



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 12, Issue 5, May 2023

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.423

9940 572 462

6381 907 438

ijirset@gmail.com

www.ijirset.com

Exploring a Design Vocabulary for Detached Residences in the Contemporary Kerala Context

Ar. Vidya Kamath¹, Dr. Manoj Kumar K²

Associate Professor, T.K.M. School of Architecture, Kollam, Kerala, India¹

Principal, Kerala State Institute of Design, Kollam, Kerala, India²

ABSTRACT: Kerala is known for its dense settlement pattern manifested with an urban-rural continuum with a relatively uniform spread of dwelling units, characterized by dwellings in individual plots scattered all over the habitable area[1], a derivative of farmstead houses. The rapid urbanization over the previous decades has put high pressure on land, making the buildable residential plot less affordable and reducing the average available plot size to 3 to 5 cents (121 m² - 202 m²). The fast pace of urbanization has brought about the over-exploitation of open/ green spaces and resulted in massive changes in land use. Agrarian land use has given way to residential and commercial land use and increased footprints. These have resulted in severe microclimatic changes, massive waste generation, pollution of water bodies, and decreased percolation. Traditionally Kerala dwelling units used to hold open spaces inside the building as courtyards "nadumuttom" or outside the building as external yards "muttoms" and the larger extent of green land "parambu." These helped not only in creating a micro-climate that would help achieve thermal comfort for the residents but also acted as threshold spaces for the social and cultural activities which bound the people together as a community and hence lead a sustainable life.

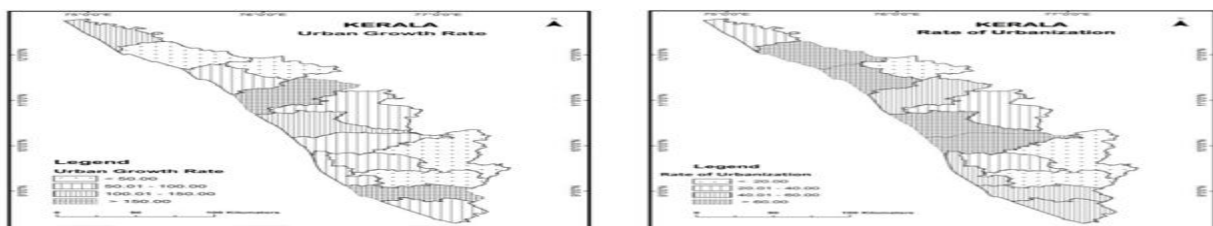
It is in this context present-day architects have to work with all the issues, trying to balance establishing thermal comfort, addressing ecological concerns, reducing construction costs, and creating a spatial quality that encourages a healthy sociocultural connection within/between families. A new typology of detached residence in small plots 2 – 5 cents is evolving. It is also interesting to note that it is an acceptable typology for most people in Kerala. This research focuses on creating a model approach to design dwelling units in small plots (less than 121 m²). The research explores spatial, climatological, ecological, and materialistic design dimensions. The paper also investigates how a holistic, sustainable built space can be designed, considering energy needs, waste management, and the building lifecycle of a single-family residence. This research explores generating a model for independent residential buildings in small urban plots.

KEYWORDS: Residential architecture, small plot, urban context, sustainability in the built environment, passive design, spatial quality, rapid urbanization

I. INTRODUCTION

Kerala has been undergoing rapid urbanization and population growth for several years. Urbanization in Kerala is quite interesting; it was only 26.39% in 2001, and in 2011, it almost doubled to 47.71 %, which means nowadays, almost half of the Kerala population lives in urban areas[2]. The increasing concentration of population in the urban area puts pressure on the land as a resource hence a piece of land is treated as an asset of prime importance. The unusual price increases have immensely facilitated land proliferation, resulting in smaller plot sizes for land development.

