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IN SEARCH OF AN ARCHITECTURAL GENOME OF TRADITIONAL HOUSES: CASE OF THE HABITAT OF THE DECHRAS OF ARRIS

Abstract: This paper investigates the traditional production process that defines the perfect symbiosis between the site, culture, and construction engineering lifestyle. Indeed, despite the limited means, ancient builders have erected collective edifices well adapted and suited to the occupants' needs. This study aims to assess ancient auressian clusters to investigate the relationship between space and the resident community and establish a reference cultural model. Therefore, Arris villages (Dechras) have been selected as it represents the earliest and most significant settlements in the Aurès region. This study is based on syntactic analysis of several traditional houses dispositions using qualitative and quantitative approach of Agraph and Depthmap sotware data processing. The spatial organization analysis findings outline numerous genotypic similarities and few discrepancies. Moreover, the outside is directly linked to the interior space by the yard, representing the divergence pole. The outdoor is rarely accessible by the roof (Skiffa) to enforce the domestic life introversion aspect.

Key words: Dechras d'Arris, depthmap, genotype, traditional houses, space syntaxe

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Introduction

Vernacular architecture, local architecture also known as non-architectural architecture, is present worldwide, attesting to the most subtle nuances between cultures, nations, and the environment (Machane, 2016). The latter describes the reflection and the implementation of the built-up space, the materialization of thoughts and lifestyles. It reveals the community techniques in a given environment or a country for a specific period of its history. This could only be grasped by understanding the constructor and the user's environment and origin. This traditional style reinforces the relationship that links the occupants to their houses with respect to their social life, representing a precious source and a legacy furthered between generations, comprising the notion of cultural diversity, landscape, climate, and historical sets. This architecture is confronted with the current changes and a lifestyle metamorphosis, which is a homogenous component to perpetuate, maintain and promote.

Traditional architecture is a typical vivid style, which relies on local resources. This construction combines nature, culture, and landscape under different forms comprising auxiliary structures and modest components (Casanovas, 2008). Some architects define this architecture as a corpus containing forms, vocabularies, and configurations (types, forms references) that could be reproduced and reinterpreted by modern designers (Robin, 1992).

Traditional architecture is subject to the violent pressure of designs conveyed by other civilizations, which are considered a sign of development. Similar to the community, this architectural aspect is losing its fundamentals and values. Certainly, the nations' lifestyles cannot be internally the same. However, society's development is affecting other aspects. Since the population has different aspirations, it should not hamper the evolution of traditional architecture (Cisse, 2016). Therefore, several researchers have focused on spatial configurational analysis and its modalities related to social manifestations to fully understand the evolution of traditional housing and meet the real needs of users (Bellal, 2003; Hamouda, 2013; Assassi, 2017). Traditional habitation is part of the built-up environment of humans (Viaro & Ziegler, 1983). It is also a collective composition of an individualized homogenous society, which evolves using its own means to meet its needs. Traditional habitats exist due to the human-environment's strong sociocultural coherence sustaining communities over history and changing sociocultural contexts (Sriti, 2013). Traditional construction is an intelligent model of humans over time (Fathy, 1970).

Arris dwellings are organized to consider the occupants' private lives; thus, separating private and public spaces ensures family members' safety. Consequently, accessing the house's privacy, the interior space needs to be imperceptible to strangers, and the spatial configuration should be appropriate to provide effective communication within the home (Alitajer & Molavi Nojoumi, 2016). The traditional community is characterized by a limited specification of individuals, solidarity, and cohesion resulting from inter-individual relations based on moral rules rather than technical rituals and beliefs implying shared goals and overall a “common world” vision (Viaro & Ziegler, 1983). This formula enabled conceiving their culture according to a reference model, leading to the central question: How to draw out the architectural genotype that constructs the traditional space and create a referential cultural corpus?

With regard to this problem, it is necessary to verify throughout this study that the Algerian traditional houses' spatiality is due to a combination of several factors and that the architectural genotype plays a central role in the lifestyle which builds and structures the inhabited space. Through an analysis of ancient Arris settlements, we have tried to move towards a more homogeneous cultural model that considers the individuals needs and values. Thus, evaluate the traditional process that expresses the lifestyle through the consideration of the genotypic and phenotypic values of the spatial configuration.

Methods and Materials

Spatial syntax is a collection of techniques for describing, quantifying and interpreting the spatial configuration of structures to demonstrate the social logic of space. The latter is based on graphs theory and is mainly used to analyse spatial configurations (Jeong & Ban, 2014) and defined as the relationships between spaces in a complex by taking into consideration all other spaces (Hillier et al, 1987). In this framework, the spatial configuration of a home or settlement would present a quite accurate map of the economic, social, and ideological relationships of its inhabitants (Hanson, 1998; Dawson, 2002).

