The Architectural Genotype Approach in Contemporary Housing (1995 to 2010)

The Case Study of Setif, Algeria

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Abstract-The current paper aims to analyze the architectural genotype principle that considers the arrangement of spaces as an abstract relational model. The goal is to demonstrate that syntactic measurements show that spatial structures allow messages to be decoded in each dwelling's inner spaces' architecture. The research uses the justified graphic technique for spatial syntax. Twelve detached houses have been randomly selected out of a total of sixty-two contemporary buildings that were built in a subdivision of Setif between 1990 and 2010. The analysis findings showed that the spatial characteristics and properties that constitute the generic rule underlying the studied space can be detected. This research supports the notion that the implementation of the spatial syntax method can aid in the proposition of innovative solutions regarding the design of sustainable housing projects.

Keywords-space syntax; self-built individual houses; architectural genotype; spatial configuration

I. INTRODUCTION

Housing constitutes an imperative of our daily life [1, 2] and is a symbol of human life and society. Social success and individual and family happiness depend heavily on the quality of dwelling. The right to housing [3] is considered inalienable. Housing can be regarded as a product from a single housing unit to a neighborhood or town housing stock [4]. Housing can be approached as a process. This interpretation of housing allows researchers and practitioners to consider the multiple interrelations between housing conditions and human processes in particular localities [5]. In Algeria, the adaptation of an analytical and critical approach to contemporary housing is reflected in large urbanization operations qualified as real new cities in terms of urban sprawl. However, the vast housing programs operated within the socio-economic challenges and changes have been increasingly funded by public authorities to absorb the high housing demand. The State has adopted this policy in the light of the new legislative and institutional means implemented in this dynamic sector.

After a transitional period, the economic downturn has triggered profound changes from a communist regime to a democratic state with a market economy after integrating new political orientations. Profound changes have taken place as a result of both accelerated urbanization and socio-economic shifts. The built environment is evolving and becoming the breeding ground for new social adjustment and urban integration. The residential mobility arising from these improvements contributes to the construction of new residential models [6-9]. However, the detachment of the State, which eliminates the land monopoly and allows private initiative, has enabled local authorities to develop a land portfolio. These land reserves have been compensated almost exclusively for residential properties [6]. Consequently, a modern architectural expression and space creation has emerged as a reflection of the inhabitants' social, cultural, and ideological status [6]. In this study 12 new dwellings were chosen randomly for study from 62 houses in the Hebbache Brothers subdivision. The houses were built over a chronological period from 1990 to 2010 (from the beginning of construction until its final realization). To understand every new house's spatial layout, the space syntax via the AGraph software using the justified graph technique has been utilized. By referring to syntactic measures such as total depth, mean depth, relative asymmetry, integration value, and control value it can be concluded that spatial genetic constants could maintain, at the level of its spatiality, any coherence which could be identified as an architectural genotype. The findings of this research study could be used as a design output for further housing construction in Algeria.

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II. LITERATURE REVIEW

The purpose of the current paper is to identify the genotypes which form the basis for genesis. The meaning of the genotype in the fields of genetics and architectural studies, is presented below.

The genotype is the information carried by the genome of an organism found in each cell in the form of Deoxyribonucleic Acid (DNA). DNA contains all the genetic information, called the genome, which allows organisms to grow, function, and reproduce. In other words, the set of genes (the chromosomes are made up of DNA containing the genes) of an individual shapes its genome. The gene is an inherited DNA fragment which forms an inherited genetic information unit [10]. The genotype has been identified as the complete genetic code for the organism [11]. The idea is that the gene can be activated or not. The degree of gene activation may have functional significance at the behavioral level. Latest observations have demonstrated that certain genes remain passive while waiting for stimuli to be activated. Experimental and environmental factors have been found to be among the stimuli. The authors state that the phenotype is considered as the physical expression of the genes that have been activated and their degree of activation. In a technical sense, the phenotype is the totality of an individual's traits and characteristics [11]. The phenotype is not limited to physical traits. It also includes physiological traits, such as intelligence, emotional profile, and the predisposition to react in a certain way to a given situation. For other researchers the phenotype is considered at the level of a single character, at the cellular or molecular level [12]. It should be noted that genotype and phenotype are two different concepts. The genotype is a genetic code that encompasses the cell, nucleus, chromosomes, genes, and DNA. The phenotype is the set of traits and characteristics of an organism.

