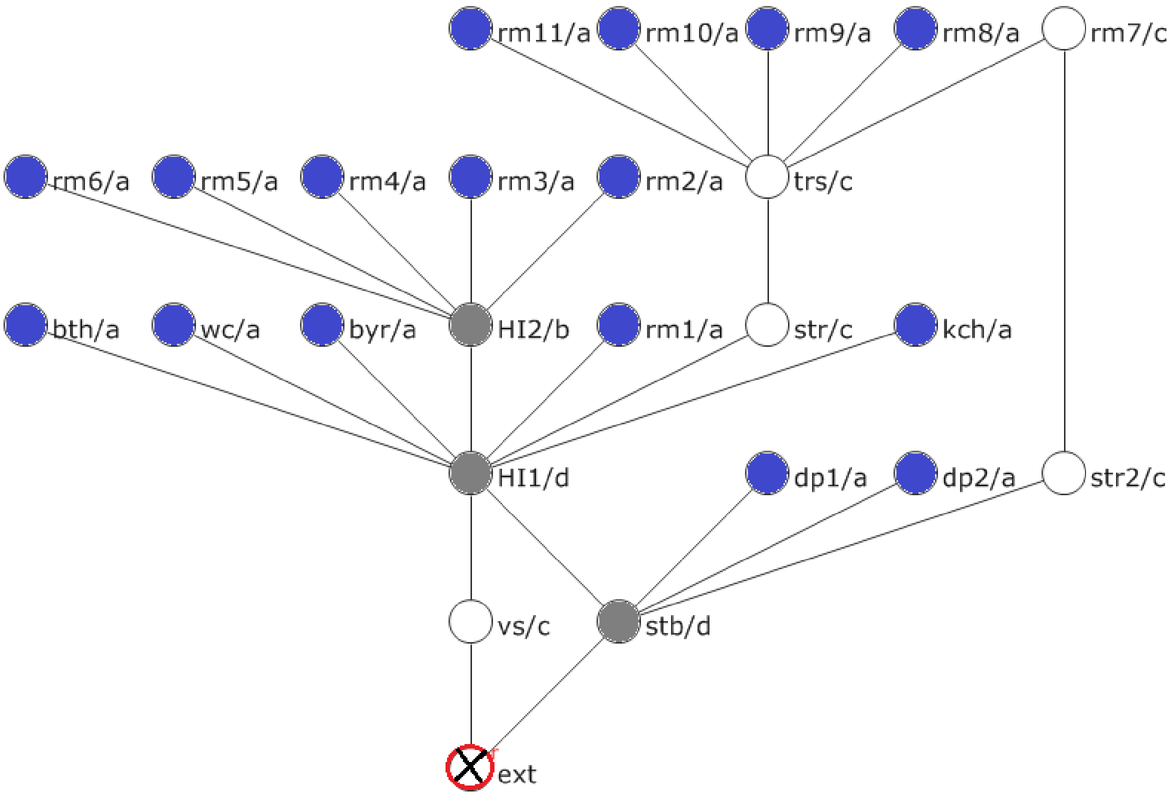
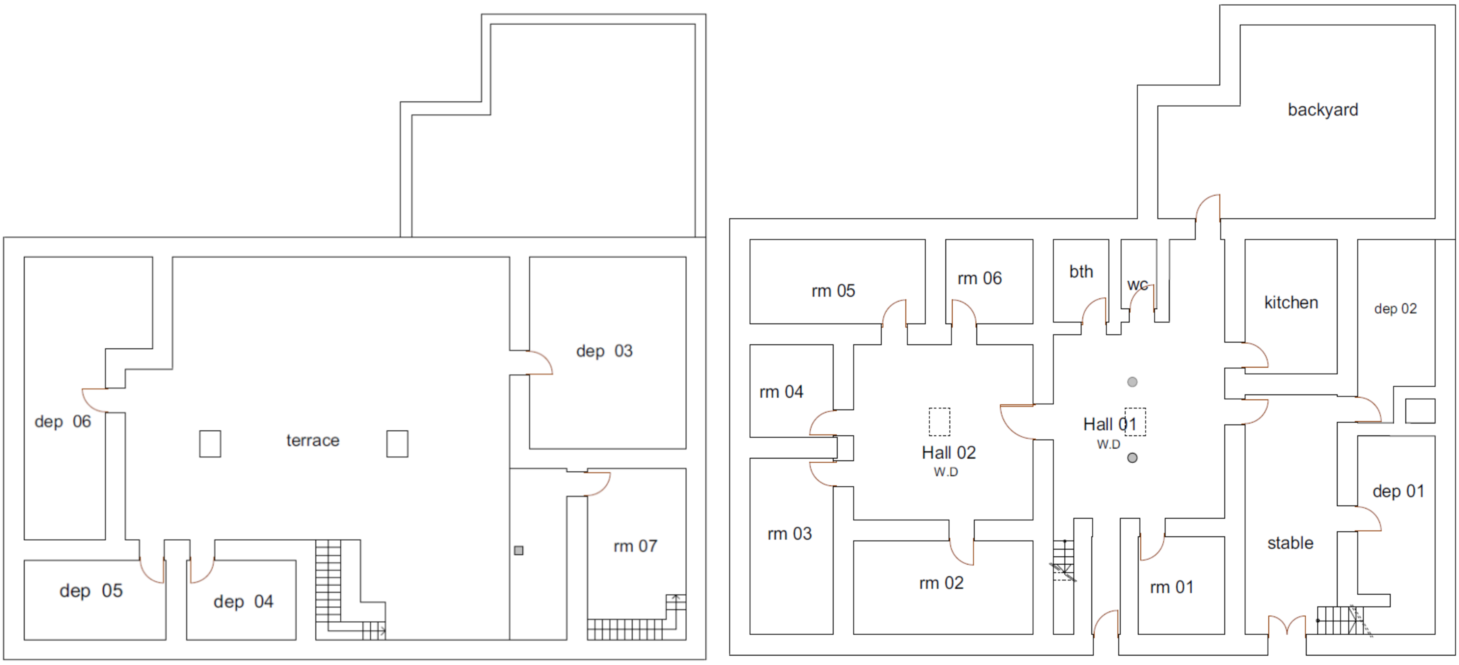
Appendix

I- Precolonial period:

- The vernacular House HV01

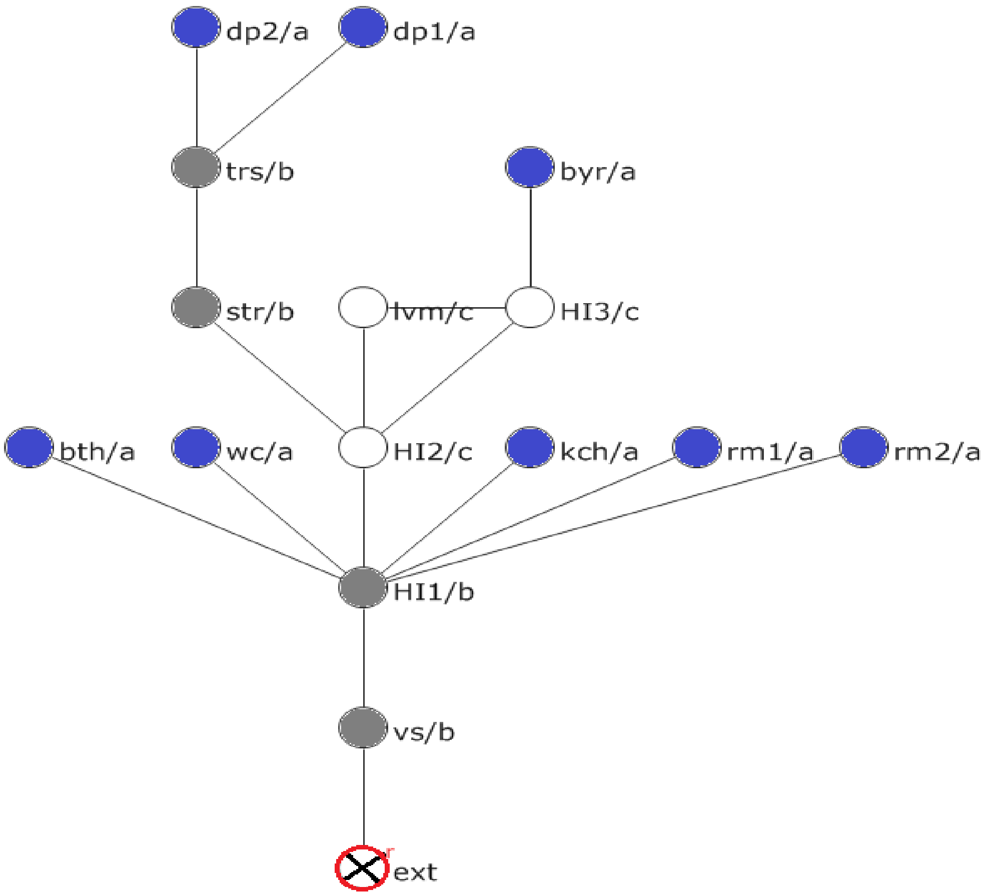


The j-graph of the house HV01

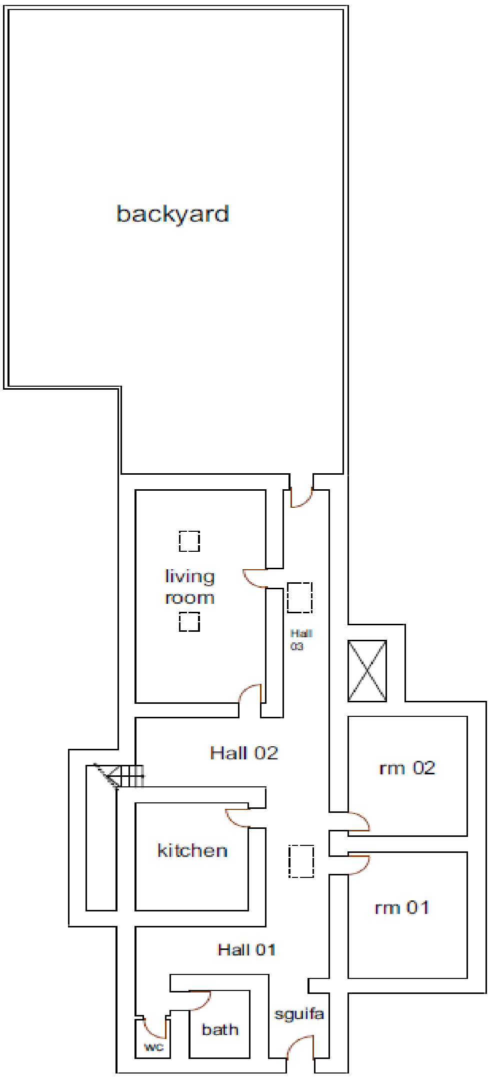


Plan of house HV01

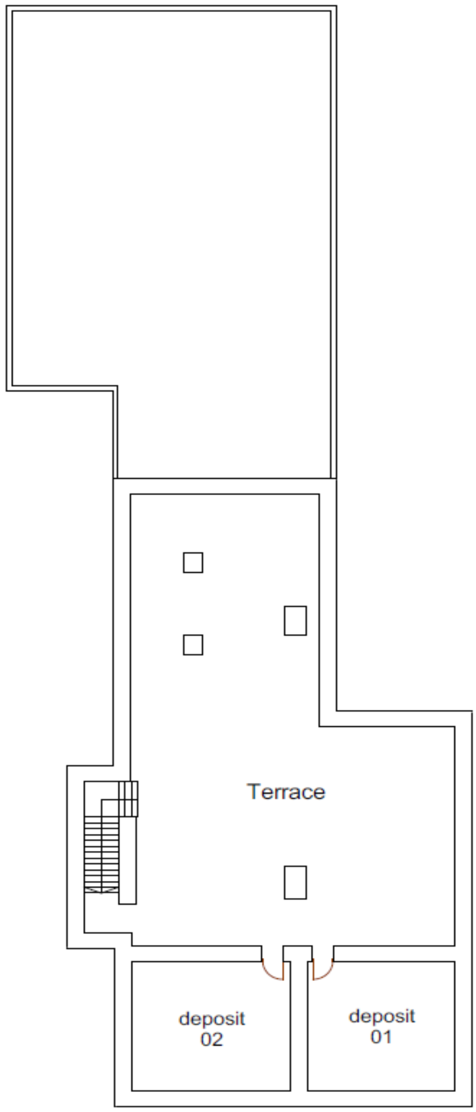
- **The vernacular house HV02**



The j-graph of the house HV02



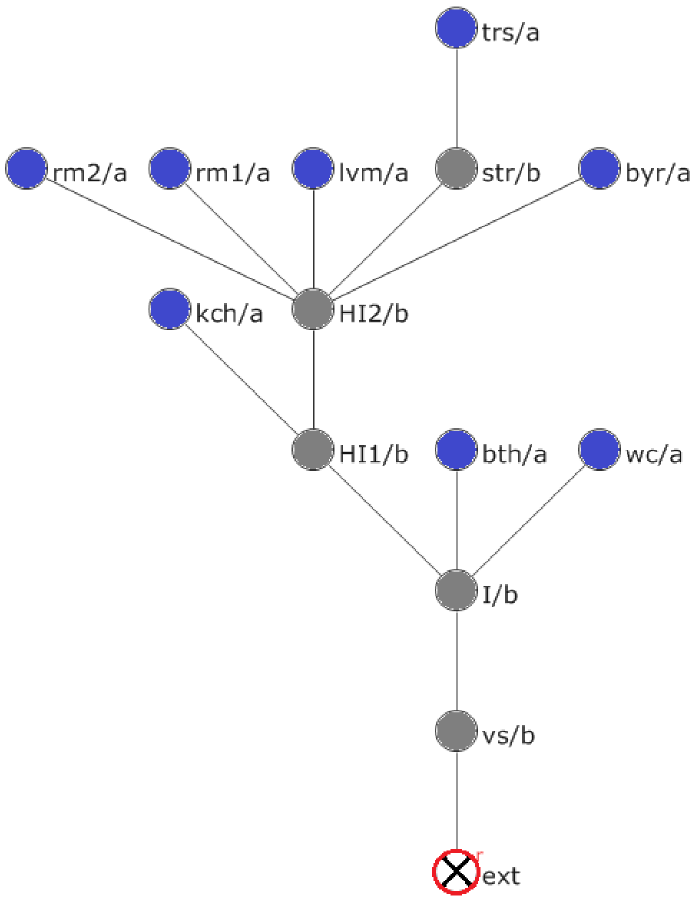
Ground floor

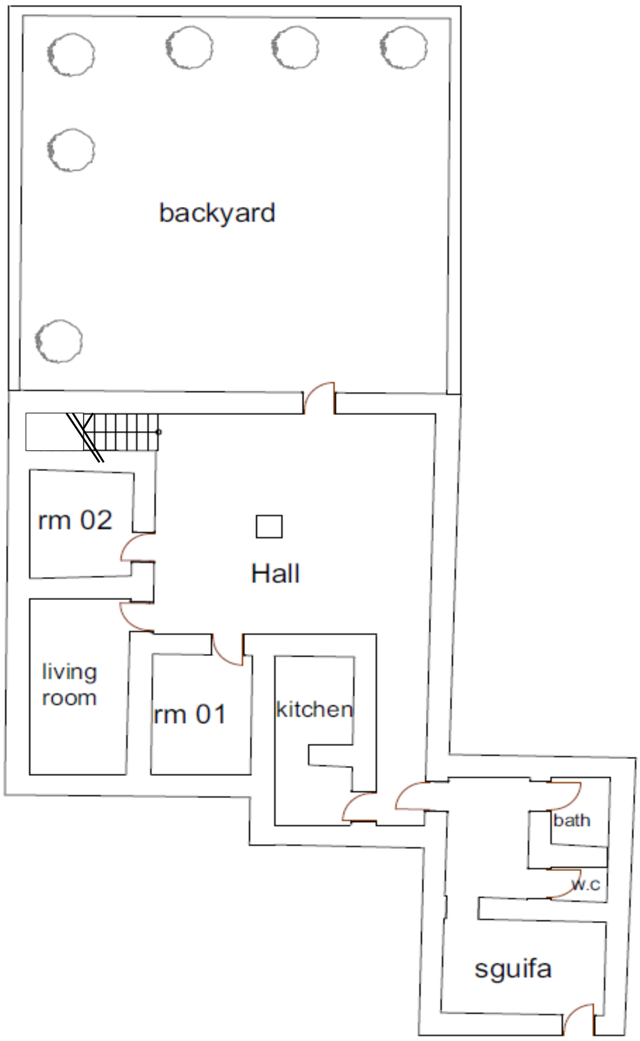


First floor

Plans of house HV02

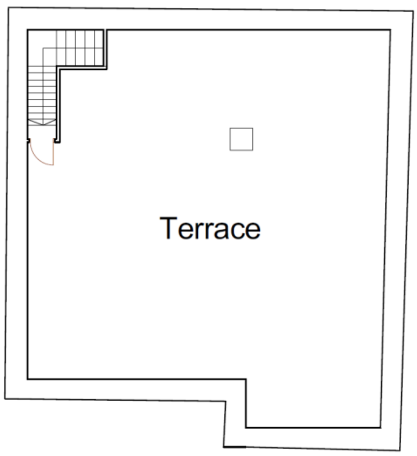
- **The vernacular house HV03**



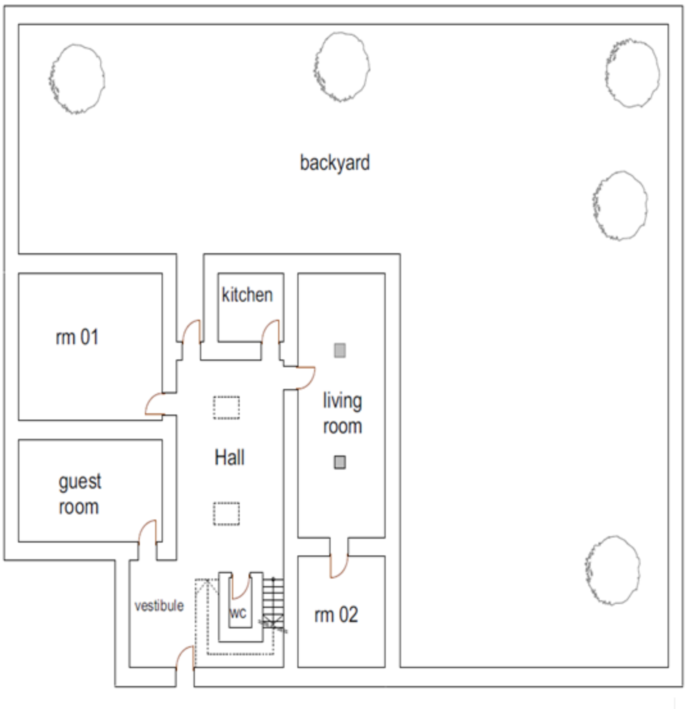


- **The j-graph of the house HV03**

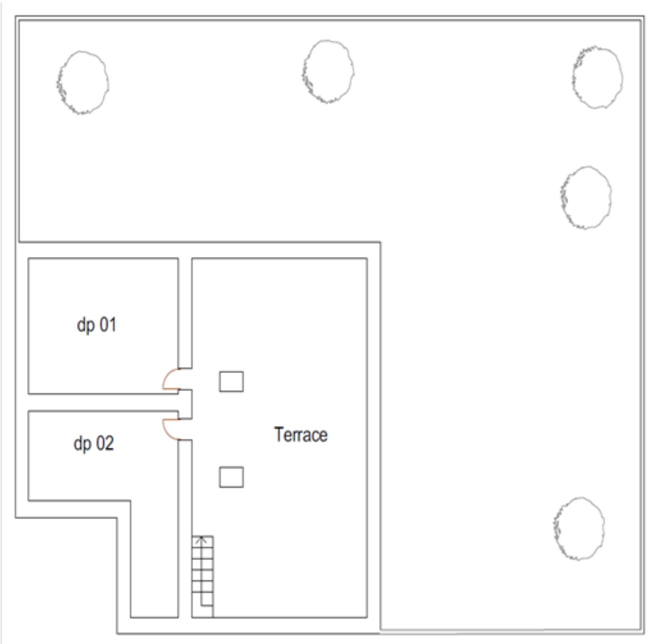
- Plan of house HV03



- **The vernacular house HV04**

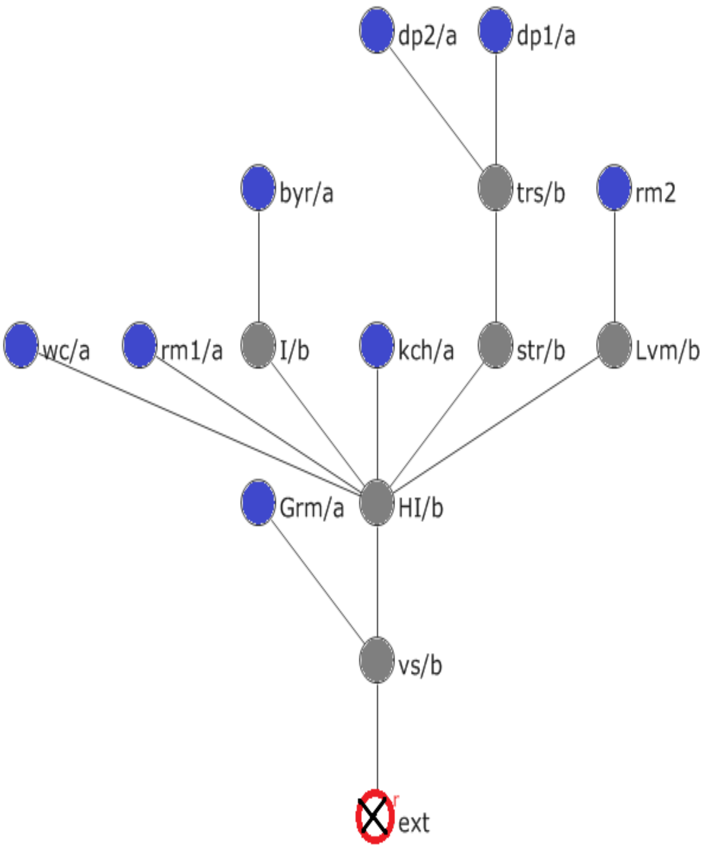


Ground floor



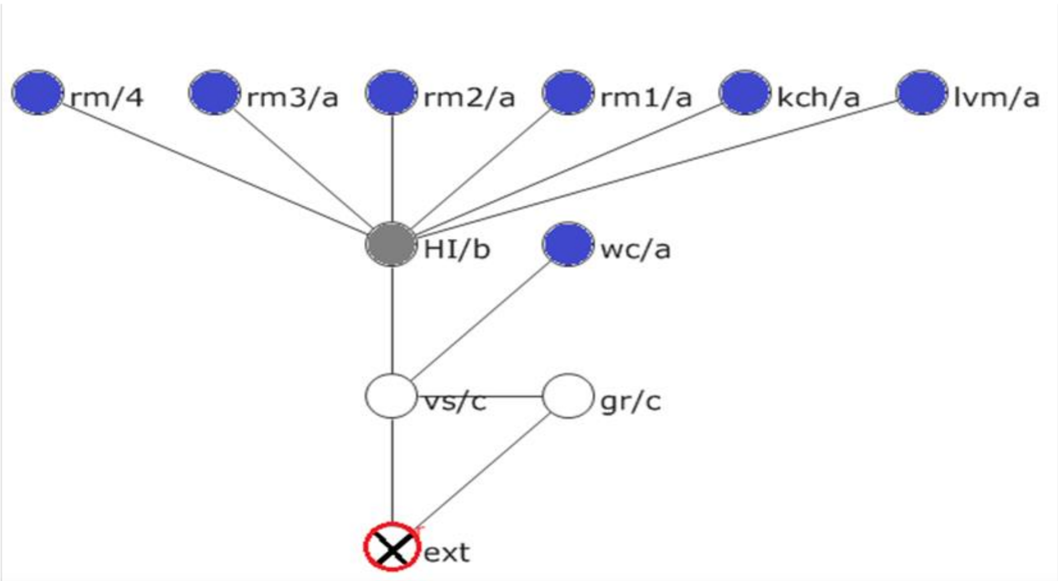
First floor

Plans of the house HV04



The j-graph of the house HV04

- **The vernacular house HV05**



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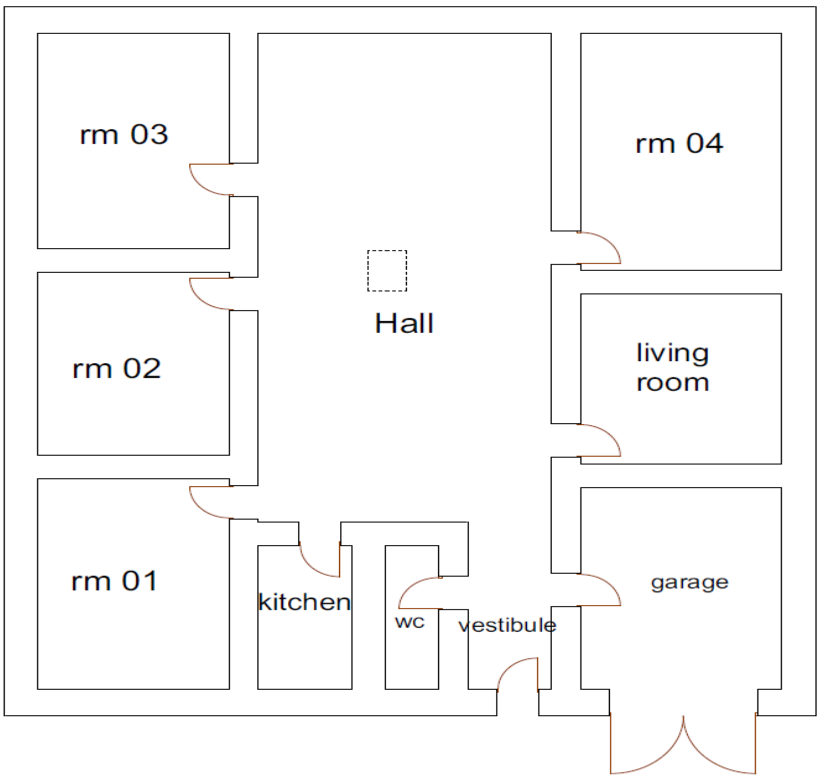
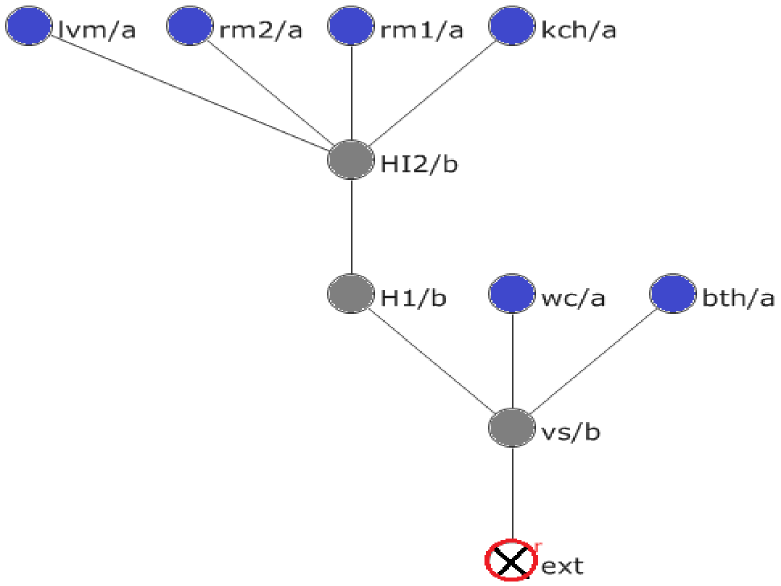
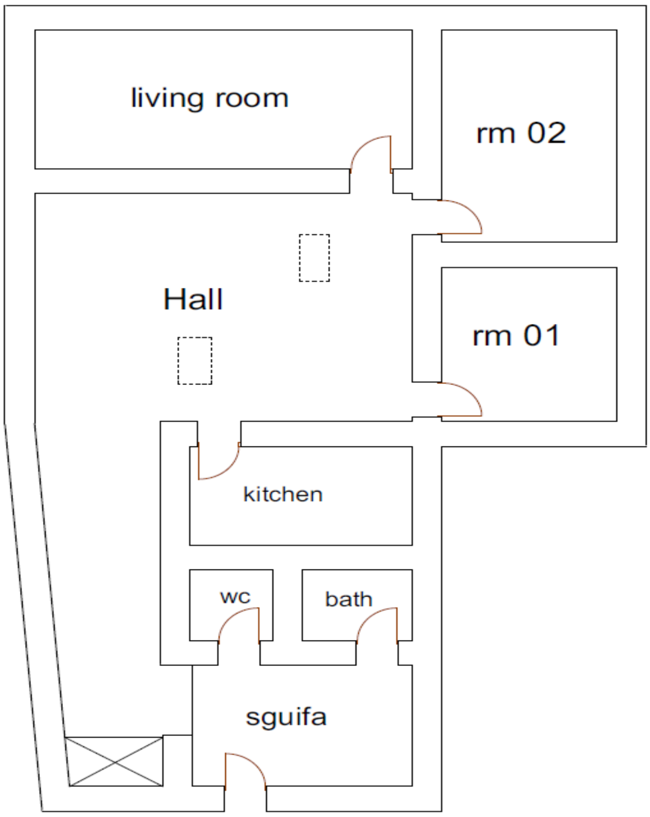


