Patterns of Use and Conditions of Rooftops in Low-Rise Housing in India: Insights from Hyderabad

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Abstract

The increasing urban density and the need for sustainable living spaces in cities around the world make the use of rooftops a vital aspect of urban developments. In Hyderabad in India, urbanization has led to growing concerns about the efficient use of available spaces, especially in the low-rise residential areas. Undeniably, rooftop spaces, often underutilized, hold immense potential for addressing these challenges by serving as multifunctional areas. In this context, this paper explores the vernacular use of rooftops in the low-rise residential buildings in Hyderabad in order to propose improvements based on user feedback.

The research employs case studies as a methodology. 32 residential buildings in Hyderabad were visually observed to document existing rooftop designs, usage patterns, and challenges. A questionnaire survey was administered to 154 residents. Semi-structured interviews and surveys were carried out to gather user feedback on their satisfaction, preferences, and ideas for rooftop spaces. Thematic analysis was conducted to identify opportunities and constraints for using rooftops.

Findings reveal that rooftops are used primarily for utility purposes such as water tank installations, laundry drying, and occasional storage. However, users showed interest in converting rooftops into active spaces, including urban gardens, recreational areas, and solar energy setups. Despite this interest, barriers such as inadequate design, lack of awareness, and safety concerns limit widespread adoption of rooftop innovations. This study underscores the need for collaborative efforts between architects, urban planners, and residents to transform rooftops from underutilized spaces into vibrant, functional areas that could contribute to sustainable urban living.

Keywords: Rooftop Space, Patterns of Use, User Perception, Residential Terraces, Informal Rooftop Design, Hyderabad, India

Introduction

Urbanization in India, particularly in cities like Hyderabad, has intensified challenges related to land use, resource management, and sustainable urban planning. Despite increasing vertical developments in many metropolitan areas, low-rise residential buildings continue to form a substantial part of the urban fabric of Hyderabad. Within this context, the effective use of rooftop spaces becomes a critical concern, as rooftops represent a significant yet often underutilized urban resource. In fact, despite this is an everyday vernacular practice, there is a possibility for the promotion of such vernacular processes, which could transform the root tops by the activities of the people themselves. Moreover, these spaces have the potential to address multiple urban challenges by supporting environmental, social, and domestic activities.

In this connection, previous scholarship has highlighted the possibilities of rooftop gardening (Chowdhury et al., 2016), renewable energy installations (Shahsavari & Akbari, 2018) and recreational or communal uses (Sharma et al., 2020), although not much has been examined on the people's own vernacular process and patterns of using these informal spaces.

In this context, this research examines how the rooftop spaces in low-rise residential buildings in Hyderabad are currently used, and how residents perceive, value, and anticipate the potential of these spaces. It investigates not only observable patterns of use but also people's preferences and evaluations, which shape both present practices and future aspirations.

The aim of this research is to develop a richer understanding of rooftop spaces as experiential, social, and evolving parts of life in the low-rise residential buildings in Hyderabad.

Its objectives are as follows.

- To document the existing patterns of roof top use in low-rise residential buildings in Hyderabad.
- To assess residents' perceptions, preferences, and expectations regarding rooftop spaces.
- To identify opportunities and constraints influencing the everyday use and potential enhancement of these spaces.
- To contribute insights that can inform architectural and urban planning approaches towards more sustainable and people-responsive rooftop environments.

Theoretical Framework

Vernacular Culture

Understanding rooftop spaces as lived, social, and adaptive environments requires a theoretical foundation anchored in environmental behavior theory, place-making, vernacular studies, and urban informality.

According to Rapoport (1969), built forms are cultural artifacts shaped by the values, needs, and behaviors of their users. Within this perspective, rooftops can be understood not merely as architectural surfaces but as culturally and socially mediated extensions of domestic space. Lawrence (2000) shows that domestic environments contain both formal and informal spatial layers, where residents reinterpret and adapt built elements according to everyday life. Rooftops, particularly flat roofs, therefore constitute 'potential spaces' that residents reinterpret as functional, social, or symbolic domains based on their intentions and cultural practices. There are a number of other theoretical concepts that need to be understood in this regard as follows.

Patterns of Use

Gibson (1979) introduces the notion of "affordances," explaining that physical environments offer opportunities for actions based on people's perceptions. Thus, patterns of use are behavioral regularities shaped by socio-cultural expectations, environmental conditions, and the affordances of the built environment. Similarly, Gehl (2011) emphasizes that everyday outdoor behaviors—socializing, resting, viewing and domestic activities—emerge not only from the need but from available spatial conditions. Thus, patterns of rooftop use can be understood as the recurrent, socially meaningful behaviors that residents perform on these elevated spaces.

Intentions

Intentions relate to the motivations behind people's actions. In this regard, Schutz (1967) explains that social actions occur through 'projects' in which individuals assign meaning and purpose to their activities. Applied to rooftops, such intentions include the desire for comfort, privacy, utility, income generation, or leisure—each shaping how residents appropriate their roofs. Rapoport (1982) further argues that intentions are culturally influenced. This means that rooftop use reflects embedded cultural norms, aspirations, and lifestyles.

Culture and Spatial Practice

Culture, as defined by Rapoport (1980), is the primary determinant of environmental meaning and the behavioral patterns in domestic settings. Spatial practices such as rooftop use thus emerge from culturally encoded routines and expectations, which vary across neighborhoods, income groups, and climatic contexts. Lefebvre (1991) adds that everyday spatial practices reflect lived space—spaces appropriated by users through habit, imagination, and social relations. Rooftops thus represent lived spaces whose meanings are shaped through social interactions, household structures, and evolving urban lifestyles.

Informality and Everyday Adaptation

De Certeau (1984) argues that users "tactically" adapt and modify formal spaces to suit their needs. Rooftops in low-rise housing—often sites of storage, leisure, gardening, or incremental construction—exemplify this everyday informality. These adaptations reflect resident agency and are central to understanding rooftop transformations in rapidly urbanizing environments. Together, these theoretical insights frame rooftops as culturally embedded, behaviorally negotiated, and socially meaningful spaces rather than purely architectural elements. They establish the conceptual foundation for examining how residents in Hyderabad interpret, use, and modify their rooftop environments.

