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Datça vernacular houses as a rule-governed plan language: a shape grammar and J-graph reading

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ABSTRACT

Vernacular housing studies have documented spatial patterns in detail, yet the rules that generate these patterns are less often formalised within a single analytical framework. This article examines how traditional Datça houses can be read as a rule-governed plan language, drawing on 13 analytically selected cases from a documented Reşadiye housing corpus. Shape grammar is used to extract formation, articulation and growth rules from the corpus; dual-root J-graph readings, supported by basic J-graph-derived topological indicators, are used to test topological consistency. The analysis reveals a core – growth – derivation logic: [GARDEN] and [ROOM 1] establish the corpus-wide core, while [ROOM 1] also drives primary growth. [ROOM 2] appears as a subtype-specific derivative unit; [KITCHEN] and [STORAGE] form a recurrent non-core service layer; and [HALL] acts as a conditional distributive node in more complex or vertical cases. Controlled derivation serves as a methodological proof-step, testing whether the extracted rules produce consistent intra-grammatical variation. The model shows that a local vernacular corpus can support rule extraction and topological verification within the same analytical framework, extending the analysis from descriptive documentation to plan-language formation.

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KEYWORDS
Vernacular housing; shape Grammar; J-Graph; plan language; topological verification

1. Introduction

The traditional dwellings of the Datça Peninsula have been documented through studies of Reşadiye, Hızırşah, Çeşme and the wider Datça-Bozburun rural settlement context. These studies record plan types, settlement organisation and material practice, including stone-built single-room cores, garden-plot-street relations and the progressive addition of rooms or upper floors (Başoğlan 2001; İşcanı 2016; Naycı 2012; Uyan 2011). In the Reşadiye and Hızırşah material, the single-room stone dwelling and its relation to the open domestic exterior are especially significant: this exterior space connects the street to the interior, while additional rooms and upper floors develop around the initial core. The literature does not specify the rules governing this process: which units combine, in which sequence, and through which access and threshold relations.

The problem addressed in this article is therefore not the absence of documentation, but the absence of a rule-based reading of the documented material. Existing typological and conservation-oriented studies identify plan types, settlement relations and architectural components; they do not formalise the rules that govern unit combinations, growth sequences or access relations.

This article re-reads traditional Datça houses as a rule-governed plan language. The article does not replace conservation or typological documentation; it uses the documented material as evidence for rule extraction and topological verification. Shape grammar identifies the spatial units, their vocabulary and the rules governing their formation, articulation and growth. Dual-root J-graph readings then serve as a validating layer for access, depth and distribution relations.

The central research question is: what rules govern the plan language of traditional Datça houses, and how can their topological consistency be verified through dual-root J-graph reading? The study also examines whether controlled derivation can serve as a methodological proof-step without functioning as a design proposal.

The study is guided by four analytical propositions, not by statistical hypotheses. Datça houses can be read as variations of recurring grammar units and formation/articulation relations. [GARDEN] and the first [ROOM 1] are expected to establish the corpus-wide core; [ROOM 2], [KITCHEN], [STORAGE] and [HALL] are expected to operate as derivative, service or

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distributive layers. These structural relations should be consistent with access and distribution patterns observed in dual-root J-graph readings.

The contribution of the article is threefold. First, it adds a rule-extraction layer to existing Datça housing documentation. Second, it proposes an asymmetric analytical model in which shape grammar provides the rule-extraction framework and the J-graph provides the topological verification layer. Third, it uses controlled derivation as a methodological proof-step rather than as a design proposal. The analysis is confined to documented plan evidence; it supports analytical interpretation, not statistical generalisation, full space syntax analysis or design guidelines.

2. Literature and theoretical framework

2.1. From descriptive typology to rule-based reading in vernacular housing

Vernacular housing studies have documented plan types, settlement patterns, construction systems, environmental adaptation and conservation problems across many regional contexts. Such documentation records formal variation, settlement organisation and responses to material and environmental conditions (Haakonsen, Rønnquist, and Labonnote 2022; Moosavi et al. 2025; Wang, Zhang, and Fan 2024). Research on domestic spatial organisation has also shown that apparent plan differences may conceal recurrent access hierarchies, privacy gradients, service layers and open-space relations (Al-Mohannadi and Furlan 2022; Alnaim 2023; Barkat, Bada, and Güney 2021; Ding, Zhuo, and Xiao 2024). In Turkish and Mediterranean contexts, plan families have also been shown to share organisational logics beyond surface morphology (Ayyıldız and Durak 2023; Coşkun and Haştemoğlu 2025). The limitation of descriptive typology is not that it lacks value, but that it usually stops at classification. It can identify a one-room house, a courtyard relation, a service addition or a two-storey variant, but it does not necessarily formalise the rules that explain how these units are formed, sequenced and connected. For historical-house corpora, this distinction is important. Hosseini et al. (2024) argue that typological studies of historical houses remain limited when they do not explain the structural relationships between spaces. For the present study, this distinction justifies a rule-extraction layer beyond typological inventory.

2.2. Shape grammar and rule extraction in vernacular house studies

Shape grammar reads architectural form through vocabularies, relations and rules rather than through final forms alone (Flemming 1987; Koning and Eizenberg 1981; Stiny and Mitchell 1978). Its relevance to vernacular housing comes from its capacity to infer recurrent formation rules from existing corpora. Çağdaş (1996) demonstrated this potential through the grammar of the traditional Turkish house, while Duarte (2005) distinguished analytical grammars inferred from existing buildings from original grammars used for design generation. In the Datça study, grammar is the primary tool for inferring rules from a documented corpus.

Recent shape-grammar studies have extended this logic to vernacular and historical house corpora. Wang, Zhang, and Fan (2024) show that shape grammar can be used to decode formal and organisational rules in vernacular houses, while Hosseini and Bemanian (2022) use it to study the formal structure and spatial relations of Kashan traditional houses. Wen et al. (2025) similarly demonstrate the use of shape grammar for extracting construction rules in traditional dwellings, although their digital-regeneration emphasis differs from the analytical aim of the present article. Work on inferred and typology-defining grammars further shows that architectural knowledge can be translated into explicit rule structures, including distinctions between core, optional and subtype-specific components (Eloy and Duarte 2014; Mamoli 2020; Wutte and Duarte 2021). For the Datça study, this literature clarifies two methodological points: grammar can be inferred from an existing corpus, and its units can be differentiated by rule status within a structured analytical framework.

Accordingly, the present article positions shape grammar as the primary analytical layer. It identifies a grammar vocabulary, formation rules and articulation rules from the Datça corpus.

