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Adaptive Reuse Of Pol Houses: Addressing Structural And Material Constraints To Blend Modern Services With Authentic Preservation

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1. Abstract

Pol houses in Ahmedabad embody a distinctive vernacular architecture that harmoniously integrates cultural heritage, climatic adaptation, and artisanal building techniques. These structures, typically featuring load-bearing masonry walls, timber frameworks, and central courtyards, preserve profound historical significance yet present formidable obstacles to contemporary adaptation. Challenges such as timber decay, irregular load distribution, and diminished natural ventilation complicate the incorporation of modern amenities without eroding their authentic character.

Meanwhile, escalating requirements for services like plumbing, electrical systems, and HVAC demand inventive strategies that prioritize compatibility and reversibility. This study systematically analyses these structural and material limitations, alongside diagnostic methods and intervention approaches that uphold conservation ethics. Ultimately, it demonstrates how adaptive reuse can sustain the cultural essence of Pol houses while ensuring functional viability for modern use, thus promoting enduring heritage preservation.

Keyword: Adaptive reuse**,** Heritage authenticity**,** Timber degradation**,** Load paths**,** Passive ventilation**,** Reversible interventions**,** Service integration**,** Material compatibility**,** Diagnostic methods**,** Cultural continuity.

Aim

To examine the structural and material constraints of traditional Pol houses in Vadodara, Gujarat, and learn strategies for integrating modern services without compromising the architectural authenticity and structural integrity of these heritage buildings.

2. Introduction

Pol houses in cities like Vadodara and Ahmedabad, Gujarat, stand as classic courtyard homes crafted from timber frames, brick infill, and lime plaster, thoughtfully attuned to local culture and climate. Today, many suffer from neglect, material wear, and shifting lifestyles, yet adaptive reuse offers a path to safeguard their heritage while opening doors to fresh functions. What sets these cases apart from broader adaptive reuse studies are the specific hurdles—timber rot, unpredictable load paths, and faltering ventilation—that demand nuanced tactics for weaving in modern essentials like plumbing, HVAC, and wiring without undermining their essence. For interior designers, this context invites a creative, design-focused approach to harmonize preservation with practicality, favoring light-touch changes that honor cultural threads (Touliatos & Fabbri, 2023; Aziz & Rahman, 2023).

3. Objective

This research focuses on two key objectives:

- First, to analyse the **structural systems and material degradation** of Pol houses, focusing on timber framing, load distribution, and wall construction while identifying deterioration such as timber decay, moisture damage, and masonry disintegration.
- Second, to examine the **integration of modern services**, addressing spatial and construction challenges with survey-based insights, and proposing sensitive, reversible, and sustainable methods for plumbing, HVAC, and electrical systems (Khaleefah et al., 2023; Xu & Wang, 2025).

Scope of study

The study is geographically centered on Pol houses in **Vadodara, Gujarat**, particularly those built between the 18th and early 20th centuries. It explores material systems such as timber and lime masonry, spatial configurations, and strategies for integrating modern services. The orientation is design-focused, emphasising conservation and retrofit practices relevant to architectural and interior design, rather than purely engineering approaches. Solutions are tailored to Gujarat's climatic and cultural context, and may not directly apply to all vernacular housing elsewhere (Della Torre & Zanotto, 2024).

Limitations

1. **Limited Structural Testing**: Due to the heritage status of buildings, physical testing or destructive analysis may not be possible.
2. **Case Study Availability**: Limited access to documented case studies specifically on service integration in Pol houses.
3. **Context Sensitivity**: Solutions may not be universally applicable to all vernacular houses outside the specific climatic and cultural context of Gujarat.
4. **Budgetary Constraints**: High-end conservation technologies (e.g., advanced non-invasive scanning or imported reversible materials) may be cost-prohibitive and not always feasible for typical reuse.
5. **Interdisciplinary Complexity**: Requires close collaboration with structural engineers and conservationists, which may be beyond the scope of an academic thesis without professional partnerships.

