

# Spatial Configuration of Traditional Dwellings in Riyadh Al-Khabra Traditional Town, Saudi Arabia

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## Abstract

Traditional buildings, particularly residential dwellings, are spatio-temporal reflections of the society and culture in which they were originally sited. Understanding the nature of this built heritage thus fosters interpretation of previous generations' experiences in these older settlements, all of which can thus be described as products of several different cultural dimensions. Qassim province, which sits in the central province of the Kingdom of Saudi Arabia, is distinguished by having retained various traditional towns and villages, including multiple dwellings representing important eras in the past. However, due to the local population's abandonment of these traditional towns and movement to new urban areas, and related failures in conservation and restoration, some of these towns have lost many of their unique characteristics, especially with regard to their dwellings. This research thus attempts to interpret the relationships between the spatial configuration of traditional dwellings in Saudi Arabia and their socio-cultural principles and values, focusing on decoding their interior spatial constants and genotypes. The study proposes the use of space syntax theory, represented by the justified plan graph method, as an appropriate socio-spatial methodology for such work, targeting the traditional town of Riyadh Al-Khabra in Qassim province as a case study area, with eight dwellings built between 1900 and 1940 used as examples. Interpretation of analysis results enabled defining spatial constants digitally in these traditional dwellings through the benefit of syntactic analysis techniques, and the main findings of this research reveal the significance of various social and cultural factors and customs among inhabitants with regard to determining the spatial form and properties of traditional dwellings in towns such as Riyadh Al-Khabra.

## Keywords

Traditional Dwellings, Socio-Cultural, Space Syntax, Spatial Configuration,

## 1. Introduction

Houses or dwellings are associated with the elements of safety and control, as well as offering a reflection of values and ideas, a place for social relationships, a refuge from the outside world, and an indicator of personal status [1]. Traditionally speaking, dwellings can be defined as places distinguished by respect for various human, social and environmental dimensions, thus offering an expression of human traditions, customs, and culture at the time and place of their creation [2]. From a social point of view, a dwelling is an expression of how households accommodate human everyday activities over time, while from an architectural point of view, it is a pattern or a spatial arrangement that elucidates how spaces become connected to each other based on how activities are grouped and separated.

Traditional dwellings were generally influenced by various socio-cultural factors, primarily based on inhabitants' freedom of choice in the presence of other non-negotiable factors such as climate, economy, materials, and technology. This is clarified by Reference [3] assertion that any traditional dwelling is usually a result of evolution over successive generations. Reference [4] further emphasizes the fact that a dwelling is a social artifact, thus playing an essential social role: he describes this as a true reflection of the internal activities, suggesting that the social meaning of any dwelling is reflected through the arrangement and distribution of spaces within it. Space can thus be considered a social product to be developed through social relationships, though it is not simply supported by those relationships, rather generated by them [5].

Focusing on traditional settlements in Saudi Arabia, they are distinguished by having retained various traditional towns and villages, including numerous dwellings that reveal a fascinating mix of authenticity, culture, and tradition and represent important eras in the past. Most of the traditional towns confront an irrecoverable loss of indigenous architectural characters and patterns which has been perpetuated by the local population's abandonment [6] [7], and related failures in conservation and restoration [8].

Qassim province, represented by Riyadh Al-Khabra's town, is one of those sites that encompass distinct traditional settlements. However, the literature review shows that no studies have been conducted on understanding or preserving its indigenous architectural characters and socio-spatial patterns despite many dwellings being in a decent shape and retaining their original traits. **Figure 1** illustrates some examples of these dwellings from Riyadh Al-Khabra's town.

However, this research is directed toward answering the following questions that targets the socio-cultural essence of traditional Saudi dwellings' spatial relations in order to foster their values: What is the relationship between the spatial



**Figure 1.** Dwellings examples from Riyadh Al-Khabra's town. Source: Author.

configuration of traditional dwellings in Riyadh Al-Khabra's town and its socio-cultural principles and values? In addition, how can the interior spatial constants and genotypes be identified?

To answer these research questions, this paper primarily adopts using the space syntax methodology as it enables to describe the spatial properties links between inhabitants' behaviors and various socio-cultural factors with respect to interpreting both the use of spaces and spatial configurations.

## 2. The Traditional Saudi Dwelling

Traditional built environments are established based on dwellers' perceptions of their own physical, biological, social, and cultural interactions, which they must consider to form their own settlements [9]. Reference [10] states that traditional architecture and its dwellings in Saudi Arabia represent a strong and distinctive local identity that reflects the region's Islamic values and cultural customs, thus representing a basis for the behavior of inhabitants in the form of a product that meets the needs of human scale, human values, and local society. Moreover, Saudi's residential architecture is further distinguished by its response to multiple non-negotiable factors such as the harsh climate, local culture, economic limitations, and the availability of local building materials [11].

