The Scientific Journal of Cihan University – Sulaimaniya PP: 1-23
Volume (8), Issue (1), June 2024
ISSN 2520-7377 (Online), ISSN 2520-5102 (Print)

Genotypical Change of Traditional Houses in Sulaymaniyah City

Wrya Sabir Abdullah[1], Ameera Ahmed Abdullah[2]

[1,2] Architecture Department, College of Engineering, University of Sulaimani, Sulaymaniyah, Iraq

Email: wrya.abdullah@univsul.edu.iq[1], ameera.abdullah@univsul.edu.iq[2]

Abstract:

Over the past thirty years, Sulaymaniyah City has experienced tremendous sociocultural and economic upheaval, which has led to substantial changes in both the urban and architectural layouts. There have been many traditional houses in the old city center that were destroyed and rebuilt with new structures, which has negatively impacted the form and spatial organization of the original fabric. This study aims to investigate how the contemporary reconstruction activities that landowners in traditional city neighborhoods undertake affect the basic genotype or genetic constants of housing spatial design. The research entails morphologically assessing the architectural arrangements of the rebuilt and original structures. In order to achieve this goal, five distinct designs of traditional homes built in the years 1900–1960 were selected and compared with five newly reconstructed modern homes from the years 1990–2020 in the same area. Using (A-graph software) as a space syntax technique, specifically (Gamma analysis), the spatial arrangements of these structures were assessed using an analytical quantitative approach to ascertain the layout characteristics such as (symmetry/asymmetry) and (distributiveness/non-distributiveness) of the entire system. The results show that, whereas many organizing principles are common, there are distinct structuring patterns based on genotype differences.

Keywords: Architecture genotype, Space syntax, Justified graph map, Traditional house layout

الملخص:

أحدثت التحولات الاقتصادية والاجتماعية والثقافية السريعة التي شهدتها مدينة السليمانية خلال الثلاثين عامًا الماضية تغييرات كبيرة على المستويين الحضري والمعماري. وقد تم هدم العديد من البيوت التراثية في وسط المدينة التاريخي واستبدالها بمباني معاصرة، مما أدى إلى احداث آثار سلبية على النسيج الأصلي من حيث الشكل والتنظيم المكاني. الهدف من هذه الدراسة هو استكشاف تأثير عمليات إعادة البناء الحديثة التي يقوم بها أصحاب العقارات في أحياء المدينة التقليدية على تغيير الثوابت الجينية الأساسية للتكوين المكاني لهذه البيوت. تتضمن الدراسة تحليل السمات المورفولوجية للمخططات المعمارية لكل من الهياكل الأصلية والمعاد بناؤها. ولتحقيق هذا الهدف، تم اختيار خمس مخططات مختلفة للبيوت التراثية التي تم بناؤها بين الفترة (1900 - 1960) لمقارنتها مع خمسة منازل حديثة أعيد بناؤها حديثا من الفترة (1990 إلى 2020) ضمن نفس المناطق حيث تم تقييم التنظيمات المكانية لهذه الهياكل باستخدام منهج تحليلي كمي، باستخدام برنامج (A-graph) كأحد تقنيات نظرية التركيب الفضائي، وتحديدًا تقنية (تحليل جاما)، لتحديد خصائص هذه المخططات مثل (التماثل/عدم التماثل) و (التوزيع/الانتشار) للنظام بأكمله. تشير النتائج إلى وجود أنماط تشكل هيكلية مختلفة اعتمادا على مفهوم النمط الجيني، على الرغم من بعض المبادئ التنظيمية المشتركة.

الكلمات المفتاحية: النمط الجيني المعماري، قواعد تركيب الفضاء، خارطة الرسم البياني المبرر، مخططات البيوت التراثية.

DOI: http://dx.doi.org/10.25098/8.1.23

Volume (8), Issue (1), June 2024
ISSN 2520-7377 (Online), ISSN 2520-5102 (Print)

پوختە:

لە سی ساڵی ڕابردوودا شاری سولەیمانی هەڵچونی گەورەی کۆمەڵایەتی و کەلتوری و ئابوری بە خۆیەوە بینیوە کە بۆتە هۆی گۆڕانکاری بەرچاو لە شێوازی تەلارسازی و شاردا. لە ناوەندی شارە کۆنەکەدا چەندین خانووی کۆن و نەریتی (تەقلیدی) هەبوون کە ڕووخێندراون و بە خانوو و باڵەخانەی نوێ شوێنیان پڕکراوەتەوە، کە ئەمەش کاریگەری نەرێنی کردۆتە سەر شێوە و ڕێکخستنە فەزاییە ڕەسەنەکە. ئامانجی ئەم توێژینەوەیە بریتیە لە لێکۆڵینەوە لەوەی ئەو چالاکیە بنیاتنانە سەردەمیەکان کە خاوەن موڵکەکان لە گەڕەکە نەریتیەکاندا ئەنجامی دەدەن چۆن کاردەکەنە سەر جۆری جینی خانووەکان لە ڕووی دیزاین و دابەشبوونی فەزاییەوە. ئەم توێژیەوەیە هەڵسەنگاندنی شکڵی (مۆرفۆلۆجی) ڕێکخستنی تەلارسازی خانوە کۆنەکان و دووبارە دروستکراوەکان لە خۆ دەگرێت. وە بۆ بەجێگەیاندنی ئەم ئامانجەک پێنج خانووی کۆن و نەریتی گەڕەکە کۆنەکان لە شاری سولەیمانی کە لە نێوان ساڵانی 1900-1960 دروستکراون هەلبژێردراون و بەراورد کراون بە پێنج خانووی نوێ دروست کراو لەهەمان گەڕەکە کۆنەکاندا لە نێوان ساڵانی 1990-2020. بەبەکارهێنانی پرۆگرامی (A-graph) وەک تەکیکی ڕستەسازی بۆشای(Space Syntax) بەتایبەتی شیکاری گاما (Gamma Analysis) شێوازی ڕێکخستنی بۆشایی ئەم خانوانە هەڵسەنگێندران بەشێوازی شیکاری چەندایەتی بەمەبەستی دڵنیابوون لە تایبەتمەندی شێوازی ڕێکخسن وەک (سیمەتریبوون/ نا سیمەتری بوون) وە (توانای دابەشبوون/ نەبوونی توانای دابەشبوون) ی تەواوی سیستەمەکە. ئەنجامەکە نیشانی داوە کە هەرچەند زۆرێک لە بنەماکانی ڕێکخستن هاوبەشن، بەڵام شێوازی جیاواز لە پێکهاتەکان دروست بوون لەسەر بنەمای جیاوازی جۆری جینیی (Genotype).

کلیلە ووشە: شێوازی جینیی تەلارسازی، ڕستەسازی بۆشایی، نەخشەی هێڵکاری ڕێکخراو، شێوازی خانووی نەریتی.

