RS Global Journals

Scholarly Publisher
RS Global Sp. z O.O.
ISNI: 0000 0004 8495 2390

Dolna 17, Warsaw, Poland 00-773
Tel: +48 226 0 227 03
Email: editorial_office@rsglobal.pl

JOURNAL	International Journal of Innovative Technologies in Social Science
p-ISSN	2544-9338
e-ISSN	2544-9435
PUBLISHER	RS Global Sp. z O.O., Poland

ARTICLE TITLE	DISTRIBUTIVITY AND SYMMETRY IN SPATIAL CONFIGURATION OF RURAL HOMES. EL KANTARA (BISKRA) CASE STUDY
AUTHOR(S)	Sabrina ACHERARD, Abida HAMOUDA, Lamia BENYAHIA, Abdelhalim ASSASSI
ARTICLE INFO	Sabrina ACHERARD, Abida HAMOUDA, Lamia BENYAHIA, Abdelhalim ASSASSI. (2023) Distributivity and Symmetry in Spatial Configuration of Rural Homes. El Kantara (Biskra) Case Study. *International Journal of Innovative Technologies in Social Science*. 4(40). doi: 10.31435/rsglobal_ijitss/30122023/80090
DOI	https://doi.org/10.31435/rsglobal_ijitss/30122023/80090
RECEIVED	21 November 2023
ACCEPTED	28 December 2023
PUBLISHED	29 December 2023
LICENSE	This work is licensed under a **Creative Commons Attribution 4.0 International License.**

DISTRIBUTIVITY AND SYMMETRY IN SPATIAL CONFIGURATION OF RURAL HOMES. EL KANTARA (BISKRA) CASE STUDY

Sabrina ACHERARD
Institute of Urban Techniques Management, Laboratory of Dynamic, Intelligent and Resilient Territories, University of Salah Boubnider Algeria
ORCID ID: 0000-0003-4997-0908

Abida HAMOUDA
Institute of Architecture and Urbanism, LEVE laboratory, University of Batna1, Algeria
ORCID ID: 0000-0002-2705-7547

Lamia BENYAHIA
Institute of Architecture and Urbanism, LEMPAU laboratory, University of Batna1, Algeria
ORCID ID: 0000-0002-1652-4699

Abdelhalim ASSASSI
Institute of Architecture and Urbanism, University of Batna1, Algeria

DOI: https://doi.org/10.31435/rsglobal_ijitss/30122023/80090

ARTICLE INFO

Received 21 November 2023
Accepted 28 December 2023
Published 29 December 2023

KEYWORDS

Rural Housing, Space Syntax, Justified Graph, Distributivity/Non-Distributivity, Symmetry/Asymmetry, Genotype.

ABSTRACT

Several studies have addressed the mode of evolution of inhabited space and several methproposed to understand the interface between user and space and its impact on spatial configuration. In this field, space syntax provides a theory and a method for analyzing the correlation between spatial properties and the behavior of people in inhabited space and the modeling of space according to endogenous and exogenous influences. El Kantara, a case study, was predominant in pre-colonial and colonial times by the traditional vernacular type of architecture. After independence, the so-called modern construction took over. The objective is to shed light on constants and evolutions by a diachronic reading through the use of the spatial syntax method which is a set of techniques for the representation, quantification and interpretation of the spatial configuration of the built environment. Each house was analyzedaccording to its distributivity/non-distributivity corroborated by control visibility and symmetry/asymmetry corroborated by integration visibility recommended by space syntax and elaborated by depthmap. The results show that the genotype of El Kantara dwelling has undergone changes throughout its journey from the nineteenth century to the present day. The mainly constant is that it has always been a question of establishing a demarcation between the inner sphere and the outer sphere and that the spatial configuration takes many forms and revealed degrees ofrupture with respect to the outside.

Citation: Sabrina ACHERARD, Abida HAMOUDA, Lamia BENYAHIA, Abdelhalim ASSASSI. (2023) Distributivity and Symmetry in Spatial Configuration of Rural Homes. El Kantara (Biskra) Case Study. *International Journal of Innovative Technologies in Social Science*. 4(40). doi: 10.31435/ rsglobal_ijitss/30122023/80090

1. Introduction.

Human habitability has changed or developed, in terms of its norms and values, according to the cultural standards of the time and society (Kim, 2011), because space is the result of social and cultural production oriented by intentions and purposes that give it form, utility and meaning. A meaning that is renewed and enriched as it is used (Bonetti, 1995). The original historical meanings of the habitat never fade away, they always emerge, but they are constantly reworked, reshaped, transformed by society and by the generations of occupants who succeed one another and imprint their marks on it. Through movements of devalorization/enhancement, we discover unsuspected virtues or defects in them, so that each construction is a veritable palimpsest (Bonetti, 2001).

Algeria through its history has undergone several changes, along several periods, namely the Romano-Byzantine period in the 1st century AD, the advent of the Arab-Muslims around 620, the Ottomans and finally the French colonization in 1830. This historical evolution was not without influence on the rural and urban architectural space. Each society has built on the same physical support or sometimes bordering a space in its own image. It should be noted that a space can never completely erase the previous one and therefore cannot represent today's society (Cote, 1993). The traditional Arab-Muslim space of the pre-colonial period present in the collective memory and the influence of Western cultures inherited from the colonial period have had an impact on the present society.

The post-independence architecture is not an integral reflection of the present society; it retains characteristics of the precolonial and colonial society. It represents an architecture that has evolved over time. Thus, the historical evolution of the habitat according to Moley (1999) is the product of the combination of a sedimented and re-actualized architectural culture. When the function of a construction changes or when social relations between inhabitants change, new spatial orders appear (Boutabba, 2011; Dawson, 2000; Rapoport, 1972).

Hiller and Hanson (1984) developed the spatial syntax method which allows the study of the relationship of spatial forms in relation to lifestyle issues related to social issues whether in the urban, architectural, heritage or archaeological fields. The basis for the study of space syntax in a particular region is established by determining whether the social or cultural practices of that region are reflected in syntactic values (Zaco, 2006; Brown & Bellal, 2001). Several studies have adopted this approach, some of which have adressed the evolution of the habitat over time and its transformation through uses (Moreira & Serdoura, 2018; Saeid & Ghazaleh, 2016), while other studies have conducted comparative analyses between the old and the new (Soares, Serra & Furtado, 2018; Bessioud & Mazouz, 2018) or the generative and the conservative habitats (Maziar, Farzin & Elaheh, 2019; Umbelino, 2018).

Trigueiro (2001) applied space syntax techniques to house plans designed in the mid-19th century to examine traces of British lifestyle influence on Brazilian domestic space. Çil (2007) analyzed the transformation of Ottoman houses under the influence of European architecture and then how the style of these houses has changed to accommodate social and economic evolution. Hybrid forms emerged in the period from the end of the 18th century to the end of the 20th century. Otherwise, Cunha (2012) studied the spatial organization of middle-class apartments in Brazil from 1930 to the present day to analyze the transformations that these different dwellings have undergone.

