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ARTICLE

Spatial Organisation of Housing and Factors Influencing Residential Choice in the Town of Bol, Lake Province, Chad

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ABSTRACT

Housing, access to which is recognised as a universal right for all, embodies the values, traditions and social dynamics specific to different communities. It is a place of residence whose choice is often influenced by social, economic, religious, demographic, cultural and environmental factors. The housing in Bol, a Sahelian town in the Lac province of Chad, is a good example of this. This study looks at the spatial organisation of housing and the factors influencing residential choice in Bol, a Sahelian town in Chad's Lake Province. The study explains how traditional and modern influences intersect in the built environment, affecting architectural identity and social cohesion. The research methodology includes documentary analysis, field observations, photography, architectural surveys, interviews with urban stakeholders, focus group discussions and household surveys. The results reveal that there are three types of housing in the

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town of Bol, namely traditional housing, semi-modern housing and modern housing. In addition, three modes of spatial organisation were identified, including organisation around the central courtyard, separation of men and women, and random layout. Housing choice and spatial organisation were influenced by culture, age ($p < 5\%$), gender ($p < 0.001$), religion ($p < 0.001$), occupation ($p < 0.001$) and income ($p < 5\%$). The field surveys reveal a transition to modernity that would result in a loss of the architectural identity of the town of Bol. These results provide urban players, political decision-makers and the public with essential information for improving housing and preserving the architectural identity of Bol.

Keywords: Housing; Spatial Organisation; Residential Choice; Typology; Bol; Lake Chad

1. Introduction

Housing is an important part of the urban morphology of the city and responds to demographic and economic realities likely to alter and transform urban planning in physical and socio-cultural terms [1]. Access to housing is recognised as a universal right by the International Covenant on Economic, Social and Cultural Rights [2,3]. Indeed, housing is both a basic human need and an essential element of settlement status [1]. This is why, since the dawn of time, humans have always sought to shape human life through their quest to tame nature and its hazards [4]. In their quest to protect themselves from the elements and external dangers, and to create privacy and comfort, they have made the home an existential living environment. Throughout history, man has sought to build a wide variety of habitats, from the simplest to the most complex urban structures [5]. As a result, housing has become not only an essential element for mankind, but also a part of the identity of each society [4,5]. It goes beyond the simple function of housing. It reflects cultural models and lifestyles, and is linked to space, time and materiality [1,6].

In the African context, housing takes on an even more significant dimension. More than just a place of residence, it is also a living manifestation of the values, traditions and social dynamics specific to communities. In other words, it reflects cultural richness, reveals the complexity of social structures and highlights the importance of family ties [7]. Moreover, in many African languages, the term 'habitat' symbolises the clan or lineage, signifying membership of a community. It embodies a process of affiliation or allegiance, with the result that any problems linked to housing have a profound effect on a society's identity [8].

In sub-Saharan Africa, the home is a veritable meeting place for customs, traditions and mores [9]. In addition to their use and aesthetic value, they are a marker of identity, enabling each community to become part of the process of sustainable development, whose guiding principles are the conservation of the environment and the transmission of assets and values to the next generation [9]. It is designed to blend in with the environment and withstand harsh climatic conditions, while reflecting the cultural, social, religious and economic dimensions of the communities [10].

Socio-cultural, traditional, religious, demographic and economic factors, therefore, play a significant role in housing and living patterns. This importance has been underlined by several studies around the world, such as Choi and Jaepil [11], who highlighted the persistence of cultural influences in the spatial configuration of housing in Kenya, Ghana and South Africa, and Sulaksono et al. [12], who studied the influence of Islam on Hindu housing, particularly through building typologies, the compactness of interior design and the use of ornamental architectural elements based on plant and abstract motifs. Alavi and Tanaka have also examined the evolution of Herat's architecture, highlighting the several factors that influenced this transformation [13]. Finally, in Burkina Faso, Aguilar-Sanchez et al. analysed housing typology, considering the cultural, social and economic factors that influence each type of housing [14].

However, the desire for modernity and the need for progress have led each society to create its own distinct spaces over time [15]. Global demographic, socio-economic and technological changes, as well as rapid urbanisation, social and political interventions, have all contributed to the transformation of habitat around the world [15]. However, this new trend tends to neglect cultural practices, social norms and local values, while creating and standardising building styles with standardised solutions to the detriment of local identities. These new types of housing create en-

vironments that are incongruous with the way people live and interact [11,16]. In many African cities, and more particularly Sahelian cities, this mismatch between the form of housing on the one hand and the cultural and traditional contexts on the other, exacerbates the challenges associated with housing. The one-size-fits-all approach has failed to meet the needs of local communities [11,17,18]. This raises the crucial question of the balance between modernity and the preservation of traditional, local and cultural values, and invites us to rethink housing as a space capable of combining innovation with respect for local identities and values.

Chad, the ancestral homeland of humanity [19], is a plural country in terms of its human, geographical, historical and religious make-up [9]. It is characterised by cultural diversity, with a variety of traditions, languages, religions and ways of life. By its geographical location, it is a veritable crossroads between the Saharan world, the Sahel and equatorial Africa [20]. This diversity has a considerable influence, from north to south and east to west, on the habitat and its spatial organisation, giving rise to a varied style adapted to the needs, beliefs and environments of the different regions of the country. This shows how the same natural resources in a similar climate are used by diverse cultural groups to form a unique architectural identity. Architectural richness contributes to a unique national identity. Unfortunately, despite this diversity and cultural potential, there is a lack of mechanisms for promoting and passing on the know-how and constructive cultures of the habitat [9], and a clear craze or desire on the part of the population to build contemporary homes using modern materials without taking account of local cultural practices and values.

The town of Bol is located on the shores of Lake Chad, approximately 153 km north of the capital N'Djamena, in the Sahelian zone of Chad, and occupies a strategic geographical position, sharing borders with Nigeria, Niger, and Cameroon [21]. This situation has made Bol a veritable convergence basin for migrants, with a demographic growth rate of 3.6% per year, higher than the national average [22]. Its population is estimated at 35,013 according to the 2nd General Census of Population and Housing (RGPH) in 2009, and by 2024, around 50,000 people will live in the town's urban area, which has doubled in size over two decades [22,23]. This growth has resulted in a diverse array of cultures, ethnicities, and traditions coexisting within the same boundary, enriching the social fabric of Bol [24]. This cultural diversity is also reflected in religious practices, with Islam, Christianity, and animism living side by side [25]. All these factors play a vital role in shaping lifestyles, as well as in the choice of housing and its spatial organisation [25]. Consequently, housing in Bol is not limited to a simple built environment; it reflects rituals, traditions, customs, religion, and practices that testify to its cultural richness [26]. The ongoing population increase, coupled with globalisation and modernity [27], has impacted Bol's image and identity due to the modernisation of the housing construction process, incorporating modern materials like cement, concrete, and metals [25]. These conditions have led to significant changes in the types of housing in Bol. The housing typologies, traditional construction techniques, and the influence of cultural, religious, traditional, demographic, and economic factors, along with the various transformations of housing in the town of Bol, represent an important heritage, which unfortunately has not been studied.

This study, therefore, addresses these concerns by asking the following question: What factors influence the choice of habitat and its spatial configuration in Bol in the Lake Chad region? The main objective of this study is to analyse the spatial typologies of housing in Bol and to identify the types of housing, as well as the socio-cultural, religious, and economic factors that influence residential choice.

This study set several specific objectives, particularly (1) to identify and evaluate the different types of habitat and their spatial organisation, (2) to determine the various factors influencing habitat choice and its spatial distribution in Bol in the Lake Chad region, and (3) to propose strategies and recommendations for integrating these factors into habitat design. Ultimately, this research adds to the existing literature on Sahelian housing and the preservation of local architectural heritage. Furthermore, it enriches the understanding of the impact of socio-cultural, religious, traditional, economic, professional, and demographic factors on the design of functional housing, reflecting social values in Sahelian towns in general and Bol in particular.

This article is structured as follows: the introduction describes the context of the research; the methodology outlines the methods and data collection. The results present

various types of habitat and modes of spatial organisation, along with the factors influencing the choice of habitat type. The discussion analyses these results and compares them to existing literature. The recommendations guide those involved in construction and policy. The conclusion summarises the main findings, the limitations of the study, and suggestions for future research.

2. Materials and Methods

2.1. Study Area

This study was carried out in the town of Bol, located about 153 km north of the capital, N'Djamena, in the Sahelian zone of Chad, on the shores of Lake Chad, between 13°27′31″ north latitude and 14°42′53″ east longitude. Bol is the capital of the Lake region and serves as the regional and prefectural (Mandi and Wayi) capital [22]. Due to its strategic geographical position, the town shares borders with Nigeria, Niger and Cameroon [21]. The town of Bol benefits from an arid climate and a large surface water basin known as the "arm of Lake Chad" and is a veritable convergence basin for migrants with a population growth rate of 3.6% per year, higher than the national average [21,22]. **Figure 1** below shows the location of the town of Bol as described above.