Literature Review

Much research exists that examine informal environments and spaces such as roof tops. Amon them, research on domestic rooftops increasingly recognizes their emerging role as multifunctional spaces in dense urban environments. Globally, scholarship examines how rooftops support food production, energy generation, microclimate regulation, and social interactions. The majority of these studies approach rooftops as underutilized resources within the built environment; however, relatively few explore the everyday patterns of use within low-rise residential contexts, especially in the Global South.

According to Thomaier et al. (2015), rooftop agriculture represents one of the most widespread reappropriations of roof surfaces, particularly in high-density cities where access to open space is limited. Studies across Asia, Europe, and North America demonstrate that rooftop cultivation enhances urban biodiversity, improves food security, and contributes to ecological resilience. Chowdhury et al. (2016) observe that in Dhaka, residents use rooftops for both subsistence gardening and climate mitigation, revealing how socio-economic needs shape rooftop adaptation. These findings indicate that rooftops operate as hybrid ecological-domestic spaces that respond simultaneously to household and environmental pressures.

Research on rooftop energy installations similarly highlights the functional redefinition of roofs. For example, Shavari and Akbari (2018) show that urban rooftops are critical for generating decentralized renewable energy, especially in cities with favorable solar exposure. Studies from China, Europe, and the Middle East identify comparable patterns, noting that rooftop photovoltaic systems reduce emissions and promote energy independence. However, this strand of literature focuses largely on technical performance, offering limited insights into how residents perceive, negotiate, or utilize their roofs beyond energy functions.

A substantial body of work engages with rooftops as contributors to thermal comfort and climatic moderation. For example, Akbari et al. (2016) argue that cool roof materials significantly reduce indoor heat gain, supporting both energy efficiency and thermal well-being. Global analyses confirm reductions in urban heat island intensity through reflective

coatings, rooftop vegetation, and other passive strategies. Nevertheless, these studies prioritize thermal performance metrics, providing limited understanding of everyday lived experiences or the social dimensions of rooftop adaptation.

Other international research discusses rooftops as social and recreational spaces. In this connection, Abuseif and Gou (2018) cite several studies in their review paper about how roofscapes offer unique opportunities for community interactions, physical activities, and restorative outdoor environments. Across these studies, rooftop use is linked to well-being and social cohesion, yet the literature rarely connects recreational use with broader cultural or household practices.

While these global studies collectively recognize the multifunctional potential of rooftops, research focusing specifically on low-rise residential housing remains scarce. Much of the existing work examines either high-rise contexts or institutional/commercial buildings, leaving a gap in understanding how households in low-rise buildings appropriate rooftops in their daily lives.

Within India, research mostly addresses rooftop agriculture, thermal performance, and solar energy. For example, Patel, et.al. (2021) show that rooftop gardens in Ahmedabad reduce cooling loads while supporting household food production. Kumar, et.al. (2018) examine cool roof technologies in Indian cities, demonstrating measurable improvements in thermal comfort. Chaturvedi, et.al. (2024) discuss rooftop solar adoption and note that climatic conditions in South Indian cities make them favorable for photovoltaic expansion. Although these studies provide important insights, they concentrate mainly on environmental performance rather than social use.

Moreover, a smaller number of Indian studies examine cultural or social dimensions of rooftop use. In this connection, Dasgupta and Bose (2020) argue that privacy norms, gendered behavior, and family structures shape how the rooftops are accessed and utilized, often limiting women's use of outdoor domestic spaces. Similarly, Jain and Mehta (2019) analyze barriers to rooftop adaptation in Mumbai and highlight safety concerns, maintenance costs, and low awareness.

Nevertheless, across the literature, two gaps of knowledge become evident. First, research rarely investigates rooftop use in low-rise residential housing despite its prevalence in many Asian and Middle Eastern cities. Second, few studies integrate user perspectives—such as motivations, preferences, and constraints—with architectural and environmental analyses. As a result, the everyday cultural and behavioural dimensions of rooftop living remain underexplored. This study addresses these gaps by examining how the residents of Hyderabad interpret and utilize their rooftops, combining qualitative and quantitative insights to build a holistic understanding of rooftop practice.

Research Methodology

This study employs a mixed-methods research design, combining quantitative and qualitative data to examine rooftop usage patterns in low-rise residential buildings (four floors or lower) occupied by middle- and high-income groups in Hyderabad. The methodology is organised into (A) data-gathering techniques and (B) analytical methods.

Data-Gathering Techniques

Case Studies

Case studies are conducted on 32 low-rise residential buildings located in the neighborhoods in East Marredpally and Mahendra Hills of Secunderabad region of Hyderabad City. These buildings are selected through purposive sampling to include a variety of types of people, a wide range of ages, and socio-economic contexts within the middle and high-income communities.

The Case Study: Description of the Area

Hyderabad is situated in the Deccan Plateau in the northern part of South India. It lies at approximately 17.366° N latitude and 78.476° E longitude. It has a tropical wet and dry

climate bordering on a hot semi-arid climate, an established urban form with diverse residential types including apartments and villas, and social characteristics (such as a focus on family life and community engagement) that influence how the residents use rooftop spaces.

Climatic Conditions

The city experiences three main seasons:

- Summer (March to June): This is the hottest period, with temperatures often exceeding 40°C (104°F). Days are sweltering and dry, with high solar irradiance.
- Monsoon (June to October): The region receives most of its moderate to heavy annual rainfall (averaging around 864 mm city-wide), leading to lower temperatures and high humidity.
- Winter (November to February): This season is mild and pleasant, with cool and dry weather. Temperatures range from 15°C to 30°C (59°F to 86°F), making it an ideal time for outdoor activities.

These conditions strongly influence rooftop behavior, with intense sun driving the need for shade or cooling in summer, and pleasant weather encouraging outdoor use in the cooler months.

East Marredpally and the Mahendra Hills area in Hyderabad are chosen for a study on rooftop usage patterns in low-rise residential buildings due to its representative mix of an established urban form, diverse residential typologies, and socio-cultural characteristics typical of a developing Indian metropolis. These neighborhoods feature a significant concentration of independent houses and low-to-medium-rise apartment buildings, which are the primary focus of the study.

