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THE EFFECT OF HOUSE PLAN TYPES ON HOUSE PLAN USAGE PATTERN TRANSITIONS IN UPPER MIDDLE-CLASS RESIDENCES: CASE IN ANIWATTE, KANDY

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ABSTRACT

This research aims to explore the effect of house plan types on residents' spatial usage pattern transitions over time with reference to upper-middle-class suburban residences, with a case study of Aniwatte East, Kandy. The houses are intended as permanent architectural forms, the extended period of occupancy results in a change of spatial intensity and spatial usage. The study is limited to upper-middle-class suburban houses in Kandy, as this specific socio-economic and contextual category remains underexplored in research. Through literature review physical parameters which affect house plan and the social parameters which affect usage patterns were identified. This research used a mixed-method approach for the case study of ten houses. Spatial data and usage data were collected via measured drawings, observations, and photographic records and interviews with the residents. The houses were analyzed across three phases, from the original plan, early occupancy, and current status, using both physical factors related to circulation, spatial utilization, material adaptability, durability, and furniture arrangement, analyzing with temporal parameters addressing the interval and frequency of house type transformation. The research identified six house types based on space use intensity. The results showed a trend from higher to lower intensity of use, indicated by the centralization of daily activities within a functional zone and increasing dormancy of peripheral areas. This change occurs mainly through interior rearrangement rather than structural alterations, preserving the original architectural form. The study provides insights for architects and housing professionals to create more adaptable and sustainable homes for upper-middle-class suburban residents.

Keywords: *Residences, Transition, Upper-Middle-Class, Suburban, Kandy*

1. INTRODUCTION

The study explores the realization and aspiration of house types through the transition between the initial and final house-type conditions and their usage patterns. Architecture in suburban Sri Lankan residences is influenced by cultural aspirations and values. Architecture in suburban areas such as Aniwatte, near Kandy, upper middle-class houses have often been designed as permanent objects, as opposed to meeting changing family

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needs. This dichotomy between static design and changing household that there is space for improvement in terms of architectural adaptability, whereby houses may change in usage patterns while their physical structures remain unchanged. This can be better understood by examining these houses as multi-level entities consisting of frameworks, replaceable parts, and furniture.

The main concern of this study is that these suburban houses are static structures that, although meeting short-term needs, are not flexible enough to adapt to long-term needs. This means that as family needs change, such as in the case of reduced family size, these homes may remain unchanged, leading to inefficiencies. The lack of intrinsic flexibility could also cause problems in the utilization of space and energy. For example, unused rooms could be underutilized, and the core spaces become cramped. identifying this, the current research aims to examine how the physical design of the UMC houses of Aniwatte facilitates adaptability. The literature on Sri Lankan housing, mainly focuses on low-income settlements or informal sectors (Warakapitiya *et al*., 2024), and there are few studies on houses in the upper middle class in suburban areas. As far as, the literature does not include all the dimensions of physical design, such as spatial configuration, volumetric properties, and materials and their transitions.

For the present research, a mixed-methods case study approach was employed to achieve the objectives, focusing on ten upper middle-class houses in Aniwatte East, Kandy. The data collection combined architectural plan analysis, on-site observation, archival records, and resident interviews (to track spatial changes). The selected houses were analysed at three stages of evolution: the original design (Design stage), early occupation (changes during construction stage), and the current stage (changes during usage).

1.1 RESEARCH AIM AND OBJECTIVES

The research aim is to examine how different house plan types influence the transition patterns of house plan usage over time in upper middle-class residences. The objectives of the study are: (i) to examine the spatial, volumetric, and material configurations of the selected houses; (ii) to identify the parameters of house plan elements, and transition; and (iii) to investigate the realization and aspiration of house types through the usage transition. The overall objective of the study is to improve the typology of house plans and thus enhance the flexibility of future house designs.

1.2 SCOPE AND LIMITATIONS

The proposed study will be limited to the upper-middle-class residential houses in Aniwatte East, a suburban area of Kandy. The proposed study will also be limited to the suburban area of Kandy and will thus exclude the lower-income groups of the population. The proposed study will also be limited to ten selected houses, and the period of transition will be around thirty-five years, so the findings are context-specific and not broadly generalizable. The proposed study will thus enable the researchers to compare the selected houses and thus analyze the spatial changes and usage patterns of the selected houses. The limitations caused by having only ten case study houses were mitigated by selecting a diverse set of cases (varying in construction period, family size and plan type), giving a proper cross section of the houses in the selected case study area. Since the typical case-study limitations remain, the results describe only the sampled cases. Therefore, the study findings are limited to similar socio-economic and geographic settings only.