Asif (2018) aimed to understand how syntactic analysis can extract social information embedded in architectural practice. The result shows that the syntactic properties of a particular configuration in a particular region reflect the traditions of the inhabitants of that region. The author argued that the study of space is incomplete without relating it to the culture and practices of peoples. Spatial organization is a function of the form of social solidarity, and different forms of social solidarity are built on the foundations of a society as a spatial and transpatial system. Other researchers believe that space syntax, as a prospective method, can be used in the design phase to simulate the effect of selected constructed forms on the use of space. Indeed, it offers an opportunity to address problems related to the spatial aspect of housing (Zerouati & Bellal, 2019).

2. Materials and Methods.

The qualitative analysis of space syntax consists in translating an architectural plan into a justified graph made up of circles corresponding to spaces or cells, arranged in horizontal lines connected to each other by lines according to the permeability relation-ships they maintain between them. The basic models of a justified graph refer to the symmetry/asymmetry variables relating to the

form of integration, and the distributivity/non-distributivity variables relating to the form of control (Hillier & Hanson, 1984). They also refer to topological types (Figure 1).

3. Symmetry /asymmetry, distributivity/non-distributivity.

In Table 1, the first case shows a configuration where "a" is symmetrical to "b" with respect to "c". It is a ring tree-like configuration, if there is no connection between the two (case 2), then the system is non-distributed and therefore has a pure tree-like configuration. The third case shows a configuration where "a" and "b" are asymmetrical with respect to "c". In this case, "b" can only be accessed from point "c" if one has to go through "a", so "a" controls access to "b". The system presents an asymmetric non-distributed tree-like configuration and therefore a chain or linear sequential configuration.

Table1. Different configurations of the justified graph.

Layout	Signification
	Case 1: Symmetrical distributed and ringy configuration
	Case 2: Non-distributed symmetrical and tree-like configuration
	Case 3: Asymmetrical non-distributed configuration
	Case 4: Asymmetrical distributed and ringy configuration
	Case 5: symmetrical non-distributed and tree-like configuration.

The fourth case shows a globally asymmetrical configuration insofar as "a", "b", and "d" are not symmetrical with respect to each other relative to "c" because the system has a closed circuit (ringy layout) forming a chain sequence. Access to "d" can be from "a" or "b". "a" and "b" control access to "d" relative to "c", in which case there is some flexibility of movement; and "d" controls access to "a" and "b". The fifth case shows a pure non-distributed tree-like configuration, since there is no ring-like configuration, and symmetrical at the first level of depth, i.e. from point "d". In this case "d" is a pole of convergence in that all points (a, b and c) are articulated there, and it also exerts a strong potential of control over these points. A symmetrical configuration means that there is a tendency towards the integration of social categories, while on the contrary if it is asymmetrical then there is a tendency towards segregation. If the configuration is distributed, then there is a tendency towards the diffusion of spatial control, while a non-distributed configuration indicates a tendency towards super ordinate unitary control.

Distributivity Index = (a+b)/(c+d) (1)

Symmetry Index = (a+d)/(b+c) (2)

The values a, b, c, and d correspond to the number of type-a, -b, -c, and -d spaces in the system. A low distributivity index indicates a distributed system and a high distri-butivity indicates a non-

distributed system, where a low symmetry index refers to asymmetry, and a high symmetry index refers to symmetry (Hanson, 1998).

4. Topological types.

According to Hillier (1996), two kinds of human behaviour in space can be observed in a generic way: occupation and movement. Movement makes use, mainly, of relations between spaces, in contrast to occupation, which makes use of the spaces themselves, and is therefore static or involves only localized movements. The requirements of occupation and movement imply four basic topological properties. This typology makes it possible to express, in terms of movement and occupation, the spatial relations between the cells constituting a building, whose configuration is made explicit by the justified graph (Figure 1). The spaces that make up the graph can be divided into four topological types (Hillier, 2007).

b-Type spaces have at least two links and are on the passage to (and from) at least one such space; they remove the possibility of through movement, but also strongly control it, because each route through b-type space is unique. The return movement must pass through the same space. The c-type spaces have at least two links and are on a single ring, they also remove the possibility of through movement, although without the same requirement for the return passage. The same applies to type-d spaces, which contain at least two rings and have at least one space in common. They allow movement, but with much less control because there is always the choice of routes in both directions (Hillier, 1996; Bellal, 2007).

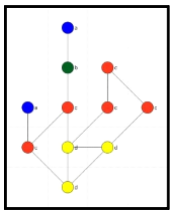


Figure1.Topological types.

5. Study case.

The study site the oasis of El Kantara (the toponymy of El Kantara comes from the Arabic word Pont) is situated in north eastern Algeria, in the wilaya of Biskra. It is located at the border of the southern region of the country (Sahara desert) at an altitude of 538.23 meters. Its climate is cold in winter and hot in summer. This oasis is home to 11 415 inhabitants with a population density of 47.8 /km.

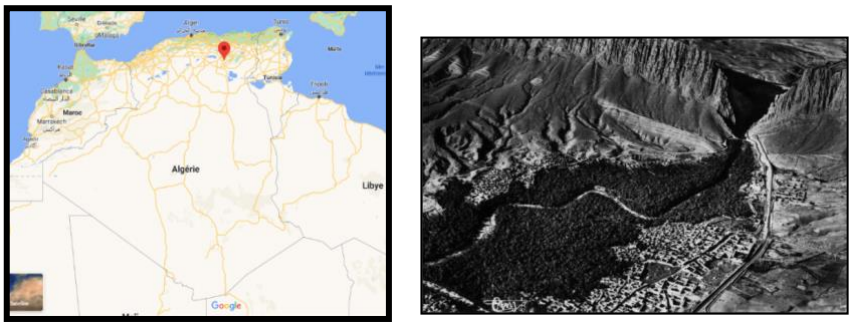


Figure 2. Situation of El Kantara village.

The sample to be analyzed includes a total of about a hundred houses distributed on the various districts of the agglomeration and belonging to the three main periods characterizing the history of the Algerian space (pre-colonial, colonial and post-colonial). This analysis provides information on how this habitat has evolved. There are 29 houses from the pre-colonial

period (p), 22 houses from the colonial period (c), 37 houses from the post-independence period (pc) and 9 houses that hybridize the old and the new (h) styles.

The former house of the pre-colonial period has different plot bases, impossible to meet two similar plots, and was strongly introverted. This introversion is explained by the need for separation between public and private sphere and the segregation of family life in order to maintain privacy (Saeid & Ghazaleh, 2016). Access to the house is through the door that opens onto a chicane space (sguifa) that acts as a buffer or intermediary space, which in turn opens onto the reception space (bit eddiaf) and the courtyard (hawsh) that represents the central space of the house and distributes the rest of the rooms in the house. During the colonial period the mode of occupation of the plot is reversed, the centre that is occupied by the courtyard is, in this configuration, occupied by the main building. The courtyard is now excluded from this same body which itself is organized along a corridor that distributes the different rooms.

After independence, in 1962, the house marks a shift towards the street, providing a more innovative response to a change in the shape of the house. The facades are open to the outside through the windows. The courtyard is built at the back of the house and access is directly on the corridor. In recent years, the courtyard is always at the back of the house and access to the house is through a veranda that constitutes a buffer or intermediate space between public and private space. Table 2 lists all these schemes.

Table2. Diagrams of houses at different periods.

			
			
Diagram of the pre-colonial house	Diagram of the colonial period house	Diagram of the house after independence (1962)	

6. Results of Syntactic analysis.

The observation of the qualitative properties refers to the study of the justified graph as to the shape of the arrangement of the cells between them and their topological types. The aim is to identify the trends in these variations and to explain them.

