

Original Article

Analysis of Architectural Works of Geoffrey Bawa, Laurie Baker, and Hassan Fathy with Tropical Modern Relevance

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Abstract - Modern architecture offers a high-quality ambiance to support human living style based on its geographical location, climatic conditions, and unique human characteristics and emotions. The goal of tropical climate architecture is to create comfortable and healthy indoor environments while minimizing the use of energy-intensive systems. This is achieved through the use of passive cooling techniques such as natural ventilation, shading, and thermal mass. Additionally, tropical architecture often incorporates passive design strategies, traditional building techniques, and materials that are well-suited to the local climate. This paper compares the architectural design approaches of 'three architects' who practiced regional/ tropical modernism: Geoffrey Bawa, Hassan Fathy, and Laurie Baker. We attempt to comprehend and study the ways in which they have managed their strategy in an effort to attain the ideal combination that suits several aspects of Chennai's microclimate by deriving the ideal combination of the chosen three architects. The paper can conclude with the findings on various parameters like natural lighting and shading, ventilation, design pointers for a seamless space, appropriate building materials and construction techniques, climate-responsive features, and building metabolism. The above findings are then used to produce a tabulated design analysis and typology, which can be used as a playbook for future designers. As an inference, the findings from the conducted survey can be concluded that the Tropical modern architecture is a step ahead in response to our environment, and with Global climate-changing consequences, it can be considered the way forward,

Keywords - Tropical climate architecture, Modern architecture, Geoffrey Bawa, Hassan Fathy, Laurie Baker.

1. Introduction

Tropical climate architecture is the design and construction of buildings in areas with a tropical climate. The main goal of tropical climate architecture is to create buildings that are comfortable for inhabitants while also being energy-efficient and sustainable. Tropical/ Sustainable architecture is a response to the facts of local geography and context (Manjusha, 2016) [1]. Traditional tropical architecture is built using native materials by applying passive design strategies to fix tropical problems so the occupants feel comfortable and protected (Nadiar, 2020) [2]. In analyzing traditional practices, man kept simulating and matching the forces of nature to choose the best construction method (Mahdy, 2018) [3]. Tropical Modernism focuses on adapting traditional methods to modern contexts for sustainable living in tropical climates (Algburi and Beyhan, 2018) [4]. Three Architects who prominently practiced tropical architecture were Geoffrey Bawa, Hassan Fathy, and Laurie Baker. Fathy's thought was complexly intertwined with larger mid-twentieth-century architectural debates on culture and modernity

(Panayiota, 2007) [5]. Bawa reinterpreted outdoor transitional spaces such as verandas and courtyards integral to traditional houses, which were multifunctional living and circulation spaces that created physical and social interactions and thresholds (Perera and Pernice, 2022) [6].

His works and ideas are based on four key principles: shielding from direct sunlight, promoting natural ventilation, controlling humidity, and adapting to local conditions. These principles align with passive design concepts, which minimize reliance on fossil-fuel energy and mechanical systems. By integrating these strategies, his approach offers valuable insights for sustainable architectural design, emphasizing energy efficiency and environmental harmony in built environments (Chansomsak, 2017) [7]. These brought the idea of 'space' a distinctly modern meaning, making it a universal signifier (Estela Duque, 2009) [8]. This paper compares the architectural approach of three architects who practice regional/ tropical modernism: Geoffrey Bawa, Hassan Fathy, and Laurie Baker. In the present study, we strive to analyse



and examine the ways in which they have managed the strategies in order to achieve the ideal combination that fits the different features of Chennai's microclimate.

A notable research gap exists in the comparative analysis of Geoffrey Bawa, Laurie Baker, and Hassan Fathy's works within tropical modernism. Limited integrative studies explore the intersections of their design philosophies, vernacular adaptations, and sustainability, which are crucial for understanding their collective impact on contemporary tropical architecture.

2. Methodology

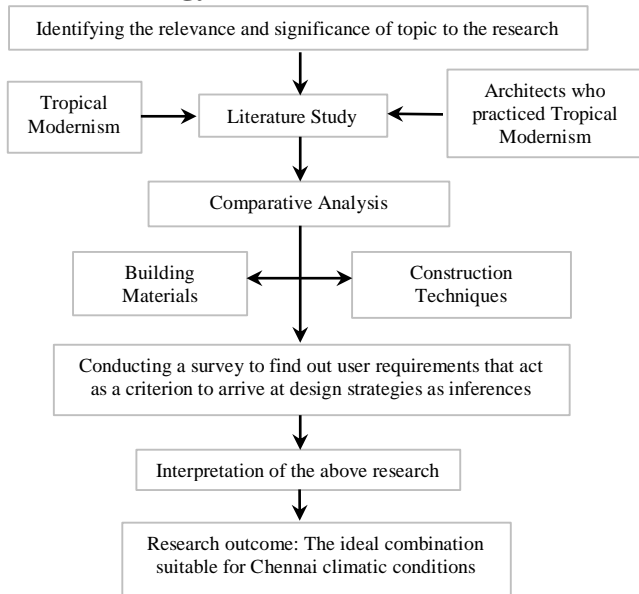


Fig. 1 Methodology

The above flow chart depicts the process methodology in which the research is conducted to infer the specific desired outcome. In the end, as an inference, the literature study is analyzed with a survey to compare the theoretical values and the user groups. The process also includes a detailed study of the key attributes that contribute to the chosen style of architecture.

3. Tropical Modernism

Tropical Modernism is a style of architecture that emerged in the mid-20th century, identified by its use of simple, clean lines and a focus on indoor-outdoor living. This style is particularly well-suited to tropical climates, as it incorporates elements such as wide overhangs, deep verandas, and open-air spaces to provide shading and natural ventilation, and it often incorporates elements of local culture and traditional building techniques. Tropical modernism also emphasizes the use of vernacular materials, such as wood and stone, and incorporates elements of nature into the design, such as gardens and water features. Some famous architects

and buildings that are associated with Tropical Modernism include Le Corbusier, Oscar Niemeyer, and the works of the Brazilian architect Roberto Burle Marx. The architects of Tropical Modernism sought to create a new style of architecture that would be appropriate for the tropics, which is modern and functional yet still incorporates the local culture and considers the specific climatic conditions.