Plan of the house HV05

- **The vernacular house HV06**

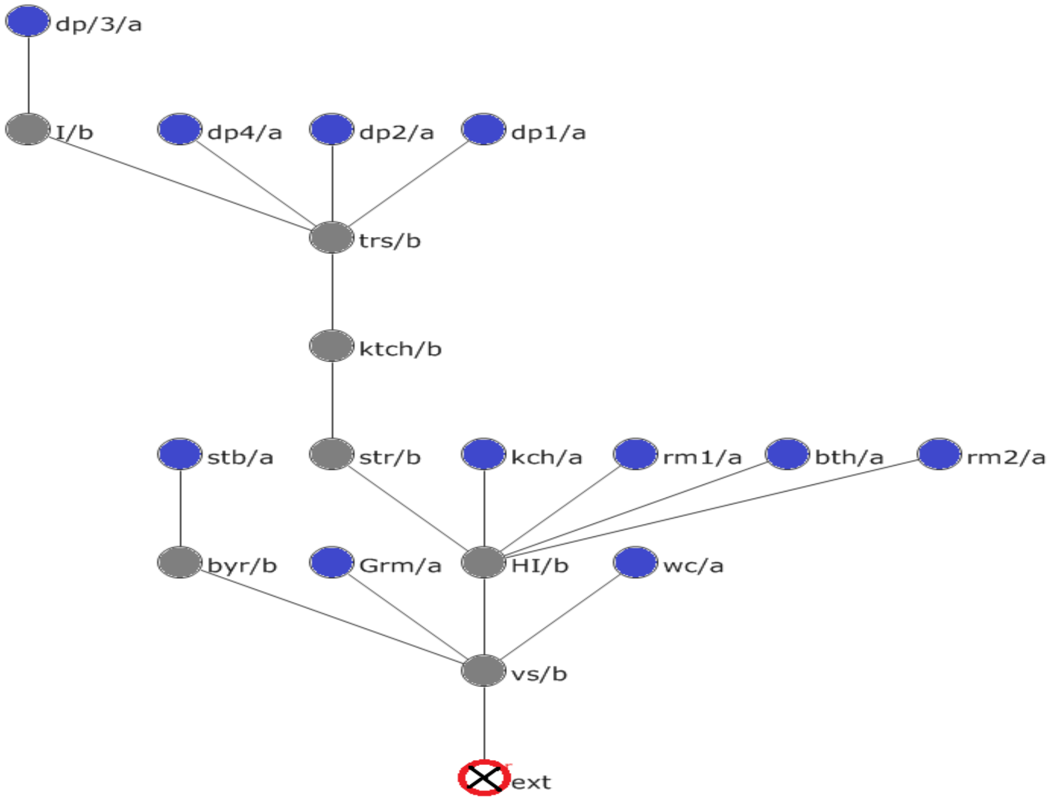


The j-graph of the house HV06

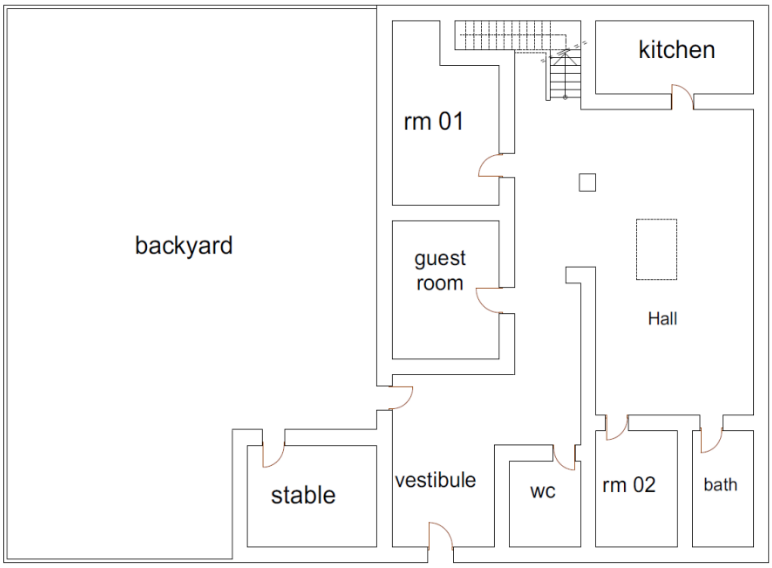


Plan of the house HV06

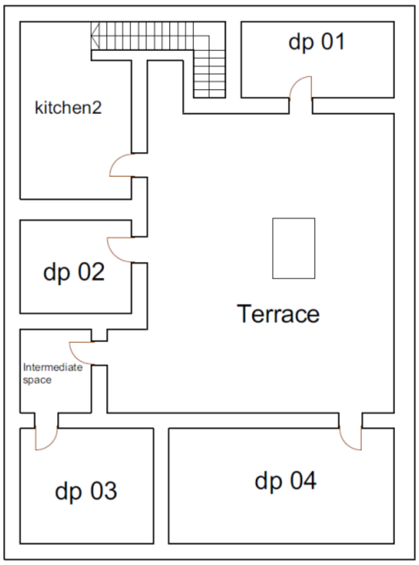
- **The vernacular house HV07**



The j-graph of the house HV07



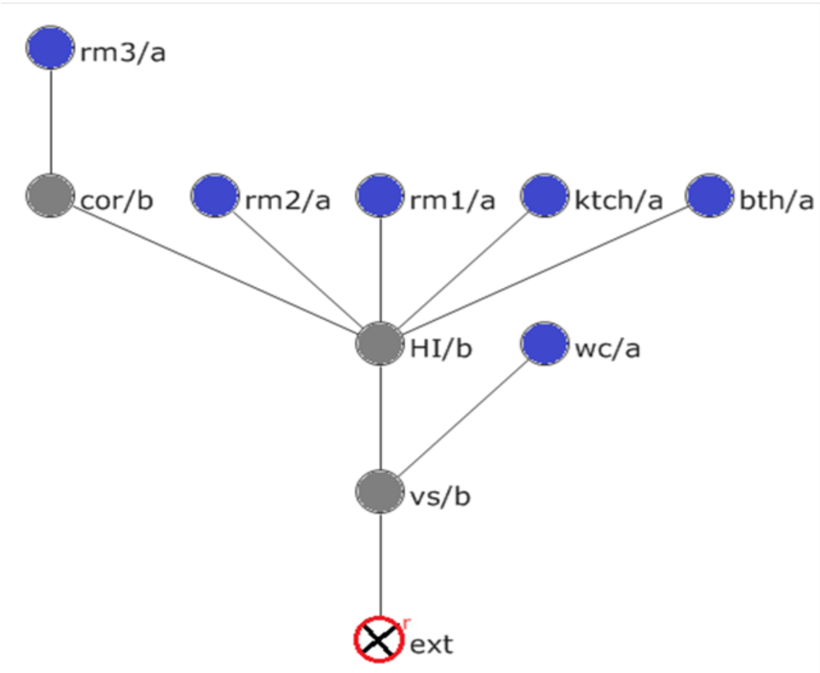
Ground floor

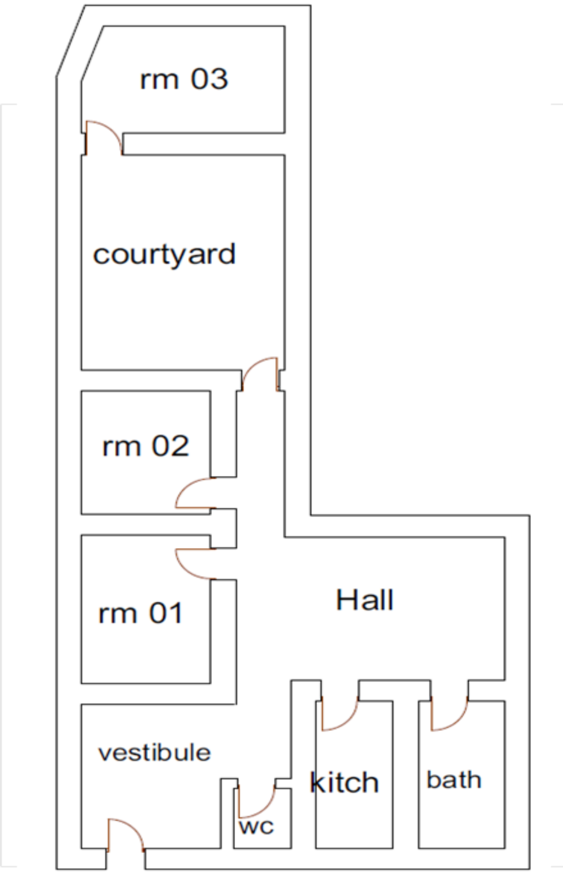


First floor

Plans of the house HV07

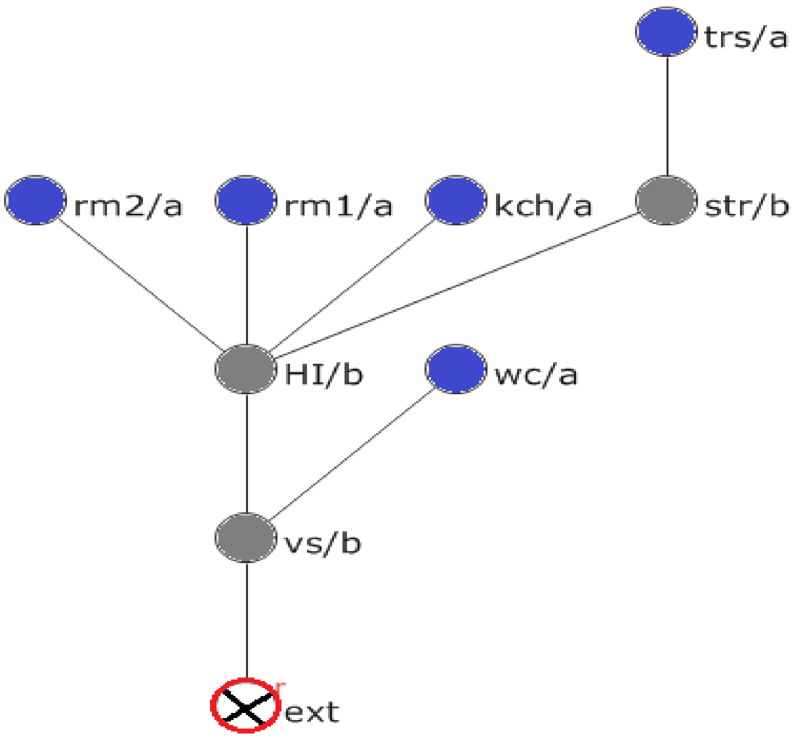
- **The vernacular house HV08**



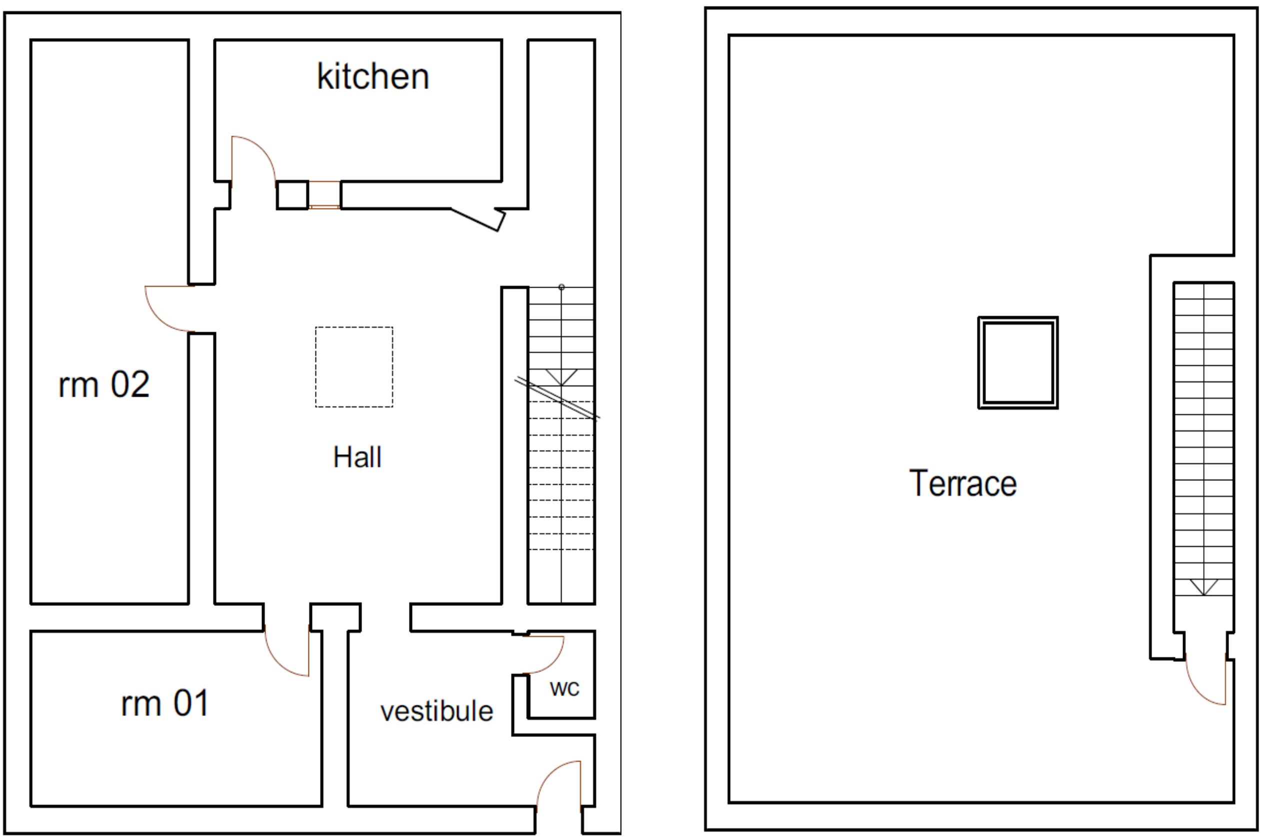


Plan of the house HV08

- **The vernacular house HV09**

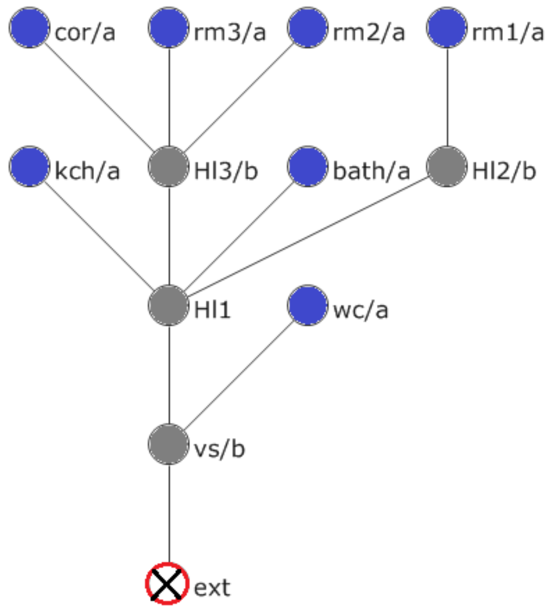


The j-graph of the house HV09

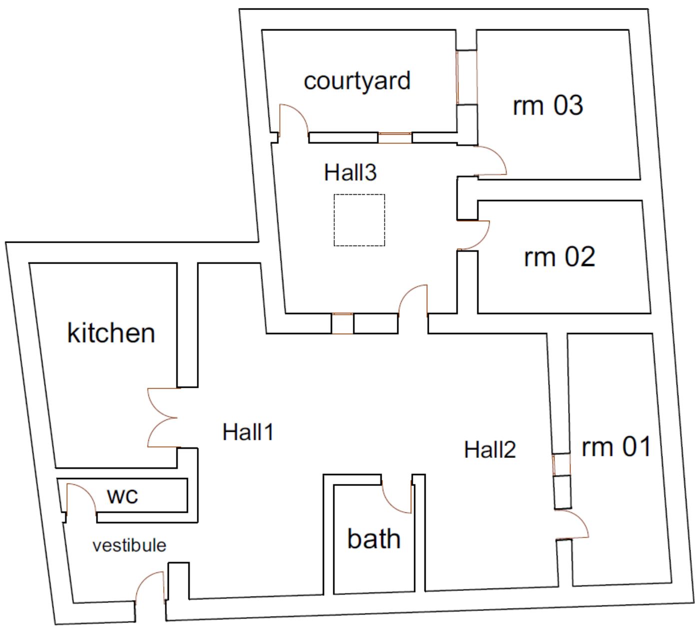


Plan of the house HV09

- The vernacular house HV10

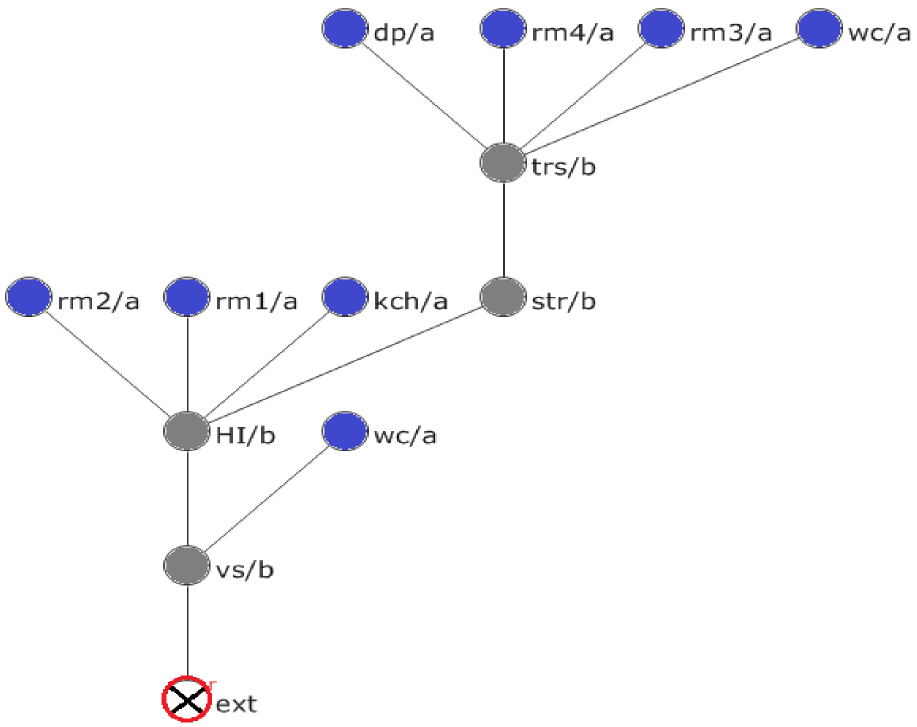


The j-graph of the house HV10

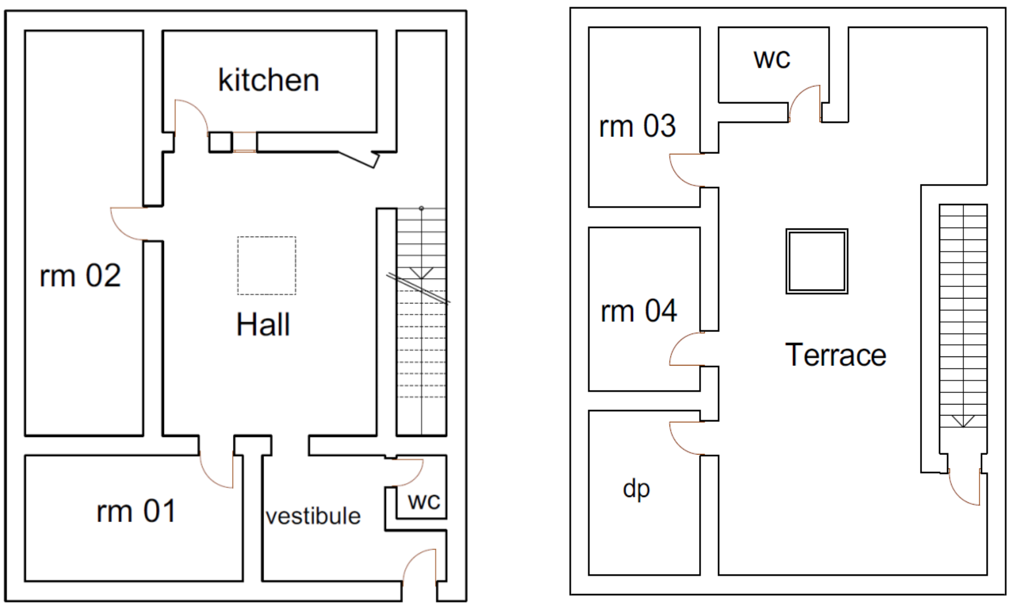


The plan of the house HV10

- **The vernacular house HV11**



The j-graph of the house HV11

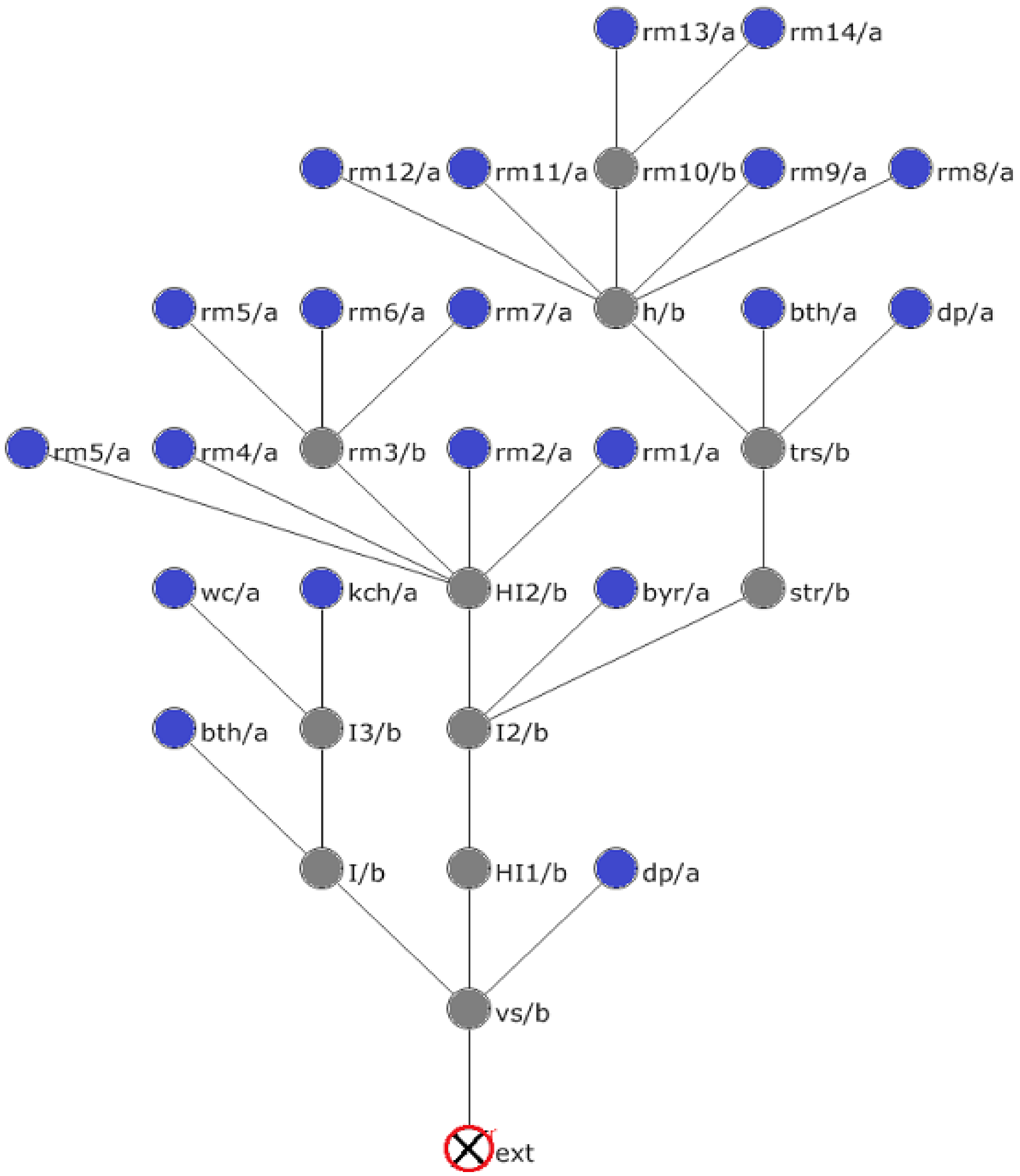


Ground floor

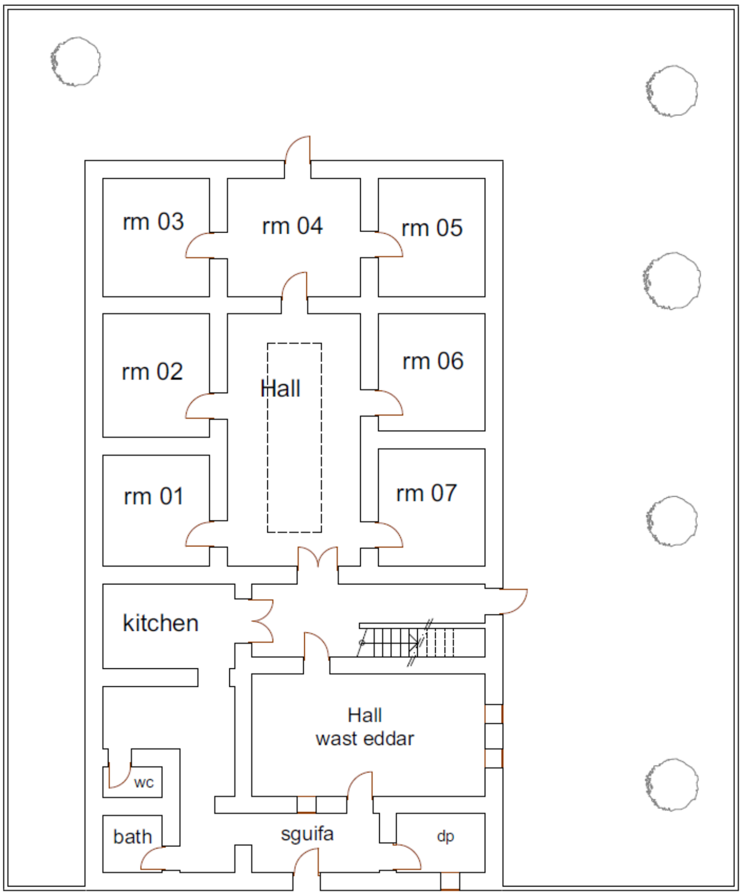
First floor

The plans of the house HV11

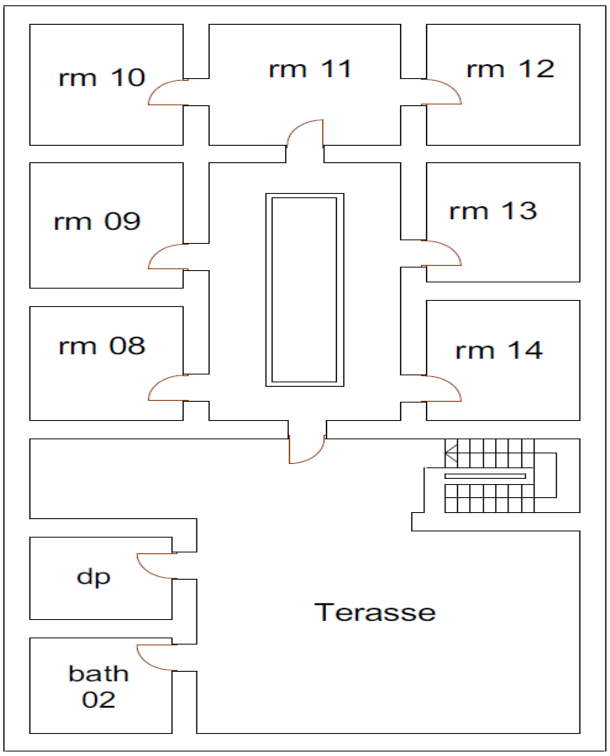
- **The vernacular house HV12**



The j-graph of the house HV12

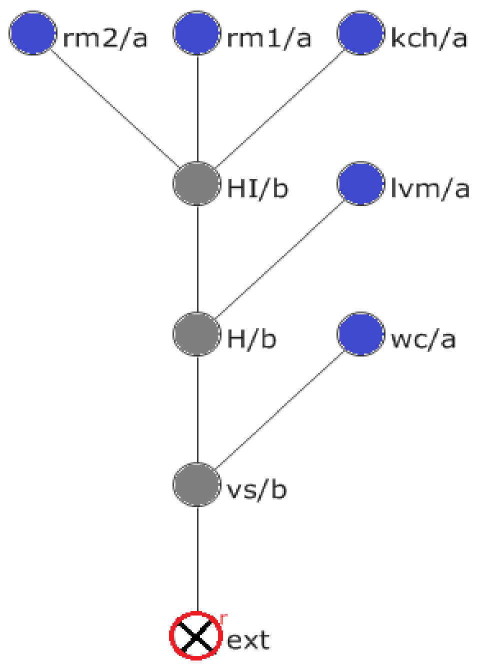


Ground floor

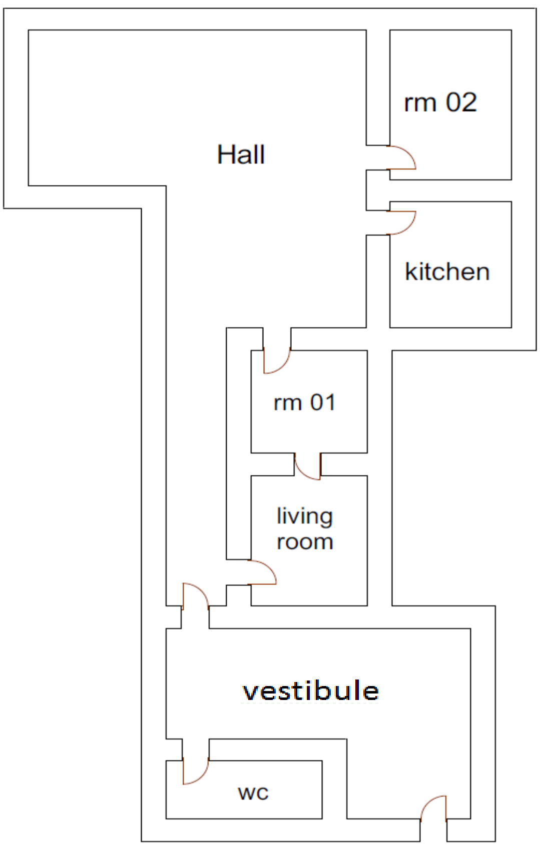


First floor

- **The vernacular house HV13**

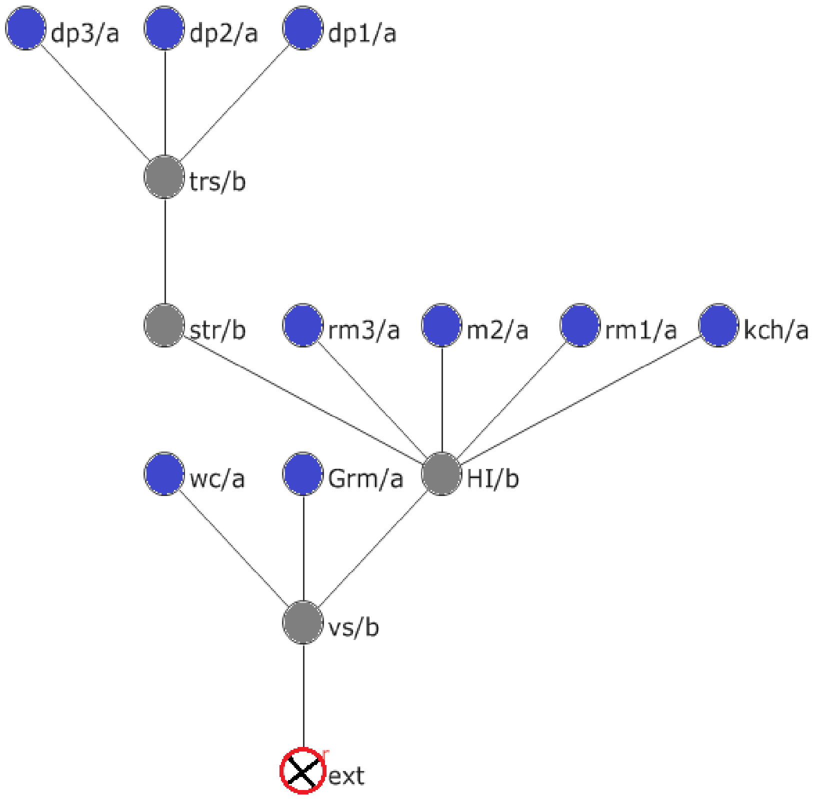


The j-graph of the house HV13

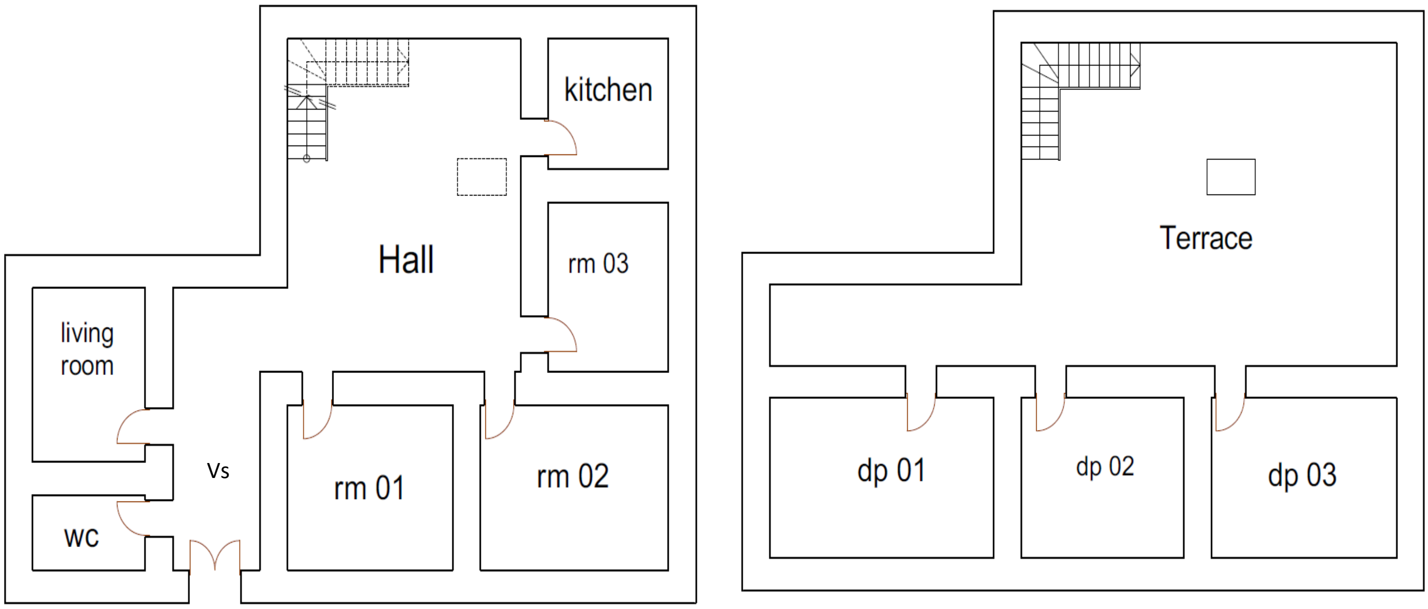


Plan of the house HV13

- The vernacular house HV14



The j-graph of the house HV14

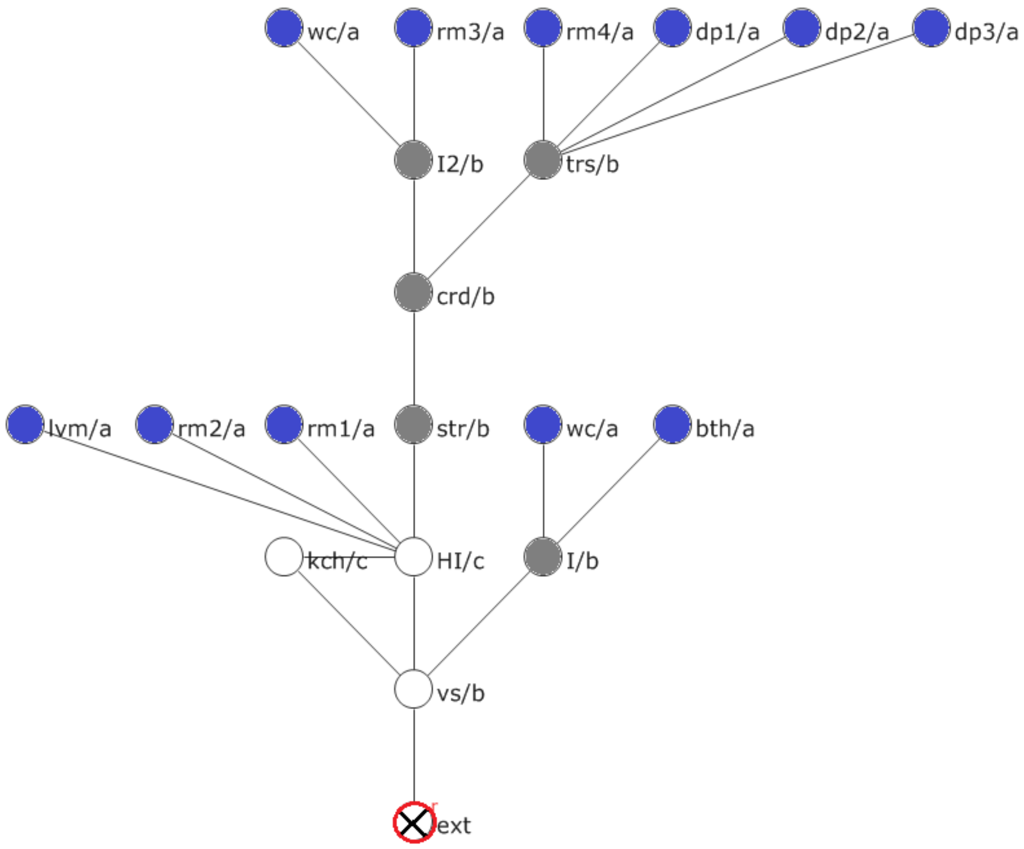


Ground floor

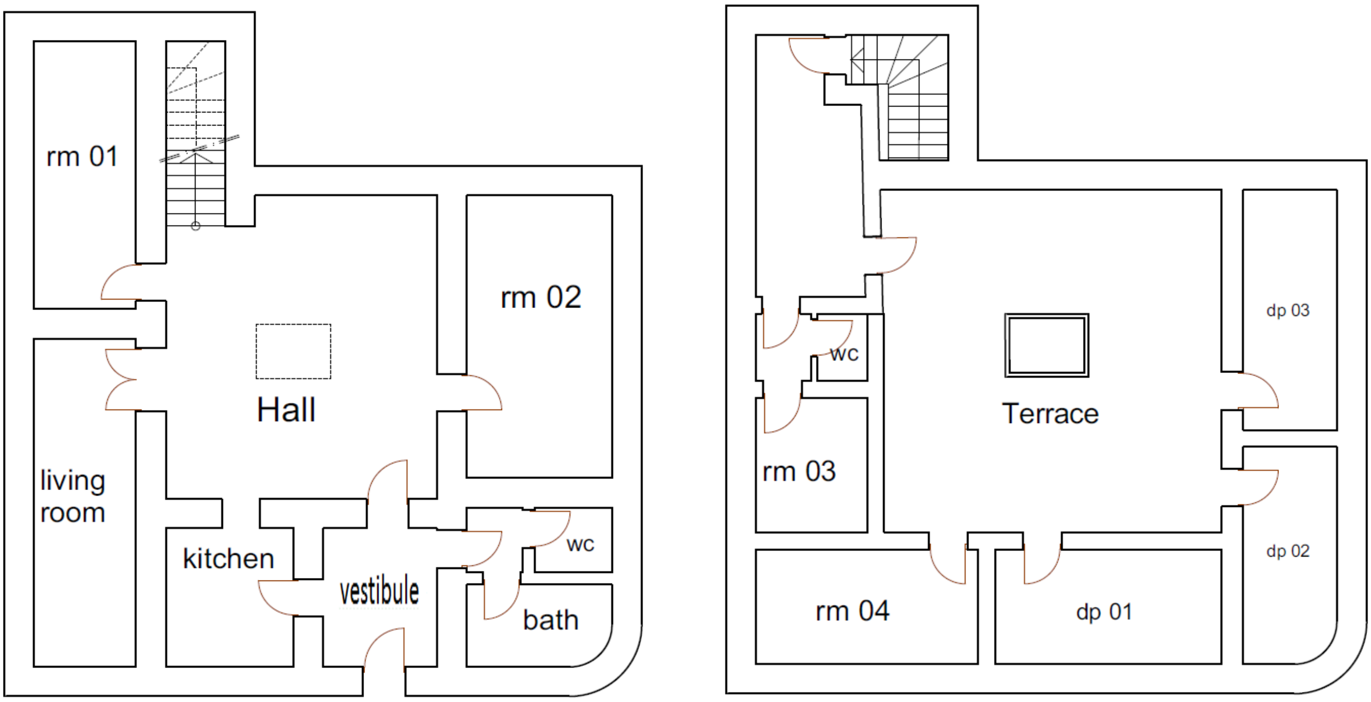
First floor

Plans of the house HV14

- **The vernacular house HV15**



The j-graph of the house HV15

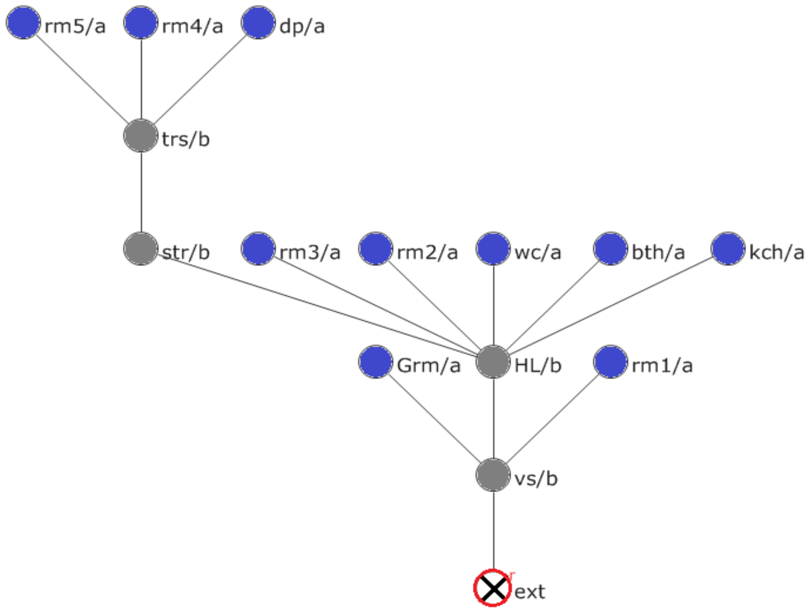


Ground floor   First floor

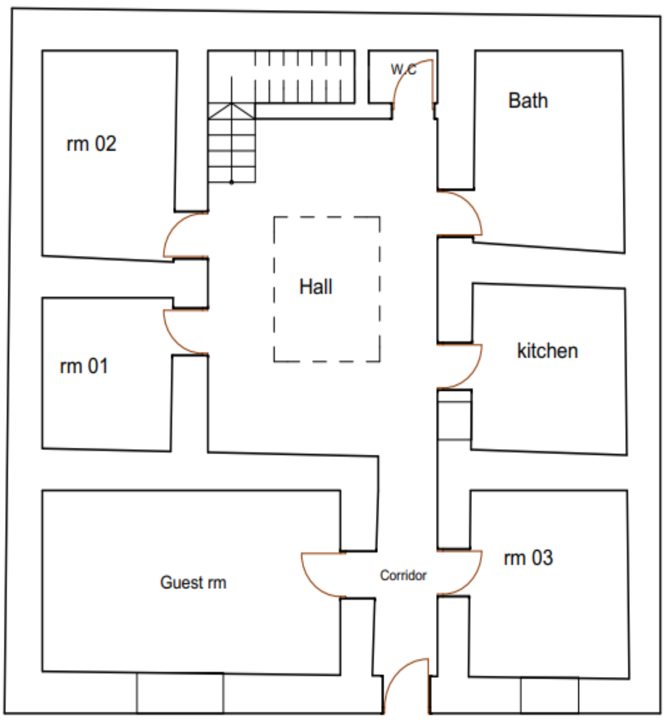
Plans of the house HV15

I- Colonial period:

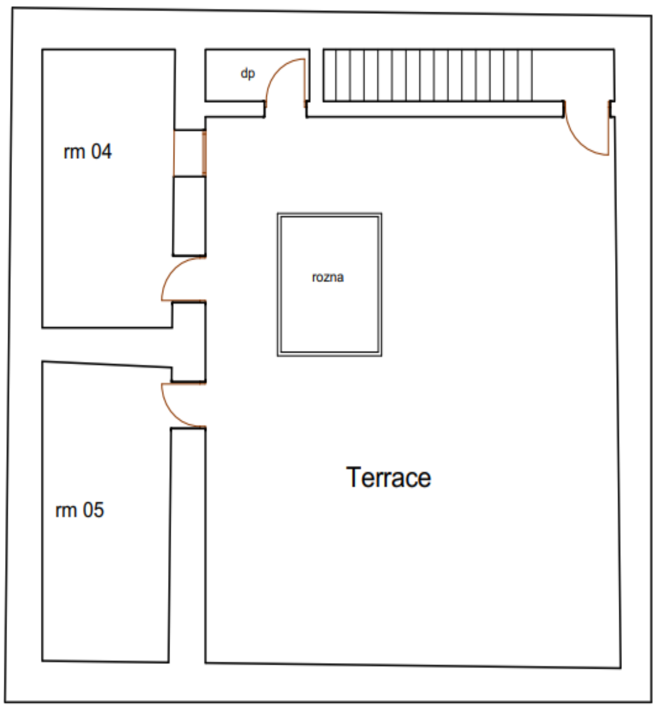
- The colonial house HC01



The j-graph of the colonial house HC01



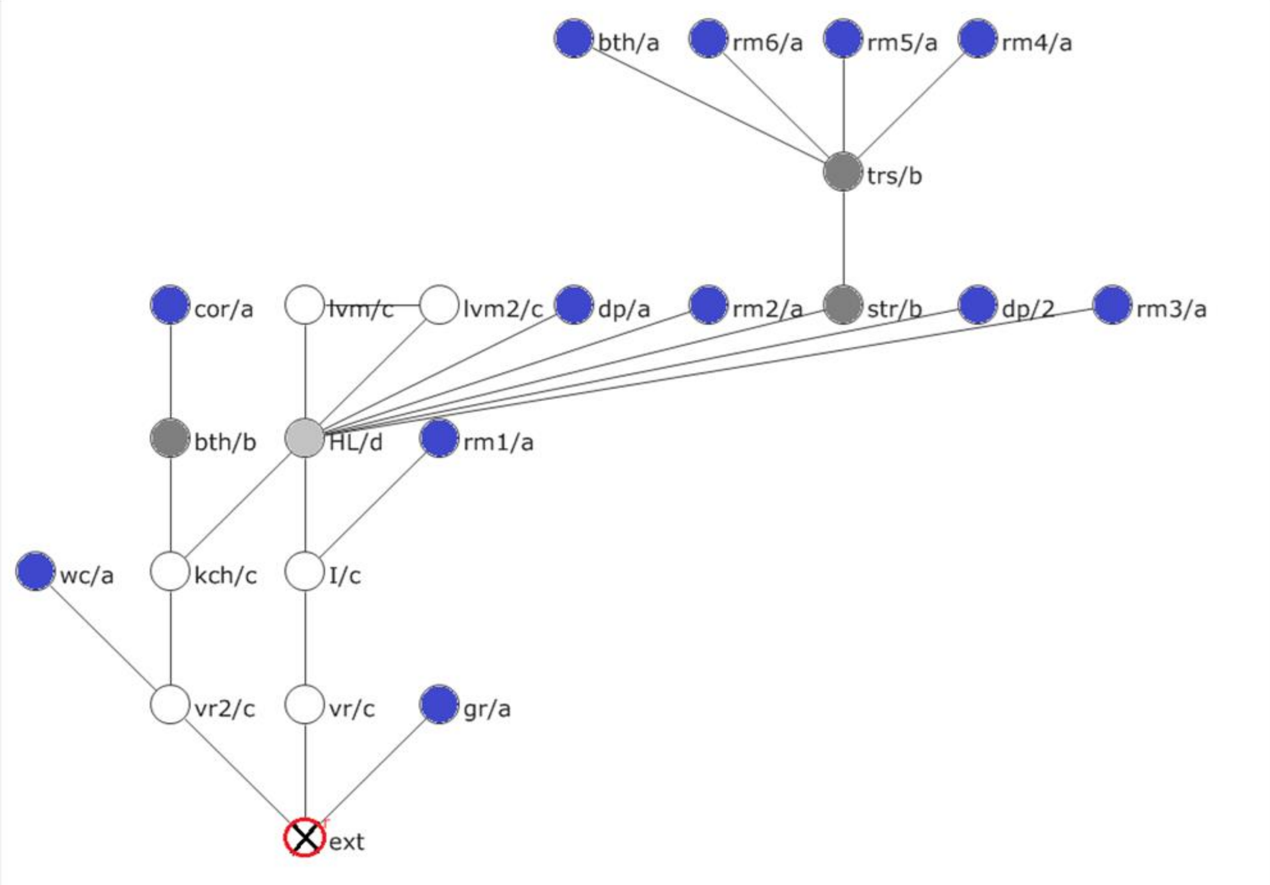
Ground floor



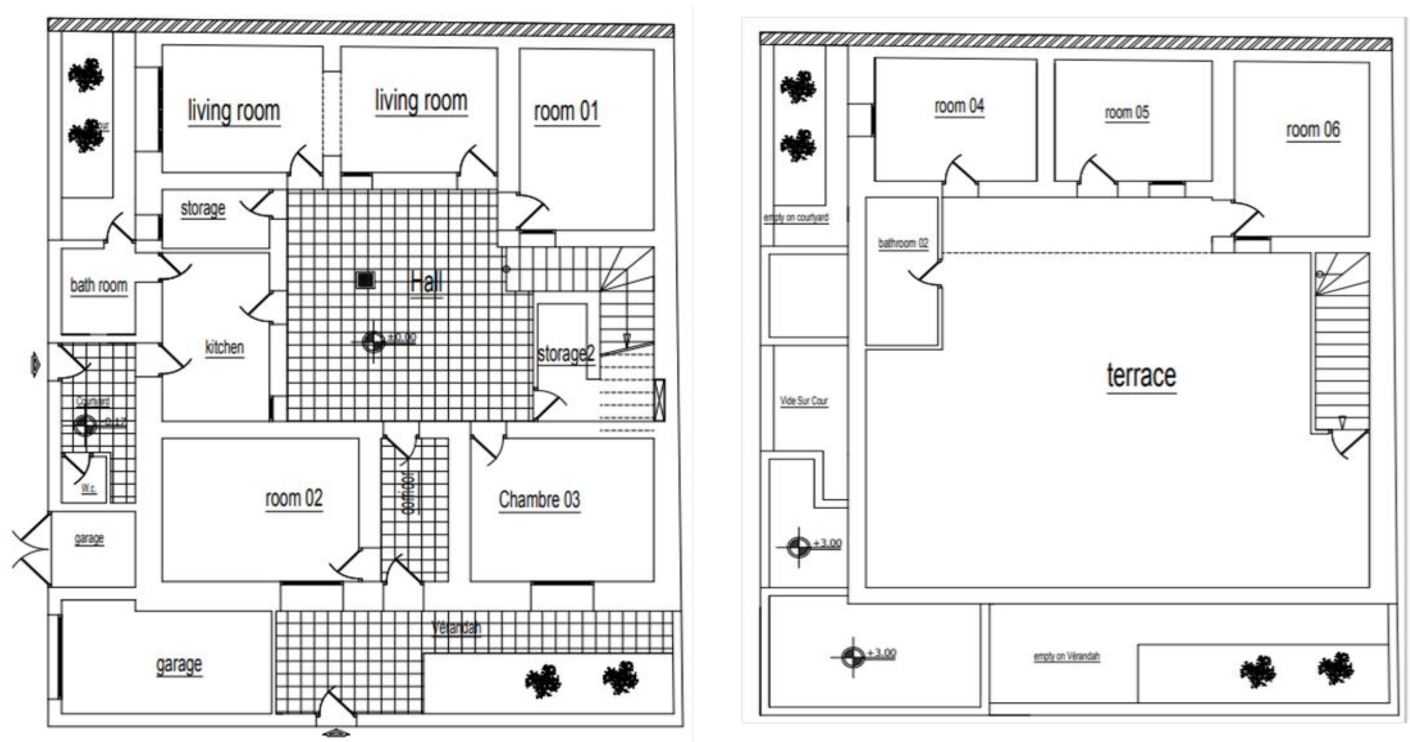
First floor

Plans of the house HC01

- **The colonial house HC02**



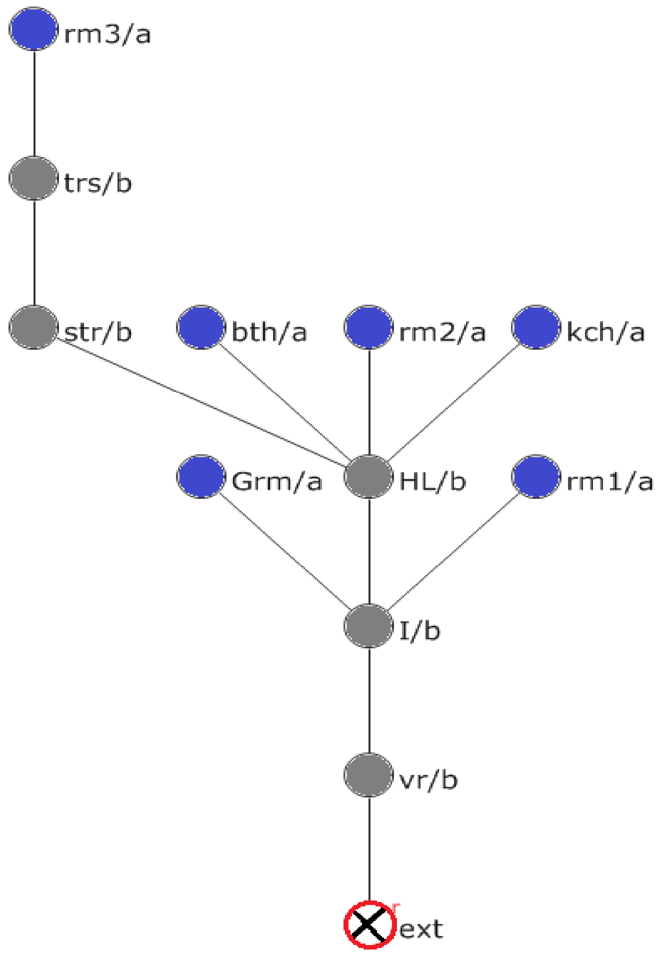
The j-graph of the house HC02



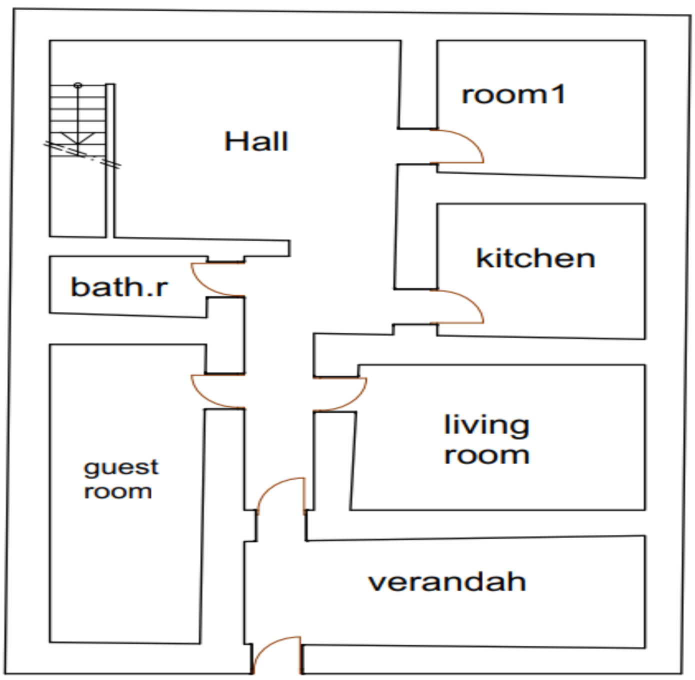
Ground floor First floor

Plans of the house HC02

- **The colonial house HC03**

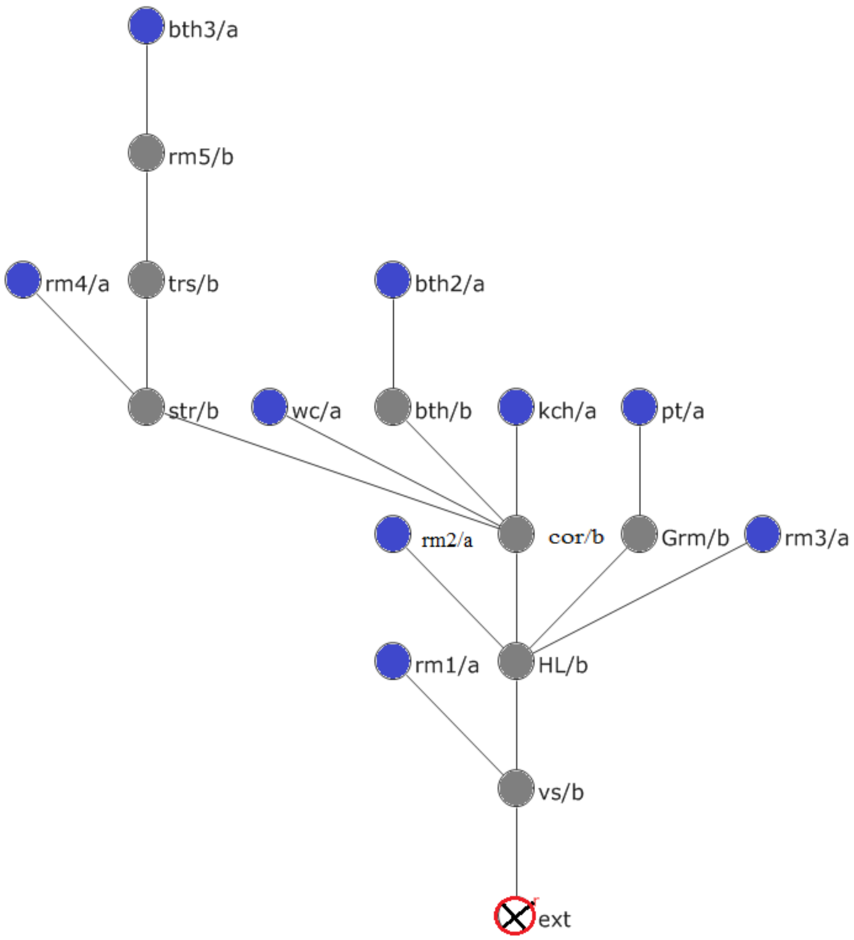


The j-graph of the house HC03

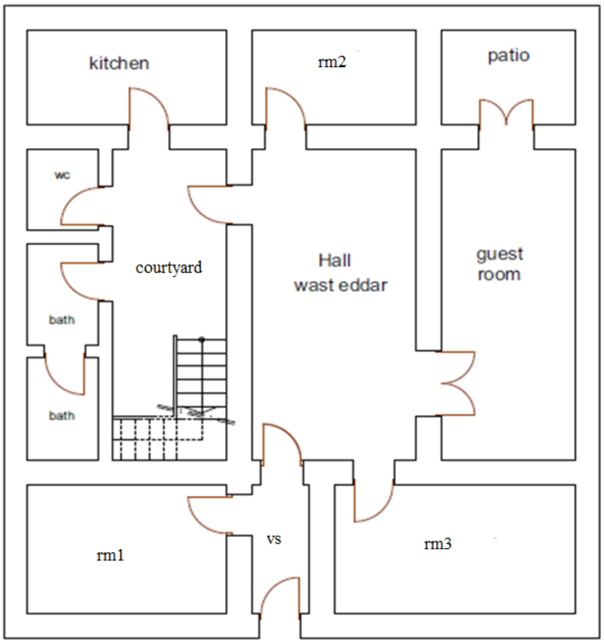


Plan of the house HC03

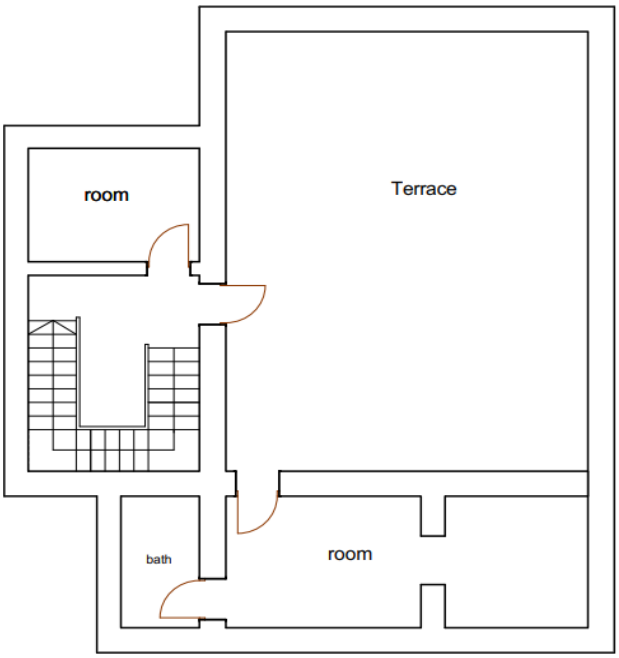
- **The colonial house HC04**



The j-graph of the house HC04



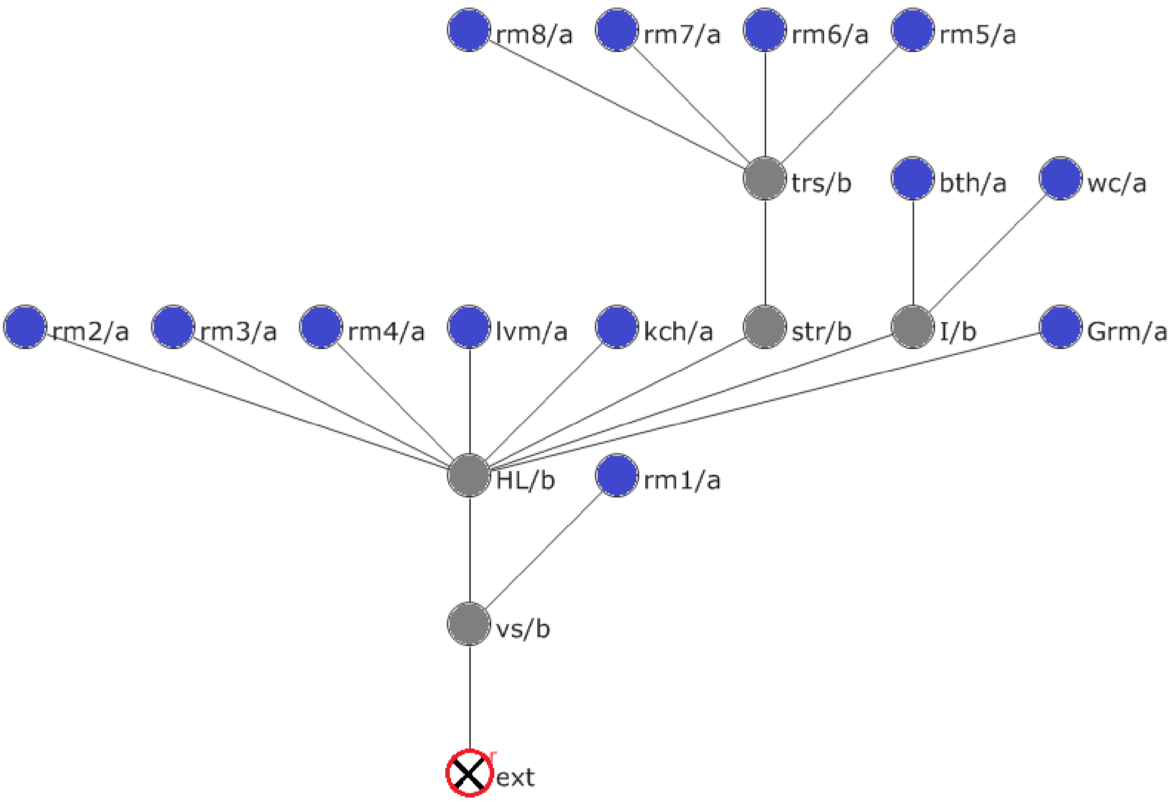
Ground floor



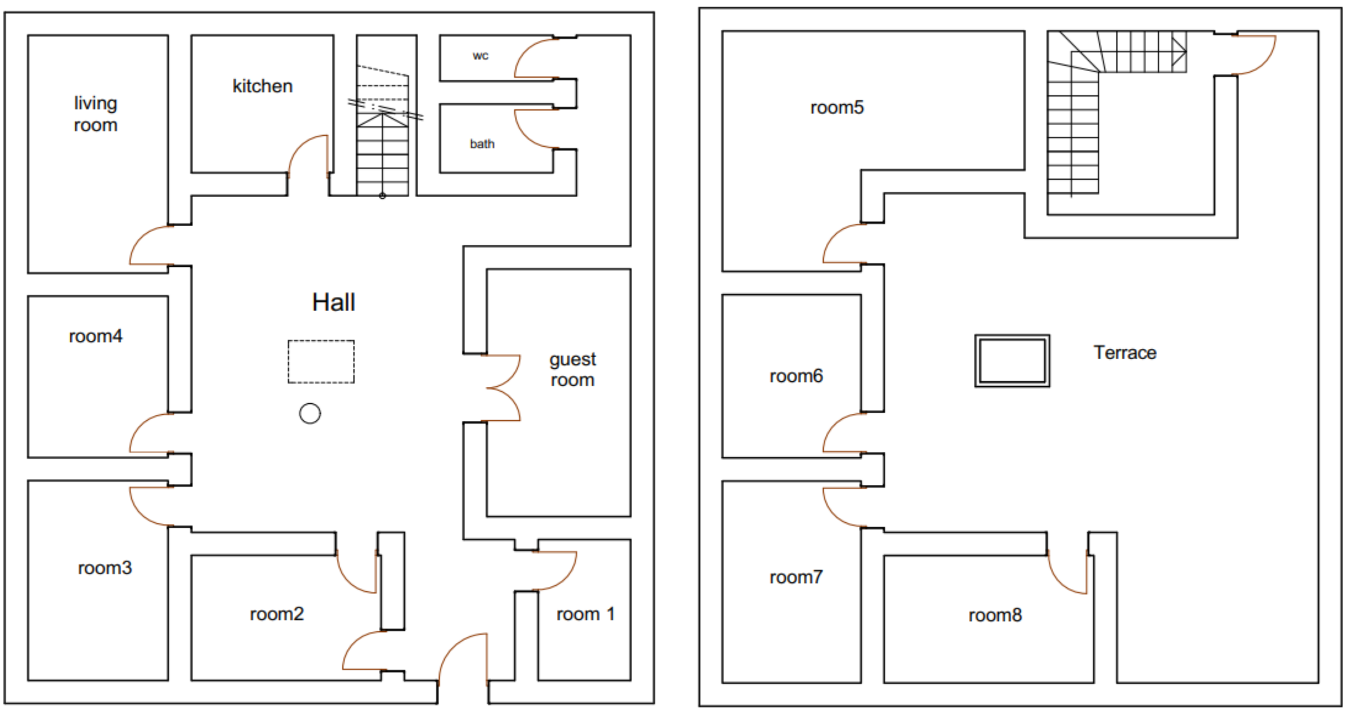
First floor

Plans of the house HC04

- **The colonial house HC05**



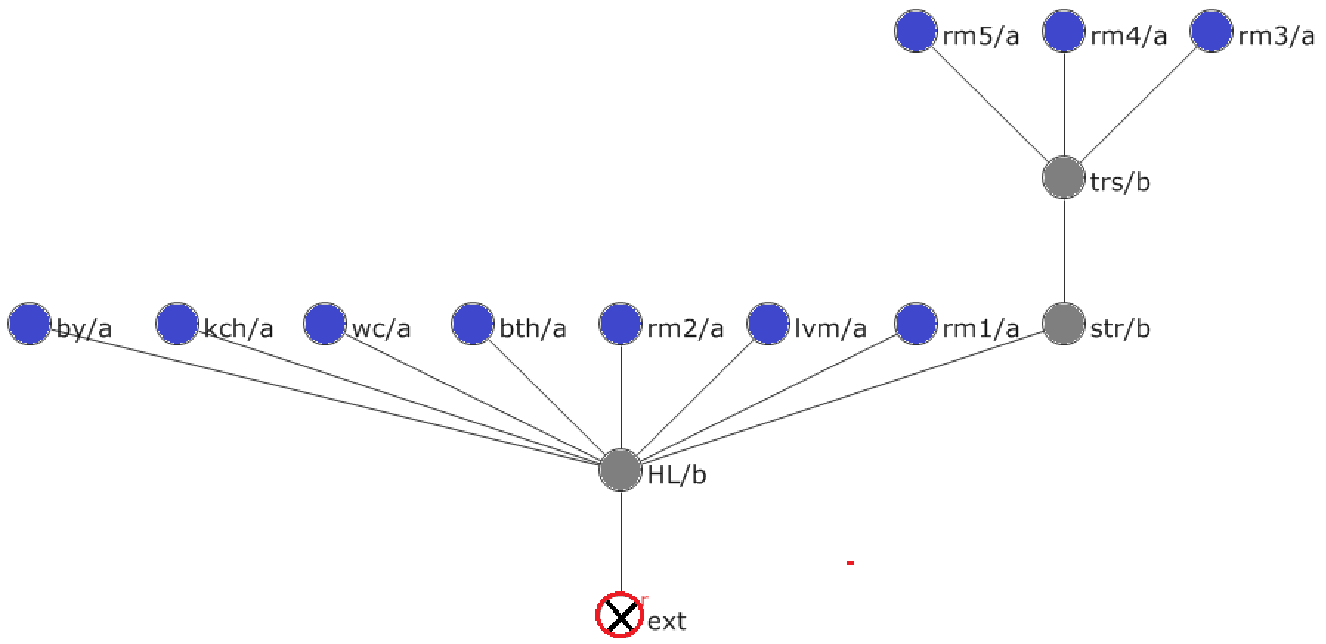
The j-graph of the house HC05



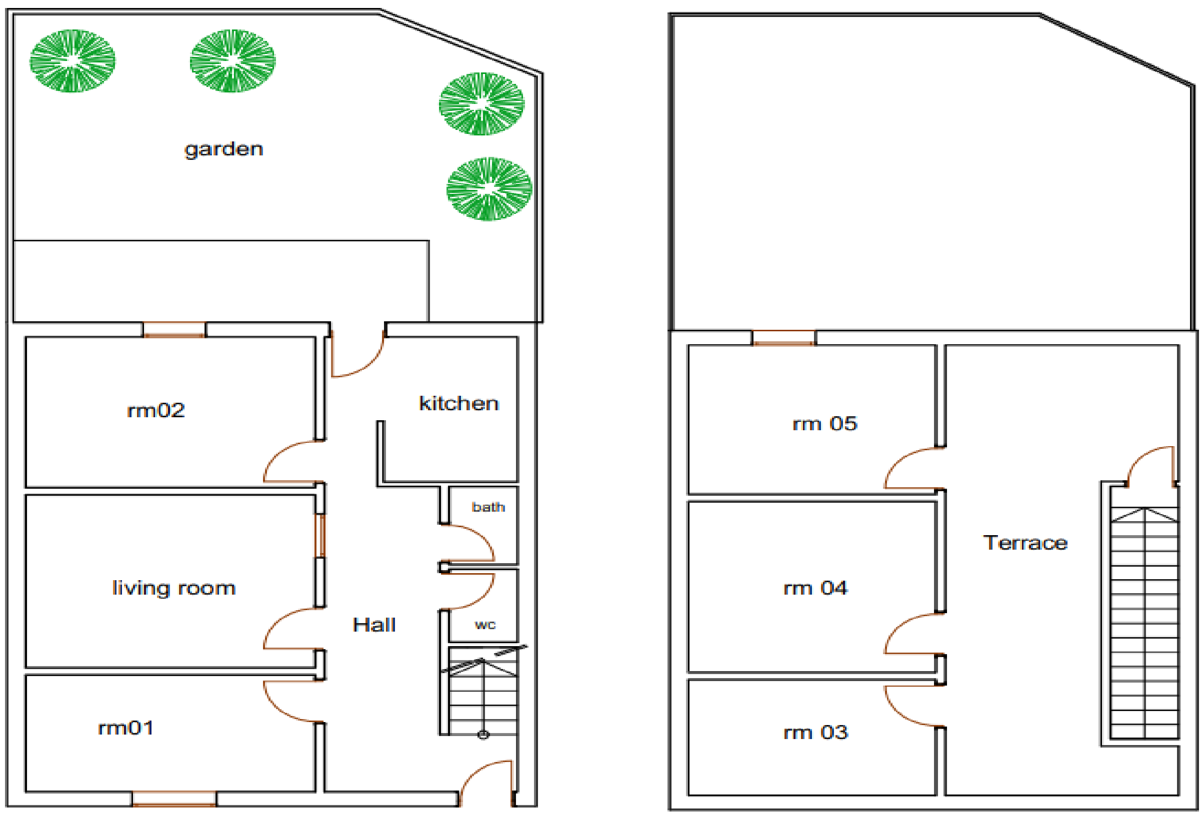
Ground floor First floor

Plans of the house HC05

- **The colonial house HC06**



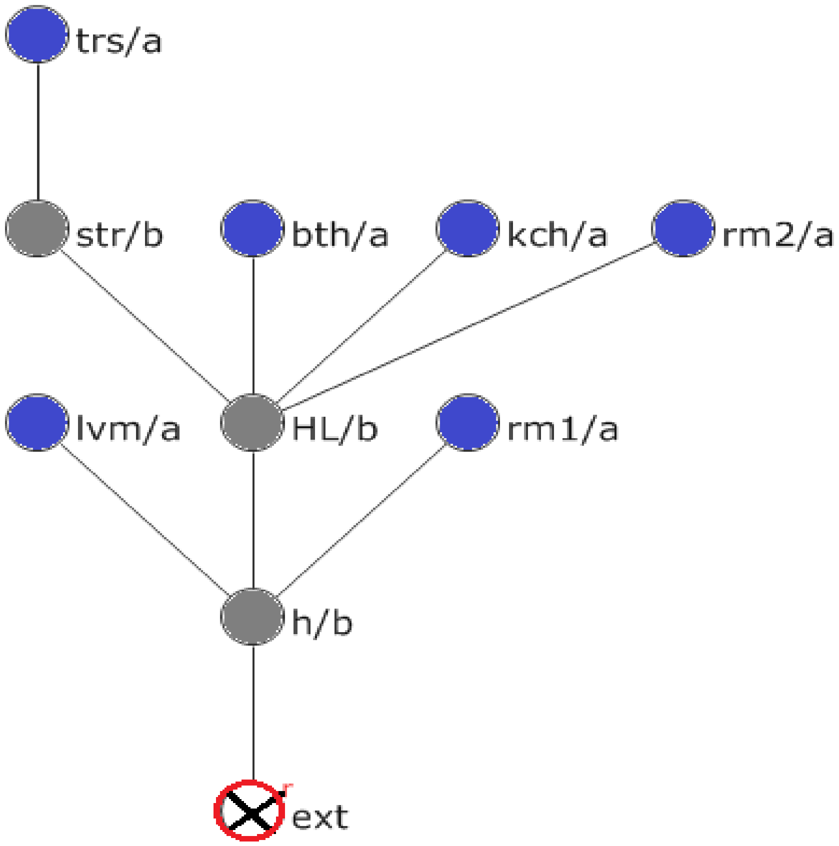
The j-graph of the house HC06



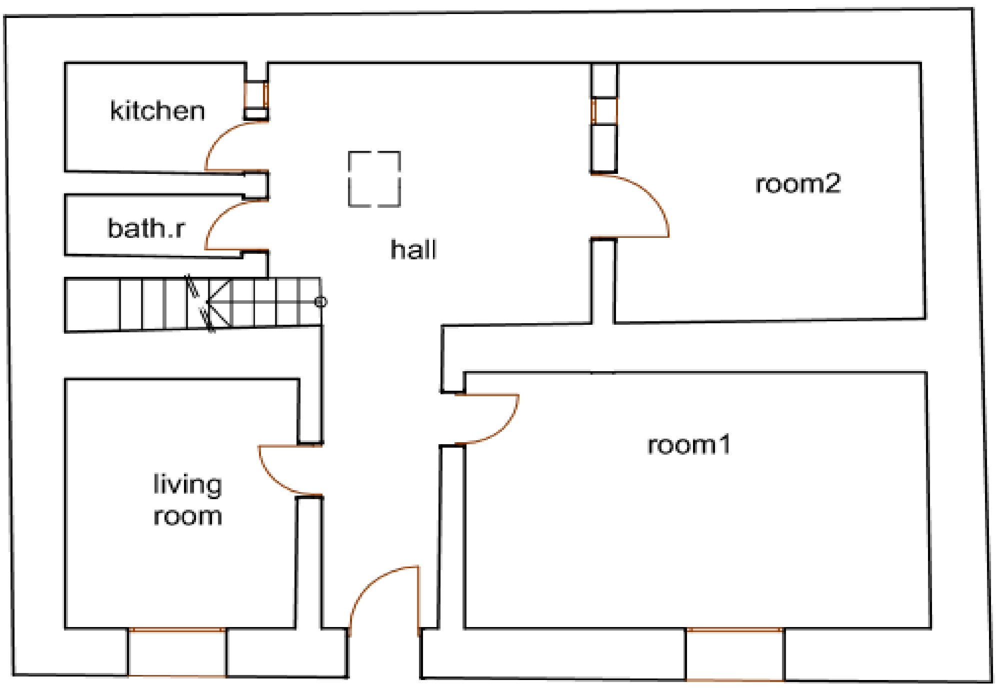
Ground floor First floor

Plans of the house HC06

- **The colonial house HC07**

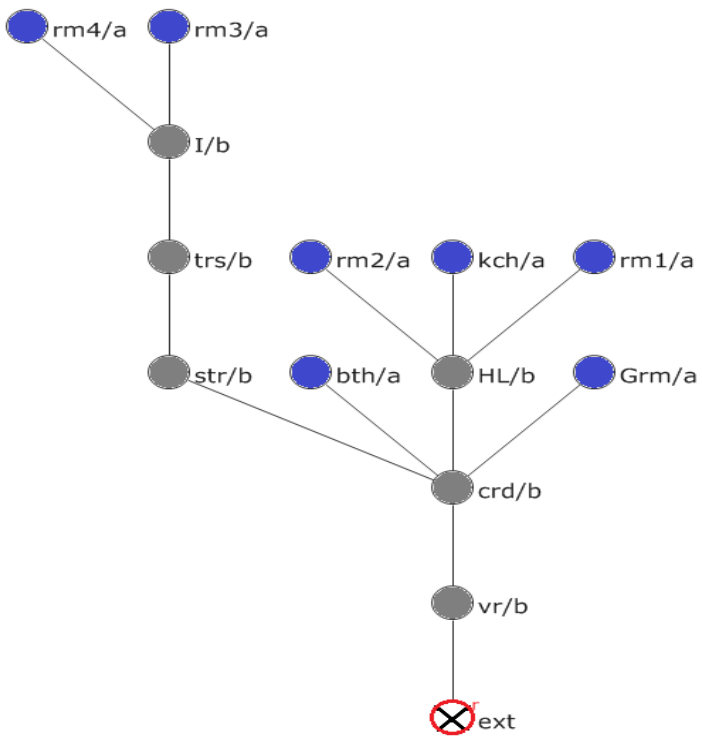


The j-graph of the house HC07

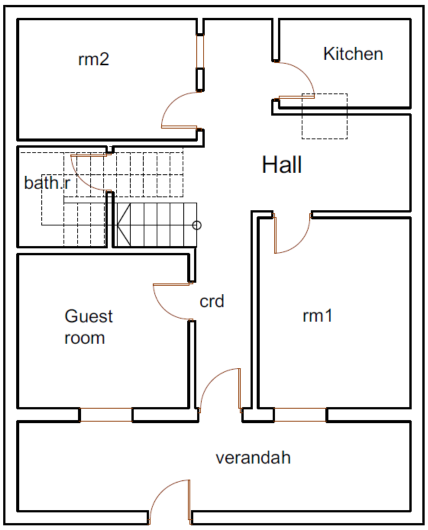


Plan of the house HC07

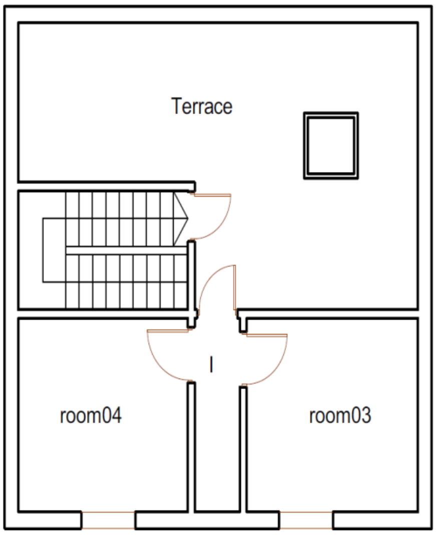
- **The colonial house HC08**



The j-graph of the house HC8



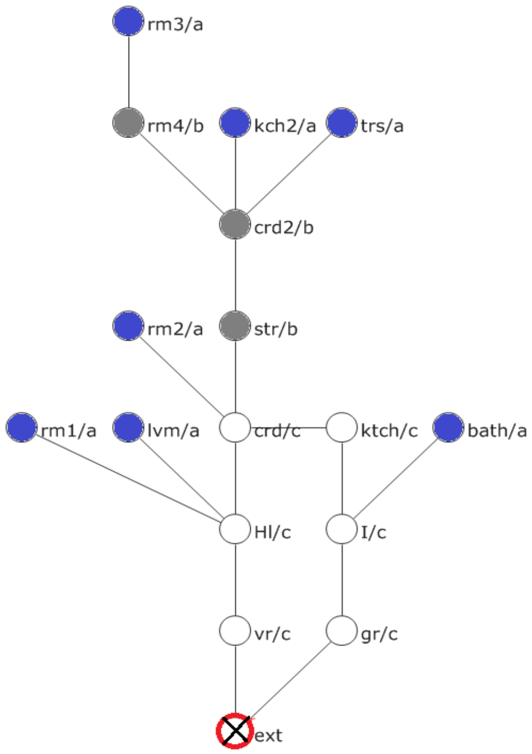
Ground floor



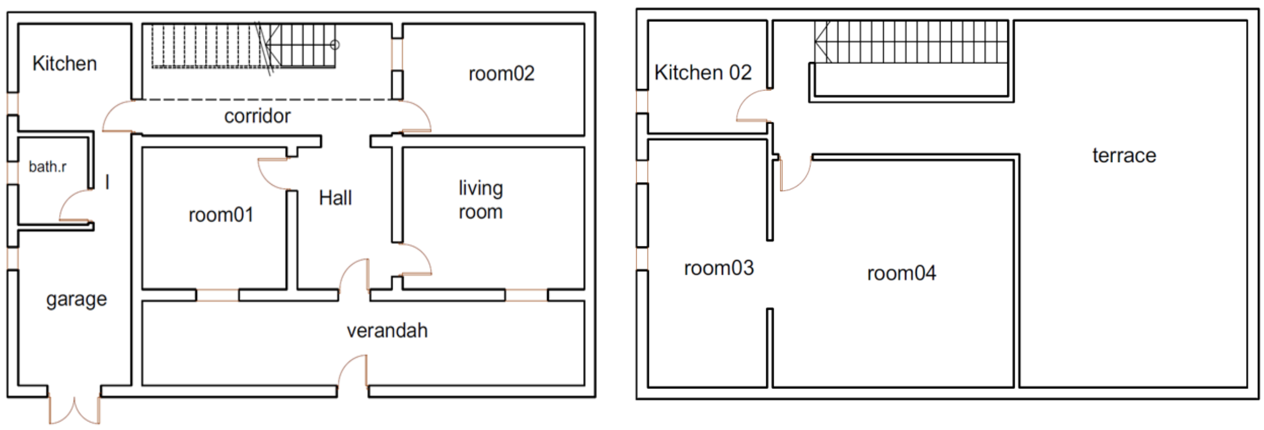