Figure 1: Map showing urban growth rate and rate of urbanization in Kerala



Source: Ishaque, Aboo "A Spatio-temporal analysis of urbanization in Kerala, India.[3]"



Kollam is one of the major cities in Kerala, Figure 1. shows the urban growth rate and rate of urbanization of Kollam as per the 2011 census. Urbanization leads to developmental activities that should improve the city's quality by making it safe, comfortable, sustainable, and environmentally friendly. On the other hand, unplanned rapid urbanization is causing over-exploitation of open/ green spaces and resulting in massive land-use changes. Agrarian land use has given way to residential and commercial land use and increased footprints. These have resulted in severe microclimatic changes, massive waste generation, pollution of water bodies, and decreased percolation.

A dwelling unit is the smallest block of any urban development but significantly impacts the city's whole behavioral and social setup. Improving the conditions of the city starts by improving the conditions of the dwelling unit. This research looks into providing guidelines to architects, researchers, and residents to create a new design vocabulary for detached residences in the current land use context of Kerala.

II. RESEARCH METHOD

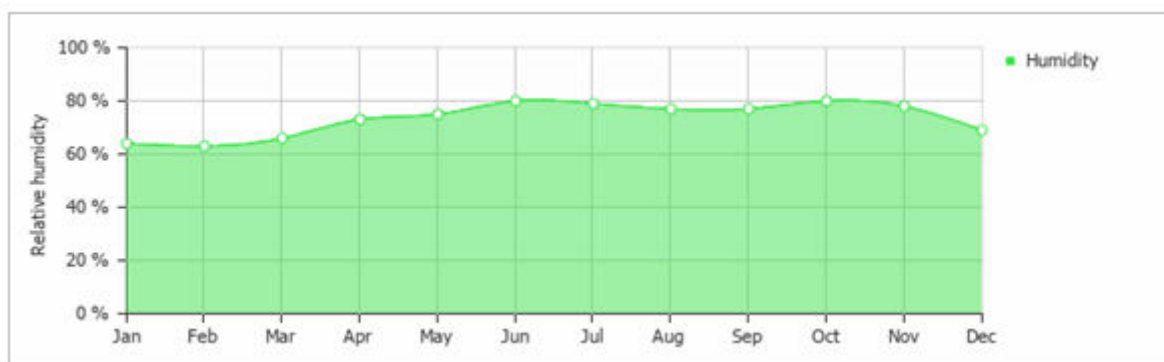
This research paper was an outcome of the ongoing architectural practice for building in dense urban residential plots. Building in dense urban footprint areas is always challenging as a residence is not a building alone; it is an emotion and setting for its inhabitants to explore and celebrate life. A residence influences the cultural, social, emotional, mental, and physical well-being of the inhabitant, making them humans with imbibed values, which is very much the need of the time for society. Designing comfortable living conditions in a hot and humid tropical climate in a small plot of 3 to 5 cents (121 m² - 202 m²) has always been challenging. The passive design strategies used vernacularly and otherwise were observed and documented, the inhabitants' social, cultural, and economic context were deciphered, and the neighborhood and climatic/ microclimatic conditions were observed to develop the design strategies for creating the spatial and material vocabulary for the design of the residence.

III. UNDERSTANDING THE CONTEXTS

3.1 Climatic context

Kerala has a hot and humid tropical climate with seasonally excessive rainfall and hot summer. The State is extremely humid due to the existence of the Arabian Sea [4] in the west of it. The maximum summer temperature in Kollam is 34°C, and the minimum temperature recorded during the winter is 21°C[5]. The average rainfall in Kollam city varies between 1100 mm to 1500 mm per annum. The proximity to the Arabian Sea and the constant rainfall have kept the average humidity of the place to around 70%, the lowest humidity being around 60%; summers are sultry and uncomfortable.

Figure 2: Average relative humidity in Kollam[6]



Source: <https://weather-and-climate.com/>

3.2 Urban and neighborhood context

Kollam is rapidly urbanizing, with increasing pressure on the vacant plots for commercial and residential purposes. As per Census 2011, in Kerala, about 68% of the families occupy pucca houses, while the national average is about 55%. This suggests that Kerala has far more better-living conditions for the poor when compared to the nation. However, the rate of urbanization and increasing cost of living might affect the average living conditions of the urban poor.