4. Literature review

Pol houses are compact courtyard dwellings built with load-bearing masonry, timber frameworks, and lime mortars, relying on artisanal joinery (Prabhu & Kumar, 2023). Their cultural and spatial intimacy creates fragility—small interventions can destabilise structures. Timber degradation, caused by termites, borers, and fungal decay, often leads to sagging floors and redistributed loads (Aziz & Rahman, 2023). Narrow load paths and irregular grids complicate service integration, as partitions may act structurally despite not being designed for it (Touliatos & Fabbri, 2023). Ventilation and microclimate strategies—courtyards, jaalis, verandas—are often compromised by urban congestion and blocked openings. Scholars recommend restoring passive systems before adding mechanical HVAC (Xu & Wang, 2025). Diagnostic approaches include visual mapping, non-destructive testing (resistographs, ultrasonic velocity, infrared thermography), material sampling, and structural modelling, supplemented by occupant surveys. Conservation charters stress **minimum intervention, reversibility, legibility of new elements, and material compatibility** (Della Torre & Zanotto, 2024). Practical methods include routing plumbing through existing wet zones with modular pods, using surface-mounted or wireless electrical systems, prioritising passive HVAC, and employing reversible timber strengthening with intumescent coatings (Barontini & Borri, 2014).

Section	Key Points	Implications for Adaptive Reuse
1. Vernacular Construction & Pol House Typology	Compact houses with courtyards (chowk/otla); load-bearing masonry and timber; lime mortars; timber joists and artisanal joinery.	Spatial intimacy and irregular grids create cultural value but also fragility—small interventions can have large structural impacts.
2a. Timber Degradation	Causes: termites, borers, fungal decay, fatigue in joints. Consequences: sagging floors, brittle joints, redistributed loads stressing masonry. Methods: NDT (resistograph, moisture meters).	Critical to detect hidden decay before reuse; weakened timber compromises safety.
2b. Narrow Load Paths & Irregular Systems	Organic growth → irregular columns, offset beams, partitions acting as load-bearing. Removing walls risks instability.	Limits alterations: new openings, services, or enlargements can destabilize load transfer.
2c. Ventilation & Microclimate Issues	Original: passive systems (courtyards, jaalis, verandas, cross-ventilation). Problems: blocked openings, infilled courtyards, urban congestion. Emphasis: revive passive before invasive HVAC.	Modern comfort needs often clash with original design; passive strategies should be restored first.
3. Diagnostic & Assessment Methods	Visual mapping (cracks, stains, deflections). NDT (moisture meters, ultrasonic, infrared). Sampling for wood species/mortar. Structural modelling (FEM, load paths). User surveys for historic use.	Multi-layered diagnostics ensure informed interventions and reduce risks of unforeseen failures.
4. Principles for Sensitive Service Integration	- Minimum intervention & reversibility. - Legibility of new elements. - Material compatibility - Prioritise passive/decentralised solutions.	Ensures authenticity, reversibility, and reduced long-term damage.
5a. Plumbing	Use existing wet zones; raised/false floors; service trunks in secondary partitions; prefabricated wet-pods.	Minimises cutting into heritage fabric and allows modular, removable systems.
5b. Electrical	Surface conduits painted to match; wireless + LEDs; use ceiling cavities/voids.	Reduces invasive rewiring, maintains wall integrity.
5c. HVAC	Restore passive cooling; if mechanical needed, use split/mini-split or local units; thermal buffering (loft insulation, night purge).	Enhances comfort without major structural changes.
5d. Fire & Safety / Structural Strengthening	Concealed steel/timber sistering; reversible bolted frames; intumescent coatings; concealed suppression instead of visible sprinklers.	Improves safety and stability while keeping visual/aesthetic integrity.