Reference [12] indicates that Saudi's traditional architecture, as represented by these dwellings, contains various symbolic dimensions that can be used to clarify the way architectural elements are transformed into nonverbal signals that express the culture of a society and act as a tool for communication between people. Thus, it can be said that it has a meaning that goes beyond its physical form, expressing the surrounding community.

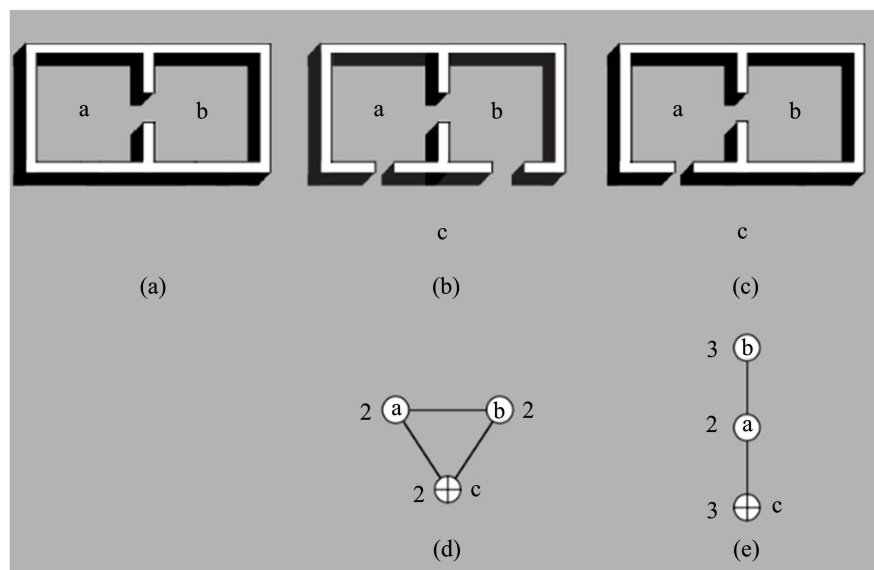
## 3. Space Syntax Theory and Applications

Space syntax theory was conceived by Hillier, Hanson, and their colleagues at the Bartlett School of Architecture, University College London in the late 1970s to early 1980s [13]. The theory is a science-based approach that focuses on studying spaces as spatial configurations based on understanding their relationships

with a range of social, economic, and environmental phenomena [14]. The significance of this theory lies in the ability to analyze and understand spatial layouts and their relation to human activities patterns in those spaces. Reference [13] thus argues that the theory can be utilized to develop insights into mutually constructive relationships between society and space, based on the ways in which spatial layouts impact social patterns; thus, buildings must be recognized as having social value. The theory also delivers descriptive and qualitative analyses of spatial configurations and urban systems that span the breadth of scale, from the interior of a single room to an entire city [15].

The space syntax theory represents the use of spatial configuration concepts to explain people's behaviors, perceptions, and social activities, where spatial configuration is defined as any and all the relationships that exist between a number of spaces in both simple and complex spatial systems, taking into account all other spaces in the complex [16] [17] [18].

Reference [19] thus simplifies the spatial configuration concept, as shown in the graphic example in Figure 2. This demonstrates a cell divided into two sub-cells, namely a and b, where space a is connected to space b by means of a permeable door, creating a relationship between the two spaces. When a third space (c) is added to the system, the relationships between a and b are changed, however. Case 1(b) shows spaces a and b both being connected directly to space c, and thus continuing to have an equal relationship, while in case 1(c), only space a is connected directly to space c, making it compulsory for users to pass through a to reach space b from space c. These three simple cases thus illustrate how relationships between two spaces can be changed when a third space is added to a spatial system, as well as how two spaces can be connected by means of a third space.



**Figure 2.** Relationships in spatial configuration. Source: Hillier, B. (2007) *Space is the Machine: A Configurational Theory of Architecture*. Space Syntax.

A considerable volume of literature has been published based on space syntax theory and its applications as a way to understand the impact of social and cultural factors on space usage and spatial configuration. One of the most notable publications in the early development of the theory was a study by reference [20]. Using space syntax theory, they examined seventeen samples of houses to measure how various functions were adapted to varied spatial configurations. Reference [21] also adopted the theory to analyze several houses in Ankara, Turkey, as a way to identify houses pattern genotypes and their transformation over time. Additionally, reference [22] investigated the spatial configurations of several dwellings built in different historical periods in Adana, Turkey, applying space syntax tools to explore outcomes determined by space-related adjacencies and how complex spatial configuration systems can affect space functions and usages. Similarly, reference [23] endeavored to decode traditional Berber dwellings in Algeria in the Aures region: their research assumed that despite the impact of key natural variables in the region, such as topographic, climatic, and tribal differences, various spatial constants in these dwellings serve as common at-tributes for Berber spatial and social structures.