Tropical Modernism combines the minimalist design of Modern architecture with climate-responsive strategies, adapting to the environmental challenges and conditions unique to tropical regions. A few architects who practice this style of architecture are Geoffrey Bawa, Hassan Fathy, and Laurie Baker. This research paper analyses the works of these architects by comparing the major aspects like Building Materials and construction, lighting and ventilation, spatial planning, response to climate, and means of achieving sustainability. It ends with an integration of all points in common to deliver a style that best suits Chennai and to figure out what works where and how.

3.1. Geoffrey Bawa

Geoffrey Bawa is considered one of the most influential architects in the development of tropical architecture. It could be recognized that Geoffrey Bawa's architectures reveal the place characteristics as nature, place characteristics as journey and stay, and place characteristics as sense. (In-Su Lee et al, 2014) [9]. Bawa's vernacular architecture resonated with communities accustomed to smaller spaces. He designed to blur the boundaries between public and private, and inside and outside, seamlessly integrating nature into human-made environments. (Perera, 2013, p. 86) [6]. He assesses space as a site of memory and a location where modernity and history are negotiated (Robin James, 2011) [10]. Distinctive flavors of Asian native tropical architecture include open verandas, courtyards, elevated foundations, gabled roofs, spacious frontage, ornately chiseled wooden balconies, and high-ceiling or double-storey structures (Stephen Poon, 2019) [11].

Bawa's designs respond to climate and meld with the surrounding landscape and elements. He imbued the colloquially revived architectural practices to create his adaptation of Tropical modern architecture. His freedom is all about how much more comfortable a space can get. "A building is understood by moving through it, experiencing the flow and modulation of spaces-from outside to veranda, then rooms, passages, and courtyards. Architecture cannot be fully explained; it must be felt and experienced firsthand."

Bawa's approach to tropical architecture was characterized by his use of traditional building techniques and materials, such as clay tiles, brick, and plaster, and the incorporation of local culture and history into his designs. He also placed great emphasis on the relationship between the building and its surroundings, often designing buildings that blended seamlessly with the landscape.

3.2. Laurie Baker

Laurie Baker was a British-born architect who worked in India for over 40 years. He is best known for his contributions to the field of tropical architecture, which focuses on designing buildings that are energy-efficient and well-suited to the local climate and culture.

Sustainability in this paper is viewed holistically, encompassing ecological, economic, human, cultural, and historical dimensions. In most cases discussed, these dimensions are interwoven and inseparable, reflecting a comprehensive approach to sustainable design and development. (Saurabh Tewari, 2015) [12].

His practices are visible proof of his understanding of culture, climate, and context. He used locally available materials, especially wastes, to significantly reduce the consumption of energy and secondary resources needed for extraction, processing, fabrication, and transportation. (Vaishali et al, 2018) [13].

Laurie Baker's work is celebrated for its blend of earthy and divine qualities, using vernacular techniques to create cost-effective, modern architectural solutions that respond to tropical climate conditions. His approach exemplifies sustainable, site-sensitive design. (Nitesh Dogne, 2017)[14].

He focused on nature primarily and gave importance to elements like landscape, rain, soil, rocks, and existing site factors that can be retained and designed around to bring the best from each site. He says in an interview, "Cost-effective housing is not just for the poor; it is for everyone. The notion that affordable homes are unattractive and only for the poor is misguided. Isn't it the responsibility of the middle and upper classes to avoid excess and create beautiful, efficient homes instead? This classification is entirely flawed, as affordability and aesthetics can coexist in thoughtful design."

3.3. Hassan Fathy

Hassan Fathy was an Egyptian architect who is best known for his work in sustainable architecture, particularly the use of traditional building techniques and materials. He believed that architecture should be accessible to all people, regardless of their economic status, and that it should be in harmony with the natural environment. Fathy's most famous project is the village of New Gourna, near Luxor, Egypt, where he used mud brick and other traditional building techniques to construct homes for the villagers.

During his long career, Fathy designed more than 170 projects, but only the village of New Gourna (1945) achieved real international attention, thanks to the publication, 24 years later, of Fathy's book *Gourna, A Tale of Two Villages*, the first time his work became known to a larger architectural community outside Egypt (Viola Bertini, 2020) [15]. Earth as a building material is globally valued for its sustainability and

passive energy efficiency. The construction techniques of rural communities have transcended geographical boundaries, evolving over time from ancient Egypt to the present day. This enduring tradition highlights the versatility and environmental benefits of earth-based architecture in various cultures and regions across centuries. (Ayman, 2018) [16].

Fathy's ideas were deeply connected to mid-20th-century debates on culture and modernity, surpassing simplistic identity narratives often linked to his concept of vernacular architecture. (Panayiota I. Pyla, 2007; In Research paper on 'Hassan Fathy Revisited') [5].

This architect from Egypt clasps the architecture that resonates with the culture and chronology of people and the place (site). He created a style with a 'local-modern' approach when the usual building materials were not available during World War II. His works extend with harmony and balance with his creative intellect beyond the vernacular approach. His passive ventilation methods in hot-arid climatic conditions, like wind catchers, traditional mud construction, and courtyards, at low cost, are why he is commemorated the most. He states in his book, "Build your architecture from what is beneath your feet. Tradition is the social equivalent of personal habit. Once you have mastered the craft, you can use it for whatever purpose you choose."