1. INTRODUCTION

Every residential dwelling possesses a tale to narrate; it acts as memory of the historical ideological processes and spatial organization of previous generations. Architecture, functioning as a mode of non-verbal symbolic communication, mirrors societal values, perceptions, and convictions, acting as a channel for conveying and exchanging cultural ideologies **(1)**. Among all architectural edifices, houses are uniquely complex due to their multifaceted purposes and symbolic significance, with their spatial configurations revealing insights into the cultural beliefs embraced by their inhabitants **(2)(3).**

Numerous scholars posit that the underlying principles governing the layout of houses within a specific culture originate from the socio-cultural standards of that society, resulting in a consistent spatial design known as the "Housing genotype." This notion is described as an "archaeological space" **(4) (2)**. Housing embodies a characteristic that acts as a bridge between form and function in architectural design, while also demonstrating how the space encapsulates societal influences the original structure **(5)**.

Sulaymaniyah city’s historical residential layouts are a vital component of the local architectural legacy. These homes were erected by local craftsmen who took into account both the physical and intangible needs of the inhabitants, employing construction methods that were handed down through generations. Despite showcasing a range of architectural designs, these residences shared common spatial arrangements since the city's foundation to the 1960s, when regional social and cultural factors began to influence the house layouts. Nevertheless, the contemporary remodeling practices undertaken by property owners have led to significant changes, as they have begun to replicate modern Western architectural styles, resulting in the emergence of altered architectural structures **(1)**. Consequently, the spatial layouts of historical housing were rebuilt with new configurations which display diverse physical characters. Hence, this paper addresses a problem pertaining to the

DOI: http://dx.doi.org/10.25098/8.1.23

modifications and disappearance of the indigenous space configurations (Genotype) of the houses by exploring these inquiries:

- To what degree do the intrinsic genetic elements in spatial organization impact the layout of dwellings in traditional neighborhoods of Sulaymaniyah city?
- To what extent do the architecture space patterns of newly constructed residential layouts in historic districts differ from those of traditional ones, and in what particular ways?
- How can the idea of genotypical change be applied for upcoming architectural and reconstruction projects in the traditional region of the city to improve the sustainability of rebuilding practices?

The aim of this paper is to observe the physical characteristics of traditional dwellings, concentrating on seven particular Sulaymaniyah city neighbourhoods. This study examines how patterns have changed over time by contrasting the modern reconstructions of traditional (courtyard) dwellings with their architectural arrangements. Architectural designs are analysed and turned into graphs and numerical data for this comparison applying (A-Graph program), commonly recognized as “Gamma Analysis”. The final objective is to identify the spatial genotypical constants that these structures include.

The study's challenge emerged from the critical need of preserving the true architectural genotypes of traditional homes, which are often overlooked in the rebuilding process of today's homes. These spatial genotypes may have an impact on modern spatial configurations and household arrangement. The study employs space syntax as a socio-spatially relevant methodology to answer the research subject. Architectural space arrangements of all categories are identified and evaluated by getting the syntactic signs of dwellings, such as mean depth (MD), integration (RRA), Base difference factor (H*), space link ratio (SLR), and space types (space), after comparing and contrasting the similarity and distinctions among all chosen spatial layouts with respect to (symmetric/asymmetric) and (Distributes/non-distributes). Regarding Phenotypical aspects, the physical architectural features of the homes (such as shape, length, and envelope), and the social, behavioural, and psychological facets of the occupants are not covered in this work.

Due to its transitional nature and transformative effects on the housing sector in the urban area, the analysis also excludes the years 1960–1990. By allowing the original fundamental principles of spatial genotypes to be integrated into various formal expressions (phenotypes), the study's findings may have an impact on future architectural design and rebuilding processes. This will allow the original architectural genotypes to be preserved while modifying to meet modern needs and maintain the distinctiveness of local architecture.

DOI: http://dx.doi.org/10.25098/8.1.23

1.1.Architecture Genotype

The concept of Architectural Genotype is the architectural counterpart of the idea of Genotype as it applies to biology **(6)**. This phrase was first used in the field of architecture by Hillier and Leaman in their space syntax literature. It is used to distinguish the spatial principles that inspired the design of the built environment from its physical form **(7)**. In the architectural sphere, genotypes are defined as basic rules regulating spatial arrangements, which can be identified by using space syntactic techniques. According to Hillier and Hanson, these principles are abstract spatial templates that are culturally transmitted and relate to certain building types or settlements **(8) (9)**.

Both the fields of architectural and the of urban studies have discussed genotypes in their researches. Housing genotypes have been studied before, employing space syntactic methods to look at different aspects. For example, an examination of Normandy's vernacular dwellings was conducted in order to show how cultural notions were represented in both the physical buildings and the designer's mind **(10).** The study of genotypical patterns in early German residential plans attributed to Mies Van Der Rohe **(11)**, suburban houses in London **(2)**, and gender differences in the genotype of historical court-yard houses in Baghdad City are just a few examples of the diverse design strategies used by architects **(12)**. The development of flat plans in Ankara city is examined in relation to the interplay among genotype of architecture layout and function setting **(13)**. An exploration is conducted regarding the correlation between space patterns and function layouts in both conventional and contemporary housing patterns in Erbil City **(14)**.

In her study, Seo identifies genotype of houses observing the change happened to the code of houses in Korean flats **(15)**. Raith and Estaji, study the consistency in the space organization of historical residential blocks in Iran **(16)**, while Elizondo investigates resident changes on standard based societal houses genotype influenced by societal aspects **(5)**. Depending on previous studies, the study deduces that by discerning analogies and disparities within interior arrangement of various structures, it becomes feasible to recognize architecture genotypical pattern **(17)**.

As such, a housing genotype is a coherent system of spaces organisation which forms the basis of the formal expressions that are observable **(18)**. These patterns are only culturally and socially transmitted; people copy them in an attempt to feel a connection to the past. These timeless patterns reflect societal traits including complex relational structures and nonverbal design components that architects are unable to express because of their innate social knowledge. They are also guided by internal rules of spatial organisation **(19)**. The genotype index is defined as the recurrence of particular physical features **(20)**. According to Hillier, 'genotype' originates within recognition of similar spatial possibilities used to solve certain architectural problems, such integrating religious components with secular areas. This can be seen in religious buildings where the focal point is located in the farthest point, creating a direct line of sight between the public entry and the inner sacred chamber **(19)**. People tend to repeat these themes because they believe them to be useful, which spreads the ideas through social and cultural channels **(21)**. These themes create a resilient structure that adheres to the three Vitruvius principles and permits modifications in function, technology, and aesthetics without compromising the essential qualities **(22)**.

DOI: http://dx.doi.org/10.25098/8.1.23

These patterns' recurring qualities help to identify their architectural identity, which may then be utilised to inform future modern designs that support sustainable development **(23)**. To identify the genotype of a specific architectural style, it is essential to identify recurrent themes that are prominent and long-lasting organisational traits **(24)**. In the same way, the housing spaces genotypes can be recognized as a spatial arrangement which is basically seen within specific situations **(25)**. Many researchers seem that each family demonstrates one space-function genotypical structure, that is defined by consistency in both relationships and configurations. Within many architectural masterpieces, the dominant genotype can be easily recognised by analysing all space-function relationships. On the other hand, in other arrangements, the likelihood of identifying these genotypes decreases when specific spatial norms are not found **(10)**.