#### 4. The Case Study Selection and Dwellings Samples

The Riyadh Al Khabra governorate, located at the heart of the Al-Qassim province (Figure 3) is an ancient town, established at the end of the 12th century AH (1688-1785 CE) [24] [25]. The town is now considered one of the best examples of traditional housing in Saudi Arabia's central region because it includes a diverse range of traditional dwellings, and the town is more generally in decent shape, with many areas retaining multiple original traits. However, many houses in the town have recently deteriorated and been demolished due to a lack of conservation policies, triggering a more urgent need for the present research.



**Figure 3.** The Selected dwellings samples from Riyadh Al-Khabra's town. Source: Google Earth.

The research employed eight dwelling samples built nearly between 1900 and 1940. Criteria for selecting the samples were as follows:

- 1) Dwellings being in good conditions that retain many of their original features and can be eligible for conducting the study.
- 2) The possibility to conduct personal interviews with people who had previously lived in these dwellings (four samples).
- 3) Dwellings that represent the prevailing pattern in the town which were inferred from the field survey.

Data were collected during a field visit, with the selected dwellings surveyed using electronic instruments. The resulting data then were transformed into a CAD model using AutoCAD software. The key functions of each space in the examined dwellings were calibrated and observed in comparison to interviews conducted with people living in those dwellings. **Table 1** presents a list of space names and functions across all selected dwellings, showing the symbols employed in this research Riyadh Al-Khabra Heritage Village.

## 5. Methodology

This research employs the theory of space syntax, represented by the Justified Plan Graph (JPG) technique to investigate and decode traditional dwellings in Riyadh Al-Khabra in KSA. This theory was adopted as it enables the creation of links between inhabitants' behaviors and various socio-cultural factors with respect to interpreting both the use of spaces and spatial configurations. In

**Table 1.** List of spaces names, functions, and cods in all selected dwellings.

No.	space	cod	No.	space	Cod
1	Yard-Family section	YR. F	14	Room inside room (AMP)	RIR
2	Arcade-Men's guest section	AR.M	15	Open vestibule-Family section	VES.F
3	Yard-Men's guest section	YR.M	16	Corral	COR
4	kitchen	KI	17	Fodder store	FOS
5	Stair-Family section	STI	18	Loft store	L.STO
6	Arcade-Family section	AR. F	19	Store	STO
7	Firewood store	FS	20	Loft room	L.RO
8	Men's reception room	GR.M	21	Back yard	BY
9	Stair-Men's guest section	STI.M	22	Family hall	F.H
10	Roof	RF	23	Private store	PST
11	Dates room	DR	24	External room	O.RO
12	Room	RO	25	Open vestibule-men's section	VES.M
13	A multi-purpose room	AMP			

addition, the theory provides the capacity and innovativeness of analyzing spatial relationships and explaining the socio-spatial organization [26]. Regarding historical sites, reference [27] also confirms that space syntax tools can be efficaciously utilized in the accurate analysis of relationships between exterior or interior spaces within any heritage-built environment.

The Justified Plan Graph (JPG) is a practical analytical technique that offers a graphical, mathematical, and associated theoretical paradigm for analyzing the spatial configuration of buildings [28]. Within this technique, building diagrams are subdivided into multiple components representing spatial configurations, with each configurational node in the JPG referring to a space, and the linking lines between the nodes referring to the interconnections and relationships between those spaces. A JPG performed in conjunction with JASS software thus provides mathematical data and various measurement variables related to the syntactical characteristics of the spatial configuration of the associated buildings [29].

In this research, analysis was carried out on the selected dwellings as a way to explore the similarities and differentiation between the observed spatial patterns in terms of spatial characteristics. The functional spaces in the spatial system were analyzed both with and without exterior calculation. The main parameters used in the analysis were thus as follows: mean depth (MD), real relative asymmetry (RRA), base difference factor (BDF), and space-link ratio (SLR). In addition, the analysis considered syntactical characteristics such as symmetry, asymmetry, distributedness, and non-distributedness as essential measures within the investigation process to determine the necessary features for the justified plan graphs.

The analysis procedures implemented in this research were thus:

- 1) All traditional dwelling samples were surveyed and then drawn using AutoCAD software. These drawings were then converted to justified plan graphs (JPG), taking the exterior as the root by dividing the spaces into elements within the creation of the JPG, with the nodes representing the rooms and the lines representing the relationships between those rooms.
- 2) Spatial configuration is analyzed by calculating different syntactical parameters, such as the mean depth (MD), the real relative asymmetry (RRA), the space-link ratio (SLR), and the base different factor (BDF).
- 3) Once analyses of these parameters were obtained, the genotypes of the dwellings were determined.
- 4) The dominant topological types and spaces were then identified in each case.
- 5) Finally, a comparison was made between the genotypes of dwellings to identify similarities and differences in their spatial configurations.

## **6. Analyses and Discussion**

### **6.1. Visual Review**

Visual review analysis is an essential configurational feature for any spatial sys-

tem, as it indicates the number of areas (often referred to as “steps”) through which a person must pass to move from one particular area to any other area in the configuration [21].