When translated into architecture, the genotype becomes the concept of architectural genotype. Researchers define the genotype as abstract rules underlying spatial shapes in the field of spatial syntax [13]. Field experts point out that the house study suggests evidence of at least one spatial-functional genotype defined in terms of relational and configurationally consistency. The dominant genotype is sometimes strongly detected when all the spatial-functional themes are present. In other cases, these genotypes are less likely to be detected when some themes are present, and others are missing. Also, these themes seem to be completely absent or even reversed in some cases [14]. Researchers also argue that as soon as common patterns are identified in integrating different functions or names of dwellings, cultural genotypes that acquire a spatial dimension are treated objectively [14]. Sustainable architecture has been employed in order to deliver practical realizations and aesthetical buildings [15]. New publications have been issued explaining the basics of spatial syntax theory, how it works, and how it can be implemented in contemporary housing [16]. To measure the strength of a spatial genotype, authors used the difference factor. Referring to a sample of traditional Turkish houses from the 17th to the 19th century, the difference factor was deployed to identify households' functions, which are differentiated by their integration or relative separation. It is worth mentioning that these houses have been strongly structured and articulated with other houses. Two signature patterns of integration arc have been noticed. In the same vein, a study conducted in Syria has offered a review on the influence of the Islamic culture on the architecture of the houses and the social practices. The paper analyzed how the architectural pattern of the Islamic community has contributed in the increased privacy, mutual respect, and social segregation [17]. The author in [18] uses basic syntactic data according to the phases of the representation of justified graphs and calculations. This classification brings out seven genotypes. In [19-21], the authors compare domestic spaces through a sample of houses on three Berber regions of Algeria. The authors in [21] also focused on the different factors and highlighted certain similarities between the cases with some fundamental differences. Taken as a whole, the use of the difference factor suggests a characteristic mode for structuring the domestic interior of traditional Berber houses. The genotypes highlight centralized nuclei such as Ammas N'Taddart (the space on the ground floor in the M'zab), the main room in Kabylia, or the main room on the first floor of the Aures. Berber houses tend to be integrated into the spatial configuration with a shallow core in the Aures and Kabylia regions and with a deep core and relatively segregated in the M'Zab region. In another work on the M'Zab region [19], the presence of a strong spatial genotype was shown. The visual map conducted on this same dataset reveals that these spaces are coherently located where multidirectional views can be managed. In contrast, other spaces such as the Tisifri (women's living room) are much more closed and have deliberately limited visibility and permeability. Ammas N'Taddart, Ikoumar, and Tigharghart control access and offer a wide scope of vision by highlighting the different facets of the architecture towards dead-end spaces. Authors in [20] confirmed through justified graphics that the genotypes of the M'Zab house, Ammas N'Taddart, and the male guests' space on the ground floor (the Houdjrat or Douira) are relatively shallow. However, the men's room (the Aali) on the first floor and the basement are deep. The justified graphics demonstrate the importance of the entrance in regulating the interior layout of the M'Zab house and its depth. Furthermore, the justified graphics also demonstrate that the outdoor area is always separated from the domestic life. This demonstration reinforces the social code in such a society. Regarding the spatial interface between guest and inhabitant, the study provides an understanding of the domestic environment at M'Zab in terms of guest/inhabitant interface. In real conditions, the interface is between male guests and the families who live in the houses.

Similar studies have categorized the different genotype types in the conclusion of their work. The topological genotype types A are the bedrooms, the kitchen, the guest bedroom, the toilets, and the stable. The topological types B are the courtyard, the penthouse, the patio, the roof, and the corridor. The topological types C are the courtyard, the guest room, the middling room, and the sideling room. Finally, the topological types D are very rare [22]. Authors in [23] demonstrated that the genotype of traditional oasis dwellings from El Kantara to Biskra (Algeria) displays a tree structure signifying a less elaborate configuration than an annular complex. However, it should be noted that the above mentioned studies confirm the assumption that spatial syntax theory encourages the search for genotypes.

III. RELEVANCE AND RESEARCH QUESTIONS

The scientific motivation behind this research resides in the use of space syntax and the AGraph software. The measurements of total depth, mean depth, relative asymmetry, integration value, and control value were used to identify spatial genetic constants that are architectural genotypes. It is worth mentioning that there is an absence of architectural studies using the space syntax method, particularly in Setif. Hence, the current paper proposes the space syntax method as an innovative solution for sustainable housing projects in Setif. Space syntax theory offers useful tools to understand configuration logic through its engagement with social structure. It also helps social influences consider the properties of the spaces concerning the forms of correlation. Consequently, a clearer comprehension of spatial logic is highlighted as well as each space's functions and activities are routinely known. This connection, interpreted in a coherent sequence, contributes to a social logic interpretation [14]. The advantage of space syntax is that by dissecting spaces, it allows great precision in analysis. Syntactic analysis using the justified graph helps one examine the plans of these 12 new dwellings to create spatial arrangements and discover patterns of space described as architectural genotypes. The project aims to define structures of socio-cultural expression and social logic manifested in the spatial distribution of domestic space. Thus, it is believed that the new housing could retain consistency in terms of its spatial structure that could be defined as an architectural genotype. The focal point resides in the intrinsic and complex relationship between the built environment and the human factor. While it is evident that society's comprehension cannot be restricted to this relevant equation alone, the fact remains that such contemplation, focused on the theory of space syntax and its methods for calculating mathematical order, remains central to the discovery of architectural genotypes.

Spatial syntax theory is used not just for the study of housing, but also for studying urban spaces [23-25], neighborhoods [26], and the city [27]. Space syntax offers resources to interpret architectural reality differently. Famous architects and urban planners have used the theory of space syntax, particularly the dynamic computer modeling techniques of space syntax, to design the internal and external environments of their projects in order to plan scheduled and unscheduled activities. Through using the space syntax system, they were able to model a range of types of activities and also to build simulation models before and after the work was completed, much like the movement models with an accuracy of about 85% [9, 28-30]. In Setif, architects and space designers are still trapped in their old form-function assumptions and their projects tend to be monotonous as can be seen throughout the city. The findings of this research would enable project managers and space planners to realize that there is another way to understand space architecture and to enrich their ventures. They would also encourage students to review their architectural analyses, which are often imprecise and vague, to focus on basic spatial relationships.

IV. PRESENTATION OF THE ANALYSIS METHOD

This analysis's theoretical methodology is focused on using the space syntax approach, which derives its methodological foundation from converting architectural plans into a conveniently comparable data collection. Thus, it is described as selecting suitable mathematical tools apprehended via graphs that reflect a constructed spatial area. The abstraction of plans in graphs contributes to understanding the spatial configuration and space-generating mechanism, considered important in social organization and intrinsic components. Space syntax forecasts socio-spatial structure or architectural genotype information by developing its computational methods. The special relation between function and social meaning in a building is created by the space [13]. The research method applies to both quantitative and qualitative approaches reflected in a set of metrics.