2.3. J-graph reading and topological verification of domestic space

Shape grammar and J-graph reading address different questions. Shape grammar explains the formation of the plan; J-graph reading examines access sequence, depth, threshold order and distribution relations (Ostwald 2011). Within the broader space syntax tradition, domestic layouts have been examined through access, configuration and transitional relations, while methodological reviews show the field's expansion beyond a single set of measures (Bandyopadhyay and Merchant 2006; Mohamed and Yamu 2023). In domestic space, these relations are closely tied to privacy, hierarchy and everyday use. Studies using space syntax or justified-plan graph approaches have shown that traditional houses often organise access and privacy through depth, threshold control and distributive spaces rather than through morphology alone (Alitajer and Nojoumi 2016; Barkat, Bada, and Güney 2021; Zolfagharkhani and Ostwald 2021).

This topological perspective is especially relevant for vernacular houses in which open exterior spaces operate as more than climatic voids. Research on courtyard and open-space domestic systems shows that such spaces may function as social, environmental and distributive elements within the house system (Alnaim 2023; Borg and Bianco 2025). In the Datça corpus, this supports the analytical treatment of [GARDEN] as an open domestic exterior and as a root condition in the J-graph reading, without treating it as a universal courtyard type.

Several studies have combined grammatical or configurational readings with justified plan graph analysis. Heitor, Duarte, and Pinto (2004) showed that grammar and syntax can cooperate in formulating, generating and evaluating spatial configurations. Lee, Ostwald, and Gu (2015, 2016, 2017) and Asriana and Khidmat (2024) also demonstrate that grammatical patterns can be interpreted alongside justified graph structures. The present study builds on this integration but keeps the relation asymmetric: the grammar extracts the production logic, while dual-root J-graph readings verify whether that logic is consistent with access, depth and distribution relations. The article does not claim a full space syntax analysis; it uses J-graph reading as a topological verification layer.

2.4. Datça-specific gap and position of the present study

The Datça literature provides a rich documentary and typological foundation. Reşadiye has been studied through housing types, core dwelling forms and garden-house-street relations (Başoğlan 2001); Çeşme Mahallesi through settlement documentation and conservation problems (Uyan 2011). The wider Datça-Bozburun rural settlement system is covered by Naycı (2012), while Kütükçüoğlu (2022) situates Datça villages within a broader set of peninsula-scale micro-ecological spatial relations. Hızırşah's one-room masonry houses, parcel organisation and architectural elements are documented by İşcanı (2016) and İşcanı and Eres (2017). More recent work on Yazıköy addresses conservation regulations, tourism pressure and rural transformation (Sözen and Kılıç 2025).

This literature establishes Datça as a well-documented vernacular housing context. Its limitation for the present article is not documentary weakness but analytical incompleteness at the level of plan-language rules. The existing literature does not specify the grammar vocabulary, the formation sequence, the articulation rules or the topological consistency of the documented plans. This is the Datça-specific gap addressed by the present article.

The study occupies a specific position in this literature. It does not repeat Datça typology, replace conservation documentation or propose a design guideline. It applies rule extraction and topological verification to the documented Datça corpus. Methodologically, it combines shape grammar and dual-root J-graph reading in an asymmetric framework: shape grammar extracts the rules of plan formation and articulation, while the J-graph checks whether those rules correspond to access and distribution patterns. Controlled derivation then serves as a methodological proof-step within this framework.

3. Methodology

3.1. Research design

This study is designed as a comparative analytical case-based study with rule extraction and topological verification. Each house plan constitutes a case; the analytical focus is the rule relation read comparatively across the 13 cases: which spatial units combine, in which sequence, and through which access and threshold conditions. The research design combines two analytical layers. Shape grammar provides the primary framework for identifying spatial units, formation rules and articulation rules. Dual-root J-graph reading provides a topological verification layer by examining access sequence, depth and distribution relations.

The relation between these layers is intentionally asymmetric. Shape grammar is used for rule extraction, not design generation. J-graph reading is used as a topological verification layer, not as a full space syntax analysis. Controlled derivation is used after rule extraction as a methodological proof-step; it tests whether the extracted rules can produce consistent intra-grammatical variation.

The study is analytical and explanatory rather than statistical. It does not claim to represent all Datça houses. Its aim is to identify the rules governing plan formation and variation within a criterion-based corpus. Methodological validity rests on cross-checking between plan evidence, grammar rules and J-graph readings; the full validity framework is discussed in Section 3.5.

Figure 1 summarises the methodological workflow and shows how corpus selection, analytical normalisation, rule extraction, topological verification and controlled derivation are connected within the same research design.

3.2. Corpus and sample selection

The corpus was derived from documented plan records of Reşadiye, the principal settlement studied in Başoğlan (2001), which provides a concentrated set of comparable plan records from a single Datça locality. The starting pool consisted of 45 documented houses. This pool was used as the starting frame

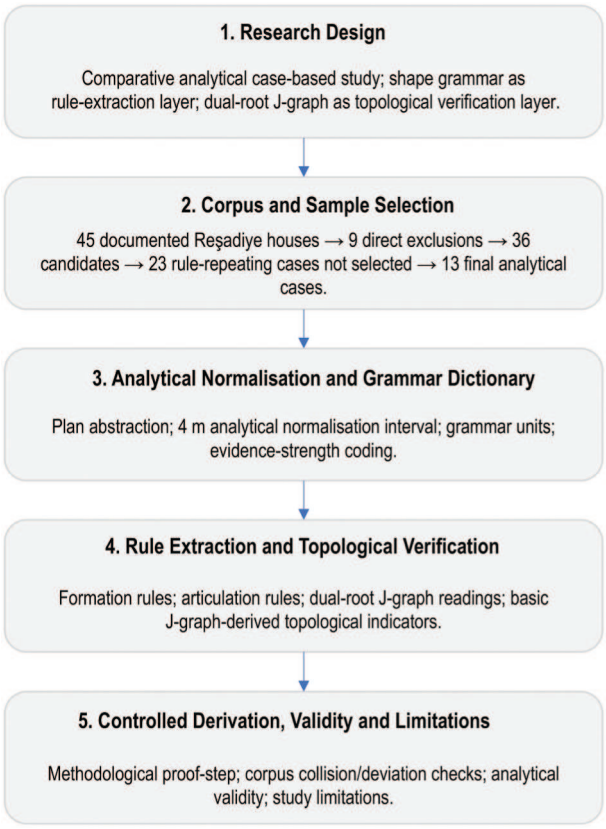


Figure 1. Methodological workflow of the comparative analytical case-based study.

because all cases belong to the same local settlement, share a broadly comparable building tradition and draw on the same documentary base. The selection process aimed not at statistical representativeness but at establishing a criterion-based analytical corpus capable of supporting rule extraction.