4. Tropical Architecture Attributes

Tropical architecture is a style of architecture that is specifically designed to address the unique climate and environmental conditions found in tropical regions. Some of the key attributes of tropical architecture include:

- **Natural ventilation:** Tropical architecture prioritizes natural ventilation and cooling to reduce the need for mechanical cooling systems. This is achieved through the use of large windows, high ceilings, and the use of shading devices such as verandas, eaves, and louvers.
- **Use of local materials:** Tropical architecture often incorporates the use of locally sourced, sustainable materials such as bamboo, thatch, mud, and clay, which are well suited to the tropical climate and environment.
- **Climate-responsive design:** Tropical architecture takes into account the specific climatic conditions of the region, such as high humidity, high heat, and heavy rainfall, in order to create buildings that are comfortable and energy-efficient.
- **Indoor-outdoor living:** Tropical architecture promotes an open-plan design and an easy flow between indoor and outdoor spaces, with features such as courtyards, terraces, and balconies.
- **Sustainability:** Tropical architecture promotes sustainability by using natural light, reducing energy consumption, and conserving water.

- Cultural sensitivity: Tropical architecture also takes into account the cultural heritage of the region and incorporates traditional architectural elements and styles into modern designs.

Tropical Modernism is an architectural style that incorporates elements of modernism with design strategies that address the specific climate and environmental conditions of tropical regions. Some advantages of Tropical Modernism include:

- Energy efficiency: Tropical Modernism prioritizes natural ventilation and cooling, reducing the need for mechanical cooling systems and reducing energy consumption.
- Climate-responsive design: Tropical Modernism takes into account the specific climatic conditions of the region, such as high humidity, high heat, and heavy rainfall, in order to create buildings that are comfortable and energy-efficient.
- Flexibility: Tropical Modernism allows for flexibility in design, which allows architects to adapt to changing weather conditions and to respond to the specific needs of the occupants.
- Sustainability: Tropical Modernism promotes sustainability by using natural light, reducing energy consumption, and conserving water.
- Cultural sensitivity: Tropical Modernism also takes into account the cultural heritage of the region and incorporates traditional architectural elements and styles into modern designs.
- Cost-effectiveness: Tropical Modernism often incorporates the use of locally sourced, sustainable materials, which can be less expensive than imported materials.
- Aesthetics: Tropical Modernism often creates buildings that are visually pleasing and unique, as it combines traditional and modern architectural elements.
- Comfort: Tropical Modernism buildings are designed to be comfortable in the tropical climate and to provide a pleasant living environment.

5. Analysis of Tropical Architecture Attributes

The mentioned attributes are analyzed based on Chennai, the southern region of India.

5.1. Light, Shade and Ventilation

The location and size of openings and the light, temperature, and humidity from these openings contribute majorly to the thermal comfort inside the built shells in tropical modern architecture. Various methods have been evolved to achieve this comfort.

- Bawa's windows do not have glass to avoid the modern touch that shows a pattern of wooden frames that let the light beautifully illuminate the interiors through the outdoor atmosphere.

- Fathy's openings are a part of the building itself like arches, jali patterns, and on varying levels, that let the light come in, regulating the heat and dust entering through the same openings.
- Baker's way of lighting and ventilation is minimal and optimal, using perforated walls and grilled wall cut-outs that organically flow with the building, which becomes a significant feature in his works.

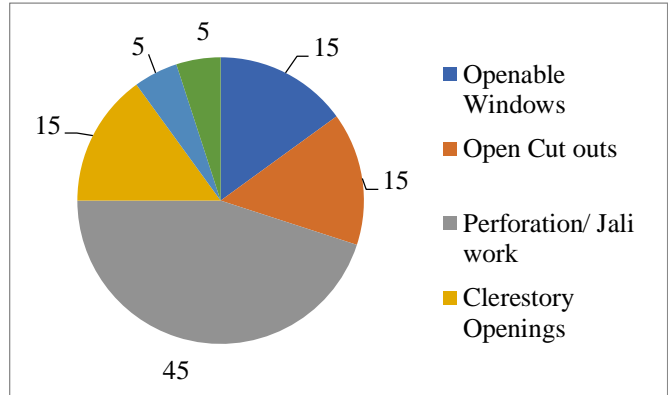


Fig. 2 Pie chart representing various general methods of natural ventilation

5.2. Seamless Space: Simple and Natural

There is an attempt to blur the boundary between inside and outside such that the rigorous periphery of a closed building structure is not prominent. The landscaping is such that it provokes the interaction between closed and open spaces, with courts around and within the built periphery.

- Fathy's spaces are open, with minimal furniture, and are cozy Tortilla. The entering light brightens the province inherently and enhances it. The roofing is usually arched (vaults and domes) in the interior and exterior.
- Bawa's spaces are cohesive with the landscape, blurring the boundary between indoors and outdoors. Artifacts and accent details add to this Walnut Wood space, and it creates warmth.
- Baker's spaces are seamless in Cinnamon Brown, with a small quantity of parametric design that glides flamboyantly into each other. They are minimally lit to make sure it gets intimate.

5.3. Materials and Construction

The similarities in all three architect's works are the usage of native and locally available materials that suit the context of the place in terms of climate, topography, thermal comfort, and other similar aspects. Mud and its associated derived materials are found to be the key solution to tropical conditions. The construction techniques and materials usually are inherited from traditional practices. The Bar graph shown below indicates the usage of Mud/ Earth in their construction as a primary building material. It is derived from various case studies of the chosen architects' practices and their style of architecture over the years and is, hence, representative.

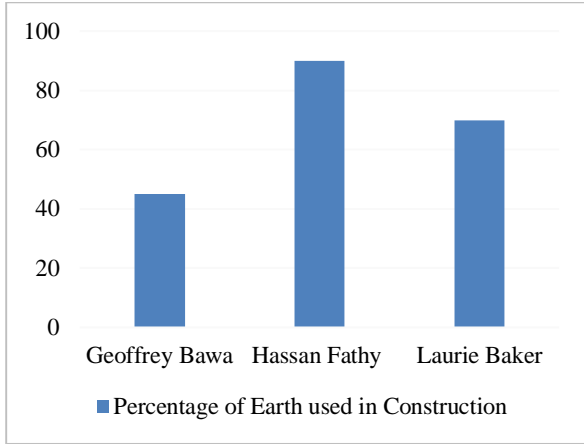


Fig. 3 Bar graph representing the usage of the earth as a primary building material

- Bawa used sun-dried bricks, finished with plaster and paint coat; wood for rafters and purlins in the roof and columns; glass panels for windows; steel for structural support system(s); and pebble turf flooring.
- Baker primarily used low-cost materials like bricks, Terracotta jali blocks of different volumes and functions, pot tiles for roofing, cement concrete for slabs and structural support system(s), and stone to blend the landscaping and oxide flooring.
- Fathy used mud, rarely finished with a whitewash or painted with warm color tones. The arches are usually built with mud bricks, and the structure is majorly load-bearing, with stone or paver blocks for flooring.