The investigation process relies on two analytical methods. First, a qualitative approach performed through the study of the justified graph using the "Agraph" software to interpret the spatial configuration. Second, a quantitative approach performed using mathematical formulas to study and evaluate the traditional lifestyle. The results will substantiate by the analysis of the visibility graphs (VGA) and the convex analysis on each case study using the software "Depthmap" to extract a cultural referential model.

Convex Map

Figure 1 illustrates an example of decoding an architectural layout designed by Frank Gehry using the convex space representation. The architectural space (a) could be described as the set of smallest and largest convex spaces. These spaces are linked in direct access from one space to another forming a convex map (b). Then, the convex map is represented by a graph (c). The spatial relationships between spaces in a given arrangement could be described by justified graphs. The latter, reads a spatial network of convex spaces from one space (root) to all others, representing each convex space with a circle and each permeable connection between two spaces with a line as in. From a root space, all spaces one syntactic step apart are placed on the first level above the root space. Moreover, any spaces that are two steps apart are levelled on the second row, etc. (Al Sayed et al, 2018). This analysis gives an overview of structures integration or segregation in a space system. Covex analysis could replace manual techniques based on connectivity graphs (Graphs theory), by convex maps, where each bond in the justified graph of each space represents the entire space in the convex map (Bouandes, 2012).

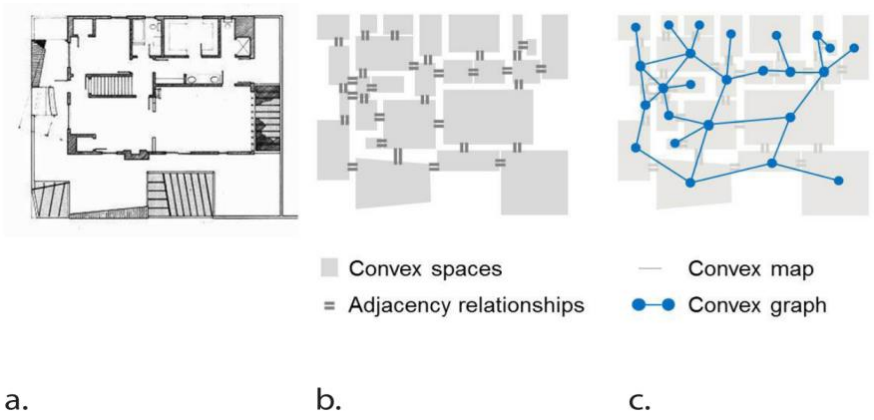


Fig.1. The convex representation of spatial syntax (Al_Sayed, 2018)

Qualitative Syntactic Properties

Justified graphs

The spaces that constitute a building are thus abstractly represented in a graph by circles and are called knots or cells (Preziosi, 1983). The permeability relationship is represented by an arc or a connecting line (Hillier & Graham, 1985; Boutabba, 2013). Two variables allow a first visual qualification of a justified graph (Hanson, 1998). These are symmetry and asymmetry relations (boundary as a physical separation), which refers to the concepts of integration and segregation, and distributivity and non-distributivity patterns (boundary as a crossing point) (Hillier & Hanson, 1984).

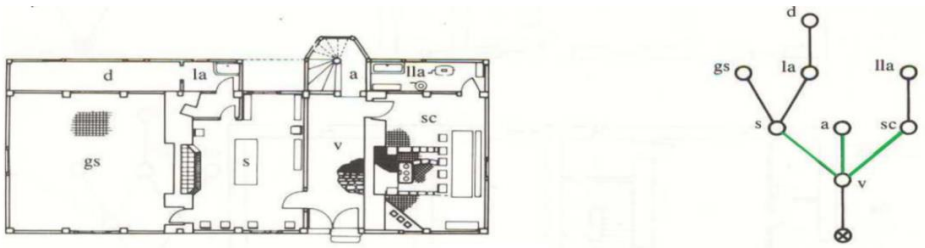


Fig.2. Justified graph of an architectural plan (Hillier et al, 1987)

Topological types

The user space's occupation and movement within it define its behavior. The latter is considered static in the case of occupation and dynamic in the case of movement. To identifies these usages: occupation or movement, Hillier relied on the space topologic described in Figure 3, which are classified into four categories:

- Topological type –A is the last space in an arborescence structure, indicating a restricted movement.
- Topological type – B is the transitional space in an arborescence structure, which restricts the user's displacement.
- Topological type –C is a space with an annular space leading to an annular system providing the user mobility choices.