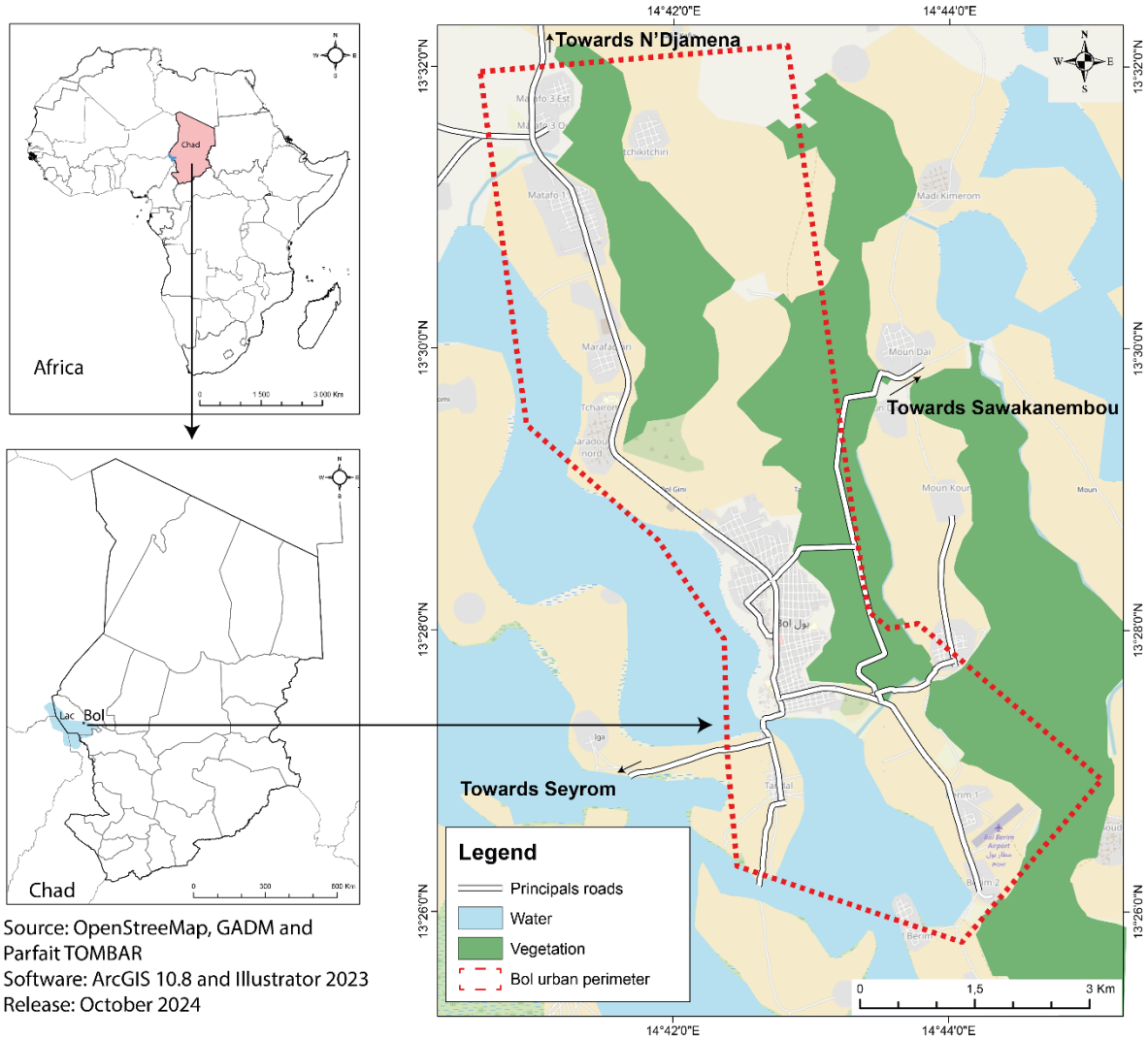

Figure 1. Geographical Location of the Town of Bol.

Source: Authors.

2.2. Sampling and Data Collection

To carry out this research, we used a mixed methodological approach combining quantitative and qualitative methods based on the exploration of existing literature and fieldwork. The adoption of multiple approaches will improve the research results, provide a more complete explanation of the phenomenon and allow various areas of the study to be explored [28,29].

The bibliographical research was carried out in two phases: on the one hand, it enabled us to explore similar work carried out in other areas, and on the other, it enabled us to collect and analyse urban planning documents, works on housing, and historical and cultural data on the town of Bol.

The fieldwork was carried out in Bol using several data collection techniques, such as household surveys, individual interviews, observations, architectural surveys, and focus groups with several stakeholders. Allarané et al. used this approach in their scientific work on N'Djamena in Central Africa [30].

2.2.1. Household Survey

To collect data, a survey of 385 households in Bol was carried out, and each household was selected randomly to avoid duplication (**Table 1**). All heads of household in neighbourhoods in the town of Bol were included in the sample. This approach was also used in a recent study carried out in Central Africa by [21,31].

Table 1. Information on Participants in the Household Survey.

Information	Category	Frequency	Percentage
Genre	Male	335	87.01
	Female	50	12.99
Age	Under 20 years old	13	3.38
	20–39 years old	196	50.91
	40–59 years old	133	34.55
	60 and over	43	11.17
Religion	Muslim	238	61.82
	Christian	117	30.39
	Animist	23	5.97
	No religion	7	1,82
Level of education	No	93	24.16
	Koranic school	114	29.61
	Primary education	31	8.05
	Secondary education	45	11.69
	University studies	102	26.49
Place of birth	Bol	238	61.82
	Lake Chad region	89	23.12
	Chad	43	11.17
	Outside Chad	15	3.90
Nationality	Chadian	366	95.06
	Foreign	19	4.94
Time spent at Bol	Less than 5 years	82	21.30
	6 to 10 years	142	36.88
	11 to 20 years	111	36.88
	Over 21 years old	50	12.99
Occupation	Breeder/fisherman/farmer	116	30.13
	Artisan	14	3.64
	Private-sector employee	56	14.55
	Public sector employee	39	10.13
	Retired	9	2.34
	Retailer	121	31.43
	Student	12	3.12
	No work	14	3.64
	Other	4	1.04
Monthly income	Less than 59,999f CFA	118	30.65
	60,000–99,999f CFA	83	21.56
	100,000–199,999f CFA	98	25.45
	200,000f CFA and more	86	22.34
Total		**385**	**100**

Source: Authors.

The survey was based on a questionnaire containing closed and open questions. The questionnaires were created using the KoboToolbox platform and administered using the KoboCollect application, version 2024.2.4 [30]. This method was also used in the work of Admasu and Jenberu, Maru et al., and Teadoum Naringué et al. in East and Central Africa [31–33]. The information collected from households is based on the following variables:

- Socio-demographic and economic characteristics of respondents (age, sex, occupation, monthly income level, religion).
- Housing materials and construction costs.

- The several types of housing, the periods of construction and the method of construction.
- Ways in which the home is organised and the several factors that influence its design.

The study population was sampled throughout the town of Bol. The sample size was determined using the Schwartz formula, as described by Allarané et al. and Teadoum Naringué et al. [30,31], which enabled inferences to be made about the entire population of the town of Bol. Schwartz's formula is as follows:

If n_q is the sample size for a neighbourhood q, then:

$$n_q = \frac{[(z_a)^2 \, x \, P(1\text{-}P)]}{d^2} \quad (1)$$

Formula 1: The Schwartz formula

With Za: fixed deviation or reduced deviation at a risk of 5% (1.96), corresponding to a confidence interval of 95%; d: the margin of error set at 3% and P the proportion of the population of the town of Bol in the Lake Chad region (8.29% or 0.0829 rounded to 0.1).

By performing the numerical application:

$$n_q = \frac{[(1.96)^2 \, x \, 0,1(1\text{-}0.1)]}{(3\%)^2} \quad (2)$$

n_q = 385.

2.2.2. Individual Interviews

The individual interviews aimed to gather the opinions of local professionals, traditional and religious chiefs, Bol elders and people working in the construction, housing, regional planning and cultural sectors. A total of 21 interviews were carried out with technicians from the regional planning, urban development and housing delegation of the Bol municipality (**Table 2**), as well as with neighbourhood chiefs, neighbourhood elders who had lived in the town for more than 20 years, youth leaders, religious leaders and local traditional authorities.

Table 2. Profile of Participants in Individual Interviews.