5.4. Response to Site Context

- Building for a tropical climate in a regional modern style is all about regulating the temperature, humidity, and ventilation to cater to the climate and provide maximum user comfort with available resources. This response from built material to the site context is what makes Tropical modernism, an effective style to get inspired from.
- It is observed that all three architects primarily used Mud (adobe) and materials made out of mud. This is not just because it is vernacular but also because it has the highest thermal mass, which is proportionate to the capacity of time lag. The thicker the exterior walls, the more the time lag, and the more efficient it becomes.
- It is also observed that since ventilation and lighting are both achieved naturally, it minimizes energy consumption from artificial means to achieve the same. Moreover, materials that reflect and penetrate heat easily are avoided to regulate the heat entering the building.
- The Site surroundings are integrated with the building in the best way possible such that there is outdoor within the indoor, which adds aesthetic and biophilic value to the entity.
- It is evident that there are no efforts taken to alter the physical characteristics or elements on the site. Possible

features are retained, and the shell is built around it to maintain an eco-friendly environment, like the on-site vegetation, topography (contours), access, underground water levels, etc.

Many details are executed particularly to a site based on its characteristics, that cannot be generalized and vary case to case based on site conditions. They also add up to the attributes that help provide user comfort, among various other solutions.

5.5. Metabolism on a Longer Span

Le Corbusier famously stated, "A house is a machine for living in," highlighting the rationality of machine design in architecture. In contrast, Fathy (1986) argues that "A machine is independent of its environment, little affected by climate and not at all by society," suggesting a disconnect between mechanical design and the nuances of human living conditions.

The major reason why these buildings have a long-life span is because it is not affected by the climatic context (They will not rust like iron and steel). The energy consumption is very low due to the availability of natural lighting and ventilation which makes it independent of exterior resources that help to function this machine. Most importantly, the built machine will be environment-friendly in all stages of construction, even beyond its lifespan.

5.6. Qualitative Analysis: A Case Study

Examining the Kumarakom Lake Resort in Kerala, designed by Laurie Baker. Renowned for his integration of traditional and modern techniques, Baker utilized locally sourced, low-cost materials such as laterite stone and terracotta tiles, adhering to his philosophy of sustainability and vernacular architecture. The construction process emphasizes minimal environmental impact, with techniques like rat-trap bond masonry to reduce material use while enhancing thermal insulation. Baker's approach to passive design, evident in the resort, maximizes natural ventilation and daylighting, reducing dependency on mechanical systems. The sloping roof, a hallmark of tropical architecture, facilitates rainwater runoff while providing shade. Furthermore, Baker's signature use of jaali walls enhances airflow, maintaining thermal comfort in the tropical climate. The resort embodies his ethos of simplicity, economy, and harmony with nature, exemplifying tropical modernism.

6. Survey and Inferences

6.1. Sample Analysis, Categorizing the Survey Questionnaire

As a part of this research, a questionnaire survey was floated among various user groups that benefit the study under the age range 22-45, sample size of ~ 103 professional respondents being professionals being Architects, urban planners, designers, and users that understand the benefits of

an Architect in the role of designing and planning, from various locations, majorly from Chennai, India

6.2. Survey Responses and Analysis

The following survey pie charts offer a quantitative analysis of public perception and expert insights on tropical modern architecture. These visual data representations examine key parameters such as material sustainability, passive cooling techniques, and vernacular influences. The inferences drawn provide a nuanced understanding of contemporary preferences and the efficacy of modern tropical design principles.

The survey's limitations include small sample size, potential respondent bias, and regional restrictions, which may restrict the generalizability of the findings to wider tropical contexts.

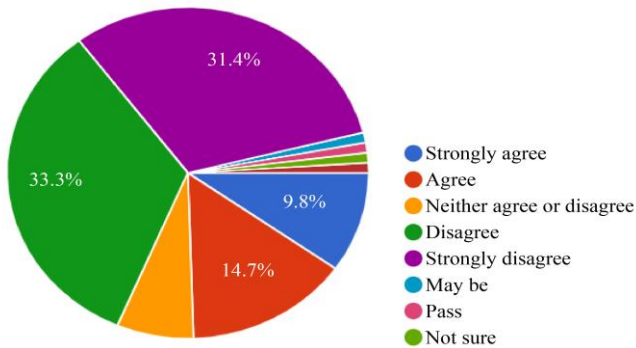


Fig. 4 Response to the question “Tropical modern architecture cannot be efficiently used for offices and high-rise structures. It is limited to residential scale only”

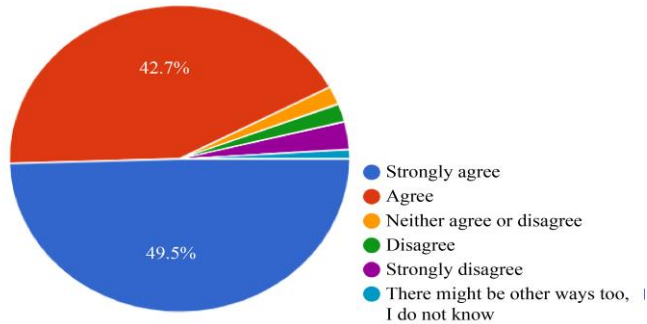


Fig. 5 Response to the question, “The main goal of tropical architecture is to create buildings that are comfortable for inhabitants while also being energy-efficient and sustainable”

Figure 4 represents the respondent's possibility of Tropical modern solutions for any typology of building, provided user comfort and energy efficiency come along with it to curb heat and cooling load.