The screening proceeded in two stages. First, nine houses were excluded before analytical coding because their plan evidence could not support reliable abstraction. The exclusion reasons were uncertain originality, collapsed or incomplete parts, substantial later additions or interventions, and insufficient plan data. This left 36 candidate houses. Second, the remaining candidates were compared for formation, articulation and topological information. Twenty-three cases were not selected because they repeated rule relations already present in other cases without adding a new formation sequence, articulation mode or topological configuration. The final corpus consists of 13 analytically selected cases. Tables 1 and 2 summarise this screening process and the direct exclusion reasons.

The final 13 cases are not presented as a representative sample in a statistical sense. They are treated as an analytically sufficient corpus for identifying non-redundant rule relations within the documented Reşadiye material. Each case was selected because it contributes at least one rule relation not already represented in the corpus, whether related to formation, growth, service, distribution or topological organisation. This logic follows a criterion-based case selection approach, in which information-rich cases are selected for their explanatory value rather than their frequency alone (Flyvbjerg 2004; Palinkas et al. 2013).

Ground-floor plan evidence is available for all 13 cases and forms the primary basis of the comparative analysis. Upper-floor evidence is uneven and is available only for Cases 8, 9, 11, 12 and 13. For this reason, upper-floor data are used as supplementary evidence for vertical development and distribution, not as an equally available layer across the full corpus. This distinction is reflected in the evidence-strength coding (Section 3.3) and J-graph verification (Section 3.4).

3.3. Analytical normalisation and grammar dictionary

All selected plans were redrawn according to a common analytical representation protocol. Decorative or non-analytical details that did not affect the reading of spatial units, access relations or rule formation were removed. This abstraction did not aim to reproduce the surveyed plans as measured drawings; it made different plans comparable for analytical reading (Pinho and Xavier 2012). Ground-floor

Table 1. Corpus screening and selection logic.

SCREENING STAGE	NUMBER OF CASES	METHODOLOGICAL ROLE
Documented Reşadiye house pool	45	Starting corpus based on documented plan records from a single Datça locality
Directly excluded before analytical coding	9	Cases removed because reliable plan abstraction was not possible
Candidate pool after direct exclusion	36	Houses available for comparative analytical screening
Rule-repeating cases not selected	23	Cases repeating already represented formation, articulation or topological relations
Final analytical corpus	13	Non-redundant cases used for rule extraction and topological verification

Table 2. Direct exclusion reasons before analytical coding.

DIRECT EXCLUSION REASON	NUMBER OF CASES	RATIONALE
Uncertain originality	2	The documented plan could not be reliably attributed to the original formation logic
Collapsed or incomplete parts	2	Essential spatial relations were missing or could not be reconstructed
Later additions or substantial interventions	4	Later alterations obscured the original formation/articulation logic
Insufficient plan data	1	Available documentation did not support reliable abstraction
Total	**9**	

plans were treated as the primary layer of comparison, while available upper-floor plans were incorporated only where the documentation allowed reliable reading.

The 4 m grid was used as an analytical normalisation interval, not as a precise dimensional module. Its use is informed by Başoğlan's documentation of core dwelling dimensions in Reşadiye, which indicates recurrent room-width ranges consistent with local timber construction practice (Başoğlan 2001, 56). The grid is therefore used to express local structural proportions in a comparable analytical form. Spacing, adjacency and relative position are compared across cases; no claim of precise dimensional equivalence is made.

The grammar dictionary was compiled from the abstracted plans. Units were coded by their constitutive and topological roles in plan formation rather than by functional labels alone. Table 3 summarises the grammar-unit vocabulary used for rule extraction.

For [ROOM 1], identification relied primarily on its position within the [GARDEN]–[ROOM 1] core relation and its role in the growth structure; where visible in the documented plans, fireplace position supported this identification as a secondary morphological indicator (Başoğlan 2001).

Evidence strength was assessed separately from rule status. Corpus-wide / strong evidence was assigned to units that appeared across the full corpus and supported core formation. Recurrent non-core evidence described units that appeared in several cases without forming the core. Subtype-specific / limited but analytically significant evidence described units that appeared in fewer cases but clarified derivative growth, distribution or vertical organisation. Table 4 summarises the recurrence and evidence strength of the grammar units.

3.4. Rule extraction and topological verification

Rule extraction was carried out after the plans had been abstracted and the grammar dictionary had been defined. Recurrent units were identified across the 13 cases. From these, formation rules were derived from the sequence of unit establishment: the [GARDEN]–[ROOM 1] core, [ROOM 1] primary growth, subtype-specific [ROOM 2] derivation and non-core service additions. Articulation rules were derived from the way established units connect through surface contact, threshold relations, access sequence and distributive nodes.

Formation and articulation rules were checked against dual-root J-graph readings. Two roots were used. The Root = Outside reading traces the transition from the street or exterior approach into the house system. The Root = Garden reading takes the open domestic exterior as the internal root condition of the Datça house. This dual-root structure reflects [GARDEN]'s double role: as the external access threshold and as the internal distribution surface.

The J-graph reading was used as a topological verification layer, not as a full space syntax analysis. Its purpose was to test whether the grammar-derived relations corresponded to access, depth and distribution patterns in the corpus. Basic J-graph-derived indicators were recorded for each case: total nodes (N), mean depth (MD) and maximum depth (MxD). Mean depth was calculated by excluding the selected root node from the denominator.

Table 5 summarises the basic J-graph-derived indicators used for topological verification. The dual-root indicators express plan depth and access hierarchy in quantitative terms without turning the study into a full syntactic analysis. The indicators serve as a methodological check on the extracted grammar; topological interpretation appears in the findings and discussion sections.

3.5. Controlled derivation, validity and limitations

Controlled derivation served as a methodological proof-step: it tests whether the extracted grammar

Table 3. Grammar dictionary of the Datça plan language.

GRAMMAR UNIT	SPATIAL DEFINITION	CONSTITUTIVE ROLE	TOPOLOGICAL ROLE
[GARDEN]	Open domestic exterior; threshold surface linking street, plot and dwelling	Mandatory starting surface of the plan language	Root node; access and distribution surface
[ROOM 1]	Primary enclosed room unit	Core-forming unit; primary growth unit when repeated	Core node; repeated nodes form the primary growth layer
[ROOM 2]	Secondary enclosed room unit	Subtype-specific derivative unit added after the core is formed	Derivative node beyond the core relation
[KITCHEN]	Food preparation and service unit	Recurrent non-core service unit attached to the core or growth structure	Service node; may act as an intermediate access node
[STORAGE]	Storage and secondary service unit	Recurrent non-core unit extending storage and service capacity	Storage/service node attached to the non-core service layer
[HALL]	Internal circulation and distribution unit	Conditional distributive node activated when direct garden-based access is insufficient for plan organisation	Intermediate distribution node; may mediate horizontal and vertical access

Note: This table defines the grammar-unit vocabulary used for rule extraction. Recurrence and evidence strength are reported separately in Table 4; formation and articulation rules are provided in Appendix C.