Participants	Frequency	Percentage
Technicians from the provincial delegation for land use planning, urban development and housing	3	14.29
Technicians from the Bol commune	1	4.76
Local administrative authorities	1	4.76
Neighbourhood leaders	4	19.05
Neighbourhood elders who have lived in the town for more than 30 years	5	23.81
Youth leaders	3	14.29
Religious leaders	2	9.52
Local traditional authorities	2	9.52
Total	**21**	**100**

Source: Authors.

2.2.3. Discussion Groups

The focus group is a qualitative technique designed to bring together discussions centred on specific, concrete situations and subjects relevant to the research [21,34]. Group discussions were held with local stakeholders from different socio-professional categories (**Table 3**). These discussions made it possible to identify the different players involved in the construction of the city, the cultural and religious nuances that influence the choice of housing and to carry out a diagnosis of the housing to see how it has evolved, the materials used and the construction techniques. Interpreters were used to facilitate communication within each group, enabling all stakeholders to participate effectively. We decided to include the entire population, which shows a participative approach and allows us to have their perception of the way of living in Bol.

Table 3. Profile of Focus Group Participants.

Participants	Frequency	Percentage
Representatives of the population living in the old part of the city	3	6.52
Representatives of the living population in the city's new districts	3	6.52
Representatives of the population living on the outskirts of the city	3	6.52
Neighbourhood leaders	4	8.70
Representatives of the elders	3	6.52
NGO leaders	2	4.35
Youth association	3	6.52
Officials from the Bol commune	4	8.70
Construction workers	6	13.04
Officials from the provincial delegation for land use planning, urban development and housing	3	6.52
Religious leaders	2	4.35
Traditional authorities	2	4.35

Table 3. *Cont.*

Participants	Frequency	Percentage
Resource people in the community	8	17.39
Total	**46**	**100**

Source: Authors.

2.2.4. Observations, Photography and Architectural Surveys

Several methods were used during fieldwork to document the architecture of housing. Firstly, an architectural survey using field observation sheets was used to examine the aesthetic and architectural characteristics of the homes/households in Bol, particularly the mix of traditional and modern elements. Photographs, sketches, and field notes were then used to identify various aspects of the housing, including architectural features and building materials. Photography enriched the results by adding a visual dimension that complemented them [4]. Finally, architectural surveys described by previous works were carried out to measure, document and represent the design of the distinct types of dwellings and how they were organised [35,36]. These architectural studies were used to understand the habitat's stages, materials and construction techniques. Case studies of housing in the various districts of Bol were carried out to supplement this data. These case studies aimed to assess the different aspects of housing in Bol.

2.3. Data Processing and Analysis

As part of this research, Microsoft Excel 365 was used to process and analyse the data collected. We also used R-Studio 4.4.0 software with specific packages to produce certain graphs. Geographic information system (GIS) software, particularly QGIS 3.24 and Arcgis 10.8, was used to process the cartographic data and design illustrative maps based on geographical data (in shapefile format) obtained from the Geographic Information System (GIS) department of the town of Bol. The maps were then processed in Illustrator 2024. Architectural surveys were carried out using a digital decametre. Revit Architecture software was used to produce the plans and illustrations for the case studies derived from the architectural surveys. The data collected is first cleaned, then analysed using R 4.4.0 software. The chi-squared test and the analysis of its residuals were used to assess the dependency between the different modalities. **Figure 2** Summary of the methodology.

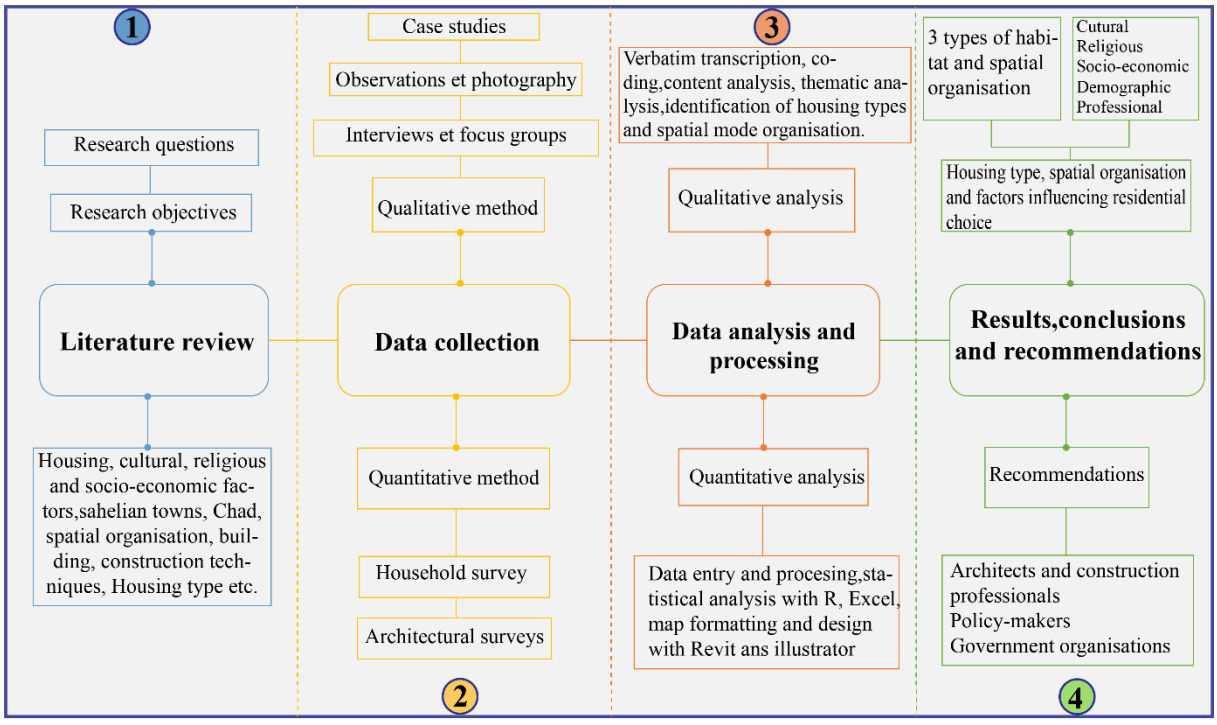

Figure 2. Summary of the Methodology.

Source: Authors.

3. Results

3.1. Housing in Bol

3.1.1. Different Types of Housing

Figure 3 shows the three types of housing in the town of Bol, on Lake Chad. Depending on the materials and construction techniques, the three types of dwellings have different structures. Modern housing (**Figure 3a,b**) has a rectangular shape and a roof that is usually gabled or pitched, with overhangs and acroteria. The walls are 0.2 cm thick and have a layer of cladding. They are built using modern materials such as breeze-block bricks, cement, concrete, sheet metal, steel, etc. The floors are made of cement or tiles, and the walls are made of cement with a coat of paint. White paint is used less in the area because of the dust. They have corrugated steel roofs, large glass or metal windows and concrete structures, and are equipped with modern conveniences such as electricity and air conditioning. Semi-modern housing (**Figure 3c,d**) is an intermediate stage between traditional and modern construction. Also, rectangular, the roofs are often single pitched, with overhangs and acroteria. It is built using a combination of modern and traditional materials. These houses use mixed materials, such as cement, breeze blocks and fired bricks for the walls, earth or cement floor coverings, cement wall coverings and roofs made of sheet metal or local materials such as earth. The windows, which are also large, are generally made of steel and located next to the door on the main façade. Lastly, the traditional dwellings (**Figure 3e,f**) are rectangular and built using local materials such as earth and straw. These dwellings have small openings and flat earthen roofs. During the rainy season, the roof is planted with grasses, allowing the greenery to be integrated into the building. The earth is used for the thick walls, the roof, the flooring and the walls. This is the most dominant type of housing in Bol. These often-simple buildings perfectly suit the Sahelian climate, providing good ventilation and natural cooling.