First floor

Plan of the houses HV08

- **The colonial house HC09**



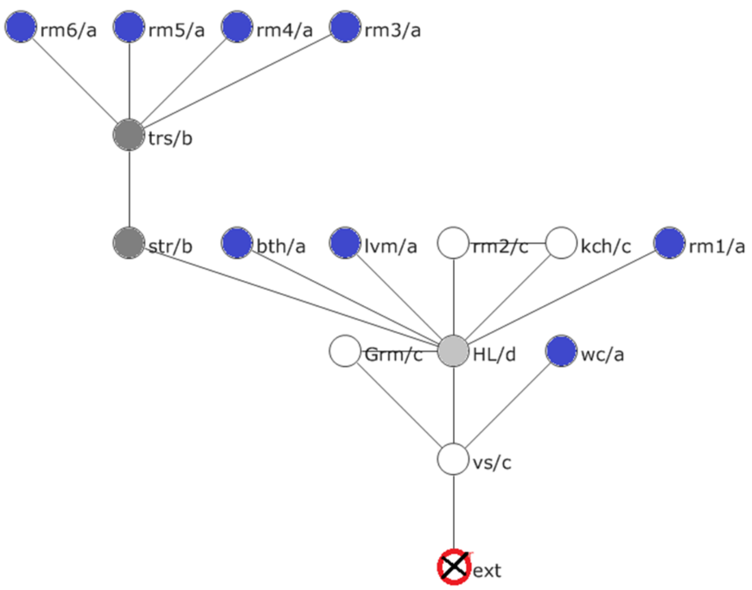
The j-graph of the house HC09



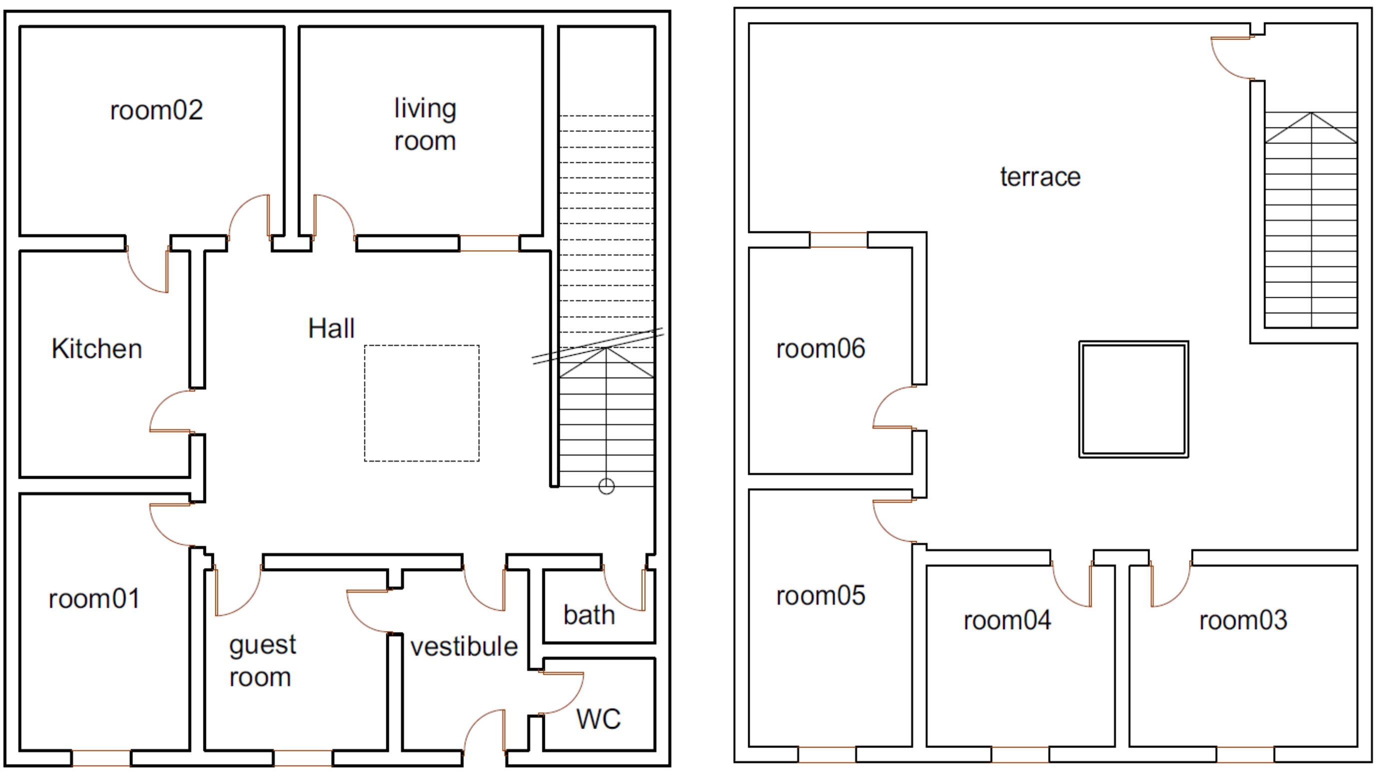
Ground floor First floor

Plans of the house HC09

- **The colonial house HC10**



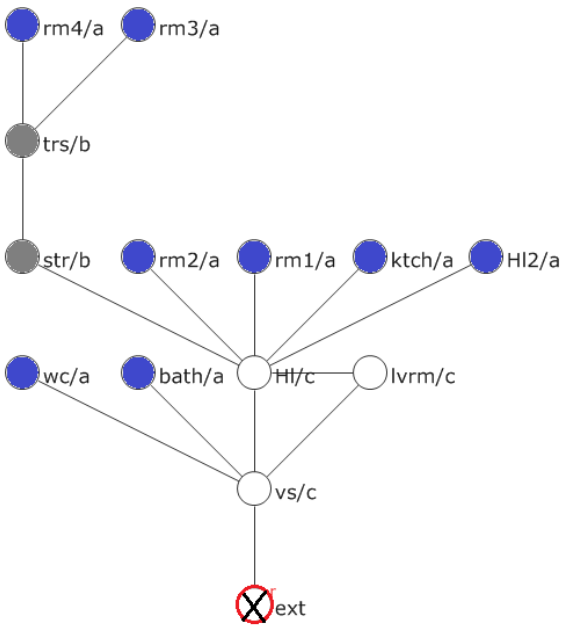
The j-graph of the house HC10



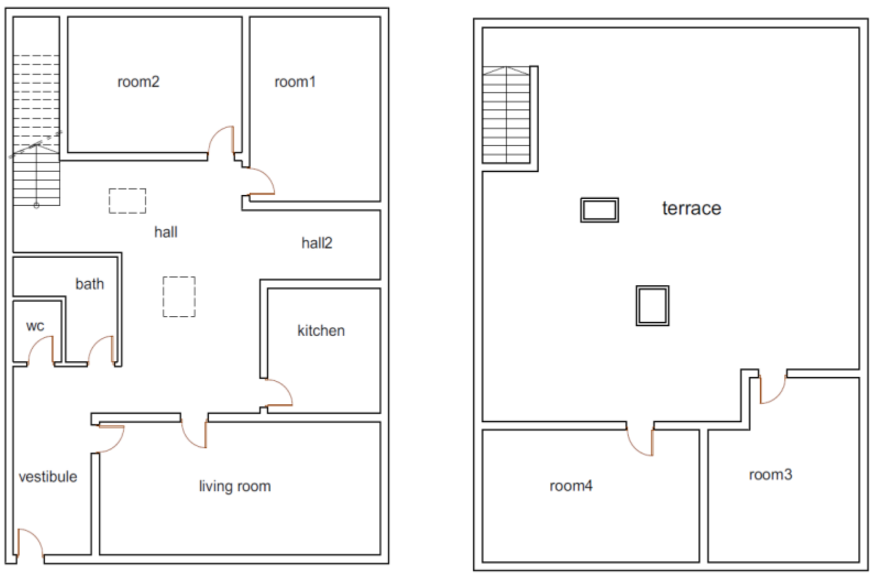
Ground floor First floor

Plans of the house HC10

- **The colonial house HC11**



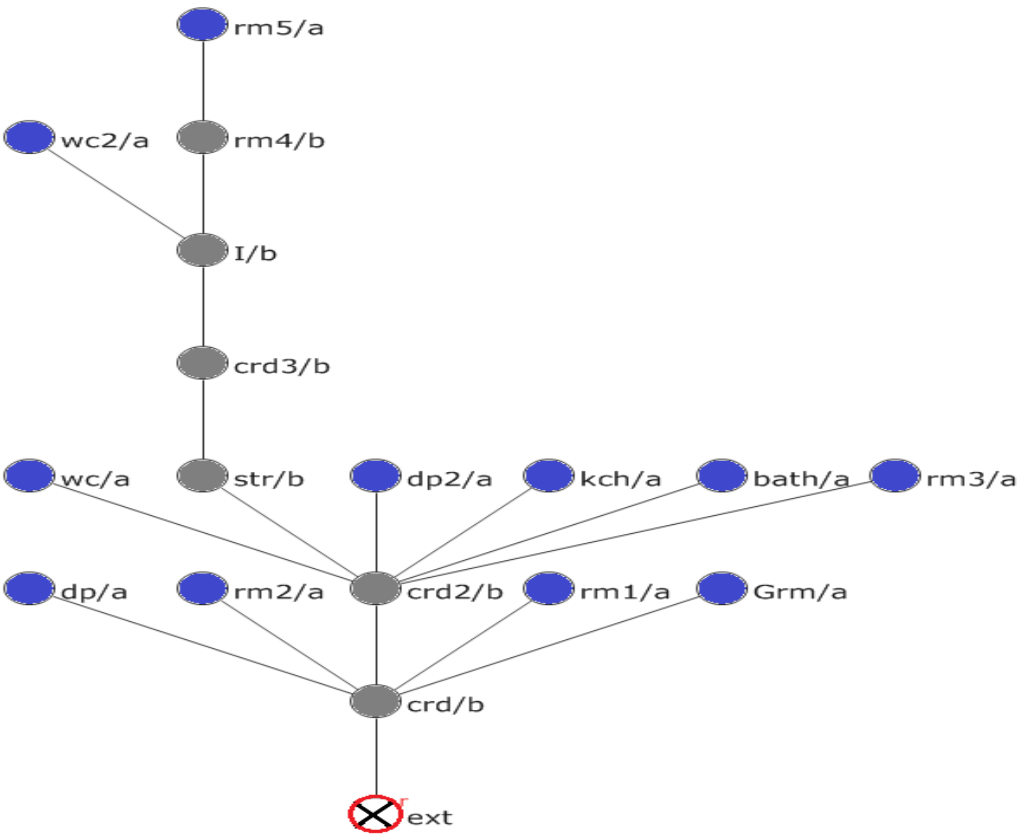
The j-graph of the house HC11



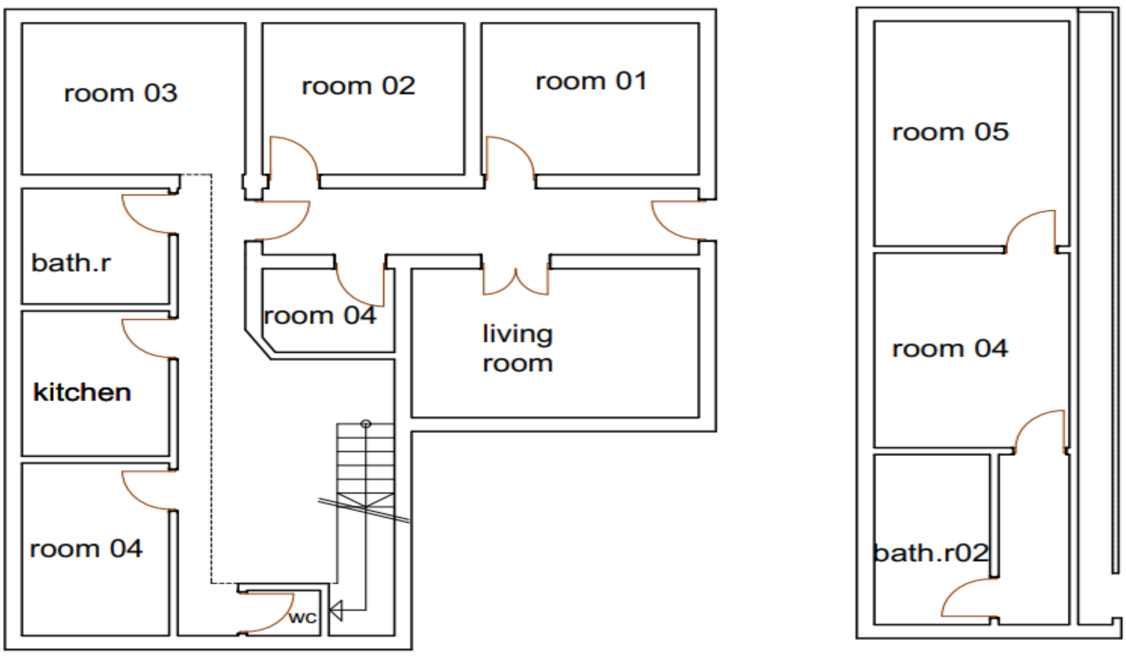
Ground floor First floor

Plans of the house HC11

- **The colonial house HC12**



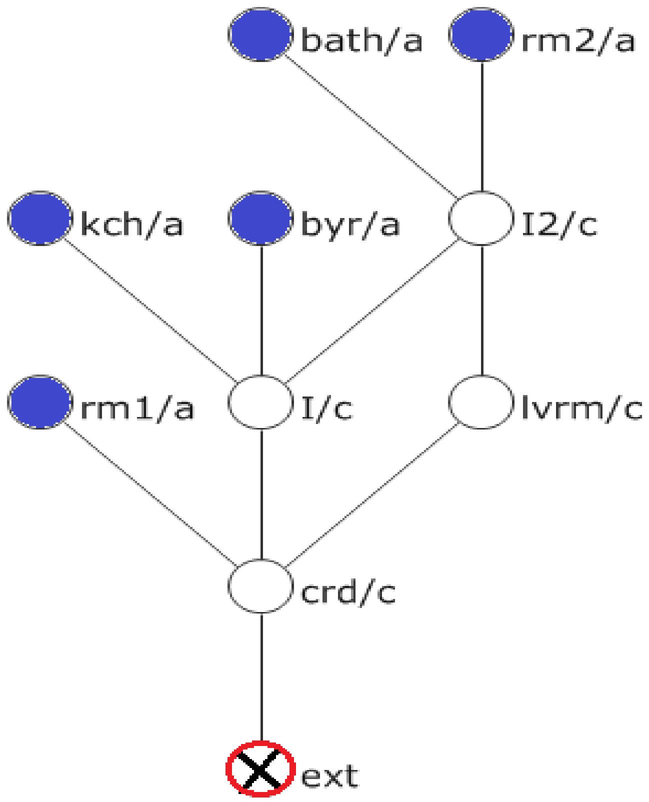
The j-graph of the house HC12



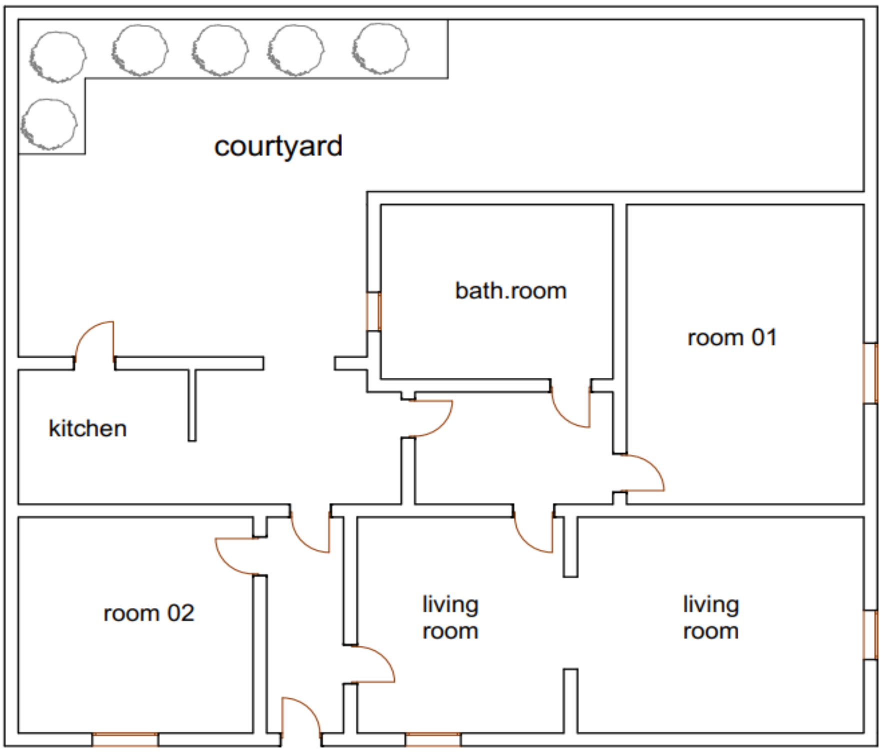
Ground floor First floor

Plans of the house HC12

- **The colonial house HC13**

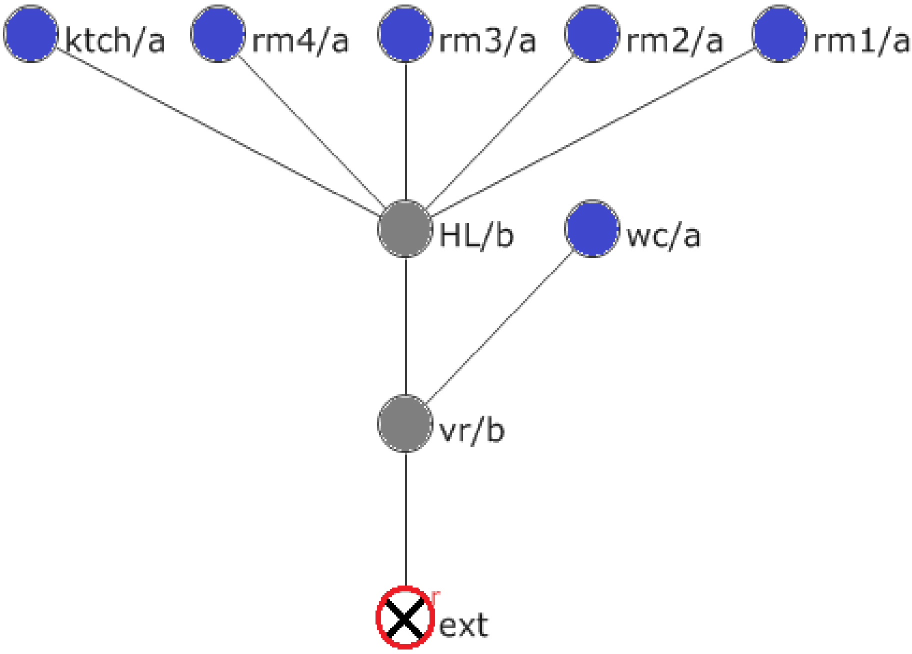


The j-graph of the house HC13

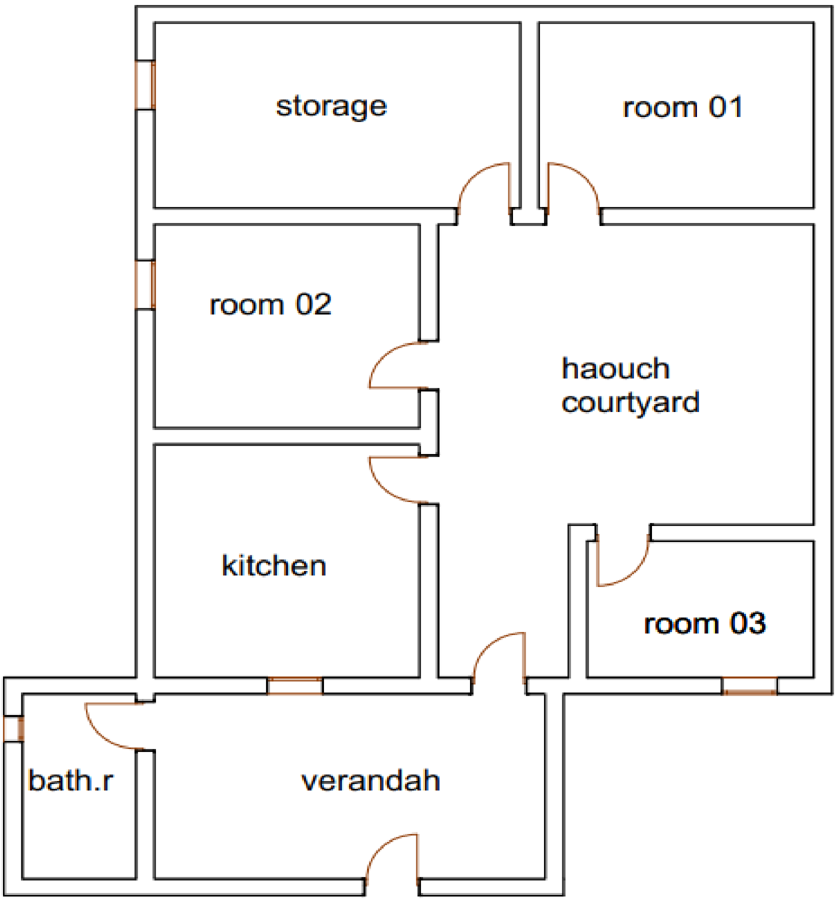


Plan of the house HC13

- **The colonial house HC14**

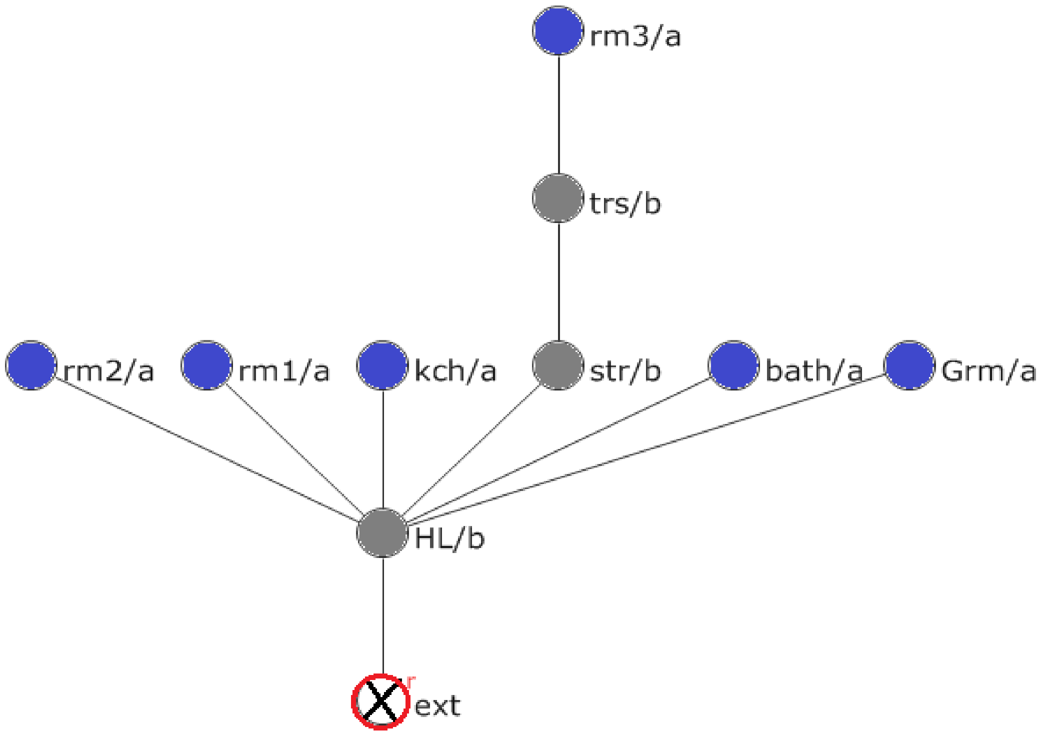


The j-graph of the house HC14

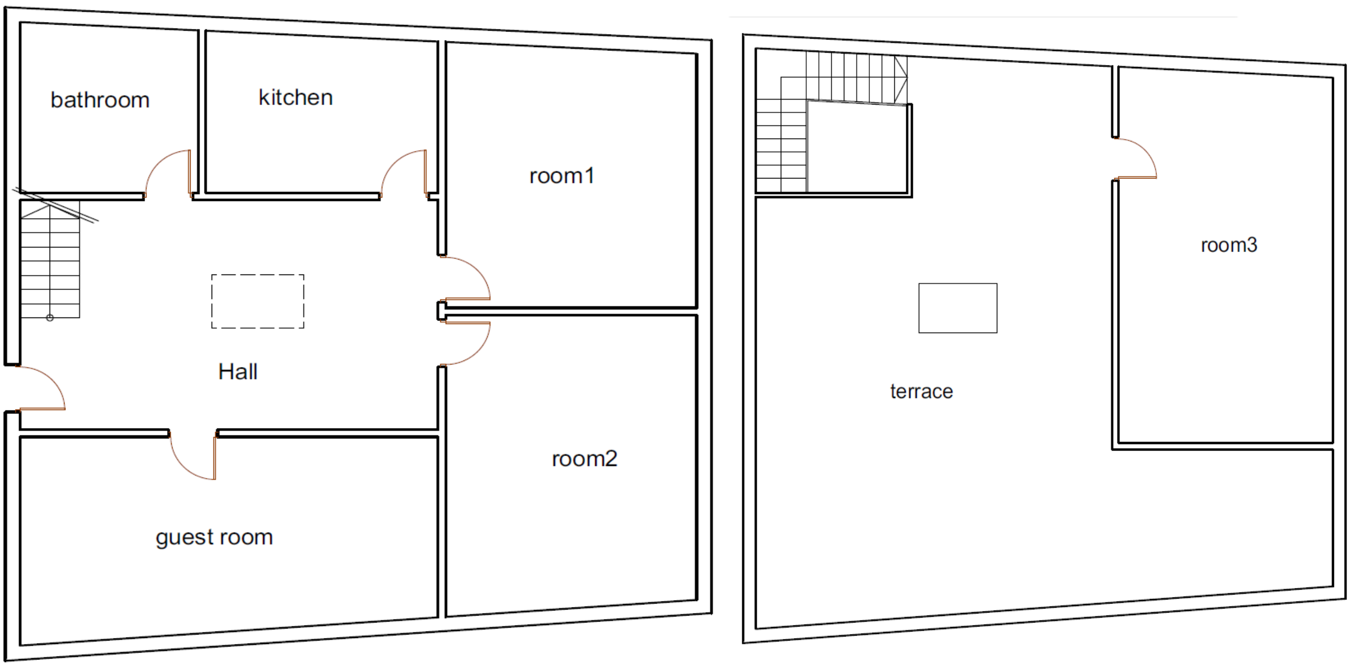


Plan of the house HC14

- **The colonial house HC15**



The j-graph of the house HC15

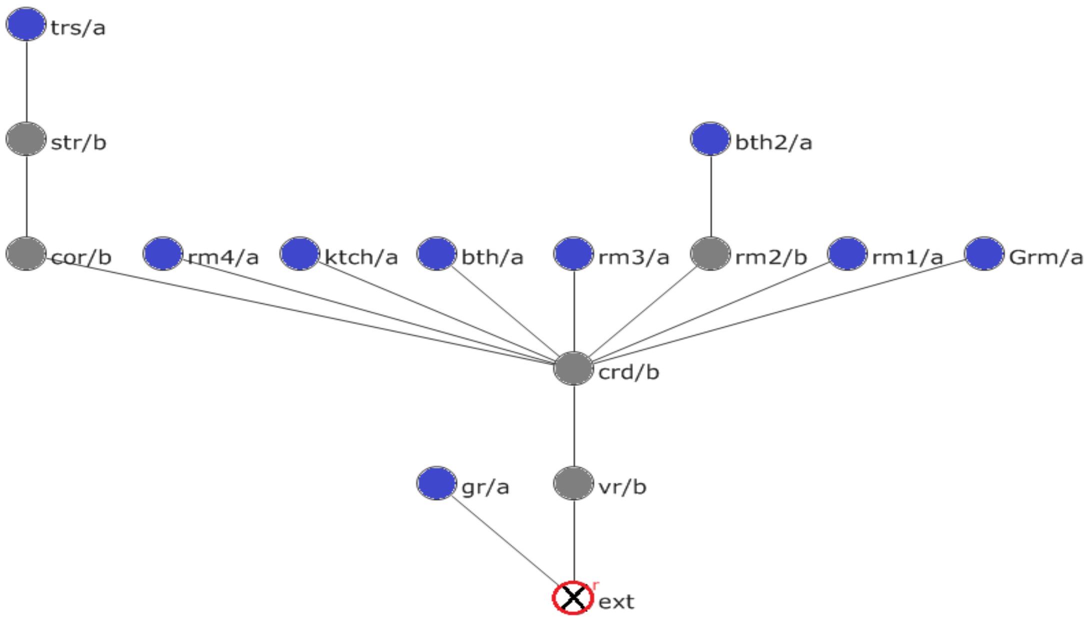


Ground floor First floor

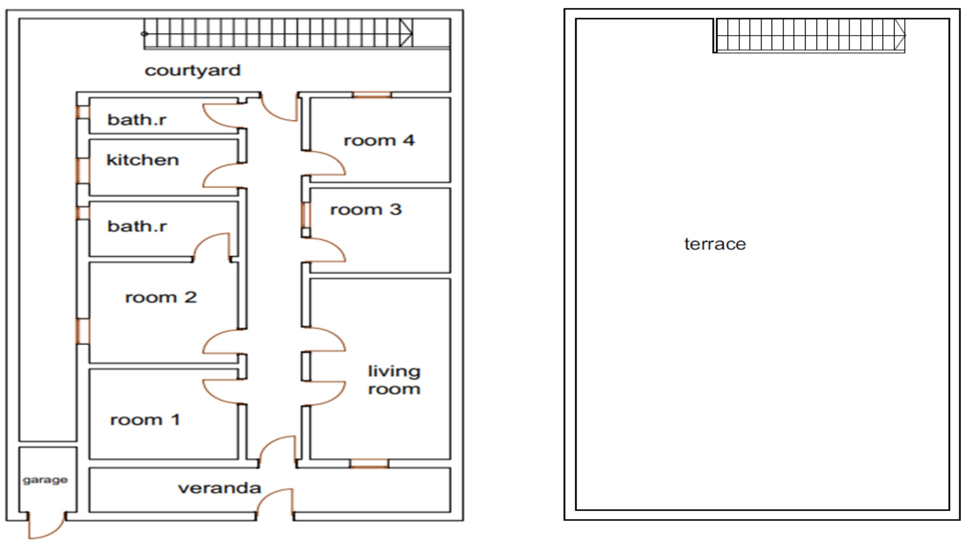
Plans of the house HC15

III- The independent period

- The house HI01



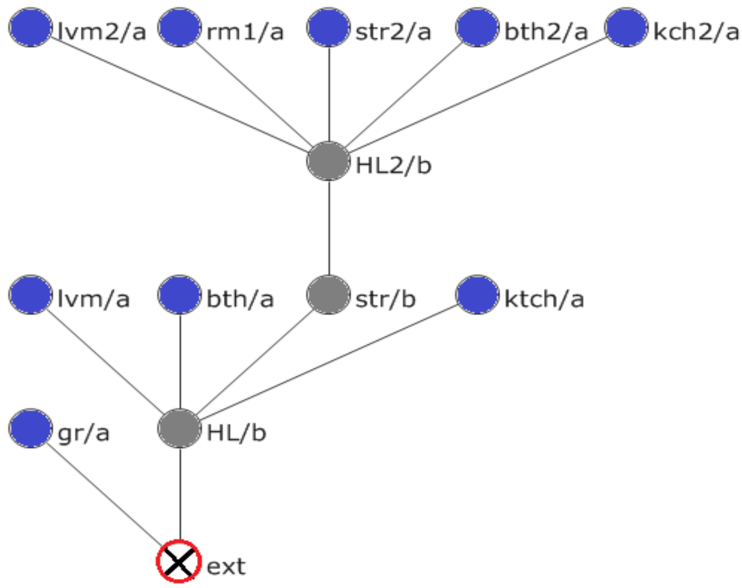
The j-graph of the house HI01



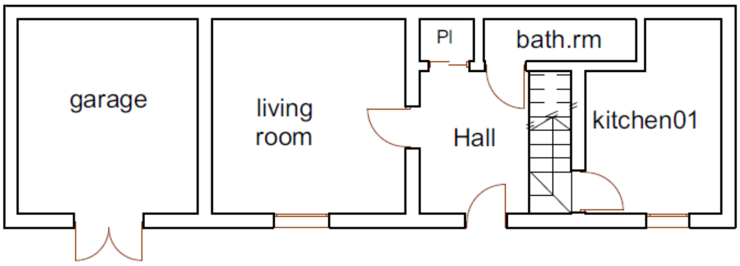
Ground floor First floor

Plans of the House HI01