Table 4. Grammar unit recurrence and evidence strength.

GRAMMAR UNIT	GROUND-FLOOR RECURRENCE	UPPER-FLOOR RECURRENCE	CASE-LEVEL RECURRENCE	EVIDENCE CATEGORY	ANALYTICAL ROLE
[GARDEN]	13/13	N/A	13/13	Corpus-wide / strong evidence	Root and distribution surface; open domestic exterior
[ROOM 1]	13/13	4/13: Cases 8, 9, 12, 13	13/13	Corpus-wide / strong evidence	Core-forming unit and primary growth unit
[ROOM 2]	2/13: Cases 6, 12	2/13: Cases 11, 12	3/13: Cases 6, 11, 12	Subtype-specific / limited but analytically significant evidence	Derivative growth unit
[KITCHEN]	3/13: Cases 3, 5, 13	1/13: Case 11	4/13: Cases 3, 5, 11, 13	Recurrent non-core evidence	Service unit
[STORAGE]	5/13: Cases 3, 8, 9, 10, 11	N/A	5/13	Recurrent non-core evidence	Secondary service/storage unit
[HALL]	3/13: Cases 6, 8, 12	2/13: Cases 8, 12	3/13: Cases 6, 8, 12	Subtype-specific / limited but analytically significant evidence	Conditional distributive node in complex/vertical cases

Note: Upper-floor recurrence refers to grammar-unit recurrence on the upper floor where analytical evidence is available. Upper-floor [ROOM 1] recurrence (Cases 8, 9, 12 and 13) differs from upper-floor analytical evidence availability (Cases 8, 9, 11, 12 and 13) because Case 11 contains upper-floor [KITCHEN], not upper-floor [ROOM 1].

Table 5. Basic J-graph-derived topological indicators for dual-root topological verification.

Case	N (Out)	MD (Out)	MxD (Out)	N (Grd)	MD (Grd)	MxD (Grd)
Case 1	3	1.50	2	2	1.00	1
Case 2	4	1.67	2	3	1.00	1
Case 3	5	2.00	3	4	1.33	2
Case 4	4	1.67	2	3	1.00	1
Case 5	6	2.00	3	5	1.25	2
Case 6	6	2.20	3	5	1.50	2
Case 7	4	1.67	2	3	1.00	1
Case 8	8	2.86	4	7	2.17	3
Case 9	5	1.75	2	4	1.00	1
Case 10	5	1.75	2	4	1.00	1
Case 11	7	2.17	3	6	1.40	2
Case 12	8	2.86	4	7	2.17	3
Case 13	6	2.20	3	5	1.50	2

Note: *N* = total nodes; MD = mean depth; MxD = maximum depth; Out = Root = Outside; Grd = Root = Garden. Total nodes include the selected root node in each J-graph reading. Mean depth was calculated by excluding the selected root node from the denominator. Root = Outside includes the Outside node as the graph root; Root = Garden uses [GARDEN] as the graph root. Upper-floor nodes were included for Cases 8, 9, 11, 12 and 13 where documented upper-floor evidence was available.

can produce coherent intra-grammatical variation. The protocol covers the mandatory core, optional growth and service steps, and final in-grammar verification; the full sequence is presented in Section 5.

Validity rests on cross-checking between four layers: plan evidence for abstraction, the grammar dictionary and rule set for formation logic, dual-root J-graph indicators for topological consistency, and controlled derivation for intra-grammatical coherence. In this framework, controlled derivation checks whether the extracted rules can produce variation without replicating existing corpus cases or deviating outside the rule system.

The same abstraction protocol, grammar-unit definitions, evidence-strength categories and J-graph calculation rules were applied consistently across all 13 cases. Mean depth was calculated by excluding the selected root node from the denominator, and the same two root conditions were used for each case. This does not make the study a large-sample quantitative analysis; it makes the analytical procedure explicit and traceable.

The study has four main limitations. First, it is based on a criterion-based corpus of 13 analytically selected cases and does not claim statistical representativeness for all Datça houses. Second, the analysis is primarily plan-based; façade composition, construction details and full three-dimensional form are outside the main scope. Third, upper-floor evidence is uneven across the corpus and is used only where documented plan information is available. Fourth, the J-graph reading is limited to basic topological indicators and does not constitute a full space syntax analysis. The study produces a corpus-based analytical grammar of documented Reşadiye/Datça plan evidence, not a universal grammar of Datça vernacular housing. The detailed methodological procedures and evaluation criteria are provided in Appendix A.

4. Analysis and findings

The detailed comparative analytical matrix is provided in Appendix B; the findings below synthesise its recurrent grammatical and topological patterns. The analysis follows the core – growth – derivation logic that emerged from the corpus: the corpus-wide core formed by [GARDEN] and [ROOM 1], the growth and service layers that extend this core, and the topological

patterns confirmed through dual-root J-graph indicators.

4.1. Core formation and grammar units

In all 13 cases, plan formation begins from an open domestic exterior; no case starts directly from an enclosed room. [GARDEN] is the spatial surface from which access begins, distribution operates and domestic threshold relations take shape.

[ROOM 1] is the second component of the core. Its recurrence across the full corpus shows that the Datça plan language is built around a primary enclosed unit attached to the open domestic exterior. This pairing of open exterior and first enclosed unit is the only structural relation present in every case.

The role of [ROOM 1] extends beyond initial formation. At ground level [ROOM 1] establishes the core; in Cases 8, 9, 12 and 13 it also appears on the upper floor, extending the same core structure vertically. This dual role distinguishes [ROOM 1] from the other enclosed units in the grammar dictionary.

The documented garden – house – street relation in Reşadiye housing records this exterior space as a contextual feature; the present analysis shows that it also functions as the grammatical starting condition of the plan, the first operative unit from which access, distribution and core formation proceed.

4.2. Growth, service and distribution layers

After the [GARDEN]–[ROOM 1] core, the most stable growth mechanism is the repetition of [ROOM 1]. Additional [ROOM 1] units extend the core without changing its grammatical basis. The same unit appears both as the initiating enclosed room and as the primary growth element. Growth occurs by repeating and extending the unit that already establishes the core.

[ROOM 2] has a different status. It appears in fewer cases and does not establish the corpus-wide core. Its role is derivative: it appears where the basic [GARDEN]–[ROOM 1] relation has already been formed and where additional spatial differentiation is required. For this reason, [ROOM 2] is read as a subtype-specific growth unit, not as a second core. Its limited recurrence shows that grammatical differentiation operates selectively: not every Datça house develops a derivative growth ring.