The layout of house spaces might be classified into four sections, each of which is a collection of spaces with related social and functional requirements. These sectors serve as a broad framework that determines the configuration, boundaries, and development of interconnected places **(26)**. To facilitate a comparison investigation of two spatial situations, this categorization is essential. The sectors of traditional houses can be divided into four different groups, as suggested by Amorim **(26)**, which are described below:

- The Sector of Visitors: This encompasses shared areas between relatives and unfamiliar individuals, including the entry hall, formal dining area, bedroom, the library and the reception.
- The Family Sector: This pertains to private areas for the family, like living-room, the family dining-room, bedroom, and bathrooms.
- The Sector of Service: This comprises spaces like the kitchen, laundry room, garage, front yard, backyard, and servant quarters.
- The Sector of Mediator: This serves to interconnect two distinct sectors, utilizing elements like hall ways (corridor) and transition areas.

All aforementioned categorization of house areas to distinct groupings represents the best pertinent division of the confines of this paper and also serves as the initial pragmatic classification to utilize space syntax methodologies.

1.2 Traditional Houses in Sulaymaniyah City

The techniques, supplies, and elements that have progressively come to be recognised as customary or conventional within a particular community are referred to as traditional architecture. Usually, these customs are transferred verbally or, to a lesser degree, through written documents that include concepts, procedures, and information that were conveyed verbally. It is significant to remember that, even if it happens slowly, traditional methods and items do evolve throughout time while maintaining their original origins **(27)**. Before 1960, Sulaymaniyah City's traditional housing, while exhibiting a variety of typologies (phenotypes), was influenced by vernacular architectural features that represented the regional architectural identity, which was shaped by socio-cultural, religious, and climate factors **(28)** **(29)**. However, all of these homes had the same spatial layout around an interior courtyard, defining the court-yard housing genotype as the prevailing city's architectural form.

DOI: http://dx.doi.org/10.25098/8.1.23

The Scientific Journal of Cihan University – Sulaimaniya **PP: 1-23**
Volume (8), Issue (1), June 2024
ISSN 2520-7377 (Online), ISSN 2520-5102 (Print)

By using the previously mentioned sector classifications to Sulaymaniyah city's traditional houses, it can be observed that every one of them has an internal open courtyard that acts as a link between different sectors. As seen in **Fig. 1**, it also serves as the main centre for distribution for every other location in the house. A typical Kurdish traditional house is divided into two sections: the "Sar khan" (upper level) and the "Zher khan" (lower level), which can accommodate more than one family, especially as the size of the family grows. The enclosed areas, or rooms, are used for many purposes, including dining, studying, and sleeping. The semi-open "Iwan" is significant for family get-togethers. Toilets and other service spaces are usually situated next to the house's main entrance, apart from the living areas, and separated from the living areas as shown in **Fig. 2**.

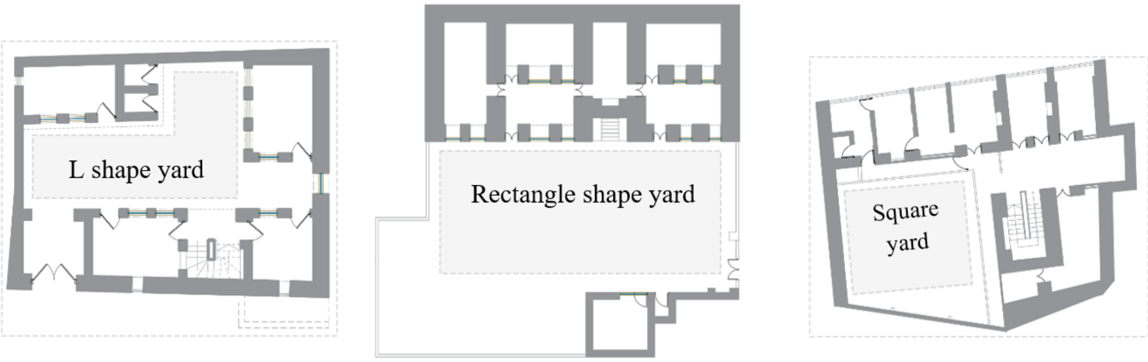


Figure 1. Relationships between open and closed areas in various Sulaymaniyah Courtyard home layout arrangements.

Figure 2. The Sector of Service (bathroom, storage, WC, kitchen) that are isolated from other house spaces, connected to inner-yard

DOI: http://dx.doi.org/10.25098/8.1.23

1.3 Contemporary Rebuilding Process in Traditional Area

Within historic urban plan, traditional dwellings have either been destroyed by households as a result of inadequate preservation legislation or have suffered degradation from natural phenomena. As such, the common old arrangement with an internal court-yard were replaced by a distinct spatial arrangement. More recently reconstructed homes have architecture akin to any contemporary housing type; they have no connection to the sociocultural value or local architectural identity **(30)**. As seen in **Fig. 3** and **Fig. 4**, modern rebuilding techniques tend to favour demolishing traditional homes in favour of constructing retail structures or contemporary homes of creative formal and spatial layouts.

Figure 3. Standard traditional house styles in Sulaymaniyah city

Figure 4. Some new houses reconstructed on the remnants of destroyed traditional samples.

2. METHODS AND APPLICATIONS

In order to examine the similarities and distinctions in the spatial genotype of five selected traditional house layouts founded between (1900-1960) and five selected new house layouts built between (1990-2022) within the same traditional localities, a comparative analytical approach will be used in this paper. The purpose of this study is to evaluate the features and degree of changes in their spatial distribution. Space syntax technique that was presented by Hillier with the intention of revealing the underlying spatial genetics of particular configurations in order to reveal the cultural codes impacting the spatial organisation of constructed environments. This methodological approach applies to both architectural and urban scales; it uses Gamma-analysis to evaluate architectural spaces and Alpha-analysis to examine urban settlements **(10)**. This methodology's main goal is to use numerical data to quantify the built environment's characteristics in order to clarify the complex relationship between humans and the built environment. The physical and morphological features of the house layouts are explained by these associations, which convert them into simplified graphs known as "*justified graph maps*" **(4)**.

As **Fig. 5** illustrates the network comprises of nodes representing the functional zones of houses, lines representing the connections between the spaces; each space possesses a depth value in respect to a chosen space called the carrier, which is normally the house entry.