Case Study References

1. Heritage House Renovation, Ahmedabad by HCP Design
2. House of MG, Ahmedabad
3. Rain Centre, Chennai (Laurie Baker philosophy)

Item	Heritage House Renovation (HCP Design) — Ahmedabad	House of MG - Ahmedabad	Rain Centre / Laurie Baker-influenced Vernacular Retrofit Kerala typology
Project Type / Original Use	Historic residential/heritage house	Large historic residence / family home	Vernacular/community building / experimental vernacular project
Current / New Use	Library + gallery / cultural reuse	Heritage hotel / hospitality reuse	Community / demonstration centre emphasizing passive strategies
Primary Conservation Goal	Retain structural grid, craft, and spatial character	Preserve domestic character while making hotel-grade services available	Demonstrate climate-sensitive, low-tech retrofits that respect vernacular materials
Key Structural Interventions	Retained original timber column/grid; repaired decayed members; localised strengthening	Repaired timber/masonry; stabilised floors and roofs; preserved major partitions	Repair and selective replacement of damaged timber; use of local repair techniques and skilled craftsmen
Service (Plumbing) Strategy	Vertical service ducts placed in existing wall cavities or discreet chases; located near existing wet zones	Plumbing routed in corridor walls / secondary partitions to avoid invasive cuts to heritage fabric	Minimal plumbing intervention; where needed, routed in add-on service trunks or near non-historic partitions
Service (HVAC) Strategy	Use of split systems or discrete units; service pipework routed via concealed vertical ducts or attic voids	HVAC units kept detached from heritage walls; mechanical services located in new or secondary structures (service cores)	Passive cooling prioritized (cross-ventilation, courtyards, roof insulation); low-energy fans or small localized units if required
Service (Electrical) Strategy	Surface-concealed conduits painted to blend; use of existing voids for wiring; LED conversion	Electrical wiring installed in corridor/secondary walls or false soffits; minimal chase cutting on primary fabric	Minimal electrification in core vernacular elements; wiring concealed in new joinery or service inserts; low-voltage/LED emphasis
Material / Finish Approach	Match repairs with compatible timber & lime plaster; avoid Portland cement on old masonry	Preserve patina; repair with traditional materials; new insertions read as contemporary but reversible	Use local materials and crafts; lime plaster, clay tiles, timber; avoid cement and incompatible modern finishes
Reversibility & Legibility	New ducts/fixtures designed to be removable; new work legible as contemporary insert	New services designed to be non-permanent where possible; new elements distinguishable	Interventions are low-impact, reversible, and based on traditional techniques—high legibility of original craft
Stakeholder / Community Engagement	Typically involved owner, conservation architect, local craftsmen	Hotel conversion involved owners, heritage consultants, conservation architects	Community/owner participation, artisans engaged in repair; demonstration/fabrication with local involvement
Challenges Faced	Limited space for service routing; timber decay; need to meet modern codes without heavy intervention	Balancing guest comfort with preservation; meeting fire/egress and service requirements in narrow plan	Delivering acceptable comfort levels while staying low-tech; convincing stakeholders of non-invasive benefits
Outcome / Impact	Cultural reuse preserved structural grid and	Successful hotel conversion that maintained domestic character	Proved that passive, craft-based interventions can significantly

Item	Heritage House Renovation (HCP Design) — Ahmedabad	House of MG - Ahmedabad	Rain Centre / Laurie Baker-influenced Vernacular Retrofit Kerala typology
	allowed public access/use with modern service comfort	while providing modern amenities	improve comfort and durability without heavy mechanization
Typical Documentation / Monitoring	Before/after surveys, NDT for timber, service routing maps, phased intervention records	Condition surveys, service routing documentation, maintenance plans for hotel operations	Process documentation, craft manuals, performance monitoring of passive systems