Individual houses are prevalent in the city, while the trends of multi-family dwelling units are emerging in the peripheral areas. The detached houses carry over the agrarian society that Kollam used to have, and this residence typology has a deep-rooted cultural value in the people's hearts. This is also a reason for the proliferation of the land, and the increasing land value has made people go for smaller plots to build houses. Figure 3 suggests the typical footprint of any residential plot in Kollam. Today it is not only about the quantitative shortage of dwellings; qualitative aspects of housing have gained importance too[7].

Figure 3: The figure and ground map of a typical residential sector in Kollam



Source: Author

3.3 Socio – Cultural context

Due to the changing lifestyles and habits, people prefer more individual freedom and hence resort to a small, independent family setup. Families and households in the city mainly consist of nuclear families with 2 to 3 children or even a three member house. Other types of household compositions are two or more working individuals and single women living independently[7]. Despite several advantages and disadvantages of the joint family system, the number of nuclear families is increasing at an alarming rate due to the impacts of urbanization. People still try to keep the spirit of community alive through residential associations, which play the role of an extended family. Each residential association may have a place of worship, a place to gather, and a small play area for kids, with schools and other necessary infrastructure nearby.

3.4 Sustainability context

The human purpose of constructing buildings is to fulfill the spatial, visual, cultural, social, thermal, and aural needs. In 1987, the United Nations Brundtland Commission defined sustainability as "meeting the needs of the present without compromising the ability of future generations to meet their own needs." Today, there are almost 140 developing countries in the world seeking ways of meeting their development needs[8]. However, with the increasing threat of climate change, substantial efforts must be made to ensure that development today caters to future generations. Hence a building should be designed with the utmost care, reduced ecological footprint, and a significantly lower operational cost and should also be flexible.

IV. DESIGN CONSIDERATIONS

The site is located at Mulamkadakam, Kollam, in Kerala. It is one of the old residential zones in Kollam. The occupant family had six members comprising a couple, the earning members, two kids, and a grandparent. The plot size was three cents or 121 m².

