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Orginal Article

Morphological mutations of patios, from traditional to contemporary housing in Tadjmout city (Algeria): implications and considerations

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Abstract: This study investigates the morphological transformations of patios in Tadjmout city (Algeria), tracing their evolution from traditional to contemporary housing through a typo-morphological approach at both urban and architectural scales. Thirteen representative houses, distributed across five urban zones reflecting different historical periods, were analysed. Field measurements were redrawn and normalised using computer-aided design tools, while void/solid and height/width ratios were computed for typological comparison, complemented by geometric and pictorial analyses. The results reveal a transition from central, spacious, and horizontally developed patios in traditional houses to lateralised, multipolar, and increasingly vertical voids (light wells) in contemporary dwellings. These transformations indicate a weakening of absolute introversion and a decline in the patio's structural and distributive roles, driven by socio-economic and spatial constraints. Nevertheless, the patio persists as a symbolic element of local building culture.

Keywords: Morphological mutations, patio, traditional housing, contemporary housing, Tadjmout city

1. Introduction

The patio house is an ancient vernacular type that has transcended both history and geography. Archaeological evidence shows that it existed in Mesopotamia as early as

8000 BC [1]. Viollet-le-Duc [2] confirmed its widespread presence, from Isfahan to Spain. On the Mediterranean coast, it spread between the 5th and 4th centuries BC [3].

In Algeria, the patio house is a vernacular type that extends across the country, from north to south and from east to west, following the typology of Medinas in the north and Ksour in the south. It has attracted the interest of several renowned architects. Examples include Guérineau and Bastelica (1937) with the "Indigenous City of Sainte Corinne" in Algiers, Aillaud (1979) in Skikda with the project of 1,400 "L" houses [4], Ravereau (1989–2003) [5,6], Bofill with the socialist village of Abadla in Bechar (1980) [7], and the Canadian firm Lemay with the new city of El Menia (2013) [8].

However, this housing type is no longer reproduced in contemporary programmes, except for occasional experiments such as the new Ksar Tafilel in Ghardaia, where the patio house has been successfully reinterpreted.

In Tadjmout city (Wilaya of Laghouat, 440 km south of Algiers) (Fig. 1), the patio house continues to be reproduced through self-construction, beyond the traditional central core. It exists in four main urban zones, each shaped by a different phase of urbanisation. From 1962 to 1990, housing followed a socialist model. Between 1990 and 2000, liberalism guided urbanisation. From 2000 to the present, contemporary housing programmes have dominated.

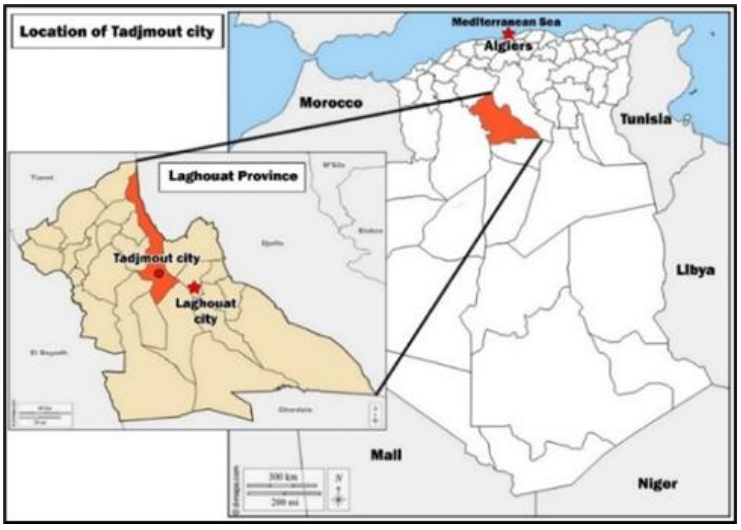


Fig. 1. Location of Tadjmout city in Algeria. *Source*: Authors

Thus, the contemporary patio house in Tadjmout reflects temporal, spatial, and socio-political dynamics. It combines significant transformations and hybridisations that distinguish it from the vernacular type. This process raises questions about how the patio is reformulated in contemporary houses. The first observation shows that it is mainly the shape of the patio that expresses this change. The patio, as a pole of geometric organisation of the house [9], also functions as a central space that ensures distributive, social, and climatic roles [10].

So what are the morphological elements that carry and mark these mutations? Moreover, how do they characterise the contemporary patio house in Tadjmout? Above all, what impact do they have on the organisational and structural distributive functions of the patio space?

2. Conceptual and theoretical backgrounds

2.1. Patio and courtyard: An archetypal distinction and a conceptual confusion

The patio and the courtyard constitute two archetypal spaces, around which distinct habitat typologies have historically been consolidated through their cultural and geographical contexts.

The courtyard house is recognised as a Western typology with rural origins, while the patio house is an Eastern typology with urban origins [3]. Several researchers – Reynolds (2002) [11], Rehailia (2007) [12], Ghayeghchi (2015) [13], Pfeifer (2007) [14] and Costa (2023) [15] – have attempted to clarify patio space and courtyard space to resolve the etymological confusion, which tends to associate the two terms.

The patio is a private and introverted domestic space, always open to the sky. It is both inside and outside [3]. In contrast, the courtyard is external, serving, extroverted, and semi-private, open to the outside.

Other distinctions of form and topology contribute to differentiating the courtyard and patio morphologically. In this sense, the patio is a subtraction within the building, distinguished by its proportions, which determine its degree of openness to the sky. The courtyard, on the contrary, is an addition that defines an interface between the interior and the exterior. Indeed, the work of Faure (2022) has demonstrated that the inversion of the solid and the void between a courtyard house and a patio house also makes it possible to reverse the types [16].

This distinction between the types of patio/courtyard spaces is thus a fundamental element in explaining the mutations of the typological process at work in the patio houses of Tadjmout city.

To clarify the terminology used in this paper, (Fig. 2) below illustrates the distinction between the concepts: the patio, defined as an introverted open space at the core of the dwelling; the courtyard, understood as a broader space that may be central, lateral, or peripheral; and the light well, considered a specific subtype of courtyard, characterised by its narrow footprint and pronounced verticality.

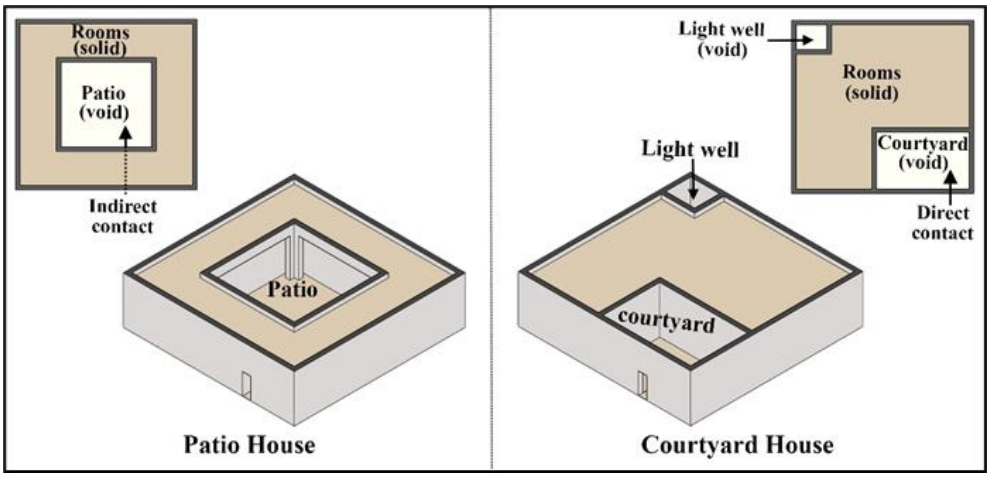


Fig. 2. Schematic distinction between a patio house and a courtyard house. *Source*: Authors

2.2. Morphological mutations within typo-morphological methods

It should be remembered that the idea of the genesis of forms (evolution by mutation) is very old. Since Hippocrates (4th century BC), Lucretius (1st century BC), and Vitruvius (1st century BC), the dynamic dimension of form (in nature, biology, the arts, or architecture) has long been the subject of scientific reflection.