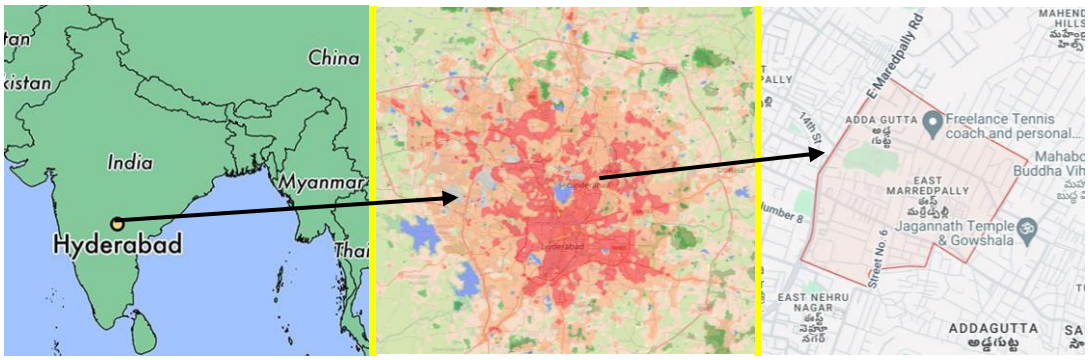

Fig. 1: Case Study Site in Hyderabad.
Source: Google maps

Location Plan and Photographic Documentation

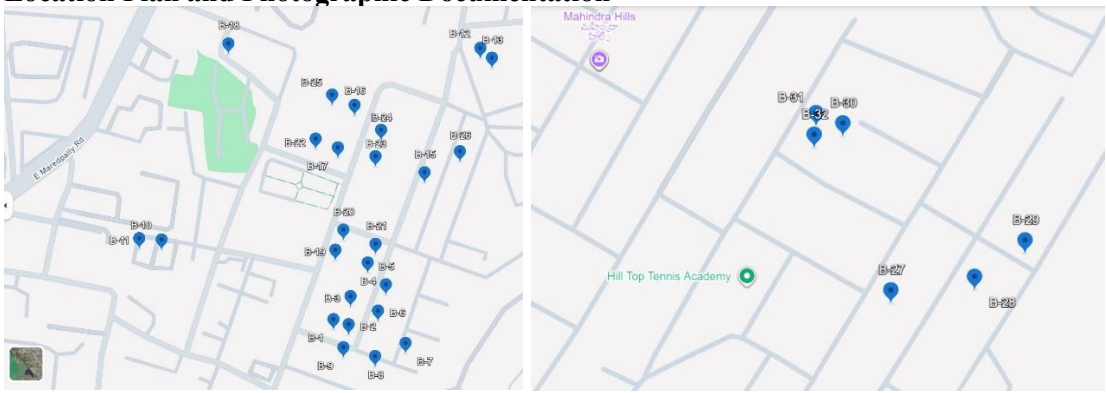

Fig. 2: Locations of all the 32 buildings
Source: Google Maps (B-1 to B-26 in East Marredpally and B-27 to B-32 in Mahendra Hills)

Fig. 3: Photographic documentation of all the 32 rooftops
Source: Author

Semi-Structured Interviews

Semi-structured interviews are conducted with the users of the buildings in the case areas. The purpose is to obtain qualitative insights into:

- Motivations and barriers for rooftop usage;
- Social and Cultural meanings of terraces and
- Aspirations for improved rooftop design.

Each interview that lasts around 15-20 minutes is audio-recorded with the consent of the participant. Selection is based on the willingness to participate and representation of diverse demographic groups.

Questionnaire Survey

A structured questionnaire was administered to residents across Hyderabad to collect quantitative data on rooftop access, use patterns, preferences, and willingness to retrofit. The survey was disseminated online using a SurveyMonkey form (from June 2024 to March 2025) and was distributed through social media platforms, community groups, and personal networks to ensure broad coverage. A pilot study led to the refinement of the questionnaire, enabling the respondents to choose from options for most questions. They were also allowed to express freely in their words for some sections that can vary widely from one person to another (e.g. their intentions and aspirations for using the rooftop space).

Sampling Strategy

A convenience and snowball sampling method was used. Respondents who resided in low-rise residential buildings (≤4 floors) within Hyderabad city limits were chosen.

Sample Size

A total of 207 responses was received, of which 154 valid responses were then analyzed after data cleaning. Since there was no control on who answered the survey, though the instructions clearly mentioned that the respondents should be living in low-rise residences in Hyderabad, several responses were received from people living in apartments in more than 4 floors too. They were removed from the data set.

Structure of the Questionnaire

The questionnaire consisted of three sections as follows:

Section 1: Demographic Information

- Gender
- Age
- Locality of residence
- Housing type
- Floor of residence
- Ownership status (owner/tenant)

Section 2: Patterns of Rooftop Use

- Availability of open spaces in the building premises
- Frequency, duration, and seasonal variations of rooftop visits
- Activities performed
- Desired improvements
- User-assigned importance to design aspects:
    - Accessibility
    - Functionality
    - Sustainability
    - Physical Comfort
    - Safety
    - Privacy
    - Aesthetics

Section 3: Retrofitting Perception

- Willingness to retrofit
- Motivations for retrofitting
- Readiness and constraints

The survey design enables replication by other researchers following the same sampling and administration procedure.

Analytical Methods

(a) Statistical Analysis

Quantitative survey data were analyzed using descriptive and inferential statistics. Analyses included the following.

- Frequency distributions
- Cross-tabulations
- Correlation analysis (e.g., between demographics and usage patterns)

Statistical analysis helps identify overarching patterns in rooftop use and perception.

(b) Thematic Analysis

Interview transcripts were coded and analyzed using Braun & Clarke's (2006) thematic analysis framework which involves categorizing based on theme and reporting. Themes capture user motivations, constraints, and informal adaptation practices.