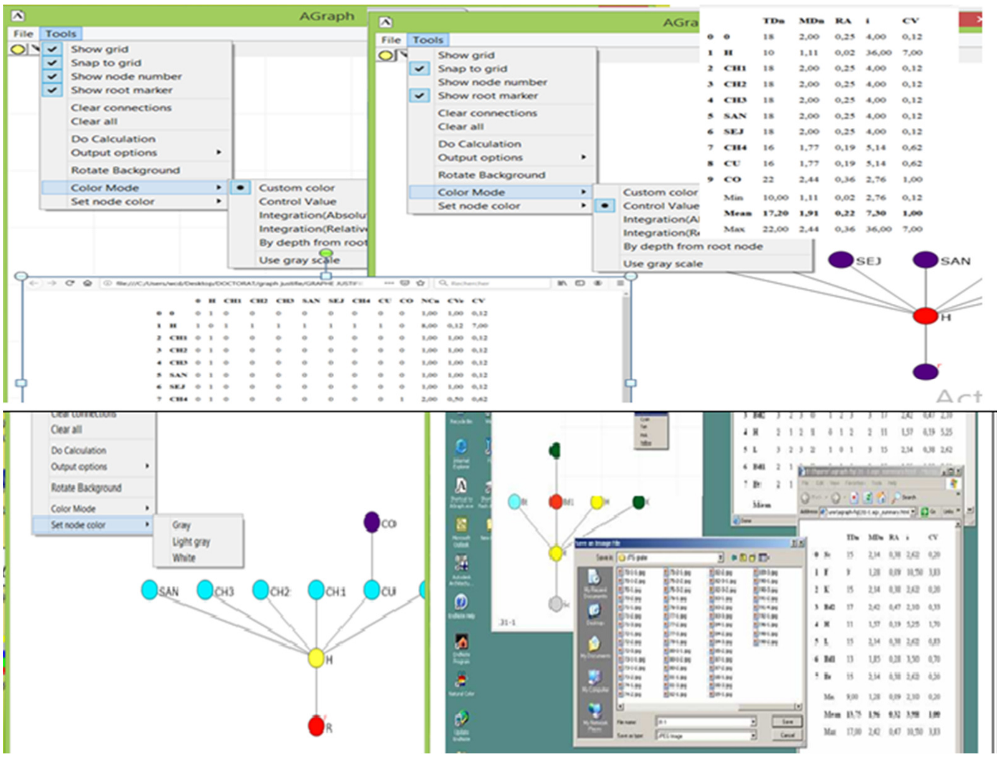


Fig. 1. AGraph software interface.

V. GEOGRAPHICAL LOCATION OF THE CASE STUDY

The studied area is located in the state of Setif. It is a town in the highlands region of eastern Algeria. It is 300km away from the capital of Algiers and rises to an altitude of 1100m. It is one of the major cities of the country, covering an area of 127.30km² with a population density of 2259 inhabitants/km². The 56.46% of the population is located in the state's chief town, with 88% urbanization rate. The sample is a private residential city that is located 1500m from the city center.

A. The Subdivision of Hebbache Brothers

The Hebbache Brothers subdivision, the object of our study, is a residential area in the city of Setif. It began to grow after a state land session in favor of a subdivision as stipulated in circular No. 5 of 11 August 1987 on the creation of individual housing sectors. The subdivision, with a trapezoidal geometric shape, occupies a total area of 37800m^2. A corpus of 12 self-built, arbitrarily chosen houses in the subdivision was the study's subject.

B. The Specifity of the Hebbache Brothers Subdivision

The specificity of the Hebbache Brothers subdivision resides in its proximity to the city center. It is also closely juxtaposed with Tandja, one of the city's largest famous communities with population over 50,000 inhabitants (Figure 2). This position creates a direct dialogue between two models of individual architectural expressions with regard to the dimension of constructions, shape and diverse spatial configuration. Its specificity is also proved by the importance of the subdivisions in the city of Setif (Table I, authors' research), which ranks first nationally regarding the number and the scale of subdivisions in the urban tissue.

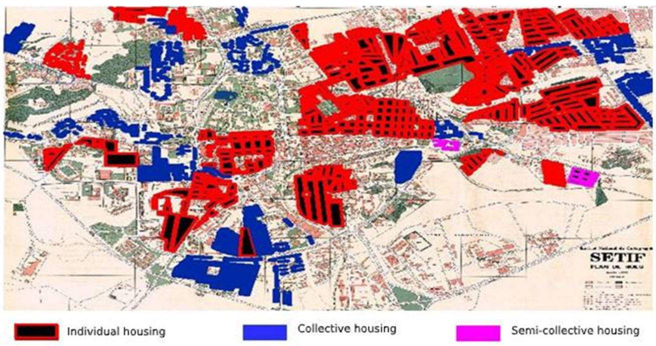


Fig. 2. Housing typology in Setif city (original image © The National Institute of Cartography and Remote Sensing. Processed by the authors).

TABLE I. SUBDIVISIONS IN SETIF CITY

Number of subdivisions during 1986-2019	Number of parcels	Total surface (m^2)	Built environment (%)
415	12965	2,493,000.00	63.15 %

VI. INDICATORS

Twelve houses from the 62 investigated cases were chosen and evaluated with the space syntax process. A justified graph simplifies the architectural strategy. Any space, whether it is a place, a hall, or even a yard, is a field cell at this graph level. Each field cell is defined by circles located according to each field's depth. The cell's depth-dependent value is determined based on the number of cells that can be crossed from an original (outside) point to reach it.