2. LITERATURE REVIEW ON RESIDENTIAL ARCHITECTURE AND USAGE PATTERNS

House plans are dynamic spatial frameworks that change over time in response to evolving functional and social needs. Theories by Rapoport, Lawrence, Habraken, and Brand explain that while the structural shell remains stable, interior spaces adapt through reconfiguration and changing use. Flexible housing concepts further emphasize the importance of adaptability for long-term residential performance.

Family life-cycle changes significantly influence how domestic spaces are used over time. Events such as children growing up, migration, ageing, and reduced household size shift daily routines and cause some spaces to become underused while others remain active. Thus, house plan usage transition is shaped by both the architectural framework and changing family behaviors.

2.1 THEORETICAL FRAMEWORK

The study is based on a theoretical framework where architecture is treated as a dimension independent of other factors. The study is centred on the physical aspects of dwelling units, focusing on form, spatial interconnection, materials, and interior fit-out, using layered readings and their transition over time (Lawrence, 1987; Rapoport, 1969). This is achieved by means of plans, sectional drawings, diagrams, tables, etc., based on six basic parameters (P1-P6). The parameters P1-P4 analyse the spatial connection, materiality, and interior arrangement based on hierarchical levels such as primary structure, secondary structure, and furniture. The parameters P5-P6 analyse the temporal progression by focusing on the interval and periodicity of spatial and interior changes.

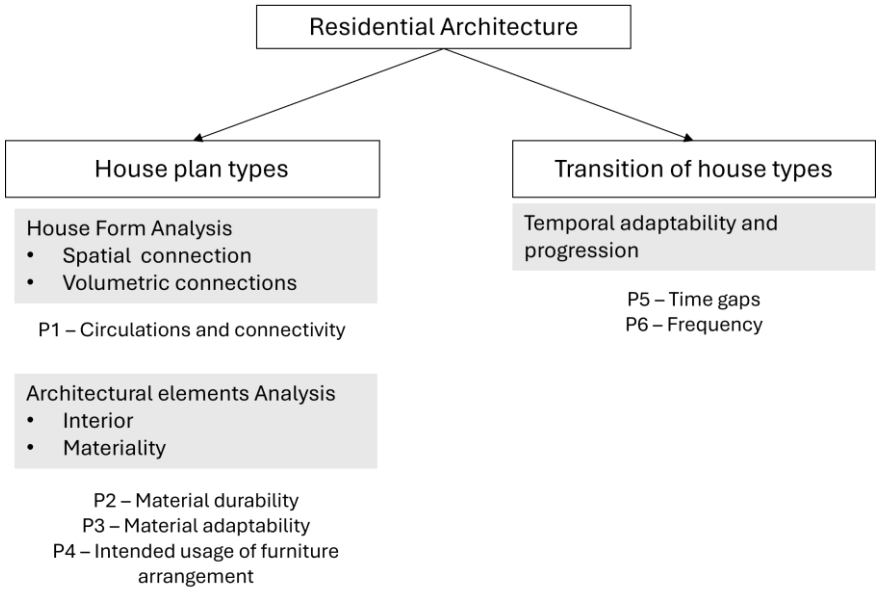


Figure 1: Theoretical framework of the study

2.2 PARAMETERS THAT AFFECT HOUSES PLAN TYPES

In accordance with the above framework, the following architectural parameters (P1–P4) and temporal parameters (P5–P6) were used to analyse the transitions:

Table 1: Theory – Matrix chart for architectural parameters

Analytical focus	Spatial connection		Materiality	Interior	House type transition	
Theory – parameters	**P1 – Circulation and space usage**	**P2 – Material adaptability**	**P3 – Material durability**	**P4 – Intended usage of furniture arrangement**	**P5 – Time Gaps**	**P6 – Frequency**
Family Life Cycle / Development (Lawson, 1988)	✓ family routines reconfigure routes	✓ spaces shift across life stages	✓ families prioritize durable elements	✓ furniture/layout adapts with family	✓ family stages, spatial transition	✓ recurring adjustments across stages
Open Building (Habraken, 1998)	✓ support infill allows plan change	✓ Building objective	✓ base/supports emphasise longevity	✓ infill and furniture easily modified	✓ long-term phased change	✓ infill systems - over time
Shearing Layers of Change (Brand, 1994)	✓ Changing active circulation patterns	✓ Adaptable material layers	✓ layered durability	✓ Frequent interior adaptations	✗	✗
Typology & Spatial Org (Panerai *et al*., 2004)	✓ typological ordering shapes movement	✓ typology can embed flexible modules	✓ typological endurance supports longevity	✓ interior hierarchy informs furnishing	✓ typological - historical periods	✗
Flexible Housing (Schneider & Till, 2005; Till & Schneider, 2012)	✓ designs allow adaptable paths	✓ central to flexible housing discourse	✗	✓ reconfigurable furniture recommended	✓ temporal adaptability	✓ flexibility capacity for repeated change
Materiality & Details (Brownell, 2014; Zumthor, 2006)	✗	✓ details enable reversible adaptation	✓ craft, finishes and longevity are central	✓ details and finishes shape usability and longevity	✗	✗

P1: Circulation and Space Usage – This parameter examines the relationship between the circulation and the utilization of the space. This parameter assesses how the circulation crosses the space. The interconnections of the space influenced daily routines. The more efficient, direct, and uninterrupted the circulation is, the more the space can be utilized. Fragmented circulation can result in isolated spaces with low functional potential.