It is interesting to note the mixed response for the first pie chart indicating that the users feel Tropical modern architecture cannot be efficiently used for office and high-rise

structures, although 48% of the users feel otherwise, indicating there is awareness and possibility.

On the other hand, 92.2% of users clearly state that the main goal of the Tropical Architecture is user comfort while also being energy efficient and sustainable (See Figure 5).

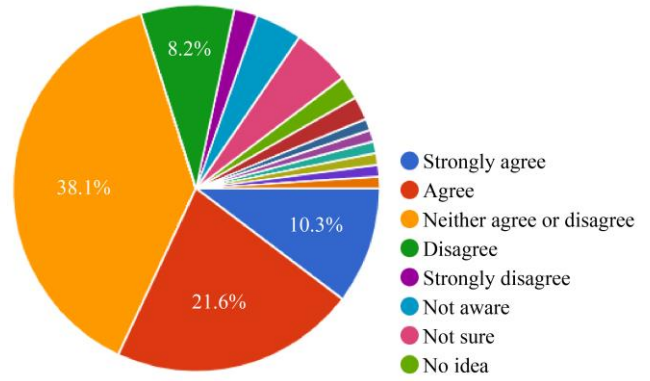


Fig. 6 Response to the question “Geoffrey Bawa's spaces were more elaborately designed than Laurie Baker's spaces”

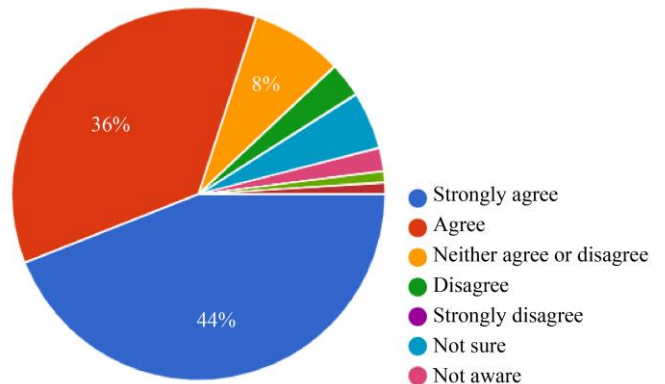


Fig. 7 Response to the question “Laurie Baker not just designed low-cost buildings, but also low-energy consuming buildings”

Figures 6 and 7 represent the contribution of Geoffrey Bawa and Laurie Baker to Tropical Modern Architecture. 59.7% of users agree that Geoffrey Bawa's spaces were more elaborately designed than Laurie Baker's spaces. Although it is noticeable that the response is mixed stating that Tropical architecture is not about spaces designed elaborately, but would be an element of it. Laurie Baker's contribution majorly focused on designing low-cost buildings, but it also came with low energy consumption, which is the most important factor corresponding to user comfort.

Figures 8 and 9 represent the importance of Traditional/Vernacular buildings. It is important to note that the response is mixed regarding vernacular building maintenance and space in the long run. However, 47.5% of users feel otherwise. On the other hand, 51.% of the people agree that tradition has its value and is sustainable by itself being materials, environment, energy consumption, or habitual routine, which makes it essential over the long run.

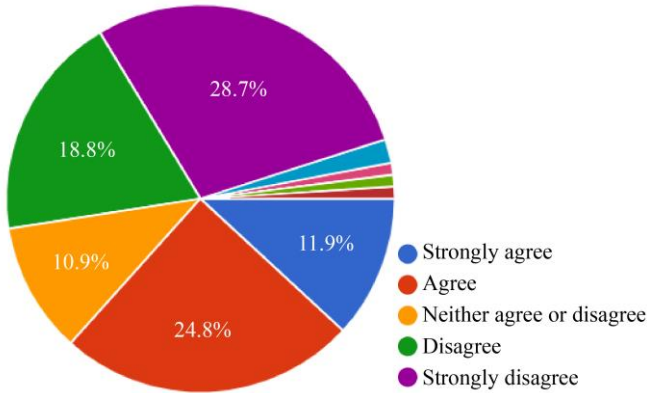


Fig. 8 Response to the question “Vernacular buildings are not durable and reliable in the long run (years) as RCC construction”

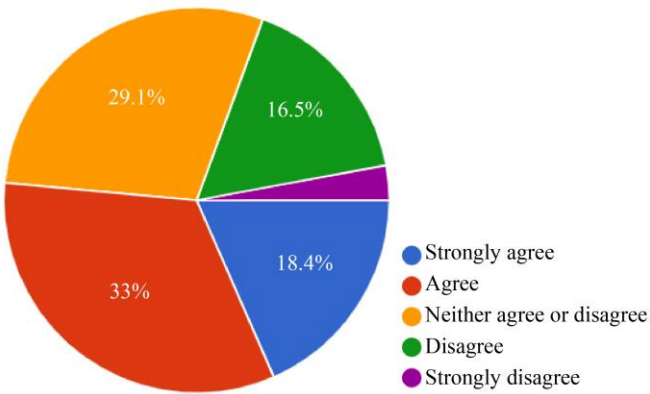


Fig. 9 Response to the question “All traditionally built buildings are sustainable by nature”

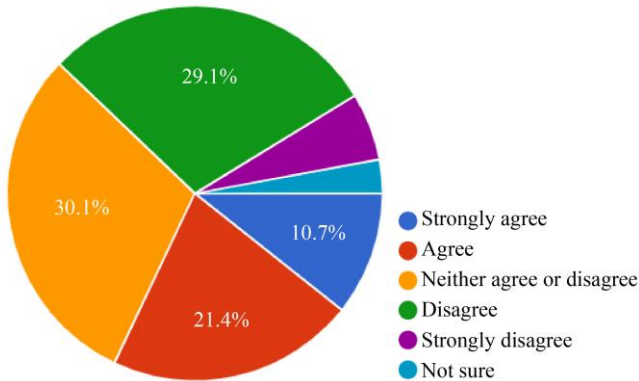


Fig. 10 Response to the question “Shading in buildings can majorly be done by using sunshades or overhangs only”

Figures 10 and 11 represent the key factors that bring user comfort in Tropical Architecture.