To justify, each cell has the same depth and must be on the same imaginary horizontal axis. A graph composed of circles parallel to the depth of the imagined horizontal lines is deduced. The circles are, therefore intertwined in terms of their permeable interactions. The diagram's lines express the building's outbound connections. In other words, whether two fields are linked by door or entry, the circles they refer to are linked by a line in the justified graph that helps interpret the following indicators:

- Control Value (CV): The CV is calculated for each node giving a total of one for all the nodes. The CV of node n is the total value received by the node n during this operation.
- The Total Depth of a node (TDn): It is the total of the shortest distances from a node n to other nodes in the system.
- The Mean Depth of a node (MDn): The average depth of a node n is the average depth (or the average of the shortest distance) from a node n to the other nodes.
- Relative Asymmetry (RA): RA describes the integration of a node by a value between (or equal to) 0 and 1, where a low value describes a high integration.
- The Integration Value (i): The i is a parameter which (unlike RA) describes integration by a high number when a node is highly integrated. The i is the inverse of RA.

The indicators and their mathematical formulas are summarized in Table II. The studied houses' information is given in Table III and the codification of house spaces is tabulated in Table IV.

TABLE II. CODIFICATION OF INDICATORS

Symbol	Mathematical formula
TDn	TDn= $(0*n\ x) + (1*n\ x) + (2*n\ x) + \ldots (X*n\ x)$
MDn	MDn= TDn/(k-1) (k=number of nodes in a set)
RA	RA= 2(MDn-1)/(k-2)
i	i=1/RA
CV	Potential spatial control. (CV<1: low potential, CV>1: high potentail)

TABLE III. STUDIED HOUSES' INFORMATION

House No.	Construction date	Area (m²)	Storys
1	1990	168.95	03
2	1992	203.82	03
3	1994	223.11	02
4	1997	300.00	02
5	1999	297.86	04
6	2000	190.00	03
7	2002	140.00	02
8	2004	135.00	03
9	2006	187.50	04
10	2007	96.65	03
11	2009	180.00	04
12	2010	280.00	03

The owner names are not published for privacy reasons, but are known to the authors

TABLE IV. CODIFICATION OF CONSTITUENT HOUSE SPACES

Code	Space
Ext	Exterior
H	Hall
SEJ	Living room
CH	Bedrom
CU	Kitchen
CO	Courtyard
SAN	Bathroom + Shower

VII. SYNTACTIC ANALYSIS

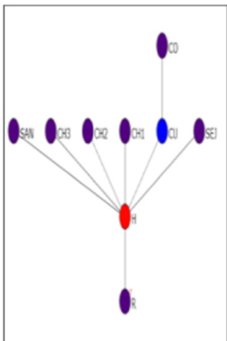
A. The Justified Graphs

In Figures 3-8 we can see the justified graphs of the houses 1-12. The results are summarized in Tables V and VI.

VIII. FINDINGS AND DISCUSSION

The syntactic data from justified graphs reveal that the shallowest space in 100% of the studied houses is the Hall, which is readily accessible from outside. Furthermore, the Hall holds the lowest RA value and the highest CV, showing that the Hall is the most integrated space in all houses and has the highest connection to other related spaces. The most profound spaces of the justified diagrams are usually the courtyard with the maximum RA value and the lowest CV, showing that the courtyard is the most isolated area with the lowest connectivity. The functional spaces among floors are entry, cooking, eating, working, sleeping, and ventilation. The main feature in all the studied houses is that the designs are formed around the Hall's transitional area. This space is a multi-functional space used as either a TV room or a study or even as a daily sitting room.

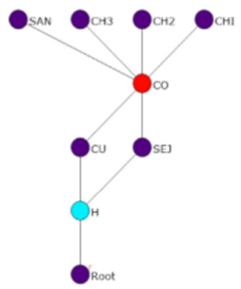
Space syntax theory allows one to discover the underlying spatial arrangements and to demonstrate in-depth the socio-spatial systems and the widespread genotype of architecture. The recurrence of such structural features is considered as the genotyping index. Thus, the translation of this term into architecture implies a qualitative constancy by constancy of justified plans and another qualitative interpretation of digital data relating to the mean depth of the degree of power, the relative asymmetry, and the importance of integration.



Justified Graph
House 01

		TDn	MDn	RA	i	CV
0	**R**	16	2,00	0,28	3,50	0,14
1	**H**	9	1,12	0,03	28,00	6,50
2	**SEJ**	16	2,00	0,28	3,50	0,14
3	**CU**	14	1,75	0,21	4,66	1,14
4	**CH1**	16	2,00	0,28	3,50	0,14
5	**CH2**	16	2,00	0,28	3,50	0,14
6	**CH3**	16	2,00	0,28	3,50	0,14
7	**SAN**	16	2,00	0,28	3,50	0,14
8	**CO**	21	2,62	0,46	2,15	0,50
	Min	9,00	1,12	0,03	2,15	0,14
	Mean	**15,55**	**1,94**	**0,26**	**6,20**	**1,00**
	Max	21,00	2,62	0,46	28,00	6,50

House 01

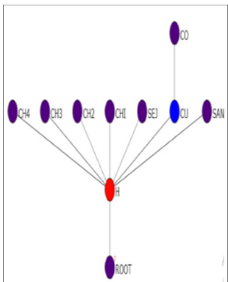


Justified Graph
House 02

		TDn	MDn	RA	i	CV
0	**Root**	24	3,00	0,57	1,75	0,33
1	**H**	17	2,12	0,32	3,11	2,00
2	**SEJ**	14	1,75	0,21	4,66	0,50
3	**CU**	14	1,75	0,21	4,66	0,50
4	**CO**	11	1,37	0,10	9,33	5,00
5	**CHI**	18	2,25	0,35	2,80	0,16
6	**CH2**	18	2,25	0,35	2,80	0,16
7	**CH3**	18	2,25	0,35	2,80	0,16
8	**SAN**	18	2,25	0,35	2,80	0,16
	Min	11,00	1,37	0,10	1,75	0,16
	Mean	**16,88**	**2,11**	**0,31**	**3,85**	**1,00**
	Max	24,00	3,00	0,57	9,33	5,00

House 02

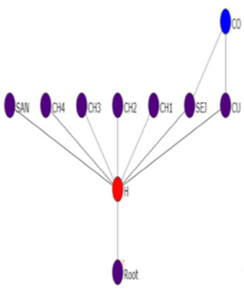
Fig. 3. The justified graphs for houses 1 and 2.