Morphological mutations were first studied by the Italian school in the 1960s, through the typo-morphological method. This approach, developed by Muratori, Rossi, Aymonino, and Caniggia, emphasised the continuity and evolution of architectural and urban forms. Their analyses highlighted the processual character of history through the evolution of built types. Typo-morphological analysis thus combines the procedures of typological analysis and those of the typological process.

Caniggia (1986) defined typological analysis as "the description and classification of the causes that contribute to the formation and modification of the physical structure of a building, a fabric, or a city." Thus, the type is considered more than a simple classification category; rather, it represents a form of production of space [17], especially through the work of Rossi (1982) on the "theory of permanence" [18].

In addition, the typological process was defined by Caniggia as: "The process of formation and typification of architectural, urban and territorial organisms draws its dynamics from a fundamental combinatorial requirement, which can be recognised through the study of the typological process...". In this sense, his method proposes to analyse the building according to two dimensions: diachronic (evolution over time) and synchronic (evolution over space).

Typo-morphological analysis proceeds by interweaving several morphological relationships: the house within the fabric, the fabric within the city, and the city within the territory. The morphological components are specified according to three criteria: dimensioning, topology, and geometry.

Caniggia's studies above all allowed him to affirm the importance of permanent elements and persistences in the growth and transformation of urban form, considering that the internal organisation of the built environment is the bearer of its formation process. Consequently, he supported two postulates:

- "There is no unstructured built reality," specifying two basic structures to analyse: the formal structure and the functional structure.
- "The genesis of habitat structures is a logical genesis or at least logically reconstructable" [19].

Other analyses of the typological process have highlighted a dynamic of mutation of form. Malfroy (1986) demonstrated that structures and forms of built elements were not receptive to change in the same way: some devices resist change without preventing the mutation of other devices at other scales. Similarly, one-off modifications occur continuously, without impacting the entire system [20].

This work has highlighted that the typological process allows the detection of a rationally analysable order at the level of partial mutations of the different components of the habitat in space, by considering the interdependence and continuity of their relationships.

In another approach, Deleuze (1988) introduced the notion of "objectile" to characterise a process of continuous change that he designates as "a continuum by variation." This formulates a change of form, continuous (chronologically) and discontinuous (structurally). This typological process is illustrated by the structural mutation of the central distribution of the Fasaha room in the palaces of Cairo in the 18th century, which persisted in its distributive function but lost its form as a room, being reduced to a hall-corridor since the 20th century [21].

Darin (1993) breaks down the typological process into “strong” or “weak” typological elements, so that the transmission and maintenance of morphological elements, among a succession of transformations over time, will depend on their structural content. For example, the structural arrangement of the staircase in the English house persists to the present day. In contrast, the row of state rooms that overlook the street in the Haussmannian building has over time lost its structural content in favour of the free-plan rearrangement of apartments in contemporary times, without affecting the overall morphology of the Haussmannian building [22].

3. Methodology

This study adopts a typo-morphological approach as the main analytical framework, through a mixed-methods design (quantitative and qualitative). It reconstructs the typological process of morphological mutation of the patio and the transformations of the organisational and structural distributive functions by combining the methods developed by Abdulac (1982) [9], Borie and Denieul (1984) [23]. This combination of methods makes it possible to define the typological process and identify the typological elements that carry permanence or transformation through a succession of changes over time, in order to frame the morphological mutations according to different types of houses (traditional – colonial – contemporary) and at several scales (from the city to the house).

3.1. Analysis grids of morphological mutations of patios

3.1.1. Analysis at the urban scale (neighbourhoods)

The analysis grid at this scale (Fig. 3) considers three relationships: solid (built frames), void (unbuilt frames), and solid–void together (plots in each district) [23]. This approach makes it possible to explore structural mutations in houses and to classify patio houses according to the three basic criteria of the Italian school typological method:

- Topological criterion: in this case, the positioning of voids and their number in relation to the plots.
- Geometric criterion: in this case, the classification of void shapes, built frames, and plots according to their regularity or irregularity.
- Dimensional criterion: in this case, specifying the proportions between voids, built frames, and plots.

3.1.2. Analysis at the architectural scale (houses)

This scale is based on the work of Abdulac (1982) [3], who described the patio house as having three nested zones: the patio, the interior spaces, and the exterior space. The analysis therefore studies the bilateral relationships between these zones:

- Intrinsic morphological relationship of the patio.
- Patio/interior space relationship.
- Patio/exterior space relationship.
- Intrinsic morphological relationship of the interior space.
- Interior space/exterior space relationship.

Each relationship is examined according to three criteria: topological, geometric, and dimensional.

In light of this, an analytical grid is developed that allows for the exploration of organisational and distributional changes (Fig. 4).

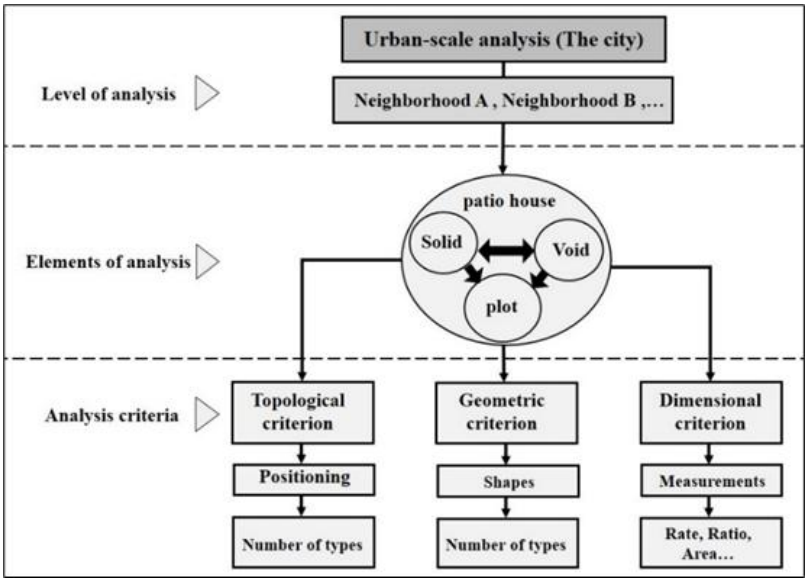


Fig. 3. Urban scale analysis grid. *Source*: Authors

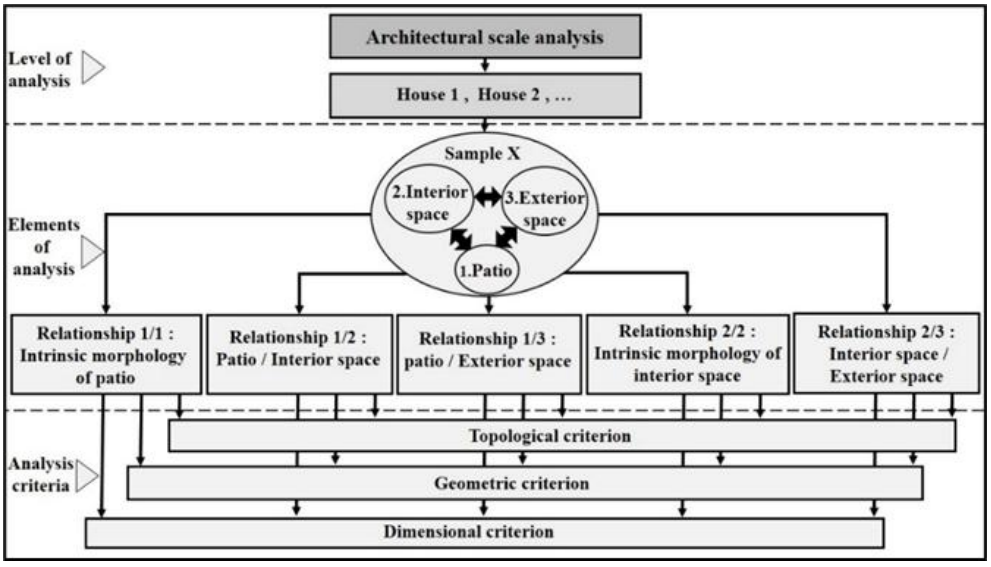


Fig. 4. Architectural-scale analysis grid. *Source*: Authors

3.2. From city as a macro corpus to house as a micro corpus

The definition of the study corpus depends on the scale of analysis (Fig. 5).