[KITCHEN] and [STORAGE] form a recurrent non-core service layer. [KITCHEN] appears in four cases and [STORAGE] in five. Their recurrence shows that service spaces are part of the Datça plan language, but their position in the rule system differs from [ROOM 1]. They attach to already established spatial relations and modify the access chain, adjacency pattern or service capacity of the house. Service units and core-forming units therefore occupy distinct positions in the Datça rule system.

[HALL] appears as a conditional distributive node. It enters the plan when the access chain between [GARDEN] and the enclosed units can no longer be handled directly. In simple cases, [GARDEN] distributes access without mediation; in more complex or vertical cases, [HALL] assumes that role. This pattern explains why [HALL] is analytically important despite its limited recurrence: it marks a shift from direct garden-based access to mediated internal distribution.

Datça plan variation is not random; it follows a legible sequence. [ROOM 1] extends the core, [ROOM 2] differentiates it, [KITCHEN] and [STORAGE] add service capacity, and [HALL] reorganises distribution when plan complexity increases. Figure 2 presents this hierarchy as the core – growth – derivation structure of the Datça plan language. The full formation, articulation and derivation rule table is provided in Appendix C.

4.3. Topological verification through dual-root J-graph indicators

The dual-root J-graph indicators show that the grammar-derived hierarchy corresponds to access and depth relations in the corpus. In every case, mean depth decreases when the root is shifted from Outside to [GARDEN]. Outside-root mean depth ranges from 1.50 to 2.86, whereas Garden-root mean depth ranges from 1.00 to 2.17. This consistent reduction confirms [GARDEN]'s role as the internal distribution surface across the full corpus.

The shallowest configurations are the minimal core cases. Cases 1, 2, 4 and 7 show Outside-root mean depths between 1.50 and 1.67, while their Garden-root mean depth is 1.00. These values indicate that the [GARDEN]–[ROOM 1] relation can organise direct access without mediation. This supports the reading of [GARDEN] and [ROOM 1] as the corpus-wide core.

The deepest configurations appear when [HALL] combines with vertical development. Cases 8 and 12 both reach an Outside-root mean depth of 2.86 and a maximum depth of 4. Case 6, where [HALL] operates horizontally, shows a more moderate profile, with an Outside-root mean depth of 2.20 and a maximum depth of 3. This value is comparable to the more complex non-HALL cases. [HALL] does not automatically produce the deepest configuration, but when it mediates access in vertical or multi-layered cases, it becomes the main distributive device behind topological deepening.

Service units extend depth locally. Cases 3, 5, 11 and 13, which contain [KITCHEN] or [STORAGE], reach a maximum depth of 3. Where [KITCHEN] or [STORAGE] sits between [GARDEN] and the main

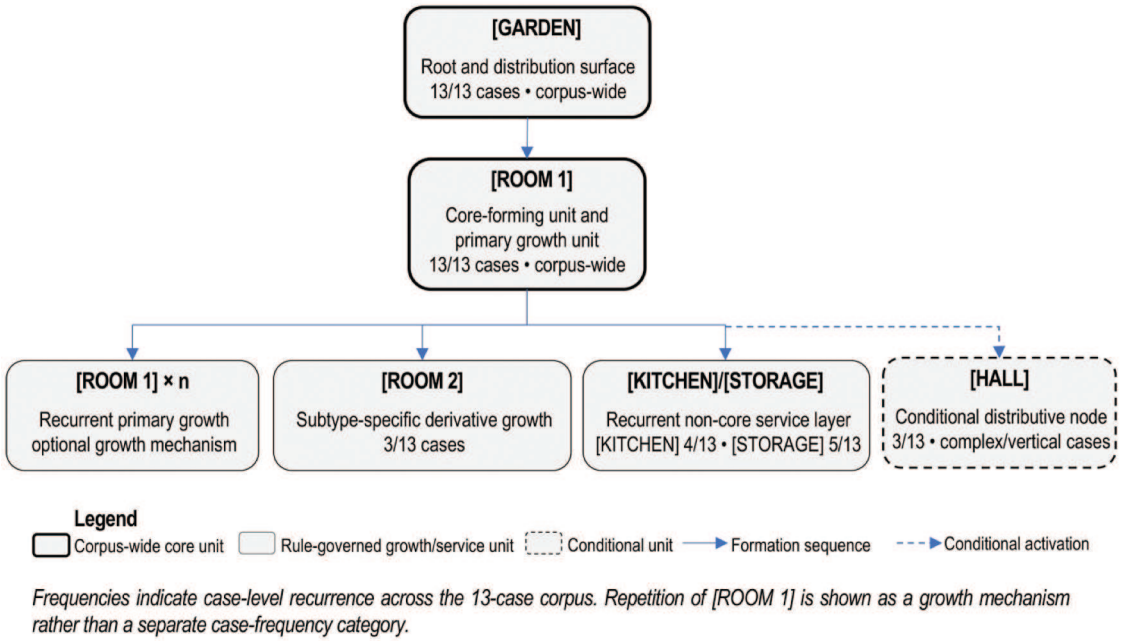


Figure 2. Core–growth–derivation structure of the Datça plan language.

room, it adds one depth step to the access chain. Their mean-depth profile remains closer to the non-HALL baseline than to the deeper [HALL] cases. This supports the distinction between recurrent service units and conditional distributive nodes in the grammar.

Shape grammar explains how the plan is formed; the dual-root J-graph shows how the resulting plan is accessed and distributed. Together, the Datça J-graphs show a shallow, directly distributed core, selective growth, local service-mediated depth and conditional distributive deepening. This profile aligns with the grammar-derived hierarchy.

4.4. Integrated reading of the Datça plan language

The Datça corpus is organised by a core – growth – derivation logic. The [GARDEN]–[ROOM 1] relation establishes the corpus-wide core. Variation begins when this core is extended by repeated [ROOM 1] units, differentiated by [ROOM 2], supplemented by service units, or reorganised by [HALL] in more complex cases.

This structure explains why the corpus contains both repetition and variation. The repeated core gives the plan language its stability; the selective activation of derivative, service and distributive units gives it its variability. The resulting plans are neither identical copies nor unrelated individual solutions. They are variations within a shared grammar.

The J-graph profile adds the topological counterpart to this grammatical reading. Minimal cases retain a shallow garden-based access structure; service units add local depth; and vertically developed [HALL] cases show mediated distribution under greater plan complexity. The topological profile mirrors the grammatical order: core, selective growth, service-mediated depth and conditional distributive deepening.

The Datça plan language is a limited but coherent rule system. It begins with a shallow garden-room core, grows through repeated room units, differentiates through subtype-specific additions, and deepens when distributive mediation becomes necessary. Section 5 uses controlled derivation as a proof-step for testing whether the extracted grammar can produce coherent intra-grammatical variation.