- Topological type –D is a space with additional annular space which also leads to an annular structure enabling the user to move freely (Hillier, 1996).

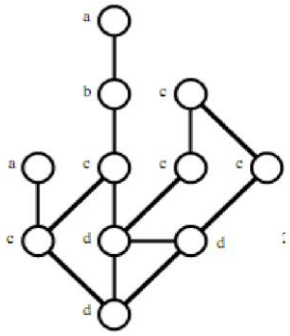


Fig.3. Topological types relationships (Hillier, 1996)

Quantitative Syntactic Property

After the qualitative analysis of the house, the syntactic analysis provides a range of mathematical formulas to support the observations mentioned above with numerical data. The advantage of these formulas is that they allow greater analysis precision, facilitating comparisons between different buildings.

Mean Depth (MD)

Depth is a crucial configuration property of spatial models. It indicates the number of steps to be followed to reach a specific configuration space. Each step in the justified graph has a depth number multiplied by the step cell number. Then, these values are aggregated. The resulting sum is divided by the overall system's spaces number minus one, as the retrieved space is the system transmitter (Hamouda, 2018).

Real relative Asymmetry (RRA)

It is a global measure as it considers the link between a specific space and the whole system's spaces. Moreover, integration values under1 (ranging from 0.4 to 0.6) are considered highly integrated compared to values higher than 1. The latter are segregated (Hillier & Hanson, 1984).

Visibility Graphs (VGA)

Visibility defines in-movement individuals' behavior and refers to the «visible» or the «could be seen». The visibility graphs analysis VGA provides global and local outputs (Turner, 2005). The latter outlines the different space components on a plan view comprising colored zones. These colored zones reveal the configuration value attributed to each zone (Torkia, 2021). The rationale is that all spaces within a building can be categorized as visual relationships maintained with other spatial points in a plan. Depthmap software was developed to perform these analyses (Hamouda, 2013).

The architectural genotype results from the spatial syntactic analysis of several buildings in which qualitative and quantitative terms recurrences in spatial configurations are observed. In this case, a genotype exists, and we can speak of a cultural model. In the opposite case or the designs with the same organizing principles express a model differently, it is, in this case, an identity of unique aspect called phenotype (Benbouaziz, 2019).

Architectural Genome

Based on the analysis of ancient Arris cores, this work seeks to extract a homogenous cultural model using a spatial configuration genotypic evaluation. Accordingly, this study's work can be divided into two main phases:

- Data collection, built on field surveys and taking photographs of the selected samples based on their representativeness. The architectural plan of each specimen has been transported as a DXF image.
- The architectural plan will then be converted into a graph using Agraph which provides all the qualitative and quantitative spatial configuration data. Moreover, results corroboration, the study relies on Depth map software. The latter provide a convexity analysis which enables to define interior spaces arrangement and the integration or segregation rate of the system's structures.

Study Area: The Commune of Arris

Arris is a small Algerian city, located on the right side of Oued El Biadh valley, 60 km south-east of the city of Batna. It comprises two municipalities: the municipality of Arris capital and Tighanimine.

This city is made up of three villages: Dechra of Arris, Dechra El Beidha and Inerkeb which represent the origin of the first group, and which are characterized by their purely traditional settlement. The relief of the site is mainly mountainous, defensive in nature and difficult to access (Figure 4).

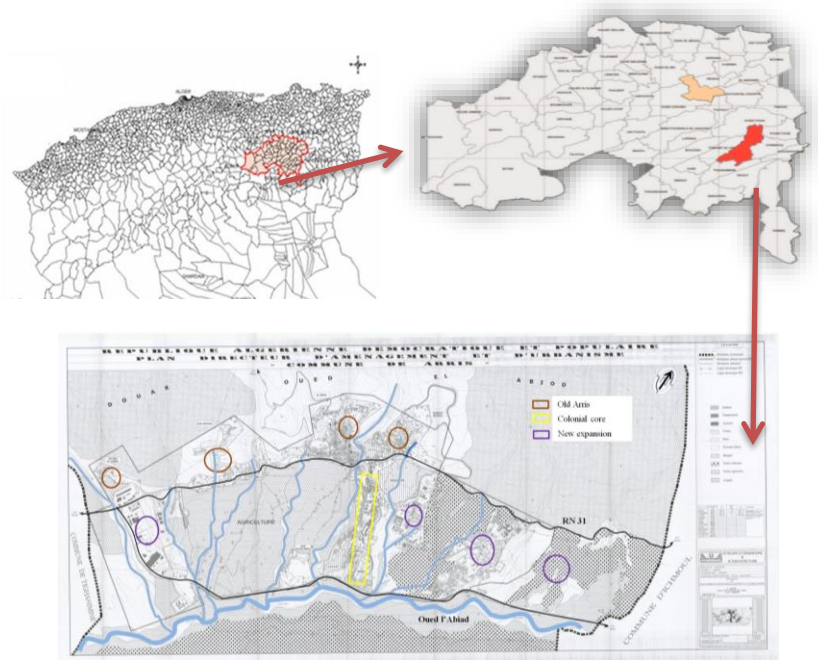


Fig.4. Map of the studied area (Aksas & Hamouda, 2019 from the land cover map and the monograph of the wilaya of Batna)