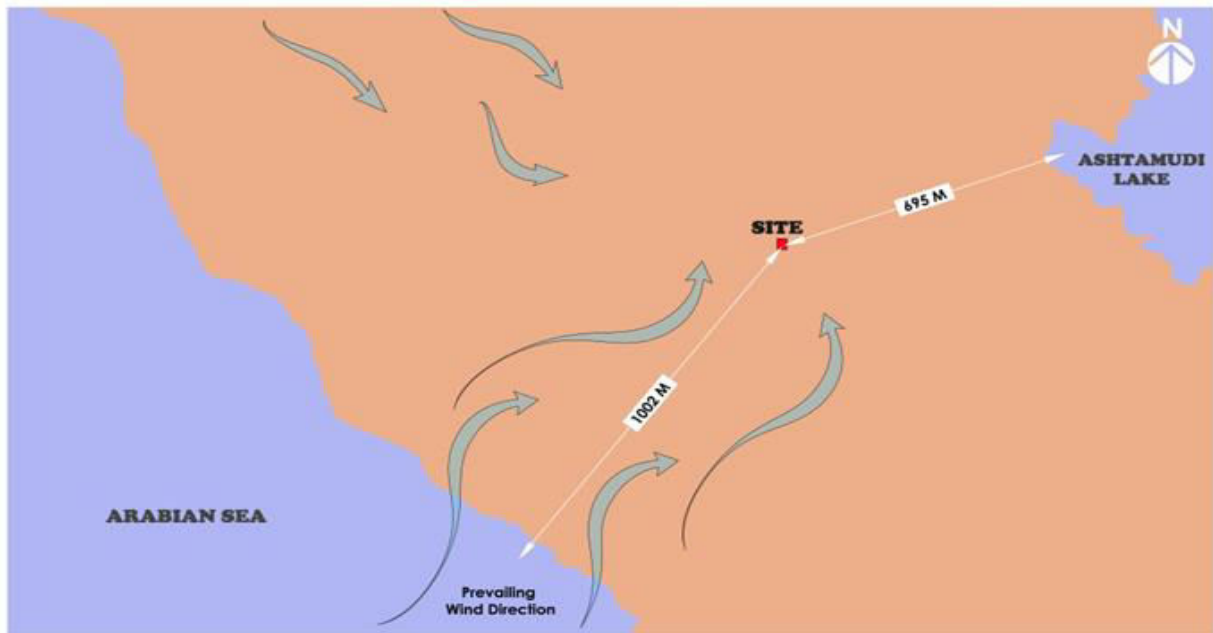
4.1 Zoning

The attributes of the site that were considered for zoning were

4.1.1 Location and distance of site w.r.t. the water bodies

Mulamkadakam is only a kilometer from the Arabian Sea and 600 meters from Ashtamudi backwater, suggesting that it typically enjoys excellent wind movement but is highly humid. The high humidity is responsible for uncomfortable summer conditions making it very sultry. The design required to have maximum possible cross ventilation to create a very comfortable living condition for the occupants.

Figure 4: Map showing the proximity of the site from the Arabian sea and Ashtamudi backwaters



Source: Author

4.1.2 Orientation and neighborhood context

The geographic orientation of the site was towards the North, with the longer side of the plot facing North. The plot in front of the site was vacant that could be used for the advantage of the design; on the west and south, it was closely flanked by residences that were single-storey high with barsati roofs, and on the east was again residences which are set apart by a pedestrian path. Like any typical plot in Kerala, it looks to a secondary road that has moderate traffic during peak hours and is sparse during the early morning and late evenings. The site was topographically 0.9 m higher than the road level making direct access from the road to the plot difficult.

Figure 5: Location and orientation of the site and its sun path diagram.



Source: Author

4.1.3 Family size and lifestyle of the occupant

The occupants were a six-member family of a couple with their two kids and grandparent. The income generators, the husband and wife of the family, were working in the private service sector. Their lifestyle demanded a 3 B.H.K. residence with a parking space for at least a four-wheeler and a two-wheeler.

4.1.4 The social and cultural context of the occupant

The occupants, before residing here, were a part of a joint family and hence had a deeply rooted belief in the extended family system and entertained family and friends frequently at the residence. The occupants had a firm religious belief and followed the traditional customs and values of the clan. Hence, the design had a prominent pooja space and a Tulsi thara in the front yard.

Considering the above attributes, the residence was zoned into an activity and private zone. The activity zone was the heart of the whole residence, where family activities and social gatherings would happen. The spaces include formal living, pooja, dining, kitchen, and study. The private zone included the bedroom and dressing.

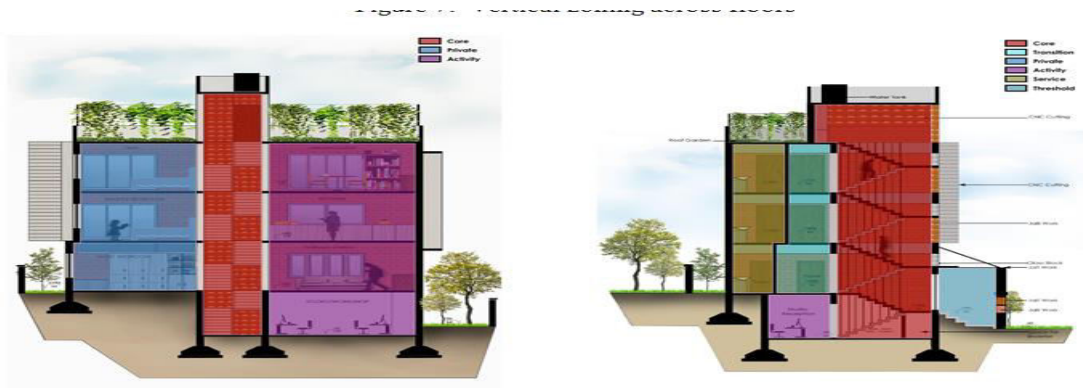
As the plot area was limited, each floor would contain an activity zone and a private zone separated by the core that housed the staircase. The transition zone connected these two major zones, which also was the stair's landing. The activity zone was placed on the eastern side of the plot, and private zones were on the western side of the plot. As the northeastern part of the plot looked onto a vacant green plot beyond the road, the activity zone was placed here to get maximum daylight and visual openness. On the other hand, the western and southern side flanked by residences was chosen for service and bedroom; the service core was onto the south, which had minimal privacy, and bedrooms faced the northwest, that looked onto the open space; hence maximum light was borrowed from the northwest corner than the western side, so the privacy of the space was maintained. A few threshold zones were also created to add to these zones, which became a link between the residence and the neighborhood. The core, which housed the staircase, the transition zone, and the services, vertically connected the private and activity zone on all floors making accessibility very easy. To meet the requirement of three bedrooms, the design was done on three floors, each housing an activity zone and a private zone. The terrace floor acted as the utility area along with being the green space of the residence, a reinterpretation of the traditional backyard space.