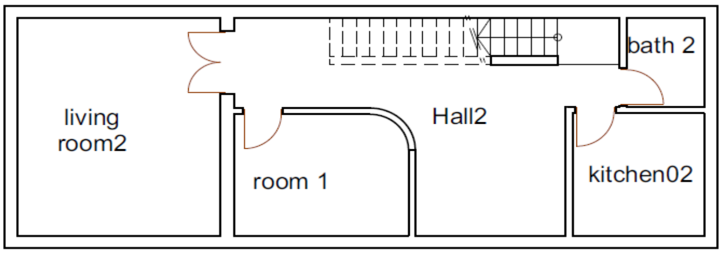
- **The house HI02**



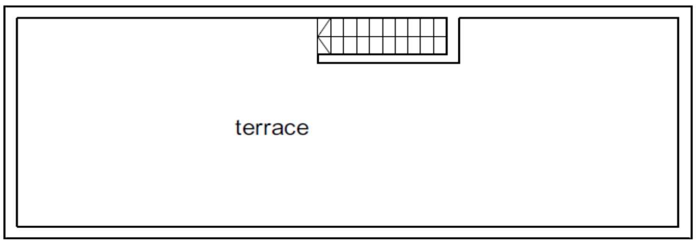
The j-graph of the house HI02



Ground floor



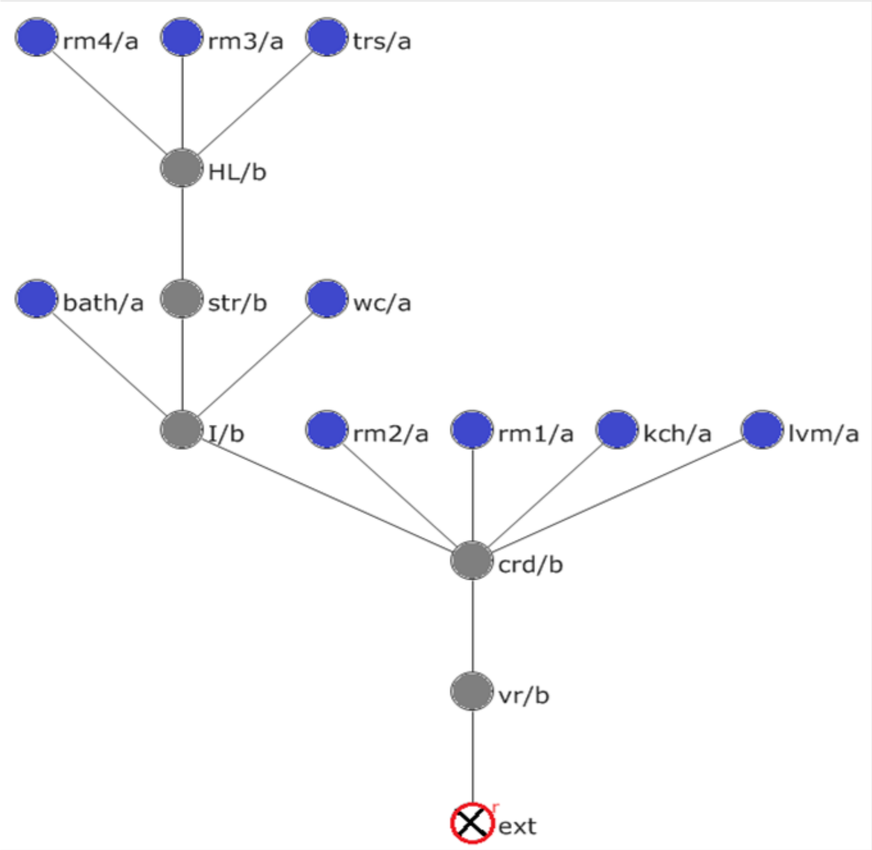
First floor



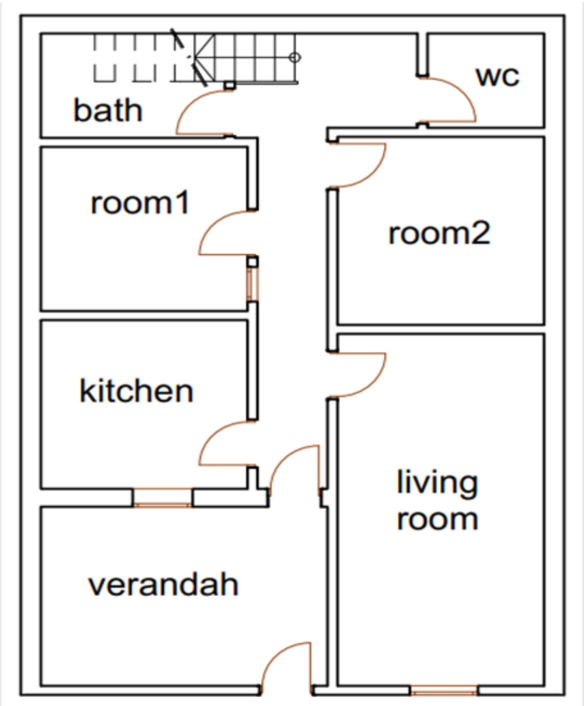
Second floor

Plans of the house HI02

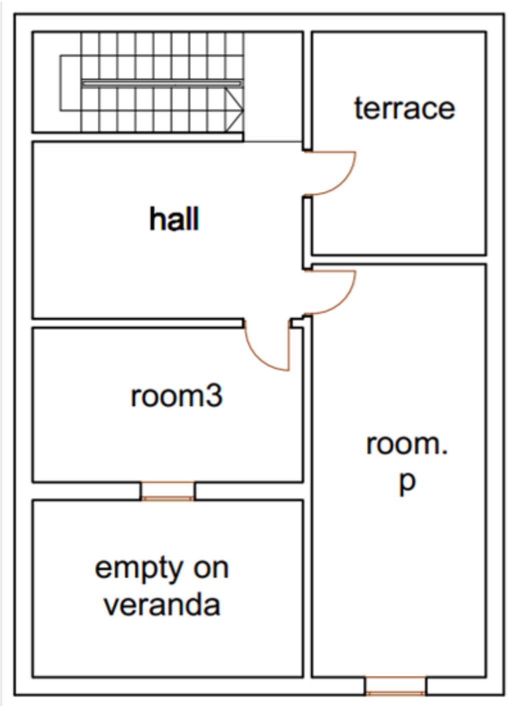
- **The house HI03**



The j-graph of the house HI03



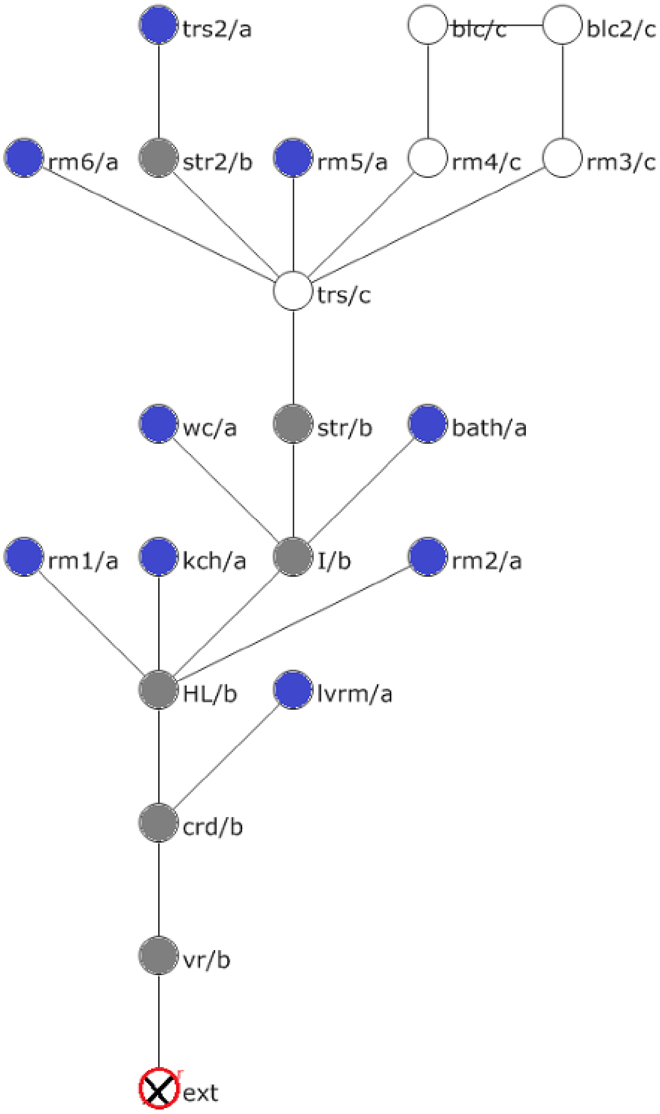
Ground floor



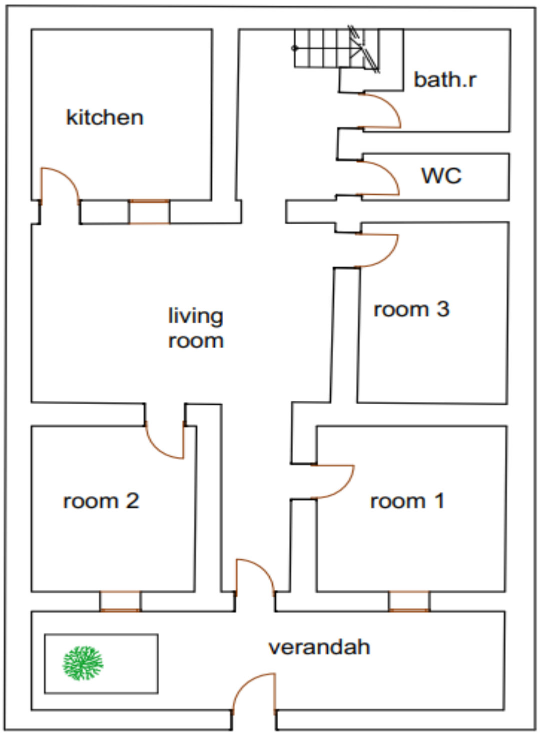
First floor

Plans of the house HI03

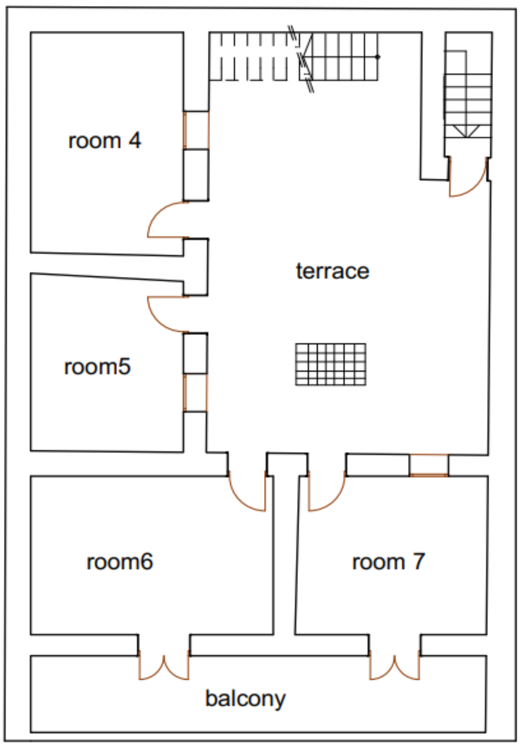
- **The house HI04**



The j-graph of the house HI04



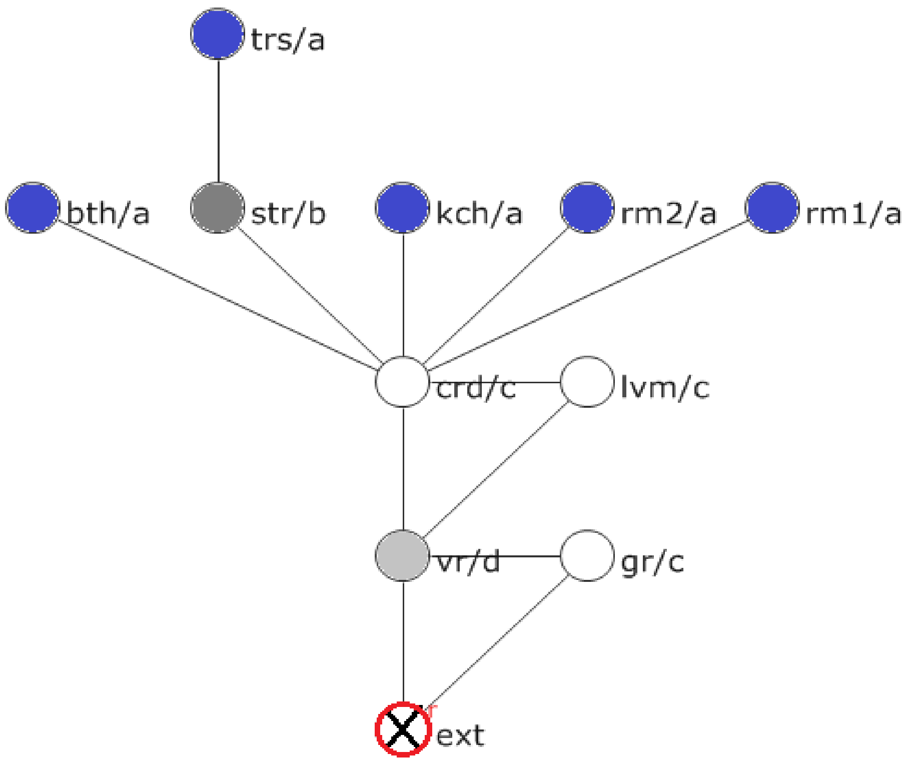
Ground floor



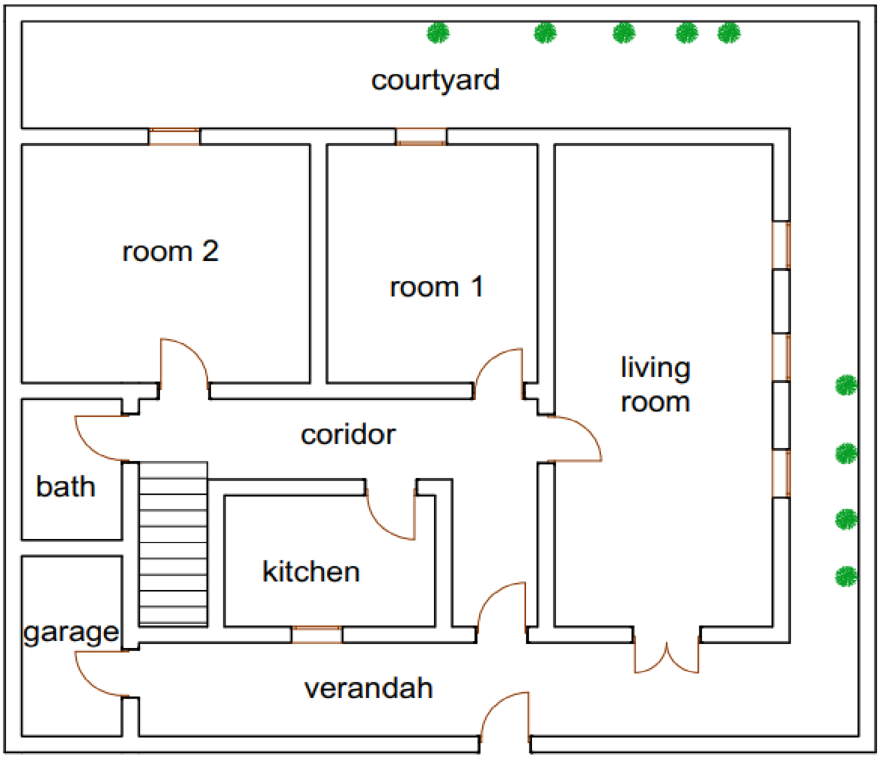
First floor

Plans of the house HI04

- **The house HI05**

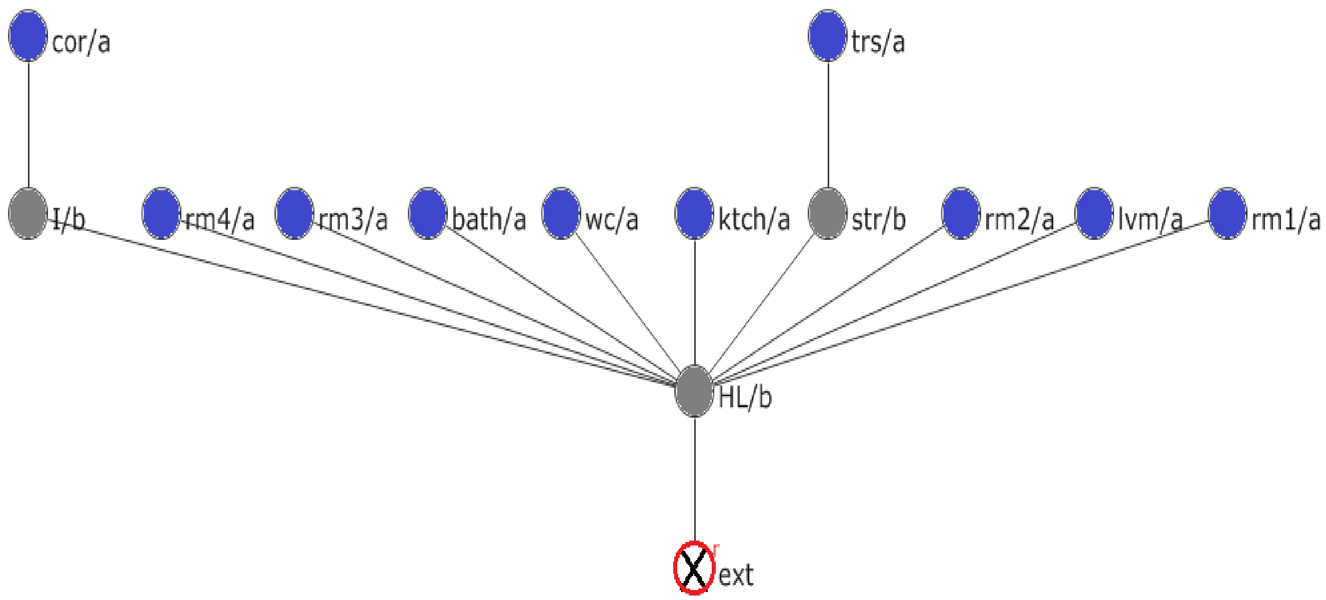


The j-graph of the house HI05

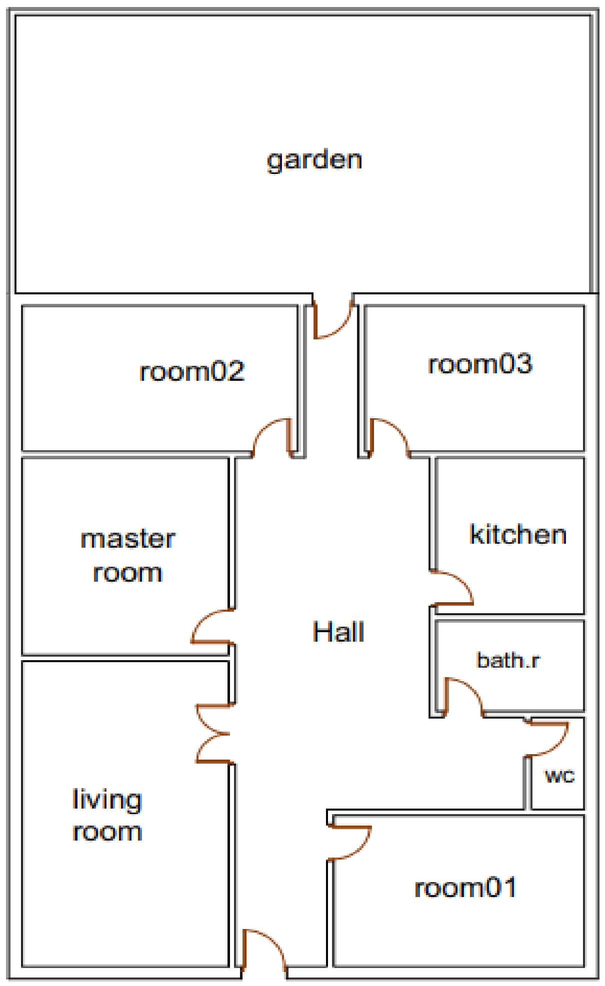


Plan of the house HI05

- **The house HI06**

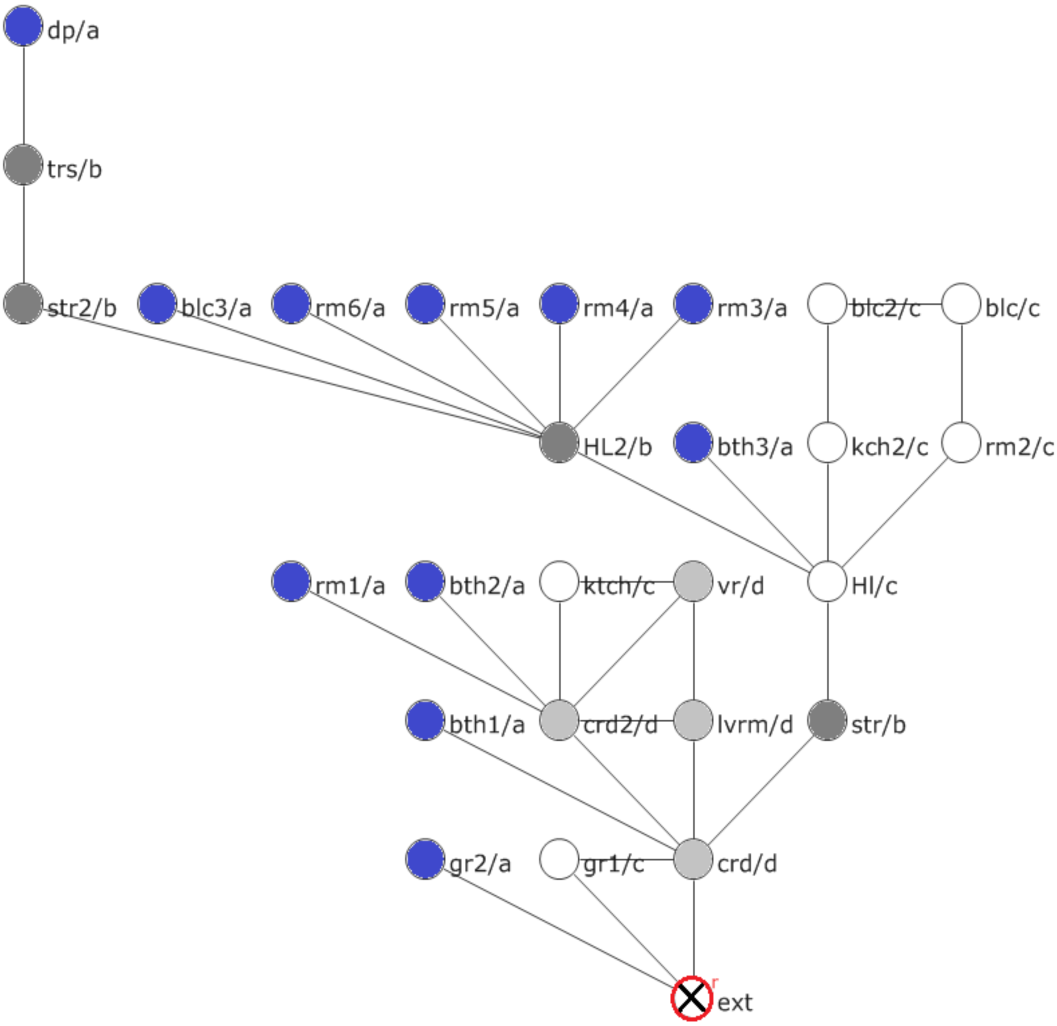


The j-graph of the house HI06

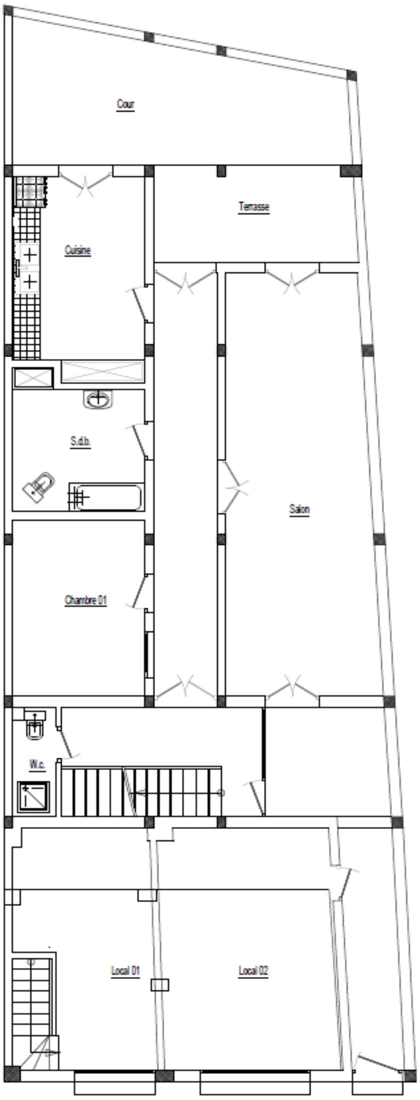


Plan of the house HI06

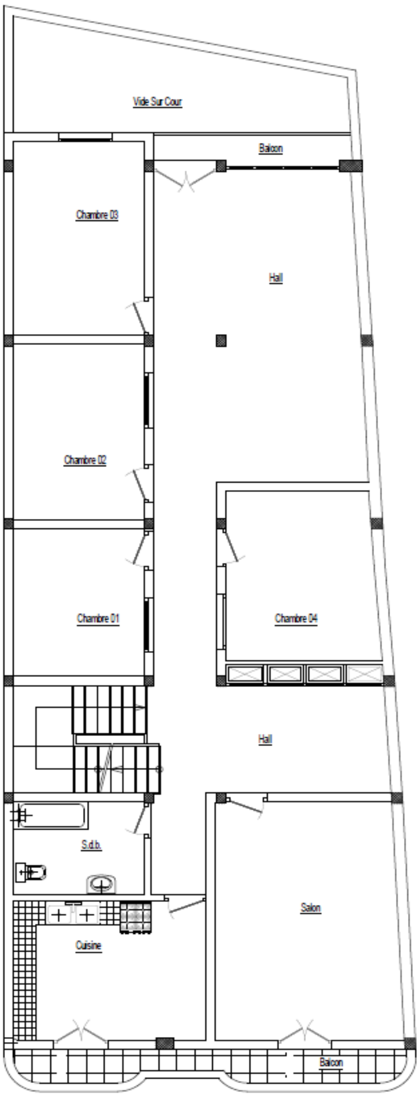
- **The house HI07**



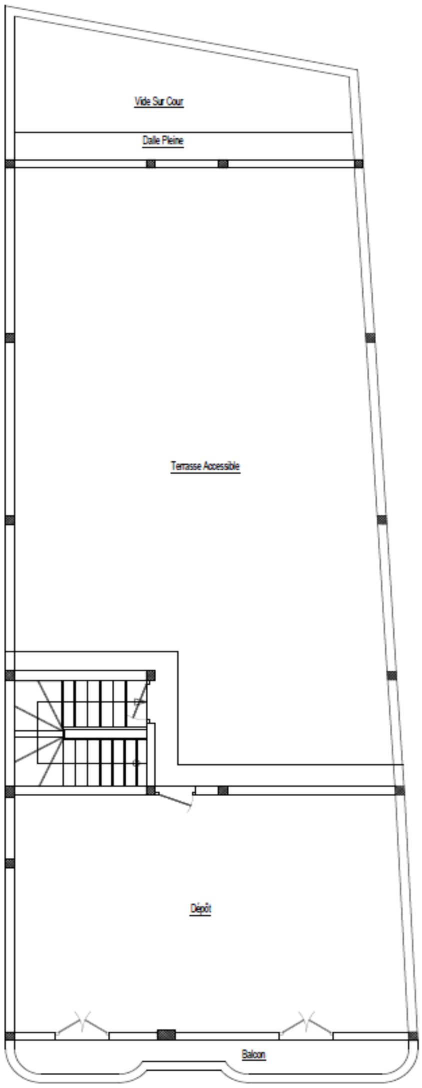
The j-graph of the house HI07



Ground floor



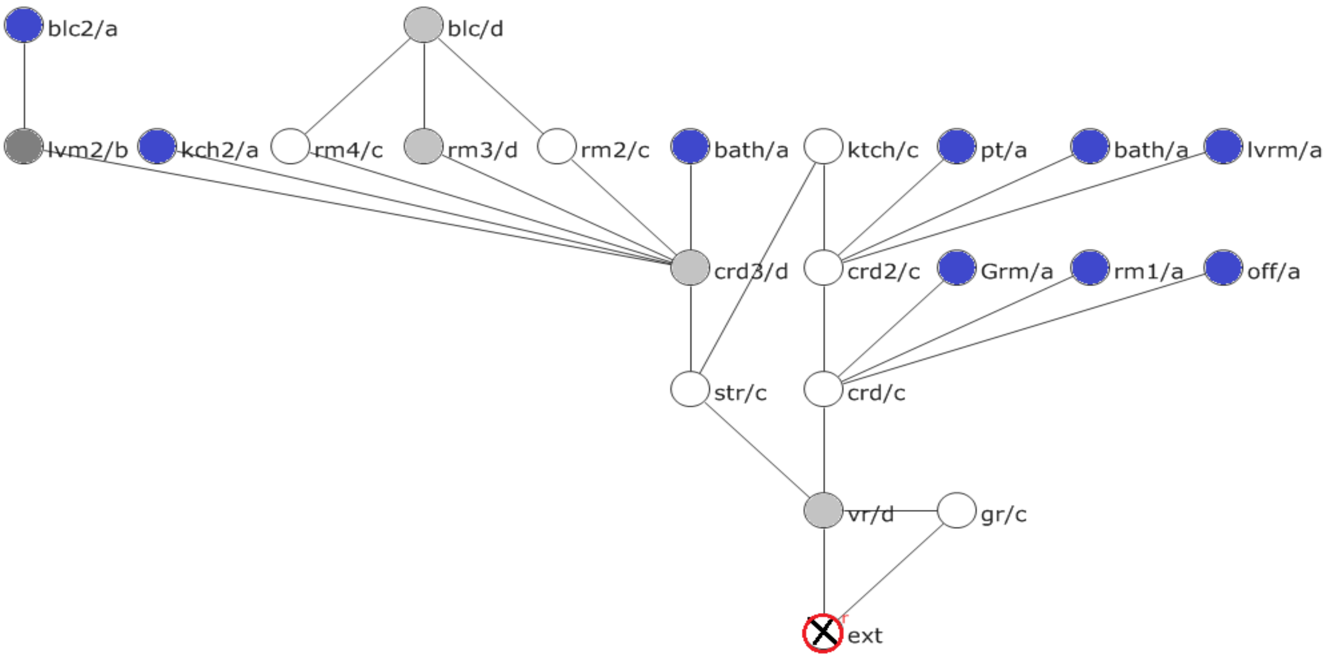
First floor



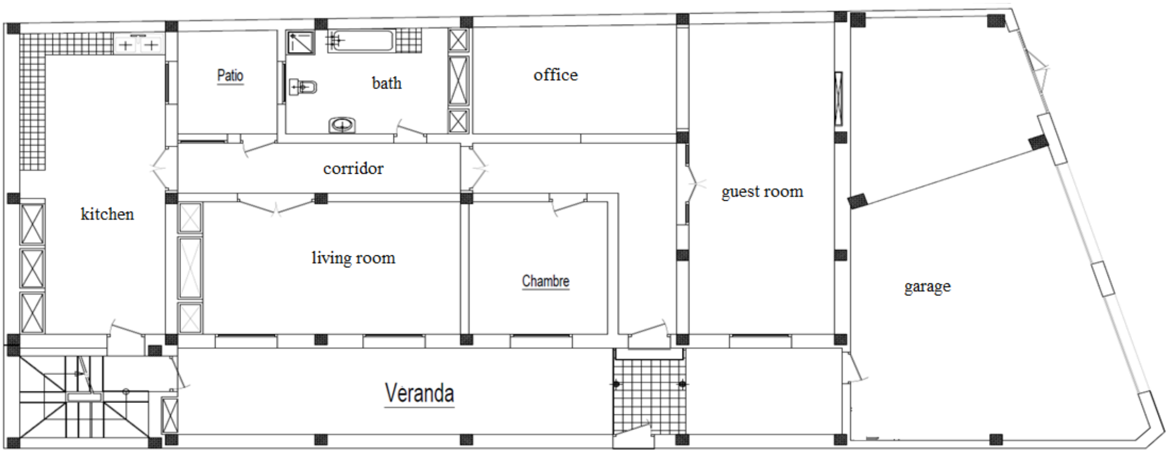
Second floor

Plans of the house HI07

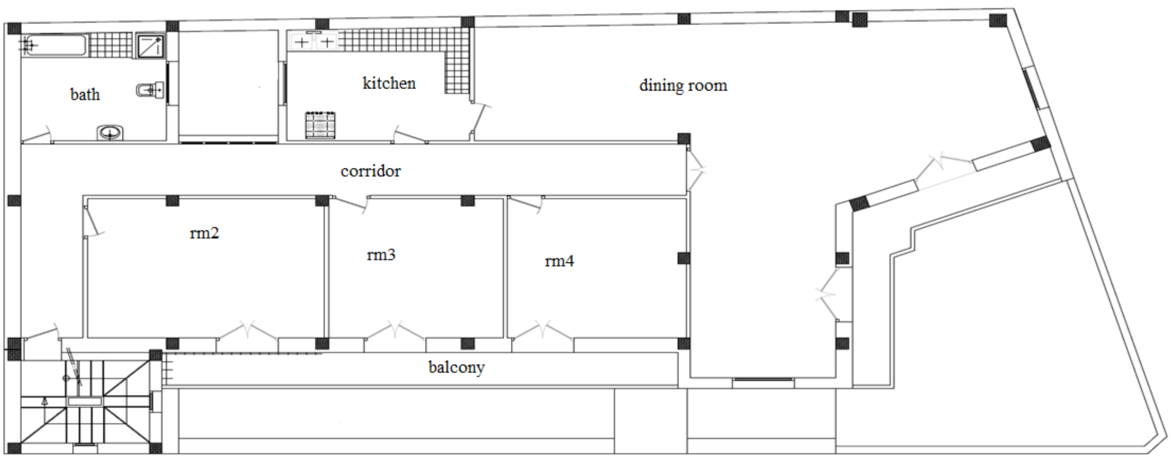
- The house HI08



The j-graph of the house HI08



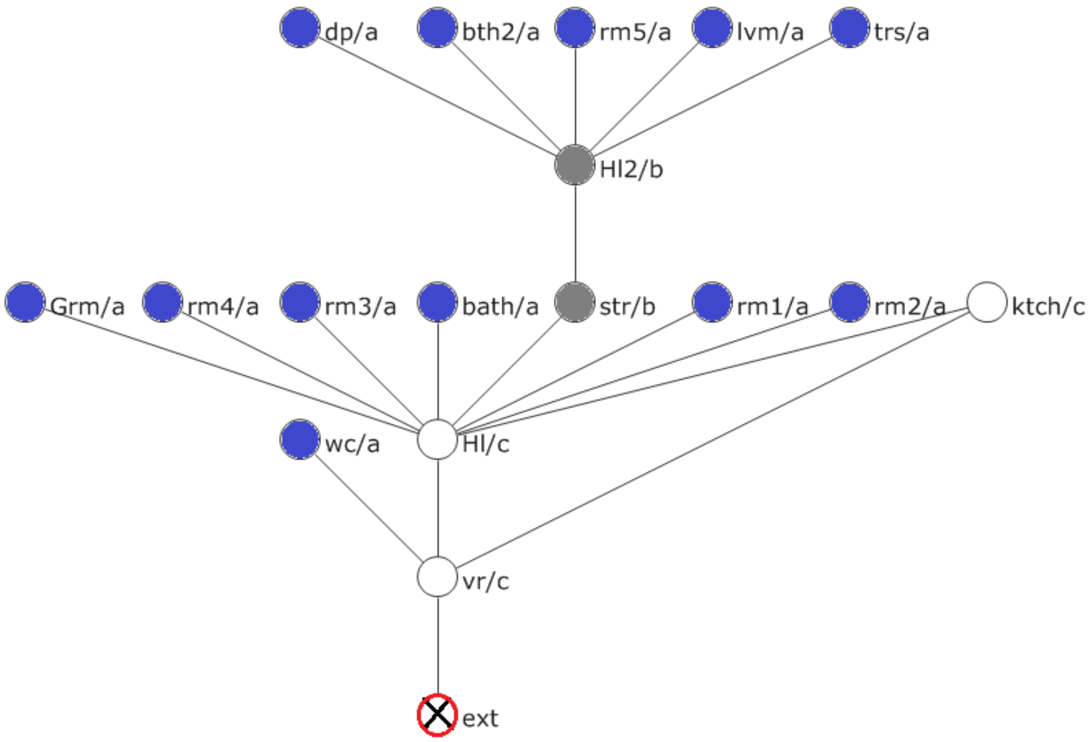
Ground floor



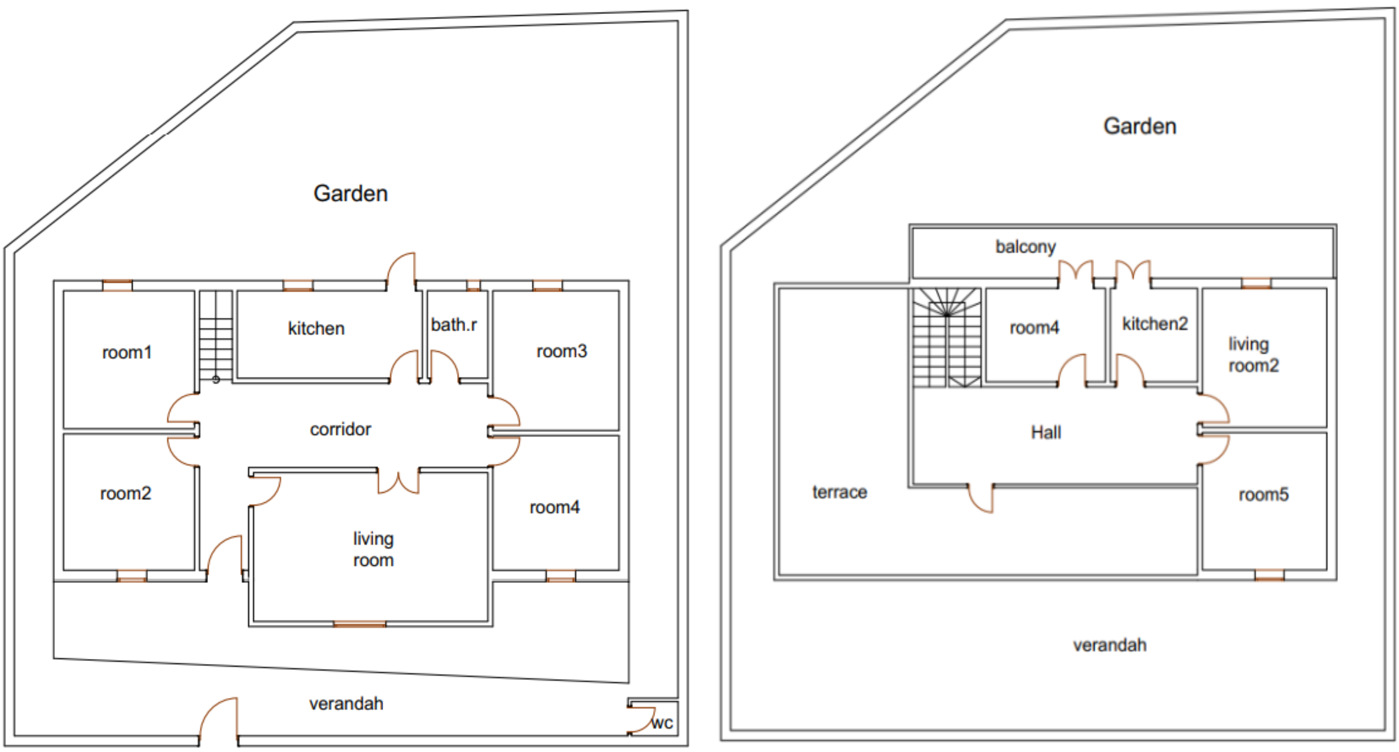
First floor

Plans of the house HI08

- **The house HI09**