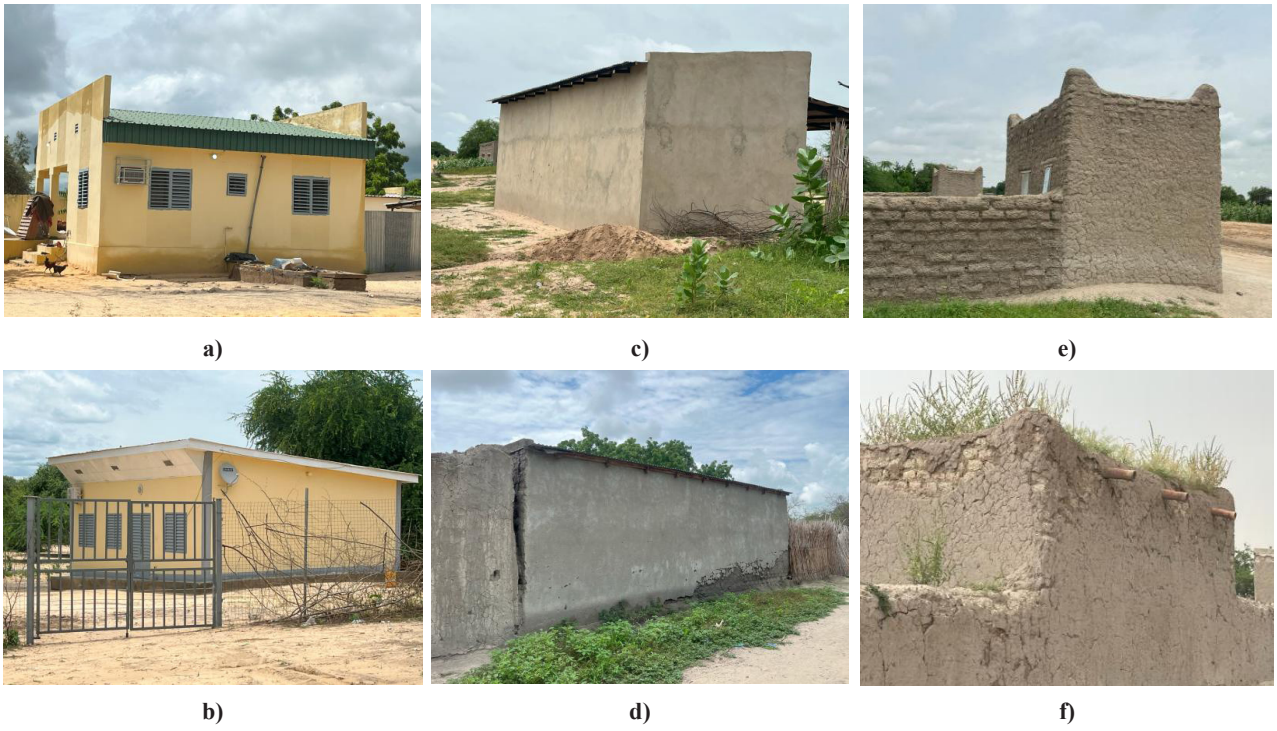

Figure 3. The Distinct Types of Housing in Bol. **(a,b)** Modern Housing. **(c,d)** Semi-Modern Housing. **(e,f)** Traditional Housing.

Source: Authors.

3.1.2. Characteristics of Different Types of Housing: Building Materials

As clothing creates an external identity for people and is frequently used to identify them, building materials act as clothing for the structure, providing residents and visitors with a distinct identity [13]. The results show that the building materials used to construct the Bol home vary according to the type of home. Modern housing is characterised by modern materials such as breeze blocks and concrete for the walls, sheet metal, tiles and concrete for the roof, and tiles and cement for the wall and floor coverings. Semi-modern housing combines modern and traditional materials (cement, sheet metal, earth, concrete, etc.) for the walls, roofing and wall and floor coverings. In the case of traditional housing, the walls, roofing, and floor coverings are built using traditional materials such as earth, straw, millet stalks, etc. **Table 4** shows the distribution of construction materials (walls, roofing, coverings) according to the three types of dwelling: modern (N = 1201), semi-modern (N = 1081) and traditional (N = 1571). The p-values from Pearson's chi-squared test indicate significant differences between these categories. The table shows that the construction materials used are linked to the type of home. The proportions differ from one type of home to another. Semi-modern homes are in an intermediate position, gradually transitioning to modern materials. The distribution of wall materials significantly differs between habitat types ($p < 0.001$). Similarly, there was a highly significant difference ($p < 0.001$) between the dwelling types regarding roofing materials. The same is true for flooring materials.

Table 4. Characteristics of Distinct Types of Housing: Building Materials.

Characteristics	Modern N = 120 [1]	Semi-modern N = 108 [1]	Traditional N = 157 [1]	P_Value [2]
Wall materials				
Modern materials	119 (99%)	29 (27%)	0 (0%)	<0.001
Precarious materials	0 (0%)	1 (0.9%)	23 (15%)	
Traditional materials	1 (0.8%)	78 (72%)	134 (85%)	
Roofing materials				
Modern materials	120 (100%)	89 (82%)	1 (0.6%)	<0.001
Precarious materials	0 (0%)	0 (0%)	32 (20%)	
Traditional materials	0 (0%)	19 (18%)	124 (79%)	
Wall cladding materials				
No	27 (23%)	24 (22%)	53 (34%)	<0.001
Tiles	1 (0.8%)	0 (0%)	0 (0%)	
Cement	92 (77%)	65 (60%)	11 (7.0%)	
Earth	0 (0%)	19 (18%)	93 (59%)	
Flooring materials				
Tiles	32 (27%)	0 (0%)	0 (0%)	<0.001
Cement	88 (73%)	46 (43%)	21 (13%)	
Earth	0 (0%)	62 (57%)	136 (87%)	

Source: Authors.

[1] n (%).

[2] Pearson's Chi-squared test.

3.1.3. Building Methods for Different Types of Housing

Figure 4 illustrates the relationship between housing types and construction methods. The size of the tiles is proportional to the frequency of the different combinations observed. Architectural firms (Ent_cab_archi) are underrepresented in all three housing types. On the other hand, there is a strong association (14.0%) between modern housing and companies or architectural firms (Ent_cab_archi), but the proportions of semi-modern (1.8%) and traditional (1.3%) housing are particularly low. Traditional homes are predominantly self-built (28.3%), unlike mod-

ern (11.7%) and semi-modern (17.9%) homes. The 'other' mode, which combines the use of local masons, self-builders, contractors, etc., shows a more balanced distribution between the three housing types. The standard residuals for combining traditional housing and self-build are 2, indicating proximity to the expected values. On the other hand, the combination of companies or architectural firms and modern housing is overestimated, with a standardised residual greater than 4. The Chi-square test shows a p-value < 2.2e−16, indicating that the construction method is highly dependent on the type of housing.

3.2. Spatial Organisation of Housing in Bol

Case studies are extremely important in the field of architecture, as they provide unique information about a city's historical and current architectural environments [37]. We carried out case studies on the spatial organisation of housing in Bol. Therefore, our research focused on the three modes of housing organisation. The results of the case study are described below and presented in the following lines.

3.2.1. Housing Layout with a Central Courtyard (Cou_Centra)

Figure 5 shows an example of a case study of the spatial organisation of housing around a central courtyard that serves as a meeting place and family gathering place, a symbol of family unity.

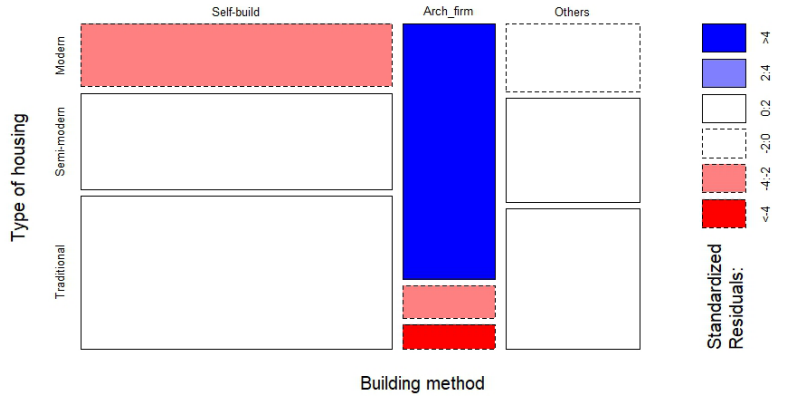

Figure 4. Construction Methods and Distinct Types of Housing.

Source: Authors.

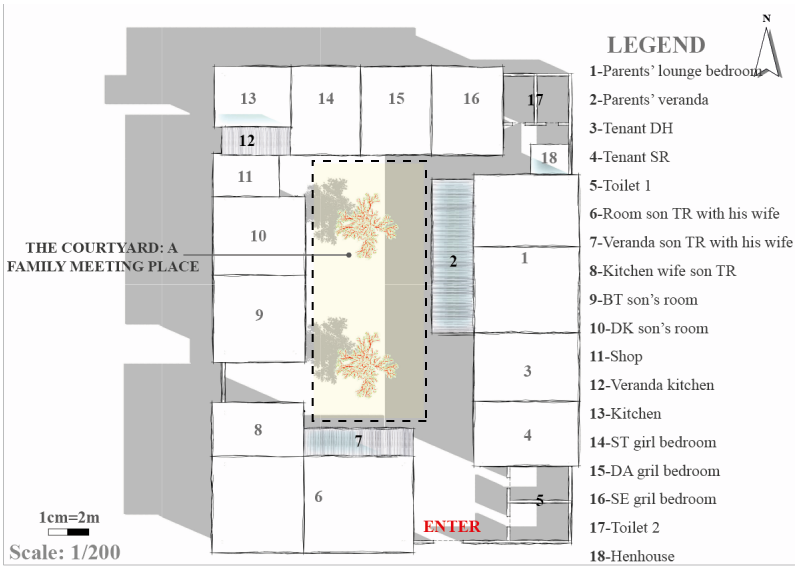

Figure 5. Spatial Organisation of Housing Around a Central Courtyard.