Justified Graph
House 03

		TDn	MDn	RA	i	CV
0	**ROOT**	18	2,00	0,25	4,00	0,12
1	**H**	10	1,11	0,02	36,00	7,50
2	**CU**	16	1,77	0,19	5,14	1,12
3	**SEJ**	18	2,00	0,25	4,00	0,12
4	**CHI**	18	2,00	0,25	4,00	0,12
5	**CH2**	18	2,00	0,25	4,00	0,12
6	**CH3**	18	2,00	0,25	4,00	0,12
7	**CH4**	18	2,00	0,25	4,00	0,12
8	**CO**	24	2,66	0,41	2,40	0,50
9	**SAN**	18	2,00	0,25	4,00	0,12
	Min	10,00	1,11	0,02	2,40	0,12
	Mean	**17,60**	**1,95**	**0,23**	**7,15**	**1,00**
	Max	24,00	2,66	0,41	36,00	7,50

House 03

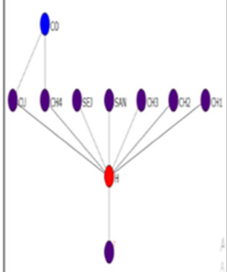


Justified Graph
House 04

		TDn	MDn	RA	i	CV
0	**Root**	18	2,00	0,25	4,00	0,12
1	**H**	10	1,11	0,02	36,00	7,00
2	**CU**	16	1,77	0,19	5,14	0,62
3	**SEJ**	16	1,77	0,19	5,14	0,62
4	**CH1**	18	2,00	0,25	4,00	0,12
5	**CH2**	18	2,00	0,25	4,00	0,12
6	**CH3**	18	2,00	0,25	4,00	0,12
7	**CH4**	18	2,00	0,25	4,00	0,12
8	**SAN**	18	2,00	0,25	4,00	0,12
9	**CO**	22	2,44	0,36	2,76	1,00
	Min	10,00	1,11	0,02	2,76	0,12
	Mean	**17,20**	**1,91**	**0,22**	**7,30**	**1,00**
	Max	22,00	2,44	0,36	36,00	7,00

House 04

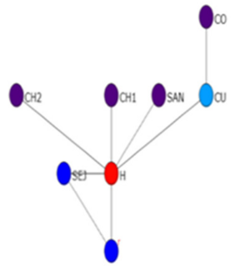
Fig. 4. The justified graphs for houses 3 and 4.



Justified Graph
House 05

		TDn	MDn	RA	i	CV
0	0	18	2,00	0,25	4,00	0,12
1	H	10	1,11	0,02	36,00	7,00
2	CH1	18	2,00	0,25	4,00	0,12
3	CH2	18	2,00	0,25	4,00	0,12
4	CH3	18	2,00	0,25	4,00	0,12
5	SAN	18	2,00	0,25	4,00	0,12
6	SEJ	18	2,00	0,25	4,00	0,12
7	CH4	16	1,77	0,19	5,14	0,62
8	CU	16	1,77	0,19	5,14	0,62
9	CO	22	2,44	0,36	2,76	1,00
	Min	10,00	1,11	0,02	2,76	0,12
	Mean	**17,20**	**1,91**	**0,22**	**7,30**	**1,00**
	Max	22,00	2,44	0,36	36,00	7,00

House 05

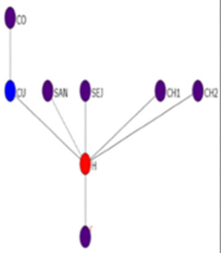


Justified Graph
House 06

		TDn	MDn	RA	i	CV
0	0	13	1,85	0,28	3,50	0,66
1	H	8	1,14	0,04	21,00	4,50
2	SEJ	13	1,85	0,28	3,50	0,66
3	CU	12	1,71	0,23	4,20	1,16
4	CH1	14	2,00	0,33	3,00	0,16
5	CH2	14	2,00	0,33	3,00	0,16
6	CO	18	2,57	0,52	1,90	0,50
7	SAN	14	2,00	0,33	3,00	0,16
	Min	8,00	1,14	0,04	1,90	0,16
	Mean	**13,25**	**1,89**	**0,29**	**5,38**	**1,00**
	Max	18,00	2,57	0,52	21,00	4,50

House 06

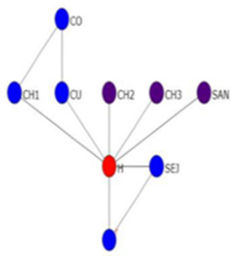
Fig. 5. The justified graphs for houses 5 and 6.