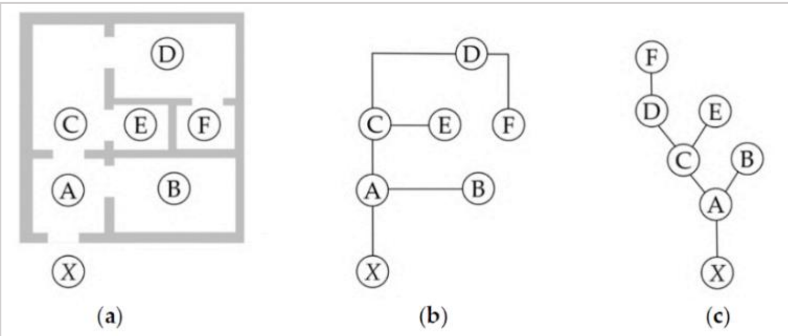


Figure 5. Justified Graph Map examples: (a) Architectural plan having six zones, annotating A–F, exterior zone (X) as a carrier; (b) graph illustrates relationship between spaces; (c) justified graph of architecture layout **(31).**

As soon as the graph sets out, the following mathematical formulas are used to get syntactic measurements of the home blueprints and the accompanying calculations:

DOI: http://dx.doi.org/10.25098/8.1.23

The Scientific Journal of Cihan University – Sulaimaniya PP: 1-23
Volume (8), Issue (1), June 2024
ISSN 2520-7377 (Online), ISSN 2520-5102 (Print)

2.1 The Mean Depth (MD):

This value clarifies how spatial elements are interconnected or isolated by counting number of transitions needed to go from one fundamental space (root) to another. Additionally, it sheds light on the depth measurement of the spatial arrangement. **Fig. 6** illustrates that maximum depth is seen whenever all the zones are placed in a linear order starting from the root (Asymmetric system), and the minimum depth is seen when rooms are directly joined to the root (Symmetric system). Eq. (1) illustrates how mean depth is measured.

$$MD = \frac{TD}{(K-1)} \quad (1)$$

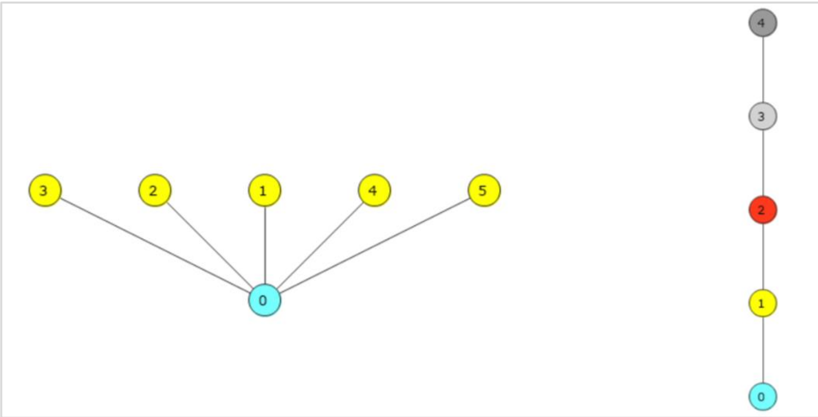


Figure 6. Left: symmetric system, and right: asymmetric system **(8).**

2.2 Relative Asymmetry (RA) and Integration (i):

This value represents a node's relative separation, and its counterpart is (i), which represents a node's degree of integration. To put it simply, more integrated areas are typically more accessible and communal, whereas less integrated areas tend to be more private and less accessible. When comparing measures derived from graphs or designs of comparable magnitudes, Relative Asymmetry (RA) is utilised to guarantee the same space numbers by normalising (MD) on the scale ranging from (0.0 to 1.0). The following equations are used to determine these two values:

$$RA = \frac{2(MD-1)}{(K-2)} \quad (2)$$

$$i = \frac{1}{RA} \quad (3)$$

2.3 Real Relative Asymmetry (RRA) and Integration (i) of (RRA)

Because spaces in the architectural plans vary, this measurement is used in place of (RA). (RRA) considers a fixed number of spaces based on a designated table, standardising the (RA) measurements with respect to an ideal diamond graph D **(8) (32)**. The integration value is indicated by (RRA), also known as the integration degree. A space's permeability is shown by its RRA values; lower values denote higher integration while larger values denote lesser integration (or increasing segregation). When observing spatial arrangements, the two main syntactic metrics are depth and integration. The following equations are used to calculate this indicator:

$$RRA = \frac{RA}{D_k} \tag{4}$$

$$i_{RRA} = \frac{1}{RRA} \tag{5}$$

2.4 Control Value (CV)

This metric evaluates the degree to which one area limits the access of its neighbour, hence illustrating the influence of one space on another within the house layout **(33)**. That can have to do with an area that is more alluring than the others. Higher (CV) values correspond to more connections to other spaces. Eq. (6) could be used to measure the control value.

$$CV_a = \sum_{D(a,b)=1} \frac{1}{Val(b)} \tag{6}$$

2.5 Base Difference Factor (H) and Relativized Difference Factor (H *)

This factor assesses how much integration values of every space in a house differ from one another. The value of the (BDF) is between 0 and 1. According to Hanson (2003), an Asymmetric System is more divided than a Symmetric System, whereas a number close to (0) denotes a more integrated system. Within the spatial framework, cultural trends may be reflected in the consistency of these values' order. Therefore, it is an essential entropy-based metric for morphological analysis of residential layouts since it reveals the existence of regular spatial patterns, or “inequality genotypes” **(19)**. Eq. (7) and (8) could be used to measure these indicators.

$$H = -\sum \left[\frac{a}{t}\ln\left(\frac{a}{t}\right)\right] + \left[\frac{b}{t}\ln\left(\frac{b}{t}\right)\right] + \left[\frac{c}{t}\ln\left(\frac{c}{t}\right)\right] \tag{7}$$

$$H^* = \frac{(H - \ln 2)}{(\ln 3 - \ln 2)} \tag{8}$$

DOI: http://dx.doi.org/10.25098/8.1.23

2.6 Space Link Ratio (SLR)

It shows the extend of ringiness in the spatial system or the amount of (distribuends) or (non-distribuends) of the layouts. When two spaces have a single non-intersecting path connecting them, the system is said to be non-distributed and is akin to a "tree-like structure" with not any rings. On the other hand, a distributed system with a " Ringy structure" is one where many non-intersecting path exist connecting any multiple areas of the system **(34)**.

2.7 The Degree of Space (space type):

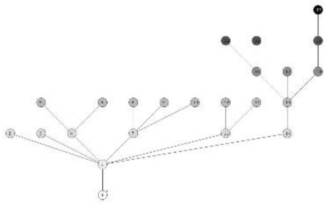
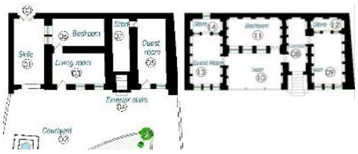
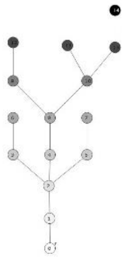
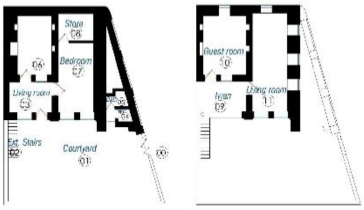
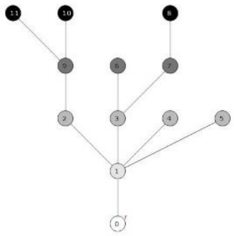
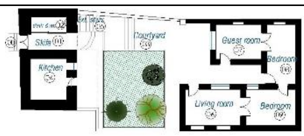
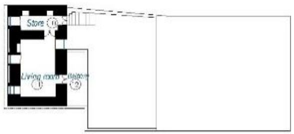
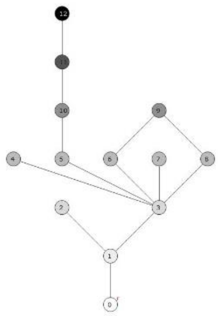
In Hillier's researches, the spatial system can be divided into four different topological categories: a-type, b-type, c-type, and d-type. Whereas b-type space has several connections and is arranged in a tree form, a-type space possesses only single connection to other spaces. In contrast to d-type space, which has more than two connections and is positioned on at least two rings, c-type space has more than one connection that is located on a ring structure. To be more specific, a-type and b-type spaces belong to the category of tree-like graphs, while c-type and d-type spaces are related to ring structures **(2) (13) (19)**.