5. Controlled derivation as a methodological proof-step

Controlled derivation serves as a methodological proof-step: it tests whether the extracted grammar can produce coherent intra-grammatical variation. The derivation operates within the corpus grammar. It begins with the [GARDEN]–[ROOM 1] core, activates optional growth, service and distributive rules selectively, and checks whether the resulting configuration remains traceable to the rule hierarchy established in the analysis.

The controlled derivation protocol follows the formation, articulation and derivation rule table provided in Appendix C. T0 and T1 define the mandatory core. T2–T6 form an operational production pool: they may be activated selectively according to the variation being tested, but they do not constitute a mandatory linear sequence. T7–T10 operate as verification steps, checking surface constraints, dual-root J-graph consistency, corpus collision and corpus deviation.

Table 6. Controlled derivation protocol: T0–T10 steps, rule basis, status and analytical function.

T-code	Step / operation	Rule basis	Status	Analytical function
T0	Establish the starting surface with [GARDEN]	R0; E1–E2	Mandatory core	Establishes the open domestic exterior as the root and distribution surface
T1	Establish the first [ROOM 1] core	R1–R2; E3	Mandatory core	Forms the corpus-wide [GARDEN]–[ROOM 1] core
T2	Activate additional [ROOM 1] units	R3; E5–E7	Optional production step	Tests primary growth through repetition of the core-forming unit
T3	Activate [HALL] as a conditional distributive node	R7; E11–E12	Conditional production step	Tests mediated access and internal distribution under greater plan complexity
T4	Activate [ROOM 2] where derivative growth is required	R4; E8	Optional / subtype-specific production step	Tests subtype-specific derivative growth beyond the primary [ROOM 1] layer
T5	Attach [KITCHEN] and/or [STORAGE] as a service layer	R5–R6; E9; E13	Optional service step	Tests service attachment without allowing service units to become core-forming elements
T6	Activate vertical propagation where required	R8a–R8c; E6; E14	Conditional vertical step	Tests upper-floor continuation through grammar-consistent vertical organisation
T7	Check surface and local constraints	E4; E10	Mandatory verification step	Checks whether local adjacency, threshold and surface relations remain valid
T8	Perform dual-root J-graph verification	Dual-root J-graph protocol	Mandatory verification step	Tests whether Root = Outside and Root = Garden readings remain topologically consistent
T9	Perform corpus collision check	Formation, articulation and topological patterns of the 13-case corpus	Mandatory verification step	Checks whether the variation directly reproduces an existing corpus case
T10	Perform corpus deviation check	Appendix C rule set	Mandatory verification step	Checks whether the variation remains within the formation, articulation and constraint logic of the grammar

The controlled variation configurations and derivation-check tables are provided in Appendix D.

5.1. Operational protocol and validity framework

Table 6 summarises the T0–T10 protocol used for controlled derivation. The table identifies the rule basis, status and analytical function of each step. This protocol ensures traceability to the extracted rule set.

Figure 3 shows the controlled derivation protocol as a visual sequence. It distinguishes the mandatory core, the operational production pool, the verification steps and the final in-grammar acceptance or revision loop.

5.2. Comparative assessment of controlled variations

The three controlled variations test the protocol through different levels of rule activation, unit density and configuration complexity. Each starts from the same [GARDEN]–[ROOM 1] core. Variation 1 activates a selective subset of the production pool, while Variations 2 and 3 activate the full production pool at different levels of density and configuration complexity. Detailed variation configuration and step tables are provided in Appendix D. Figures 4–6 show the resulting configurations and their dual-root readings.

5.2.1. Variation 1: core-oriented controlled variation

Variation 1 demonstrates a low-mediation configuration. The active production steps are T0, T1, T2, T4 and T5; T3 and T6 remain inactive. The mandatory [GARDEN]–[ROOM 1] core is established first; additional [ROOM 1] units extend the primary growth layer; [ROOM 2] adds subtype-specific derivative growth; and [KITCHEN] / [STORAGE] operate as service units. Distribution remains garden-based and single-level. Variation 1 shows that primary growth, derivative [ROOM 2] additions and service attachment operate within the grammar when [GARDEN] handles distribution directly.

5.2.2. Variation 2: hall-mediated vertical extension

Variation 2 examines a configuration in which all production steps are active but unit density remains controlled. All production steps are active: T0–T6. After the [GARDEN]–[ROOM 1] core is established, additional [ROOM 1] units extend the primary growth layer. [HALL] operates as a conditional distributive node, [ROOM 2] adds a derivative unit, [KITCHEN] activates the service layer, and vertical propagation extends the same rule set to the upper floor. The upper floor follows the ground-floor grammar through [HALL]-mediated vertical propagation. The dual-root readings show how [HALL] increases depth while [GARDEN] retains its root status in the overall house system.

5.2.3. Variation 3: complex derivative growth

Variation 3 activates the same production steps as Variation 2 (T0–T6) but combines them at maximum unit density and configuration complexity. T7–T10 operate as verification steps for surface constraints, dual-root J-graph consistency, corpus collision and corpus deviation.