The Dechra of Arris has been built by the Zhahfa community; it is protected from the exterior by a massive staircase and by housing disposition. The dechra is accessible through two streets (Lamjaz and Taaricht) which lead to the main road; they occupy relatively the residual surface of the building and sometimes exceed the floor of the houses which border them.

Fig.5. View of Dechra of Arris (Aksas & Hamouda, 2019 and Photographer at Arris)

Dechra El Beida has been buit by Ouled Takhribt. This village is the largest compared to the others. It is characterized by a compact development, expressing a high sense of privacy, social interaction, luminosity and obscurity, warmness and cold. It is accessible by Bali Street which leads the principal road bordered by the Inerkeb and El Biadh Oued affluent.

Fig.6. View of Dechra El Beida (Photographer at Arris)

Inerkeb Dechra represent the smallest core funded by Ouled Ouazza, it occupies the highest level of the hill. The urban layout is more spacious and the alleys are not well defined. This village has the same physical characteristics of defensive purpose.

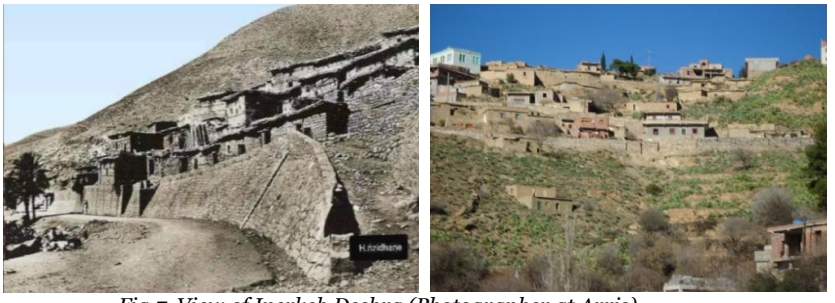


Fig.7. View of Inerkeb Dechra (Photographer at Arris)

Architectural Features of Arris Traditional Houses

The traditional house is a cultural representation, symbolic and social for the trilogy Man-animal-reserve. The domestic space is planned in an evolutionary fashion (in many cases rooms could be added without changing the basic structure).

The houses are built using dry stones, connected by lime mortar, or in toubs disposed on a stone sub-base, stacked one on top of the other. The latter are joined to each other, forming a protective facade that ensures the protection of the dechras (Barrou, 2019).

Fig.8. Arris dechras houses, exterior (Aksas & Hamouda, 2019)

The spatial organization (Figure 9) is very simple resumed in multipurpose introverted spaces articulated around a central uncovered space (houch). Double access to the home: an access to the animals (stable) and the other to the man (Figure 9-A).

The vestible (skiffa) is a space covered and not simply a passage; it is the mediator between the outside and the courtyard (Figure 9-B). The courtyard (houch) is the main core of the chaoui house, around which family life is organized. The living room (sala) is assigned to receive male guests; it is accessed from the vestibule (Figure 9-B). The room (bit) is a multipurpose place for family reunion and reception during the day and for sleeping at night. The kitchen (cousina) partly replaces the multi-purpose space, settles in a pronounced way in the domestic space chaoui. She is generally equipped with a chimney otherwise a corner is reserved where three square-shaped stones are placed to receive the cooking utensil. The toilet (zerdeb) is always designed away from living quarters in a hidden corner. It is a space arranged to allow the collection of waste that will be incinerated (Figure 9-A).