A visual review of the justified plan graphs (JPG) of the selected dwellings indicates that spaces in sample 6 are distributed in six levels of steps (transitional levels) which represent the highest level reached for all selected samples. While the lowest is achieved in sample 7 which the spaces are distributed in three levels of steps, samples 1, 3, 4 and 5 are distributed at five levels of steps, and samples 2 and 8 are distributed at four at five levels of steps.

From these analyses, it is found that the level of steps average in all samples is between 5 to 6 steps, thus it can be inferred that the selected dwellings are formed in semi-deep spaces and in a ring-like system.

A visual review of the JPG (**Figure 4** and **Figure 5**) shows that the exterior (carrier) is directly linked to three spaces in three dwellings samples, while in the other five samples, the carrier is directly linked to only two spaces. The fewest links to the exterior are thus seen in these latter cases. This arises due to the social principle of segregating the male guest section from the family area, which requires each section to have its own entrance linked to the exterior. Where a third linked space emerges, this tends to have the functions of service, frequently featuring a corral (COR) or fodder store (FOS), as shown in samples 8 and 1. In sample 3, a link to an external room (OR.O) represents access to a carpentry shop owned by the householder.

Within the justified plan graphs, it shows that the principle of complete segregation between the guest section and family section is a common feature across all samples. The samples also seem to be divided into two separate dwellings, with the Yard-Family section (YR.F) or Arcade-Family section (AR.F) acting as an interior root for the family section, and the Arcade-Men’s guest section (AR.M) acting as an interior root for the male guest sections. Such segregation confirms the important social principle of privacy across selected samples in the town.

## 6.2. Mean Depth (MD)

Reference [14], defines the values of mean depth (MD) as it represents how deep or shallow a spatial system within a particular space. **Table 2** shows that the mean depth across the eight selected dwellings ranges between 2.43 and 3.20, offering an indication of a lack of accessibility steps for moving to the deepest spaces in the system: the average of all mean depth values is 2.78. This can be generally attributed to the simplicity of forming links between spaces, as shown on the JPG.

The highest average depth, 3.20, is obtained for sample 6, which is as expected, as this sample contains the largest number of spaces (21 spaces) and has the deepest number of levels (6). Across the other seven dwellings, for example in samples 3, 1, and 5, the number of levels is equal (5), but these vary in number



**Figure 4.** Plans and Justified plans graph for dwelling samples 1, 2, 3, and 4. Source: Author. (a) Plans for dwelling sample 1 and, Justified plan graph; (b) Plans for dwelling sample 2 and, Justified plan graph; (c) Plans for dwelling sample 3 and, Justified plan graph; (d) Plans for dwelling sample 4 and, Justified plan graph.



**Figure 5.** Plans and Justified plans graph for dwelling samples 5, 6, 7, and 8. Source: Author. (a) Plans for dwelling sample 5 and, Justified plan graph; (b) Plans for dwelling sample 6 and, Justified plan graph; (c) Plans for dwelling sample 7 and, Justified plan graph; (d) Plans for dwelling sample 8 and, Justified plan graph.

**Table 2.** Basic syntactic data for dwelling. SLR: space-link ratio; MD: mean depth; RRA: real relative asymmetry; BDF: base difference factor.

Dwelling sample	No. of Spaces	No. of Depth	SLR	MD	RRA WITH EXTERIOR			BDF	RRA WITH EXTERIOR			BDF
					MEAN	MIN	MAX		MEAN	MIN	MAX	
1	19	5	1.16	2.68	0.85	0.34	1.61	0.94	0.90	0.34	1.64	0.94
2	16	4	1.13	2.68	0.95	0.38	1.37	0.99	1.00	0.38	1.44	0.98
3	18	5	1.22	3.19	1.15	0.59	1.77	1.01	1.27	0.65	1.91	1.01
4	16	5	1.20	2.43	0.81	0.30	1.44	0.94	0.86	0.30	1.44	0.94
5	19	5	1.11	2.81	0.92	0.40	1.56	0.97	0.96	0.40	1.58	0.97
6	21	6	1.15	3.20	1.05	0.55	1.61	1.01	1.09	0.57	1.66	1.01
7	14	3	1.21	2.51	0.94	0.43	1.39	1.00	1.02	0.49	1.48	1.01
8	17	4	1.12	2.74	0.95	0.41	1.61	0.97	1.05	0.42	1.78	0.96
AVERAGE			1.20	2.78	0.96	0.43	1.54	0.98	1.02	0.44	1.62	0.98

of spaces and thus in mean depth. In samples 5 and 1, the number of levels appears to match the mean depth closely; however, in sample 3, the number of spaces is 18, while that in samples 1 and 5 is 19, while the mean depth is higher despite this smaller number of spaces. This is attributed to the presence of loft rooms (L.RO.1, L.RO.2, L.RO.3) at level five 5 in dwelling sample 3, as clarified in (Figure 4(c)).