Study Limitations

The study is limited to:

- Low-rise residences (≤4 floors)
- Middle- and high-income groups
- Voluntary participation, which may lead to sampling bias

Findings

The study investigates how residents of low-rise buildings in Hyderabad use, adapt, and perceive their rooftop spaces. To capture the complexity of informal rooftop practices, the research employs multiple methods: (a) case studies of 32 rooftops documenting existing conditions and user-led modifications, (b) a structured questionnaire survey (154 valid responses) analysing demographic patterns and terrace use, and preference-based questions assessing perceived constraints, desired improvements, and willingness to retrofit. Together, these datasets offer a comprehensive picture of the rooftop as a functional, climatic, and social extension of domestic life.

Findings from Case Studies

(1) Case Studies: Existing Conditions and User Modifications (32 Rooftops)

Existing Rooftop Conditions

Physical documentation of the 32 rooftops shows considerable variations in design and maintenance. Most rooftops included originally planned elements such as parapet walls, head rooms/penthouses, water tanks, and column extensions. However, conditions in older buildings often revealed deteriorated waterproofing layers, cracked surfaces, or weakened edges—factors influencing safety and usability. Families in independent houses frequently had access to alternative ground-level open spaces, reducing reliance on rooftop activities.

User Additions and Modifications

Residents had introduced a wide range of informal and semi-permanent additions, indicating active adaptation of rooftop spaces beyond their intended design:

- Dish antennas, AC outdoor units, and water pipes
- Temporary/permanent seating, drying wires, shade structures
- Potted plants, gardening materials, and makeshift storage units

The prevalence of these add-ons illustrates the evolving role of the terraces as a multifunctional, user-driven space.

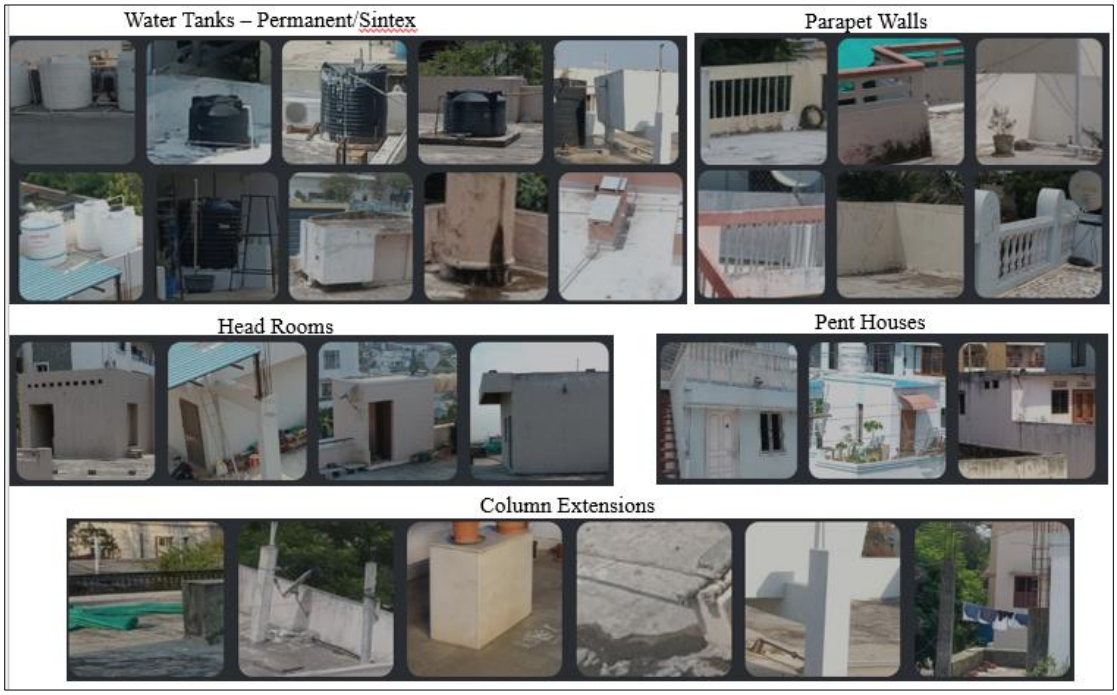

Fig. 4: Designed elements on rooftops
Source: Author

Fig. 5: User added elements on the rooftop space
(Source: Author)

Perspectives of the Users

Semi-structured interviews conducted with the users in the houses which were studied revealed that women accessed rooftops more frequently than men, particularly in the houses where terraces supported domestic activities such as drying clothes or gardening.

Many respondents had experimented with cool-roof paints, which had initially improved thermal comfort. However, this has lost popularity due to glare issues, surface chipping, and the short lifespan. Structural capacity emerged as a major constraint for gardening

and solar installations. Tenants/renters who were renting the properties were generally unwilling to invest in retrofitting unless the costs were shared among the co-residents.

(2) Interview Data Summary

The consolidated data collected from the 32 interviews reflects the following:

- Recreational Interest: Highest among homeowners (mean 4.6).
- Gardening Interest: Strong among owners (mean 4.2) vs renters (mean 2.8).
- Solar Panels: Moderate interest (mean 3.56) but limited by structural and cost concerns.
- Cool Roofs: Slightly higher interest (mean 3.75), with adoption linked to awareness.
- Structural Safety Concerns: Higher in older or rental buildings (mean 2.78).
- High Cost as a Barrier: Consistently significant (mean 3.78); strongest among renters (mean 4.2).
- Willingness to Pay: Moderate overall (mean 3.06), higher among owners (3.7) than renters (2.2).

Inferences from the Case Studies and the Interviews

Almost all the 32 case studies showed some level of design changes made by the user to serve a purpose beyond what was originally intended during the design of the rooftop spaces. Ownership status strongly influences rooftop investment. Homeowners tend to treat the rooftop as a long-term asset, enabling recreational use, gardening, and thermal retrofits. Renters adopt a minimal, utility-driven approach, constrained by financial and structural limitations. These findings emphasize that rooftop retrofitting policies must address affordability, shared responsibility in rental contexts, and structural reinforcement where needed.

(3) Findings from the Questionnaire Study

The Demographic Profile

The final dataset included 154 valid responses after removing incomplete forms, respondents under 18, and those living in buildings above four storeys. The majority were male (62%), and 85.66% were aged 18–60, indicating strong representation of active decision-makers. Most respondents lived in G+1 to G+3 buildings, and 77% were homeowners—suggesting high levels of autonomy in rooftop modification. The dominance of owner-occupants and residents of multi-level houses positions the sample to provide relevant insights into informal rooftop transformations.