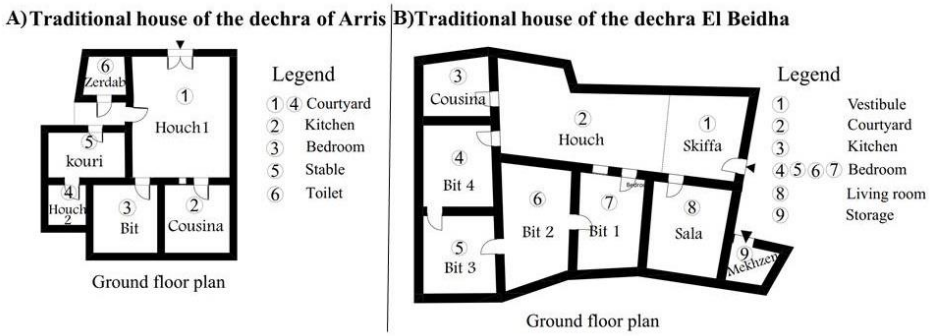


Fig.9. The spatial organization in the dechras houses of Arris (Aksas & Hamouda, 2021)

Results and Discussion

Convex Map

The integration convex map (Figure 10) is a visual description of integration values (based on the smallest and the most elevated integration value derived for a singular plan). Spaces with high connectivity rates are associated with highest integration values. The latter are defined as the most integrated spaces, represented in red in the convex integration map. Conversely, spaces with the lowest number of connections are associated with lower integration values and are described as separate spaces (Adeokun, 2013).

Depthmap (Figure 10) visual integration results, which assign a set of colors ranging from blue (low values) to red (high values), reveal that the core space is the most integrated in the set of systems. This finding that it is a visually accessible and penetrable space. In most cases, the integration's core is located in the centre of the main space. Consequently, the benefit is that the extent of the integration encompasses all adjacent spaces.

The courtyard was the most integrated space in the system followed by the vestibule. The room; kitchen and the toilet were the most segregated spaces (Figure 10).

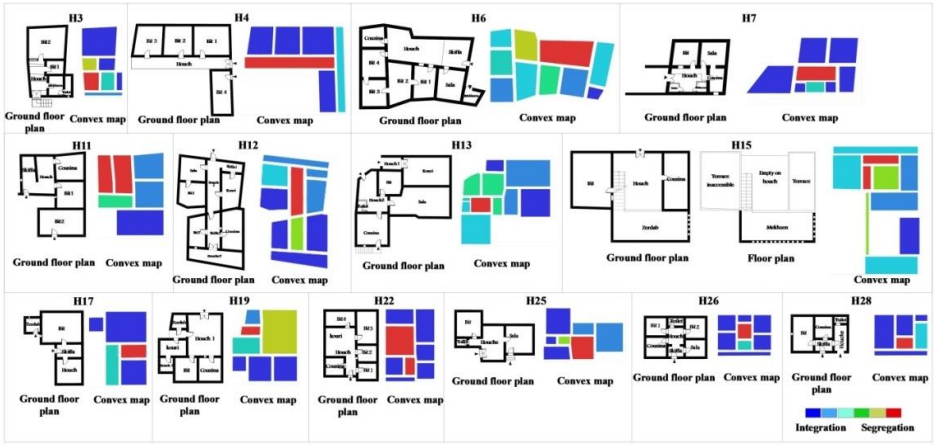


Fig.10. The results of the convex map for the integration value (Aksas & Hamouda, 2021)

Qualitative Analysis

Configurational classification

The justified graphs are divided into two main categories: Tree graphs and annular graphs. Two genotypic are identified. The dominant group comprises 22 houses and the small group seven (Table 1). The dominant group 1 has a tree configuration and a non-distribution compared the small group 2 demonstrate annular spatial configuration offering an alternative movement in a specific part of the house. Houses arrangement analysis suggests two types of houses in the identified samples, with two functional spatial genotypes.

Tab.1. Deciphering the tree structure and annularity

	Tree graphs		**Annular graphs**	
	Pure	**Indefinite**	**Minor ring**	**Internal annular**
Number of dwellings	1, 2, 3, 4, 5, 8, 9,10, 11, 14, 17, 18, 19, 20, 21, 22, 23, 24, 26, 27, 29	15	7, 12, 13, 16, 25, 28	6
Sum and percentage	21 (72.41%)	1(3.45%)	6 (20.69%)	1(3.45%)

Tree graphs

These are tree-like spatial articulations primarily formed of spaces of the topological type B that structure and direct the movements inside the dwellings. The movement from one space to another according to Julienne Hanson (1998) is predictable and stongly controlled from the outside. Moreover, these movements are organized in such a way as to cross the type B nodes to reach the type A nodes which are never crossed. Non-distributed configurations are patterns characterized by a simple arrangement of domestic spaces. Two subcategories of tree graphs are distinguished:

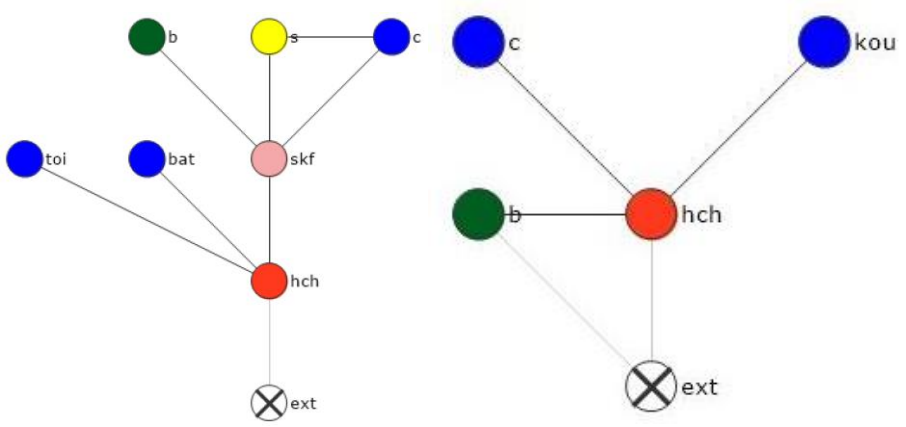
- Plain graphs whose plans are free of stairs in the ground floor.
- Undefined graphs whose plans are composed of one or more stairs on the ground floor.

Annular graphs

Justified graphs or ringy designed graphs, mostly contain topological type C or D spaces or both at the same time. Moreover, moving from one space to another is more difficult compared to the tree configuration. Thus two sub-categories in this case study are distinguished: minor ring configurations and internal annular configurations.

Minor ring configurations

Representing a much localized space arrangement, connecting three spaces together (Hanson, 1998), including topological type C and D. The effect can be external or internal and the distributivity is very weak (Figure 11).



H7 *H16*

Fig.11. Internal and external minor annularity pattern (Aksas & Hamouda, 2021)

The traditional corpus displays 20.69% of minor external and internal ring configuration. Furthermore, the number of cells for houses H7, H13, H16, H25 and H28 is limited to eight. Consequently, even if the ring is minor its impact is global (Table 2).

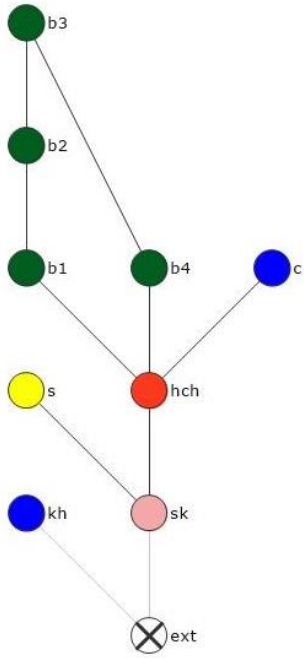
Tab.2. Internal and external annular minor annular configuration

Internal annular	Number of cells	Distributivity index	Outer ring	Number of cells	Distributivity index
H7	8	1.66	H13	8	1.66
H12	10	2.33	H16	5	0.66
			H25	5	0.66
			H28	6	1

Internal annular configurations

Internal ring patterns are defined by the existence of one or more inner rings, including the important core of inner circulations (Hillier & Hanson, 1984). The latter constitutes the "Pole of Convergence" of ring systems. Its impact can be local (connecting a small number of nearby spaces) or global (connecting a large number of distant spaces). The internal ring graph of local importance displays a relatively low distributivity, compared to the internal ring graph of global importance, which displays a relatively high distributivity.

The only instance in the corpus that fulfills this requirement is House H6 (Figure 12). Indeed, it is an internal ring configuration of global importance. Thus, its distributivity index is low (1).



H6

Fig.12. Internal ring finger of global importance (Aksas & Hamouda, 2020)

Quantitative Analysis

Mean Depth (MD)

The depth represents the number of spaces to be traversed to cross from a particular space to another in the system (Mustafa & Sanusi, 2010). As outlined in Figure 13, the simplification of the justified graphs of the 29 plans led to 16 types of permeability graphs.

In the sample studied, it is possible to consider a prevalence of structures with two levels of depth from the outside (68.75% of cases) and a tendency of 31.25%, with three levels of depth.

The living space occupies the majority of depth (1) in 86.20% of cases, and depth (2) in 13.8%, as it counts as the shallowest space in all systems. However, the configurations in which the transition space is located at the first level of depth represent a percentage of 62.5%. The latter displays a presence of 27.59% in the corpus.

The lobby space is completely absent in most cases. It is often connected to the vestible (the cases of houses H6, H7 and H26) or isolated from the rest of the rooms, whose entrance is straight from the outside (the cases of houses H4, H11 and H25) and rarely connected to the backyard (the types T3 and T12).