P2: Material Adaptability – This parameter assesses the adaptability of the materials used in the space. Material adaptability allows reversible modifications, making it

possible to easily reinterpret spaces. Robust, warm finishes make it easier to adapt spaces, whereas rigid, fixed materials limit flexibility (Habraken, 1998). Material adaptability defines in the study ability to accommodate changing family needs (Schneider & Till, 2005; Till & Schneider, 2012).

P3: Material Durability – This parameter assesses the durability of the space. Durable space can be achieved by making sure the materials are strong. Strong materials can be used to make the interior. This can be achieved by using strong materials such as wood. On the other hand, a non-durable space can be abandoned due to the high cost of maintaining the space (Lawson, 1988).

P4: Furniture Arrangement – This parameter assesses the dynamic layer of the interior. Spaces that are constantly being rearranged are considered to have evolved (Panerai *et al.*, 2004). Adaptation is considered as A1 extensive change, A2 moderate change, and A3 minimal change. Adaptation is considered to have taken place when the interior is being constantly rearranged (Brownell, 2014; Zumthor, 2006).

P5: Time gap - This parameter assesses the time gap between the stages of spatial or functional transformation of the dwelling. This parameter assesses the period during which a spatial or functional transformation occurs.

P6: Frequency - This parameter assesses the recurrence of adaptive interventions within a defined time span. It considers how often spatial reorganization, material modification, or furniture rearrangement takes place within the architectural framework. Higher frequency reflects a greater capacity for repeated adjustment, while lower frequency indicates relative stability in spatial and interior conditions.

3. RESEARCH METHODOLOGY OF CASE STUDIES ON SELECTED HOUSES IN ANIWATTE

In addition, this section identifies the methodology applied in assessing the temporal evolution in selected upper middle-class houses in Aniwatte East. Ten houses with extended occupancy were used as a case study in assessing architectural evolution in Aniwatte East. The methodology applied in assessing architectural evolution is based on in-depth architectural analysis, which includes house plans, sections, site analysis, photographs, interviews, and sketches. Furthermore, this section identifies the basis on which the case houses were selected, a general overview of Aniwatte, and the methodology applied in assessing architectural transformations. All these methodologies form a basis for analyzing the dynamism of spaces (Habraken, 1998).

3.1 CASE STUDY SELECTION CRITERIA AND AREA

Kandy is a compact city with a limited core of residential areas, resulting in a high proportion of upper-middle class residents and professionals (doctors, engineers, etc.) living in proximate suburbs. Aniwatte East is one such area, with a population of approximately 1,200 people, divided into 245 households. It is approximately 2.5 kilometres from the city core. This has resulted in a large number of houses being under-occupied or rented out. This trend, where a house has fewer occupants, is the backdrop for this study on the role of architectural design. Ten upper-middle-class residential buildings, constructed or occupied between 1990 and 2010, were purposively selected to allow for depth analysis, depending on the willingness of the owners to allow access to

architectural plans, renovation histories, and interviews. Although the buildings have similar architectural features to those in the region, they vary in terms of plot size, floor numbers, roofing materials, and renovation levels, which allow for comparative analysis of differing architectural responses to similar residential conditions. Aniwatte East, 2.5 km from the center of Kandy, is a green suburb in close proximity to major schools and hospitals.