Initially, data was collected through the researcher's field investigation for the practical analysis. After that, the chosen homes were recorded and converted using AutoCAD software into computer-aided design (CAD) models. Then, using A-graph software, architectural designs were changed into graph-based illustrations or a justified plan graph (JPG). In this illustration, space number (00) and the houses' exteriors are referred to as the root, and **Table 1.** and **Table 2.** show the hierarchical placement of the remaining spaces. This is a graphical representation with nodes standing in for functional zones and lines for the relationships between them.

DOI: http://dx.doi.org/10.25098/8.1.23

Volume (8), Issue (1), June 2024
ISSN 2520-7377 (Online), ISSN 2520-5102 (Print)

Table 1. Traditional house samples (HT) with their Justified Plan Graphs.

Traditional Houses samples (1900-1960)				
	House	Architectural style	Plans	Justified Graph
1	HT-01 Osman Chawash House Sabunkaran		 Ground Floor Plan First Floor Plan	
2	HT-02 Ahmed Qopcha House Sarshaqam		 Ground Floor Plan First Floor Plan	
3	HT-03 Al Zahra Sarshaqam		 Ground Floor Plan First Floor Plan	
4	HT-04 Osman Hama Nayar House Malkandi		 Ground Floor plan  First Floor Plan	

DOI: http://dx.doi.org/10.25098/8.1.23

Volume (8), Issue (1), June 2024
ISSN 2520-7377 (Online), ISSN 2520-5102 (Print)

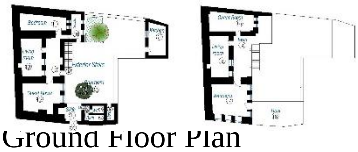
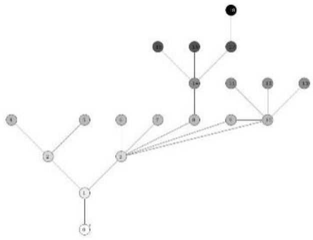
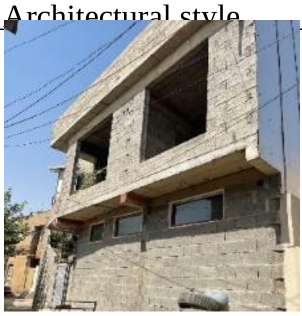
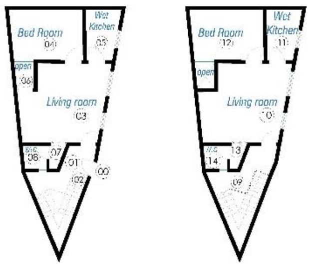
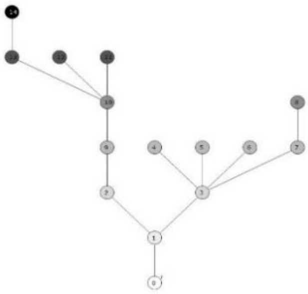
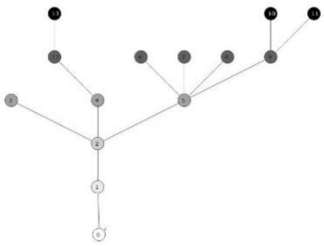
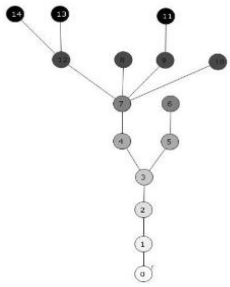
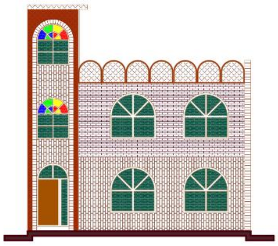
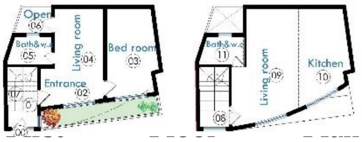
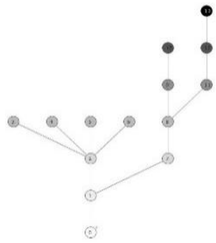
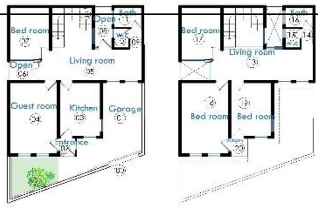
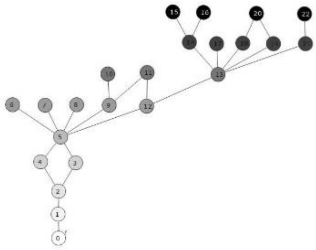
5	HT-05 Ali Boskani House Sabunkaran		 Ground Floor Plan First Floor plan	
Legend	◯ Least Depth ● Highest Depth	Depth lines	spaces	

Table 2. Contemporary house Samples (HC) and Justified Plan Graphs by A-graph.

Modern Houses samples (1990-current)				
	House	Architectural style	Plans	Justified Graph
1	HC-01 House Malkandi		 Ground Floor Plan First Floor Plan	
2	HC-02 Salar Ali Hassan Julakan		 Ground Floor Plan First Floor Plan	
3	HC-03 Banaz Muhammed Faraj House Julakan		 Ground Floor Plan First Floor Plan	

DOI: http://dx.doi.org/10.25098/8.1.23

Volume (8), Issue (1), June 2024
ISSN 2520-7377 (Online), ISSN 2520-5102 (Print)

4	HC-04 Aram Qasim House, Sabunkaran		 First Floor Plan	
5	HC-05 Kafya Abdullah House Sabnukaran		 Ground Floor Plan First Floor Plan	
Legend	○ Least Depth ● Highest Depth | Depth lines —— spaces connection			

3. RESULTS AND DISCUSSION

In order to investigate the evolution and changes in the spatial genotypes of traditional home layouts in Sulaymaniyah's historical core, which experienced a modern reconstruction process that included modern spatial patterns, this study used a comparative methodology. In order to gather numerical data through mathematical equations, this paper used a space syntax technique. It then used space syntax methodology to analyse the results. **Table 3.** and **Table 4.** provide a full summary of the main conclusions.

DOI: http://dx.doi.org/10.25098/8.1.23

Table 3. Mean syntactic measurements for Traditional Court-yard houses.

House Signs	MD	Integration (RRA)	SLR	BDF
HT-01	3.60	1.17	1.10	0.78
HT-02	3.52	1.49	1.08	0.76
HT-03	2.84	1.28	1.10	0.76
HT-04	2.84	1.20	1.10	0.85
HT-05	2.85	1.04	1.12	0.71
Mean Value	3.13	1.24	1.10	0.77

Table 4. Mean syntactic measurements for contemporary reconstructed houses.