3.2.1. At the urban scale

At the urban scale, the study corpus includes all houses with patios or courtyards in each homogeneous zone of Tadjmout. Each zone represents a neighbourhood built in the same period with a common urban character [24]:

- Zone A: comprising 203 houses, characterised by traditional urbanism, extending from 1666 to 1852, representing the first core of the city.
- Zone B: comprising 6 houses, characterised by colonial urbanism, extending from 1852 to 1962, representing the period of French occupation.
- Zone C: comprising 460 houses, characterised by socialist urbanism, extending from 1962 to 1990, representing the period of independence.
- Zone D: comprising 504 houses, characterised by liberal urbanism, extending from 1990 to 2000.
- Zone E: comprising 2,016 houses, characterised by contemporary urbanism, extending from 2000 to 2024.

3.2.2. At the architectural scale

Given the impossibility of analysing all houses with patios or courtyards in Tadjmout, a sample of 13 houses was selected (Fig. 5). The choice was guided by a set of criteria to ensure both diversity and representativeness:

- Coverage of historical phases: the samples were distributed across the five urban zones (A–E), corresponding to the three major stages of Tadjmout's housing stock: pre-colonial, colonial/post-colonial, and contemporary.
- Typological diversity and saturation: the cases captured the main patio configurations identified during the preliminary survey (central, lateral, multipolar). Typological saturation was reached because the last three cases analysed did not reveal new morphological patterns. This indicated that additional samples would only repeat existing types without adding new insights.
- Exclusion of irrelevant types: collective housing forms such as apartment blocks, which generally lack patios or internal voids, were excluded as they fall outside the scope of this study.
- Expert validation: the selection was supported by consultations with municipal construction experts, ensuring that the chosen cases reflect the dominant housing typologies recognised in Tadjmout.
- Practical considerations: priority was given to houses that were easily accessible and where homeowners collaborated in allowing detailed surveys and measurements. Preference was also given to cases with the most complete information, including construction dates and records of subsequent modifications, to ensure reliability and comparability in the morphological analysis.

This multi-criteria rationale ensures that the 13 cases, though limited in number, are diverse and representative of the broader stock of patio houses in Tadjmout.

3.3. Data Collection and Research Tools

The research relied on a combination of different sources, as follows:

- Theoretical data: gathered through bibliographic research, including books, journal articles, theses, and technical reports.
- Statistical data: obtained partly from official institutions such as the Tadjmout municipal services and the Laghouat Land Registry Department, and partly through field inventories supported by interviews with residents and officials.
- Cartographic data: developed from field surveys and complemented with documents provided by the Laghouat Department of Urban Planning, Architecture, and Construction.

Field measurements were conducted from 2023 to 2024 using laser distance meters (MiLESEEY X5) and steel measuring tapes, applying the triangulation method to ensure dimensional accuracy. Architectural plans were then redrawn and normalised in CAD software, allowing precise calculation of geometric attributes.

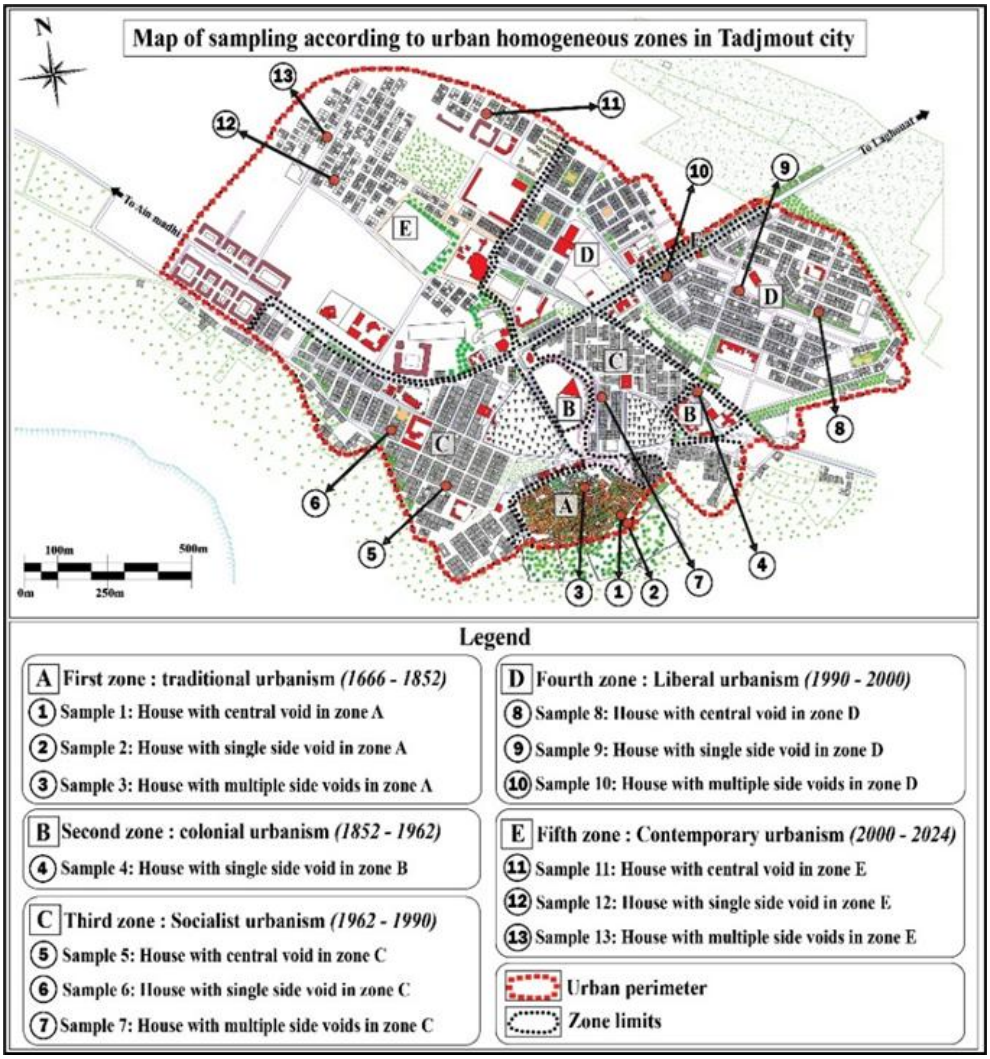


Fig. 5. Selection map of the study sample. *Source*: Authors

This step follows a well-established practice in morphological research, where dimensional attributes (height, width, ratios) are systematically computed to compare architectural types. For example, Beldjilali (2024) applied a similar workflow based on geometric parameters and dimensional ratios to analyse the historical minarets in northern Algeria [25], while Jiao (2023) highlighted how transformations of traditional buildings in China can be understood through quantitative indicators of spatial organisation [26].

Two quantitative indicators were computed: (i) the void-to-solid ratio and (ii) the height-to-width ratio of the patio. These were calculated using Microsoft Excel 2013 for comparative analysis.

Finally, pictorial comparisons (photography, axonometric views, and schematic diagrams) were produced to visualise spatial transformations across historical periods. This integrated approach ensured methodological rigour and reproducibility.