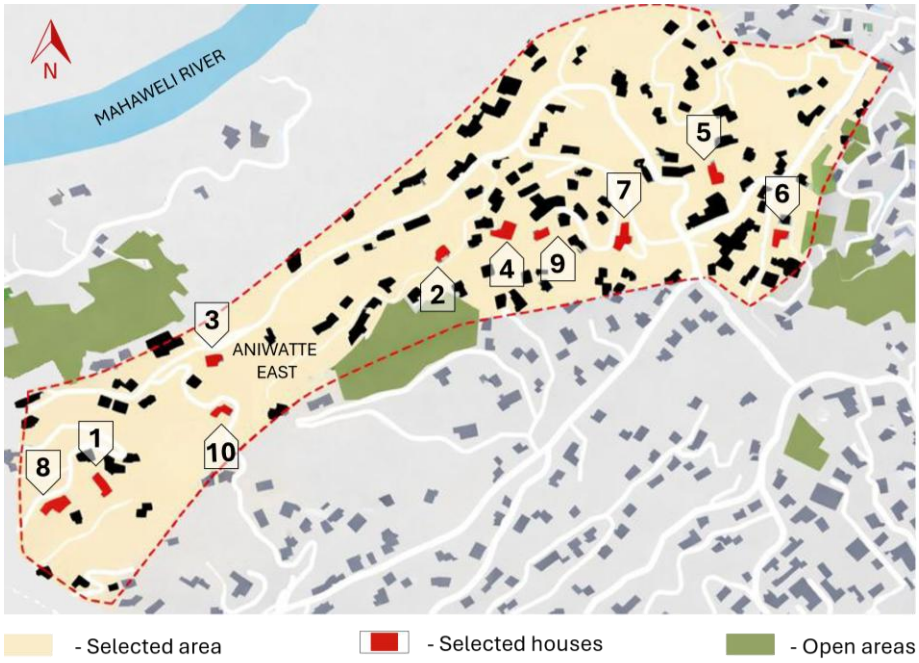


Figure 2: Selected houses in Aniwatte east

The study adopted a mixed-method case study approach representation of varying house plan configurations and house plan usage transitions. Semi-structured interviews were conducted with residents to document family life-course progression, spatial usage changes, renovation history, and reasons for physical adaptations. Qualitative data from interviews, observations, photographs, and archival records were integrated with quantitative comparative analysis through plan overlays, temporal transition charts, count-based change assessment across parameters (P1–P4), and cross-case typological classification, enabling both physical transition patterns and socio-demographic influences to be systematically interpreted.

3.2 METHODOLOGICAL FRAMEWORK

The methodology is based on the study of house changes and is structured into two analytical components: physical configuration analysis and temporal usage progression analysis. The first component includes house plan analysis and architectural elements analysis, which focuses on spatial connections, materiality, and interiority through readings of layers (P1-P4).

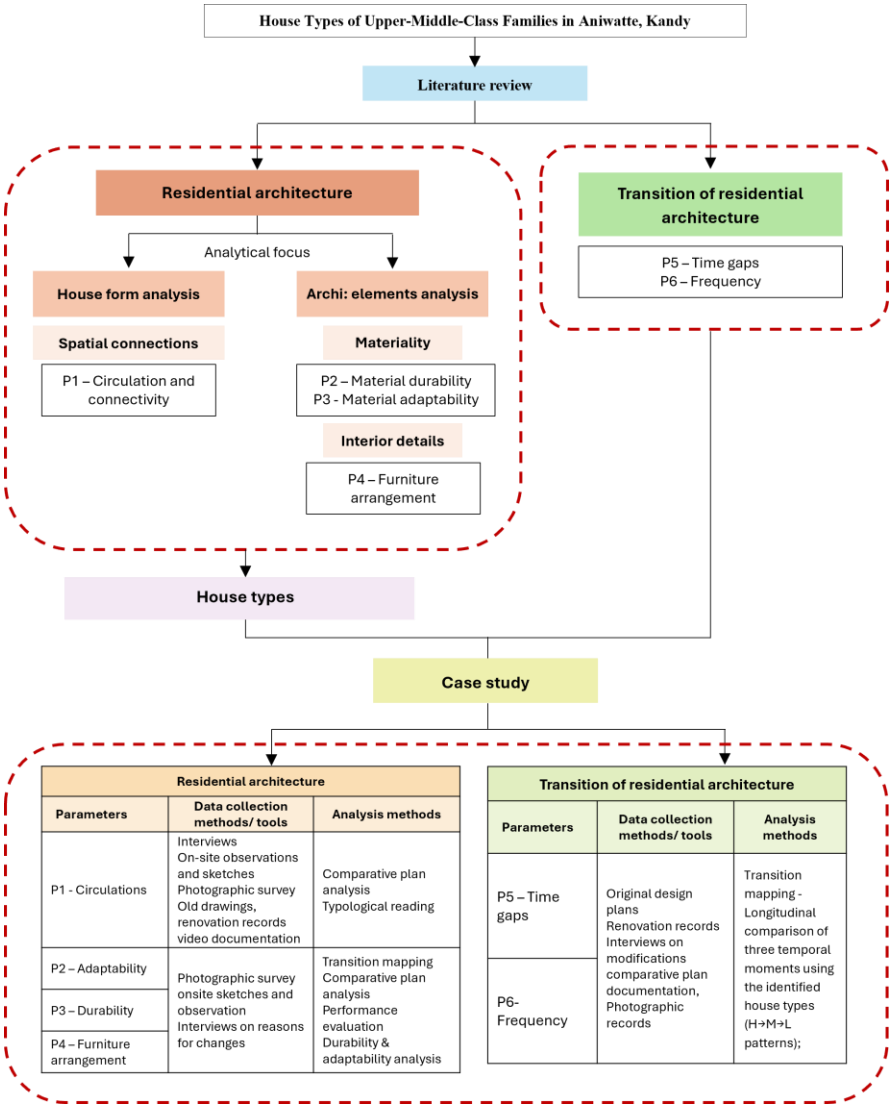


Figure 3: Research design, methodological framework

The data collection process is based on documentary study, direct observation, visual recording, architectural plans, and testimonies of inhabitants that identify the designed house and the house in use through interviews and walk-through documentation. The second component research temporal adaptability (P5-P6) by means of the chronological analysis of three temporal moments and identified house types across time bands. The analytical methods consist of comparative plan analysis, typological analysis, transition analysis, and interval/occurrence analysis.