Patterns of Terrace Use

Temporal and Seasonal Use

Daily users accounted for 27.27%, with 24.68% visiting two to three times a week. However, 32.47% used the terraces rarely, and 4.55% almost never—highlighting a varied dependence on rooftop spaces. Evenings (6–9 PM) were preferred by 51.95% of the respondents, followed by 37.07% during the early mornings. Daytime visits were minimal due to heat and glare, reflecting thermal discomfort as a key barrier.

Seasonal analysis reinforced climatic sensitivity:

- Summer: 60.65% used it for <30 minutes; 27.17% avoided rooftop completely.
- Winter: Over half used the terrace for 30 minutes–2 hours.
- Monsoon: Moderate and irregular use due to rainfall constraints.

These results confirm the need for heat mitigation, shade, and climate-responsive design.

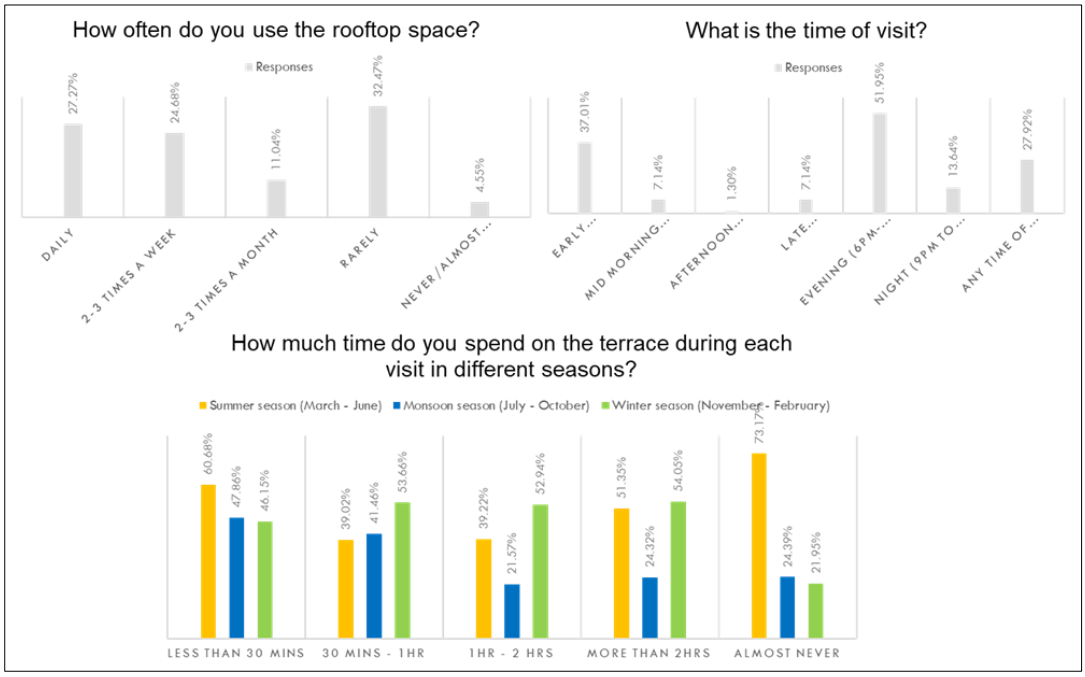

Fig. 6: Temporal and Seasonal Usage of the Rooftop Space.
Source: Author

Functional Diversity of Rooftops

The rooftop emerged as a multifunctional space:

- Physical activity (45.45%) – walking, yoga, meditation
- Utility tasks (36.36%) – servicing water tanks, solar panels
- Drying activities (35.71%) – clothes, spices, condiments
- Recreation/socializing (26.62% and 25.97%)
- Gardening and sleeping/relaxation (22.73% each)
- Studying/learning (10.39%) – low due to lack of comfort and necessary infrastructure

Open-text responses revealed nuanced activities: bird feeding, sky watching, pet walking, cooking, music, and observing sunrises/sunsets. These findings support the conceptualization of the terrace as a hybrid domestic–recreational–climatic space.

Constraints to Use of Rooftops

Structural and Infrastructural Constraints

Users highlighted:

- Aging buildings with leakage, cracks, or weak load-bearing capacity
- Poor staircase design, lack of lifts
- Clutter from service installations (solar panels, antennas, water tanks)

Personal and Psychological Barriers

- Lack of time, motivation
- Discomfort from heat, glare, mosquitoes
- Perception of "no need" unless specific tasks require terrace use

Social and Interpersonal Constraints

- Conflicts among co-owners
- Privacy concerns and fears of surveillance (“terrace peeping”)
- Limited shared responsibility in apartment buildings

Climatic and Environmental Factors

- Extreme heat and lack of shade
- Seasonal usability issues
- Presence of pests or monkeys in some areas

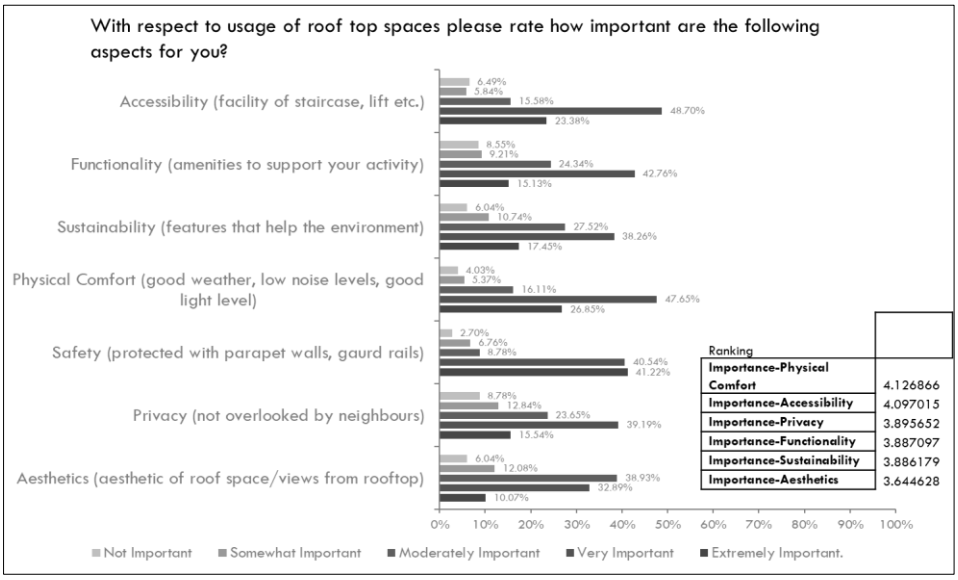

Fig. 7: User Importance of various aspects of rooftop design
Source: Author

User preferences for improvements were as follows

Users overwhelmingly preferred enhancements related to:

- Physical comfort (~4.2) – shade, thermal relief
- Functionality (~4.15) – seating, storage, lighting
- Accessibility (~4.1) – easier stair/lift access
- Privacy (~4.0) – visual screening
- Sustainability (~3.95) – solar/harvesting
- Aesthetics (~3.75) – lower priority but still valued

Overall, users envision rooftops as future-ready, comfortable, and active living spaces.

The following set of histograms shows the distribution of importance ratings for various aspects of rooftop use, along with normality test p-values to assess how closely each distribution follows a normal curve. Most dimensions are not normally distributed, with strong leanings toward high importance—particularly for physical comfort, accessibility, and functionality. Aesthetics stands out as the only dimension with a near-normal distribution, reflecting more evenly divided perceptions of its importance.

In conclusion, rooftop designs should prioritize comfort, ease of access, and privacy, with functional and sustainable elements integrated to support long-term usability.

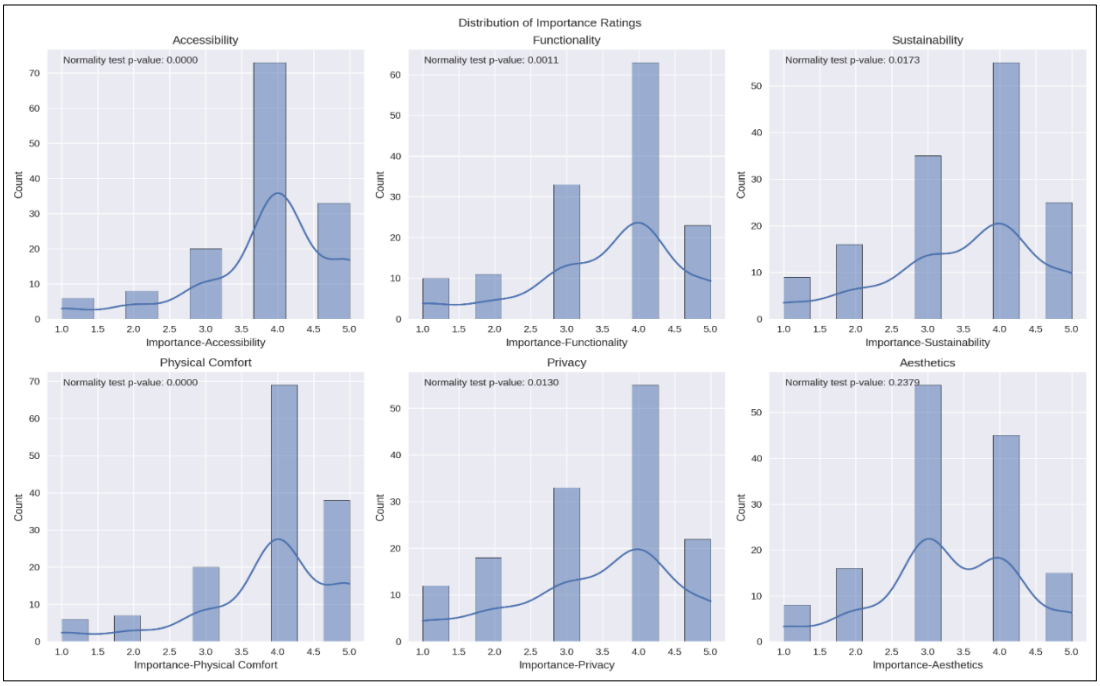

Fig. 8: Histograms showing the distribution of importance ratings for various aspects of rooftop usage
Source:Author

Perceived Benefits and Willingness to Retrofit

The opinions gathered regarding retrofitting rooftops reflect a generally positive outlook, particularly concerning environmental and lifestyle improvements. A majority of respondents agree that retrofitting rooftops is beneficial for environmental protection, with the highest weighted average indicating strong support for sustainability initiatives. Many also believe it enhances the usability of the rooftop spaces and increases comfort inside the buildings, suggesting that retrofitting contributes to both functional and livability improvements. Although economic benefits, such as increased property values or rental incomes are acknowledged, they are not the primary motivation for most of the respondents. Despite the high perceived value, thus, economic constraints heavily shape retrofit adoption.

	Strongly disagree		Disagree		Neutral		Agree		Strongly agree		Weighted Average
Is beneficial for the environmental protection	3.25%	5	3.90%	6	18.18%	28	44.81%	69	29.87%	46	3.94
Is helpful in increasing House selling price/rental income	1.95%	3	7.14%	11	29.87%	46	44.16%	68	16.88%	26	3.67
Improves usage or supports activities on rooftop	3.25%	5	1.95%	3	16.88%	26	55.19%	85	22.73%	35	3.92
Increases comfort inside building and on terrace.	1.95%	3	3.25%	5	18.18%	28	55.19%	85	21.43%	33	3.91

	Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree		Weighted Average
Is easy and a convenient process	1.95%	3	15.58%	24	32.47%	50	42.21%	65	7.79%	12	3.38
Is for which I have enough funds and the ability to carry out.	2.60%	4	19.48%	30	44.16%	68	28.57%	44	5.19%	8	3.14
Is what I will consider getting in the future when I save enough funds	3.25%	5	8.44%	13	26.62%	41	48.05%	74	13.64%	21	3.6
What I will consider if it is supported by government incentives and subsidies.	3.90%	6	3.90%	6	25.97%	40	44.16%	68	22.08%	34	3.77

Fig. 9: User opinions about perceived benefits and willingness to retrofit rooftop space.
Source: Author

Discussion of the Findings

The integration of data from both the questionnaire survey and the case study reveals a nuanced and multidimensional understanding of rooftop use, interests, and barriers among the urban Indian households. Thirty-two rooftop case studies document *actual* spatial conditions, material practices, and everyday routines, reflecting rooftops as lived spaces (Lefebvre, 1991) shaped through habitual, improvised, and socially meaningful actions. Interviews provide insight into user intentions and cultural expectations that animate these adaptations. The questionnaire survey, with a refined sample of 154 respondents provides a broad demographic and behavioral picture.