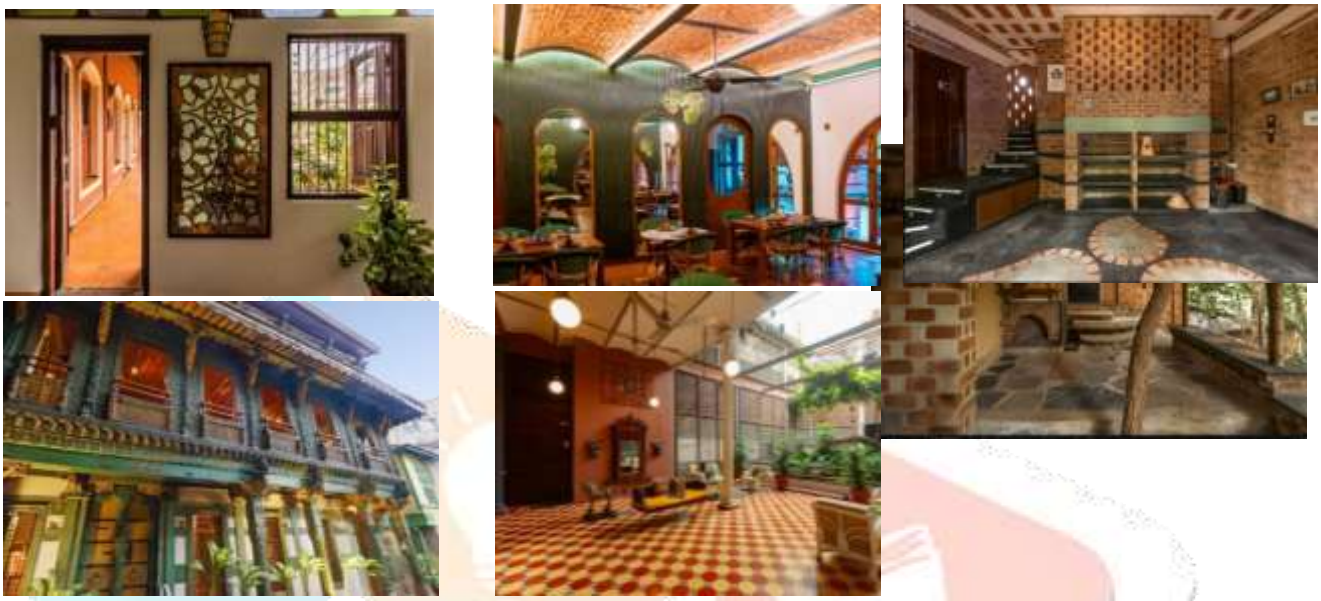


Fig-1, 2 ,3,4 ,5, 6 Images of the site internally and externally

Research Methodology

This study examines the structural and material constraints in the adaptive reuse of Pol houses, while also considering public opinion and expert insights on integrating modern services without compromising authenticity. A mixed-methods approach was adopted to capture both measurable trends and detailed perspectives. Quantitative methods were applied through structured survey questionnaires that included multiple-choice questions, rating scales, and checkboxes, enabling statistical analysis of awareness, preferences, and concerns.

The primary tool used for data collection was online surveys, designed in Google Forms and divided into sections addressing awareness, understanding of adaptive reuse, heritage and community value, structural and service-related challenges, and potential concerns. Two types of respondents were targeted: a general public survey aimed at 100–150 participants to gauge awareness and perceptions of non-specialist audiences, and a design-related audience survey involving 30–50 respondents from fields such as architecture, interior design, heritage conservation, and urban planning, to capture more technical insights. The questionnaires were distributed digitally through email, WhatsApp, and social media platforms to ensure wider outreach, with participation being entirely voluntary and self-selected. Where possible, translations into the local language were also provided to include participants from diverse backgrounds.

Ethical considerations were an important part of this research. All participants were informed that their participation was voluntary, with the freedom to exit the survey at any time. Informed consent was obtained through an introductory note at the beginning of the questionnaire, which explained the academic purpose of the study, the intended use of data, and the non-commercial nature of the research. Confidentiality was ensured, as responses were collected anonymously without requiring personal identifiers such as names, phone numbers, or email addresses unless the respondents willingly shared them. The collected data is intended solely for academic purposes and will not be used for commercial exploitation.