3.2.1 House Plan and Architectural Elements Analysis

The focus of this phase analyses how each selected house's physical spatial configuration is organized and how it supports adaptation. The house is considered as a largely static structure composed of layered elements. Three points in time are examined: the initial design or purchase, an early phase of occupancy, and the current state. At each of these points, the floor plan and section are coded to show the locations of circulation cores, space utilization, materiality, and interior arrangement. Using the physical parameters

(P1–P4), spatial connection, material adaptability, material durability, and furniture arrangement are evaluated, establishing the basis for house-type identification.

3.2.2 House-Type Transition and Temporal Usage Progression

This section is focused on the determination of house type progress across the time. In this case, the residences are seen as a mostly static structural framework with varying uses. A comparative examination of the same triad of time moments is conducted to identify the progression of the types of houses. Through the use of the time parameters (P5–P6), the time gap between the stages and the periodicity of spatial and interior changes are evaluated. In this phase, the connection between the physical configuration and the time adaptability of the spatial usage is solidified.

4. RESEARCH RESULTS

4.1 ANALYSIS OF HOUSE TYPES OF SELECTED FAMILIES

This area is focused on the architectural analysis of the selected upper middle-class houses. In this case, the analysis is conducted from the architectural or physical point of view by examining how the built form is configured and how its internal spatial connectivity evolves across three phases: the design or buying stage, the early occupation phase, and the current phase. The focus is the house as an architectural object, addressing, the dynamism of spaces, the materiality, adaptability, furniture arrangement and the layers of the fabric and the fit-out that define the level of physical change that is possible over time are examined (Brand, 1994; Habraken, 1998). In this analysis, the built form is examined as a hierarchy of physically distinct layers. As a key finding, the selected upper-middle-class houses demonstrate low material and furniture adaptability, as durable permanent elements such as teak and jack furniture limit future reconfiguration despite their long-term usability. In this area, the primary layer is comprised of the structural plan framework, the partitions, the floor plates, and the roof. The secondary layer is comprised of the fixed but replaceable items such as the joinery, the window systems, and the cabinetry.

The classification of house types into High (H), Moderate (M), and Low (L) usage was developed through a comparative count-based analysis rather than descriptive interpretation. Across parameters P1–P4, separate horizontal timeline bar charts were used to track functional changes, material adaptability, material durability, and furniture arrangement across the three stages. Based on the cumulative frequency of observed changes, houses were classified as Low (0–2 changes), Moderate (3–5 changes), and High (>5 changes), providing a more consistent and reproducible basis for typological classification.

4.1.1 House Types of Classification and Analysis

On the basis of the above analysis, houses were classified into six types based on two axes. The first axis (H/M/L) reflects overall spatial utilization (P1), where:

- H (High usage - > 5 changes): Many rooms are actively used daily. The circulation network is clear and multi-nodal.
- M (Moderate usage - 3-5 changes): Contraction is partial. Activity centers are concentrated primarily in key areas (living, kitchen), with some peripheral areas used to a less use.

- L (Low usage - 0-2 changes): Activity is concentrated in a few core rooms. Significantly large areas of the plan are dormant, often including large areas of upper floors and/or formal spaces.

The second axis (A1/A2/A3) reflects interior adaptation (P4), where:

- A1 (High adaptation - > 5 changes): Rooms have been substantially refurnished.
- A2 (Moderate adaptation - 3-5 changes): Moderate interior rearrangement. Furniture has been moved and/or added.
- A3 (Low adaptation - 0-2 changes): Rooms have not been refurnished. Original furniture layouts remain essentially intact.

Combining these yields the six empirical house types: H-A3, H-A2, M-A2, M-A1, L-A2, L-A1. Each type captures both spatial intensity and degree of interior change.