Source: Authors.

Below is a detailed description of how the home is organised:

- **Central courtyard**

Located at the heart of the home, this is a communal space, symbolising the centre around which all the other rooms are organised. It serves as a place for families to meet, socialise and circulate between the different zones.

- **Zones around the courtyard**

Private residential zone: around the courtyard are the private spaces of the family members. The various family members' bedrooms occupy the plan's left side. For example, the parents' living room (space 1) is in the top left-hand corner, with the parents' veranda (space 2) adjacent.

Children's bedrooms: The bedrooms are also distributed around the courtyard for easy interaction between family members. For example, the daughters' bedroom (spaces 14, 15, and 16) and the sons' bedroom (spaces 6, 7, 9, and 10) are located around the courtyard, creating a family balance.

Spaces dedicated to cooking and domestic tasks: rooms such as the kitchen (spaces 12 and 13), the female TR son's kitchen (space 8) and the shop (space 11) are also organised around the courtyard, making it easier to access and use the living and service spaces.

- **Circulation and access**

The main entrance is from the lower part of the plan, indicated by the "ENTER" label, and it has direct access to the central courtyard.

The toilets (spaces 5 and 17) are functionally located close to the rooms but are always connected to the courtyard, allowing good flow organisation.

- **Additional spaces**

A henhouse (space 18) is integrated into the spatial organisation. It is typically located outside or at the rear of the house, but always accessible from the central courtyard, which shows its importance in the organisation of the home.

Thus, the spatial organisation is based on the central courtyard, an interconnection points for all the living spaces. This allows the family to unite while offering private and functional areas around this central space. This layout encourages communication and proximity between family members while respecting areas dedicated to private life and daily tasks.

3.2.2. Housing Organisation with Separation of Space Between Men and Women (Sepa_hom_fem)

Figure 6 shows how the home is organised spatially, with the space divided between men and women.

This separation is accompanied by a clear functional division, favouring private life and domestic organisation.

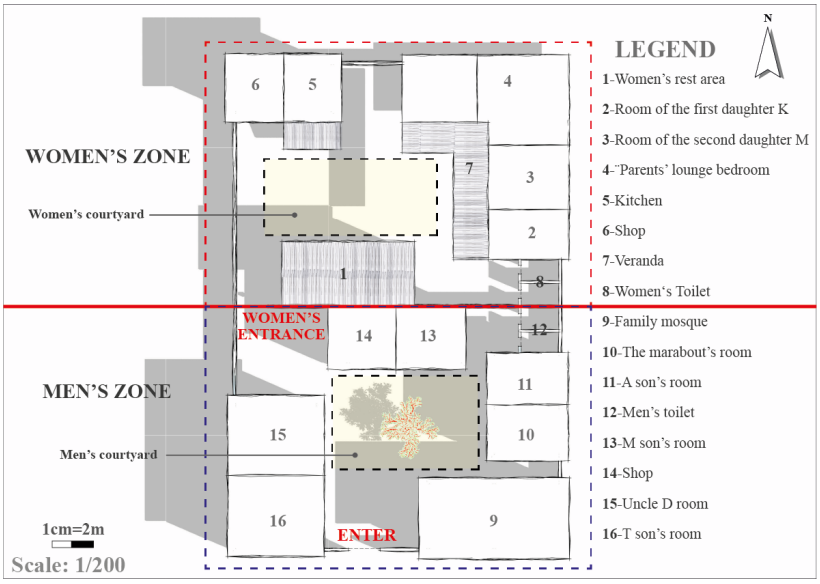

Figure 6. Spatial Organisation of the Home with Separation of Space Between Men and Women.

Source: Authors.

- **Separation of men's and women's areas**

Women's area: This area is reserved exclusively for the women of the house, and access to anyone from outside the house (especially men) is virtually forbidden, except for family celebrations, which are open to all. This zone groups together all the spaces intended for women and is centred around the women's courtyard, a semi-open space that functions as a meeting and socialising place for the women of the house. The rooms in this zone include the parents' and daughters' bedrooms, the rest area, the kitchen, the shop, the veranda and the toilets.

Men's area: This area is reserved exclusively for men. As with the women's area, it is organised around the men's courtyard, a central gathering space for men. The rooms in this area include the family mosque, the men's bedrooms, the shop, and the men's toilets.

- **Central courtyards**

Each group has a courtyard, a meeting space and a circulation area around the different rooms. The women's courtyard is above the floor plan, while the men's courtyard is below the dividing line. This illustrates a strict separation of spaces between the sexes, encouraging privacy and the division of roles within the home. These courtyards make it possible to separate daily activities while maintaining a functional organisation. These open spaces encourage socialisation and divide roles while respecting the family structure.

- **Circulation and access**

The entrances are strategically placed at opposite points of the home, one for the women's area and one for the men's area, ensuring a clear separation of flows between the sexes. These entrances preserve the privacy of each group while guaranteeing direct access to their respective spaces.

- **Usage patterns**

The use of spaces reflects a hierarchical organisation where men and women have their areas of life but remain connected by common spaces such as the courtyard and the family mosque. Each area is equipped with essentials such as kitchens, toilets, and bedrooms and is laid out to encourage community life within each group. The circulation and access areas ensure fluid interaction while maintaining a clear separation from restricted areas, thus providing a balanced, functional spatial structure that respects social and cultural roles.

3.2.3. Housing Organisation with Random Layouts (simple_disp_alea)

Figure 7 shows a spatial organisation of the habitat with a freer and more random layout, without a clear hierarchy or separation between the different zones as in the previous modes of organisation.

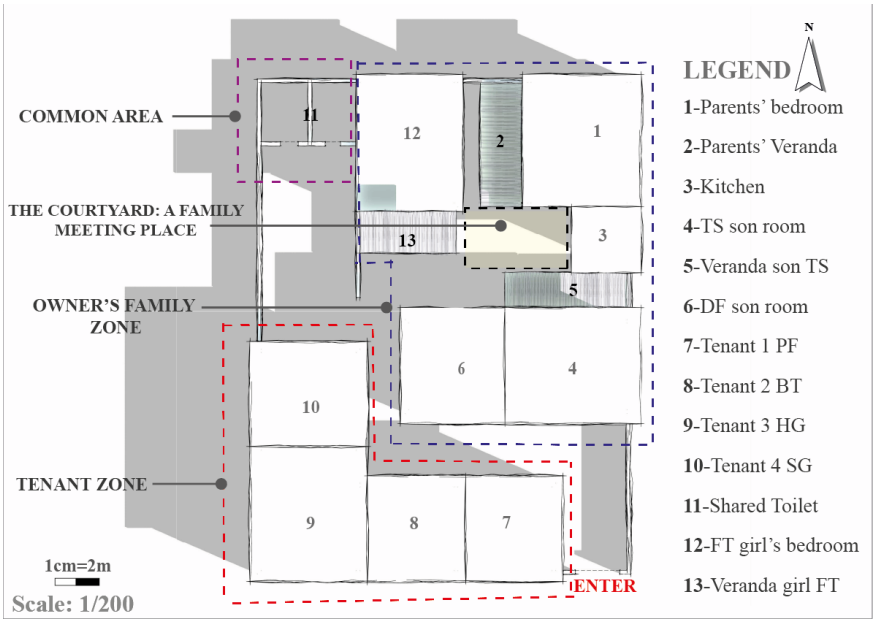

Figure 7. Spatial Organisation with Random Housing Layouts.

Source: Authors.

- **Owner's zone**

This zone, located on the right of the plan (in blue), includes bedrooms and restricted areas for the owner's family. However, there is no strict distinction between the different family members in the organisation of the spaces. For example, the parents' bedroom (space 1), the parents' veranda (space 2), and the children's bedroom (spaces 4 and 6) are all grouped around the courtyard, with no strict separation between the various categories of users (parents, children, etc.).

Similarly, the kitchen (space 3) and spaces such as son TS's veranda (space 5) or son DF's bedroom (space 6) are all in this area, but there is no real hierarchy or logical separation of spaces.

The communal zone, located in the centre of the owner's family zone, is a space where family members can meet, relax, or socialise.