Figure 6: Horizontal zoning of the site.



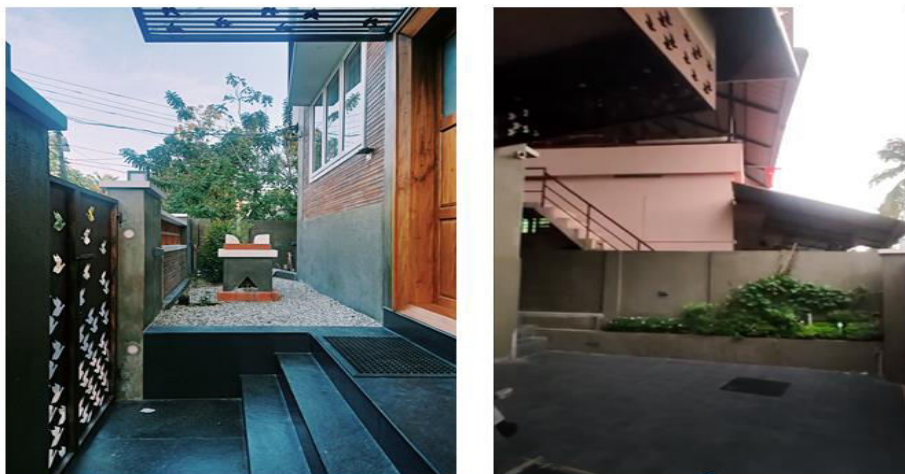
Source: Author

Figure 7: Vertical zoning across floors



Source: Author

Figure 8: The yards that extend to become social and interactive spaces



Source: Author

4.2 The structural system, material selection, and construction techniques

The attributes considered for selecting the structural system and materials were;

4.2.1 Flexibility and adaptability of the space

A framed structure was considered for the structural system as it would give the freedom to have a minimal building footprint on the ground floor and also have larger spans which will make the spaces more flexible and adaptable for not only the current need but also the future. The minimal footprint on the ground floor would ensure more open space for interaction between the street and residence, encouraging a robust social engagement with the immediate neighbors. Hence the car porch was a 3.2mx 3.2m cantilever leaving the plot more accessible without columns.