Usage patterns show a strong temporal and climatic dependency. While a third of the respondents use terraces rarely, a significant number frequent them in the evenings or the mornings, primarily in cooler months. The majority of the rooftops exhibited unfinished or partially finished surfaces, exposed utilities, rudimentary parapet walls, and open-to-sky conditions. These physical states constitute the affordances (Gibson, 1979) that invite or constrain certain behaviours—e.g., broad open surfaces afford drying clothes or gatherings, while lack of shade affords only short-term occupancy during high heat periods. Case study data supports this by pointing to climate sensitivity as a major determinant of rooftop use, and highlights how owner-occupied properties, due to their stability and long-term planning, show greater interest in features like cool roofs and gardens.

Across most sites, residents had introduced informal, tactical modifications (De Certeau, 1984) such as tin sheds, movable seating, grills, temporary water storage, and improvised electrical connections. These incremental adaptations demonstrate how users modify spaces to compensate for the shortcomings of the formal built environments. They use the rooftops as multifunctional spaces—used for doing physical exercise, utility, drying clothes, gardening, and even social events. Yet, constraints such as heat, lack of shade, and inadequate access restrict their potential, a finding echoed in both the data sets.

Structural concerns, particularly in older buildings, and psychological and social barriers—like disinterest, lack of time, or privacy concerns—further limit the use. Thus, rooftop transformation emerges as an accumulation of intention-driven micro-practices, shaped by both environmental pressures and cultural expectations.

Gendered use also surfaced in the interviews: women frequently used rooftops for domestic activities, while men used them for leisure or social gatherings—aligning with Lawrence's (2000) observation that domestic spaces contain formal/informal layers negotiated by daily routines.

Case study analysis aligns, noting that renters and residents of aging buildings express heightened concerns about safety, cost, and convenience, which ultimately hinder investment in rooftop improvements. Respondents frequently reflected on discomfort from heat exposure, intense sunlight, and lack of protection during the monsoon, demonstrating how environmental conditions mediate rooftop usability—confirming that environmental affordances strongly influence user behavior.

The case study also underscores the economic disparities affecting willingness to renovate rooftops. Owners reported a mean willingness score of 3.7, compared to 2.2 among the renters, a trend confirmed by the survey which observed heightened cost sensitivity among the rental occupants. Both data sets converge on the need for policy-driven support mechanisms, such as government subsidies and awareness campaigns, to encourage adoption of rooftop enhancements—particularly among the renters who lack agency and financial incentives. Moreover, survey responses reflect the need for retrofitting initiatives to overcome safety, accessibility, and comfort challenges, especially in structurally outdated buildings. Survey participants expressed clear intentions for improvements as follows.

- Desire for shade reflects intention toward comfort.
- Interest in gardening reflects cultural values of greenery and care.
- Preference for seating reflects social intentions for family use.
- Expectation for better lighting or storage reflects functional intentions.

These aspirations demonstrate how the residents project future meanings onto the rooftops, conceptualizing them not merely as leftover spaces but as potential spaces awaiting transformations.

In fact, both methods converge in revealing rooftops as multifunctional lived spaces, appropriated through daily routines and informal adaptations. Across the findings, rooftops emerge not as passive architectural surfaces but as culturally shaped environments where:

- affordances influence behaviour.
- intentions motivate modifications.
- informal practices compensate for inadequate design &
- cultural routines structure time and pattern of use.

This reinforces the theoretical understanding that rooftop use in the Indian context is a product of the interaction between environment, intention, and culture.

The catalogue of informal adaptations observed across the 32 rooftops offers a repository of user-generated design knowledge. Architects and planners can use these insights to develop design guidelines that acknowledge and enable flexible, everyday appropriations rather than suppress them.

Finally, the triangulated findings affirm that while rooftops are currently underutilized by a portion of residents, they hold significant untapped potential as climate-responsive, multi-functional spaces. Physical comfort, accessibility, and privacy emerged as the top priorities for rooftop use, followed closely by functionality and sustainability—indicating a collective desire to shift terraces from passive to performative spaces. The quantitative insights from the case studies support these priorities, further emphasizing that strategic design, policy interventions, and behavioral incentives are essential to unlocking the rooftop as a dynamic and equitable urban asset. Municipal authorities can incorporate these insights in rooftop utilization policies, urban renewal schemes, and sustainability guidelines (e.g., rooftop gardens, solar installations, community terraces), ensuring that they align with actual lived practices rather than idealized assumptions.

Conclusions

This study set out to develop a deeper understanding of rooftop spaces as experiential, social, and evolving components of life in the low-rise residential apartments in Hyderabad. By combining a questionnaire survey with detailed rooftop case studies, the research reveals a clear picture of existing conditions, patterns of use, and resident preferences, alongside the opportunities and constraints shaping the rooftop use in this context.

Observations across 32 case-study rooftops confirm that most terraces remain minimally furnished and climatically exposed, with limited shades, seating, or safety measures, thereby restricting their usability. Yet, even within these constraints, residents engage in everyday practices such as evening relaxation, children's play, and occasional social gatherings, revealing that rooftops already function as lived domestic extensions when conditions permit. Survey responses indicate strong interest in transforming rooftops into green spaces, recreational areas, and renewable-energy platforms, reflecting aspirations for comfort, productivity, and social interactions.

In fact, residents view rooftops as potential spaces for gardening, leisure, small events, and climate-friendly interventions. These aspirations highlight significant opportunities to enhance both environmental performance and quality of life in low-rise neighborhoods. Despite clear interest, however, several barriers limit the fuller use of the rooftop spaces: inadequate design (lack of shade, lighting, and safe parapets), climatic discomfort during summers, structural limitations in older homes, cost and maintenance concerns, and socio-cultural factors—including restricted access in rental properties or gendered norms governing outdoor use. These constraints create a persistent gap between the potentials of the rooftops and the actual practices.