The j-graph of the house HI09

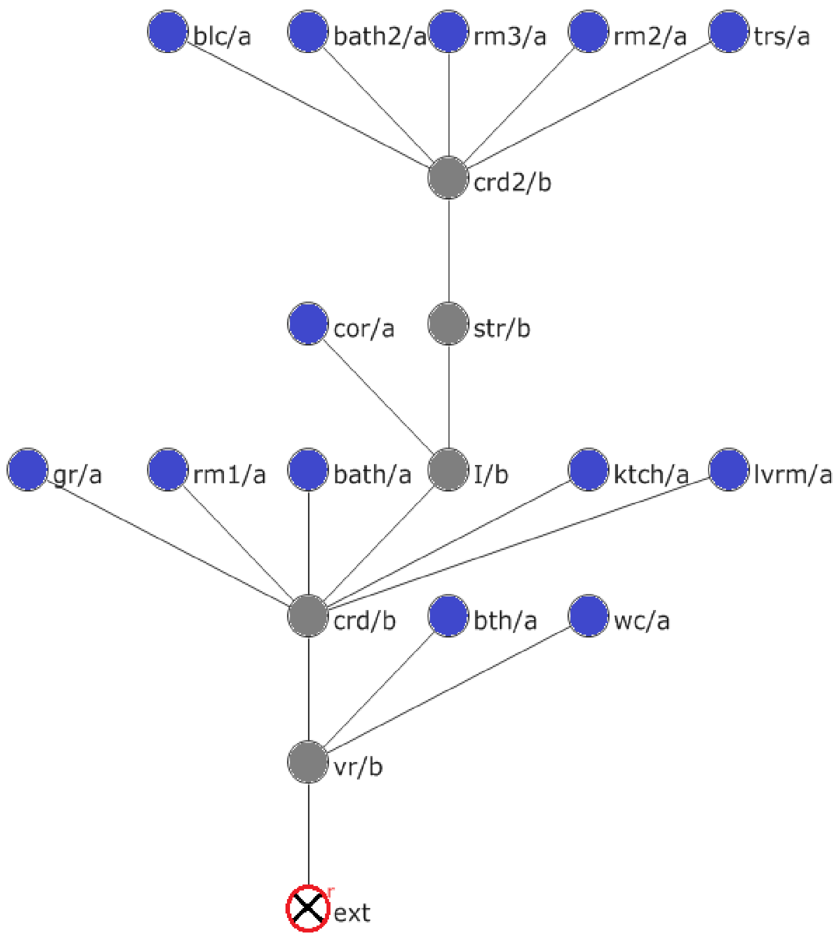


Ground floor

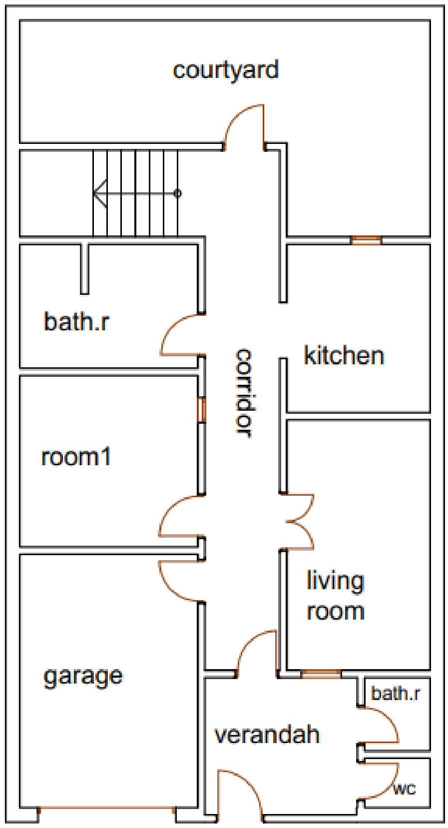
First floor

Plans of the house HI09

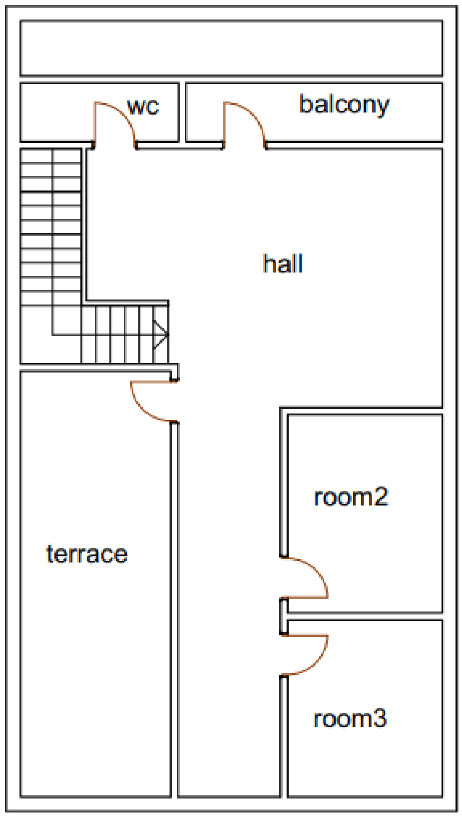
- The house HI10



The j-graph of the house HI10



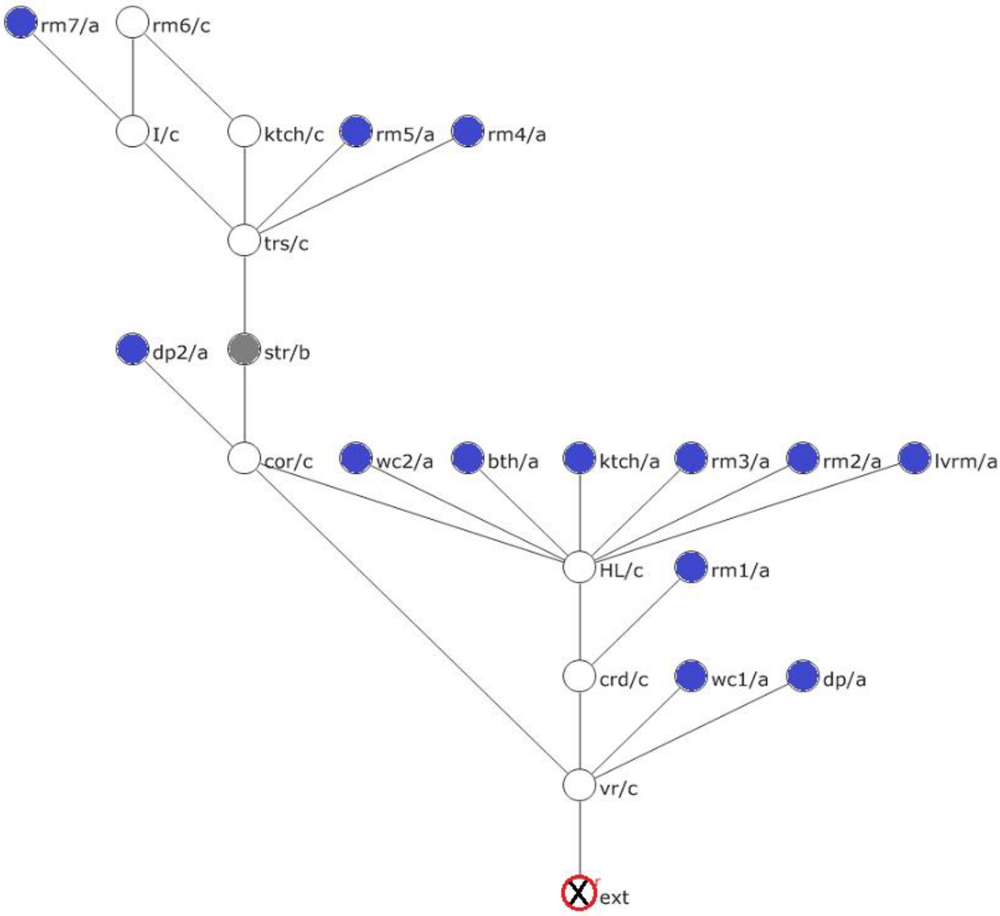
Ground floor



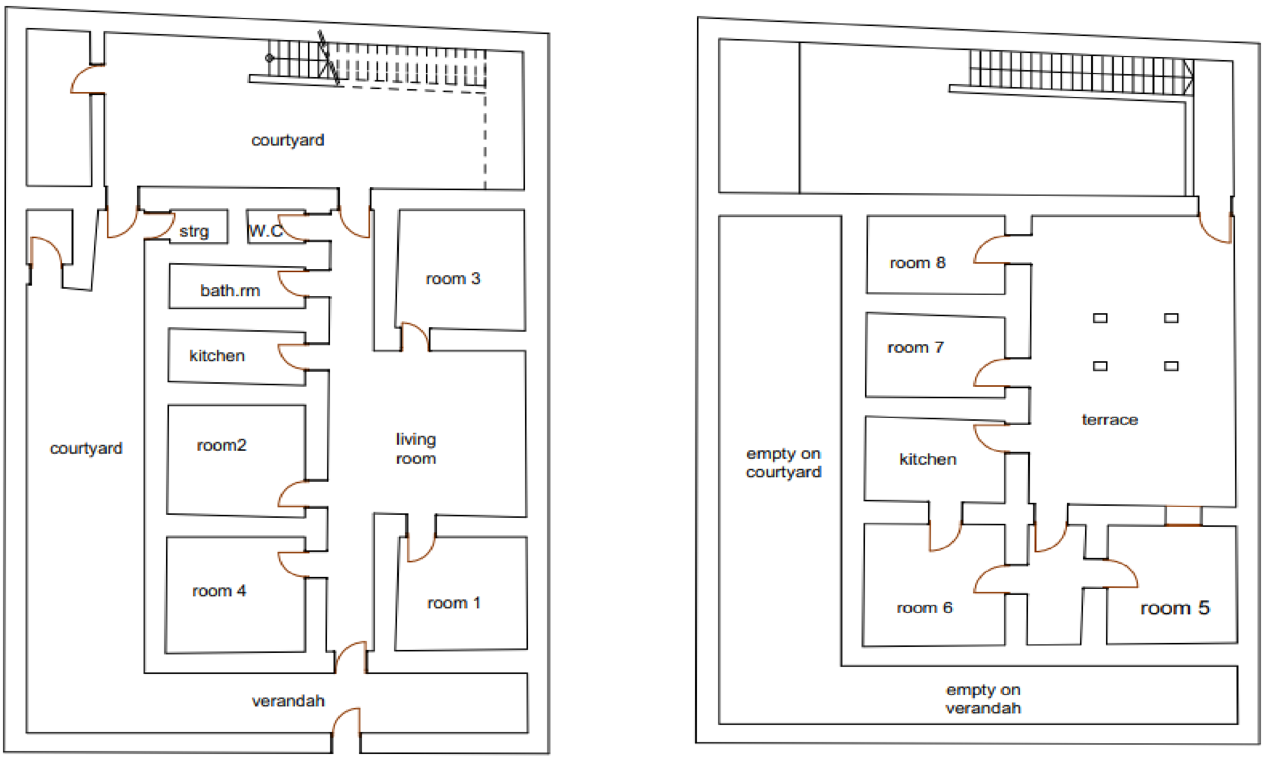
First floor

Plans of the house HI10

- The house HI11



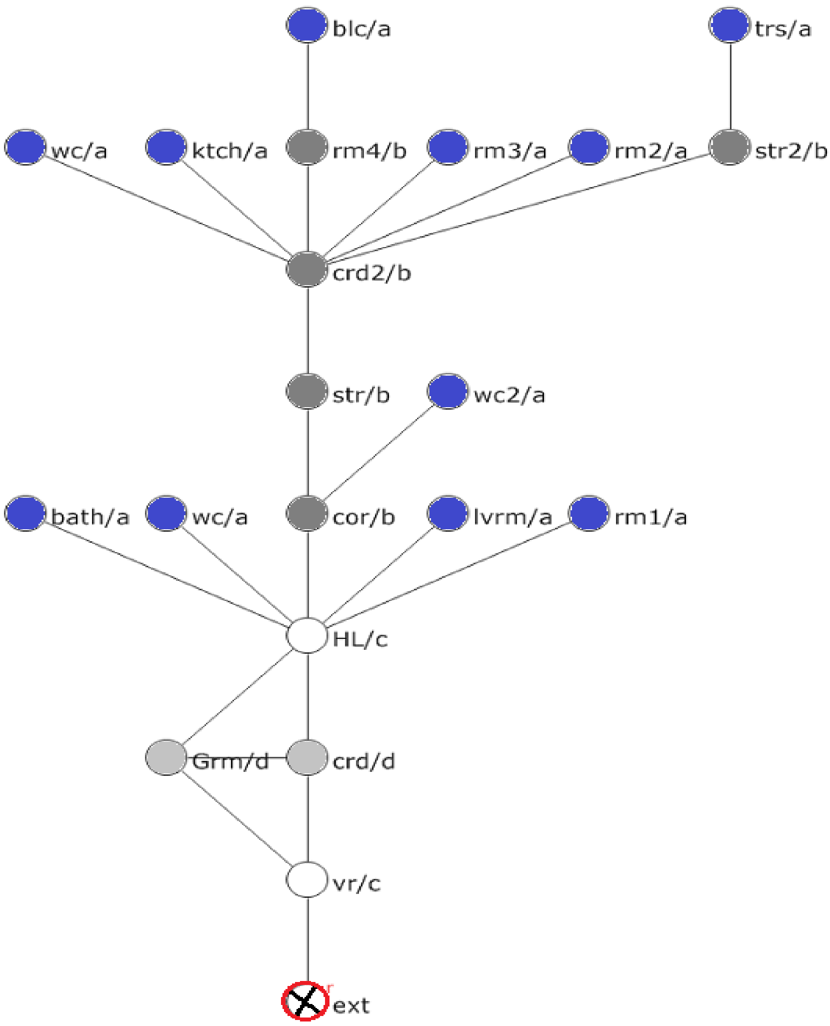
The j-graph of the house HI11



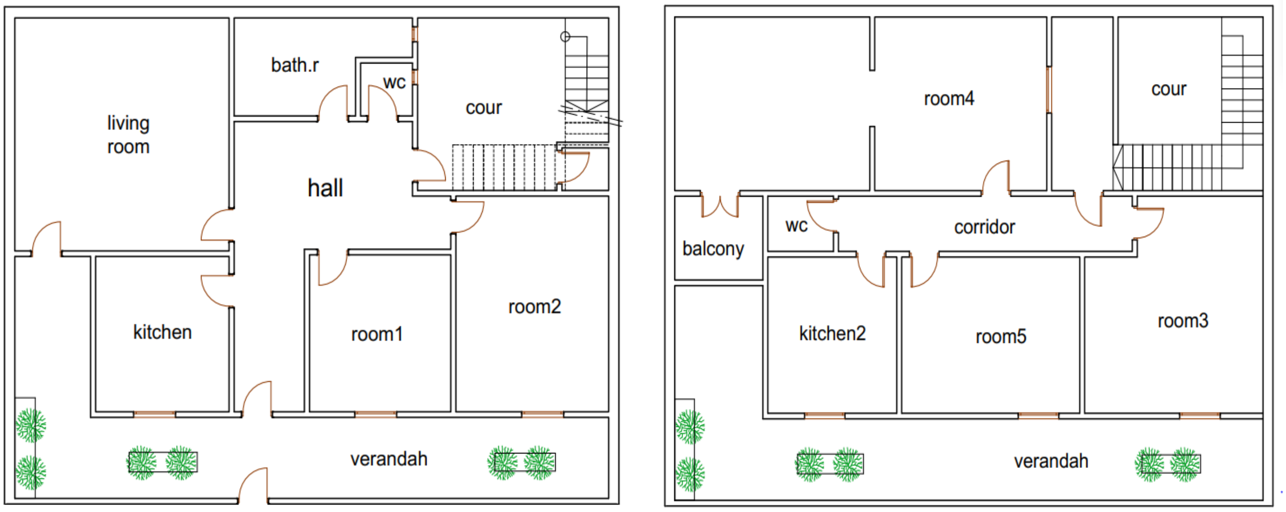
Ground floor First floor

Plans of the house HI11

- **The house HI12**



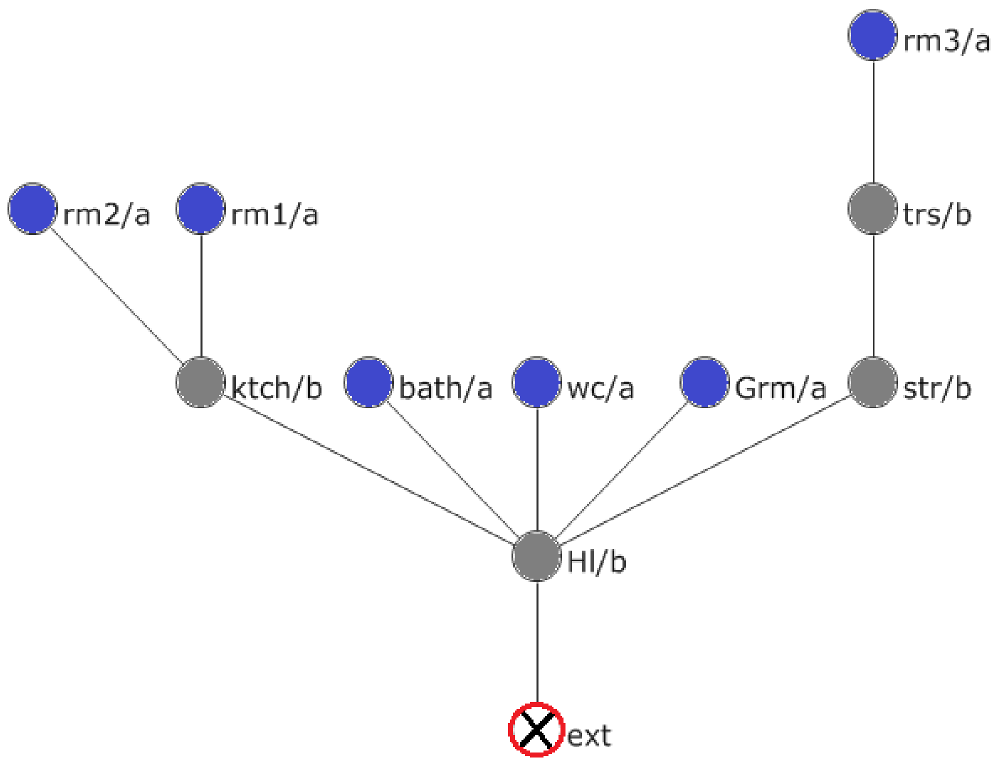
The j-graph of the house HI12



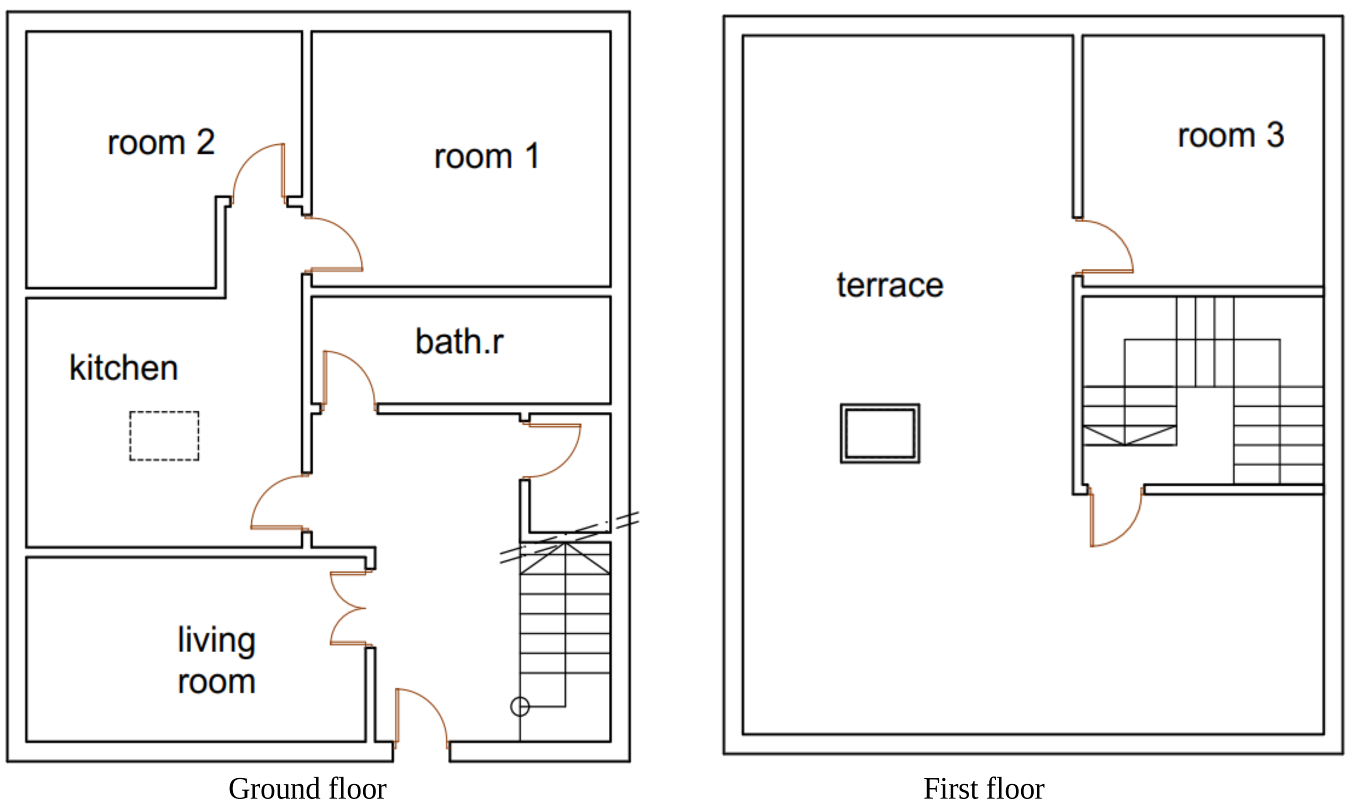
Ground floor First floor

Plans of the house HI12

- The house HI13

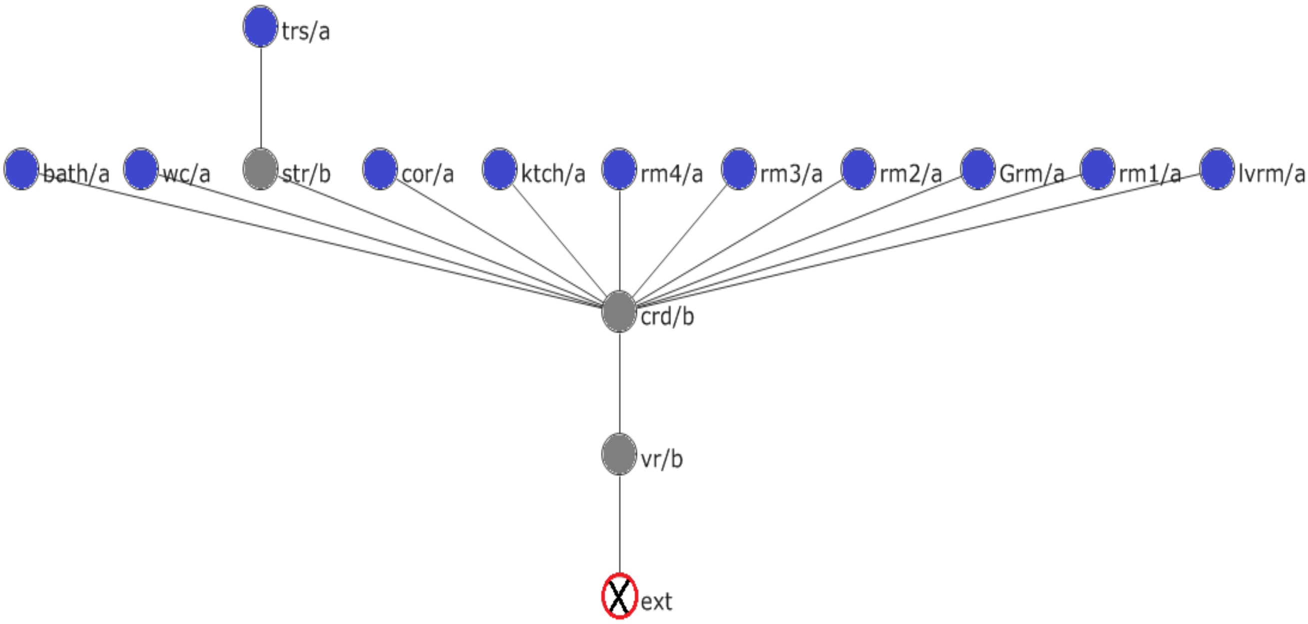


The j-graph of the house HI13

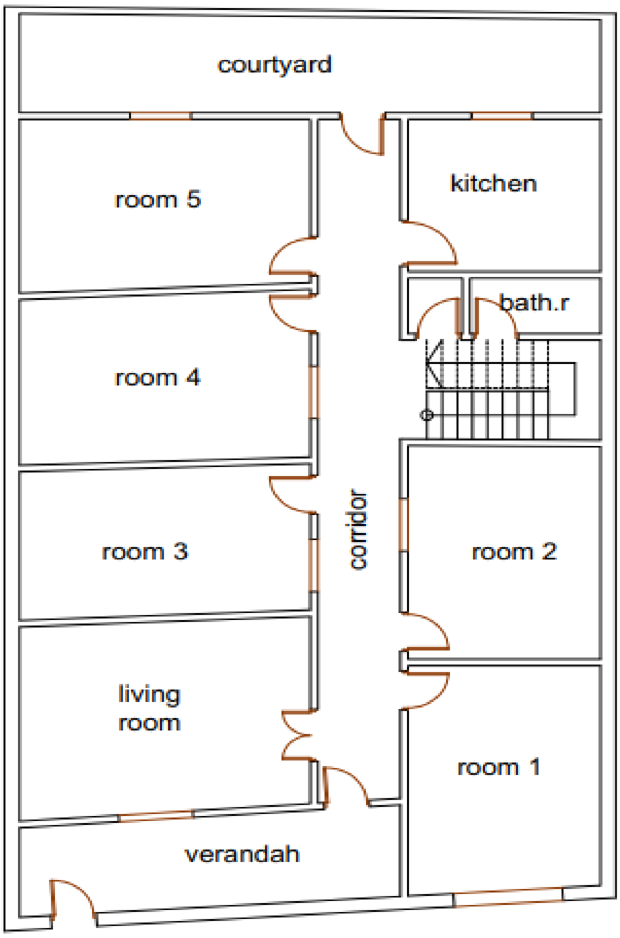


Plans of the house HI13

- The house HI14

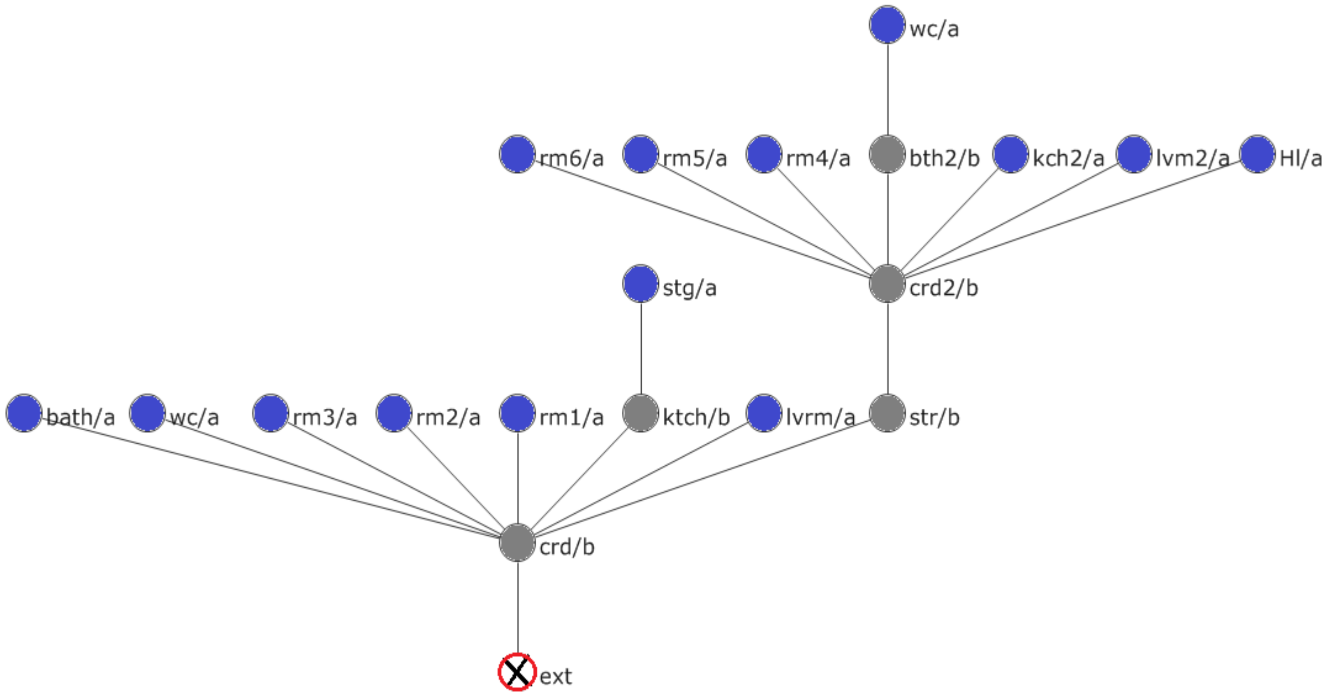


The j-graph of the house HI14

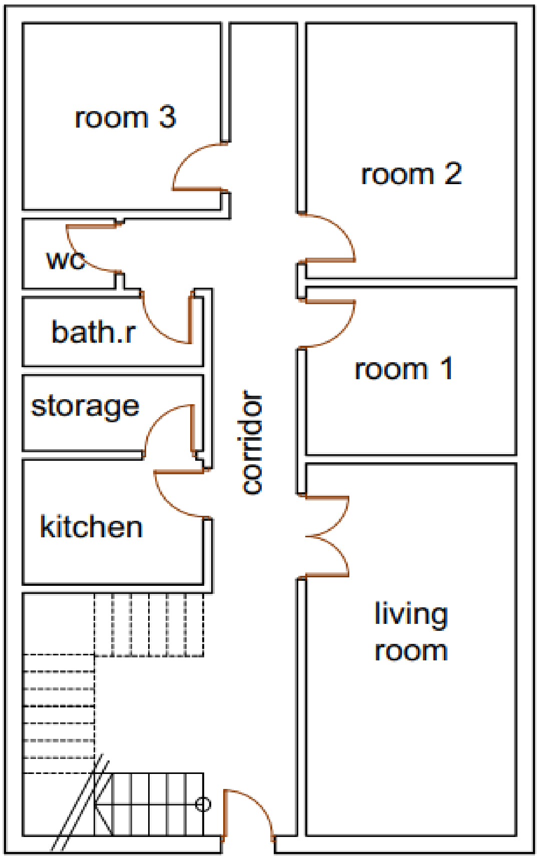


Plan of the house HI14

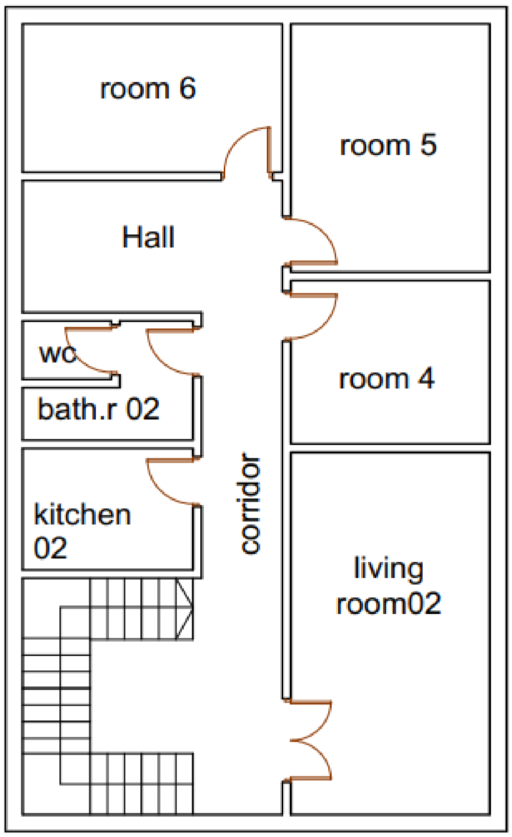
- The house HI15



The j-graph of the house HI15



Ground floor

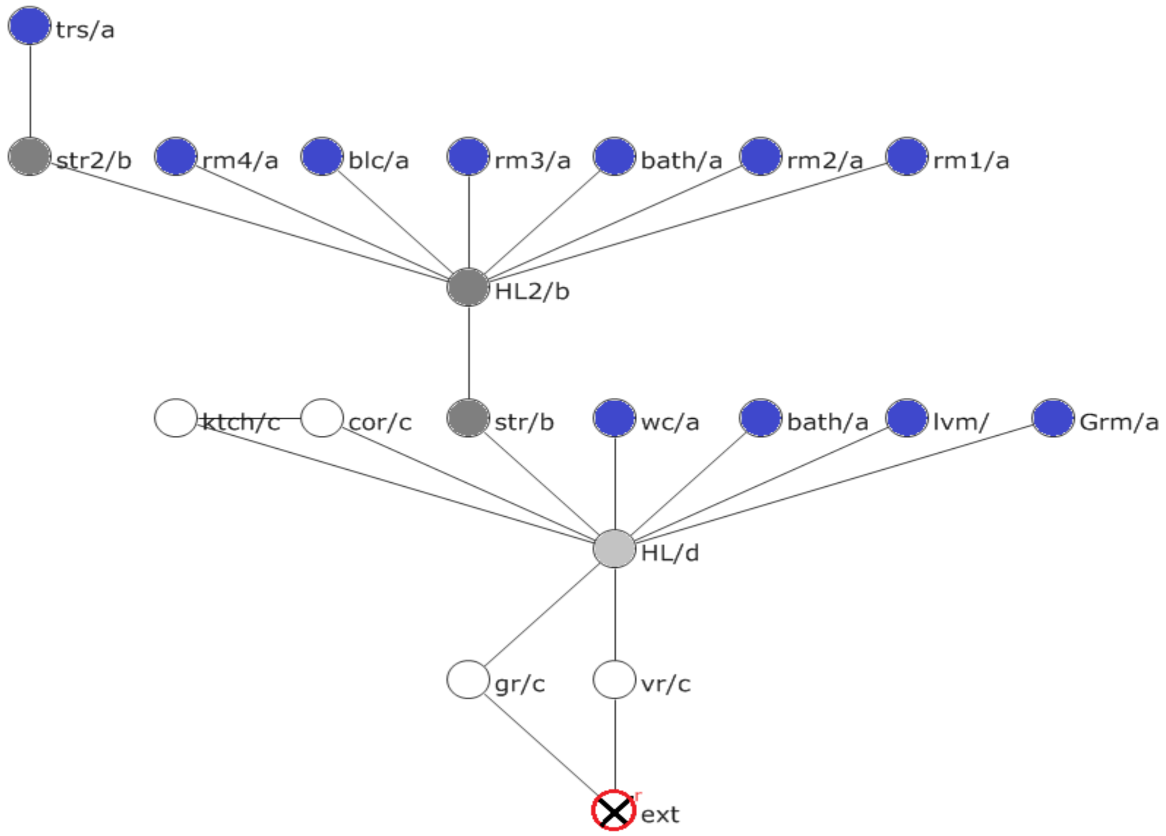


First floor

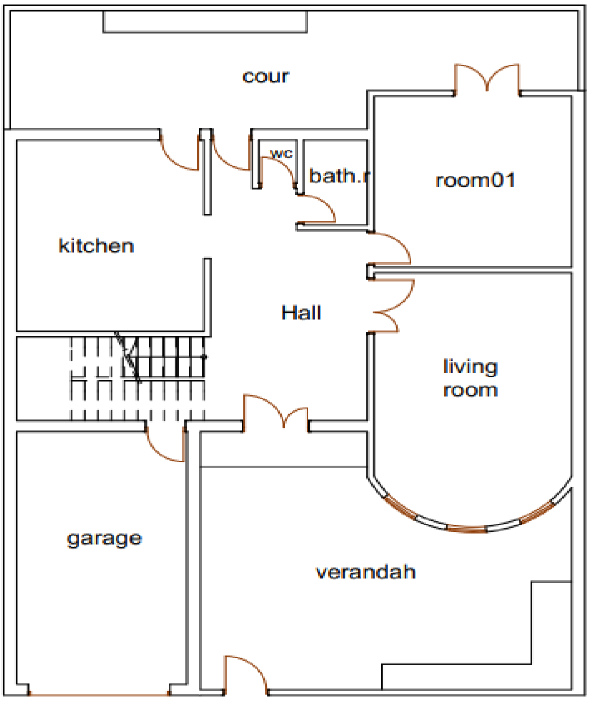
Plans of the house HI15

IV- the contemporary period

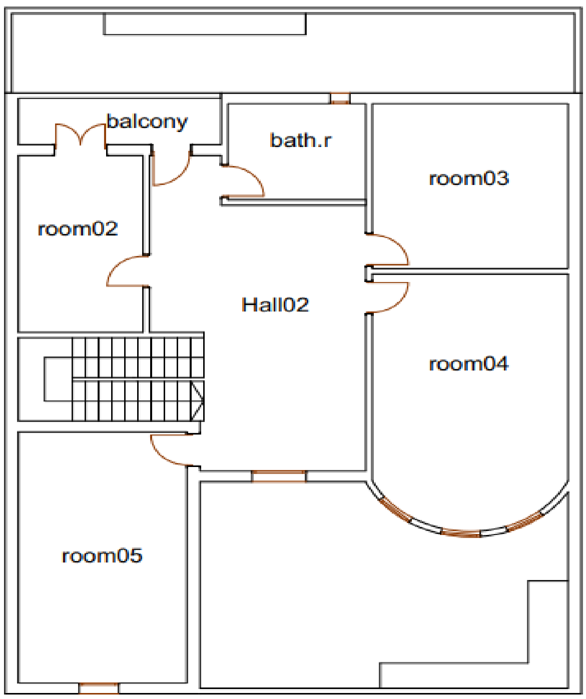
- The contemporary house HP01



The j-graph of the house HP01



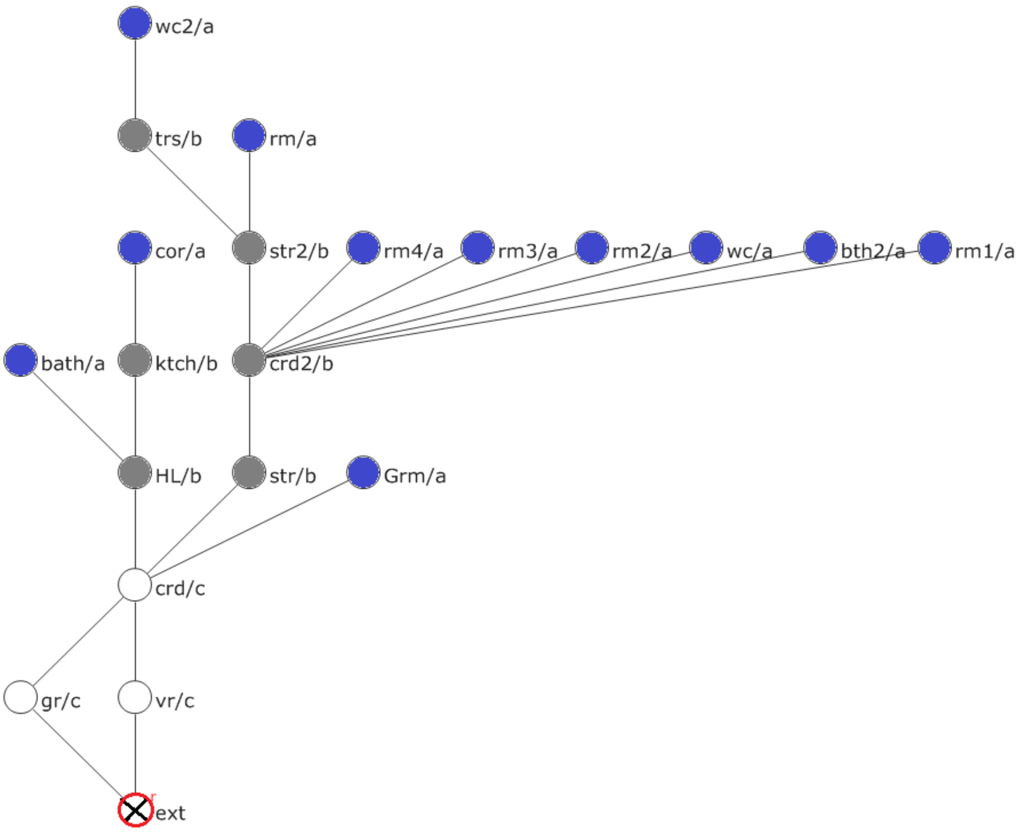
Ground floor



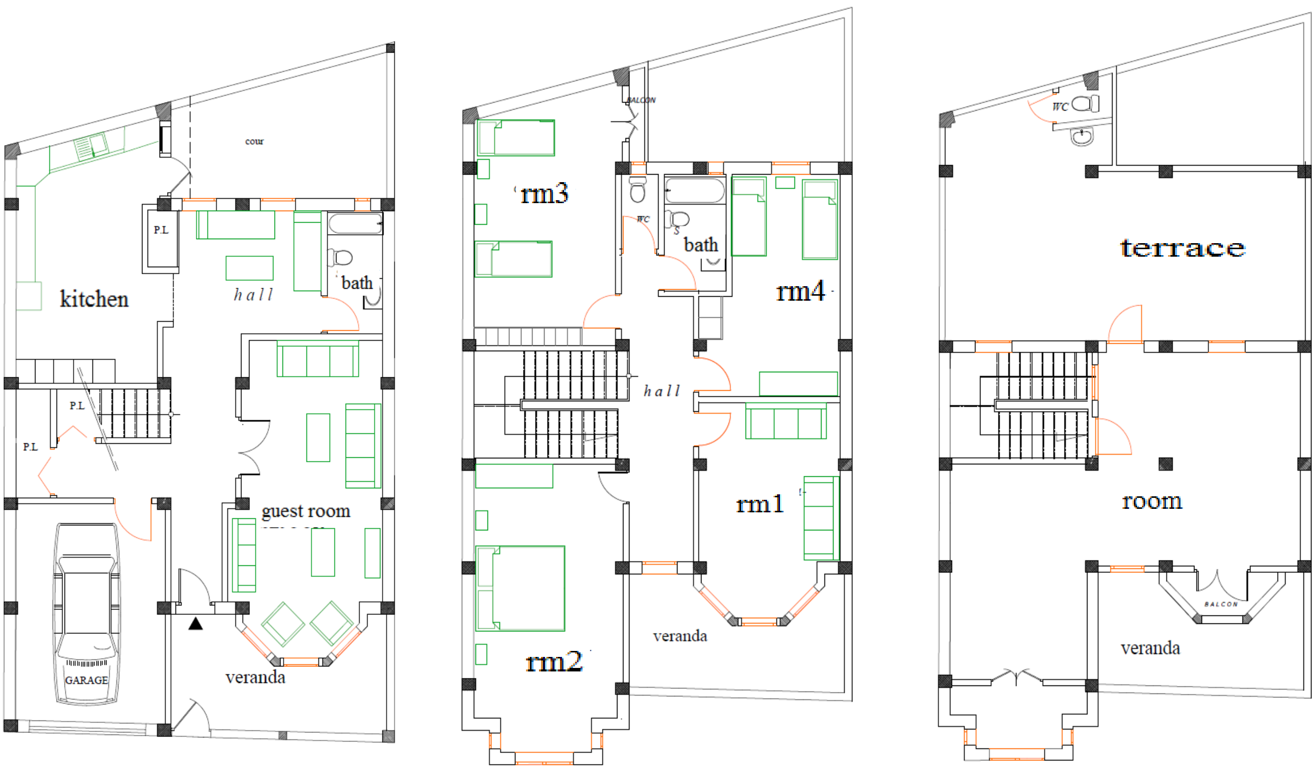
First floor

Plans of the house HP01

- **The contemporary house HP02**