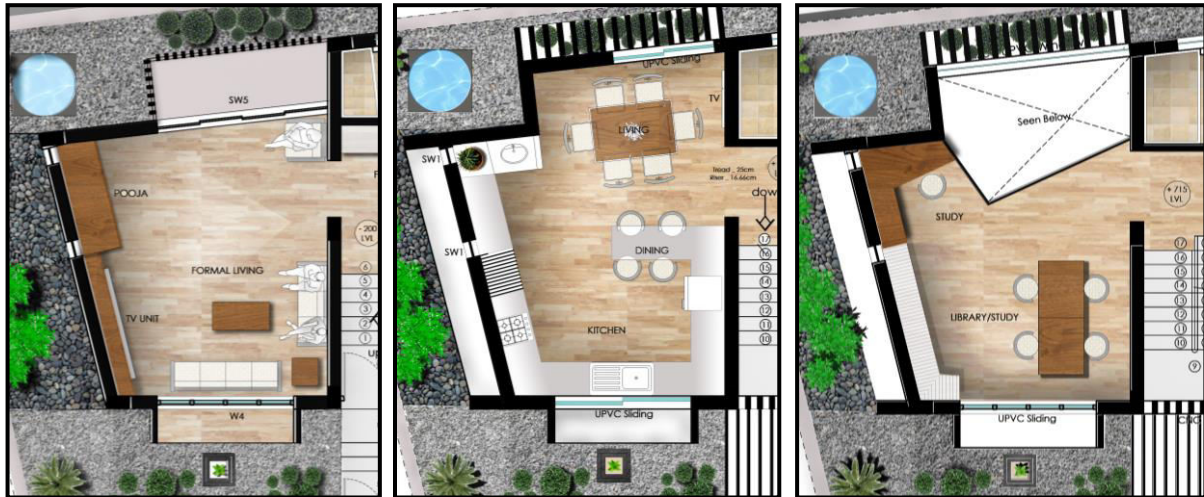
All the activity zones were large and housed two or more activities together; for instance, on the ground floor, the activity zone had pooja and formal living, which, on occasions of festivals, became an extensive gathering space for extended family. The first-floor housed the kitchen and dining together, making the space more flexible and accommodating more people, and the second-floor had a study with a library that could be converted into a guest bed if required. A double-height space connected the first and second floors over the dining, making the space volumetrically larger. Another key part of adaptability played by the framed structure is to grow vertically than horizontally in a detached residence typology. Suppose the current economic conditions of the client do not permit him to afford a three storey house. In that case, they can build two storeys to meet their present need and expand vertically when the conditions are better without compromising the spatial quality.

Figure 9: The residence from Northwest and Northeast respectively.



Source: Author

Figure 10: The flexible activity zones



Source: Author

Figure 11: The double-height space that connects the activity zone on the first and second floor



Source: Author

4.2.2 Embodied energy and operational cost of the material

We would opt for natural and locally sourced materials when discussing reducing embodied energy. However, the plot being narrow, providing enough shading from heavy rains and strong sunlight would not be possible, neither would it be possible to secure material from the site by itself; hence the next best alternative was to choose materials that would have lesser operational cost, better insulative property that would reduce the energy load on the building. Exposed porotherm bricks were used for walls, the exposed concrete finish of the structural system was kept intact, and minimal plastering and painting work was done. Porotherm bricks being hollow clay bricks, has a thermal transmittance/U

Value of 1.00 (W/m² .K), which is considerably less and hence can create very comfortable indoor conditions with natural ventilation. UPVC windows were used for the window opening because larger openings can be given with minimal section sizes for better ventilation. The maintenance cost is negligible and could be reused.

4.2.3 Occupant comfort

Passive techniques used vernacularly to induce thermal comfort in Kerala were internal courtyards, verandahs as threshold spaces, and sloping roofs with attic spaces. All these induced cross ventilation. As the plot was small and did not have the option to go for an internal courtyard, long verandahs, and sloping roof, those techniques were interpreted in different ways to create thermal comfort through cross ventilation. The core, which housed the staircase, used jalis as a material to act as a solar chimney. The core was subjected to maximum heat at the terrace level, creating the air draft.

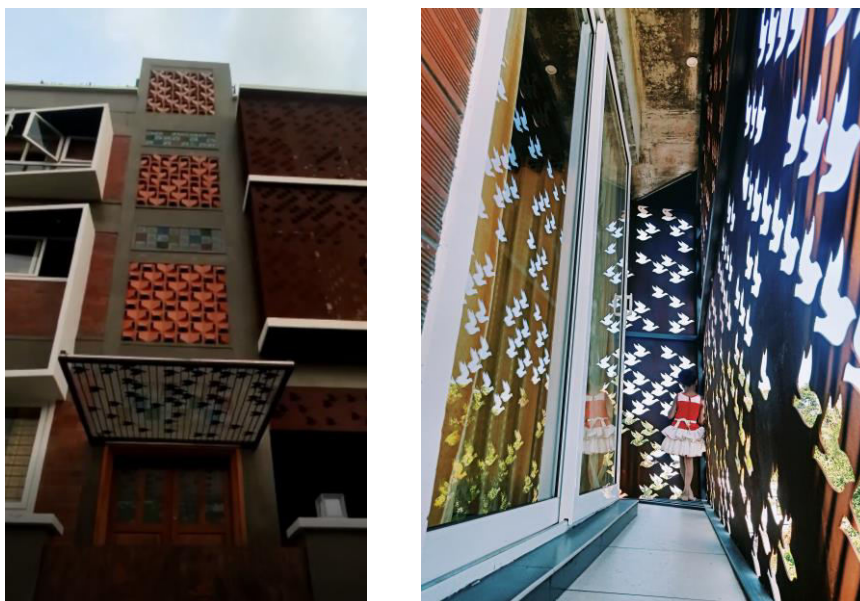
Figure 12: Passive Ventilation strategies - Wind draft created by the core, cross ventilation