A similar effect occurs in comparing dwelling samples 7 and 4, with the MD in sample 7 being 2.51, which is higher than that for sample 4, representing a deeper and higher number of spaces. This is not the case for the rest of the dwellings, however, which show only slight differences between MD values and the number of spaces identified.

### 6.3. Integration (RRA)

To eliminate potential unwarranted effects due to the number of spaces in a system, and thus to compare systems of different sizes, a derived scale known as “integration value” can be used [21]. The integration value (RRA) of space represents the relative depth of the space as compared to all other elements in the JPG [20]. Lower values thus indicate higher integration, whereas higher values indicate significant segregation. Average integration can thus be used to indicate how shallow or deep the spaces in the house are as compared to each other [18]<sup>2</sup>.

A comparison of the integration values of all houses is shown in Table 2. These values are calculated twice for each house, the first time considering the carrier (exterior) and the next without the carrier. This allows for additional insight into the role of the exterior in the resulting segregation or integration of the dwellings’ spatial configuration. As shown in Table 2, there is a slight increase in the integration values for all samples when the carrier (the exterior) is

excluded, which suggests that there is no apparent impact of the exterior on the integration of these systems.

#### 6.4. Base Different Factor (BDF)

The base different factor (BDF) measures degree of variation in integration values, and thus indicates the strength of a spatial organization of any spatial system. When the BDF value tends to 0, this indicates strong differentiation and greater structure, while when the value tends to 1, weaker differences between spaces must be assumed [20]. As shown in **Table 2**, the lowest value of BDF with or without inclusion of the exterior (carrier) is 0.94 and the highest value is 1.01. However, the average BDF is 0.98 for both scenarios. The BDF values thus indicate a weak functional differentiation of all samples, based on them approaching a value of 1, which further denotes weak differences between spaces.

#### 6.5. Space Link Ratio (SLR)

Dwellings can also be examined in terms of the rings embedded in their spatial structures. For example, as shown in the justified plan graphs (**Figure 4** and **Figure 5**), all dwelling samples examined contain at least one ring system. The space link ratio (SLR) values can thus be used to clarify the degree of rings found in each dwelling sample. **Table 2** shows that the highest ring ratio is found in sample 3, at 1.22, while the SLR average for all samples is 1.20, which indicates a high ring ratio as compared to the number of spaces, with about 20% of the links in dwellings being rings. This is most clearly visible in sample 7, where, despite the small number of spaces and lower depth level, the ring ratio is high.

#### 6.6. Topological Types

There are several types of spaces available that may act to fulfill occupancy and movement needs. Considering the essential topological characteristics represented in the justified plan graphs [19]. The spatial configurations are categorized by four topological spaces: the a-type space, with one link; the b-type space, with more than one link in a tree formation; the c-type space, with more than one link in a ring formation; and the d-type space, with more than one link that is also linked to two or more rings [30].

As shown in **Table 3**, the dominance of c-type spaces is seen in five samples (1, 4, 5, 6, and 7), followed by a-type and then d-type spaces. In three samples (2, 3, and 8), a-type is dominant, followed by c-type: however, the third dominant typology in samples 3 and 8 is d-type, while in sample 2, it is b-type. The dominance of a-type typology in samples 2, 3, and 8 is due to the use of AMP space, which in samples 2 and 8 is limited to family use and has no access from the guest section, while in sample 3, it is non-existent. In the other samples, the (AMP) has access to the hospitality section, thus allowing it to be both an occupancy and a movement space, causing the dominant topological type to be the c-type. As long as the c-type is the most dominant which is formed in rings in

**Table 3.** Topological types and distribution and symmetry in Dwellings samples.

Dwelling sample	Topological types				dist.	Asymmetry
	a	b	c	d		
1	36.8%	0%	47.4%	15.8%	0.58	1.11
2	43.75%	25%	18.75%	12.5%	2.20	1.00
3	40%	11%	28%	21%	1.00	1.57
4	37.5%	0	50%	12.5%	0.60	1.00
5	42%	0	47.5%	10.5%	0.73	1.11
6	42.8%	0	47.7%	9.5%	0.75	0.91
7	28.5%	0	57.3%	14.2%	0.40	0.75
8	35.3%	11.8%	29.4%	23.5%	0.89	1.43

dwellings spatial configurations, the rings are then analyzed in all dwelling's samples for further justifications.

Reference [20], states the rings are formed when spaces are linked together in circuits that allow passing to space through more than one path. The rings in any spatial system can also reveal several essential inherent features in the spatial patterns of such buildings as in dwellings. The number of spaces that sits on a single ring path represents the relationships between spaces. This allows dwellings to be compared based on their connectivity forms.