House Signs	MD	Integration (RRA)	SLR	BDF
HC-01	3.60	1.53	1.00	0.84
HC-02	2.93	1.19	1.00	0.72
HC-03	3.40	1.41	1.00	0.72
HC-04	3.45	1.51	1.00	0.81
HC-05	3.55	1.14	1.10	0.70
Mean Value	3.38	1.36	1.02	0.76

3.1 Mean Depth (MD)

The average depth for conventional (courtyard) dwelling configurations is (3.13), but the new housing compositions have a mean depth of (3.38). According to this research, modern home designs are typically characterised by an asymmetric form with a more linear organization. Spaces that are positioned farther from the main area (the root space) or the house entry are referred to as such. On the other hand, conventional housing plans usually show a symmetrical arrangement, with areas positioned nearer to and connected to the root space. Moreover, in conventional designs, the bedrooms—which symbolise the private sector—show the highest depths, while the inner courtyard and service area—which includes the kitchen, storage room, bathroom, and toilet—show the lowest depths. In contrast, the living space (hall) and the stairway which connects the ground floor to the first floor have the minimum depth in modern design, with the bedrooms that are attached to the hall coming in second. Instead of remaining as the courtyard, these enclosed spaces became distributor spaces—which are seen as public areas—due to this design feature. Modern houses also tend to have the bathrooms and toilets in the furthest places, which lessens the seclusion and bedroom's comfortability that are linked to and accessible from the hall.

DOI: http://dx.doi.org/10.25098/8.1.23

Volume (8), Issue (1), June 2024
ISSN 2520-7377 (Online), ISSN 2520-5102 (Print)

3.2 Integration Value RRA

A higher level of system integration (accessible) is indicated by a low (RRA) number. The computations clearly show that the traditional samples had a lower (RRA) value on average (1.24), whereas the current samples have a higher average (1.36). This disparity implies that there is more accessibility and permeability in the conventional spatial system. According to the syntactic values, the traditional home's inner courtyards have the maximum connection level (lower RRA), indicating that it plays a critical function in regulating entry to alternative regions of the home where regular users activity take place. On the other hand, the central hall in contemporary homes have the maximum integration value and functions as a location for allocating access to other areas. This discovery sheds important light on the way the distributing area evolved from open area outside the home to being contained inside, changing the dwellings' typology from introverted to extroverted. This change essentially modifies the ratio of open to closed areas, akin to a layout typically observed in Western room organization that revolves around enclosed movement.

3.3 Space Link Ratio SLR

This characteristic relates to the spatial system's (Distributes - non Distributes) display. The samples of modern houses show that the value (1.00) recurs, with an average value of (1.02) for each of the five residences. This suggests that the number of connections between rooms and the overall size of the house are equivalent (lower connectivity), and that the spatial arrangement is non-treelike or non-distributed, with only one linear channel connecting the carrier (outside) to the other rooms in the house. The conventional instances, on the other hand, show a recurrence of (1.10) with an average of (1.10), indicating a higher number of alternate routes between the rooms in a house, frequently with several points of entry between rooms. As a reflection of the socio-cultural beliefs and lifestyle preferences of the occupants, this promotes a more distributed or ring-like spatial arrangement with different routes from the carrier (outside) to various rooms, usually observed between the bedrooms. Two different spatial underlying genotypes are indicated by the recurrence of (SLR) within each category.

3.4 Base Difference Factor H*

In this indicator both traditional and contemporary groups exhibit convergent low average values of (0.77) and (0.76) with regard to the distinction factor. Closeness to (H) values of (0) indicates less difference between the regions, meaning higher functional efficiency. On the other hand, values that are close to (1) show a considerable difference between spaces, which results in lower functional efficiency. This indicator's results show almost equal functional efficiency in both spatial situations. The fact that the H value ranges between 0.78 and 0.85 in the five traditional samples and between 0.70 and 0.84 in the modern samples is a noteworthy conclusion to be made. Referred to as “inequality genotypes”, the persistence of spatial patterns in the traditional samples denotes cultural genotypic strength.

DOI: http://dx.doi.org/10.25098/8.1.23

3.5 Type of Spaces (Typologies)

This measure clarifies how various spatial areas are interconnected. Due to their limited access from other areas, the (A-type) spaces are considered the most private and are mostly meant for bedrooms or places reserved for female users. On the other hand, the (D-type) space has the most connectivity with other spaces. The court-yard and the entryway (skifa) stand out as (B or C-type) spaces after looking at the graphs and **Tables 5.** and **6.** of traditional houses. Each of these spaces has two or more links with other areas. On the other hand, the hall and the entryway in the contemporary models have the most linkages to other areas, giving the bedrooms' immediate access. In modern homes, the areas in categories A and B are more valuable than in old ones. Bedrooms fall into category (A) spaces since they don't have constant traffic, while category (B) spaces are transitional regions with less instances of (C and D) space types, which indicates fewer linkages in the spatial structure and a non-distributed system. Traditional homes, on the other hand, have more (C and D) spaces, which results in a more dispersed spatial configuration and a more connected spatial layout with more routes for moving between spaces.

Table 5. Degree of space (Space Typology) of traditional houses.

House Signs	A-ness	B-ness	C-ness	D-ness
HT-01	0.53	0.11	0.41	0.00
HT-02	0.50	0.62	0.00	0.00
HT-03	0.50	0.18	0.38	0.00
HT-04	0.44	0.27	0.27	0.55
HT-05	0.47	0.29	0.17	0.17
Mean	0.48	0.29	0.24	0.14

Table 6. Degree of space-ness (Space Typology) of contemporary houses.

House Signs	A-ness	B-ness	C-ness	D-ness
HC-01	0.57	0.50	0.00	0.00
HC-02	0.61	0.46	0.00	0.00
HC-03	0.50	0.57	0.00	0.00
HC-04	0.53	0.53	0.00	0.00
HC-05	0.53	0.20	0.66	0.06
Mean	0.54	0.45	0.13	0.01

DOI: http://dx.doi.org/10.25098/8.1.23

The Scientific Journal of Cihan University – Sulaimaniya PP: 1-23
Volume (8), Issue (1), June 2024
ISSN 2520-7377 (Online), ISSN 2520-5102 (Print)

3.6 Houses Genotypes:

According to Hillier and Hanson, genotypes are identified by a constant ranking of hierarchical integration measurement of residential spaces, that suggests the existence of sociocultural layout in house designs **(8)(35)**. In order to make it easier to organise integration values across all zones and determine genotype of spaces, **Table 7.** presents the abbreviations for residential spaces. The relative asymmetry values of the traditional and modern samples are shown in **Table 8.** and **Table 9.**, with the lowest (RA) value representing the most integrated sample and the highest (RA) value representing the least integrated sample. With the exception of home (HT02), which is built around a transitional area, **Table 8.** illustrates the repetition of the conventional samples' hierarchical ranking. Four of the house examples are arranged around courtyard. This repetitive spatial arrangement provides the existence of an underlying genotype within the particular population. However, **Table 9.** also demonstrates that modern samples (HC02 and HC05) are centred around the guest room and staircase, respectively, while the contemporary examples (HC-01, HC-03, and HC-04) are designed around a hallway, that functions as a closed transitional area. This observation highlights substantial variations in spatial organisation between the first and second groups, pointing to the lack of a strong, distinctive sociocultural genotypes in the studied examples.