Source: Author

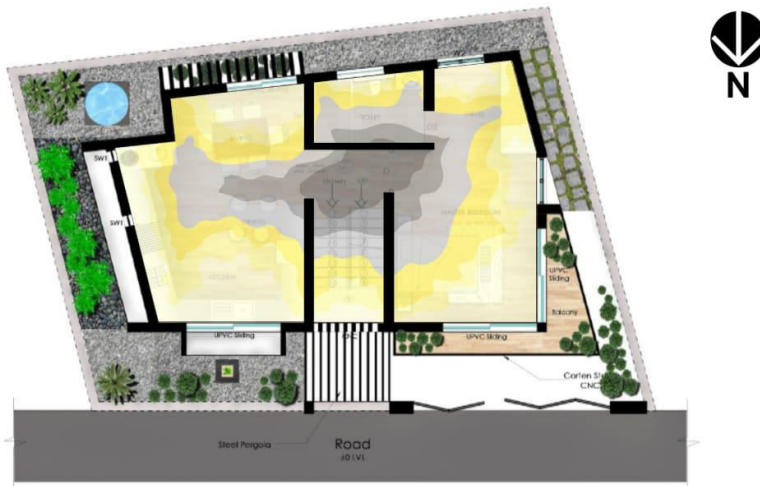
On the western side of the residence where the bedroom was located, openings were given on the south, west, and north facade to induce maximum cross ventilation. The opening on the northwestern side was larger and had more exposure to the sun; hence, a double facade was created using corten steel jaali to reduce the heat gain. Large openings were provided on the northern and southern facades of the activity zone to get maximum sunlight.

Figure 13: The core and the double facade corten steel skin



Source: Author

Figure 14: Daylight from large window openings



Source: Author

This double facade gave rise to a threshold space for the bedroom, providing better thermal comfort and a balcony space that could be used to grow plants. To avoid heat from the southern facade, climbers were provided in front of the window, and bamboo blinds were used as internal shading devices. The eastern facade had two small openings, which aided in cross-ventilation.

The terrace was given a 15 cm thick concrete slab and painted with reflective paint. The green cover helped reduce the terrace's heating up, reducing the heat load on the second floor. It also was used for the vegetable garden.

Figure 15: Terrace used as the vegetable garden and also utility space



Source: Author



4.3 Sustainability

As already discussed, minimizing the footprint on the ground floor by giving more area for rainwater and greywater percolation was one of the goals for sustainability. Waste management was another strategy applied where the compost bin provided on the terrace was used for composting all the biodegradable waste; the by-product of the same was used for gardening. All the furniture used was repurposed. The best definition of sustainability would be that traditional and cultural values were not overlooked; they were accommodated with the design so that these values could be handed over to the next generation.

V. CONCLUSION

The small plot should never become a constraint for an architect practicing today in Kerala to build residences in detached plots. The context of the plot has to be studied in terms of climate, microclimate, and neighborhood, the sociocultural needs of the client have to be understood, and sustainability as a part of the design process has to be adopted. The thermal and emotional comfort achieved in a vernacular residence in Kerala could also be very well achieved in a small plot detached residence by giving a different outlook to the passive energy ventilation method and reducing the energy load.