5. Data Collection and Analysis

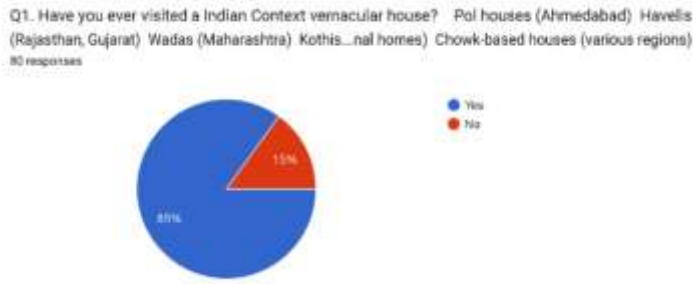
81 responses. All calculations below are from that dataset.

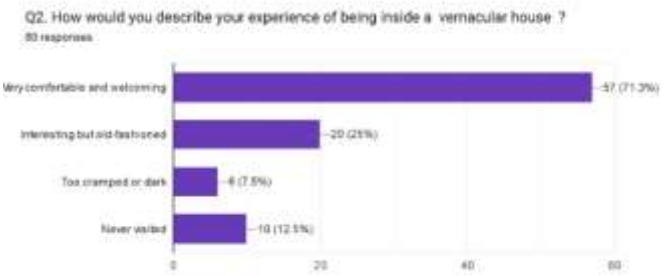
Familiarity & appreciation

85.2% (69/81) have visited a vernacular/heritage house.

61.7% (50/81) said their experience inside such houses is "Very comfortable and welcoming."

90.1% (73/81) believe vernacular houses should be preserved.

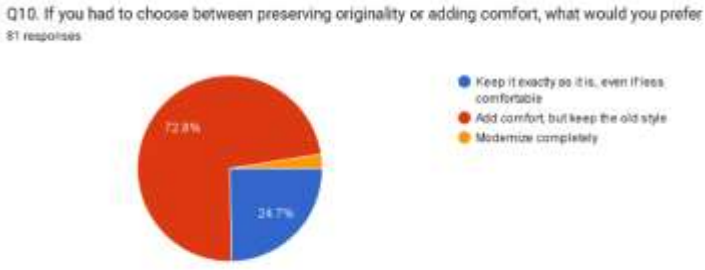


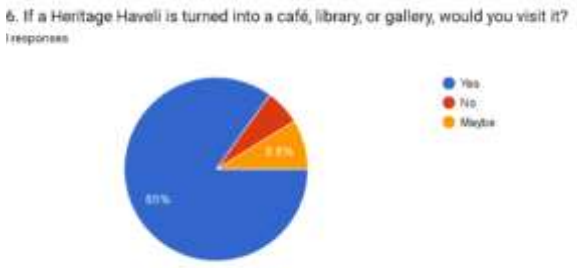


Adaptive reuse + visitor interest

85.2% (69/81) said they would visit a Heritage Haveli if it were turned into a café / library / gallery.

72.8% (59/81) prefer "Add comfort, but keep the old style" when forced to choose between preservation vs comfort.



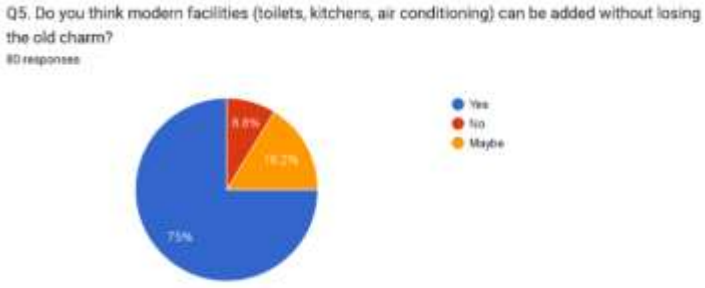


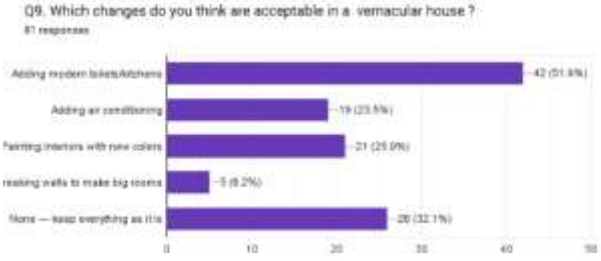
Acceptable changes & priorities

28.4% (23/81) said adding modern toilets/kitchens is acceptable.

