

Original Article

Impact of Climate Responsive Architecture: Behavioural Approach of User Group (In Terms of Dealing with Tropical Climate)

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Abstract - To interpret the architectural approach for tropical modernism in terms of the behavioural approach to improve the lifestyle standards, maximise productivity in offices and amplify the time spent in restaurants and cottages; and to derive that the impact of climate responsive architecture is immense and should not be neglected, by showcasing the alterations that can be done in any layout to modify the space and how it has an impact on the behavioural characteristics of people and to list the benefits of these alterations. This research paper deals with the study of how regional architecture can create an impact on these beneficiaries in different spaces like offices and restaurants and ends with an amalgamation of all points in common to deliver a layout for a cottage that substantiates the approach mentioned above to design in architecture. Similar to S.A. Indrivati's research, The aim is to study and analyse the impacts of tropical architecture on spaces like offices and restaurants, to derive an outcome of its extent and conclude by incorporating the interpretations and research outputs in a layout to find how it improves a built space and prove it through a psychometric chart comparing same building when designed conventionally and when designed using tropical modern design strategies.

Keywords - Behavioural approach, Climate responsive architecture, Tropical architecture and workplaces, Tropical architecture and restaurants, Tropical modernism

1. Introduction

“Modern Architecture is the product of machinery and the use of new materials, but to be modern does not necessarily suggest that it should turn its back on everything else. Nothing could be more mistaken than to regard modern buildings as architecture of steel, concrete, plate glass and machinery. That would make a cold, forbidding world. Warmth and mellowness are expected of good architecture, and the development of modern architecture could be towards its humanisation, chiefly by the greater use of natural materials and in Scotland is there a more natural material than stone.” Charles wrote these words in his diploma of architecture thesis from the Glasgow School of Architecture [1]. Tropical modernism creates a balanced atmosphere between the built design and the behavioural aspects. Behavioural design is a critical means to address human behaviour challenges, including health, safety, and sustainability. (Brix Nielsen & Daalhuizen, 2021) [2]. This can be incorporated in all shells like offices, restaurants, hotels and homes. Relevantly, Tropical architecture has been represented as a form of critical regionalism in that it offers a language based on the conditions of the non-western world. (Hanah Le Roux, 2003) [3]. In

workplaces and offices, there is health in open-plan offices while at the same time understanding design similarities shared by high-performance workspaces. (Chakraborty, et al, 2019) [4]. They include a good light around the office, which must be at the same time, comfortable, pleasing, relevant, and appropriate for the user group depending on the type of office (Lepore, 2017) [5]. In restaurants and hotels, the factors incorporate a variety of items, quality of items, the precision of administration, conveyance time, Store area, Staff obligingness, and encompassing conditions and, by and large, satisfaction, depending on the ambience the place provides. (Sreeya, 2019) [6]. The ambience is based on the elements of spatial layout, interior design, colour and music incorporated for customer satisfaction. (Saufiyudin, 2015) [7]. This paper aims to study how behavioural aspects can be significantly important and can have an impact on offices and restaurants. The research gap in modern tropical architecture includes a lack of comprehensive studies on the integration of traditional and contemporary design principles. Additionally, there is a need for more case studies analyzing the socio-cultural impacts of these architectural styles on local communities, which can be a vital part of the study for future research.



2. Methodology



Fig. 1a Flowchart 1a showing the Methodology of the conducted Research study format

3. Materials and Methods

Covers the responses of an individual to adapt to his/her environment, including the definition of personal goals, learning new skills, and adjusting responses to specific events. A study on human behaviour has revealed that 90% of the population can be classified into four basic personality types: optimistic, pessimistic, trusting and envious.