Justified Graph
House 07

		TDn	MDn	RA	i	CV
0	0	14	2,00	0,33	3,00	0,16
1	H	8	1,14	0,04	21,00	5,50
2	CH2	14	2,00	0,33	3,00	0,16
3	CH1	14	2,00	0,33	3,00	0,16
4	SEJ	14	2,00	0,33	3,00	0,16
5	SAN	14	2,00	0,33	3,00	0,16
6	CU	12	1,71	0,23	4,20	1,16
7	CO	18	2,57	0,52	1,90	0,50
	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

House 07

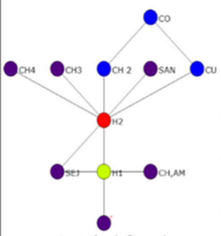


Justified Graph
House 08

		TDn	MDn	RA	i	CV
0	0	15	1,87	0,25	4,00	0,64
1	H	9	1,12	0,03	28,00	5,00
2	SEJ	15	1,87	0,25	4,00	0,64
3	CH3	16	2,00	0,28	3,50	0,14
4	CH2	16	2,00	0,28	3,50	0,14
5	CU	14	1,75	0,21	4,66	0,64
6	CH1	14	1,75	0,21	4,66	0,64
7	CO	19	2,37	0,39	2,54	1,00
8	SAN	16	2,00	0,28	3,50	0,14
	Min	9,00	1,12	0,03	2,54	0,14
	Mean	**14,88**	**1,86**	**0,24**	**6,48**	**1,00**
	Max	19,00	2,37	0,39	28,00	5,00

House 08

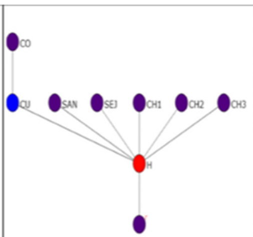
Fig. 6. The justified graphs for houses 7 and 8.



Justified Graph
House 09

		TDn	MDn	RA	i	CV
0	0	26	2,60	0,35	2,81	0,25
1	H1	17	1,70	0,15	6,42	2,64
2	CH,AM	26	2,60	0,35	2,81	0,25
3	SEJ	19	1,90	0,20	5,00	0,39
4	H2	13	1,30	0,06	15,00	4,75
5	CU	20	2,00	0,22	4,50	0,64
6	CH 2	20	2,00	0,22	4,50	0,64
7	CH3	22	2,20	0,26	3,75	0,14
8	CH4	22	2,20	0,26	3,75	0,14
9	CO	27	2,70	0,37	2,64	1,00
10	SAN	22	2,20	0,26	3,75	0,14
	Min	13,00	1,30	0,06	2,64	0,14
	Mean	**21,27**	**2,12**	**0,25**	**4,99**	**1,00**
	Max	27,00	2,70	0,37	15,00	4,75

House 09

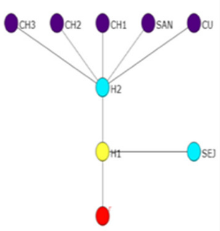


Justified Graph
House 10

		TDn	MDn	RA	i	CV
0	0	16	2,00	0,28	3,50	0,14
1	H	9	1,12	0,03	28,00	6,50
2	CH3	16	2,00	0,28	3,50	0,14
3	CH2	16	2,00	0,28	3,50	0,14
4	CH1	16	2,00	0,28	3,50	0,14
5	SEJ	16	2,00	0,28	3,50	0,14
6	SAN	16	2,00	0,28	3,50	0,14
7	CU	14	1,75	0,21	4,66	1,14
8	CO	21	2,62	0,46	2,15	0,50
	Min	9,00	1,12	0,03	2,15	0,14
	Mean	**15,55**	**1,94**	**0,26**	**6,20**	**1,00**
	Max	21,00	2,62	0,46	28,00	6,50

House 10

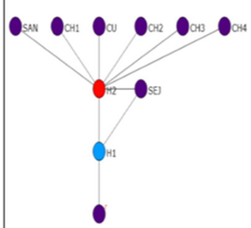
Fig. 7. The justified graphs for houses 9 and 10.



Justified Graph
House 11

		TDn	MDn	RA	i	CV
0	0	20	2,50	0,42	2,33	0,33
1	H1	13	1,62	0,17	5,60	2,16
2	SEJ	20	2,50	0,42	2,33	0,33
3	H2	10	1,25	0,07	14,00	5,33
4	CU	17	2,12	0,32	3,11	0,16
5	SAN	17	2,12	0,32	3,11	0,16
6	CH1	17	2,12	0,32	3,11	0,16
7	CH2	17	2,12	0,32	3,11	0,16
8	CH3	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

House11



Justified Graph
House 12

		TDn	MDn	RA	i	CV
0	0	23	2,55	0,38	2,57	0,33
1	H1	15	1,66	0,16	6,00	1,62
2	H2	10	1,11	0,02	36,00	6,83
3	SEJ	16	1,77	0,19	5,14	0,45
4	CH4	18	2,00	0,25	4,00	0,12
5	CH3	18	2,00	0,25	4,00	0,12
6	CH2	18	2,00	0,25	4,00	0,12
7	CU	18	2,00	0,25	4,00	0,12
8	CH1	18	2,00	0,25	4,00	0,12
9	SAN	18	2,00	0,25	4,00	0,12
	Min	10,00	1,11	0,02	2,57	0,12
	Mean	**17,20**	**1,91**	**0,22**	**7,37**	**1,00**
	Max	23,00	2,55	0,38	36,00	6,83

House12

Fig. 8. The justified graphs for houses 11 and 12.