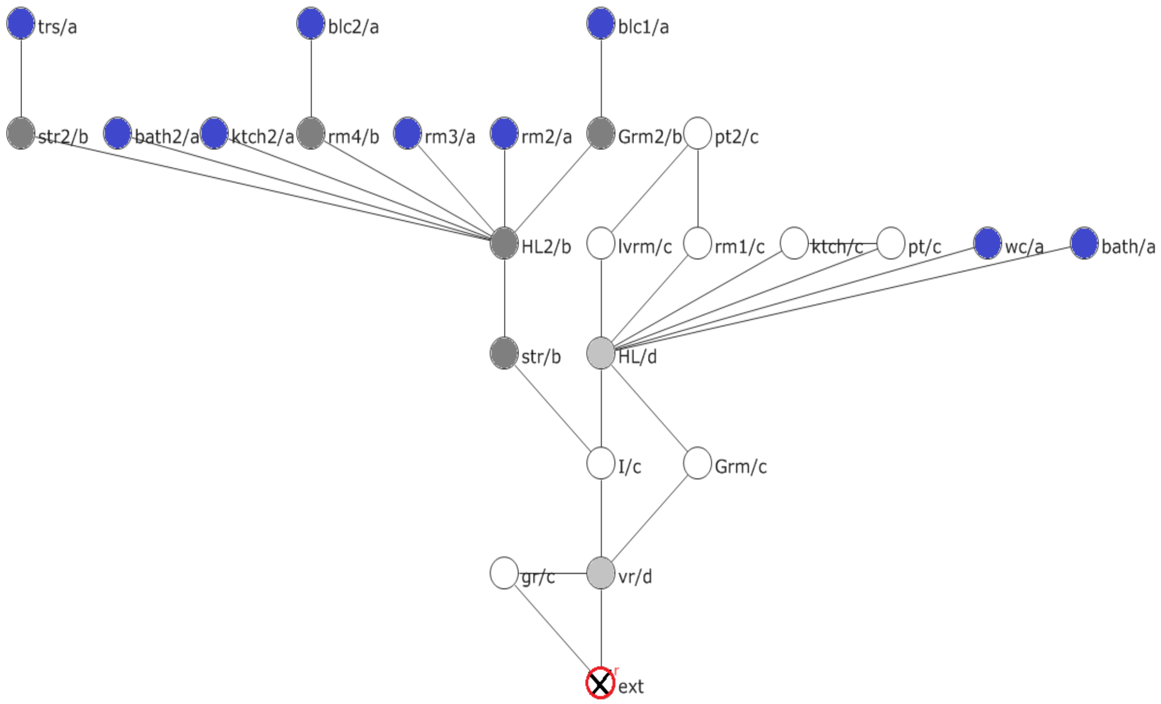
The j-graph of the house HP02



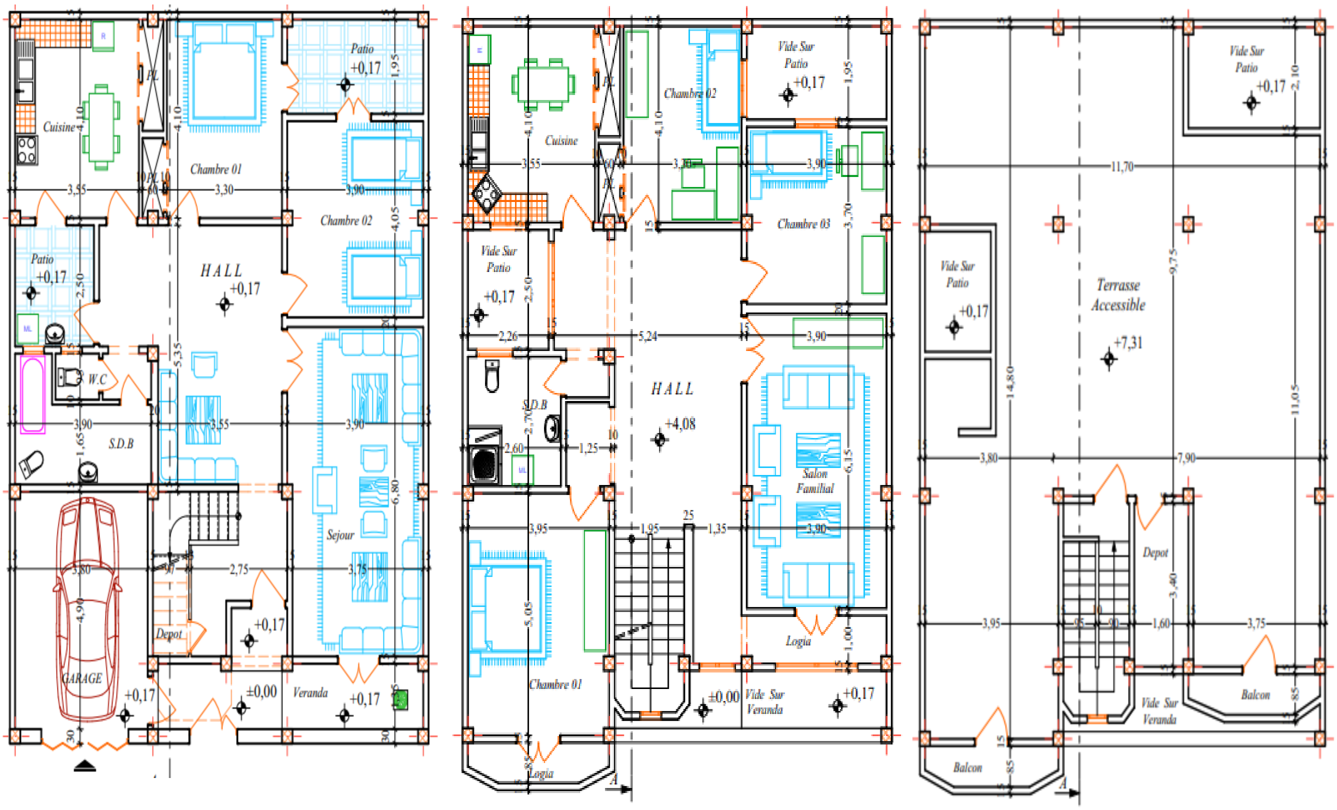
Ground floor First floor Second floor

Plans of the house HP02

- **The contemporary house HP03**



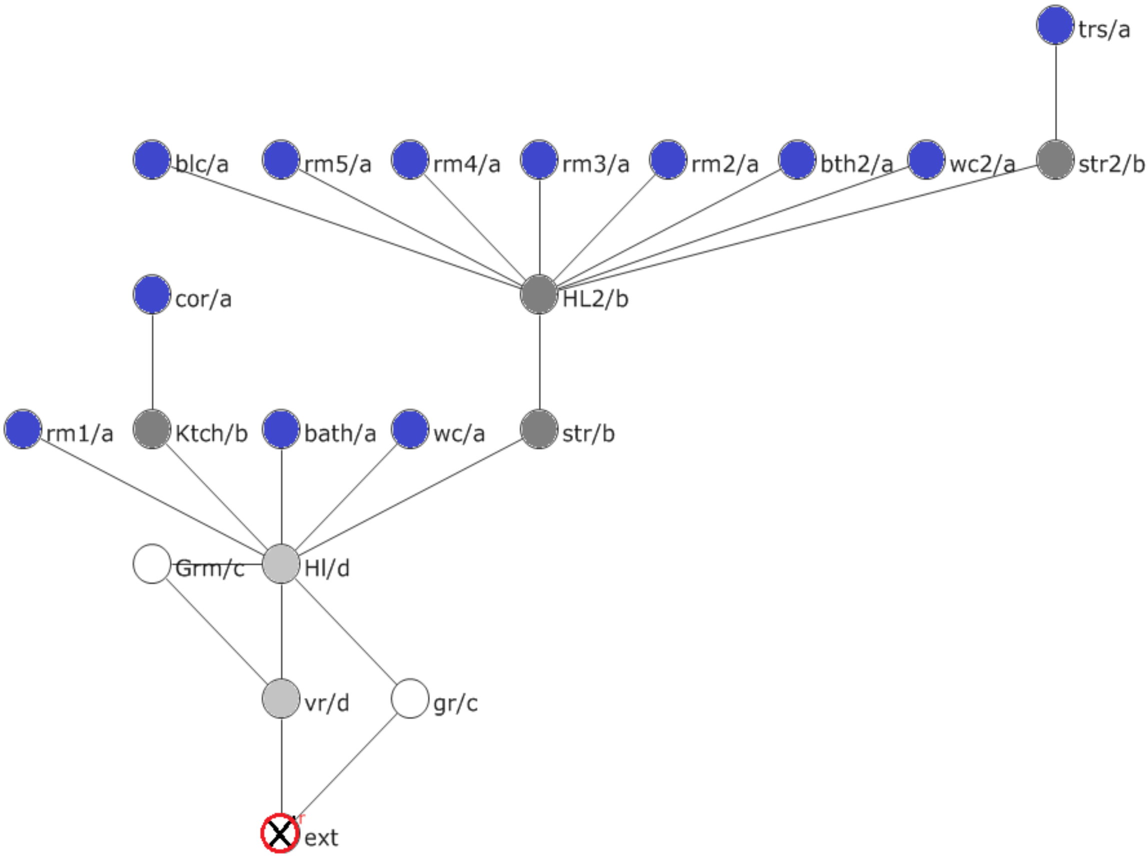
The j-graph of the house HP03



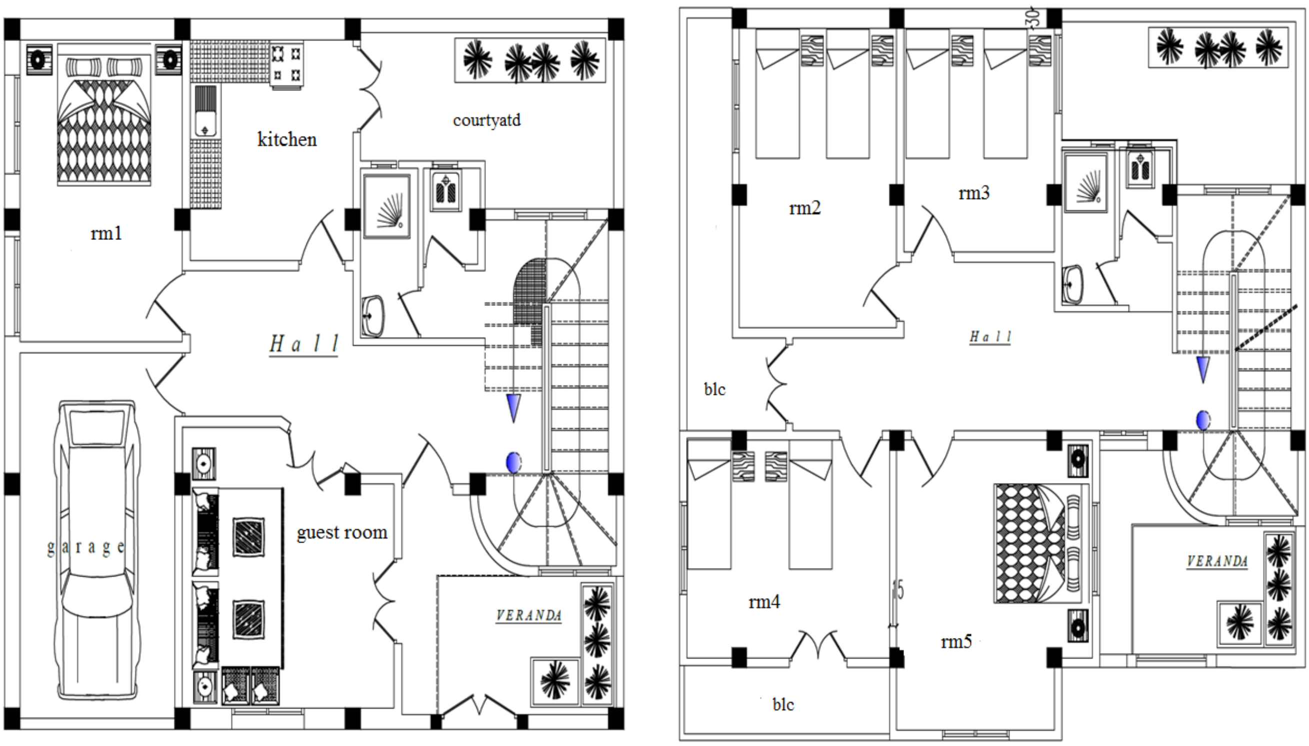
Ground floor First floor Second floor

Plans of the house HP03

- **The contemporary house HP04**



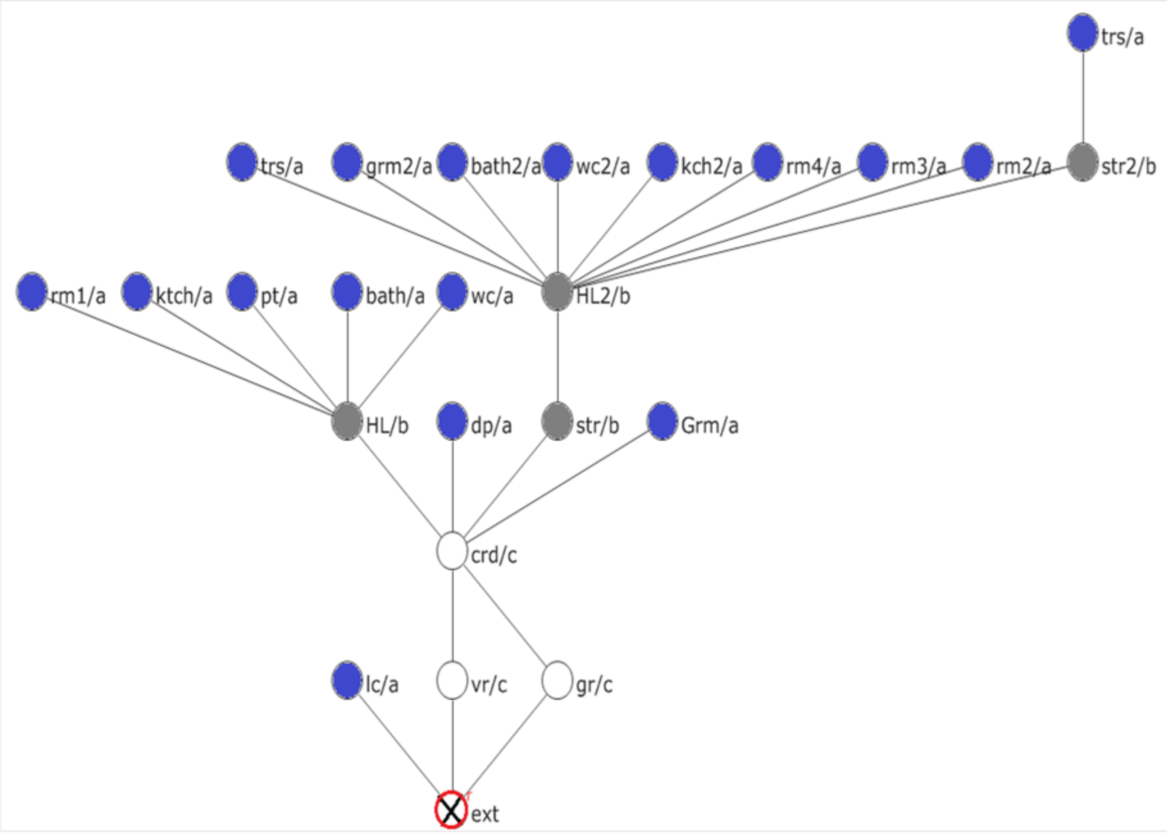
The j-graph of the house HP04



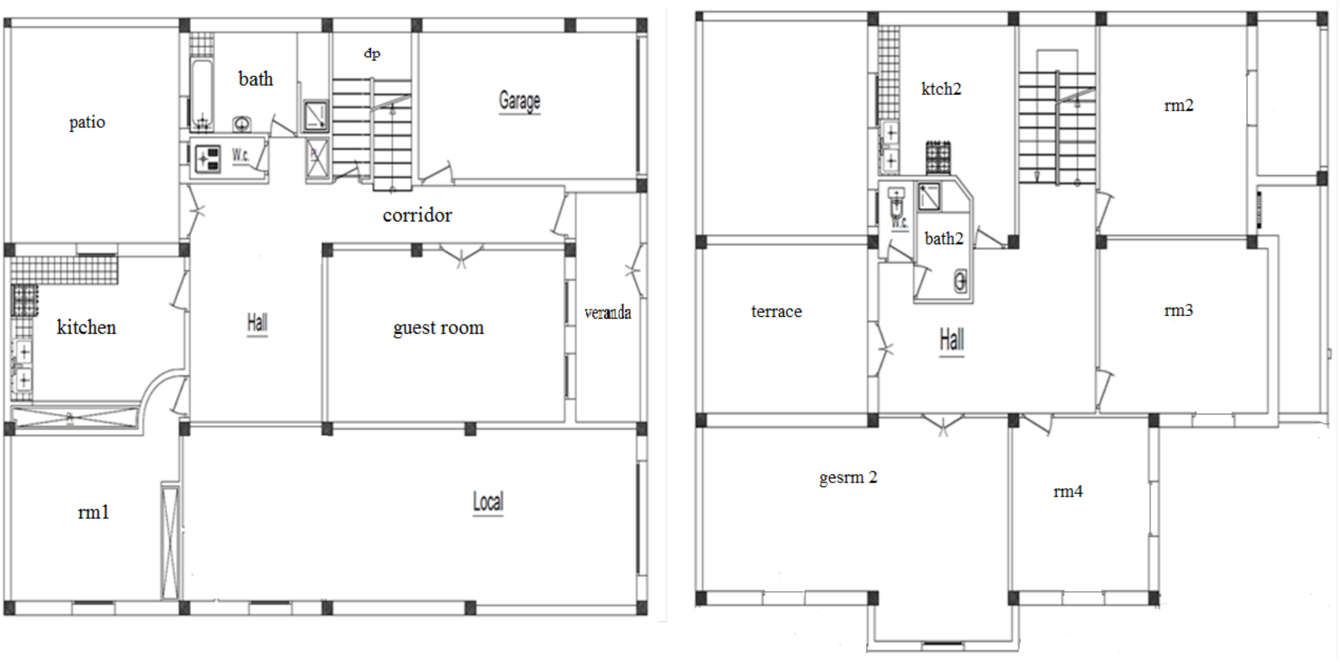
Ground floor First floor

Plans of the house HP04

- **The contemporary house HP05**



The j-graph of the house HP05

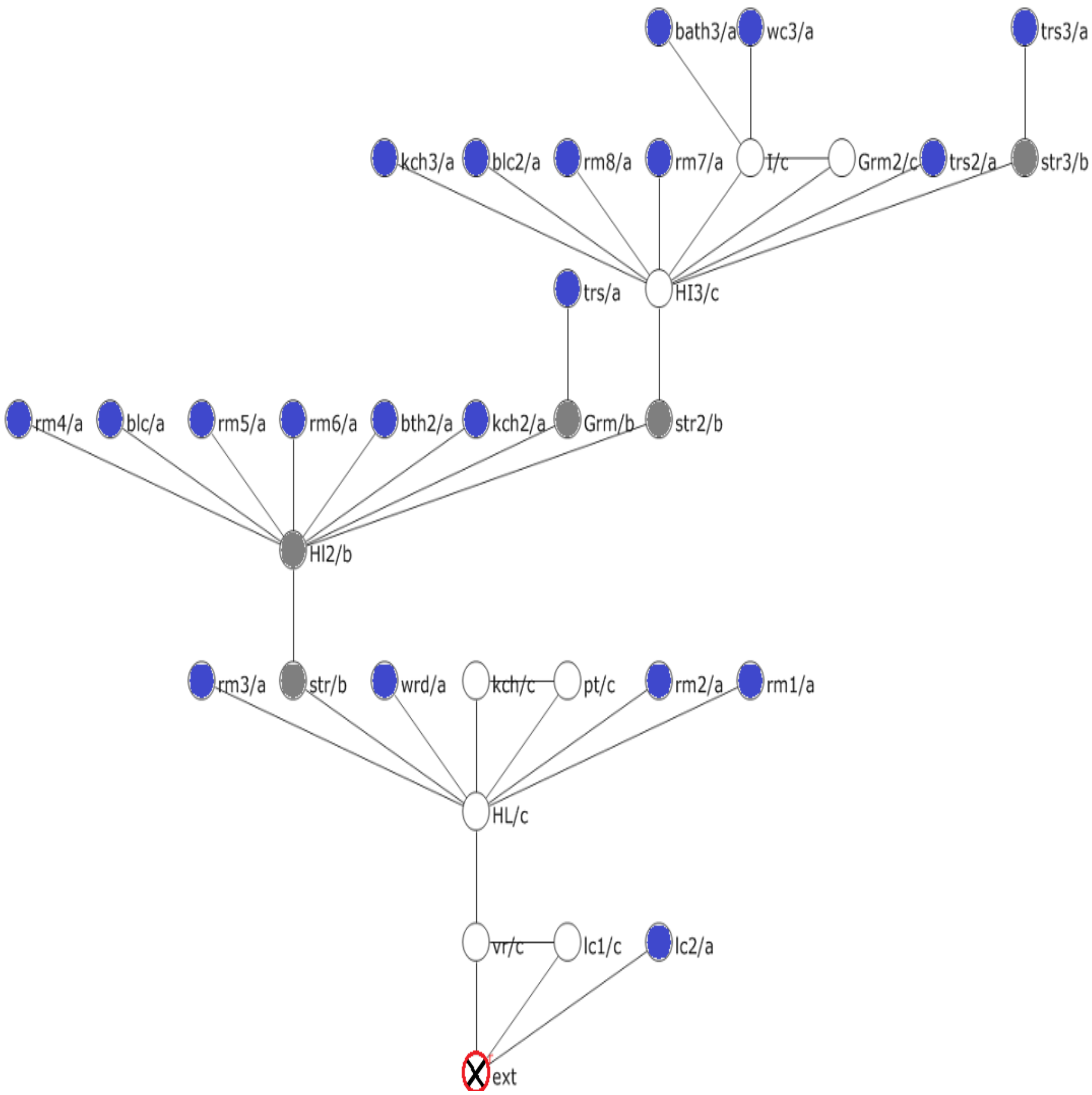


Ground floor

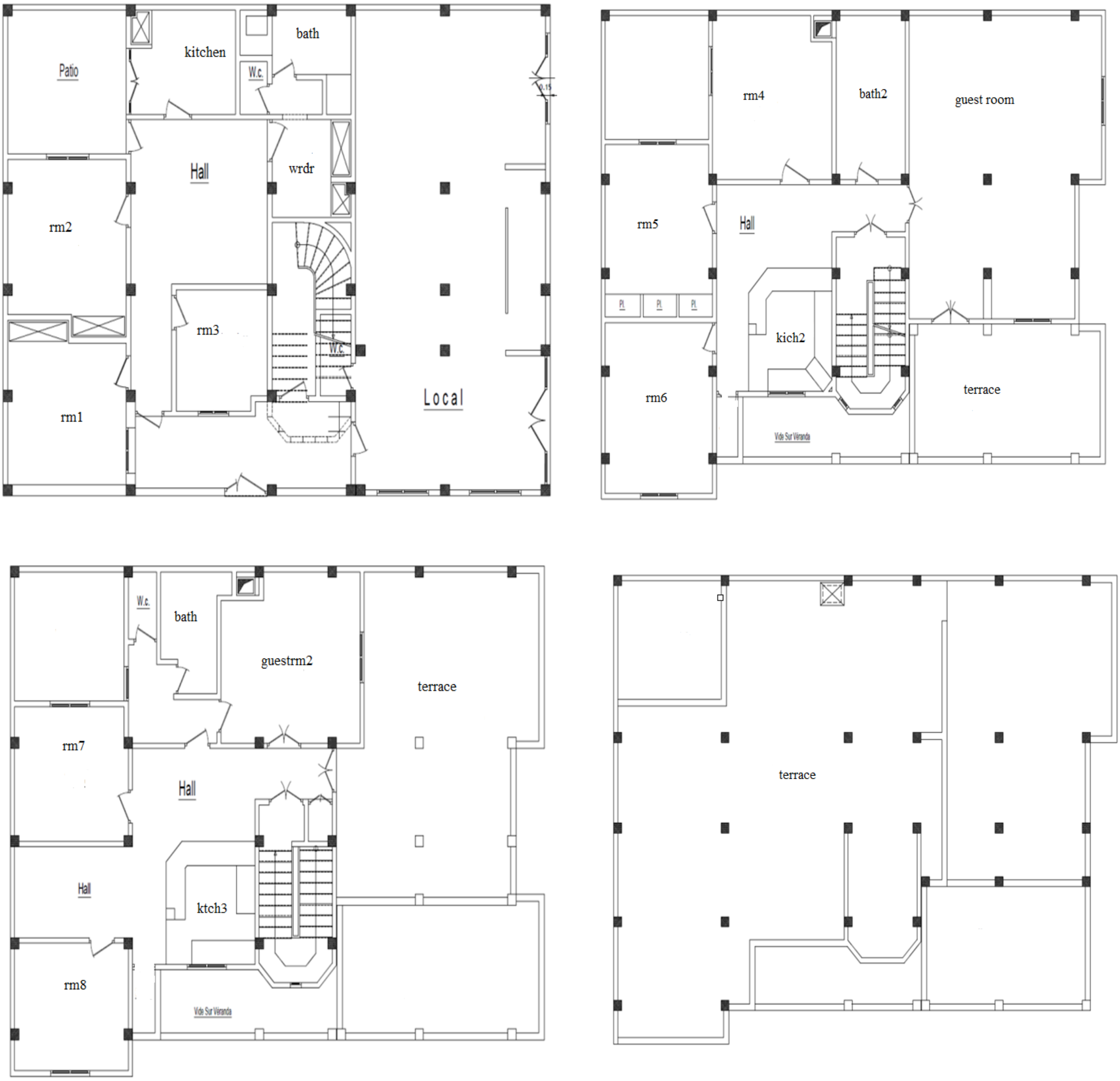
First floor

Plans of the house HP05

- **The contemporary house HP06**

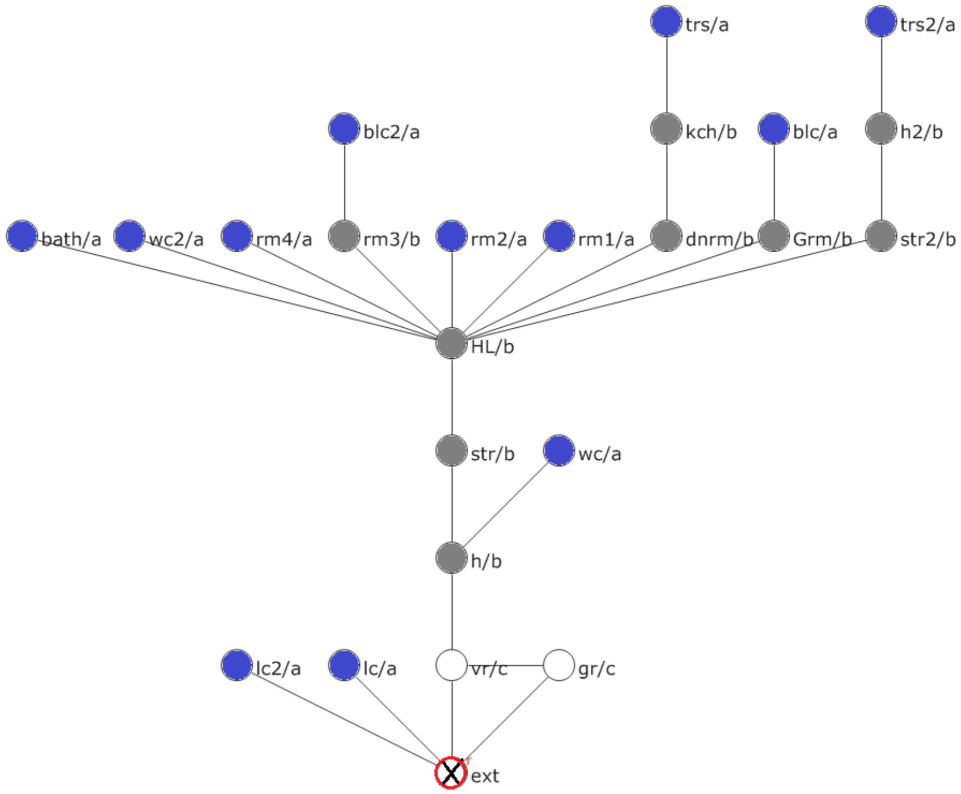


The j-graph of the house HP06

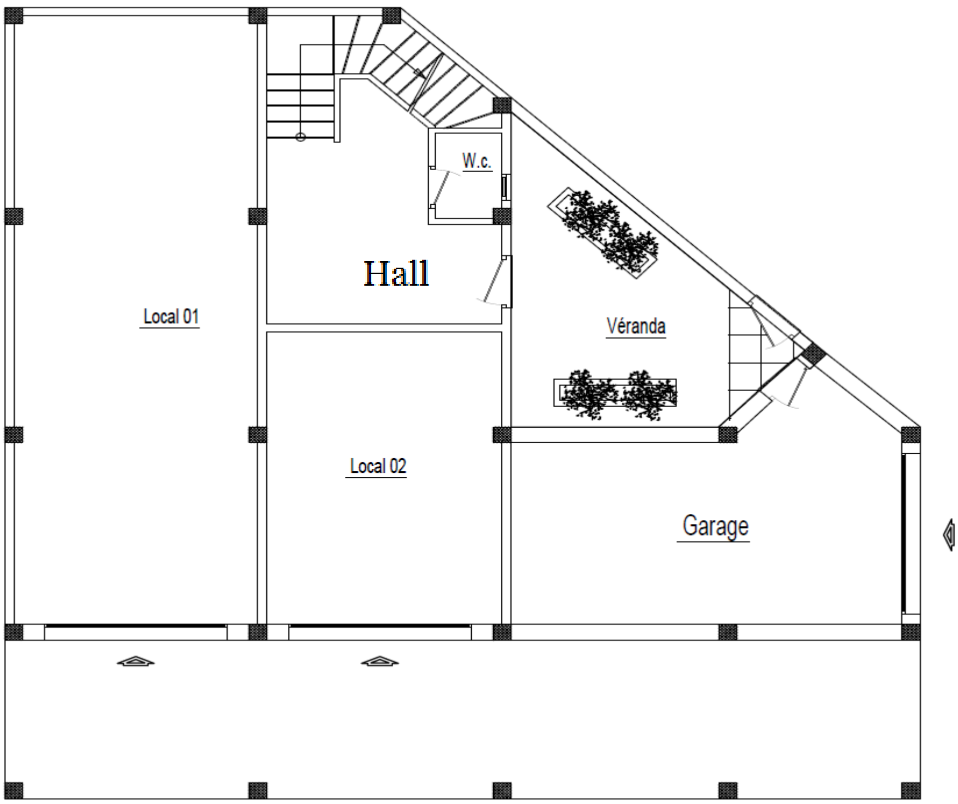


Plans of the house HP06

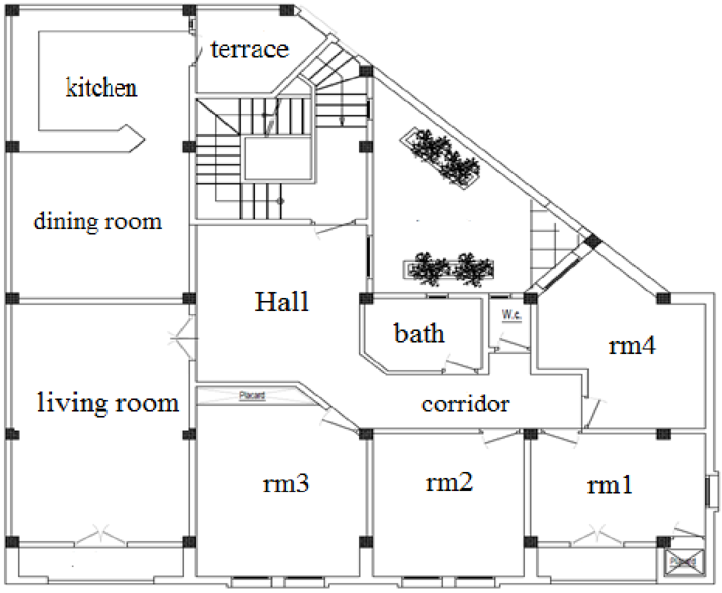
- The contemporary house HP07



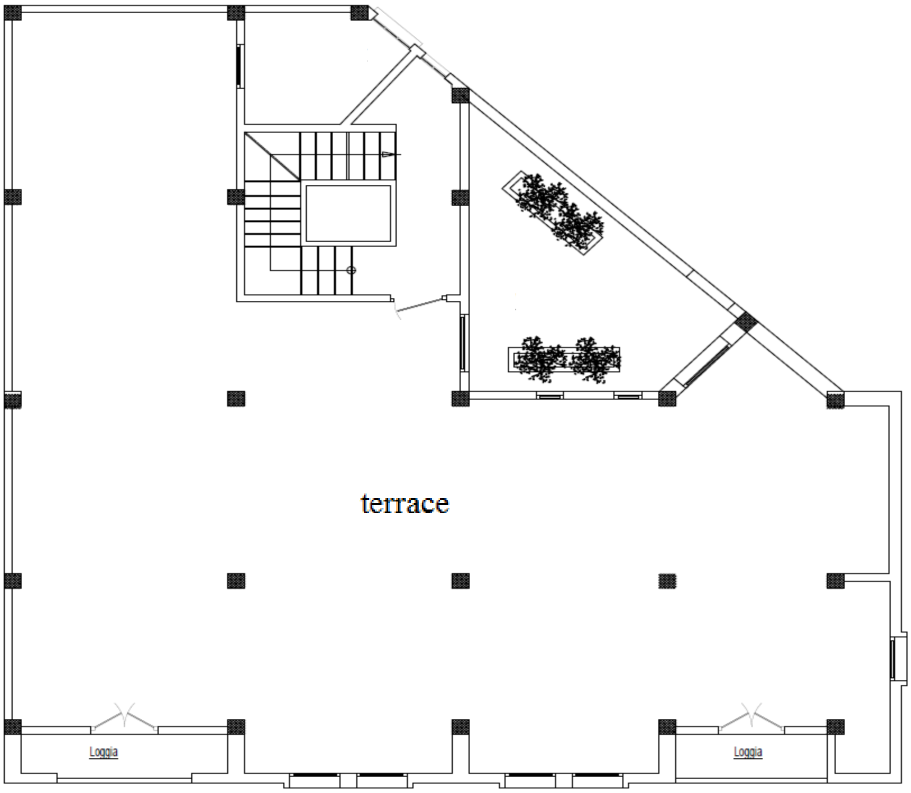
The j-graph of the house HP07



Ground floor

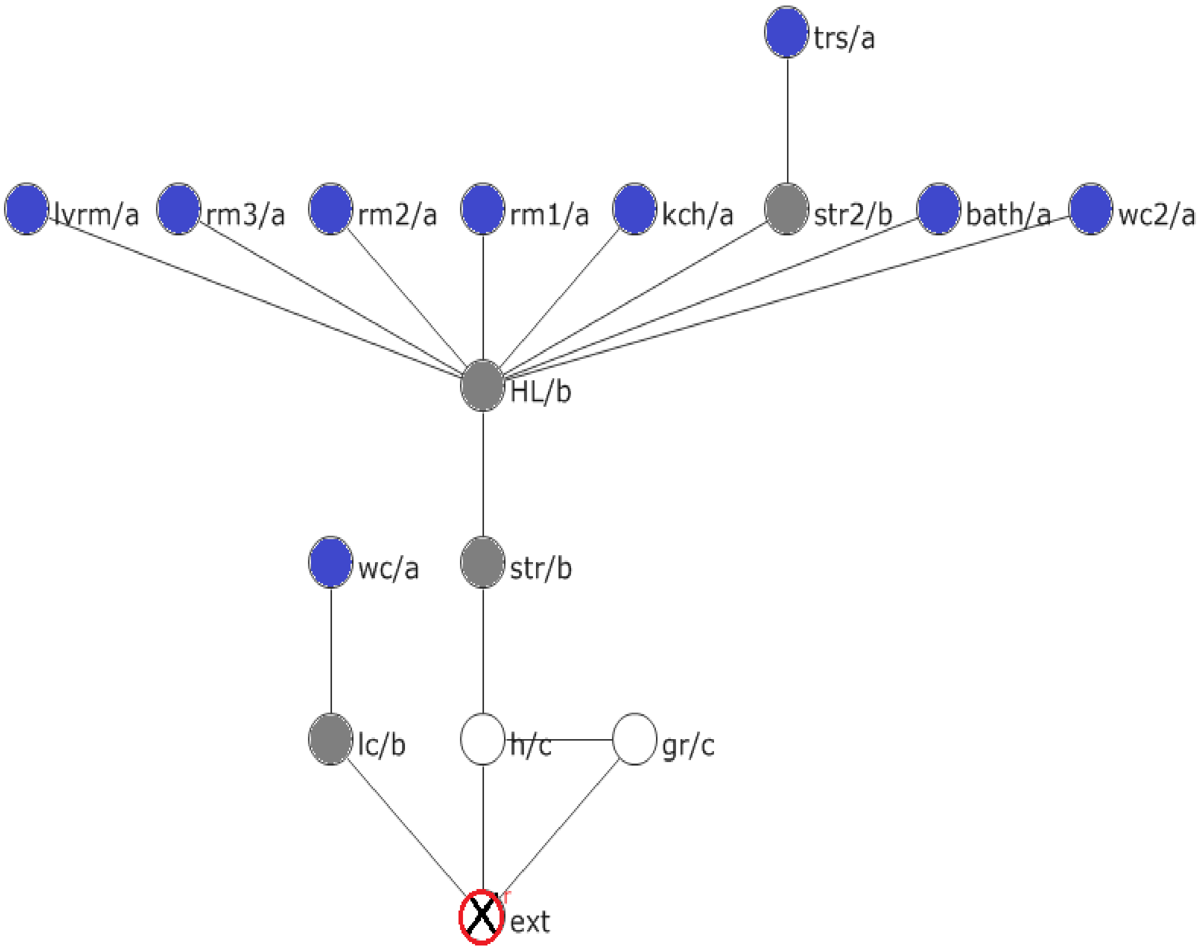


First floor

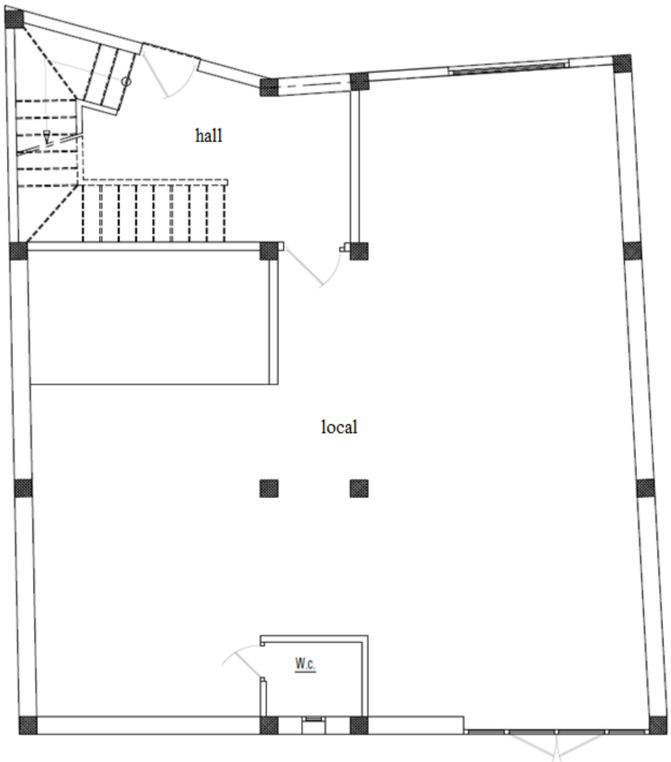


Second floor

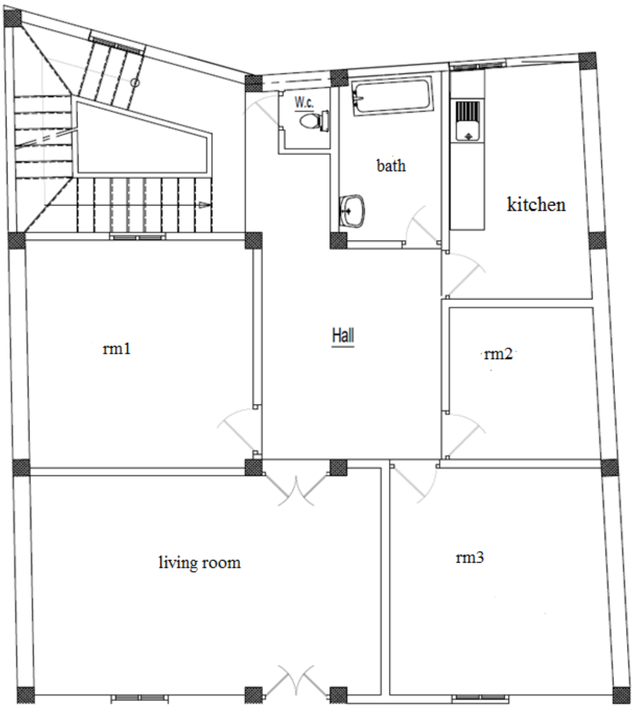
- **The contemporary house HP08**



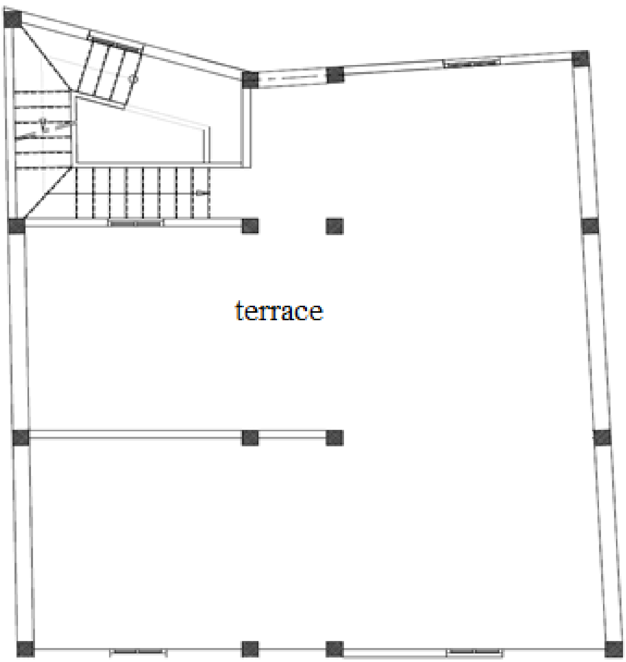
The j-graph of the house HP08



Ground floor



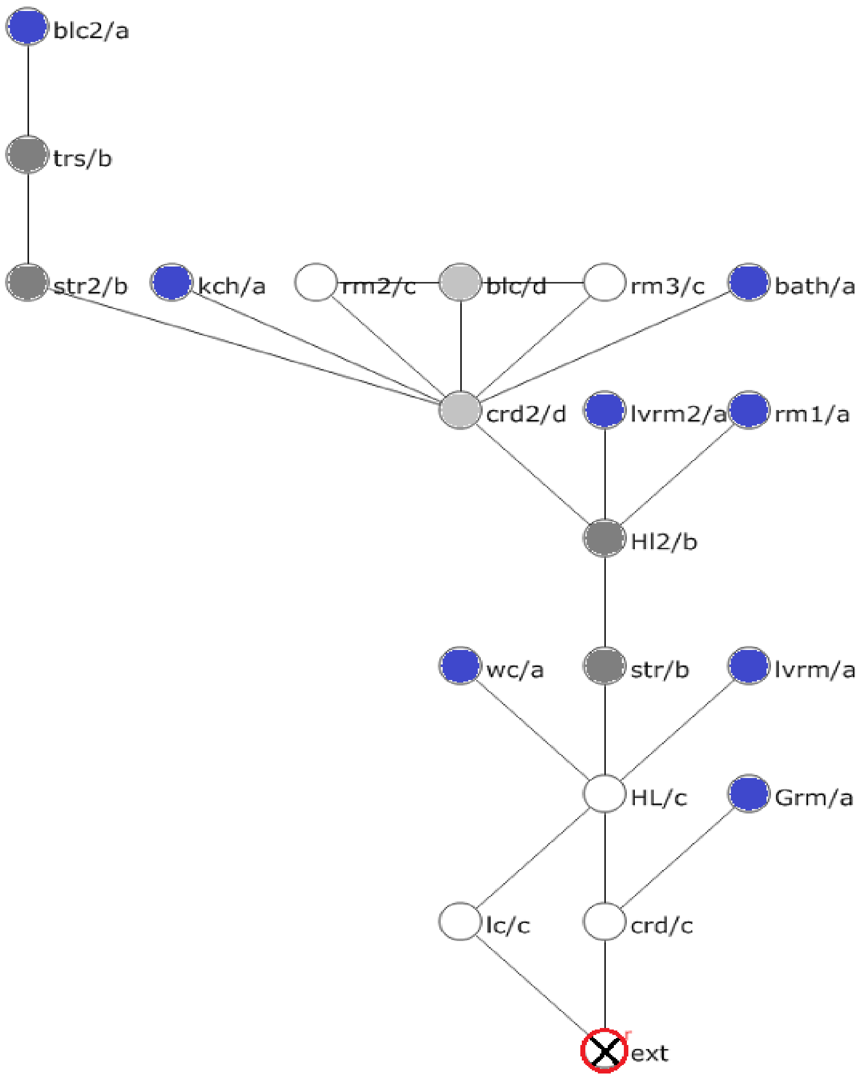
First floor



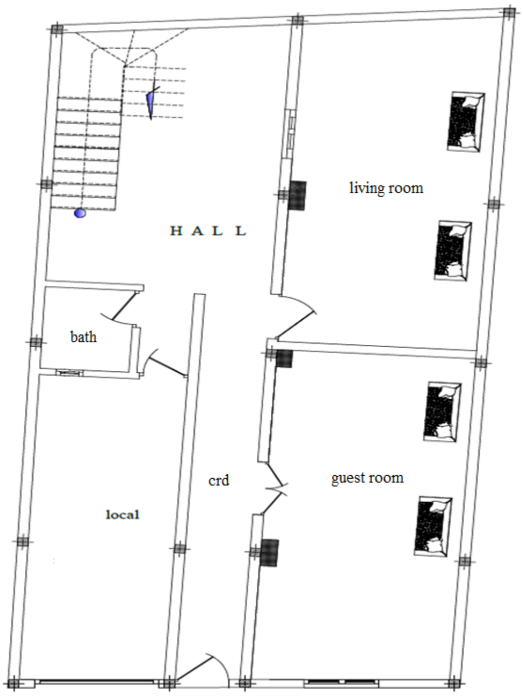
Second floor

Plans of the house HP08

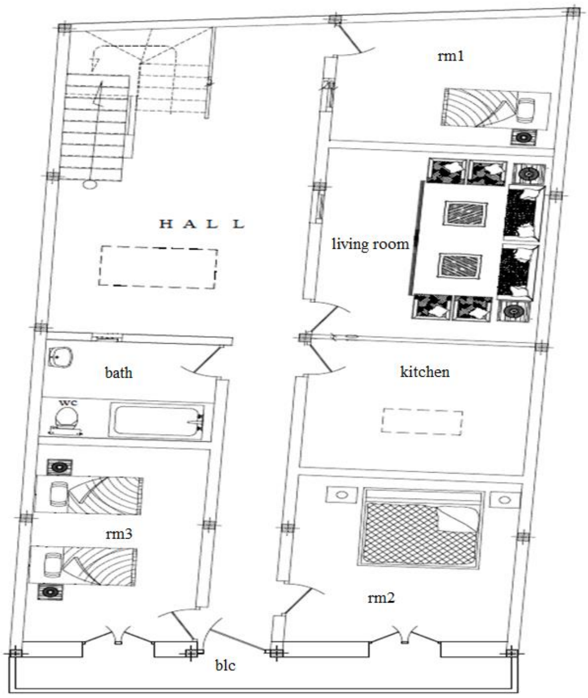
- **The contemporary house HP09**