4. Relationship between Tropical Modern Architecture and Behavioural Analysis

Through Architecture, it is proven that there can be a change in the behavioural aspect of the user group. When there are courtyards, there is a soothing calmness; when there is natural lighting and ventilation breezing in, there is a freshness that keeps us active; when there are materials that are native,

there is always a thermal comfort that comes without realisation. The better the user group is related to the architectural style of the building, here, tropical modernism, the better their behavioural characteristics, which will benefit all the parties involved in any given situation. S.A. Indrivati quoted in her research paper on 'Designing in Architecture: Behavioural Approach methodology, stating, "A fundamental premise on environmental and behavioural fields involves assumptions about the systematic interrelationships between architecture and patterns of human behaviour. The case studies conducted were to confirm the need for a specific design methodology in relation to the area of perception and human behaviour. The extent to which office space performance has an impact on employee productivity and satisfaction is glorious. Following that, it was also seen how those affect the behaviour of coping. The findings show that

there is a significant impact of space performances on space satisfaction. Further, there is a significant impact of space satisfaction on coping behaviour and also a significant impact on spaces' performances against coping behaviour. Humanist architecture with an architectural behaviour approach is required as a concept of planning and architectural design in the Future” [8]. There are various places where this relationship can benefit both sides, the user group and the space provider, in numerous ways, in different places like workspace offices, restaurants and cafés, hotels and resorts, libraries, etc. This deals with this analysis and how it can have an impact on different parties involved, including the owner and customer, employer and employee, to realise how significant it is to incorporate certain elements from the architect’s perspective.

4.1. Analysing the Impact on Workspace/ Office Buildings

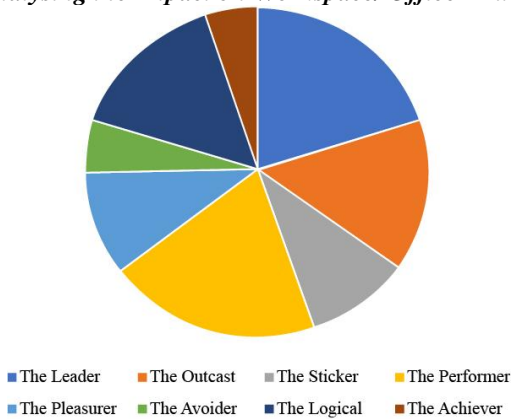


Fig. 1b) Pie chart representing various behavioural characteristics in a workplace | Source: Blog on career development (2015) by AIM HIGH group

Offices are places where people spend the most time at. To make it productive in the given premises is the most efficient way to deal with workplaces. HMC Architects lists the following points on how architecture should fit into office spaces:

- Understanding that workplace design significantly affects human behaviour
- Considering office location and designing to respond
- Creating a productive interior atmosphere
- Facilitate collaboration among employees and supervisors

The pie chart (Figure 1b) (Based on a survey conducted by the AIM HGH group) below shows the different behavioural aspects of people in an office, and the list below shows its attributes and how architecture can have an impact on these characteristics of the people in a workplace.

In an effort to meet the various needs of office workers, Fleming (2004) suggests a conceptual framework that incorporates the occupier perspective in the assessment of work environments. He then formulates a defense in addition

to the physical evaluations: Building performance paradigms' quantitative, mechanistic character ignores the impact of occupants' perceptions of their surroundings. Buildings are currently viewed by facility managers as product containers rather than human containers. According to Haynes and Price (2004), offices must have a critical density of interaction if knowledge generation and transfer are to be considered outputs of the modern workplace. Individuals who operate in a passive manner at their workstations never develop an adaptable system. On the other hand, an office setting can be disturbing and noisy reducing value to the above discussed phenomenon [9].

The most efficient interactions in the absence of disturbance and distraction and hence the proposed office spaces have to be designed within a said zone, also known as the edge of chaos (Waldrop, 1992).

One of the solutions proposed in Tropical zones is Regional Architectural style that helps curb above mentioned malfunctioning deviations. With a climate responsive environment around the user group, the productivity is increased immensely with time and the quality of work around creative people is increased [10].