Table 2: House Type Classification and Analysis

Case no.	Parameters				Type
	P1	P2	P3	P4	
01					H – A2
02					H – A3
03					H – A2
04					M – A2
05					M – A2
06					M – A1
07					L – A2
08					L – A2
09					L – A1
10					L – A1

- High, - Moderate, - Low, **H** – Highly functioning , **M** – moderate functioning, **L** – Lower functioning, **A1** – Higher intended usage, **A2** – Moderate intended usage, **A3** – Lower intended usage, - **H-A2** (Higher circulation and space usage moderate intended usage of furniture arrangement), - **H-A3** (Higher circulation and space usage low intended usage of furniture arrangement), - **M-A1** (Moderate circulation and space usage high intended usage of furniture arrangement), - **M-A2** (Moderate circulation and space usage moderate intended usage of furniture arrangement), - **M-A3** (Moderate circulation and space usage low intended usage of furniture arrangement), - **L-A1** (Low circulation and space usage high intended usage of furniture arrangement), - **L-A2** (Low circulation and space usage moderate intended usage of furniture arrangement)

4.1.2.1 House Type 01: H-A3

For H-A3 residences, circulation is highly efficient and nearly all areas are used. The floor plan is integrated, with the kitchen, living room, and master bedroom well-connected. “A3” indicates that furniture remains in its original configuration (original seating, beds, storage intact), with only minor adjustments in placement. Thus, H-A3 is marked by high utilization and minimal interior change.

4.1.2.2 House Type 02: H-A2

H-A2 residences also have active circulation and core areas acting as hubs but show moderate interior change. “A2” means one or two room usage changes (e.g. an extra bedroom converted into an office). These homes still have multi-room circulation, with stage-2 furniture rearrangements or additions, while the overall space configuration remains unchanged.

4.1.2.3 House Type 03: M-A2

M-A2 residences have partially functioning circulation. The main living core (entrance, living/dining, kitchen) is used daily, while many secondary areas (formal living, formal dining, upper-floor guest rooms) are underutilized. Vertical circulation remains, but many corridors end as dead ends. “P4 = A2” indicates moderate furniture changes (such as adding chairs in underused spaces) without significant room reconfiguration.

4.1.2.4 House Type 04: M-A1

Circulation in M-A1 is similar to M-A2 but with significant levels of interior adaptation. “A1” refers to the full repurposing and furnishing of idle spaces. In this type, the exterior remains the same, but the interior is adapted in stages with the addition of new pieces of furniture and cabinetry. Thus, M-A1 houses combine moderate levels of circulation efficiency with high levels of interior adaptation.

4.1.2.5 House Type 05: L-A2

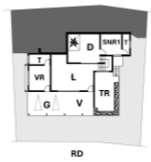
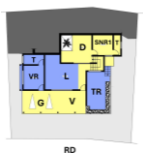
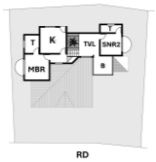
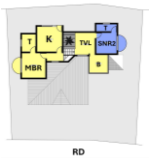
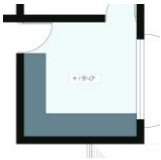
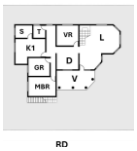
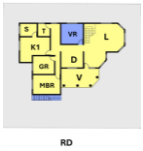
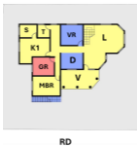
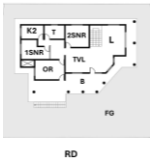
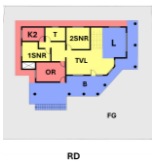
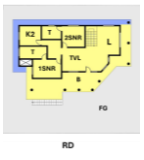
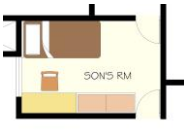
L-A2 houses have higher fragmentation, with the majority of the spaces, particularly on the upper levels and core, idle and disconnected. daily movement is confined to the designated spaces on the ground level, such as the kitchen, living room, or master bedroom. “P4 = A2” refers to moderate levels of adaptation. In this type, the idle spaces may be repurposed or reassigned. For example, the idle bedroom may be converted into a storage room. Thus, L-A2 houses combine low levels of spatial efficiency with moderate levels of interior change.

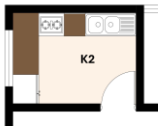
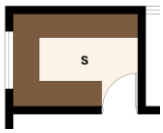
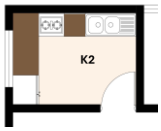
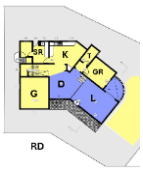
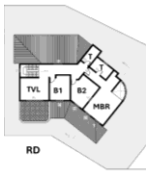
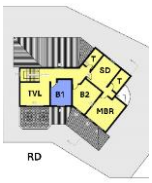
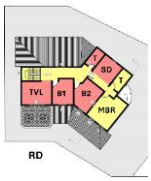
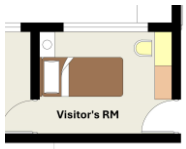
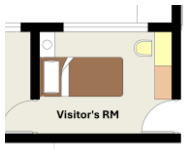
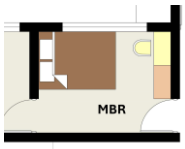
4.1.2.6 House Type 06: L-A1

L-A1 houses have poor circulation efficiency, with daily movement limited to a couple of areas (typically the kitchen, living room, and perhaps one bedroom) and most spaces idle. “A1” refers to the full repurposing and furnishing of the idle spaces. Thus, L-A1 homes have weak circulation combined with significant interior adaptation.