25.9% (21/81) said "None — keep everything as it is".

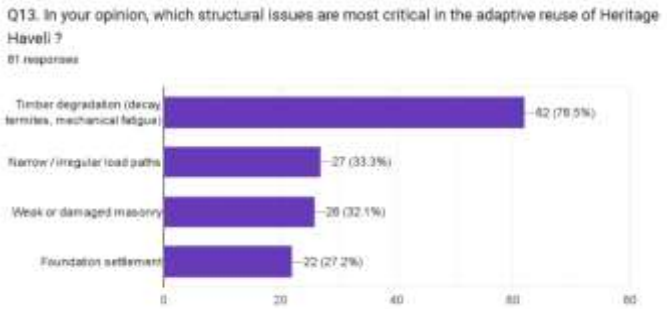
Top comfort improvements requested: good ventilation & fresh air (28.4%), better lighting / seating / clean toilets (18.5%)

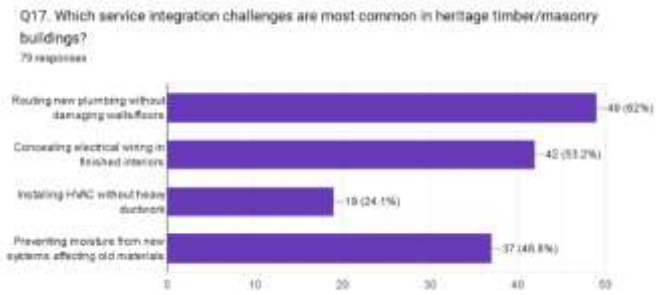


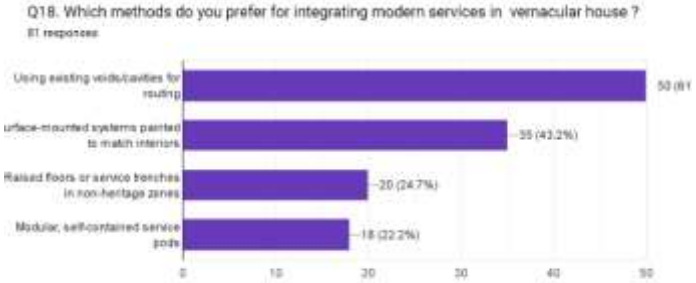


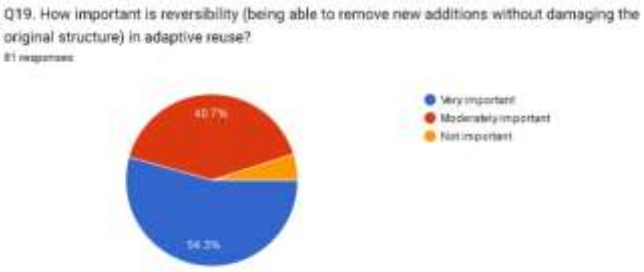
Services & technical concerns

Top structural concern: Timber degradation (decay, termites, mechanical fatigue) — 33.3% (27/81) named this as most critical.Service-integration concerns: routing new plumbing without damaging walls/floors (17.3%), concealing electrical wiring (12.3%), moisture from new systems (9.9%).Preferred methods for integrating services: using existing voids/cavities for routing (33.3%), surface-mounted systems painted to match interiors (21.0%), modular self-contained service pods (8.6%).Reversibility: Very important to54.3% (44/81); moderately important to 40.7% (33/81) — together \95% want reversible interventions.