Table 1. Listing behavioural type and how climate-responsive architecture can have an impact on increasing productivity in an office environment

| Behaviour | Attributes | Impact of Tropical Architecture |
|---------------|----------------------------------|--|
| The Leader | Controller, Aggressive, Strict | Natural ventilation can bring light to nature that helps to calm |
| The Outcast | Easygoing, Lose track of details | Natural materials like wood with sharp edges can bring attention |
| The Striker | Angry, Unkind, Pessimistic | Courtyards and skylights can bring hope and happiness |
| The Performer | Sense of Humour, Accomplishment | Interactive spaces combine the characteristics and develop a friendly network within |
| The Pleasurer | Friendly, Helpful, Social | |
| The Avoider | Quiet, Reserved, Lonely | |
| The Logical | Cautious and Accurate | Natural lighting can bring more confidence to present well |
| The Achiever | Confident and takes criticism | Ergonomic ceiling height to maintain the achievement |

Table 2. Listing behavioural type and typical comments. Source: Nathan and Doyle (2002)

| Behavioural type | Typical Comments |
|----------------------------|---|
| Colonising | "I always have a full in the tray. I have got varying degrees of urgency, so I just piled incredibly urgent tasks in front of me. Anything too big for the in-tray is put on the shelf next to me. I make an effort to manage surface areas in a hierarchy. |
| Warm desking | "I have a hot desk that I prefer." "The best positions let you face the door and observe who enters." "When you work, people come at you; you have to be ready for them." |
| Communing | "The work hot-desking area serves as a meeting place and a conversational hub in addition to a workspace. My goal when I get to work is to greet and chat with my coworkers rather than actually getting work done." |
| Keeping a low profile | "In this field, privacy is a really serious problem. The management has not offered a workable private area for private discussions, discipline, or other purposes. Most of the time, staff members use the training rooms, canteen, or reception area. However, since everyone operates at the same level, it is evident when someone needs to speak." |
| Converting and Customising | "Everything I need is always there on my screen, which doubles as my workspace." |
| Living | "I can spend up to twelve hours a day in this place. It is configured to work precisely the way I want it to. Books, bins, laptops, music, and coffee. It is my favorite spot when I am working efficiently." |

Table 2. shows various behavioural aspects from employee’s perspective, which tells us why a workspace should be designed effectively, keeping in mind that it will always have its reflection on the work productivity; especially more in creative fields of work.

It is terrible to observe offices built from concrete and glass in Chennai (warm and humid) that will not only have an impact on productivity but also the user group's satisfaction with the work environment. Including natural ventilating systems like courtyards, wind catchers, a few openable windows, and ambient elements like minimal water bodies and landscaping will be a game changer in this context.

4.2. Analysing the Impact in Restaurants and Cafés

Restaurants and Cafes are places where people spend time with their family, our closest people and sometimes, for official meetings. They come with expectations about ambience and comfort after food, which will stay with them as a memory. Therefore, architecture does play a vital role in such spaces and it should have an impact on the user group [11]. Figure 2a shows the various factors that affect the ambient environment.

The ambient environment here includes the following factors:

- Fenestrations: Natural lighting and ventilation
- Fenestrations: Location, sizes and typology
- The design of the space itself (Spatial planning)
- Landscape elements like water bodies and gardening within
- Courtyards that will have a positive psychological impact
- Natural building materials that will feel at home
- More organic than rigid structure(s)

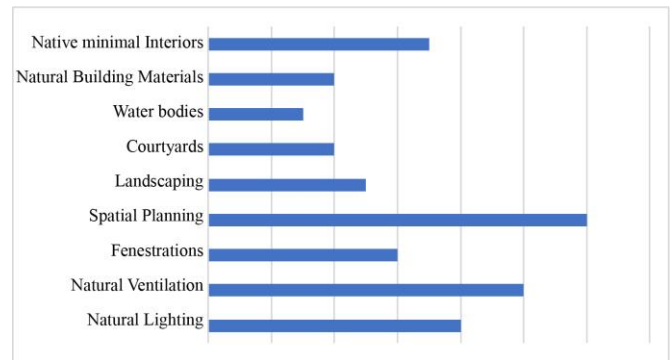


Fig. 2a Bar graph representing various attributes of tropical architecture and practicality of its presence in a restaurant or a café and analysis of its contribution to enhancing the behavioural aspects of the customers

Table 3 from a survey shows us that the ambience and empathy towards the customers are a selling factor that runs businesses in restaurants and similar places. Research goal orientation is called the hypothesis path, and how much each factor implements in customer satisfaction is called the coefficient of the same. From Table 3, it is evident that user satisfaction in selected commercial spaces is directly proportionate to the ambience created. The higher the coefficient, the higher the results achieved. Based on the survey conducted, Manoj Kumar also adds, “The ambient environment has numerous components. However, only three such components, viz., lightening, temperature and colour settings, were found significant for the present study based on the exploratory factor analysis. Restaurant managers and owners do look forward to creating an energetic environment for the customers. As discussed earlier in the paper, customers do not visit a restaurant to fulfil their utilitarian needs specifically.