Overall, the findings demonstrate that rooftops in Hyderabad are affordance-rich yet under-designed lived spaces, shaped by user intentions, cultural routines, and tactical informal

adaptations rather than formal architectural provision. Addressing design deficits, improving safety and infrastructure, and increasing awareness of rooftop possibilities can unlock meaningful opportunities for climate resilience, social well-being, and sustainable domestic environments. By documenting existing conditions and clarifying user expectations, this study provides a grounded foundation for more people-responsive architectural and urban planning approaches to rooftop design in Indian low-rise contexts.

Limitations and Future Research

This study is limited by its focus on low-rise residential buildings in Hyderabad, which restricts generalization to other climatic or cultural contexts. The questionnaire relied on self-reported data, introducing potential bias despite triangulation with case studies. Rooftop practices were captured at a single point in time, limiting insight into seasonal or long-term behavioral shifts. In addition, restricted access to certain rooftops—due to privacy, cultural norms, or security concerns—may have excluded atypical or extreme cases from the analysis.

Future studies should compare rooftop practices across diverse climatic zones to assess how environmental conditions shape affordances and lived use. The case studies can be expanded to other residentials areas of Hyderabad. Longitudinal or seasonal research could deepen understanding of cultural rhythms, festival use, and thermal adaptation. Participatory or action-research approaches may test design prototypes and examine how formal interventions interact with informal modifications. As Indian cities grow vertically, research on shared or high-rise rooftop spaces is urgently needed. Finally, future work should explore how rooftop practices intersect with sustainability goals, including energy production, water management, biodiversity, and heat mitigation.

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Ethical Research Practice: Data employed in this research has been generated by empoying ethically apprpriate means.

Availability of Data: This research uses unique data obtained from the low-rise housing in Hyderabad in India. Not all the data have been presented. They are available for scrutiny if and when it is necessary to examine them.

References

Abuseif, M. & Gou, Z. (2018) A review of the development of green roofs and rooftop gardening for urban sustainability. *Sustainable Cities and Society*, 43, 725-735. https://doi.org/10.1016/j.scs.2018.03.020

Akbari, H., Levinson, R. & Rainer, L. (2016) Monitoring the energy-saving benefits of cool roofs in India. *Energy and Buildings*, 113, 134-142.

Braun, V., & Clarke, V. (2006) Using thematic analysis in psychology. Qualitative Research in Psychology, 3(2) 77–101. https://doi.org/10.1191/1478088706qp063oa

Chaturvedi, V., Ghosh, A., Garg, A., Avashia, V., Vishwanathan, S. S., Gupta, D., Sinha, N. K., Bhushan, C., Banerjee, S. & Datt, D. (2024) India's pathway to net zero by 2070: status, challenges, and way forward. *Environmental Research Letters*, 19(11), 112501

Chowdhury, R., Haque, M. & Kabir, H. (2016) Rooftop gardening as a strategy of urban agriculture for food security: The case of Dhaka City, Bangladesh. *Urban Studies*, 53(2), 310-329.

Certeau, M. de. (2011). *The practice of everyday life* (S. F. Rendall, Trans.; 3rd ed.). California: University of California Press.

Dasgupta, R. & Bose, M. (2020) Barriers to rooftop utilization: A socio-cultural analysis in India. *International Journal of Urban Development*, 45(3), 201-216.

Gehl, J. (2011) Life between buildings: Using public space. Island Press.

Gibson, J. J. (1979) The ecological approach to visual perception. Houghton Mifflin.

Jain, S., Garg, T., Jain, R. & Kuldeep, N. (2019) Demystifying India's rooftop solar policies.

Gupta, P. (2019) Relevance of Terrace Space in Architecture. *International Journal of Research and Analytical Reviews* (IJRAR), 6(1). Retrieved from www.ijrar.org. ISSN 2348-1269 (E-ISSN), ISSN 2349-5138 (P-ISSN).

Kumar, R., Singh, M. & Jain, S. (2018) Thermal performance of cool roofs in Indian residential buildings. Building Research & Information, 46(4), 382-397.

Lawrence, R. (2000). Urban households: The intersection of public and private domains. *Journal of Housing and the Built Environment,* 15(1), 1–12.

Lefebvre, H. (1991) The production of space. London: Blackwells.

Ministry of New and Renewable Energy (MNRE). (2023) Solar rooftop subsidy scheme. Retrieved from https://mnre.gov.in

Pandey, A., Kumar, M. & Singh, R. (2017) Impact of rooftop vegetation on urban thermal environment: A review. *Building and Environment*, 112, 110-122.

Patel, D., Sharma, R. & Joshi, M. (2021) Urban agriculture and thermal comfort: Insights from rooftop gardens in Ahmedabad, India. *Urban Climate*, 37, 100857.

Rao, K., Sharma, S. & Patel, A. (2021) Potential of rooftop spaces in Hyderabad: A socio-environmental perspective. *Journal of Urban Design and Sustainability*, 9(1), 89-105.

Rapoport, A. (1969) House Form and Culture. USA: Prentice Hall.

Rapoport, A. (1980) Human aspects of urban form: Towards a man–environment approach to urban form and design. USA: Pergamon Press.

Rapoport, A. (1982) The meaning of the built environment: A nonverbal communication approach. London: Sage.

Shahsavari, A., & Akbari, H. (2018) Potential of solar energy in reducing CO_2 emissions in urban areas: A case study of Tehran. *Renewable Energy*, 123, 58-74.

Sharma, V., Patel, D., & Joshi, M. (2020) Recreational rooftop spaces: A case study in urban India. *International Journal of Urban Design*, 45(3), 243-259.

Schutz, A. (1967) The phenomenology of the social world. Northwestern University Press.

Thomaier, S., Specht, K., Henckel, D., Dierich, A., Siebert, R., & Sawicka, M. (2015) Farming in and on urban buildings: Present practice and specific novelties of zero-acreage farming. *Renewable Agriculture and Food Systems*, 30(1), 43-54.