The private space occupies the depth (2) in 62.5% of the cases. It is the deepest part of the system and is located in the upper part of the justified graph. This space is situated in the upper part of the justified graph. It is strongly provided near the yard.

Finally, the utility space is located at depth (2) in 64.29% of the cases. It is connected to the yard in most of the cases.

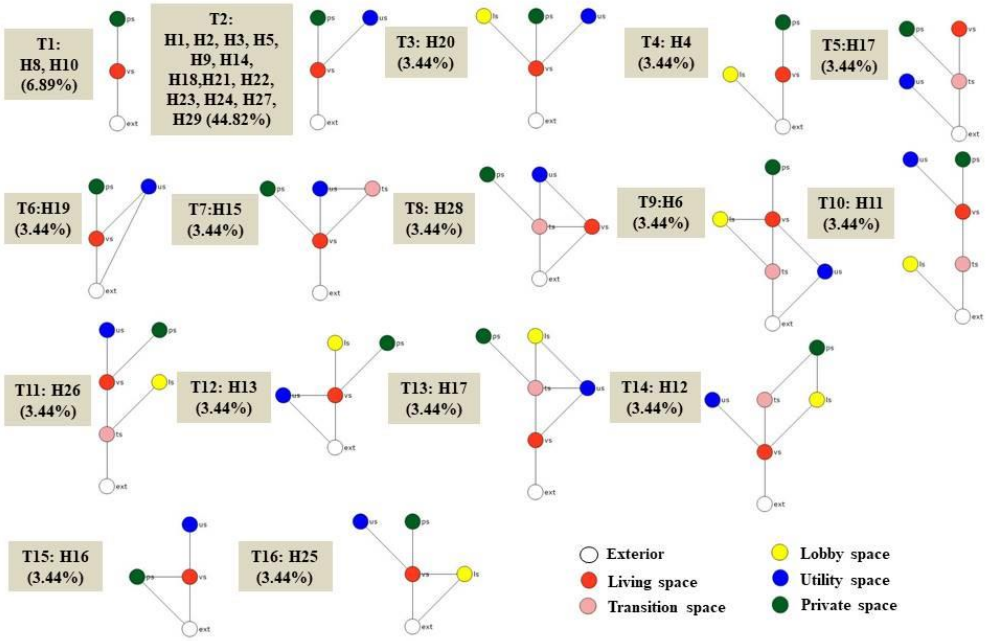


Fig.13. Simplifying justified graphics (Aksas & Hamouda, 2022)

Real Relative Asymmetry (RRA)

The integration is one of the fundamental mean for houses to communicate culture through their configuration (Hanson, 1998). Space integration indicates the connectivity or separation degree related to other spaces. A specific space presents an elevated integration rate when integrated to the system.

If numeric differences (integration values) in the function are in a coherent order in a sample…In this case there is a cultural model. This specific coherence is known as inequality genotypes (Hillier et al., 1987). Table 3 shows the number of recurrence of the cells identified in the most integrated position with exterior. The results of table 3 show a clear recurrence of the structure mode, the living space, in the most integrative position (82.75% of cases), and the transition space in the second position (13.79%). The recurrence of syntactic properties can be an indication of genotype.

The recurrence of some structural features such as RRA and MD in this sample is a potent indication of genotype. The integration results show that the space ranking order in all houses is in a consistent, and a cultural pattern is present.

Tab.3. Integration order

Housing	***RRA***
8, 10, 14.	*ext=ps> vs*
1, 2, 9, 2, 18, 22, 23, 24, 25, 27	*ext=ps=us>vs*
3, 15, 16	*ext=ps>us >vs*
20, 29	*ext=ps=us=ls > vs*
4, 19	*ps> us> ext> vs*
26	*ext=ls> us=ps> ts> vs*
5	*us > ex=ps >vs*
7	*us >ls >ext >ps >ts >vs*
6	*ls> us> ext=ls> vs*
12	*ext> es> er> ep> ev> et*
17	*es> ep=ev> ext> et*
28	*es> ep> ext> ev> et*
11	*ep>es>ext>ev=et*
13	*es> er=ep > ev> ext*
ext (exterior), ps (private space), us (utility space), ls (lobby space), ts (transition space), vs (Living space)	

Visibility Analysis

Depthmap visual integration results (Figure 14), using a specific set of colors ranging from blue for low values to red for high values, demonstrate that the yard space is associated with higher value in the VGA Moreover, this space is the most integrated in the set of systems at the level of the convex map. This implies that the yard is a visually accessible and penetrable space. In most cases we find that the core of the integration is in the center of the core space, leading to the integration covering all adjacent spaces.