Natural lighting comes with heat entering the building, for which shading is essential. It can be done in various ways, from which sunshade is basic and user-friendly in all aspects. About 51.5% of people agree with it, but it is to be noted that 29.1% of people feel otherwise, indicating that other ways of shading are not incorporated as much to benefit the users.

In other aspects like Natural ventilation and the use of local materials, almost 91.2% of users agree to it.

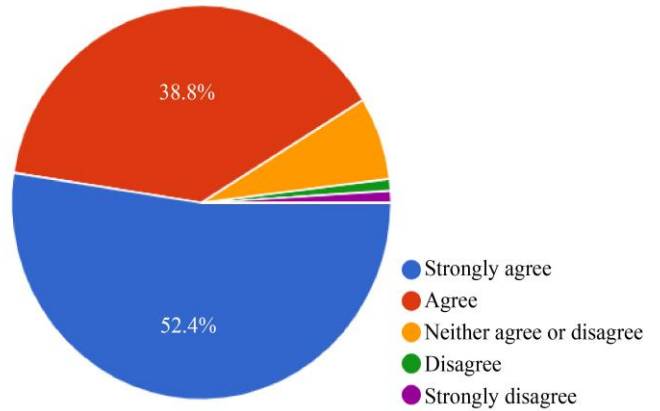


Fig. 11 Response to the question “Nature, ventilation and use of local materials are key attributes of Tropical Architecture”

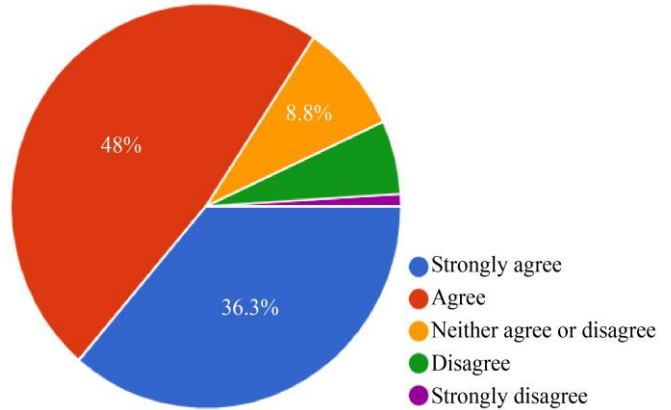


Fig. 12 Response to the question, “Any building should be cohesive with the surrounding landscape, creating a landscape and blur in the boundary between indoors and outdoors”

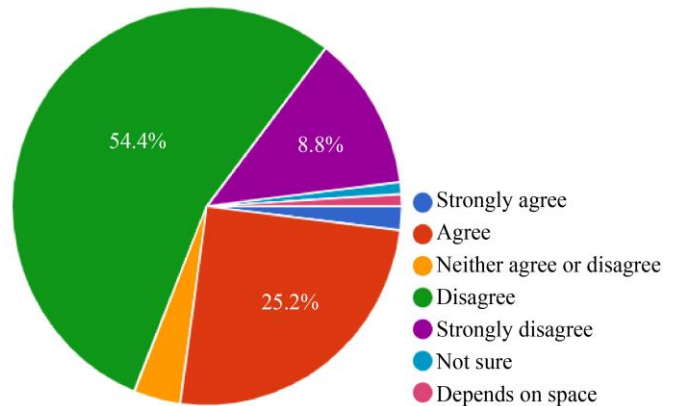


Fig. 13 Response to the question, “It is uncomfortable to have landscape inside buildings because it invites mosquitoes and insects, and it is not necessary”

Figures 12 and 13 indicate the importance of landscaping in and around the building.

84.3% of users agree that Landscaping acts as a connecting band between indoors and outdoors, encouraging interaction and activity that invites lighting and ventilation.

But it is also noticeable that 25.2% of the people feel that it might be difficult to maintain and question the practicality of landscaping and thus feel it is not necessary.

However, 54.4% agree to the importance of landscaping against its practical requirements, indicating it acts as an important part of Tropical modern architecture and user comfort.

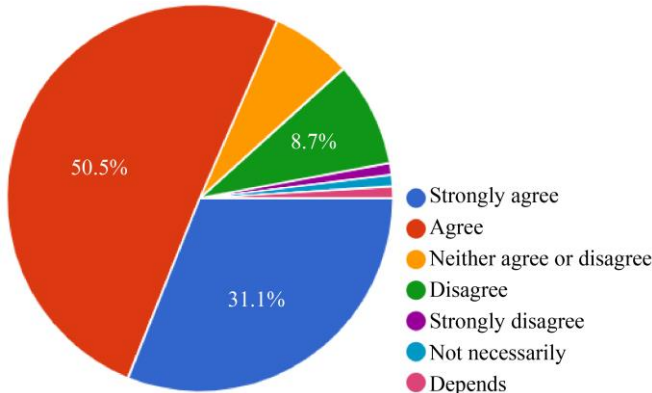


Fig. 14 Response to the question “Traditional buildings are more aesthetically pleasing than modern glazed facades and high-rise skyscrapers”

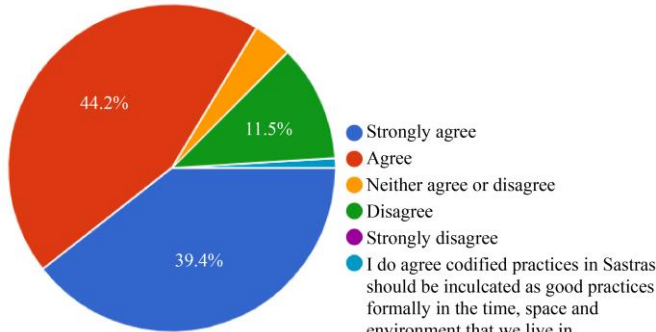


Fig. 15 Response to the question “I believe tradition is the social equivalent of personal habit”

Figures 14 and 15 indicate that user preference for comfort and their habitat is subjective and local.