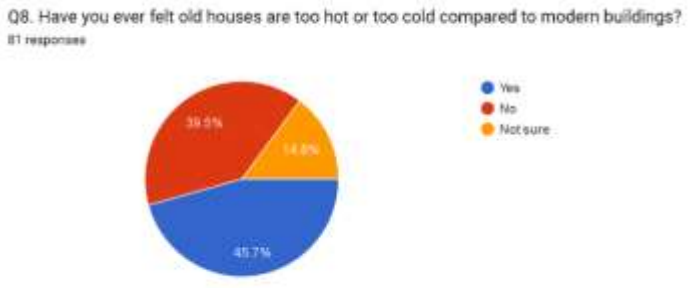


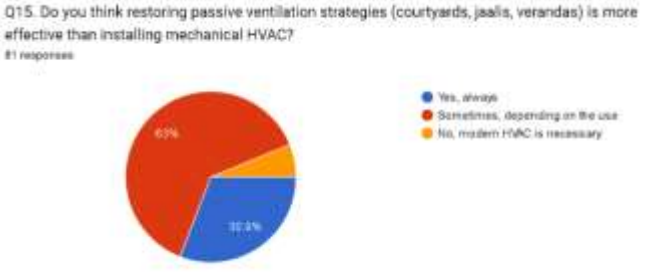


Comfort / climate strategies

45.7% (37/81) have felt old houses are thermally uncomfortable (too hot / too cold) at times; 39.5% (32/81) have not.

On passive ventilation vs mechanical HVAC: 63.0% (51/81) said “Sometimes, depending on the use”, 30.9% (25/81) said “Yes, always” in favour of passive strategies.





6. Findings & Discussions

This study investigated the structural and material constraints in the adaptive reuse of Pol houses, alongside public perceptions of integrating modern services while maintaining authenticity. The data analysis of 81 responses reveals that a large majority of participants (90.1%) believe vernacular houses should be preserved, and 85.2% expressed willingness to visit a Pol house if adapted into a functional public use such as a café, gallery, or library. These findings suggest strong public support for adaptive reuse projects that balance preservation with usability. However, usability was consistently tied to the provision of basic amenities, with ventilation, lighting, seating, and clean toilets identified as the most pressing needs. This highlights the expectation that adaptive reuse must provide modern comfort in order to ensure sustainable public engagement.

Structural and material constraints emerged as a significant concern among respondents. Timber degradation, including termite damage, decay, and fatigue, was identified by 33.3% of participants as the most critical issue in reusing Pol houses. Concerns about integrating modern services were also prominent, particularly the risk of damaging historic walls and floors during plumbing installation, the challenge of concealing electrical wiring, and the potential for moisture-related deterioration. In response, participants preferred solutions such as using existing voids and cavities for routing , surface-mounted but camouflaged systems , and modular service pods placed in secondary areas. These responses indicate a preference for interventions that are minimally invasive, discreet, and reversible. Indeed, nearly 95% of participants rated reversibility as important, underlining the public's sensitivity toward safeguarding heritage character during reuse.

The findings directly address the study's research questions. Structural constraints such as timber decay and narrow load paths are confirmed as practical challenges that must be prioritized in reuse strategies. Similarly, the integration of modern services without compromising authenticity is reflected in the public's emphasis on non-invasive methods. Importantly, the results show that even participants outside the architectural and conservation fields recognize these issues, demonstrating that technical and cultural concerns are broadly understood. Thermal comfort also emerged as a mixed issue: while 45.7% of respondents found vernacular houses thermally uncomfortable, nearly 40% did not, suggesting that climate performance depends on context, maintenance, and adaptive measures.