Table 3. Identifying significant factors of customer satisfaction in restaurants. Source: 2022 Survey from a blog on ‘Customer Satisfaction and Behavioural Intentions in Restaurant Service’ by Manoj Kumar (Adopted and Tested Variables being Aesthetics, Ambience (the created environment), Cultural Orientation, Empathy towards the place, Privacy (The amount), Entertainment (The mode of interaction), Reliability and Responsibilities (To achieve the second time-visit) and pleasing beyond satisfaction.)

| Hypothesis path | Factor | Co-efficient | Results |
|-----------------|----------------------------------|--------------|-----------------|
| Satisfaction | Aesthetics | 0.037 | Not significant |
| Satisfaction | Ambient Environment | 0.206 | Significant |
| Satisfaction | Cultural Orientation | 0.059 | Not significant |
| Satisfaction | Empathy | 0.169 | Significant |
| Satisfaction | Privacy and Entertainment | 0.010 | Not significant |
| Satisfaction | Reliability and Responsibilities | 0.511 | Significant |
| Loyalty | Satisfaction | 0.793 | Significant |
| Interactions | Satisfaction | 0.892 | Significant |

They also wish for memorable experiences that bring pleasure to them. The experiential environment is the common solution to creating a memorable experience for the customers who visit a restaurant. An arrangement with a dim light on the table would be the key to addressing the hedonic needs of the customers.

Appropriate artificial lighting would create a calm or desired atmosphere that would add to the memories and experiences of the customers. Similarly, appropriate temperature settings would make the environment cosier and would make customers stay for longer duration and are likely to spend more time. Certain colours create warmth than other softer colours.

These shall be chosen to suit the theme of the restaurants, what they offer and the kind of patronage that is expected. An ambient environment connects with the customers affectively and hence would make the customers visit again to satisfy their emotional needs. This repeat visit is owing to high levels of customer satisfaction arising out of the ambient environment.”

5. Incorporating and Analysing the outcomes of the Above Study into a Residential Layout

By interpreting a residential layout from a research paper called ‘Thermal performance design criteria for bio-climatic architecture’ by authors Amitava Sarkar and Shivashish Bose and analysing how attributes of tropical architecture can make a difference to the behavioural aspects of the user group and the residence itself [12].

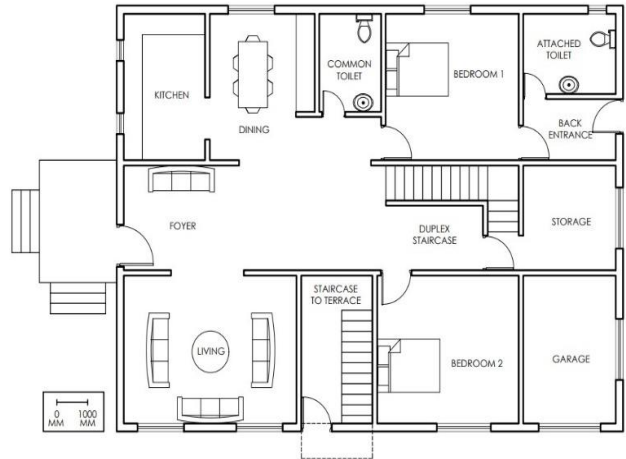


Fig. 3a) Residential Layout as per paper by authors Amitava Sarkar and Shivashish Bose

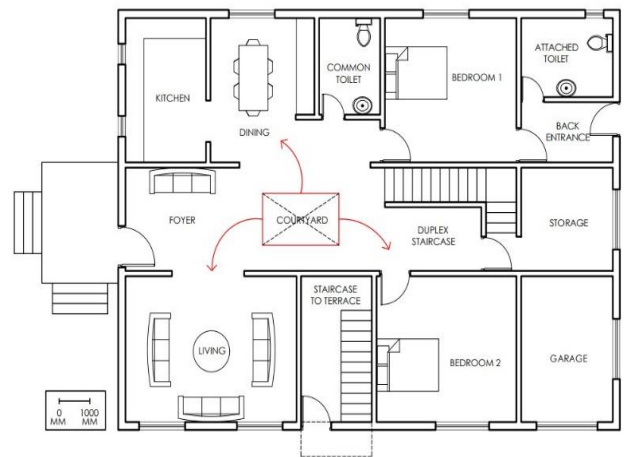


Fig. 3b) Adding a courtyard that brings natural ventilation and lighting enhances the mood of the user group by bringing fresh air, hope and light into the house.