7. Configurational classification.

Establishing a classification according to the configurational typology is equivalent to classifying justified graphs through the connections between the cells that make compose them. At the level of the sample studied, five types were inventoried: the non-distributed tree-like justified graph, the minor or trivial ring tree-like justified graph, the internal ring graph, the external ring graph, the complex ring graph. Table 3 and Figure 3 show that the further one advances in time, the more the tree-like configuration decreases in favour of the ring-like configuration.

Table3. Configurational classification of different houses at the sample.

Sample	non-distributed tree-like	Tree-like with trivial ring	External ring	Internal ring	Complex ring
Precolonial corpus	P1, p2, p3, p4, p5, p6, p7, p8, p9, p10, p17, p19, p20, p22, p23, p24, p25, p26,	P11, p12, p13, p14, p15, p16, p18, p27, p28		P29	P21
Total	18 (62%)	9 (31%)	0 (0%)	1 (3,5%)	1(3,5%)
Colonial corpus	C6, c7, c8, c9, c10, c11, c12, c13, c14, c15, c16, c17, c19, c20, c21, c22	c5, c18	C4,	C2, c3	C1
Total	16 (73%)	2 (9%)	1 (4%)	1 (9%)	2 (4%)
Post indépendance corpus	Pc20, pc21, pc22, pc24, pc25, pc26, pc33, pc35, pc36	Pc18, pc19, pc23, pc27, pc30, pc31, pc32, pc37	pc8, pc10, Pc29, pc34	pc5, pc11, Pc17, pc28,	Pc1, pc2, pc3, pc4, pc6, pc7, pc9, pc12, pc13, pc14, pc15, pc16
Total	9 (24%)	8 (22%)	4 (11%)	4 (11%)	12 (32%)
hybrid corpus	H1, h5	H7	H2, h3, h6, h8, h9	H4	
Total	2 (22%)	1 (11%)	5 (55%)	1 (11%)	0 (0%)

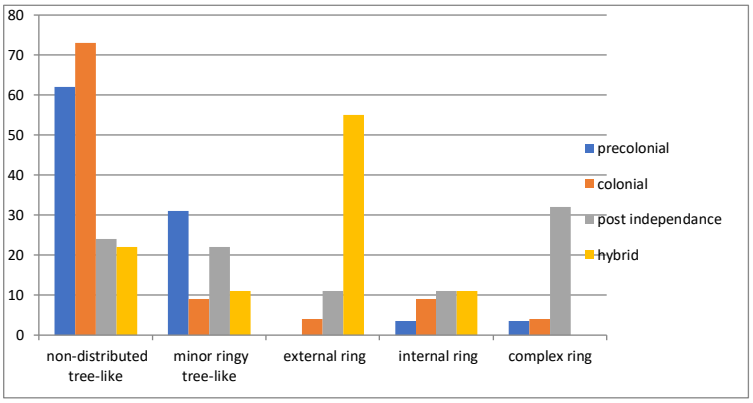
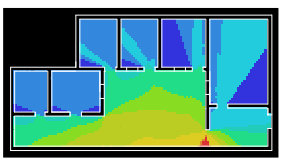


Figure3. Configurational typology.

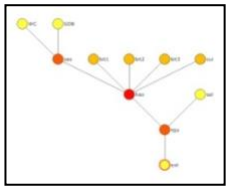
8. Tree-like configuration of the precolonial sample.

According to Table 3 and Figure 3, most houses use tree-like configurations to organize internal space. It can be assumed that internal and external movement is strongly controlled by b-type spaces where access or movement within the house needs to be controlled in the interests of the inhabitants (Hanson, 1998). The tree-like configuration consists only of a- and b-type spaces, with reduced and highly directed circulation options.

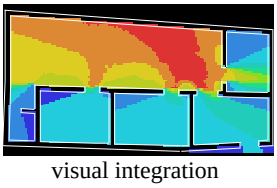
It is worth noting that the tree-like organization, strongly adopted in the traditional architecture of El Kantara (Figure 4), is a relatively elementary way of configuring a building to maintain a certain distance from the external world, but also to establish a clear architectural framework that is easy to decipher and less ambiguous in its use. Namely, in the case of the tree-like system, the poles of convergence are generally formed by a symmetrical arrangement of a-type subordinate cells to a b-type pivot space (courtyard) (Letesson, 2009).



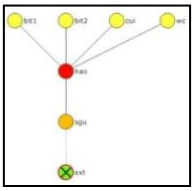
visual integration

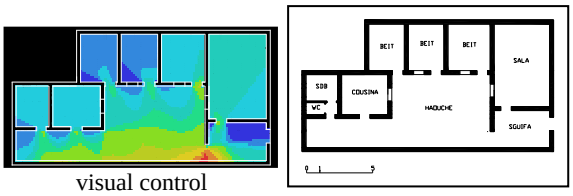


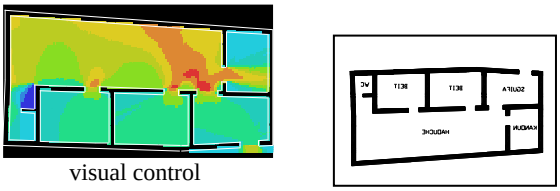
b-type space



visual integration







(a) House p2: Asymmetric tree-like layout (b) House p25: Symmetric tree-like layout.
In the above plans the red colour indicates high values of integration and control,
and the blue colour indicates the less ones.

Figure 4. Non-distributed tree-like layouts patterns at precolonial corpus.

For the pre-colonial sample, 62% of the houses have a pure non-distributed tree-like spatial articulation, of which 55.5% have an asymmetrical but locally symmetrical tree-like configuration, while 44.5% have a symmetrical structure (Tables 4 and 5).

Table 4. Houses with a symmetrical non-distributed tree-like configuration (pre-colonial period).

Houses	P7	P9	P17	P4	P5	P8	P19	P26	**Total (%) = 44.5**
Symmetry index	3,5	3,5	3,5	3	3	3	3	3	

Table 5. Houses with asymmetrical non-distributed tree-like configuration (pre-colonial period).

Houses	P2	P22	P23	P3	P10	P25	P1	P6	P24	P20	Total (%) = 55.5
Symmetry index	2,67	2,67	2,67	2,5	2,5	2,5	2	2	2	1,75	

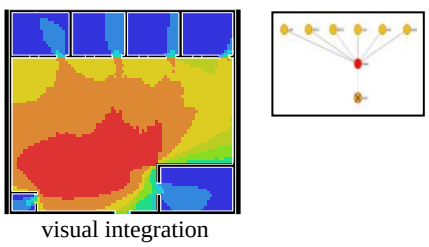
9. Asymmetrical non-distributed tree-like configuration.