The main structural and material concerns arise from timber degradation, irregular load paths, and compromised ventilation. Timber, central to both the structure and aesthetics, is highly vulnerable to termite attack, fungal decay, and fatigue, often resulting in sagging floors, brittle joints, and redistributed loads that stress masonry walls. The irregular growth of these houses creates misaligned columns and beams, with many partitions acting as unintended load-bearing members; altering or removing them risks destabilising the structure. Ventilation, once ensured by courtyards, jaalis, and verandas, has declined due to blocked openings, courtyard infill, and dense urban encroachment. As modern uses demand higher thermal comfort, literature suggests restoring passive systems before introducing invasive HVAC.

Across the literature, four conservation principles guide interventions: minimum intervention and reversibility, legibility of new additions, compatibility of materials, and prioritisation of passive or decentralised systems over intrusive mechanical ones. These principles ensure both technical integrity and respect for authenticity.

Practical strategies reflect these values. Plumbing is consolidated within existing wet zones or introduced through raised floors and modular pods to minimise cutting into historic fabric. Electrical systems rely on surface-mounted conduits, wireless controls, and discreet use of voids. HVAC interventions favour passive cooling, while mechanical options are limited to split or localised systems with minimal structural impact. Fire safety and structural strengthening are addressed through reversible and concealed techniques such as timber sistering, bolted steel frames, and intumescent coatings rather than intrusive sprinkler networks.

7. Conclusion & Recommendations

The study reveals a strong public appreciation for Pol houses as heritage assets, coupled with a pragmatic desire for their reuse as functional, community-oriented spaces. Survey findings show that while the term adaptive reuse is not widely understood, the concept resonates deeply — people want heritage houses to remain authentic yet liveable. Literature reinforces this by emphasising the fragility of timber structures, the importance of passive climatic strategies, and the necessity of reversible interventions. Together, these perspectives confirm that adaptive reuse is both a **cultural necessity and a technical challenge**: it must safeguard authenticity while enabling comfort, safety, and usability.

Key Insights

1. **Heritage Value is Recognised**

Both public opinion (90% supporting preservation) and scholarship agree on the need to safeguard heritage identity, ensuring reuse does not erase cultural meaning.

2. **Usability Drives Acceptance**

Survey participants consistently requested basic amenities — toilets, lighting, seating, ventilation — as enablers for visitation. Literature supports this, but insists such upgrades be done with minimal intrusion.

3. **Technical Challenges Must Not Be Overlooked**

Timber degradation, irregular load paths, and moisture issues are recurrent problems. These require professional conservation expertise, aligning with public concerns about safety and longevity.

4. **Community & Cultural Programming Matters**

The survey reveals that people are most excited about cafés, galleries, libraries, and guesthouses, echoing academic calls for heritage spaces to remain socially embedded, not merely preserved as static monuments.

Recommendations

1. Program & Function

- Prioritise adaptive reuse for functions with strong cultural and community appeal (cafés, galleries, homestays, libraries).
- Pair new uses with **interpretive content** (exhibits, signage, storytelling) to reinforce heritage identity.

2. Comfort & Services

- Provide essential visitor services (toilets, potable water, seating, clean lighting) as baseline upgrades.
- Use **passive strategies first** (courtyards, jaalis, verandas) for ventilation/thermal comfort; mechanical systems only where unavoidable, designed to be discreet and reversible.

3. Structural & Technical Strategy

- Undertake **timber condition surveys** and remedial treatment before reuse.
- Route plumbing and electrical through existing voids or modular pods to avoid cutting historic fabric.
- Use reversible fixings, surface-mounted but concealed wiring, and modular bathroom/kitchen units in non-significant areas.

4. Conservation Ethics

- Follow principles of **minimum intervention, material compatibility, and reversibility** in all retrofit work.
- Ensure new additions are visually distinguishable yet sympathetic to heritage character.
- Maintain detailed documentation (drawings, photos, condition maps) for transparency and future interventions.

5. Community & Policy Integration

- Involve local residents and craftspeople in reuse projects to reinforce cultural ownership.
- Encourage partnerships between municipalities, NGOs, and private stakeholders for sustainable management.
- Develop guidelines for adaptive reuse of vernacular houses that integrate both technical conservation standards and community expectations.

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