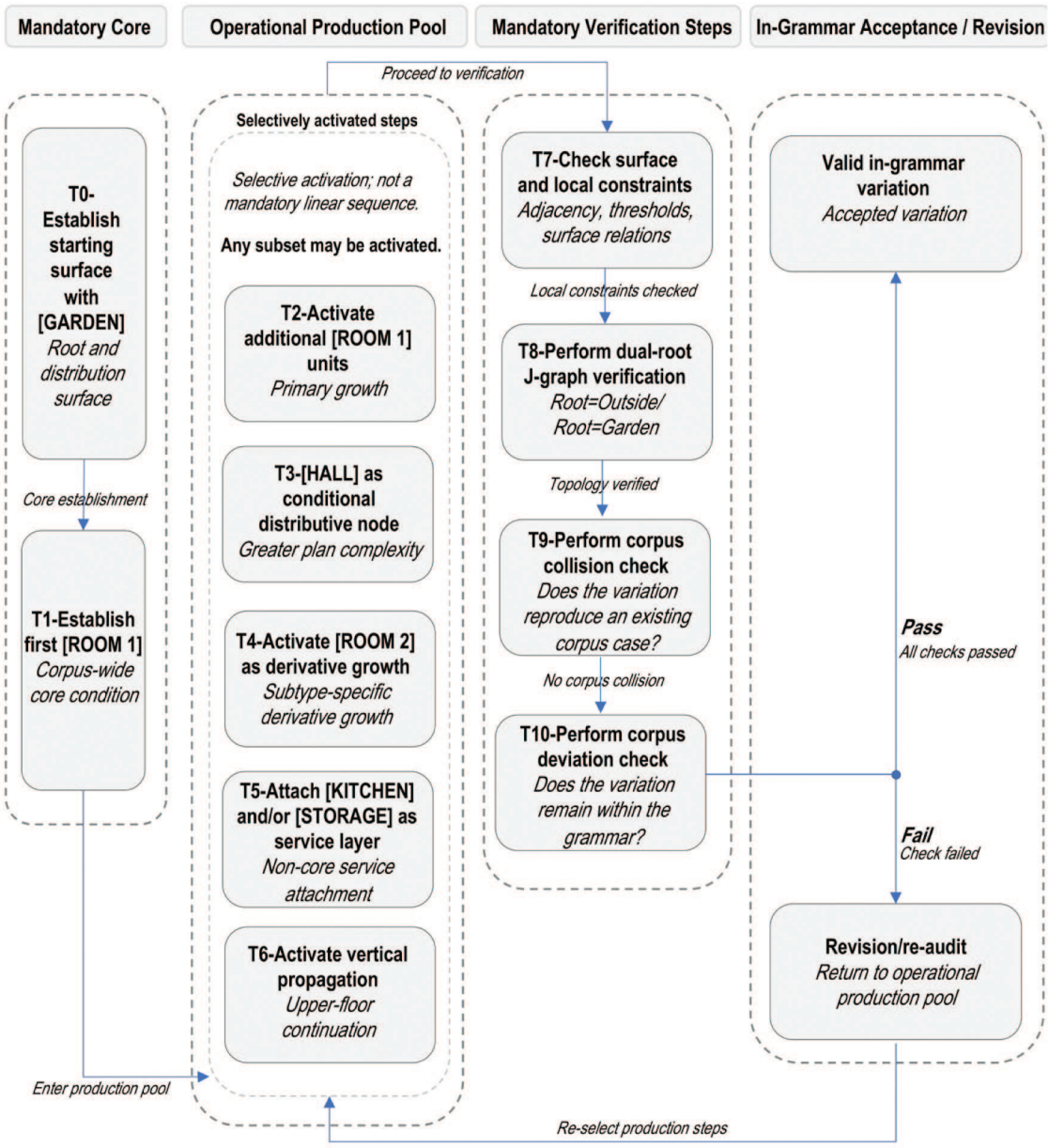


Figure 3. Controlled derivation protocol for testing intra-grammatical variation.

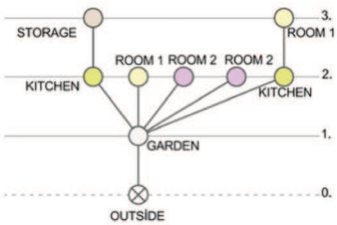
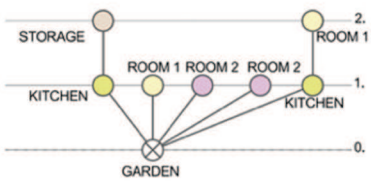
NO	SHAPE GRAMMAR	J-GRAPH	
	Ground Floor	Root=Outside	Root=Garden
V1			

Figure 4. Variation 1: core-oriented controlled variation with root = Outside and root = garden readings.

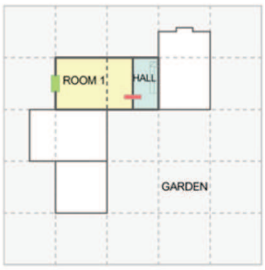
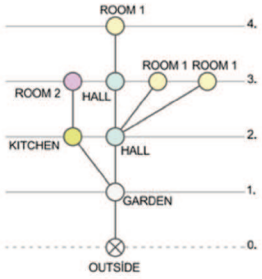
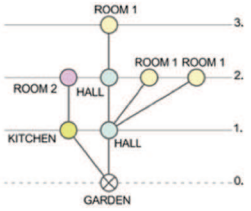
NO	SHAPE GRAMMAR		J-GRAPH	
	Ground Floor	Upper Floor	Root=Outside	Root=Garden
V2				

Figure 5. Variation 2: hall-mediated vertical extension with root = Outside and root = garden readings.

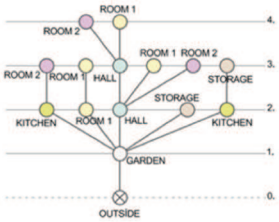
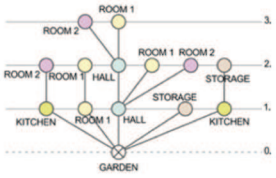
NO	SHAPE GRAMMAR		J-GRAPH	
	Ground Floor	Upper Floor	Root=Outside	Root=Garden
V3				

Figure 6. Variation 3: complex derivative growth with root = Outside and root = garden readings.

Variation 3 combines the mandatory core, primary [ROOM 1] growth, [HALL]-mediated distribution, multiple [ROOM 2] derivative units, service attachment through [KITCHEN] and [STORAGE], and vertical propagation in a single configuration. Even at this density level, the grammar remains internally consistent: no unit assumes a role outside its defined position in the rule hierarchy. Variation 3 is the most demanding configuration the grammar is asked to sustain.

5.3. Comparative summary

The three controlled variations show how the same rule system operates under increasing levels of rule activation, unit density and configuration complexity. Variation 1 uses a selective production profile: the core, primary growth, derivative growth and service attachment are active, while [HALL] and vertical propagation remain inactive. Variation 2 activates the full production pool at controlled density: [HALL], one [ROOM 2], one [KITCHEN] and vertical continuation are combined without multiplying derivative or service units. Variation 3 activates the same production range at maximum density and configuration complexity.

Across all three derivations, the grammar keeps the roles of core, growth, derivative, service and distribution stable, regardless of configuration density. Increasing complexity therefore changes the density of the configuration, not the internal role structure of the grammar.

T9 and T10 confirm the proof-step outcome. None of the three variations reproduces an existing corpus case. Each remains within the formation, articulation and constraint logic established by the extracted grammar. The controlled derivations confirm that the extracted grammar is generative within its own rule system: variation increases, while the internal role structure remains intact.

6. Discussion

6.1. Datça plan language as core–growth–derivation

The Datça corpus is best understood through a core – growth – derivation structure. The findings show

a stable [GARDEN]–[ROOM 1] core and a set of selective layers that extend, differentiate, serve or mediate this core. This reading builds on shape grammar studies that treat architectural form as a system of vocabularies, relations and rules, grounding that system in a documented local corpus (Çağdaş 1996; Duarte 2005; Wang, Zhang, and Fan 2024).

The key finding is the double role of [ROOM 1]. It establishes the first enclosed component in every case and also functions as the main unit through which primary growth occurs. This double role of initiating the core and driving its expansion makes [ROOM 1] structurally central in the Datça grammar. [ROOM 2] appears in three cases, so its significance does not depend on corpus-wide recurrence. Its role is positional: it marks derivative growth after the [GARDEN]–[ROOM 1] core has been established. This distinction connects the Datça material to broader studies of domestic spatial evolution, where plan change is read through recurring configurational adjustments rather than isolated typological variation (Krauth 2021).