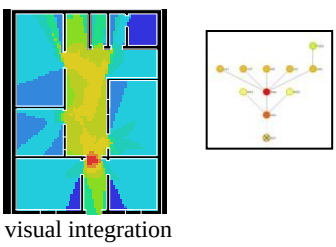
This structure is made up of only a-type and b-type spaces, where movement is highly controlled. Two b-type spaces structure the movements with a third of lesser importance (Figure 5a). At each b-core a tree-like configuration is developed. Its importance depends on the core in question, so we note:

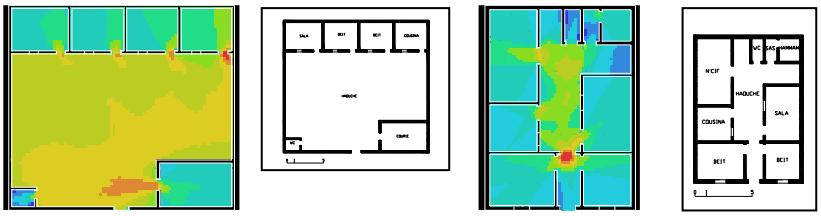
- The first one is the sguifa that divides the passages in the house in two. A route that leads to the male quarter of the dwelling, and being of a-type, it is closely related to it. Another route leads to the domestic quarter. It has an average integration, relative to the whole sample, of 0.18 and a control value of 2.37.
- The second is the courtyard which is the main space of the house where all the cells are articulated. As a pole of convergence, it is the most integrated space with an average of integration value of 0.1 and the one with the highest control value of 4.54. Its role as a spatial binder is obvious. From the courtyard the cells develop symmetrically. Such an arrangement evokes a concern to create an intelligible functional framework.

10. Symmetrical non-distributed tree-like configuration.

It is a configuration that presents an asymmetry up to the second depth level, and then it presents a total symmetry (Figure 5a). Penetration into the dwelling is always through the sguifa that controls access to the courtyard. Thus, the tree-like configurations reveal a certain segregation of the overall system from the outside, which is one of the most isolated spaces. Using the asymmetry index (2.76), the domestic area is well separated from the outside world and is only at the third level of depth and organized around the courtyard.







visual control visual control

House c12: (a) Shallow tree-like layout House c14: (b) Deep tree-like layout

In the above plans the red colour indicates high values of integration and control, and the blue colour indicates the less ones.

Figure 5. Tree-like configurations of the colonial corpus.

The tree-like configuration seems marked by a configuration that targets the relationship between inhabitants. However, it does not exclude, in most cases, the development of an area close to the outside space, and related to the sguifa; it is potentially de-signed to receive male guests. A non-distributed system is the domain of the inhabitants with very strong sanctions against the penetration of visitors. Bit eddiaf is a non-distributed and asymmetrical space, both properties can immediately be referred to the concept of transpatial solidarity, i.e. a form of solidarity achieved through the control of categories in segregation rather than the interpenetration of categories through spatial contiguity and random movement (Hillier & Hanson, 1984). It is a transpatial space with a cut link; it must be segregated from its immediate environment and daily motion.

11. Tree-like configuration of the colonial period sample.

For the houses built during the colonial period, two types of tree-like configuration can be distinguished, as revealed by the symmetry index (Tables 6 and 7). Symmetrical configurations have an index greater than or equal to 3 and asymmetrical configurations have an index of symmetry less than 3. Thus, a large number of symmetrical trees (59%) with cases that shows a very strong symmetry can be observed. This type of tree-like configuration appeared during this period, attesting to the gradual disappearance of the first space of access to the house (sguifa) before penetrating the family space (hawsh), which itself became this time the space of penetration into the house (Figure 5a).The corpus also includes houses with an asymmetrical configuration (Figure 5b), similar to the houses dating from the pre-colonial period with a proportion of 41% (Table 7). Except that the access space to the house is no longer only through the sguifa, but through the corridor or the hawsh.

Table 6. Symmetrical non-distributed tree-like configuration (colonial period).

Houses	**C9**	**C11**	**C13**	**C12**	**C18**	**C10**	**C8**	**C15**	**C7**	**C20**	Total(%) = 59
Symmetry index	9	9	8	7	5,5	5	4	4	3,5	3,5	

Table 7. Asymmetrical non-distributed tree-like configuration (colonial period).

Houses	***C6***	***C14***	***C16***	***C17***	***C19***	***C21***	***C22***	Total (%) = 41
Symmetry index	2,67	2,67	2,67	2,67	2,67	2,5	2,5	

12. Tree-like configuration of the post independence and hybrid sample.

In the post-independence period, the tree-like configuration declined in favour of the ringy configuration (Figure 3). The non-distributed tree-like configuration has two aspects: 33% symmetrical with symmetry indices ranging from 3.5 to 4 and 67% asymmetrical with symmetry indices ranging from 1.33 to 2.67 (Tables 8 and 9). As for the hybrid corpus, all the hybrid configurations are asymmetrical (Figure 6), with a symmetry index equal to 2 (Table 10).

Table 8. Symmetrical non-distributed tree-like configuration (post-independence).

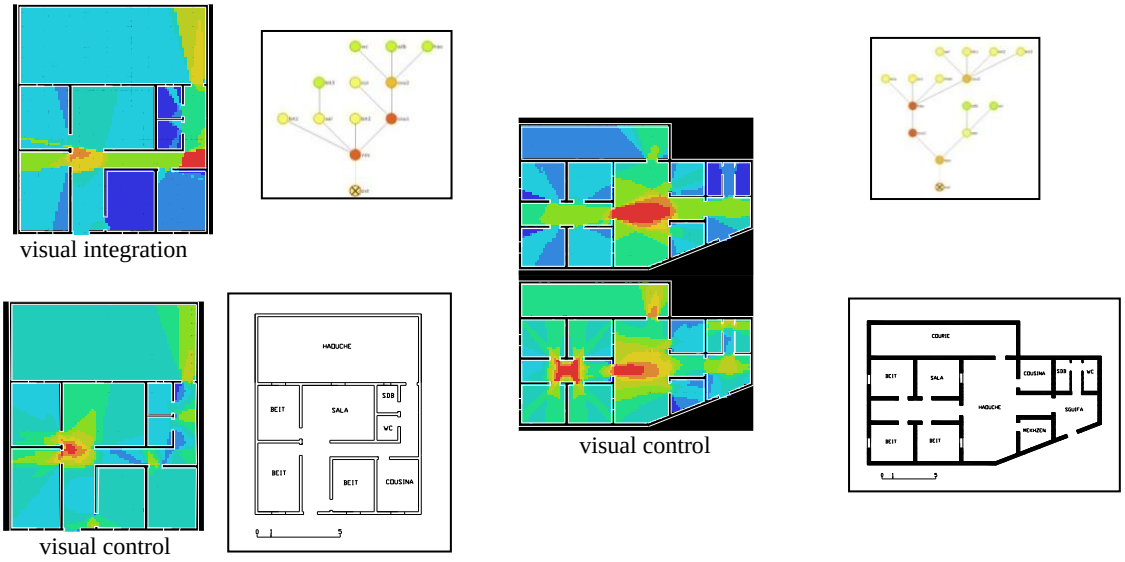
Houses	Pc24	Pc26	Pc25	
Symmetry index	**4**	**4**	**3,5**	Total (%) = 33

Table 9. Non-distributed asymmetric tree-like configuration (post-independence).

Houses	Pc22	Pc36	Pc21	Pc20	Pc35	Pc33	
Symmetry index	2,67	2,33	2,25	2	1,6	1,33	Total (%) = 67

Table 10. Asymmetrical non-distributed tree-like configuration of hybrid houses.