The VGA and convex maps review and comparison outline a difference between the results of the two analyses. These differences appear most in the integration cores that can be seen only in the convex analysis. The main reason is that in the VGA analysis, other spaces appear with large integration values; for instance, the rooms where the flux is quite large.

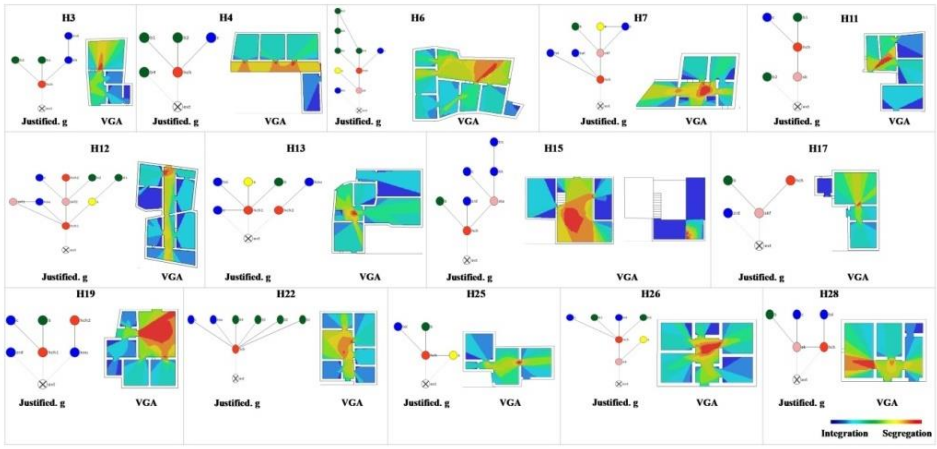


Fig.14. The VGA results for the integration value and the convex map (Aksas & Hamouda, 2021)

Conclusion

Arris house users' main concern is preserving their culture and adapting their traditions to the modern lifestyle conditions. Numerous researches highlight the importance of traditional architecture in the Aurasian region, such as Menaa, Thniet laabed, and Bousina. However, few have investigated the city of Arris, the capital of Labiadh and the Abdi valley. Therefore, this study contributes to its main purpose by extracting a referential cultural corpus for the Arris region. Indeed, this study investigates the existence of an architectural genome in the Arris dechars' traditional dwellings, considering that these habitations has been constructed on rugged parcel of Ouled Labiadh. According to Hillier (2005), space is a physical as well as a relational fact since it is immersed, formed and transformed by the user's daily activities which are derived from the lifestyle and the sociocultural and contextual origin (Benbouaziz, 2019). Arris dechras habitants have been impacted by the deterioration of their social edifices, which have been deeply modified in favour of modern configuration. The study's findings analysis the theories and validate that traditional houses spatiality is related to a spatial hierarchy and that the architectural genotype plays a crucial in the habitants' lifestyle to maintain the component that structure the space. Moreover, the results outline that the lifestyle influence the dwellings morphology from the exterior to the interior.

The Chaoui civilization houses conception seeks to maintain and protect the privacy. The house is the central space hosting most of the domestic activities. The vestible (Skiffa) is the entrance point of visitors occupying the first level of depth in all houses. The latter represent the boundary between the exterior and the interior allowing to preserve a visual privacy of the house private spaces. El Biyout (Rooms) are the most segregated spaces as these are located at the end of the graphs. These rooms are associated with private usage. The living room (Sala) space is slightly deep from the exterior, as this space is dedicated for visitors.

The syntactic analysis of Arris dechras traditional system demonstrates a significant similarity between spatial configuration, and the main space. The latter, could be comparable to the courtyard (Houch), the vestible, or a section of the courtyard and the

vestible. The deeper the analysis in the structure, the more segregated spaces become between private and utility spaces. In contrast the vestible and the courtyard are the most integrated in the houses.

Two genotypic tendencies were noted through the recurrence of certain properties. These trends are structured around the courtyard and the vestible, respectively. The dominant genotype 1 has a non-distributed tree configuration, while the minor genotype 2 has a ring structure and distribution system that provides an alternative pathway within the system. A deeper analysis reveals segregated spaces such as private and utility spaces, while the vestible and the courtyard are the most integrated in the house. This society integrates spaces with a private function (bedrooms), spaces with a family function (coutyard) and spaces with a semi-private function (vestible). It is the referential corpus of Arris traditional house.

Both VGA and convex analysis settle on the fact that private and utility spaces are segregated. In most cases the integration core is at the centre of the main space, with the advantage of an extending integration covering the adjacent spaces.

Conflicts of Interest: The authors declare no conflict of interest.

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