As shown in **Table 4**, ring path 1 is linked to the exterior (carrier), although its function is to link the guests' section to the family zone. That's because each section has a separate entrance; as such, the presence of the two entrances forms this ring. This is obvious in samples 1 and 5, where the link between the two sections is in the yard & arcade-men's guest (YR.M-AR.M), and between yard & arcade-family (YR.F-AR.F). Also, in samples 2, 6, 7 and 8, the ring is formed between yard-family (YR.F), and (YR. M-AR.M). In sample 3, the link exists between (YR.F) and arcade-men's guest (AR.M), while in sample 4, the link is between (AR.F), and (YR.M-AR.M).

There may appear to be a difference in spaces, but some are integrated between two spaces of the ring path 1. This is constant in all samples, regardless of the space steps. Furthermore, this path is intended to be only used by the dwelling's owner or male relatives, without letting females pass through it.

Ring path 2 as shown in **Table 4** is constituted as a third entrance in some dwellings is established. In samples 1 and 8, ring path 2 links the backyard (BY) with (YR.F-AR.F) in sample 1, and between (YR.F) in sample 8. An exceptional ring path in sample 3 is also produced. It links the external room (O.RO), which is used by the dwelling's owner as a carpentry shop and, between the exterior (EX) and Open Vestibule-Men's section (VES.M). This lobby is also linked to the men's reception room (GR.M) through (AR.M) as shown in **(Figure 4(c))**.

**Table 4.** Rings connected with the exterior in the dwelling samples.

Dwelling sample	1	2	3	4	5	6	7	8
RING 1	EX	EX	EX	EX	EX	EX	EX	EX
	VES.M	YR.M-AR.M	YR.F	YR.F	VES.M	VES.F	AR.M-YR.M	VES.F
	YR.M-AR.M	YR.F	AR.M	AR.F	AR.F-YR.M	YR.F	YR.F	AR.F
	YR.F-AR.F		VES.M	AR.M-YR.M	YR.F-AR.F	AR.M-YR.M		YR.F
	VES.F				BY			AR.M-YR.M
								VES.M
RING 2	EX		EX					EX
	BY		ORO					BY
	YR.F-AR.F	-	VES.F	-	-	-	-	YR.F
	VES.F							AR.F
								VES.F

The presence of this path could be attributed to the fact that the work area should be located close to the dwelling's owner zone. However, from the interviews, it seems that the most probable reason for establishing this path is the social customs that consider the importance of hospitality since the guest room is placed adjacent to the carpentry shop (O.RO), so clients could be directly invited to the house.

As for the internal rings' paths, **Table 5** shows that internal ring path 1 is recurring by 100%. From the justified plan graphs and architectural drawings of the samples, the presence of the Firewood store (FS) seems to be the reason for the recurrence of this ring path in all samples.

This recurring ring always appears as a link between the males' guest section and the family section. This link is used to supply (GR.M) with the (FS) through the family section. The storage's entrance is too narrow for a person to pass through. Therefore, this can be attributed to the fact that ladies are not permitted to access the male guest section, so the existence of this path is for only services purpose. For instance, if females are permitted to enter the male guest section, then such a path becomes unnecessary since the storage room can be served whenever the male guest section is not in use. This reinforces the principle of privacy and strict customs in restricting physical presence in this space to males only.

The internal ring path 2 in samples 1, 4, 5 and 7, as shown in **Table 5**, and the justified plan graphs, affirms that the access to a multi-purpose room (AMP) is the reason for establishing this path. Based on interviews, the (AMP) has different roles depending on its location. It can occasionally be used for guests to sleep, so it is linked to the (GR.M). However, it can also be used for other purposes. What we are concerned about here is the (AMP) link with the family

**Table 5.** Internal ring in the dwelling samples.

Dwelling sample	1	2	3	4	5	6	7	8
RING 1	AR.F-YR.F	YR.F	YR.F	AR.F	YR.F-AR.F	YR.F	AR.F	AR.F
	FS	FS	FS	FS	FS	FS	FS	FS
	GR.M	GR.M	GR.M	GR.M	GR.M	GR.M	GR.M	GR.M
	AR.M-YR.M	AR.M-YR.M	AR.M	AR.M-YR.M	YR.M-AR.M	AR.M-YR.M	AR.M-YR.M	YR.M-AR.M
RING 2	AMP		F.H	AMP	AMP	RF	AMP	
	RF		RO1	RF	RF	STIM	RF	
	STI		YR.F	STI	STI	AR.M-YR.M	STI	
	AR.F-YR.F			AR.F	YR.F-AR.F	YR.F	YR.F	
	STI.M	-		AR.M-YR.M	AR.M-YR.M	AR.F	AR.M-YR.M	-
				STI.M		STI	STI.M	
						RF		
						L.STO		

section, and according to the justified plan graphs in **Figure 4** and **Figure 5**, the family may use this space while male guests are hosted to listen to their talks and night sessions. This path differs from path 1 in which ladies are not permitted access to the guestroom; nonetheless, when the number of space steps required to reach the (AMP) space from an active space such as (YR.F), it reaches 6, which are relatively long hops. This applies to sample 6; though there is no (AMP) space in the ring, the justified plan graph shows that this path will reach roof (RF), which ends with (AMP).