Houses	H1	H5	H7
Symmetry index	2	2	2



(a) House pc20:deep tree (b) House h1: deep tree

In the above plans the red colour indicates high values of integration and control, and the blue colour indicates the less ones.

Figure 6. Tree-like configurations of the post-independence and hybrid corpus.

13. Ringy configuration.

A ringy configuration is used to give the user the choice of movement and freer exploration of the interior of the building (Hanson, 1998). Compared to the tree-like configuration, the ring-like plan is more difficult to characterize; it offers a greater number of circulation options through the addition of connections in the configuration above the minimum necessary to ensure continuity of the system (Hanson, 1998). In topological terms, these justified graphs are marked by the presence of c-type and or d-type spaces. This configuration is associated with a concern to offer alternatives of movement, to create distinct circuits of circulation, and materializes poles of convergence. By convergence pole, we mean a cell that is in a dominant position on a ring and/or a cell through which several rings transit (Letesson, 2009). The studied houses present a ringy layout that develops essentially through the spaces that are best integrated into the system and have the highest control values. Namely, a ringy system is a distributed system, i.e. a set of spaces through which the visitor, subject to more or less control, can pass (Hillier & Hanson, 1984).

14. Trivial ring configuration.

This type of structure has an arrangement in which there is a circuit that connects a maximum of three adjacent nodes and which can only have a very localized effect (Hanson, 1998). All of them are

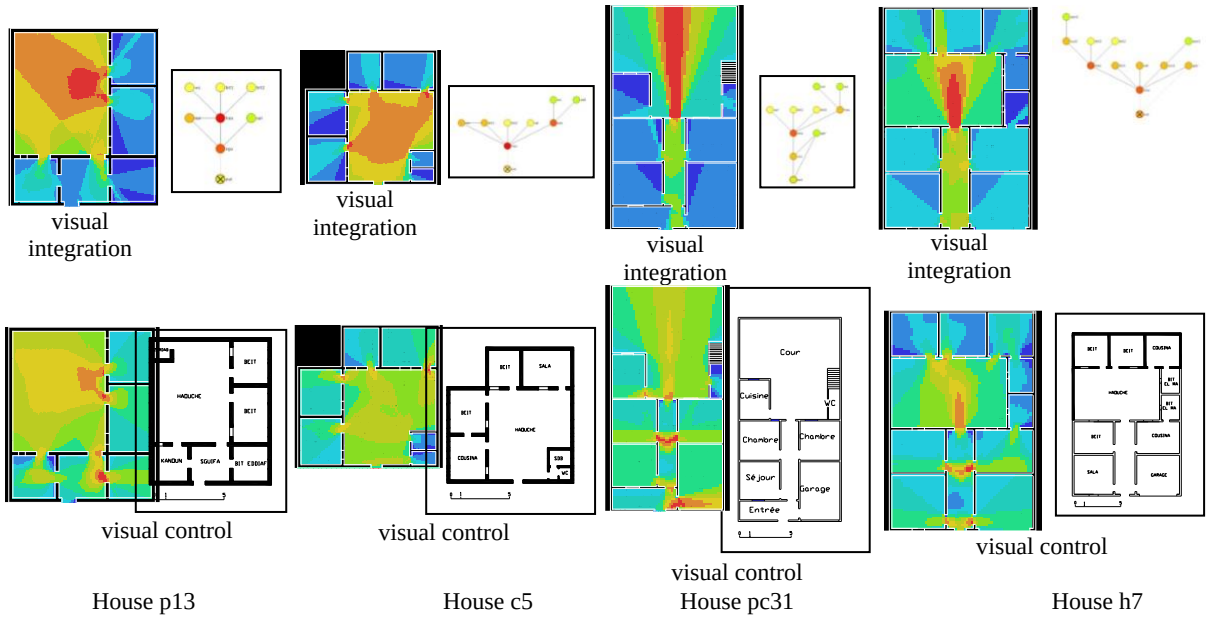
of type-c and they exert a certain control, but with a certain flexibility. In the sample studied, the internal and external rings fall into this category.

Table 10. Trivial ringy configuration per corpus.

Samples	Internal ring	External ring
Pre-colonial corpus **Total and percentage**	P11, p12, p13, p14, p18, p27, p28 7 (77,8%)	P15, p16 2 (22,2%)
Colonial corpus	c5, c18	
Total and percentage	2 (100%)	0 (0%)
Post-independence corpus	pc23, pc27, pc32	Pc18, Pc19, pc30, pc31, pc37
Total and percentage	3 (37,5%)	5 (62,5%)
Percentage by corpus in relation to the total	p (54.5%), c (18.2%), pc (27.3%)	p (37.5%), c (0%), pc (62.5%)

The pre-colonial period corpus accounts for 31% (Table 2) with an internal majority (Table 10). In this case, the hawsh is the pole of convergence forming a ring with the sguifa and the kanun (kitchen) in 33% of cases, and the ring with the kanun and a room in 33% of cases. The hawsh also forms a ring with the sguifa and bit eddiaf in 16% of the cases, as does the ring with two rooms. For the external ring, it is mostly formed between the sguifa and bit eddiaf.

The corpus of the colonial period counts 2% with an internal unanimity. The hawsh constitutes the pole of convergence by forming a ring with the kanun and a room. The corpus of the post-independence period includes 22% with an external majority. In this case, the pole of convergence is the garage, which forms a ring either with the veranda or with the courtyard. However, when it is an internal ring, it represents the transition space, in this case the corridor, which forms the pole of convergence. For the corpus of hybrid houses, 11% of the rings are external and the garage is the masterpiece (Figure 7).



In the above plans the red colour indicates high values of integration and control, and the blue colour indicates the less ones.

Figure7. Trivial ring configuration patterns.

15. Internal ringy layout.

This configuration is characterized by the fact that the ring it contains is inside the building. Its impact can be local or global. The difference between a trivial ringy layout of local importance and a ringy layout of global importance is mainly illustrated by the distributivity index. According to Tables 11 and 12, three categories can be identified; the first category (50%) has a very low distributivity (greater than 2) and the second category (45%) has a relatively low distributivity (between 1 and 2). The third (5%) has an index of less than 1 and therefore a relatively strong distributivity.

Table 11. Symmetry and distributivity indices for internal ring configurations.