- **Tenant zone**

On the left of the plan, the tenants' area contains several rooms for the tenants, such as tenant 1 PF's room (space 7), tenant 2 BT's room (space 8), tenant 3 HG's room (space 9), and tenant 4 SG's room (space 10). This area is a little more dispersed and mixed with other spaces, such as daughter FT's bedroom (space 12) and daughter FT's veranda (space 13), with no clear distinction between private and communal space for the tenants.

- **Communal area**

The communal area of the toilet, represented by space 11, is a key element in the organisation of the home. Both family members and tenants share this space.

- **Circulation and access**

Access to the house appears to be centralised via the entrance at the bottom of the plan, but the organisation of circulation inside is not very fluid. The spatial organisation of this home shows a less rigid layout, where private and shared spaces mix without a strict hierarchy. The central courtyard functions as an anchor in the owner's zone, but the other zones are arranged in a dispersed and random manner, offering excellent fluidity and constant interaction between the distinct parts of the house, but to the detriment of a clear separation of functions.

3.3. Factors Influencing the Spatial Organisation of Housing and Residential Choice

3.3.1. Reasons for Choosing Each Type of Organisation

Figure 8 shows the respondents' distribution according to the habitat organisation type and the reasons for their choice. The results show that these reasons vary from one type of organisation to another. In the central courtyard category (cou_centra), 47.826% of respondents preferred this layout for cultural and traditional reasons, followed by 'personal choice' (26.81%). On the other hand, the male-female separation mode (sépa_hom_fem) is mainly justified by religious considerations (81.818%), indicating that religion plays a significant role in the choice of this organisational mode. In addition, 44.231% of respondents opted for a random and straightforward arrangement (simple_disp_alea) for personal reasons, while 33.654% cited socio-economic factors. These results show that, on the whole, religion, culture-tradition and socio-economic factors are respectively very influential in the spatial organisation of the home-separation between men and women (sépa_hom_fem), central courtyard (cou_centra) and simple random layout (simple_disp_alea).

3.3.2. Influence of Religious Beliefs in the Choice of Housing Type

Figure 9 shows the distribution of housing arrangements according to the religious affiliation of individuals (animist, Christian, Muslim and no religion). Analysis of the relationship between these modes of organisation and religion reveals that separation between men and women (sepa_hom_fem) is adopted by most Muslims (86.71%). On the other hand, in the central courtyard category (cou_centra), half of the respondents are Christians (50.00%), while 45.65% are Muslims. And in the simple random layout (simple_disp_alea) category, 49.04% were Muslims, followed by Christians (38.46%) and animists (11.54%). Animist groups and groups with no religion are less rep-

resented in the different housing organisation modes and seem to follow more varied or less structured housing patterns, depending on the categories studied. A statistically significant difference ($p < 0.001$) was observed between the housing organisation modes according to religious affiliation.

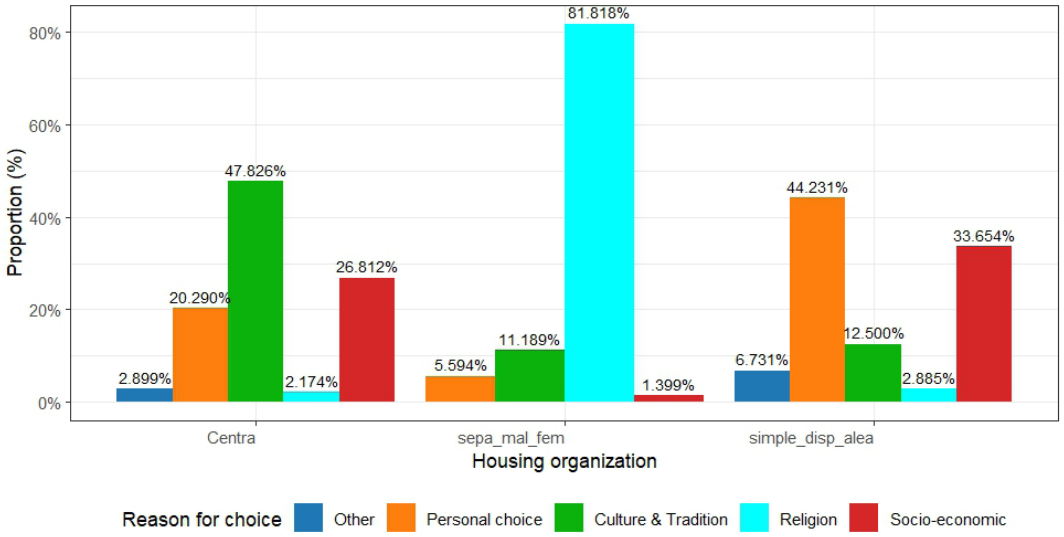

Figure 8. Reasons for Choosing Each Mode of Spatial Habitat Organisation. Cou_centra: Organisation of the Dwelling with a Central Courtyard, sépa_hom_fem: Organisation of the Dwelling with Separation of Space Between the Man and the Woman, simple_disp_alea: Organisation of the Dwelling with Random Arrangements.

Source: Authors.

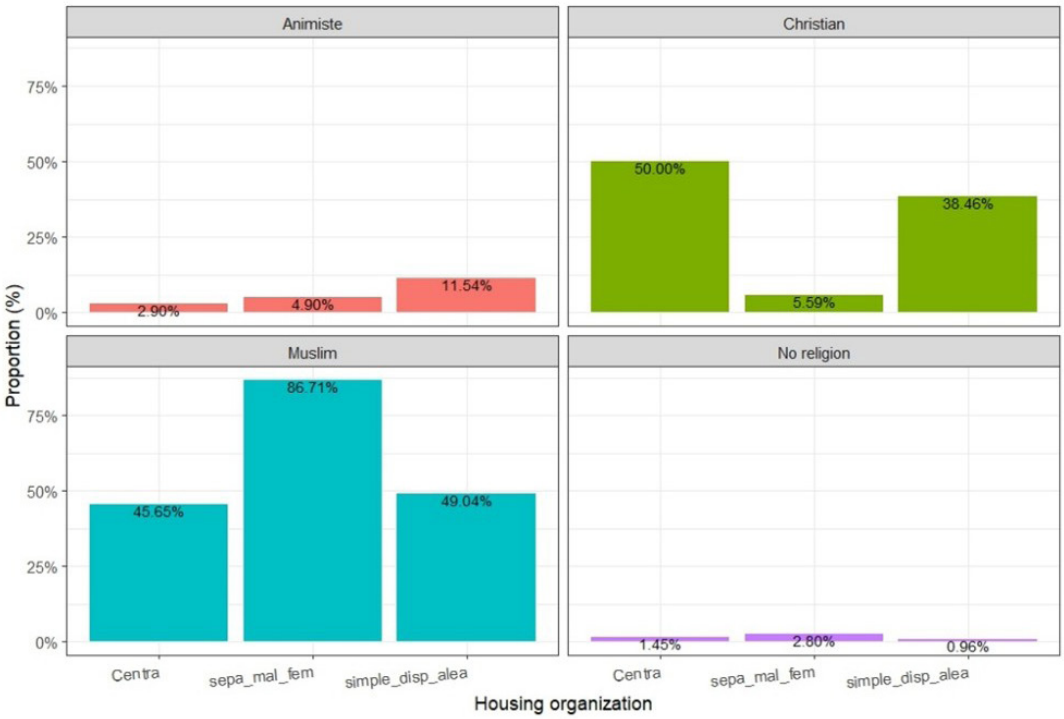

Figure 9. Influence of Religious Beliefs on the Choice of Spatial Organisation of Housing. Cou_centra: Organisation of the Dwelling with a Central Courtyard, sépa_hom_fem: Organisation of the Dwelling with Separation of Space Between the Man and the Woman, simple_disp_alea: Organisation of the Dwelling with Random Arrangements.

Source: Authors.

3.3.3. Influence of Demographic Factors and Period of Construction on Housing Choice

Figure 10 shows the distribution of housing types (traditional, semi-modern, modern) according to age, sex and construction period. Analysis of this figure shows a strong presence of traditional housing for young women (aged 18–39) between 1950 and 1980 and for adult men (aged 40–59) between 1950 and 1960, with a proportion of 100%. Men in the 18–39 and 40–59 age groups prefer semi-modern and modern housing in more recent periods, notably 1991–2024. Among those aged 60 and over, there is also a marked preference for traditional housing, especially for women in the 1961–2000 period. However, the trend towards other housing types is weaker, but present among men. Semi-modern and modern housing are also present, but with a more balanced distribution. Construction in recent years (2001–2024) shows a trend towards modern housing. These results illustrate the influence of age, sex and construction period on the choice of housing type. A strong predominance of traditional housing is observed among older people, particularly women. Younger generations, on the other hand, and especially men, tend more towards semi-modern and modern housing, which is particularly noticeable for recent constructions (with a proportion of 78.34% for 2001–2024). The difference between housing types, gender, age and construction period is statistically significant, with a p-value below the 5% threshold (0.001).