TABLE V. SYNTACTIC MEASURES FOR THE HOUSES

		Exterior	**H**		**SEJ**	**CH1**	**CH2**	**CH3**	**SAN**	**CU**	**CO**	**Min**	**Mean**	**Max**
House 1	**MDn**	2.00	1.12		2.00	2.00	2.00	2.00	2.00	1.75	2.62	1.12	1.94	2.62
	RA	0.28	0.03		0.28	0.28	0.28	0.28	0.28	0.21	0.46	0.03	0.26	0.46
	CV	0.14	6.50		0.14	0.14	0.14	0.14	0.14	1.14	0.50	0.14	1.00	6.50
House 2		Ext	H		SEJ	CH1	CH2	CH3	SAN	CU	CO	Min	Mean	Max
	MDn	3.00	2.12		1.75	2.25	2.25	2.25	2.25	1.75	1.37	1.37	2.11	3.00
	RA	0.57	0.32		0.21	0.35	0.35	0.35	0.35	0.21	0.10	0.10	0.31	0.57
	CV	0.33	2.00		0.50	0.16	0.16	0.16	0.16	0.50	5.00	0.16	1.00	5.00
House 3		Ext	H		SEJ	CH1	CH2	CH3	SAN	CU	CO	Min	Mean	Max
	MDn	2.00	1.11		2.00	2.00	2.00	2.00	2.00	1.77	2.66	1.11	1.95	2.66
	RA	0.25	0.02		0.25	0.25	0.25	0.25	0.25	0.19	0.41	0.02	0.23	0.41
	CV	0.12	7.50		0.12	0.12	0.12	0.12	0.12	1.12	0.50	0.12	1.00	7.50
House 4		Ext	H		SEJ	CH1	CH2	CH3	SAN	CU	CO	Min	Mean	Max
	MDn	2.00	1.11		1.77	2.00	2.00	2.00	2.00	1.77	2.44	1.11	1.91	2.44
	RA	0.25	0.02		0.19	0.25	0.25	0.25	0.25	0.19	0.36	0.02	0.22	0.36
	CV	0.12	7.00		0.62	0.12	0.12	0.12	0.12	0.62	1.00	0.12	1.00	7.00
House 5		Ext	H		SEJ	CH1	CH2	CH3	SAN	CU	CO	Min	Mean	Max
	MDn	2.00	1.11		1.77	2.00	2.00	2.00	2.00	1.77	2.44	1.11	1.91	2.44
	RA	0.25	0.02		0.19	0.25	0.25	0.25	0.25	0.19	0.36	0.02	0.22	0.36
	CV	0.12	7.00		0.62	0.12	0.12	0.12	0.12	0.62	1.00	0.12	1.00	7.00
House 6		Ext	H		SEJ	CH1	CH2	/	SAN	CU	CO	Min	Mean	Max
	MDn	1.85	1.14		1.85	2.00	2.00	/	2.00	1.71	2.57	1.14	1.89	2.57
	RA	0.28	0.04		0.28	0.33	0.33	/	0.33	0.23	0.52	0.04	0.29	0.52
	CV	0.66	4.50		0.66	0.16	0.16	/	0.16	1.16	0.50	0.16	1.00	4.50
House 7		Ext	H		SEJ	CH1	CH2	/	SAN	CU	CO	Min	Mean	Max
	MDn	2.00	1.14		2.00	2.00	2.00	/	2.00	1.71	2.57	1.14	1.92	2.57
	RA	0.33	0.04		0.33	0.33	0.33	/	0.33	0.23	0.52	0.04	0.30	0.52
	CV	0.16	5.50		0.16	0.16	0.16	/	0.16	1.16	0.50	0.16	1.00	5.50
House 8		Ext	H		SEJ	CH1	CH2	CH3	SAN	CU	CO	Min	Mean	Max
	MDn	1.87	1.12		1.87	1.75	2.00	2.00	2.00	1.75	2.37	1.12	1.86	2.37
	RA	0.25	0.03		0.25	0.21	0.28	0.28	0.28	0.21	0.39	0.03	0.24	0.39
	CV	0.64	5.00		0.64	0.64	0.14	0.14	0.14	0.64	1.00	0.14	1.00	5.00
House 9		Ext	H1	H2	SEJ	CH1	CH2	CH3	SAN	CU	CO	Min	Mean	Max
	MDn	2.60	1.70	1.30	1.90	2.60	2.00	2.20	2.20	2.00	2.70	1.30	2.12	2.70
	RA	0.35	0.15	0.06	0.20	0.35	0.22	0.26	0.26	0.22	0.37	0.06	0.25	0.37
	CV	0.25	2.64	4.75	0.39	0.25	0.64	0.14	0.14	0.64	1.00	0.14	1.00	4.75
House 10		Ext	H		SEJ	CH1	CH2	CH3	SAN	CU	CO	Min	Mean	Max
	MDn	2.00	1.12		2.00	2.00	2.00	2.00	2.00	1.75	2.62	1.12	1.94	2.62
	RA	0.28	0.03		0.28	0.28	0.28	0.28	0.28	0.21	0.46	0.03	0.26	0.46
	CV	0.14	6.50		0.14	0.14	0.14	0.14	0.14	1.14	0.50	0.14	1.00	6.50
House 11		Exte	H1	H2	SEJ	CH1	CH2	CH3	SAN	CU	/	Min	Mean	Max
	MDn	2.50	1.62	1.25	2.50	2.12	2.12	2.12	2.12	2.12	/	1.25	2.05	2.50
	RA	0.42	0.17	0.07	0.42	0.32	0.32	0.32	0.32	0.32	/	0.07	0.30	0.42
	CV	0.33	2.16	5.33	0.33	0.16	0.16	0.16	0.16	0.16	/	0.16	1.00	5.33
House 12		Ext	H1	H2	SEJ	CH1	CH2	CH3	SAN	CU	/	Min	Mean	Max
	MDn	2.55	1.66	1.11	1.77	2.00	2.00	2.00	2.00	2.00	/	1.11	1.91	2.55
	RA	0.38	0.16	0.02	0.19	0.25	0.25	0.25	0.25	0.25	/	0.02	0.22	0.38
	CV	0.33	1.62	6.83	0.45	0.12	0.12	0.12	0.12	0.12	/	0.12	1.00	6.83

IX. LIMITATIONS AND FURTHER RESEARCH

Using the AGraph program, the study focused on space syntax theory via the justified graph technique. It referred to indicator measurements (TD, MDn, RA, i, and CV) to find the spatial genetic constants that form architectural genotypes. This study did not tackle the concept of phenotype due to time constraints and limited research objectives. Therefore, future researchers are advised to associate genotype and phenotype in their inquiries. Also, the physical features of the dwelling (shape, length, envelope) and the inhabitant (its gestures, expressions, postures, and social practices) were not addressed or spatially defined. This limitation could be another inherent space syntax barrier that other research can undoubtedly overcome.