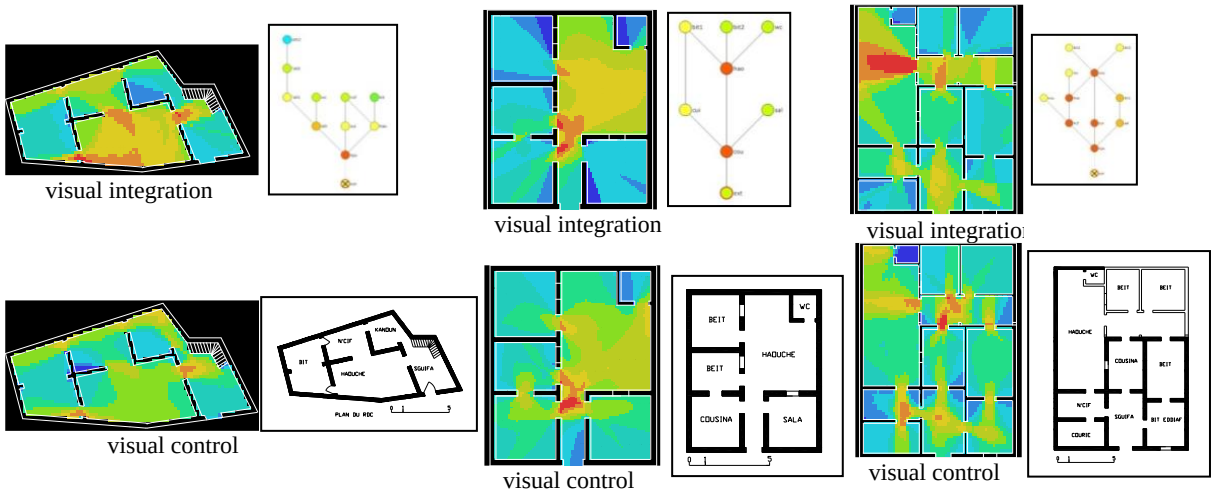
Houses	C18	Pc32	P11	P14	P18	Pc23	P28	Pc27	C5	P27
Symmetry index	2,25	1,46	1,4	1,75	1,2	1,75	1,5	2,33	1,25	1,25
Distributivity index	3,33	3,33	3	2,67	2,67	2,67	2,33	2,33	2	2
Convex spaces	12	12	11	10	10	10	9	9	8	8

Pc5	Pc17	P29	Pc28	P12	13	Pc11	C3	C2	H4
3	1,4	0,57	1,2	1,34	1,67	1	1,5	1	2
2	2	1,75	1,75	1,67	1,67	1,4	1	1	0,7
11	11	10	10	7	7	11	9	7	6

Table 12. Changes in distributivity at El Kantara houses for the internal ringy layouts.

Internal ring	Pre-colonial	%	Colonial	%	Post-independence	%	hybrid	%	total	%
Very low distributivity	5	25	2	10	3	15	0	0	10	50
Relatively low distributivity	3	15	2	10	4	20	0	0	9	45
Relatively strong distributivity	0	0	0	0	0	0	1	5	1	5

The corpus of the pre-colonial period shows a very low distributivity with an index of the order of 2.22. The corpus of the colonial period displays a relatively low distributivity with an index of the order of 2.11. The post-colonial period corpus also shows a very low distributivity with an index of 2.21.Therefore, from a general point of view, internal ringy layout if it exists, its effect is very local and it is the tree-like configuration that prevails (Figure 8).



In the above plans the red colour indicates high values of integration and control, and the blue colour indicates the less ones.

Figure 8. Internal ringy layouts patterns.

16. External ringy layout.

The external ringy layout exists only if the ring has to pass through the outside, with the existence of a minimum of two accesses to the house. It highlights the relationship between the outside and the inside because it is considered a powerful vector in the interpretation of the degree of permeability of the house and therefore the interface between inhabitants and visitors. The distributivity index must be calculated to measure its impact on the spatial system formed by a house. Table 13 summarizes the values of the distributivity index that divides this group into four categories. The first is characterized by a very large ringy configuration with a distributivity index less than 1. The second is characterized by a ringy configuration of overall importance and therefore a high distributivity with an index between 1 and 2. The second is characterized by a ringy configuration of local importance and therefore a relatively low distributivity with an index between 2 and 3. The fourth has a ringy configuration with a trivial effect, and therefore a very low distributivity with an index greater than three.

Table 13. Symmetry and distributivity indices for external ring-like configurations.

External ring	C4	Pc37	Pc30	H2	H3	H7	P16	Pc18
Symmetry index	2,14	0,6	1,5	1,43	1,43	1	1,75	1,2
Distributivity index	4,5	4,33	4	3,25	3,25	3	2,67	67
Convex spaces	21	15	14	16	16	11	10	10

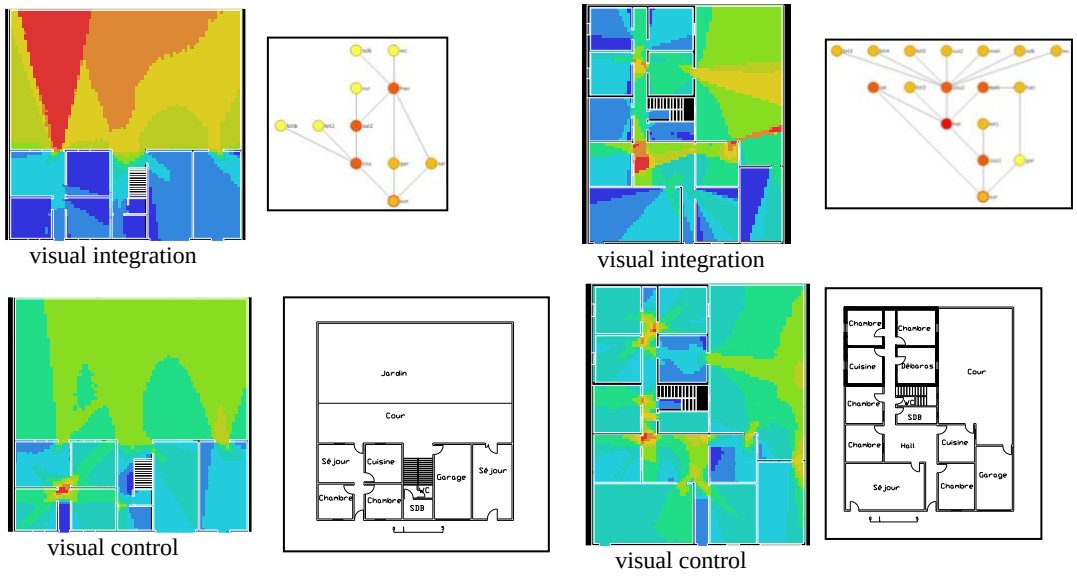
H6	H9	P15	Pc19	Pc31	Pc29	H8	Pc34	Pc8	Pc10
2,4	7,5	1	1,5	1	1,2	2,4	1,2	2,67	1,14
2,4	2,4	2,33	2,33	2,33	1,75	1,43	1,2	0,83	0,67
16	16	9	9	9	10	16	10	10	14

Table 14 lists the results obtained for the impact of the external ringy configuration per corpus, with 39% of sample homes showing a relatively low distributivity and 33 % showing a very low distributivity. In both cases, the tree-like configuration prevails. In the case of a high distributivity, it is the post-independence and hybrid corpus (Figure 9) that is characterized with 16.7%. For a very high distributivity, it is the post-independence corpus that prevails with 11%.

Table 14. Impact of the external ring-like configuration per corpus.

External ring	Pre-colonial	%	Colonial	%	Postcolonial	%	Hybrid	%	Total	%
Very high Distributivity	0	0	0	0	2	11	0	0	2	11
High Distributivity	0	0	0	0	2	11	1	5,5	3	16,7
Relatively low distributivity	2	1 1	0	0	3	16,7	2	11	7	39
Very low distributivity	0	0	1	5,5	2	11	3	16,7	6	33

The cell located deepest in the external ring in relation to the transporter is often the most important space in terms of mediating the relationship between inside and outside (Letesson, 2009). Indeed, when it comes to the pre-colonial corpus it is the sguifa that plays the most important role in this mediation. In the corpus of the colonial period, it is the hawsh. Complexity is encountered in the post-independence corpus where several spaces play this role: the veranda with 44%, the transitional spaces with 33% and the courtyard with 22%.