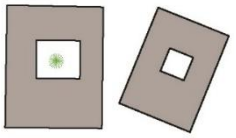
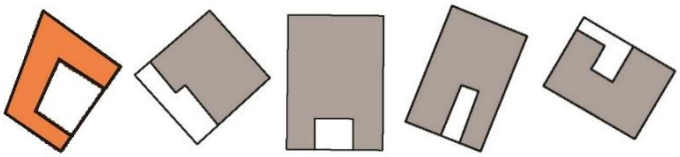
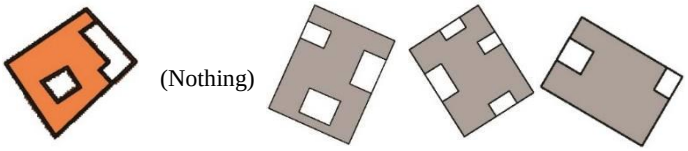
4. Results

4.1. Urban-scale analysis results

4.1.1. Tadjmout city: a regression of traditional configurations in the face of a topological diversification of the contemporary houses

Depending on the position and number of solid/void relationships in the plots of each homogeneous urban zone in Tadjmout city, the typological classification is presented in Table 1.

Table 1. Typological classification of houses in Tadjmout city. *Source*: Authors

Typology		Examples (plots plans)				
Types of houses	Types of voids	zone A	zone B	zone C	zone D	zone E
Type 1: central void house (21.9%)	- Patio - Courtyard		(Nothing)			
Type 2: single lateral void house (21.5%)	- Patio - Courtyard -Light well					
Type 3: multiple lateral void houses (56.6%)	- Patio - Courtyard - Light well		(Nothing)			

The histogram in Fig. 6 shows the transition from central void houses (central patios and courtyards), which dominated at 55% in the old neighbourhoods (zone A), to more flexible and diverse models in contemporary neighbourhoods (zones D and E). These include houses with multiple lateral voids (patios, courtyards, and light wells), which increased to 77–85%. This confirms a topological mutation and the rise of typological pluralism.

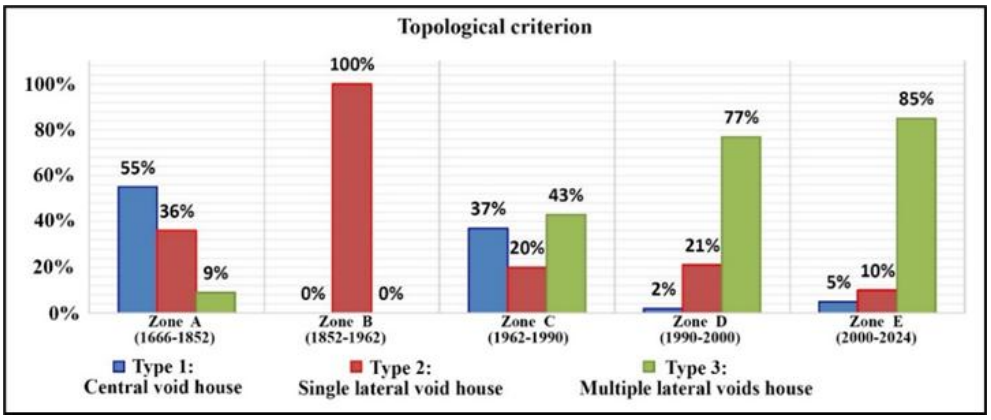


Fig. 6. Histogram of the distribution of house types by zone in Tadjmout city. *Source*: Authors

4.1.2. From formal irregularity to regularity

A radical geometric mutation occurred. In old neighbourhoods (zone A), 67% of voids and 94.6% of plots were irregular. By contrast, in contemporary neighbourhoods (zone E), 87% of voids and 100% of plots became regular (Fig. 7).

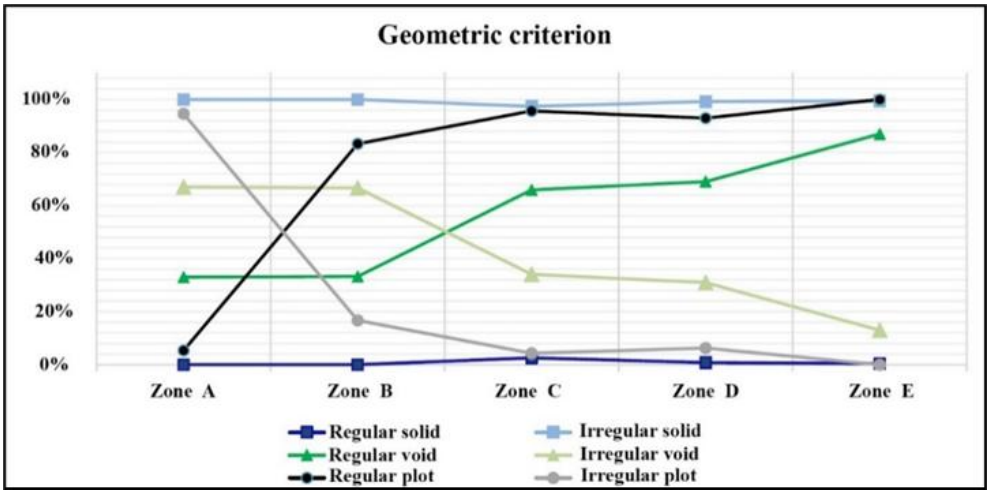


Fig. 7. Graph of the proportions of geometric characteristics of void houses in Tadjmout city. *Source*: Authors

4.1.3. From spacious plots with large voids to narrow plots with small voids

The surface area of solid spaces increased from 73.8% in old neighbourhoods (zone A) to 89.2% in contemporary ones (zone E). Concurrently, the void/solid ratio dropped from 36.3% to 12.2%, while average plot size decreased from 191 m² in zone A to 130 m² in zone E. Together, these trends confirm dimensional mutations (Fig. 8).

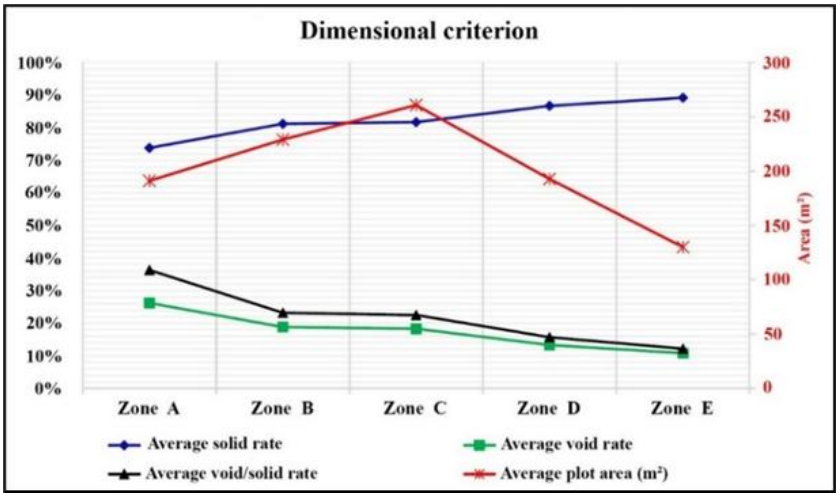


Fig. 8. Graph of the dimensional development of void houses in Tadjmout city. *Source*: Authors

4.2. Architectural-scale analysis results

4.2.1. Dimensional mutations

- Shift towards greater height and reduced surface area: by comparing the dimensions of voids in the studied samples (length L, width W, and height H), we observe a dominance of the "flat rectangular" patio type (H < W < L) in old neighbourhoods (zones A and B). In contrast, in contemporary neighbourhoods (zones C, D, and E), the "rectangular plan well" type (H > L > W) has become predominant (Table 2).