The following table presents three representative case studies from the ten identified cases, based on the three major house plan types along the first axis of analysis. The cases were selected for their strong defining characteristics, distinctive spatial qualities, and diversity in occupant and household profiles.

Table 3: House type *- Based case study summary*

Case No & type	Floor	Design/ buying Stage	Construction/ Renovated stage	Current Stage
		2014	***2015***	***2025***
Type H – Case No 03	Ground Floor Plan			
	First Floor Plan			
	MBR Interior			
	Son's RM 2 Interior			
		2003	***2004***	***2025***
Type M – Case No 06	Ground Floor Plan @ +/- 0 level			
	First Floor Plan @ 10'-0" level			
	Office room			

Case No & type	Floor	Design/ buying Stage	Construction/ Renovated stage	Current Stage
Type L – Case No 09	Kitchen 2			
		2001	***2001***	***2025***
	Ground Floor Plan @ +/- 0 & 3'-0" level			
	First Floor Plan @ 13'-0" level			
	MBR/ Store RM			
	Visitor's RM/ MBR			

- Mostly used spaces, - Rarely used spaces, - Underutilised spaces, **K** – kitchen, **D** – dining space, **L** – living room, **TVL** – tv lobby, **T** – toilet, **G** – garage, **S** – storage, **B** – balcony, **MBR** – master bedroom, **DR** – daughter's room, **SNR** – son's room, **GR** – grandparent's room, **VR** – visitor's room, **PLA** – play area, **SR** – servant's room, **OR** – office room, **RD** – road, **FG** – front garden, **RG** – rear garden, **SD** – study area, **LD** – laundry, **PA** – Prep area, **SA** – Seating area, **DRR** – Driver's room, **V** – Verandah, **C** – Couch, **STD –** Studio, **TR** – Terrace

4.2 Analysis Of House Type Transition Of Selected Families

An analysis of all the longitudinal data shows a pattern of contraction in spatial use for the selected houses. The transition table (Table 3) shows that the majority of the houses begin with an H-type configuration (either H-A2 or H-A3) and overtime transition to lower-intensity types. For example, Cases 07–10 each follow the full sequence from H to M to L. clearly demonstrating a clear progression towards a stepwise reduction in active spaces. These houses begin with high spatial activity and eventually concentrate activity within a limited core area. Cases 05-06 demonstrate a partial transition process from H to M, indicating a reduced spatial activity from their original configuration. Cases 01-03 maintain H-types over the entire longitudinal process, indicating high spatial activity; however, their trajectories suggest these houses may transition toward M-types if

observed further. Case 04 remains stable as an M-type, balancing moderate usage with moderate interior adaptation.

The identified transition pattern emerges through a combination of architectural conditions and socio-demographic changes across the family life cycle. Key contributing reasons: Children's educational progression and migration, which reduce spatial intensity as previously active bedrooms and study spaces become dormant once children relocate for higher education or overseas opportunities (e.g. Cases 07-10); Empty-nest transition and shrinking household size, which concentrate daily life within a smaller functional core while peripheral spaces become underutilised (e.g. Cases 07–10); Ageing and reduced mobility of parent occupants, which gradually limit vertical circulation and shift everyday use toward more accessible zones (e.g. Case 02, 07); and Changing family routines and intergenerational domestic needs, which result in the repurposing of spaces such as play areas, visitor rooms, and study areas (e.g. Case 01, 06). These observations suggest that the transition of house-plan types is influenced not only by physical architectural capacity, but also by evolving family structures and changing spatial demands over time.

Table 4: House type transition

Case no.	House Types Transition							
	1985 - 1990	*1980 - 1995*	*1995 - 2000*	*2000 - 2005*	*2005 - 2010*	*2010 - 2015*	*2015 - 2020*	*2020 - 2025*
01							P	H – A2
02					Q	Q	H – A2	H – A3
03					P	P	H – A2	H – A2
04						A	A	M – A2
05				P	H – A2	H – A2	H – A3	M – A2
06			P	P	H – A2	M – A2	M – A2	M – A1
07	A	Q	Q	Q	H – A2	M – A2	M – A2	L – A2
08	Q	A	P	H – A2	H – A2	M – A2	M – A3	L – A2
09	P	P	P	P	P	H – A3	M – A2	L – A1
10	A	A	A	Q	H – A3	M – A2	L – A1	L – A1