House pc8 House h8

In the above plans the red colour indicates high values of integration and control, and the blue colour indicates the less ones.

Figure 9: External ring-like configuration models.

17. Complexe ringy layout.

This configuration is characterized by the co-presence of internal and external rings. This type of justified graph is related to buildings with a particularly elaborate configuration. At the study sample, we note its absence at the pre-colonial and the hybrid corpora; it is very rare in the corpus of the colonial period with about 4%; and it is the post-independence corpus that is rich with about 32%. The impact of this type of ring will again be measured by the distributivity index according to whether it is local or global. According to Table 15, two categories can be observed: the first one shows a relatively strong distributivity with a higher index between 1 and 2; the second category has a strong distributivity with an index less than 1.

Complex ringy configuration has an overall impact relative to the system with relatively high to high distributivity (Table 16). Houses with relatively high distributivity are those with a large number of convex spaces with a multiplicity of route choices (Figure 10).

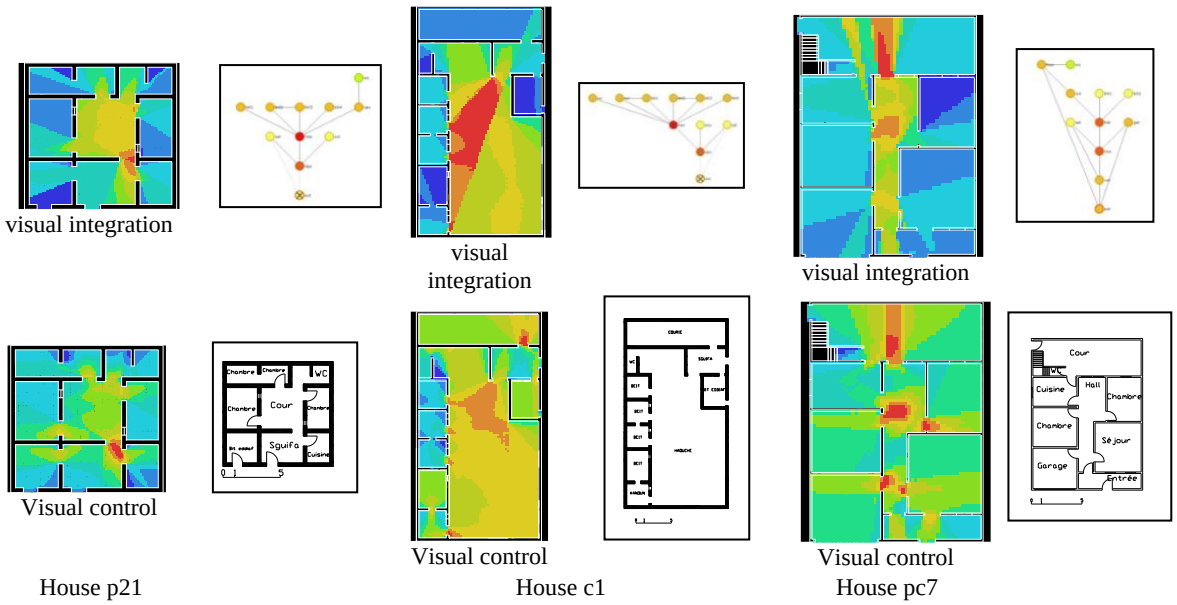
Table15. Indices of symmetry and distributivity of complex ring-like configurations.

Complex ring-like configuration	**Pc2**	**Pc13**	**Pc3**	**Pc15**	**Pc16**	**Pc1**	**Pc6**	**Pc4**	**Pc14**	**P21**	**Pc12**	**Pc9**	**C1**	**Pc7**
Symmetry index	1,33	1,27	1,4	1,4	1,16	3	3	1,6	0,62	0,57	2	2,5	0,57	1,2
Distributivity index	1,8	1,78	1,4	1,4	1,16	1	1	0,86	0,86	0,83	0,71	0,55	0,37	0,37
Convex spaces	13	24	11	11	12	15	11	12	12	10	11	13	10	10

Table16. Impact of complex ring-like configuration.

Complex ring-like configuration	**Pre-colonial**	**%**	**Colonial**	**%**	**Post-colonial**	**%**	**Total**	**%**
Strong distributivity	1	7	1	7	5	36	7	50
Relatively strong distributivity	0	0	0	0	7	50	7	50

In any case, it will be necessary to take in consideration the points of convergence of the rings and the spaces that compose them. At the level of the traditional houses, it is the hawsh that constitutes the pivot of circulation. As for the corpus of the post-independence period, it is always the spaces of transitions (hall, corridor) that are at the junction of several rings forming topologically type-d spaces; they constitute important pivots of the interior circulations. As for the spaces that make up these rings, these would be mainly the veranda, the living room, the garage and in some cases the kitchen and the courtyard.



In the above plans the red colour indicates high values of integration and control, and the blue colour indicates the less ones.

Figure10. Complex ring-like configuration Models.

18. Discussion.

This sample of houses analyzed presents some transformations through the ages. The results confirm changes in the different genotypes over the three study periods. The genotype of the corpus of the pre-colonial period displays a tree-like configuration that refers more directly to the sphere of relations between inhabitants (Hanson, 1998). If we consider the sample in the light of this hypothesis, it is clear that the tree-like plans mostly display a certain segregation of the overall system from the outside. In any case, the tree-like organization of cells with a simple linear sequencing of b-type spaces is a way of configuring a building to maintain a certain distance from the outside world, but also to establish a limpid architectural framework that is easy to decode and therefore less ambiguous in its use (Letesson, 2009).

The genotype of the corpus of the colonial period also displays a pronounced tree-like configuration, but unlike the previous one, it is less deep. The courtyard, in this case, will take, in addition to its role, that of the sguifa. Generator of symmetry, this space contributes to isolate certain activities from each other, but by being a powerful vector of circulation. On the other hand, the concern to establish a precise demarcation between the internal domain and the external world is always present. But in this case, the demarcation is not so clear-cut. Another space has taken over from the internal distribution, which is the corridor. Thus, private spaces are always kept segregated.

The post-independence period is characterized by the emergence of several models illustrating the existence of the unquestionable heterogeneity of the corpus. If we take into consideration the ring-like systems, it is obvious that other interpretative clues can be highlighted. External ringy layout, i.e. a ring that exists only with respect to the relationship between inside and outside, has often been considered as a powerful interpretative vector, especially with respect to the relationship between inhabitants and visitors. Overall, a ring-like system can have two essential functions: it can offer a

variety of movement choices to the people living in it, but it is also used to inscribe within the building the different movement patterns of different user groups (Hanson, 1998). In the genotypes of the post-independence period corpus, a growth in movement options was observed, generated by the multiplicity of connected circuits, and thus inhabitants use more transitional spaces. While in the genotypes of the corpus of the pre-colonial and colonial periods, the houses tended to increase the control of users' movements through the sguifa and the courtyard.