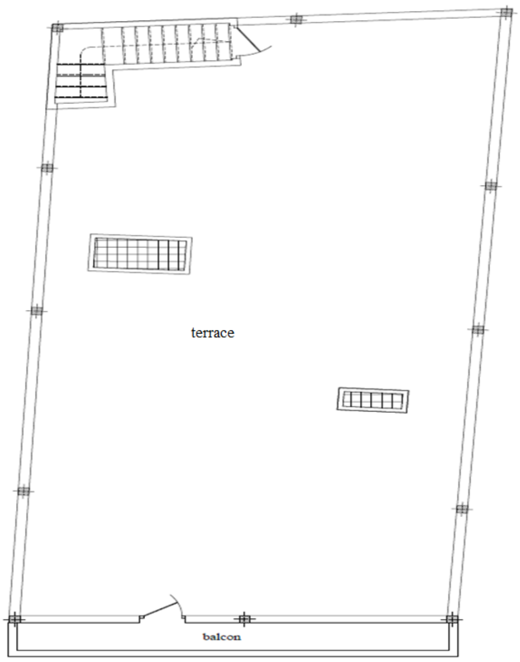
The j-graph of the house HP09



Ground floor



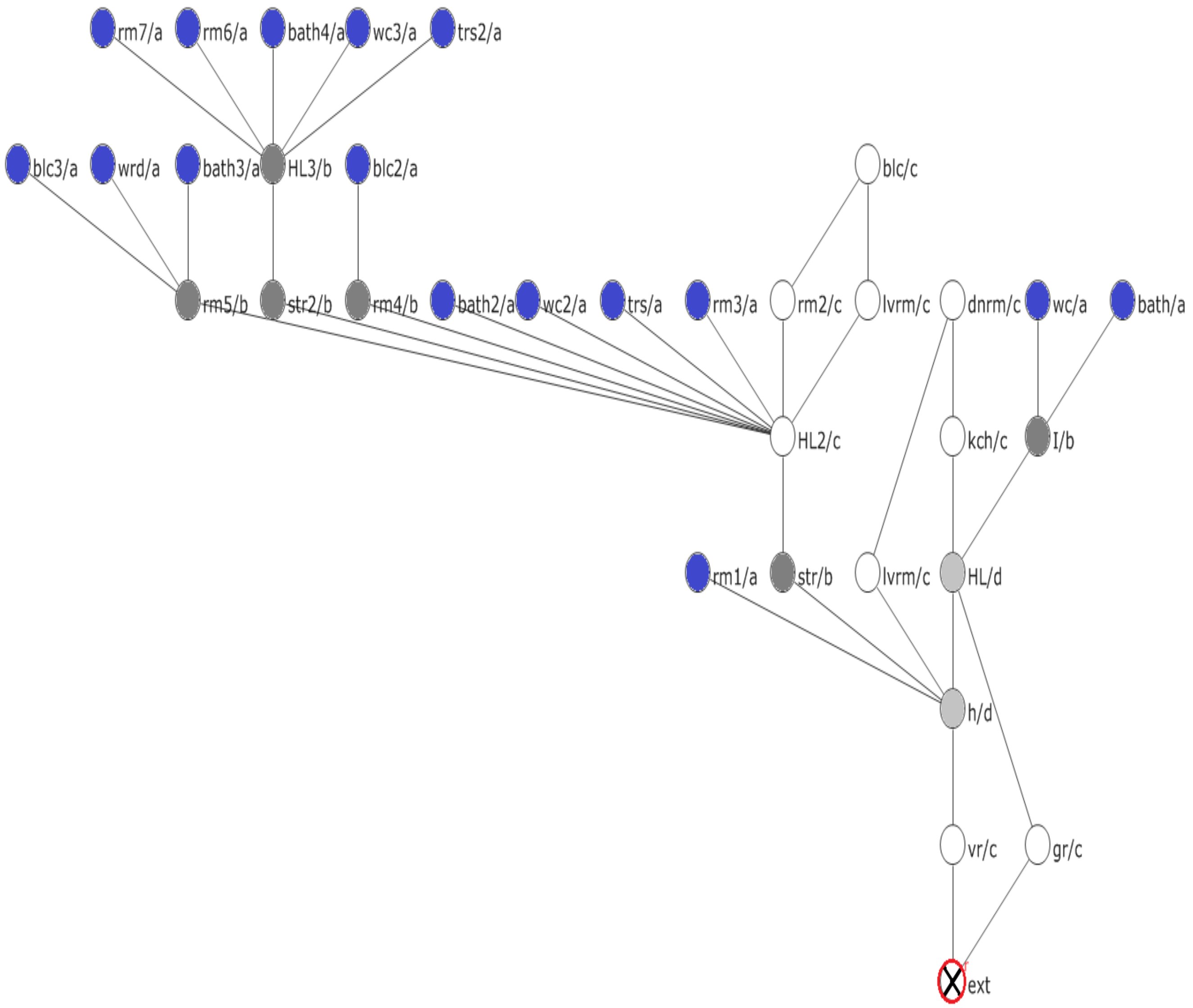
First floor



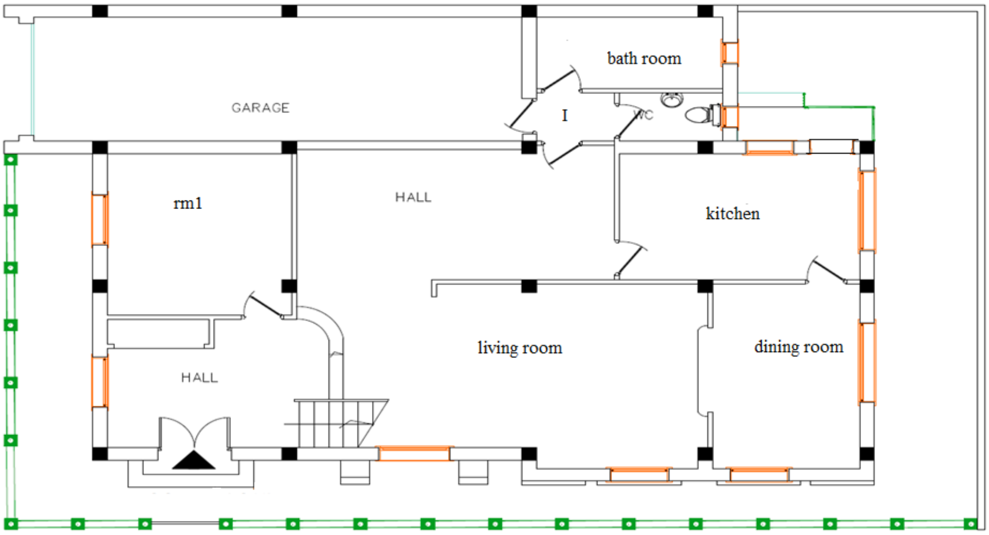
Second floor

Plans of the house HP09

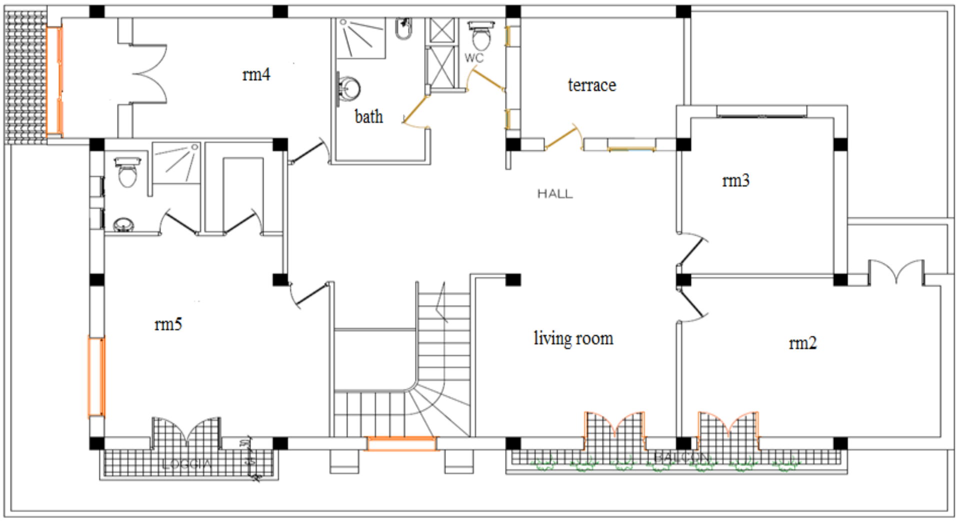
- **The contemporary house HP10**



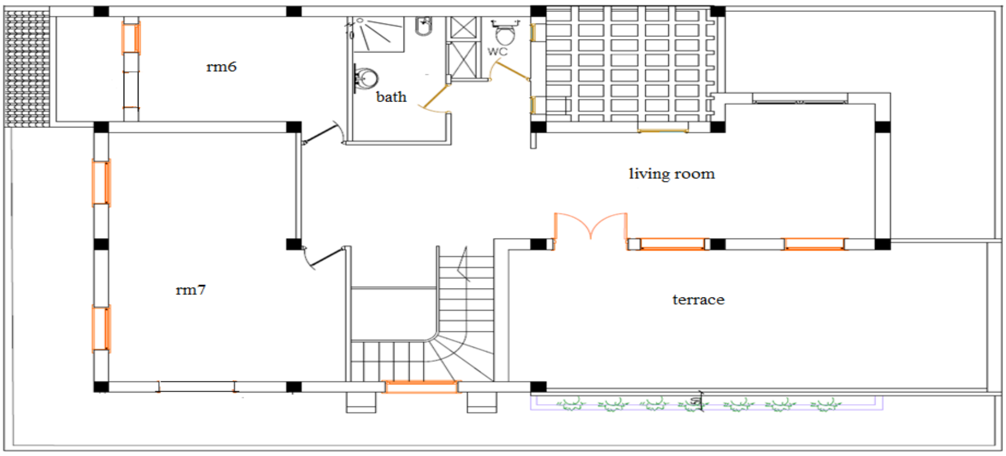
The j-graph of the house HP10



Ground floor



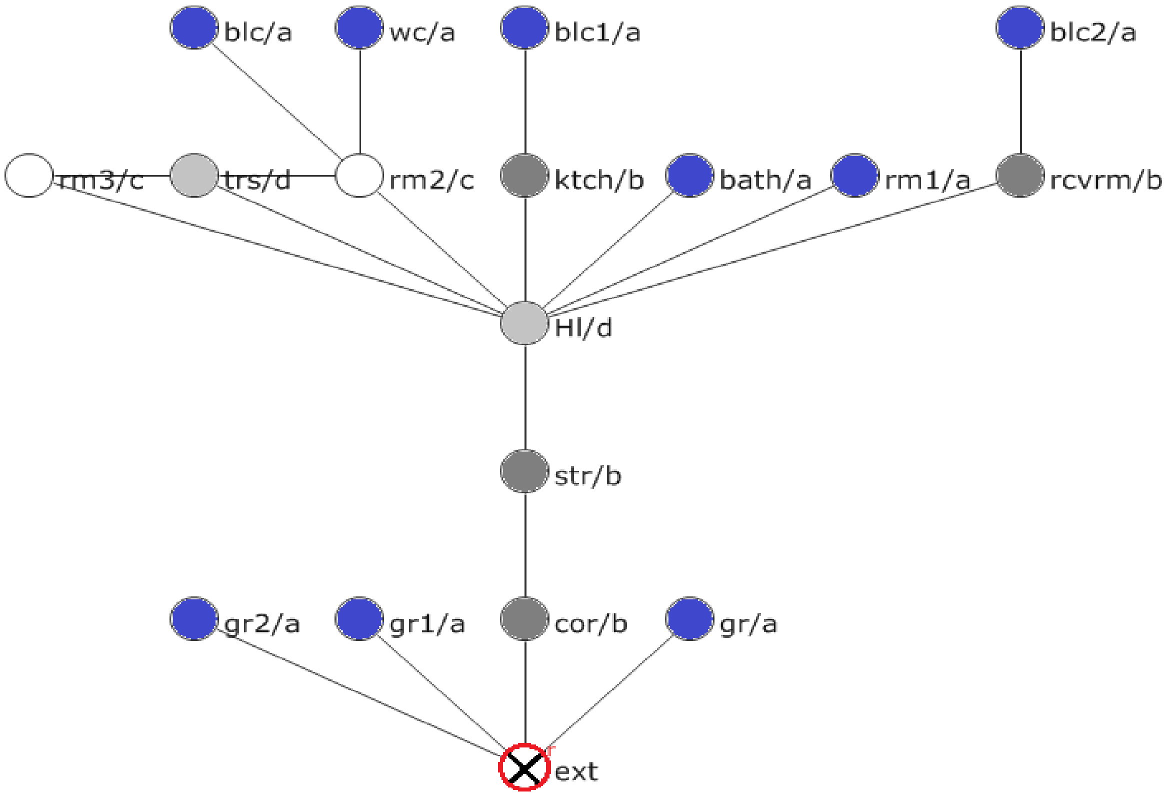
First floor



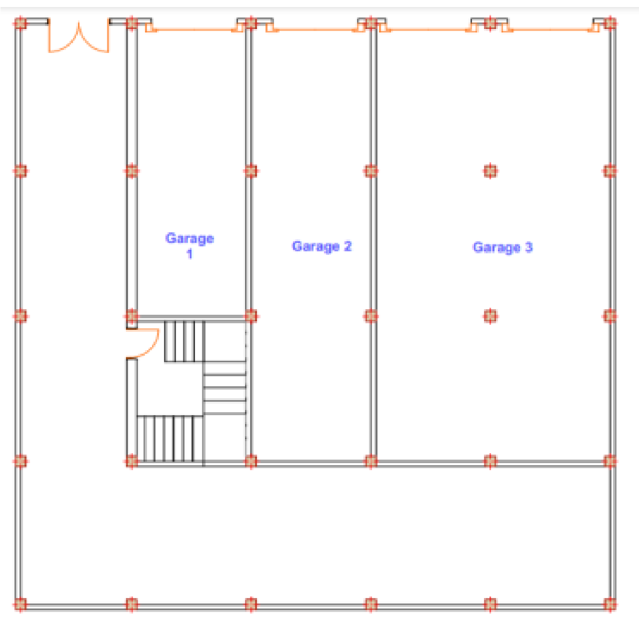
Second floor

Plans of the house HP10

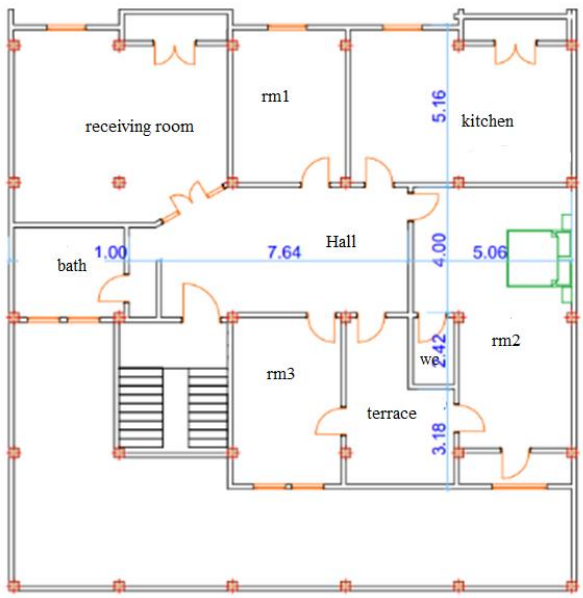
- **The contemporary house HP11**



The j-graph of the house HP11



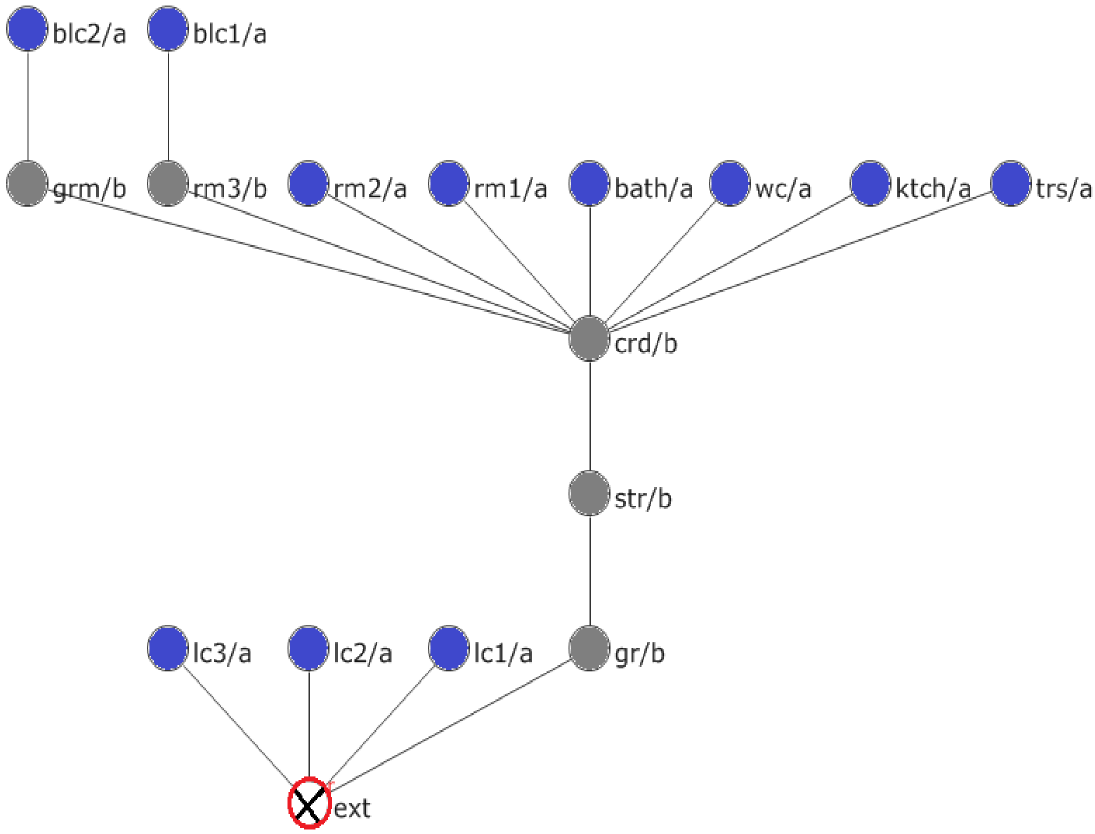
Ground floor



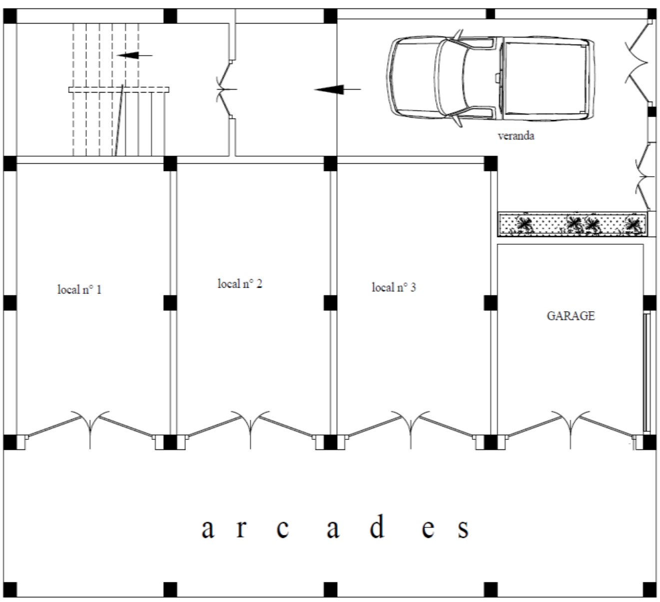
First floor

Plans of the house HP11

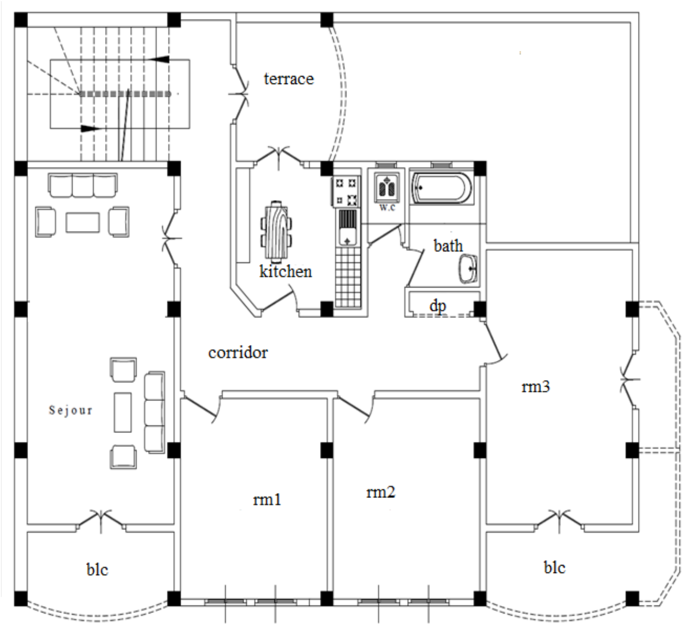
- The contemporary house HP12



The j-graph of the house HP12



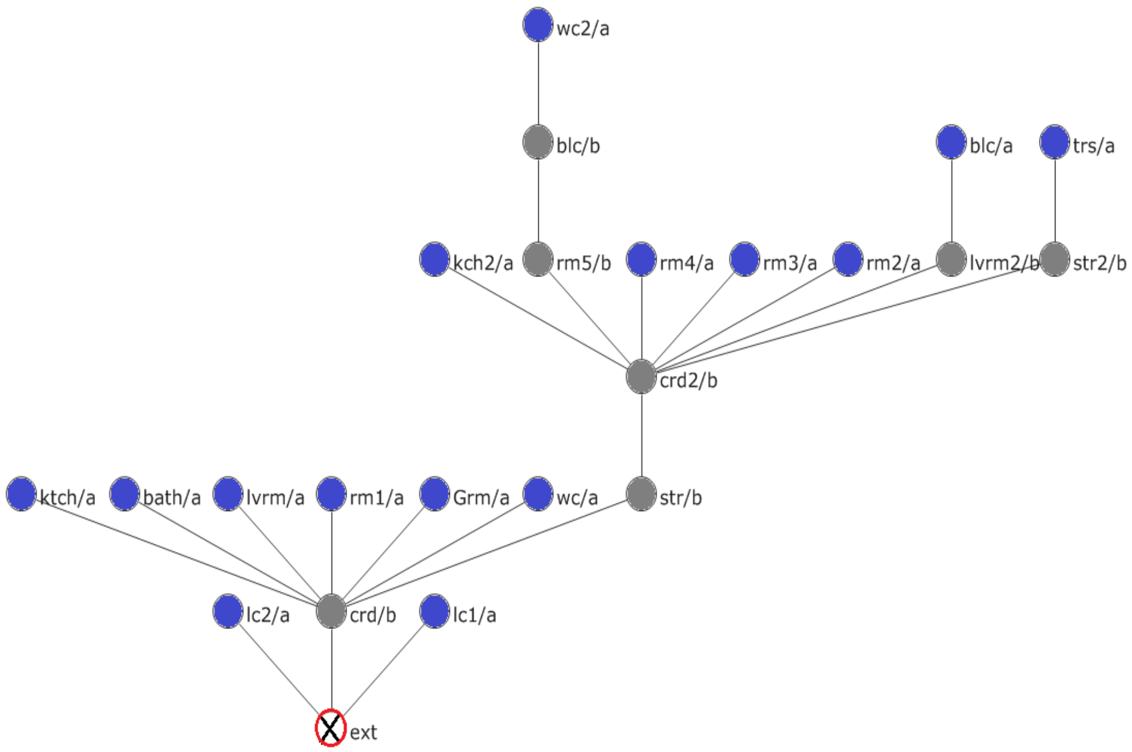
Ground floor



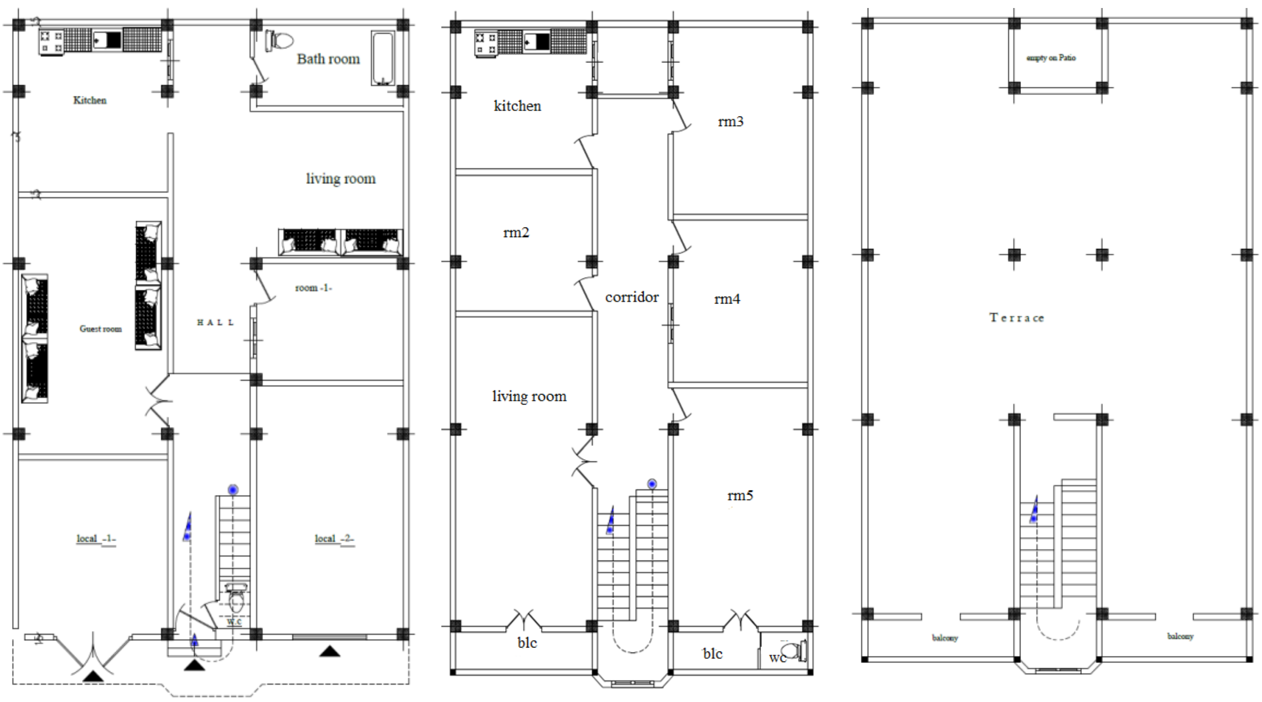
First floor

Plans of the house HP12

- **The contemporary house HP13**



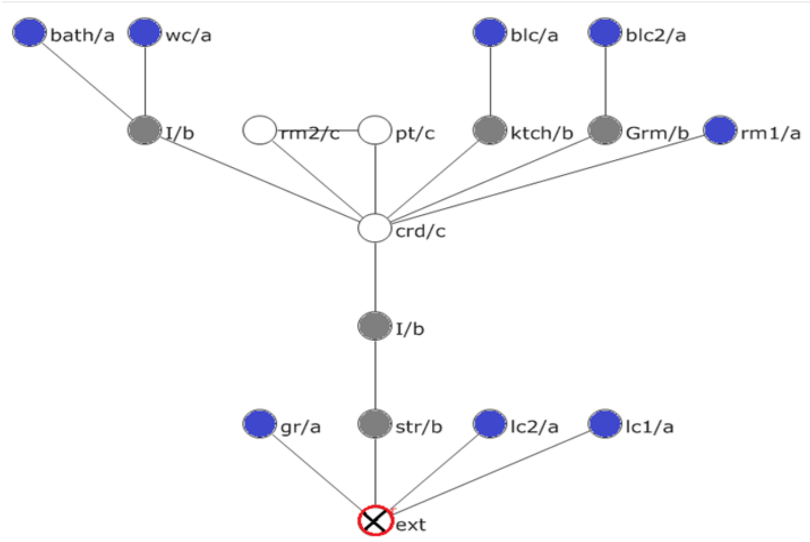
The j-graph of the house HP13



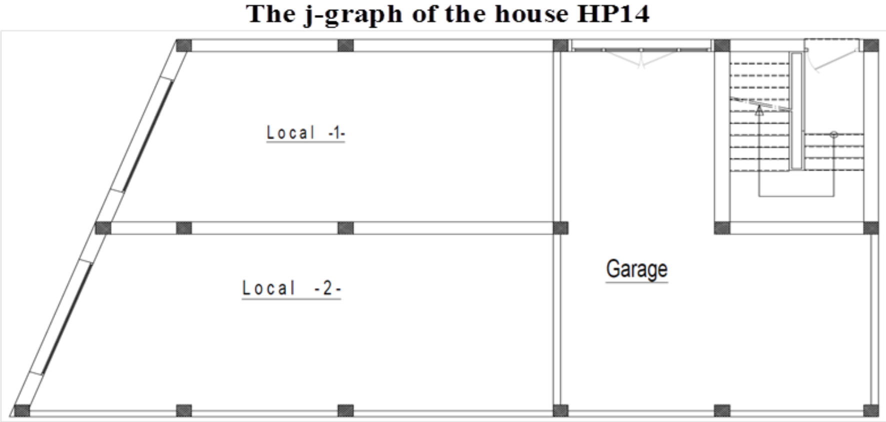
Ground floor First floor Second floor

The plans of the house HP13

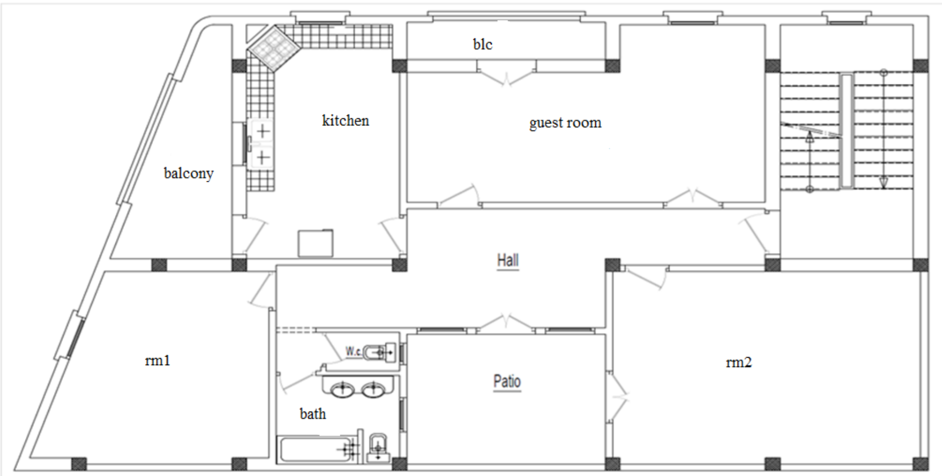
- **The contemporary house HP14**



The j-graph of the house HP14



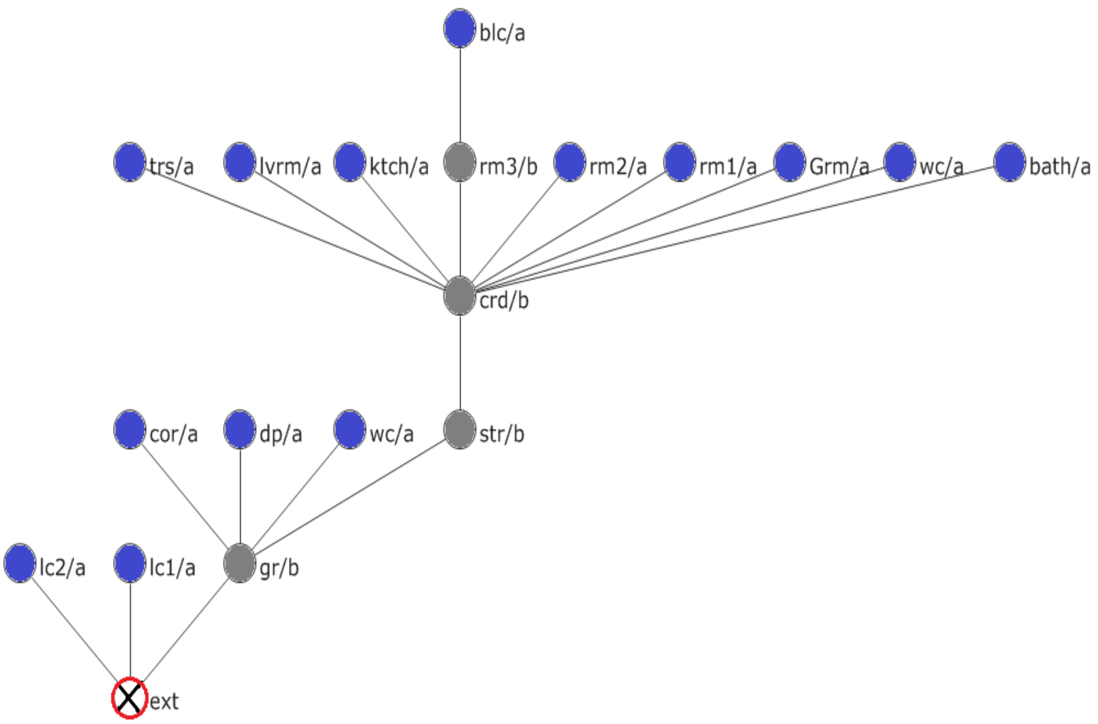
Ground floor



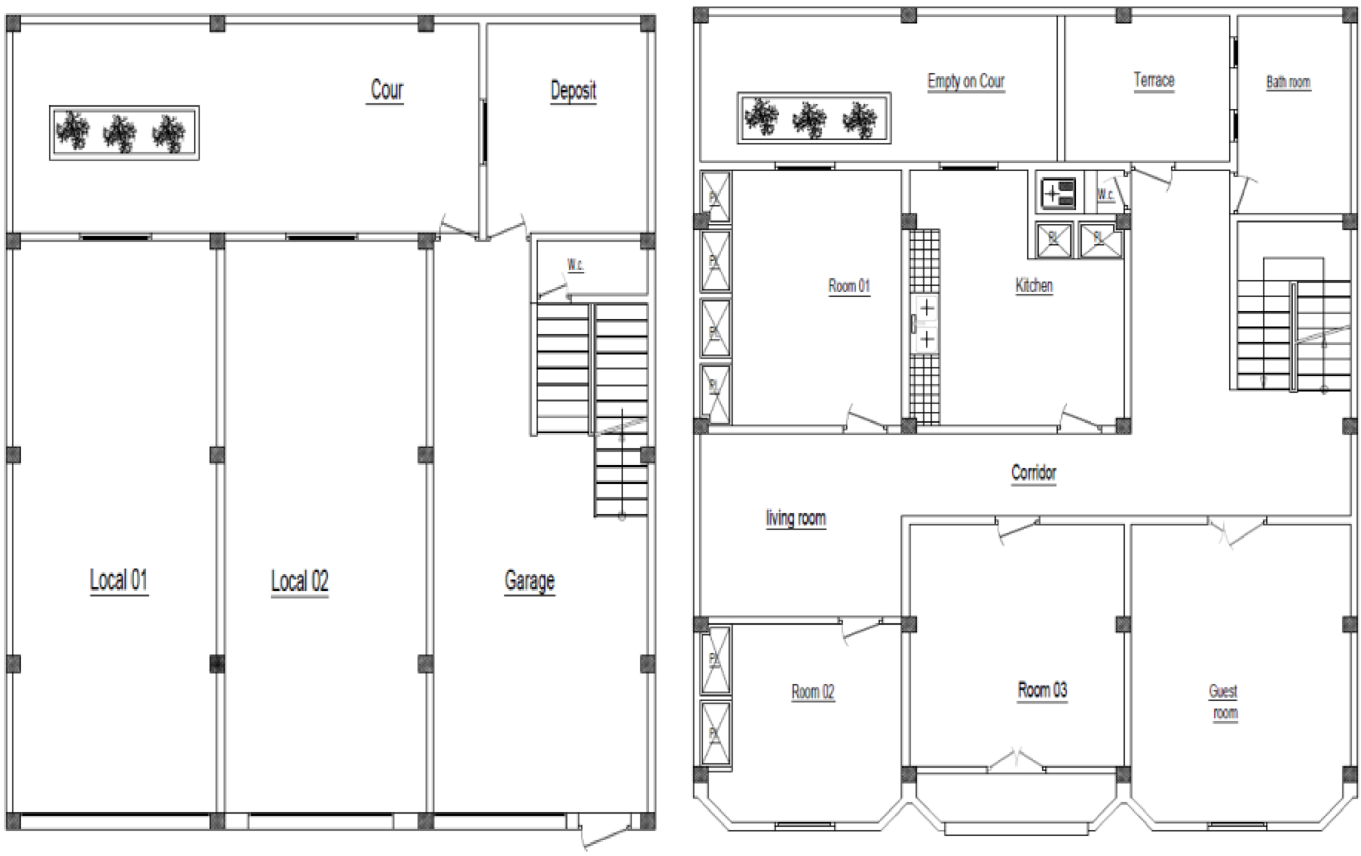
First floor

Plans of the house HP14

- **The contemporary house HP15**



The j-graph of the house HP15



Ground floor First floor

Plans of the house HP15