Table 2. Dimensions of voids in selected samples in Tadjmout city. *Source*: Authors

Zone A		
Sample 1	Sample 2	Sample 3
		
Zone B		
Sample 4		
		

Zone C		
Sample 5	Sample 6	Sample 7
		
Zone D		
Sample 8	Sample 9	Sample 10
		
Zone E		
Sample 11	Sample 12	Sample 13
		

- Persistence of horizontal proportion and decrease in the spatial proportion of interior voids: in houses with a single central or lateral void, the horizontal dimension of voids (p) is larger than that of built spaces (i) in old neighbourhoods. In contemporary neighbourhoods, however, this proportion is reduced. In houses with multiple lateral voids, the interior spaces (i) dominate, with voids representing only 14–22%. This indicates that voids remain present but no longer constitute the dominant element (Table 3).

Comparable dimensional analyses in other architectural contexts, such as Beldjilali (2024) [25], demonstrate that reductions in proportional ratios often signify adaptive responses to spatial and economic constraints, which resonates with the patterns observed in Tadjmout's houses.

4.2.2. Geometric mutations

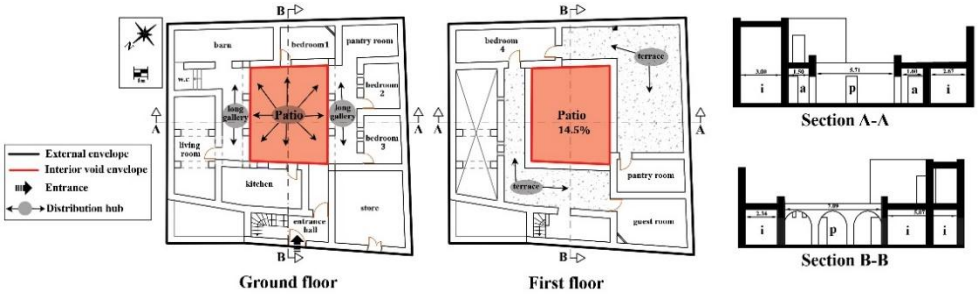
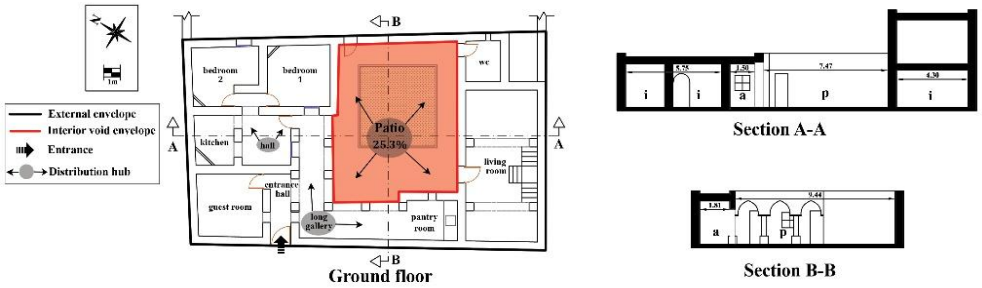
- Towards regularity of shape: irregular shapes (distorted or L-shaped rectangles) dominate in samples from old neighbourhoods (zones A and B), while regular geometric shapes (rectangles or squares with well-defined axes) prevail in samples from contemporary neighbourhoods (zones D and E) (Table 3).
- From independence to dependence on the exterior envelope: in old neighbourhoods (zones A and B), voids were geometrically independent from the external envelope,

with the exception of houses with multiple voids in zone A, which showed early dependence. In contemporary neighbourhoods (zones C, D, and E), dependence became dominant. This reflects a new architectural tendency towards greater harmony between voids and the external envelope (Table 3).

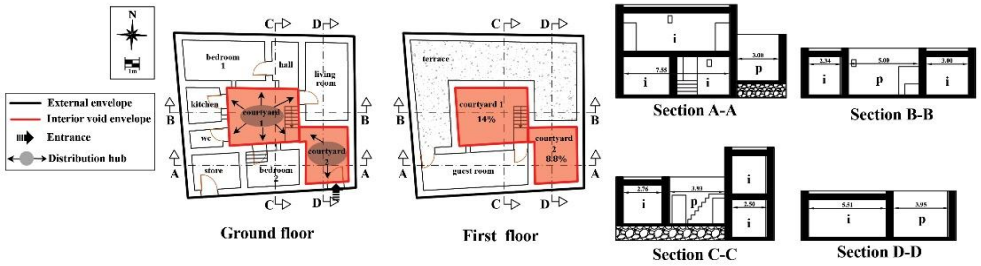
4.2.3. Topological mutations

- From independence to complementary correlation: in old neighbourhoods (zones A and B), the void is an independent structural space with a low correlation to interior spaces (30–40%), and a strict hierarchical organisation (up to the third level). In contemporary neighbourhoods (zones D and E), the correlation increased (70–75%) with a simplified hierarchy (second level), reflecting the complementarity of voids (Table 3).
- From unipolarity to multipolarity of internal distribution: in old neighbourhoods (zones A and B), the void acted as a central axis, rigidly organising interior spaces around it. In contemporary neighbourhoods (zones C, D, and E), this role has changed. The void is no longer the sole distribution pole. Other elements, such as galleries, corridors, and halls, also serve as nodes. These new or hybrid types provide greater flexibility and allow for varied horizontal mobility (Table 3).