- **H-A2** (Higher circulation and space usage moderate intended usage of furniture arrangement), - **H-A3** (Higher circulation and space usage low intended usage of furniture arrangement), - **M-A1** (Moderate circulation and space usage high intended usage of furniture arrangement), - **M-A2** (Moderate circulation and space usage moderate intended usage of furniture arrangement), - **M-A3** (Moderate circulation and space usage low intended usage of furniture arrangement), - **L-A1** (Low circulation and space usage high intended usage of furniture arrangement), - **L-A2** (Low circulation and space usage moderate intended usage of furniture arrangement)

Further, a quantitative analysis of the transition table confirms the identified patterns. Of the 10 cases, 4 cases reach L-type state, 3 cases end at the M-type state, and 3 cases remain at the H-type. This reveals a strong trend of reduced spatial utilization, as the majority of houses exhibit a movement toward reduced utilization levels. The letters (P, Q, A) in the table columns track the timing of these shifts, the key insight is that L-A1 and L-A2 appear as the final stage for most cases. This contraction pattern is consistent and directional, as they reduce the number of active-rooms over the course of the period. Therefore, the transition analysis confirms the identified trend of the houses exhibiting a

reduction of spatial intensity (from H to M to L) as the prominent typological narrative presented in the study.

4.3 FUTURE PROBABILITIES OF EVOLVING PATTERNS

Most families in the study begin their occupancy in H-A2 or H-A3 houses, reflecting high spatial intensity at the start of each case. These high-intensity house types have a high probability of transitioning through M-types and toward L-types as the family cycle progresses. In practical terms, this means that the majority of houses are likely to decrease their effective use of space over time. Indeed, according to Table 3, L-A1 and L-A2 serve as the terminal conditions in 40% of cases (Cases 07–10), making them the most common endpoint. Cases 05 and 06 terminate in M-A2 and M-A1 respectively, and Cases 01–03 stay in H-types. Thus, 7 out of 10 houses reach an M- or L-type by the final period, indicating that a downward shift in spatial usage is the norm. Notably, only one case (Case 06) continues beyond the first cycle as M-A1, which suggests a renewed cycle of adaptation. This case is effectively entering a second family cycle without declining to an L-type, showing that not all trajectories end at L-type. The persistence of Case 06 at M-A1 implies that additional interior adaptation (re-furnishing or repurposing rooms) can maintain a moderate circulation core even as spatial usage contracts. Overall, these future probabilities imply that aspiration for sustained high-intensity use is generally unmet; the realization is that most houses will follow the H to M to L path. Critically, this progression reflects behavioral adaptation rather than structural change: the physical framework of each house remains stable across cycles, and it is the patterns of occupancy and furniture arrangement that redefine the active spatial core over time. This observation is consistent with Habraken's (1998) open building concept, where the permanent structural framework remains stable while the changeable interior infill adapts over time. Similarly, Brand's (1994) shearing layers of change support this interpretation, as the observed transitions occur primarily within fast-changing interior layers rather than through alterations to the structural shell. The study findings agree with the findings of Hirudini and Yamada (2024), that house plans and their usage transit with time and the development of the family (Hirudini & Yamada, 2024). These findings advocate for an architecturally adaptable housing framework in which domestic spaces are conceived not as fixed permanent programs, but as flexible spatial systems capable of contraction, expansion, and functional reconfiguration in response to evolving family life cycles, changing occupancy patterns, and long-term socio-spatial transformations.

5. CONCLUSIONS

This study establishes a clear connection between house plan types and their long-term transition of upper-middle-class suburban residences. The study identified six empirical house types (H-A3, H-A2, M-A2, M-A1, L-A2, L-A1) that capture variations in circulation efficiency and interior change. The longitudinal analysis shows a dominant H to M to L transition pattern: houses start with high spatial intensity (H-types) and generally contract toward moderate (M-types) and then low intensity (L-types) over successive occupancy periods. This pattern was evident in Table 3, where most cases end in L-A1 or L-A2. Importantly, the contraction in space use is achieved through interior adaptation (rearranging or replacing furniture) rather than changing the building's structure. The external shell remains essentially unchanged, while certain rooms fall out of daily use and others are refurnished for new functions. This reinforces the theoretical

position of open building and shearing layers introduced as methods to achieve adaptability, which suggest that long-term adaptability of houses often occurs through interior reconfiguration rather than structural transformation. However, unlike pre-designed flexible housing models (Schneider & Till, 2005; Till & Schneider, 2012), the adaptability observed in this study appears to be activated primarily by family lifecycle changes and reduced occupancy rather than intentional design flexibility. These findings imply that upper-middle-class houses tend to consolidate activity into a smaller core (typically the kitchen, living area, and master bedroom) as families evolve. In practical terms, designers and homeowners should recognize that flexibility in furniture and interior layout is key to long-term adaptability. The typology and transition patterns developed here can inform strategies to prolong the functional life of such houses. Overall, the research highlights that without major interventions, most houses will follow the observed contraction trend, but thoughtful design can mediate this through adaptability in use rather than overhauling the structure.

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