19. Conclusion.

Of these genotypes, it can be noticed that the courtyard constituted the best integrated space, but only in the traditional type. In contrast, one notices the emergence of new spaces in the houses of the colonial period to a lesser degree, but in force in the houses of the post-colonial period, including the corridor and the hall, which also constitute the best integrated spaces and frame the concept of trans-spatial solidarity. As for the spaces in chicane (sguifa), they constituted a constant in the pre-colonial spatial organization. This space began to gradually disappear during the colonial period when it was replaced by the courtyard and in some cases by the corridor. It disappeared completely during the post-independence period; sometimes access is direct through the corridor or hall and sometimes through the veranda which replaces the sguifa as a protective barrier between the inside and the outside.

Furthermore, it can also be noticed that pre-colonial houses tend to be divided into two separate areas: one passage leading to the male neighbourhood represented by bit eddiaf (male living room) and another leading to the female neighbourhood. This separation tends to disappear later to resurface in recent years through the design of a living room whose access is from the veranda without creating the feminine/masculine separation, but by creating the interface inhabitant/visitor or stranger. With the disappearance of the sguifa and the organization around the courtyard, life in the dwelling space has become closer to the street space. The perceptual relationship created by this design offered to anyone entering the house is broken by these transformations, but replaced by other architectural elements, sometimes preconceived (veranda) and sometimes home-made (curtains).

DECLARATION OF INTEREST STATEMENT.

We do not have conflict of interest.

REFERENCES

1. Asif, N., Utaberta, N., BinSabil, A., Ismail, S., (2018), Reflection of cultural practices on syntactical values: An introduction to the application of space syntax to vernacular Malay architecture. Frontiers of Architectural Research, pp.1-10. https://doi.org/10.1016/j.foar.2018.08.005.
2. Bellal, T. (2007), Spatial interface between inhabitants and visitors in m'zab houses. In the 6th international space syntax symposium, Istambul, Turkey, pp 61.1-61.13.
3. Bessioud, H-M., Mazouz, S. (2018), Syntactic study of the old and the new Douiret villages. In Proceedings of the 11th Space Syntax Symposium, Lisbon, Portugal, pp 16.1-16.17.
4. Benyahia, L., Hamouda, A., Bouarroudj, N., Acherard, S. (2022), Habitat rural algérien: trois époques, trois génotypes. Approche syntaxique spatiale. Journal de l'université d'architecture et de technologie de Xi'an. 14(9), pp 57-67. https://doi.org/10.37896/ JXAT14.09/315804.
5. Benyahia, L., Hamouda, A., Moffok, N. (2021). Décoder la configuration spatiale du palais ottoman « Khdewedj El Amia » à Alger (Algérie) à travers la syntaxe spatiale. Prostor, 29 (2(62)), pages 192-211. https://doi.org/10.31522/p.29. 2(62).4.
6. Bonetti, M. (1995), Au plaisir de l'espace. Forum professionnel des Psychologues, CSTB Paris.
7. Bonetti, M. (2001), L'analyse générative des processus sociaux urbains et la composition des modes d'habiter. Urb & paysage, CSTB.
8. Boutabba, H., Farhi, A. (2011), Syntactic analysis and identification of the social properties in spatial arrangements of buildings: the case of the houses called diar charpenti in eastern hodna, Algeria. Theoretical and empirical researches in urban management, volume 6, issue 4, pp 78-92..
9. Brown, F., Bellal, T. (2001), Comparative analysis of m'zabite and other berber domestic spaces, In Proceeding of the 3rd international space syntax symposium, Atlanta, USA, pp. 41.1-41.14.
10. Çil, E. (2007), Space, practice, memory: the transformations of the houses in kula, a town in Anatolia, in 6th international space syntax symposium, Istambul, Turkey, pp 60.1-60.15.
11. Côte, M. (1993), L'Algérie ou l'espace retourné. Media-Plus: Algiers, Algeria.

12. Cunha, V., (2012), Can genotype patterns change over time?, In 18th international space syntax symposium, Paper ref#8215, Chile, pp 8215.1-8215.23.
13. Dawson, P-C. (2002), Space syntax analysis of central Inuit snow houses. Journal of Anthropological Archaeology 21, 464–480.
14. Fenghour, A., Hamouda, A., Benyahia, L. (2022). Fermeture des espaces extérieurs dans un environnement résidentiel entre visibilité et accessibilité, Arquitetura Revista, 18(1), pp.99-119. https://doi.org/10.4013/arq. 2022.181.06.
15. Hamouda, A., Benyahia, L., Brinis, N. (2021), Décryptage du cadre spatial des domus romano-africaines, cas du cuicul (Djemila) Algérie, Archéologie et archéométrie méditerranéenne, Vol. 21, n° 3, pp 101-1 35-5, DOI: 10.5281/zenode.5545713. 2021 /Vol21-3/3_Hamouda_et al_ 21(3).pdf.
16. Hanson, J. (1998), Decoding homes and houses, Cambridge university press, UK.
17. Hillier, B. (1996), Space is the Machine: A Configurational Theory of Architecture, Cambridge University Press, Cambridge, UK.
18. Hillier, B., Hanson, J. (1984), The social logic of space. Cambridge university press, UK.
19. Kim, H-R. (2011), Habiter : perspectives philosophiques et éthiques de Heidegger à Ricœur, doctoral dissertation, Strasbourg university.
20. Letesson, Q. (2009), Du phénotype au génotype : analyse de la syntaxe spatiale en architecture minoene (MMIIIB-MRIB). UCL university press of Louvain, Belgium.
21. Maziar, A., Farzin, H., Elaheh, S. (2019), Comparative study of the factors affecting the generativity of office spaces. Frontiers of Architectural Research, volume 8, pp.106–119.
22. Moley, C. (1999), Regard sur l'immeuble privé, architecture d'un habitat (1880-1970). Le Moniteur, Paris, France.
23. Moreira, A- S., Serdoura, F. (2018), Modernist dwellings in Lisbon, Portugal. A syntactic approach to living use analysis, In Proceeding of the 11th space syntax symposium, Lisbon, Portugal, pp: 17.1-17.18.
24. Rapoport, A. (1972), Pour une anthropologie de la maison, Dunod, Paris, France.
25. Saeid, A., Ghazaleh, M-N. (2016), Privacy at home: Analysis of behavioral patterns in the spatial configuration of traditional and modern houses in the city of Hamedan based on the notion of space syntax. Frontiers of Architectural Research, volume 5, pp.341–352.
26. Soares Saraiva, S., Serra, M., Furtado, G. (2017), Bahrain - continuity and rupture, Traditional and Subsidized Housing in Bahrain", in Proceedings of the 11th Space Syntax Symposium, Lisbon, Portugal, pp 25.1-25.17.
27. Trigueiro, E. (2001), The dinner procession goes to the kitchen a syntactic approach to nineteenth and early twentieth century British houses, In proceeding of the 3rd international space syntax symposium, Atlanta, USA, pp 19.1-19.16.
28. Umbelino, A. (2018), One house, three generations: exploring conversions in domestic space that tell about sociocultural changes over a century, In Proceedings Of The 11th Space Syntax Symposium, Lisbon, Portugal, pp: 183.1-183.8.
29. Zaco, R. (2006), The power of the veil: gender inequality in the domestic setting of traditional courtyard houses, In Social and cultural dimensions, Abingdon, pp 65-75.
30. Zerouati, W., Bellal, T., (2019), Evaluating the impact of mass housings' in-between spaces' spatial configuration on users' social interaction. Frontiers of Architectural Research, https://doi.org/10.1016/j.foar.2019.05.005.