Table 3. Morphological analysis diagrams of selected samples. *Source*: Authors

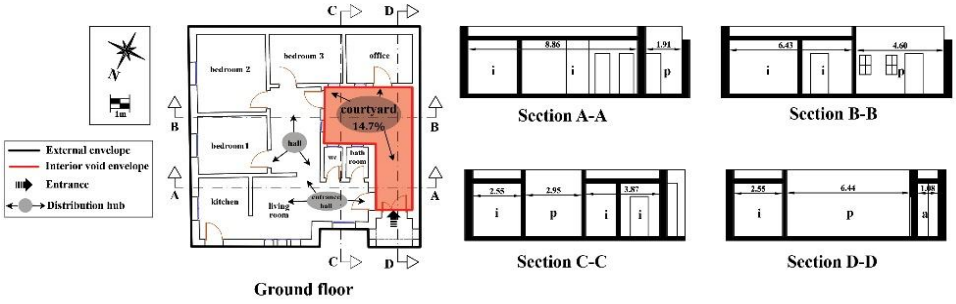
Zone A
Sample 1

Sample 2


Sample 3



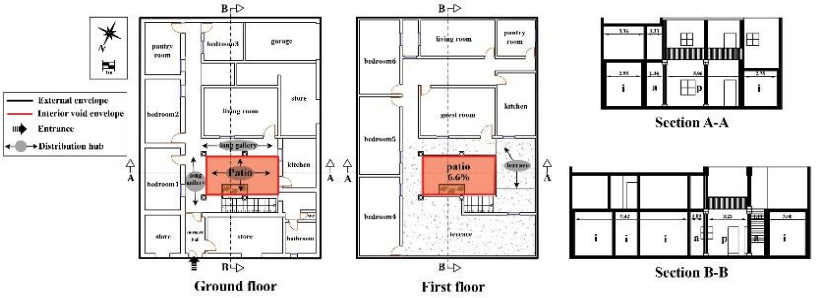
Zone B

Sample 4

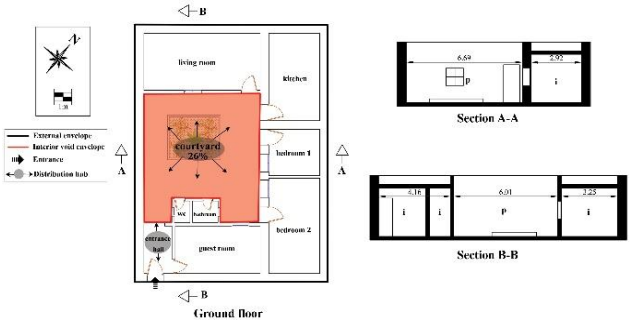


Zone C

Sample 5



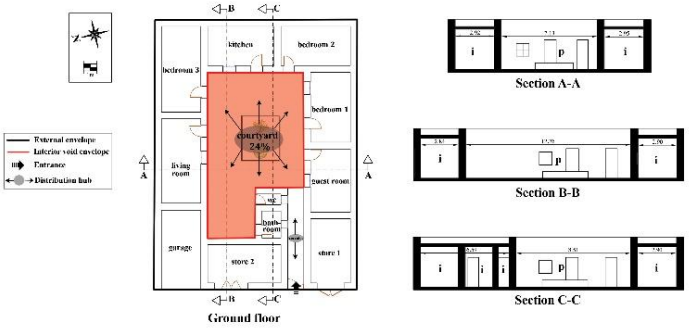
Sample 6



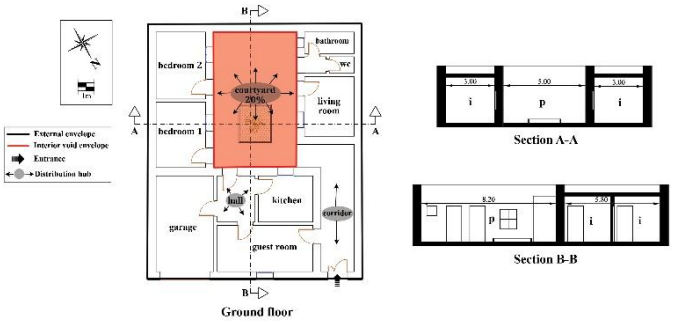
Sample 7

Zone D

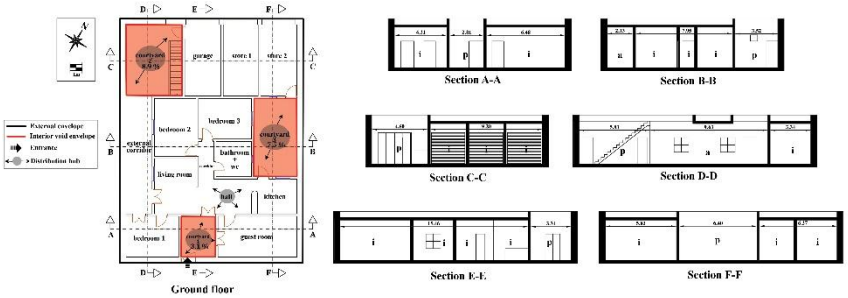
Sample 8



Sample 9

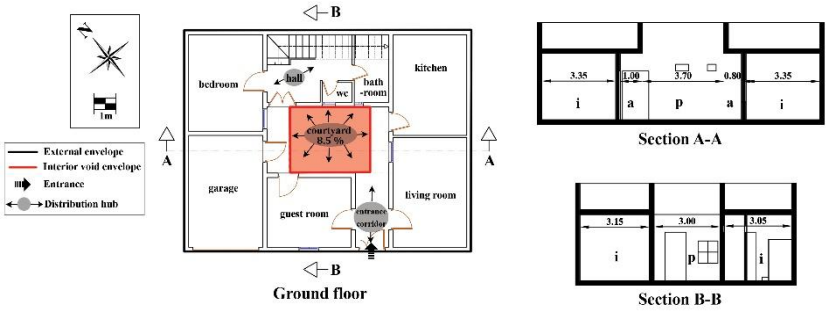


Sample 10

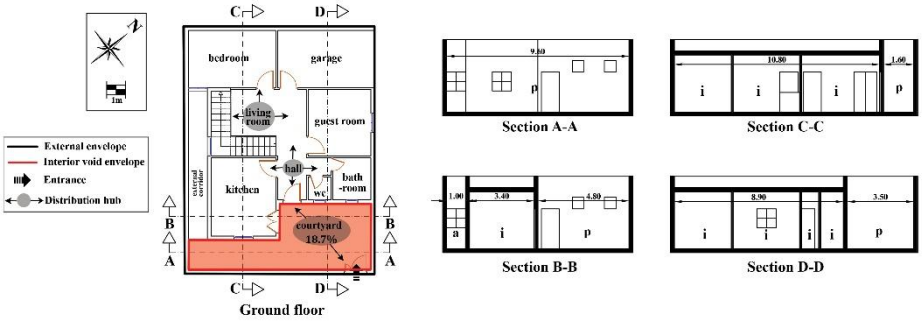


Zone E

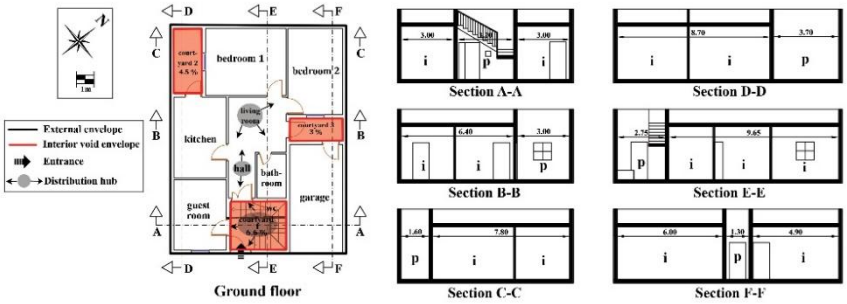
Sample 11



Sample 12



Sample 13



As a synthesis of the architectural-scale analysis, Fig. 9 presents schematic comparisons between traditional and contemporary patio houses in Tadjmout. The dimensional comparison highlights the shift from wide horizontal patios to narrow vertical courtyards and light wells. The geometric comparison illustrates the transition from irregular, autonomous forms to regular shapes more integrated with the external envelope. Finally, the topological comparison shows the evolution from a unipolar system of distribution, where the patio acted as the central organising node, to a multipolar system in contemporary houses.

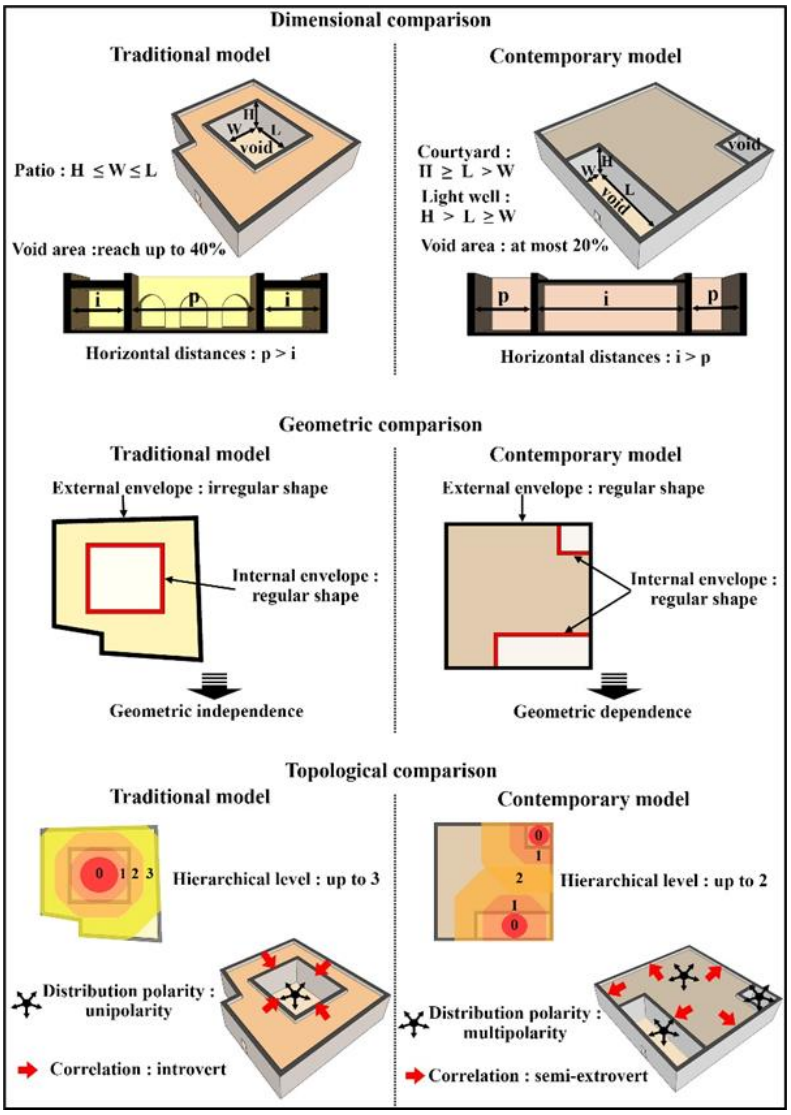


Fig. 9. Schematic comparison between traditional and contemporary house models in Tadjmout. *Source*: Authors