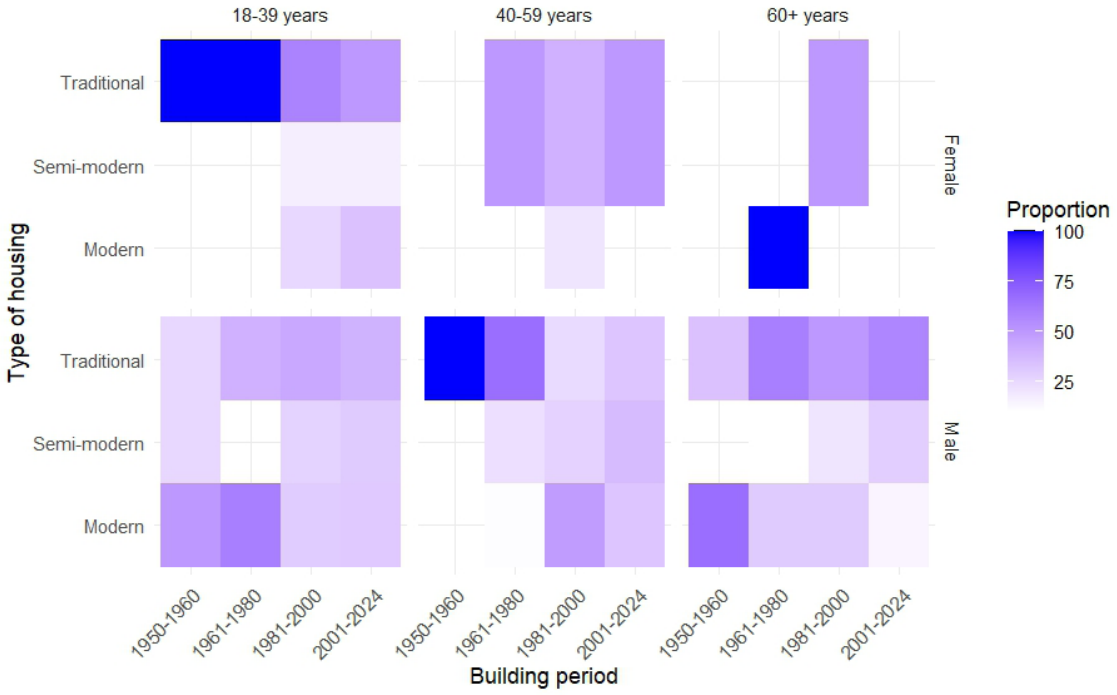

Figure 10. Influence of Demographic Factors (Sex, Age) and Period on Habitat Choice.

Source: Authors.

3.3.4. Influence of Economic and Socio-Professional Factors in the Choice of Housing Type

Figure 11 shows the relationship between the choice of housing type and the socio-economic characteristics of the respondents, in particular age, occupation and income. Analysis of this figure shows that the proportions of each type of dwelling vary from one socio-economic factor to another. In **(a)** the age group (15-30) is under-represented in modern and semi-modern housing, while the 45+ age group is more present in these two housing types, reflecting greater residential stability with age. Regarding employment **(b),** public and private sector employees are predominantly over-represented in modern and semi-modern housing. At the same time, artisans, shopkeepers and

informal workers are more diverse, with a significant presence in traditional and semi-modern housing. Finally in **(c)**, households with high incomes (CFA 201,000 and over) are strongly represented in modern housing, while those with low incomes (less than CFA 50,000) are mainly oriented towards traditional housing. This indicates that income plays a key role in the choice of housing type. The values of the standardised residuals of the proportions of these cross-tabulations are between −2 and 2, i.e., very close to the numbers expected under the hypothesis of independence, except the categories of artisans, EPA, student, private and public employee **(b)** and the class of financial means **(c),** which seem to be represented by residual values greater than or equal to 2.4.

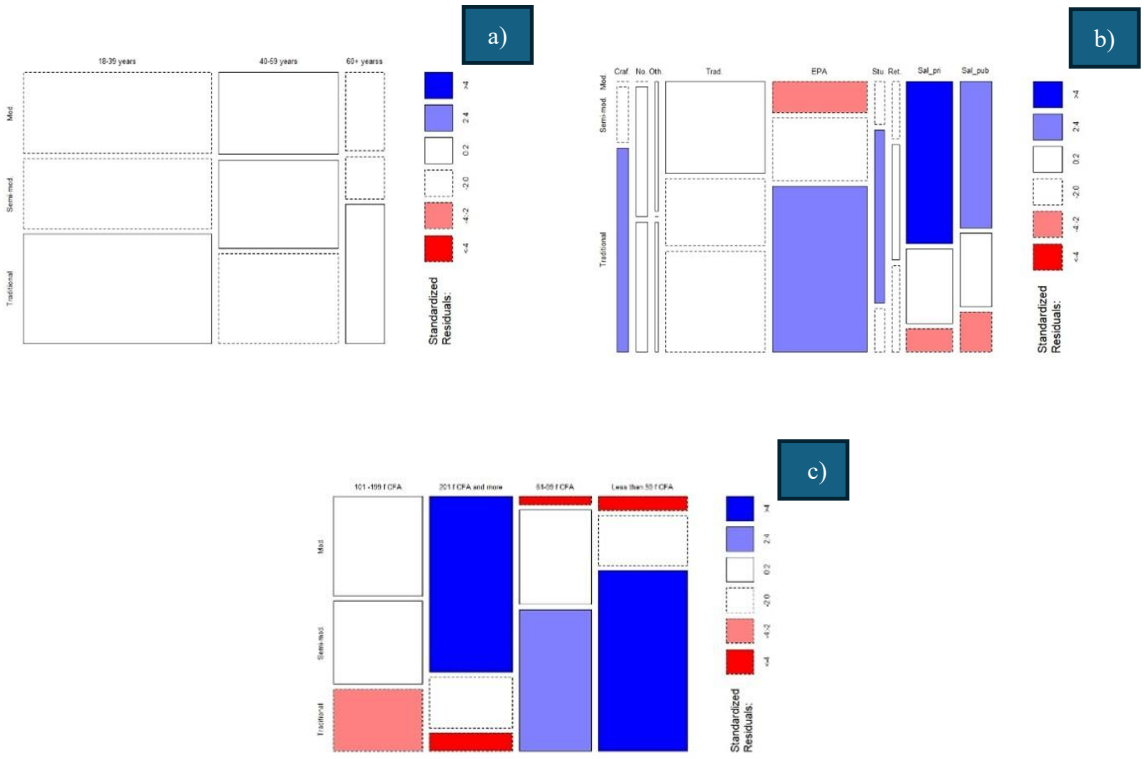

Figure 11. Influence of Economic and Socio-Professional Factors in the Choice of Housing Type. **(a)** Influence of financial stability with age on the choice of housing type **(b)** Influence of the occupational factor on the choice of housing type. **(c)** Influence of economic income on the choice of housing type.

Source: Authors.

4. Discussion

In all studies of the world of architecture, the species or "type" means a representative of a group of architectural organs with a physical appearance (architectural spaces, structures, decorations, materials, etc.) which, through a specific mechanism, belongs to a collection and categorisation [38]. Typology is a stage in the understanding and classification of the characteristics and standard principles of phenomena [39]. The results of this study highlight three types of habitats that are characterised according to the building materials and construction method. These results are consistent with those of Lidón de Miguel et al. [40], who conducted research in Burkina Faso, which identified habitat typologies from the period of the Upper Volta colony (1919–1932) to the period of Burkina Faso from 1970 to 2021. Traditional housing is characterised by local materials, semi-modern housing using corrugated iron sheets and colonial housing with modern materials imported from Europe [40]. Materials, which represent the distinctive culture and history of a society, play an essential role in shaping the architectural identity of a region over time and influence the structure, form, aesthetics and construction process of housing [41–43], which reflects the case of Bol, where there has been a gradual move towards modern materials,

in line with the findings of Olotuah et al. that house forms have evolved over the last 100 years to reflect contemporary fashions [44]. The association between housing type and construction method was demonstrated in studies by Tawayha et al. [45], who noted that Palestinians built their houses in the past according to their possibilities, their needs and the materials available. This study reveals a similarity with Bol's, where the absence of building professionals during the construction of traditional or semi-modern housing is noted.