One of the major factors that Traditional buildings bring with them is the aesthetics in their construction techniques and appearance, be it the roofing with Mangalore tiles or the columns and courtyard. It brings a unique touch of the rooted nature of the style of architecture and 81.6% of the people agree to it.

This proves that where the user group is from matters, because their habits and traditions matter to evaluate the comfort levels, and 83.6% of users agree to it.

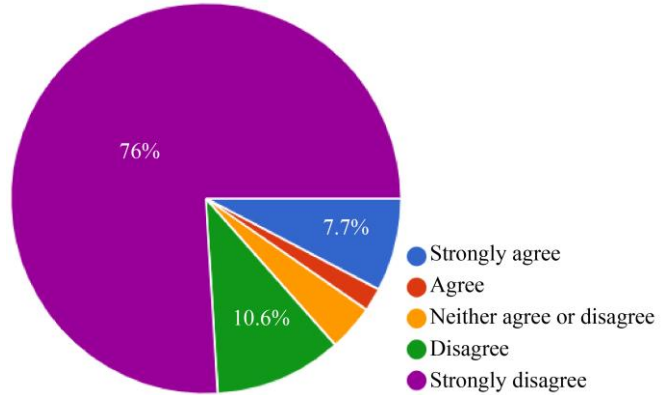


Fig. 16 Response to the question, “I feel most comfortable in rooms without any windows and openings”

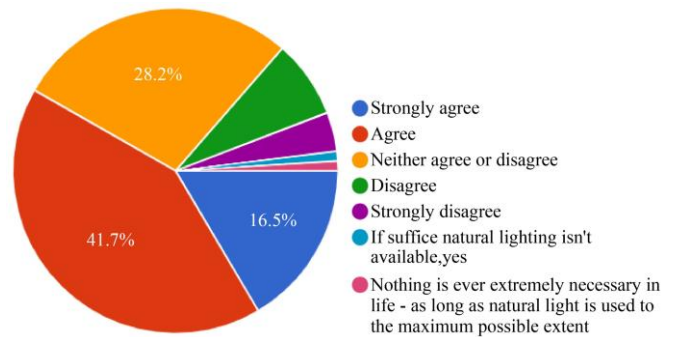


Fig. 17 Response to the question “I feel artificial lighting (tube-lights and spotlights) is extremely necessary in any room, in any case of natural lighting for utilitarian and safety purposes”

Figures 16 and 17 indicate the importance of Natural lighting as a key element in Tropical Modern Architecture 86.6% of users agree to the fact that any room requires windows and openings to bring in light, air, and therefore user comfort, But the extent of lighting in evenings and night questions safety and if it is important to have artificial lighting and 70% people agree to it, indicating that Artificial lighting can not be avoided but the extent to which it can be used such that there is energy consumption bringing sustainability, matters the most.

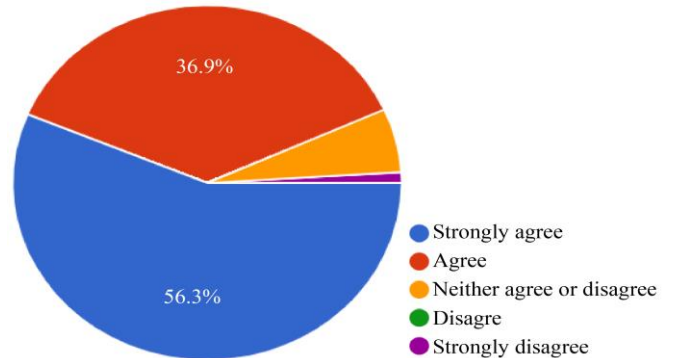


Fig. 18 Response to the question “The government must bring some necessary inclusions to the norms such that any building will have atleast one attribute of climate responsive design factors to make all buildings minimally sustainable”

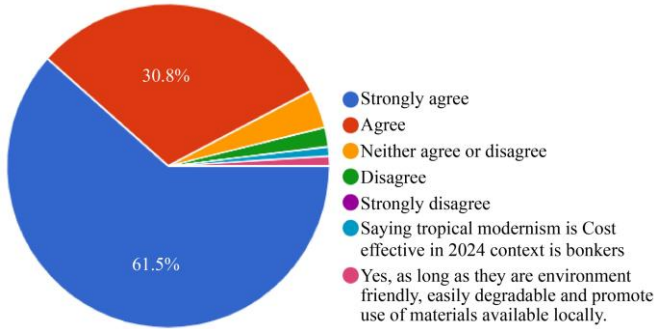


Fig. 19 Response to the question “Cost effective houses are not just for the poor, and they are for everyone”

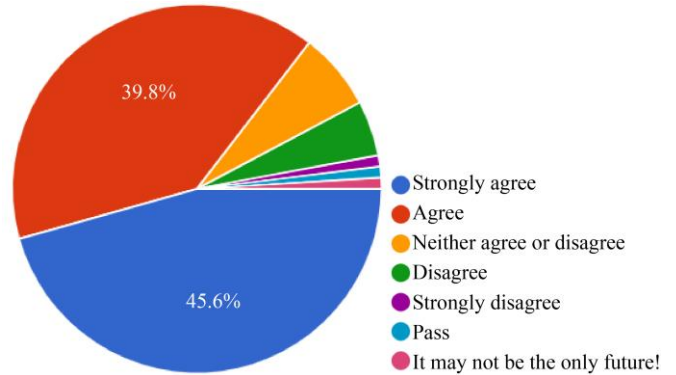


Fig. 22 Response to the question “Tropical modern architecture is essential and is the future of comfortable living”

Figures 18 and 19 indicate that Tropical Modern Architecture should not only be limited as a style of architecture and is not only for those who can afford Architects. It is universal and for all user groups and building typologies.

About 90% of the respondents agree that it should be a Government incorporating solar panels and any attribute of Tropical modern architecture because it is the way forward and contributes to user comfort and sustainable growth. It is not only for those who can afford Architects, but it should be for all, indicating its importance over the period of time in the long run.

The key reasons for the necessity of Tropical Modern Architecture are depicted in Figures 20, 21 and 22.