Table 7. Abbreviations of house spaces.

Spaces	Abbreviations	Spaces	Abbreviations
Courtyard	crt	skifa	skif
Bedroom	br	House main entrance	Ext.
Exterior	Str1	kitchen	kit
Interior	Str2	Bath	bth
Guest room	gst	Toilet	wc
Living room	Liv	Store	sto
Iwan	Iw	corridor	corr
Balcony	Bl	Laundry	Lr
Roof	Rf	Entrance (foyer)	Ent.
Open	Op.	penthouse	ph
Garage	Gr	Hall	hall

DOI: http://dx.doi.org/10.25098/8.1.23

The Scientific Journal of Cihan University – Sulaimaniya **PP: 1-23**
Volume (8), Issue (1), June 2024
ISSN 2520-7377 (Online), ISSN 2520-5102 (Print)

Table 8. Genotypic structure for traditional House examples.

House Sign	Mean RA	Hierarchical Integration (Including Exteriors)
HT-01	0.27	Crt=0.11<Str=0.15<skif=0.19Corr=0.20<wc=Sto2=Kit=Liv1= Br2=0.24<Ext=Sto1=gst1= 0.32<gst2=br3=Liv2=br4=0.34
HT-02	0.48	Crt=0.14<Iw=Kit=0.23<br1= 0.33<Ext=bth&wc=0.42<br2=gst=0.52
HT-03	0.26	Crt=0.12<str=0.16<skif=Corr2=0.18<Corr1=0.20<Iw=0.22< Sto=Kit=0.23<Lr=0.26<Ext= 0.29<br1=gst1=Liv1=0.30< br2=0.32<gst2=Liv2=0.33< bth=wc=0.37<Rf=0.43
HT-04	0.32	Crt=0.09<Str=0.15<Skif=0.16 <gst1=0.20<bth=wc=Kit=Liv2=Liv3=0.21<Iw=0.22<Ext=Liv1=Sto=0.29<br1=0.32<br2=br4=0.34<gst2=0.35
HT-05	0.23	Corr1=0.20<Str=0.23<Liv=0.25<Corr2=0.28<Crt=0.33<gst1= br1=0.35<br2=gst2=Iw=Rf=0.43<Ext=bth=wc=0.48

Table 9. Genotypic Structure of New House Examples

House Sign	Mean RA	Hierarchical Integration (Including Exteriors)
HC-01	0.41	Str=0.22<Ent=Corr=0.23<hall1=0.26<hall2=0.28<Corr1=0.32< Pnt=0.33<Ext=0.34< Corr2=0.35<Kit1=0.37<Kit2= 0.39<bth1=wc1=br1=Op=0.43<Rf=0.44<bth2=wc2=br2=0.46
HC-02	0.31	Gst=0.24<yrd=hall=0.25<Str= Corr=0.36<Ent=0.39<Sto1=br= 0.42<BL=0.50<bth=wc=0.53<Ext=0.56<Sto2=0.66
HC-03	0.38	Corr1=0.23<Hall1=Str1=0.24< Ent=Corr2=0.27<Yrd=0.32< Hall2=gst1=br1=0.33<Str2=0.35<Hall3=0.36<Kit=br2=gst2=0.37<Ext=0.42<pnt=0.44<Lr=0.45<BL=0.46<Rf=0.54<wc=Bth=0.
HC-04	0.42	Hall2=0.08<Hall1=Corr=0.12< Kit=Lr=014<br1=br2=br3=Op1=0.17<Str=0.20<yrd=0.21<gst= Op3=Op4=Sto=0.22<Hkit=0.23<Op2=wc=bth=0.24<Pnt=
HC-05	0.23	Ent=0.15<Str1=0.16<hall1= 0.17<hall2=0.19<Corr1=0.20 <yrd=Str2=0.22<gst1=gst2= Corr2=0.23<Kit1=Lr1=0.27< br1=br2=Op=0.28<Lr2=Pnt =0.29<Ext=0.30<Kit2=br3=br4 =0.31<bth1=wc1=0.34<Op2=0.35<wc2=bth3=Rf=0.37

DOI: http://dx.doi.org/10.25098/8.1.23

4. CONCLUSIONS

The purpose of this study was to compare genotypes related to the spatial layout of samples that included both traditional and modern homes situated in the historic city centre of Sulaymaniyah. The destruction of the original traditional homes and the subsequent construction of new ones are seen to have altered the spatial genotypes, suggesting the impact of modern rebuilding methods on the creation of diverse spatial arrangements and morphological characteristics. The selected homes serve as a representation of the two groups' dominant typology. The goal of the research was to pinpoint the structural rules and genetic constants influencing their architectural configurations. The study employed a quantitative technique for analyzing data including spatial syntactic methodologies demonstrating the association among home spaces in contemporary and traditional scenarios in order to accomplish this goal. In order to achieve this, syntactic metrics in relation to spatial morphology, hierarchical structure, accessibility, and structuring modalities were measured and compared. The study's findings demonstrated the followings:

1. The significance of space syntactic tools is in their ability to illustrate how the socio-cultural characteristics that the homeowners and builders possessed shaped their dependence on a particular layout arrangement of a house's architecture spatial pattern.
2. Traditional house genotypical layout differ from newly constructed modern layouts in terms of how open and closed spaces interact, how rooms are arranged in a hierarchy, how private a space is, and how social interactions take place.
3. The open courtyard and partially enclosed Iwan were important components of the residential space arrangement in the traditional setting; however, in the renovated homes, these areas have been rearranged to become the enclosed gathering area (Hall) and hallways, that serve as zones of transition.
4. Concerning to the connection with the city street, the quantitative syntactical data indicates that historical house layouts have an inward orientation, with housings facing an interior courtyard that is surrounded by strong walls from the outside, leading to a restricted relationship with the street. On the other hand, modern reconstructed homes have an outward facing layout with enlarged sections that face the street.
5. Despite the fact that city's historic homes were not created by professionally educated architects following particular codes, their spatial layouts reveal a clear shared organisational structure.
6. Despite differences in the outward manifestations (phenotypes), traditional homes display a spatial genotype that, up until the early 1990s, was moulded by regional cultural norms. Then, as society's attitudes, values, and behaviours changed over time—especially in the lack of laws and rules pertaining to conservation—these geographical patterns experienced profound changes.
7. Designers must create current designs based on the existing spatial qualities in order to ensure the modern requirements while maintaining the distinctive architectural identity of a location. These solutions have shown to be more in line with the population' cultural values, sense of place, and customs.

DOI: http://dx.doi.org/10.25098/8.1.23

Acknowledgements

The author acknowledges all house owners while documenting their houses.