Service and distribution also operate through differentiated roles. [KITCHEN] appears in four cases and [STORAGE] in five, indicating a recurrent non-core service layer. These units attach to already established spatial relations and increase service capacity without initiating the plan. [HALL] appears in three cases and becomes significant when access requires mediation, especially in vertical or more complex configurations. This conditional role differs from sofa-centred layouts in traditional Turkish houses, where the sofa can function as a primary internal distributor from the outset (Çağdaş 1996). The grammar's structure lies in the sequencing and conditional activation of these units, beyond their simple co-presence.

This interpretation refines existing Datça documentation. Earlier studies identify the single-room core, garden-house-street relations, settlement fabric and rural conservation context (Başoğlan 2001; İşcanı 2016; Naycı 2012; Uyan 2011). The present analysis adds a rule-based reading to that documentary basis. It shows that stability and variation in the Datça corpus are produced by the same grammar: a stable garden-room core and selective layers of growth, service and distribution.

6.2. Open domestic exterior, access hierarchy and local context

The significance of [GARDEN] lies in its combined recurrence, position and topological effect. It appears in every case and forms the surface through which movement enters the domestic system. This supports local descriptions of Reşadiye and Hızırşah houses, where the garden-house-street relation frames the single-room core and its later additions (Başoğlan 2001; İşcanı 2016; Naycı 2012; Uyan 2011). In this sense, [GARDEN] is best understood as a local open domestic exterior: a threshold surface that links street, plot and enclosed dwelling.

The J-graph readings add a topological interpretation to this local relation. They position [GARDEN] as the main internal reference point of the domestic system across both minimal and more complex cases. Minimal core cases retain direct garden-room access; deeper cases show how [HALL] mediates access when plan complexity or vertical development increases. In both conditions, [GARDEN] remains the spatial surface through which internal distribution is reorganised.

Privacy in the Datça plan language is a gradient of access depth, not a binary division. The sequence from street to open exterior to enclosed core establishes a threshold logic that deepens selectively through derivative, service or [HALL]-mediated spaces. This is a spatial-access interpretation of privacy, not a behavioural or ethnographic claim. It aligns with studies that read domestic hierarchy through depth, threshold order and open-space mediation, while retaining the local specificity of the Datça garden-house-street relation (Alitajer and Nojoumi 2016; Alnaim 2023; Barkat, Bada, and Güney 2021; Borg and Bianco 2025).

The local context also explains why environmental adaptation is treated as contextual interpretation. The open domestic exterior may support daily use, service work, ventilation and shaded transition in the Datça vernacular setting. Thermal or climatic performance remains outside the evidence base of this study. The Datça open domestic exterior is therefore the spatial unit from which the plan language begins, a finding supported by rule extraction and topological verification.

6.3. Methodological contribution, practical use and limits

The study contributes an asymmetric analytical model that links rule extraction, topological verification and controlled derivation. Shape grammar extracts the rule vocabulary; dual-root J-graph reading verifies whether those rules correspond to access and distribution patterns; and controlled derivation tests the grammar's internal coherence. This layered structure extends earlier work combining grammatical and configurational approaches by applying the integration to a documented vernacular corpus (Heitor, Duarte, and Pinto 2004; Lee, Ostwald, and Gu 2015, 2016; Ostwald 2011).

The model is useful for analytical documentation and conservation-oriented interpretation. It identifies which spatial relations are core, which are recurrent but non-core, and which appear only under specific conditions. This distinction makes rule-based variation legible within the corpus and separates it from

additions that fall outside the grammar. For conservation studies, the value lies in reading local housing not only as a set of plan types but as a system of relations that explains why those plans belong to the same local language. For comparative vernacular research, the model offers a repeatable way to compare corpora through units, rules and topological checks.

The contribution is corpus-specific and analytically scoped. The corpus is plan-based and bounded by available documentation; it supports analytical interpretation, not statistical generalisation, full space syntax analysis or environmental performance claims. These boundaries define what the model can and cannot be asked to do. Within these limits, the model provides a corpus-based framework for reading the Datça plan language as a rule-governed spatial system.

7. Conclusion

This study asked what rules govern the plan language of traditional Datça houses and how their topological consistency can be verified through dual-root J-graph reading. The findings show that the documented Reşadiye/Datça corpus can be read as a rule-governed plan language structured by a core – growth – derivation logic. The [GARDEN]–[ROOM 1] relation forms the corpus-wide core. [ROOM 1] also carries primary growth, while [ROOM 2] operates as a subtype-specific derivative unit. [KITCHEN] and [STORAGE] form a recurrent non-core service layer, and [HALL] acts as a conditional distributive node in more complex or vertical configurations.

The analytical propositions guiding the study are supported by the combined grammar and J-graph readings. The grammar identifies the sequence and status of the spatial units; the dual-root J-graph readings show that this grammar corresponds to access, depth and distribution patterns. The J-graph readings validate the grammatical hierarchy identified in Section 4: a stable open-exterior core, selective growth and conditional distributive deepening.

Controlled derivation further tested this interpretation. The three controlled variations show that the extracted grammar can produce coherent intra-grammatical variation without reproducing an existing corpus case or leaving the rule system. This proof-step clarifies the operative range of the grammar. Variation increases configuration density without altering the internal role structure of the grammar.

The main contribution of the article is methodological and interpretive. The combination of shape grammar and dual-root J-graph reading clarifies a relationship that neither method captures on its own: how the Datça plan is formed and how it is accessed. Shape grammar explains how the plan is formed; J-graph reading verifies how the plan is accessed and distributed. This integration moves the study of Datça vernacular houses beyond descriptive typology and towards a traceable reading of plan-language formation.

The study is plan-based and analytically scoped; its claims remain corpus-specific and interpretive. Statistical generalisation, full three-dimensional form and environmental performance require separate evidence bases. Future research can test the model's comparative reach: whether the same core – growth – derivation logic applies to other Aegean or Mediterranean vernacular corpora.

Author contributions

Kadir ÖZ contributed to the conception and design of the study, the methodological framework, the analysis and interpretation of the data, and the drafting of the manuscript. Meliha Havva ÖZ contributed to the methodological development, validation of the analytical framework, interpretation of the data, and critical revision of the manuscript for important intellectual content. Both authors contributed to revising the paper critically, approved the final version to be published, and agree to be accountable for all aspects of the work.

Disclosure statement

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Data availability statement

No new dataset was generated; the analytical corpus was derived from published/archival/local thesis plan materials.

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