About 70% of people have agreed that Climate responsive buildings are a key part of Tropical Modern Architecture and are important against rising Global warming and increasing heat and humidity. However, 25% of the respondents have indicated that Tropical Architecture is not only limited to Climate responsive building, and it can be more than that, but in a key element, like Passive design Strategies being a major solution to overcome solar heat gain issues, which over 32% users agree. Notably, 22.3% have disagreed with it, saying it is not the 'ONLY' way forward, which brings us to infer more that there are multiple ways and this is one of many. However, 85% of the people feel Tropical Modern Architecture is essential and is the future of comfortable living.

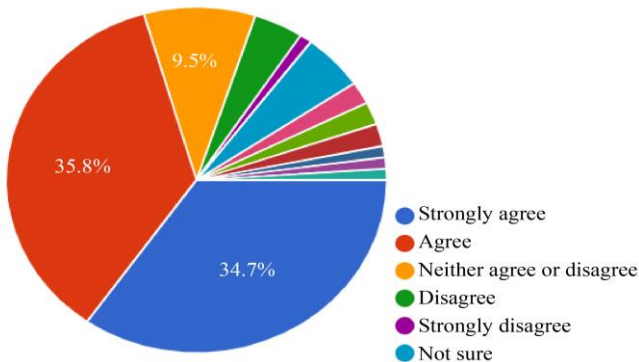


Fig. 20 Response to the question “Designs from Geoffrey Bawa, Hassan Fathy and Laurie Baker were climate responsive and, therefore, Tropical modern architects”

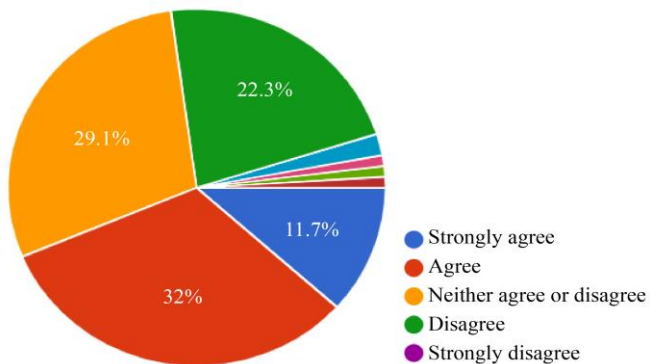


Fig. 21 Response to the question “Passive design strategies are the only way forward to overcome solar heat gain issues in a building”

6.3. Summary

As a key part of the analysis, on comparing the literature study and the conducted survey, we understand that both arrive at similar inferences, which tells us that the key attributes: Light, Shade and Ventilation, Seamless Space: Simple and natural, Materials and construction techniques, Response to local context, and Metabolism on a longer span contribute to the main aspects of Tropical modern architecture and it is essential to address that it brings the user group comfort by meeting the parameters of sustainable development, by reducing the load of energy consumption, using materials that have low carbon values, and other similar factors hereby is effectively environment friendly.

7. Conclusion

Achieving thermal comfort is essential for the well-being, health, and productivity of occupants. Traditional buildings utilize solar passive techniques—such as shape, orientation, fenestration, window-to-wall ratio, and materials—to create a comfortable environment, which many modern designs lack. In contrast, contemporary architecture often relies on mechanical systems to maintain thermal comfort. Solar

passive design harnesses the prevailing climate and natural energy resources to create comfortable indoor spaces, minimizing energy consumption and reducing dependence on mechanical systems. This approach promotes sustainability and enhances the overall quality of living.

Tropical Modernism is apt for those who seek a regional support system. As inferred from the conducted survey (indicated by the pie charts above), Tropical modern architecture has all the attributes to make it the way forward. Native, vernacular building materials, culturally innate construction techniques, the shell, the volume, shape, and framework, the choice of type, location, and size of fenestrations, and many more are the key elements that make the spaces sustainable and respond to context effectively.

The qualitative analysis of user comfort and experience in tropical modern architecture highlights the efficacy of passive design strategies. One resident of Laurie Baker's homes stated, "The natural ventilation and thermal insulation

provided by the jaali walls and terracotta tiles have significantly reduced our need for artificial cooling" (Bhatia, 2001). Testimonials such as these underscore how architectural features-such as cross-ventilation, shaded verandas, and indigenous materials-contribute to occupant well-being and energy efficiency. This feedback demonstrates that tropical modernism successfully integrates environmental responsiveness with user-centric design, enhancing both physical comfort and overall satisfaction [17]. A summarized table for the ideal design considerations for Chennai's micro-climatic conditions is in Table 1.

Future research could explore the evolving application of tropical modern architecture in contemporary urban settings, focusing on innovations in sustainable materials and advanced passive cooling techniques. Additionally, cross-cultural comparisons of tropical architecture in different regions could provide further insights into its adaptability and resilience in diverse environmental contexts.

Table 1. Attributes and effective mechanism in tropical climatic conditions

Attribute	Effective mechanism
Natural Lighting and Shading	Openings are preferred in the North and East for maximum lighting and ventilation. Maximum shading is required in the West and South to reduce the heat entering the building through openings, if any.
Natural Ventilation	Doorways in the lower area and perforations in the clerestory level in the form of jail or cut-outs can make sure the hot air exits the building, and cool air enters, creating an airflow (Stack effect) within the building.
Building Materials & Construction	Mud is the primary material in the form of Adobe bricks or similar. Roofing can be gabled with wooden rafters and purlins with terracotta (pot tiles) as roof covering material, flooring can be oxide, and plastering can be an admixture derived from limestone.
Seamless Space-Simple & Natural	Open, with minimal furniture, landscape can be blended within the building in a way that acts as an air purifier or a shading device within.
Response to Context/ Climatic Conditions	Since the materials are porous, the building breathes. This is essential in a warm and humid climatic zone, where there needs to be continuous movement of air, and the heat is let out of the building.
Metabolism on a Longer Span	Proportionate to User comfort, with proper maintenance of the building, the lifespan also increases with time.

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