Table 1: Summary of the learnings from research

Spatial Planning	<ul style="list-style-type: none"> a. Flexible and adaptable to meet the current and future needs of the occupant b. Address the current socio-cultural needs of the occupant c. Provide maximum visual connectivity to the neighborhood without compromising privacy wherever required.
Structural system	<ul style="list-style-type: none"> a. Flexible to grow vertically b. Flexible to have larger spans to accommodate versatile needs of occupants providing a better spatial quality c. Adaptable for future generations to make changes as per their social needs.
Building Materials	<ul style="list-style-type: none"> a. Cost-effective and requires less/no cosmetic treatment b. Less on-site construction cost and maintenance cost c. Reusable
Occupant Comfort	<ul style="list-style-type: none"> a. Utilize passive energy techniques to provide cross ventilation like a solar shaft, double facade, and windows on the opposite wall. b. Reduce heat load by using appropriate material and orientation of the building. c. Optimum daylighting with mechanical internal shading device d. Better spatial quality would ensure good interaction among occupants to maintain their mental and emotional well-being.
Sustainability	<ul style="list-style-type: none"> a. Minimum building footprint to maximize water percolation and green space b. Spaces that encourage interaction with the neighborhood to encourage socio-cultural sustainability. c. Space to accommodate renewable energy sources such as solar panels and water heaters. d. Use of refurbished products

Source: Author

A new vocabulary has to be created, using contemporary construction techniques and building materials to create a comfortable and sustainable residence for tomorrow. A small step achieved by creating better residential conditions would improve the city's quality in a larger context.

REFERENCES

[1] Kumar, T.M.Vinod & Dahiya, Bharat. (2017). "Smart Economy in Smart Cities." 10.1007/978-981-10-1610-3_1
 [2] Department of town & country planning, Government of Kerala., State Urbanisation Report 2012.



- [3] Ishaque Aboo., (2018).“A Spatio-temporal analysis of urbanization in Kerala, India,“ IJRAR- International Journal of Research and Analytical Reviews, 5(4), pp. 30-37
- [4] Lachireddi, G & Muthukumar, P. & Subudhi, Sudhakar. (2016). “Thermal comfort analysis of hostels in National Institute of Technology Calicut, India.” Sādhanā. 42.
- [5] Climate of Kollam, accessed 02 November 2022, <<https://www.mapsofindia.com/kollam/geography/climate.html>>.
- [6] Average humidity in Kollam (Kerala), accessed 02 November 2022, < <https://weather-and-climate.com/average-monthly-Humidity-perc,kollam-kerala-in,India> >.
- [7] Altaş, N. E., & Özsoy, A. (1998). “Spatial adaptability and flexibility as parameters of user satisfaction for quality housing,” Building and Environment, 33(5), pp. 315–323.
- [8] United Nations Sustainability Report, accessed 02 November 2022, <<https://www.un.org/en/academic-impact/sustainability>>

Author Profile



Vidya Kamath is a practicing architect and academician. She received her Bachelor's degree in Architecture from TKMCE, Kollam, and a Master's degree in Design Industrial Design from S.P.A., New Delhi. She is currently working with the T.K.M. School of Architecture, Kollam, and also is the chief architect at Design Research Foundation, Kollam. Her area of interest is design pedagogy, the role of new technologies in sustainable architecture, design thinking, etc.



Dr. Manoj Kumar K is currently Principal at Kerala State Institute of Design(KSID).He is also Assoc. Prof. at C.E.T. Trivandrum. He has two decades of experience in design education, research, and practice. He has served as the programme in Charge of Urban Design at C.E.T., Trivandrum. He received his Ph.D. from CEPT, Ahmedabad, and his Master's in Urban Design from S.P.A., New Delhi. His primary research interests include design education, theory of design, morphological studies, timber architecture and joinery details in Kerala, and architectural history.



INNO SPACE
SJIF Scientific Journal Impact Factor
Impact Factor: 8.423



ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

9940 572 462 **6381 907 438** **ijirset@gmail.com**



www.ijirset.com

Scan to save the contact details