This study identified three modes of spatial organisation of housing in Bol, the choice of which is influenced by religious, cultural and personal factors. In his studies, Njoh states that African societies have distinct socio-spatial practices rooted in community life, which continue to influence the layout of dwellings [46]. The centrality of the courtyard, a space for meeting, sharing and sociability, the incorporation of verandas in front of bedrooms, the existence of chicken coops and the priority given to privacy all indicate that the spatial organisation of housing is varied [11]. The living space is divided into two zones, one for men on the outside and one for women on the inside. The male zone, also known as the sieve or filter zone, is intended for male visitors [47,48]. One of the key features of traditional residential buildings in Islamic countries is the courtyard, an open-air space considered the heart of the house [45]. Spatial segregation between the sexes in households is a reflexive design practice, particularly regarding women's manners, ethics and social value in the domestic contexts of conservative Islamic societies [1]. In Bol, gender identities, social norms, patriarchal structures, as well as religious affiliation, shape the spatial organisation of the home, and women have a right to privacy in the eyes of outsiders. This finding corroborates the conclusions of Ajufoh et al. [49], who show that culture, religion, and environment play a key role in the spatial organisation of residential dwellings in Bauchi. The study also revealed that the spatial design of Hausa houses reflects traditional ideals of hospitality and community life. This relationship between space and culture has been widely recognised in architecture, where buildings reflect their inhabitants' cultural and social practices [11]. And for Aliyu and Ismail [50], religious beliefs form the basis of spatial design, with the architectural works of Islamic civilisations drawing their inspiration directly from Islamic principles. Muslims must preserve the privacy of their homes while separating spaces [12]. This is because privacy is a social, religious and personal necessity shaped by the culture and lifestyles of the residents [51].

The results show that socio-demographic, economic, and professional factors are the main reasons for choosing the type of Bol home. These results confirm the conclusions of previous studies that have highlighted the impact of socio-demographic factors in the choice of housing type, such as those by Yirenkyi and Debele and Negussie [52,53]. In the studies by Lidón de Miguel et al. [40], it was observed that the community elders were mainly those who continued to build and live in traditional housing types. According to some older adults, for example, the roar of the torrential rains on the metal sheet made them feel insecure, and for them, the traditional solution of roofing with wood, straw and earth was much more appropriate, even if it had to be repaired every year [40]. The young population aspires to replace traditional materials with more modern ones, such as cement or corrugated iron [40]. These results align with our own, showing that Bol's young people prefer semi-modern housing, particularly after 1991. In contrast, studies by Boateng et al. found that age was not strongly associated with the choice of dwelling type in urban households in Ghana [54]. In addition, economic and occupational factors play a particularly vital role in the choice of housing type. Wealthy households choose modern housing, while low-income households opt for traditional housing, which requires less investment. Modern homes are more dependent on financial considerations [45]. These conclusions are in line with the findings of Boateng et al. [54], Alavi and Tanaka [13], and Debele and Negussie [55], who show that economic and socio-professional factors play a particularly significant role in the choice of housing type. A household's income level remains the primary determinant of its housing choices because of its ability to pay [54]. Factors such as the level of education and professional status of the heads of household also play a significant role in the choice of housing type [56]. Residents with greater financial capacity are more likely to benefit from better housing opportunities, revealing that income factors play a crucial role in the choice of housing type [53]. Traditionally, people believe that educated people live better lives, including

housing conditions [53]. This is not necessarily the case in Bol, where some uneducated but elderly shopkeepers and farmers live in modern houses as was the case in the studies by Al Husban et al. [53], where some respondents even regretted having invested their time and money in education, because it was only after several years of work and being already elderly that they were able to access decent, modern housing. These results align with our findings that access to modern housing is reserved for people of a certain age after several years of work.

5. Recommendations for Taking Account of Different Factors in the Architectural Design of Housing

This research shows that socio-cultural, demographic, economic, religious, and professional factors significantly influence the choice of habitat and its spatial organisation. To ensure these factors are integrated effectively into housing, stakeholders — architects, decision-makers, construction professionals, politicians, and homeowners — must collaborate to consider these elements within the habitat. They must jointly create a habitat that reflects local culture and meets people's expectations. **Table 5** outlines the proposals and recommendations for integrating the various factors into housing.

Table 5. Recommendations for Integrating Socio-Cultural, Religious, Professional, Economic and Demographic Factors into the Housing Design in Bol.

Architects and Players in the Construction Sector	Political Decision-Makers and Government Bodies
When designing and building the home, consider the site's environment and natural context to establish a relationship between the environment and the house.	Regulations, standards, and guidelines for architecture and the promotion of local heritage will be drawn up to enable the design and construction of buildings adapted to the local context.
Incorporate traditional local features into the design and construction of housing to raise awareness of the town's cultural values and preserve its historical identity.	To enable and promote the participation of architects and those involved in construction in political decisions concerning the city in general and architectural initiatives in particular.
When building homes, use local, environmentally friendly materials that are characteristic of the town to preserve its identity and protect the environment.	Raise public awareness of the importance of architecture and make it compulsory for architects to participate in the design process.
To establish standards and a local architectural identity, improve the training and expertise of those involved in local construction in architecture, heritage, culture, etc.	Including the community and religious institutions in decision-making processes and bodies related to the city and architecture.
When designing housing, religious and demographic factors should be considered so that buildings are adapted to users' needs.	Encourage the local population, architects and the construction industry to use and promote local materials to ensure sustainable development.
Enabling and promoting access to the architect's services for all sections of the population, regardless of income.	Allocate funds and promote the construction of affordable housing accessible to all, considering the local cultural, religious, and socio-economic context.
Raise awareness and promote the architect's role in construction among the public to encourage people to use an architect's services when designing and building a home.	Rules, standards, and laws relating to architecture, culture, religion, demographics, and socio-economics must be considered when drafting them.

Source: Authors.

6. Conclusions

This study aims to analyse the spatial typologies of housing in Bol and identify the distinct housing types and factors influencing residential choice. Firstly, the study identifies three main types of housing: traditional, semi-modern, and modern, each distinguished by the materials and construction techniques used. The evolution of building materials and techniques shows a gradual shift from conventional to modern, resulting in a loss of Bol's architectural identity, characterised by earthen buildings. The results of the fieldwork reveal three types of spatial organisation: housing with a central courtyard, housing with separate spaces for men and women, and housing with a simple, random layout. Numerous factors, including tradition, culture, religion, and personal or socioeconomic reasons, influence the choice of layout. Finally, the study shows that the choice of dwelling type depends on occupation and income, with employees in the public and private sectors opting for modern dwellings. Meanwhile, artisans, farmers, fishermen, and informal workers prefer traditional and semi-modern dwellings because they are more affordable. Older individuals choose traditional housing, while

young people have opted for semi-modern and modern housing since 1991.

Although this study sheds valuable light on the spatial organisation of housing and the factors influencing residential choice in Bol, it has certain limitations that should be highlighted. Firstly, the methodology is primarily based on qualitative approaches (interviews, observations, group discussions), which are likely to introduce biases related to the individual perceptions of the participants. Secondly, the study adopts a one-off approach without incorporating a longitudinal analysis, which limits our understanding of changes over time, particularly in the face of rapid socio-cultural shifts. Certain external factors, such as public policy, migration dynamics, and environmental impacts, although they may influence changes in housing, were not examined in depth in this study. However, these limitations provide considerations for future research to enhance our understanding of residential dynamics in changing Sahelian cities.

Given these results, which show a trend towards modernity in construction on one hand, resulting in the loss of Bol's architectural identity, and on the other hand highlight the importance and crucial role of socio-cultural, religious, demographic, economic, and professional factors, this study suggests that these various factors should be integrated into the design of housing to preserve Bol's architectural and cultural identity.

To achieve sustainable construction that meets needs and expectations, we must better understand how we live, the values that define us, and their impact on the way we build. That's why this study, although limited to Bol, is helping to raise awareness among those involved in the construction industry, including architects, decision-makers, and the public, of the need to prioritise local values and traditions in construction to create buildings that fulfil the expectations of their occupants.

Author Contributions

Conceptualization, P.A.T. and A.K.D.; methodology, P.A.T, F.T.N and V.V.A.A.; software, P.A.T and V.V.A.A.; validation, P.A.T. and A.K.D.; formal analysis, P.A.T, F.T.N, and E.L.; investigation, P.A.T, F.T.N, and E.L.; resources, P.A.T and K.S.K; data curation, P.A.T and V.V.A.A.; writing—original draft preparation, P.A.T.; writing—review and editing, P.A.T; E.L.; F.T.N and A.K.D.; visualization, P.A.T and K.S.K.; supervision, K.S.K and A.K.D.; project administration, K.S.K.; funding acquisition, K.S.K. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki, and approved by the Regional Ethics Committee of CERVIDA-DOUNEDON at the thesis stage of the 2022-2023 academic year (266/D/CERViDA-UL/2022-05 october 2023).

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Data Availability Statement

The data are contained within the article.

Acknowledgments

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Conflicts of Interest

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

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