However, the above analysis demonstrates the idea of social cognition prevailing through design since it is determined that path 1 is constrained by not permitting, whereas path 2 allows accessing non-physically (through listening) without breaching societal customs.

Although there is no ring path in samples 2 and 8, they can be found in their spaces (APM), which are functionally related to the family section but not accessible from the visitors' section. This demonstrates that the primary purpose of (AMP) space is to provide acoustic access to the family section rather than males.

Some paths, such as the one in sample 3, can be considered exceptional cases, such as the ring path that connects the bedroom room (RO1) to the family hall (F.H) and to (YR.F). This path may have been created to meet a specific requirement, as the resident of this dwelling stated during the interview that this path did not exist in the first place but was constructed after some time of living.

When the topological types are identified, it is also possible to use two addi-

tional measures, however, represented by scales of distributedness/non-distributedness and symmetry/asymmetry, which can further express the spatial qualities of the system.

Distribution and non-distribution are values that may be used for understanding the spatial characteristics of depth and permeability in a spatial structure [31]. Reference [14], explains that in the case of a non-distributed spatial structure, there is only one path from a given space to another, while in the case of distributed spatial structure, various paths are constituted in rings. However, A low value thus indicates a distributed structure, while a high value indicates a non-distributed structure [32].

Reference [32], the symmetry/asymmetry scale reveals how spaces are used to classify activities or social roles, thus offering a way to understand the relationship between a space's occupants and its design in terms of merging or separation. Low values indicate asymmetric areas, while high values are more symmetrical.

From **Table 3**, it is clear that the distribution values in dwelling samples 1, 3, 4, 5, 6, 7, and 8 range between 0.40 and 1.00: these low values indicate that these samples are characterized by high distribution levels. Sample 2 shows more distributional moderation, with a value of 2.20. With regard to symmetry values, the four dwelling samples whose values range between 0.75 and 1.00 are characterized by asymmetric spatial structures, while the four samples whose values range between 1.11 and 1.57 are relatively symmetrical. In general, all dwelling samples examined in the town are characterized by high distribution and some asymmetry. This indicates that the movement within the spatial systems is highly flexible, and that the spatial structure is integrated.

### 6.7. Dwellings Genotypes

The genotype can be defined as the spatial arrangement of any socio-spatial structure [14]. The number of spaces and the ordination of relative symmetry values thus illustrate spatial relationships and reveal the inherited typology entrenched in a given spatial system. The existence of socio-cultural genotypes can therefore be identified when the rank order of integration values in the spatial system is consistent [14]. **Table 6** shows the real relative asymmetry values (RRA) of all dwelling samples, ranging from the lowest to the highest. This thus identifies the most integrated spaces and the most separated spaces in these spatial systems.

In samples 1 and 5, the rank order reveals the Yard-Family and Arcade-Family (YR.F-AR.F) areas as the most integrated spaces. In samples 2 and 4, however, the rank order shows only the Arcade-Family areas (AR.F) as integrated spaces, while in sample 3, the family hall (F.H) is the main integrated space. Although these spaces have different names, their functions are similar, with the rest of the family section spaces in their particular systems being distributed around them. A similar pattern applies to samples 6, 7, and 8, where the rank order shows the yard-family (YR.F) as the most integrated space, followed by the Arcade-Family

**Table 6.** Order of integration (RRA value) of spaces.

Dwelling NO.	Integration (RRA) ORDER
1	YRF.ARF (2.94) > YRM.ARM (1.96) > BY (1.61) > STI (1.54) > VES.F (1.36) > FS (1.31) > VES.M = RO1 = RO2 = DR = KI = STIM = (1.22) > EX (1.18) > GR.M (1.07) > RF (1.04) > FOS = COR = (0.91) > AMP (0.88) > RIR (0.62)
2	AR.F (2.64) > YR.F (2.20) > STI1 = STI2 = DR = (1.20) > ARM.YRM (1.15) > EX = FS = RO1 = RO3 = (1.10) > KI = STO = (1.01) > GR.M (0.75) > RO2 = AMP = RF = (0.73)
3	FH (1.70) > YRF (1.61) > RO = STI1 = (1.20) > ARM (1.11) > EX = FS = (1.01) > DR = STO = KI = (0.92) > RF (0.87) > VES.M = GR.M = (0.79) > O.RO (0.73) > LRO1 = LRO2 = LRO3 = (0.61) > PST (0.57)
4	AR.F (3.29) > AR.M.YR.M (1.88) > STI = KI = STO = (1.65) > YR.F = FS = (1.32) > STI.M = DR = RO1 = RO2 = (1.20) > RF (1.10) > EX = GR.M = (1.01) > AMP (0.88) > LRO1 (0.69)
5	ARF.YRF (2.52) > ARM.YRM (1.77) > STI (1.54) > BY (1.47) > STIM = FS = (1.22) > DR = RO1 = RO2 = KI = (1.14) > VES.M = RF = (1.10) > EX (1.04) > GRM (1.01) > AMP (0.93) > STO = COR = (0.86) > LR.O (0.72) > RIR (0.64)
6	YR.F (1.81) > AR.F (1.60) > ARM.YRM (1.39) > STI (1.19) > VES.F (1.16) > STI.M (1.07) > FS (1.04) > KI (0.99) > EX (0.97) > RF2 (0.95) > STO = RO1 = DR = RO2 = (0.93) > GR.M (0.89) > RF1 (0.87) > L.STO (0.82) > COR = FOS = (0.76) > LRO (0.66) > AMP (0.62)
7	YR.F (2.31) > AR.F (1.73) > ARM.YRM (1.60) > EX = STI = (1.22) > GR.M = FS = (1.10) > STI.M = KI = (0.99) > RO1 = RO2 = RO3 = (0.87) > RF (0.83) > AMP (0.72)
8	YR.F2 (2.44) > AR.F (1.72) > BY (1.54) > YRM.ARM (1.39) > STI (1.27) > EX (1.22) > VESF (1.17) > KI (1.08) > FS (1.08) > VESM (1.05) > GRM (1.01) > COR = RO1 = RO2 = (0.91) > AMP = RF = (0.77) > FOS (0.62)