4.3. The general process of typo-morphological mutations of patio houses

The overall process of patio-house mutations in Tadjmout is introduced by a synthetic flowchart (Fig. 10), which summarises the main stages of their typological evolution. This visual overview highlights the following accompanying phenomena of this process:

- Continuity: refers to the persistence of the original architectural model while maintaining its basic morphological characteristics across different periods. For example, the model of houses with multiple courtyards was characterised by continuity (Samples 3, 7, 10, 13), as they maintained the same morphological characteristics from ancient to contemporary periods.

- Hybridisation: the process of combining elements of a previous model with new elements, giving rise to an intermediate model that merges old and new morphological characteristics. For example, the hybridisation between the concept of the patio and the concept of the courtyard is evident in Samples 8 and 11, where the characteristics of the patio (central positioning and solid/void ratio) were combined with those of the courtyard (eliminating galleries and ensuring service functions).
- Rupture: represents the complete disappearance of a previous model, for example the disappearance of the central patio house and the house with multiple courtyards in Zone B.
- Resumption: refers to the reuse of a previous model in a new context after a period of disappearance, for example the resumption of the central patio house and the multiple-courtyard house in Zone C.

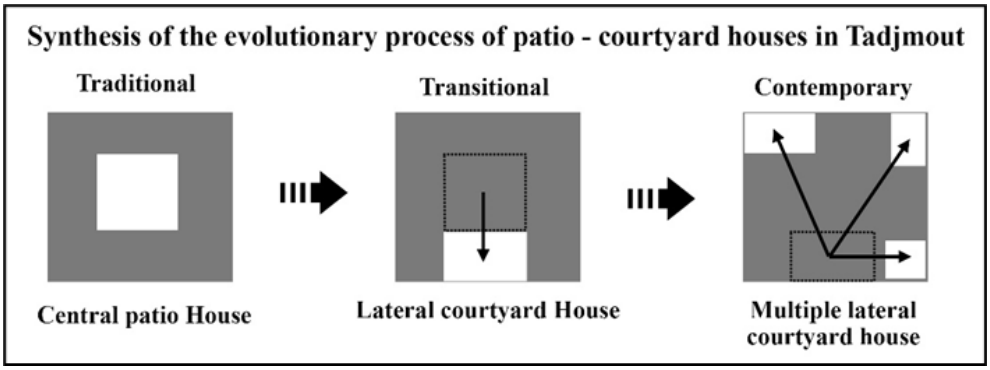


Fig. 10. Diagram of the mutation process of patio houses in Tadjmout. *Source*: Authors

Thus, the morphological mutations of the three types of void houses are outlined as follows:

- Type 1: Central void houses: in the old urban fabric, the traditional house with a central patio represented the historical origin type at 55%, while in the contemporary fabric it became a hybrid model (central courtyard house), representing only 5% (Fig. 11).

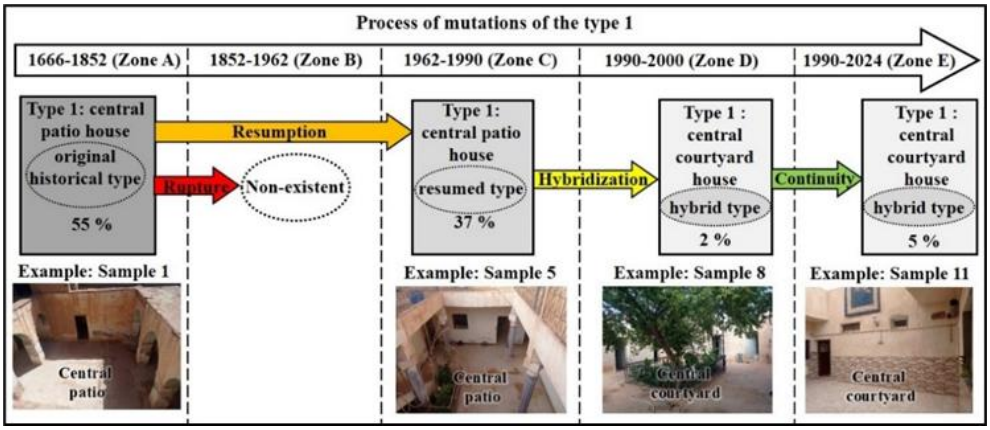


Fig. 11. Diagram of the mutation process of house type one. *Source*: Authors

- Type 2: Lateral void houses: the second historical type, the lateral patio house, represented 36% of the old urban fabric. It experienced a complete rupture and was replaced by a new colonial type (side courtyard house), which underwent hybridisation during the socialist period and continued into the liberal period. However, in the contemporary urban fabric, it was entirely taken over by the colonial type, representing only 10% (Fig. 12).

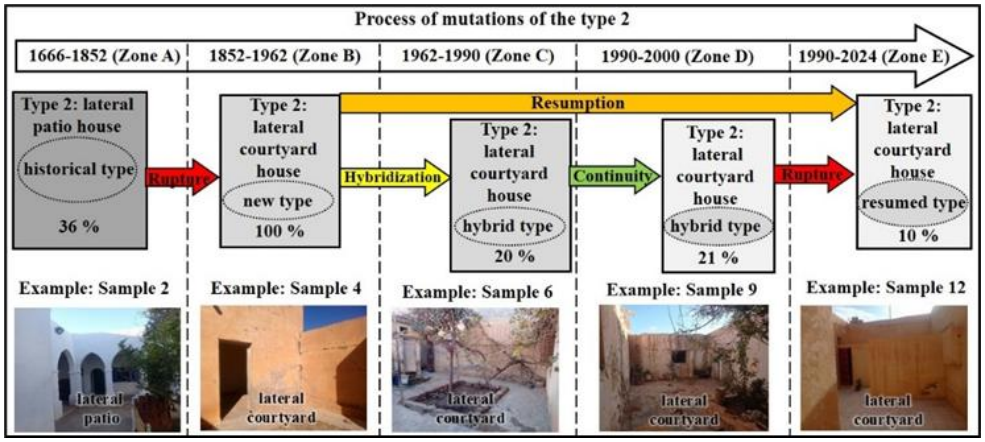


Fig. 12. Diagram of the mutation process of house type two. *Source*: Authors

- Type 3: Multiple lateral void houses: the third type, related to houses with multiple lateral courtyards, represented 9% of the old fabric (rare cases). It experienced a temporary rupture during the colonial period but was resumed after independence and continued through to the contemporary period, where it became dominant at 85% (Fig. 13).