X. CONCLUSION

Studies have noted that a residential corpus embodies a diffuse genotype [31]. Ordinary households are more diverse and idiosyncratic than the ideal form recognizes, since they are a dynamic reflection of the occupants' social and individual status. Their social structure and conventions are inextricably connected to the idiosyncratic, whimsical, arbitrary, or sometimes disorderly conditions of the inhabitants' daily lives. Consequently, they present difficulties in recognizing and interpreting hidden orders. In syntactic details, this novel approach to investigating configuration relationships could be elaborated. Applying to each house a graphic and numerical treatment can allow the comprehension of its vocabulary, decode the syntax of this environment and further push the analysis of how this space is structured.

TABLE VI. CALCULATED VALUES, INTEGRATION ORDER

House No.	Calculated values, integration order of spaces for the house	Conclusion
1	H - 0.03<CU -0.21<SEJ -0.28=CH1 -0.28= CH2 -0.28= CH3 -0.28= SAN -0.28= Ext -0.28 <CO -0.46	The most integrated space is the hall with with RA 0.03 and a strong CV of 6.50.
2	CO - 0.10 <CU -0.21= SEJ -0.21 < CH1 -0.35= CH2 -0.35= CH3 -0.35= SAN -0.35 < Ext -0.57	The most integrated space is the courtyard with RA 0.10 and a strong CV of 5.00.
3	H - 0.02<CU -0.19<SEJ -0.25=CH1 -0.25= CH2 -0.25= CH3 -0.25= SAN -0.25= Ext -0.25 <CO -0.41	The most integrated space is the Hall with RA 0.02 and a strong CV of 7.50.
4	H - 0.02<CU -0.19 = SEJ -0.19 < CH1 -0.25= CH2 -0.25= CH3 -0.25= SAN -0.25= Ext -0.25 <CO -0.41	The most integrated space is the Hall with RA 0.02 and a strong CV of 7.00.
5	H - 0.02<CU -0.19 = SEJ -0.19 < CH1 -0.25= CH2 -0.25= CH3 -0.25= SAN -0.25= Ext -0.25 <CO -0.36	The most integrated space is the Hall with RA 0.02 and a strong CV of 7.00.
6	H - 0.04<CU -0.23 <SEJ -0.28 = Ext -0.28 <CH1 -0.33 = CH2 -0.33 = SAN -0.33 <CO -0.52	The most integrated space is the Hall with RA 0.04 and a strong CV of 4.50.
7	H - 0.04<CU -0.23 <SEJ -0.33 = Ext -0.33 =CH1 -0.33 = CH2 -0.33 = SAN -0.33 <CO -0.52	The most integrated space is the Hall with RA 0.04 and a strong CV of 5.50.
8	H - 0.03<CU -0.21=CH1 -0.21<SEJ -0.25= Ext -0.25 < CH2 -0.28= CH3 -0.28= SAN -0.28<CO -0.39	The most integrated space is the Hall with RA 0.03 and a strong CV of 5.00.
9	H2 - 0.06 < H1 0.15 <SEJ -0.20 <CU -0.22=CH2 -0.22< CH3 -0.26= SAN -0.26< CH1 -0.35= Ext -0.35 <CO -0.37	The most integrated space is the Hall 2 with RA 0.06 and a strong CV of 4.75.
10	H - 0.03<CU -0.21<SEJ -0.28=CH1 -0.28= CH2 -0.28= CH3 -0.28= SAN -0.28= Ext -0.28 <CO -0.46	The most integrated space is the Hall with RA 0.03 and a strong CV of 6.50.
11	H2 - 0.07 < H1- 0.17< CU -0.32=CH2 -0.32= CH3 -0.32 = SAN -0.32 = CH1 -0.32< SEJ -0.42= Ext -0.42	The most integrated space is the Hall 2 with RA 0.07 and a strong CV of 5.33.
12	H2 - 0.02< H1 -0.16< SEJ -0.19 < CU -0.25=CH2 -0.25= CH3 -0.25 = SAN -0.25 = CH1 -0.25< Ext -0.38	The most integrated space is the Hall 2 with RA 0.02 and a strong CV of 6.83.

The findings revealed a clear spatial genotype that applies to the Hall and suggests that this space seems to be regularly located where it can order and coordinate multifunctional activities. In reality, the findings of this research have shown that the spatial arrangement was planned for the conventional courtyard from a central distribution through the hall room. This is the product of the local lifestyle, social behaviors originating in traditional society. However, the findings from syntactic data enable one to examine every calculation of the justified graph as to its spatial context. Justified diagrams indicate that the 12 houses have the same morphological characteristics. Indeed, the house arrangement appears to be identical in all instances, with the same features. Thus, it can be argued that the spatial sense of residential spaces can be reconstructed from these dimensions.

Beyond the findings of Setif's analysis of contemporary housing, studies may be valued at various levels of understanding and can pave the way for future research.

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