Declaration of Competing Interest

The author declares that he has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

REFERENCES

1. Abdullah, W. S., Shari, A. N. M., 2019. Distortion of Local Architecture Identity A comparative study for the rebuilding process of the buildings on Sabunkaran street. Sulaimania. *Journal for Engineering Sciences*, 6(3), pp. 47-58. doi.org/10.17656/sjes.10099.
2. Hanson, Julienne., 2003. *Decoding homes and houses*. Cambridge university press.
3. Rzaij, W.A., Khudair, B.H., 2022. Assessment Strategies of Fixed Firefighting system in Residential Multi-Story Building for Improving Fire Safety: A Review. *Journal of Engineering* 28(6), pp. 53–64. doi.org/10.31026/j.eng.2022.06.05
4. Hillier, B., Hanson, J., 1989. *The social logic of space*. Cambridge university press.
5. Elizondo, L. A, 2022. Justified Plan Graph Analysis of Social Housing in Mexico (1974–2019): Spatial Transformations and Social Implications. *Nexus Netw J*, 24, pp. 25–53. https://doi.org/10.1007/s00004-021-00568-7
6. Rahmane, A., Abbaoui, M.,2021. The Architectural Genotype Approach in Contemporary Housing (1995 to 2010). *Engineering, Technology & Applied Science Research*, 11(1), pp. 6810–6818. doi.org/10.48084/etasr.4006
7. Hillier, B., Leaman, A., 1974. How is design possible: A sketch for a theory. *DMG-DRS Journal: Design Research and Methods*, *8*(1), pp. 40–50.
8. Hillier, B., Hanson, J., 1984. *The Social Logic of Space, Cambridge Univ*. Pr.
9. Steadman, P., 2008. *The evolution of designs: biological analogy in architecture and the applied arts*. Routledge.
10. Hillier, B., Hanson, J., Graham, H., 1987. Ideas are in things: an application of the space syntax method to discovering house genotypes. *Environment and Planning B: Planning and Design*, 14(4), pp. 363–385. doi.org/10.1068/b140363
11. Bafna, S., 1999. The morphology of early modernist residential plans: Geometry and genotypical trends in Mies van der Rohe's designs. *Proceedings of the Second International Symposium on Space Syntax*, *1*, 1.
12. Edwards, B., Sibley, M., Hakmi, M., Land, P., 2004. *The power of the veil: gender inequality in the domestic setting of traditional courtyard.* In *Courtyard Housing*. pp. 109–123. Taylor & Francis. doi.org/10.4324/9780203646724
13. Guney, Y. I., 2005. *Appropriated 'a la Franga': An examination of Turkish modernization through the lens of domestic culture*. PhD. thesis submited to the University of Michigan.
14. Mustafa, F. A., Hassan, A. S., Baper, S. Y., 2010. Using space syntax analysis in detecting privacy: a comparative study of traditional and modern house layouts in Erbil city, Iraq. *Asian Social Science*, *6*(8), pp. 157-166. DOI:10.5539/ass.v6n8p157
15. Seo, K. W., 2017. Finding Housing Genotypes by Graph Theory: An Investigation into Malay

Houses. In *Morphological Analysis of Cultural DNA*, pp. 37–47. Springer. DOI:10.1007/978-981-10-2329-3_4

16. Raith, K., Estaji, H., 2020. Traditional House Types Revived and Transformed: A Case Study in Sabzevar, Iran. In *Urban Heritage Along the Silk Roads*. pp. 157–173. Springer. DOI:10.1007/978-3-030-22762-3_11
17. Hanson, J., 1998. Chapter Eight 'The anatomy of privacy in architects' London houses'. *Decoding Homes and Houses*, pp. 215–241.
18. Cunha, V., 2012. Can genotype patterns change over time. *In: International Space Syntax Symposium, 8*.
19. Hillier, B., 2007. *Space is the machine: a configurational theory of architecture*.Space Syntax.
20. Bustard, W., 1999. Space, evolution, and function in the houses of Chaco Canyon. *Environment and Planning B: Planning and Design*, 26(2), pp. 219–240. https://doi.org/10.1068/b4325
21. Roesler, C., 2012. Are archetypes transmitted more by culture than biology? Questions arising from conceptualizations of the archetype. *Journal of Analytical Psychology*, 57(2), pp. 223–246. doi.org/10.1111/j.1468-5922.2011.01963.x
22. Abdullah, W. S., Qaradahi, A. M. A., 2021. Measurable Mistakes in Architecture the Effect of Designer's Experience on the Propagation of Mistakes in Architectural Design - Residential Buildings in Al Sulaymaniyah City as a Case Study. *Journal of Engineering*, 24(1), pp. 89-111. doi.org/10.31026/j.eng.2021.01.07
23. Sari, I.K.; Nuryanti, W.; Ikaputra, I. Phenotype, 2020**.** Genotype and Environment in Architecture Case Study: Traditional Malay House, West Borneo. *Preprints* 2020, 2020050034. doi.org/10.20944/preprints202005.0034.v1
24. Ledent, G., 2017. Permanence to allow change. The archetypal room: The persistence of the 4× 4 room. In *Architectural Research Addressing Societal Challenges*, pp. 339–344. CRC Press. DOI:10.1201/9781315226255-54
25. Byun, N., Choi, J., 2016. A Typology of Korean Housing Units: In Search of Spatial Configuration. *Journal of Asian Architecture and Building Engineering*, 15(1), pp. 41–48. doi.org/10.3130/jaabe.15.41
26. Amorim, L., 2001. Houses of Recife: From diachrony to synchrony. *Proceeding of the 3rd International Space Syntax Symposium*, 1–7.
27. Noble, A., 2009. *Traditional buildings: a global survey of structural forms and cultural functions*. Bloomsbury Publishing.
28. Mohamed Salih A., 2019. The Characters of the FormintheVernacular ArchitectureA comparative study oftheform's charactersof facades ofindividual houses and commercial buildingsin the City of Baghdad after 2003–Zayoonadistrictas a case study. *Journal of Engineering*, 25(7), pp. 145–164. doi.org/10.31026/j.eng.2019.07.09
29. Qaradaghi, A. M. A., 2020. The effect of rural building types informing the type of traditional courtyard houses in Sulaimaneyah city. *Journal of the Planner & Development*, *42*.
30. Alhilli, H. K., Rezouki, S.E., 2022. The Causes Influencing the Occurrence of Variation Orders in the Construction of Buildings. *Journal of Engineering*, 27(8), pp. 34–53. doi.org/10.31026/j.eng.2022.08.03
31. Ostwald, M. J., Dawes, M. J., 2018. *The Mathematics of the Modernist Villa: Architectural*

DOI: http://dx.doi.org/10.25098/8.1.23

Analysis Using Space Syntax and Isovists. (Vol. 3). Springer.

32. Peponis, J., 1985. The spatial culture of factories. *Human Relations*, *38*(4), pp. 357–390. doi.org/10.1177/001872678503800405
33. Klarqvist, B., 1993. A Space Syntax Glossary. *Nordisk Arkitektur for Skning,(2). 11*, *12*.
34. Guney, Y. I., Wineman, J., 2008. The evolving design of 20th-century apartments in Ankara. *Environment and Planning B: Planning and Design*, 35(4), pp. 627–646. doi.org/10.1068/b340
35. Al-Sayed, K., Turner, A., Hillier, B., Iida, S., Penn, A., 2014. Space syntax methodology. *Bartlett School of Architecture, UCL: London, UK*.

DOI: http://dx.doi.org/10.25098/8.1.23