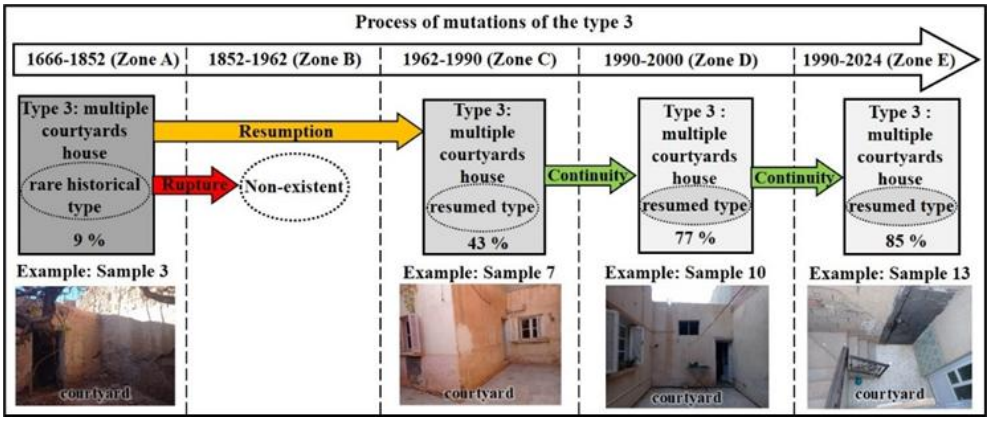


Fig. 13. Diagram of the mutation process of house type three. *Source*: Authors

4.4. Functional impacts of morphological mutations of patio houses

In light of the analysis of morphological mutations in the studied samples, it is evident that this was not merely a formal transition, as the analysis revealed that these mutations

directly affected two central functions: the distributive-organisational function and the structural function.

The following table (Table 4) shows the relationship between morphological mutations and functional impacts.

Table 4. Relationship between morphological mutations and functional impacts. *Source*: Authors

Mutation type	Mutations	Impact on structural function	Impact on distributive-organisational function
Topological	The patio from an independent structural space to a correlated complementary space	Decline in the autonomy of the void as a major structural element	Decline in the distributive role of the void and continuity of the organisational dimension
	From unipolarity to multipolarity of internal distribution	Fragmentation of the structural system	Competitiveness and flexibility of internal organisation
Geometric	Towards the regularity of geometric form	Strengthening the perception of void space	Facilitating distribution and clarifying the spatial hierarchy
	From geometric independence to dependence between the void and the external envelope	Increased correlation of void space with the exterior	Greater integration into comprehensive organisation and distribution
Dimensional	Towards greater height and reduced surface area	Preference for vertical extension over horizontal	Re-prioritisation of spatial organisation within the interior space
	Reduction in the spatial proportion of voids to interior spaces	Marginalisation of void spaces in architectural composition	Decline in the importance of voids as a central element of distribution and organisation

5. Discussion

The results showed that the patio, as a central element of traditional architecture in Tadjmout, has undergone significant morphological mutations in the transition towards contemporary housing. The analytical approach helped answer the first research question: which morphological elements carry and mark these mutations? The findings revealed three key aspects:

- Topology: in traditional houses, the patio void occupied a central position. In contemporary models, the void shifted to a lateral position, often as a courtyard. The topological relationship between the void and surrounding spaces has therefore disintegrated. Unlike the traditional model, which ensured centrality, the contemporary model reflects a new logic of spatial organisation.
- Geometry: in traditional houses, voids had flat, often irregular shapes. In contemporary houses, they became more regular and vertical, such as light wells and side courtyards. This change reflects a preference for vertical design.

- Dimension: in traditional houses, voids occupied 30–40% of the total space. In contemporary models, their size dropped to less than 10%. Their length and width were also reduced, reflecting an adaptation to new land constraints.

Regarding the second research question, which concerns the characterisation of the contemporary patio house in Tadjmout, the analysis shows a clear shift. Traditional houses were closed and organised around a central patio. In contrast, contemporary houses have moved towards a semi-open and multipolar organisation. The patio is no longer the only structural element. Other covered spaces, such as the hall, now play a similar role and sometimes compete with the patio or courtyard.

This reflects a selective reuse of the traditional patio, rooted in the local culture of construction. Similar dynamics of continuity through transformation have been documented in Chinese building morphologies, where new socio-economic pressures reshape traditional forms without erasing their cultural identity [26].

In the contemporary context, however, this reuse is often partial and introduced without reference to its original design principles. As a result, the contemporary courtyard house presents a hybrid identity. It is shaped by technical, economic, and social constraints, while still preserving the symbolic presence of the patio.

Regarding the third research question, which addresses the functional impacts of the patio space, the results showed that mutations strongly affected the distributive function of the patio. In traditional houses, the patio organised relationships between spaces and gave the house internal harmony. In contemporary houses, this role declined. The void space no longer controls distribution and has become only a secondary element.

The structural function of the patio remained strong in traditional houses, where it was a core element of the design. In transitional and contemporary models, however, this role weakened. The void space lost much of its structural importance, reducing the patio's legitimacy as an obligatory component of the house.

The weakening of the patio's role raises the question of the driving factors behind this decline. Socially, changing lifestyles and smaller family size reduced the need for large introverted spaces. Economically, land scarcity and rising construction costs favoured compact housing with smaller light wells. Environmentally, the spread of mechanical systems for lighting and ventilation diminished reliance on the traditional patio's climatic role. Insights from municipal experts, local residents, and field observations reinforced these interpretations, confirming the socio-functional decline of the patio in Tadjmout's contemporary housing. Nevertheless, this decline does not erase its symbolic persistence, which continues to shape the typological process of change and continuity observed in the city's housing stock.

The synthesis of the results reveals a duality between change and continuity in the typological process of mutation of patio housing in Tadjmout city, represented by:

- The concept of the patio persists as an interior void space, but it no longer appears in its traditional form as a central space. It can therefore be considered an evolution of the archetype, as described by Faure (2022) [16].
- In some cases, the functional relationship has remained relatively intact despite the morphological mutations of the patio. These cases correspond to what Deleuze (1988) calls "the objectile", where the function persists while the form changes [21].
- The continuity of the deep organising principle associated with introversion and spatial intimacy is consistent with Darin's (1993) concept of strong elements that remain effective [22].

On the other hand, the results confirm Caniggia's (1986) statement [17] that typological mutation occurs according to a dynamic that can be logically traced and analysed, which has

been observed in the housing types of Tadjmout through processes such as continuity, rupture, hybridisation, and resumption.

The findings also align with Malfroy's (1986) study [20], which indicated that some architectural elements are more resistant to change than others. Although the patio changed as a physical component, some of its symbolic and functional characteristics persisted, serving as reminders of a local building culture, albeit in new forms.

This finding situates the case of Tadjmout within a broader morphological debate: from North African minaret evolution (Beldjilali, 2024) [25] to Asian courtyard transformations (Jiao, 2023) [26], highlighting that typological mutation is a universal mechanism in architectural change.

Finally, it should be noted that some models show a tendency towards contemporary features (side courtyards, light wells) in the old neighbourhood (zone A), representing 9%. These result from later architectural interventions during contemporary periods (according to the field survey). Such exceptional cases offer new insights into the effects of random interventions on the traditional urban fabric and the associated risk of losing local architectural identity.

6. Conclusions

This study emphasised the local specificities of morphological mutations, from the traditional patio house to the contemporary courtyard house. This represents a fundamental inversion of the archetype and alters the understanding of patio space in its functional and structural roles. The typo-morphological analysis confirmed clear transformations at both urban and architectural scales. However, it also showed that some elements of permanence—such as introversion, spatial hierarchy, and the concept of the structuring void—remain more relevant to address than the aspects of change or rupture.

The patio space emerged as a "strong" typological element, in the sense of Darin (1993) [22]. Its introversion explains why its symbolic role persists, even when the typological process shifts from patio to courtyard in Tadjmout houses.

Several questions remain open regarding the lessons to be drawn from this typological and morphological analysis, particularly concerning how residents may reinterpret the patio in its vernacular dimensions. Finally, we propose a set of recommendations, including:

- Conduct additional research to study other effects of morphological mutations of the patio from social, ecological, and health perspectives.
- Conduct complementary research using psychological and anthropological approaches on residents' experiences of traditional and contemporary patio spaces.
- Adopt urban policies that encourage architects to reactivate the role of the patio in contemporary architectural design, in order to restore the city's distinctive urban and architectural traditions.
- Use modern technologies (such as 3D scanning) to document the morphological details of the disappearing traditional patio and create a visual archive to inspire contemporary design.

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