section (AR.F). This indicates the existence of a common feature among most dwellings, with family shared spaces such as (AR.F), (YR.F), and (F.H) ranking first in the genotype, indicating these as the most integrated and least isolated spaces. In terms of the most isolated or segregated spaces, the multi-purpose room (A.M.P.), which lies in the final rank order, is the most isolated space in the spatial structure of all dwelling samples except for sample 3. This space is connected to both the family section and the men's guest section, suggesting that it is isolated to fulfill the principle of privacy. Another interesting highly isolated space is the upper bedroom (L.R.O.), which does not exist in all dwelling samples in the town. This room is used rarely, generally only when the family's first son gets married.

As noted earlier, based on the analysis of the architectural drawings and the justified plan graphs of the selected dwellings, all of the town's dwellings are formed of two segregated areas, one for family purposes and the other for hospitality for male guests. Through genotype analysis, it can further be inferred that the town's dwellings bear a consistent genotype pattern, constituted of the dominance of family section, which is considered the main area and starting point, and the relegation of the multi-purpose room (A.M.P.) which is the least important in the genotype ordinal arrangement. The genotype for the other spaces which exist between the family section and the multi-purpose room (A.M.P.) cannot be determined to form a consistent pattern, due to the presence

of the segregation principle as well as the changes in positioning of these spaces around the main space.

## 7. Conclusions

Using space syntax theory, represented by the justified plan graph method, this research attempted to analyze and interpret the socio-cultural characteristics inherent in the spatial configurations of traditional dwellings. The research focused on Riyadh Al Khabra's town, located in Qassim province, Saudi Arabia, as a case study area, as the population of this town is shrinking.

From the analysis and findings, several features of traditional dwellings in the town can be summarized:

- Simplicity in the spatial configuration is common, with spaces reached through a few accessibility steps, and movement and transition within the entire spatial structure being flexible. Dwellings have low average depth levels, and the semi-deep system predominates on the justified plan graphs, characterized by a multiple ring system across all dwellings.
- Strict constraints are inherent in the separation between the family section and any hospitality or guest section, which begins at the exterior, with each dwelling containing two entrances. Nevertheless, the spatial configuration of some spaces seems to be relatively flexible, as seen in the cases of multi-purpose rooms (AMP), with non-physical access between the two sections (through listening and speaking) thus allowed without breaching societal customs.
- Oriented movement system "permeability" in all dwellings' spatial configuration, where all have at least two entrances (family and guests) and numerous space steps inside rings.
- All dwellings bear a consistent genotype pattern formed by the presence of two clear spaces, in which the family section as a whole is the primary area and starting point, representing the most integrated area, while the multi-purpose room (AMP) represents the most isolated space.
- Although these dwellings were not built by architects and no formal requirements or standards were applied at that time, there is a unique and remarkable common system rooted in their interior spatial configurations, despite differences in their built forms.
- It can thus be concluded that the influence of inhabitants' social customs on the architecture of the town's traditional dwellings is the prominent and most influential feature of these spatial configurations.

Overall, the outcomes of this research emphasize the significance of social and cultural factors and inhabitants' customs in determining the spatial layout of buildings. It also elucidates how useful space syntax can be as a social tool for determining the spatial and configurational properties of a dwelling's structure. Further research by expanding the dwellings samples, exploring other traditional towns, or even comparing with the new modern dwellings could result in new

findings and insights. The research also suggests exploring the potential of taking benefits from the value of these traditional dwellings derived from the spatial configurations and integrating them into the design of contemporary housing developments in Saudi Arabia.

### Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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