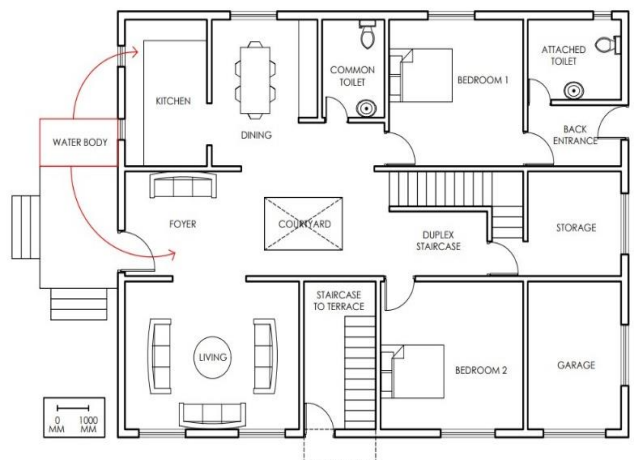


Fig. 3c) Adding a waterbody near the entrance that brings cool air within the house and acts as a welcome feature. Not bringing in inside is not to regulate the humidity that brings a sulking attitude to the users.

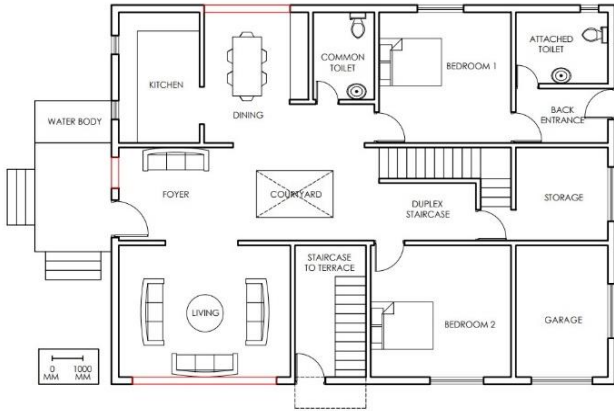


Fig. 3d) treating fenestrations: Instead of glazed windows, there can be wooden openable windows. The marked portion is a perforated wall that brings light, air and reduces the heat that comes with glass. This can change the mood of the user and add to the quality of the time spent and the productivity of the involved activity.

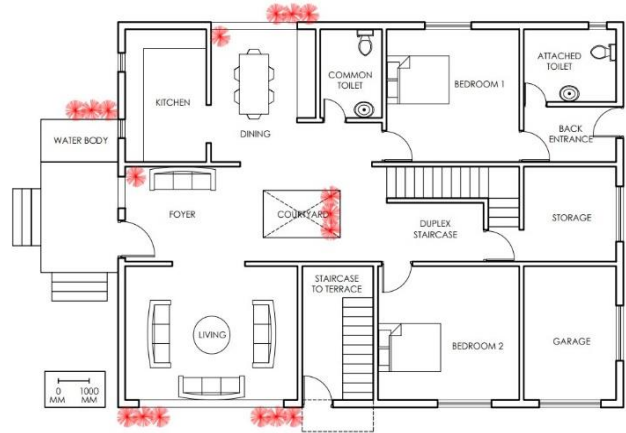


Fig. 3e) Landscaping within and around the residence adds to the soothing atmospheric value. It can boost the confidence and can uplift the lifestyle of the user group. It is also increased with interaction between the indoors and outdoors (Example: Here, access to garden from living and dining).

Table 4. Summarises the analysis of how various elements of tropical modern architecture have an impact on the user experience and user behavior

| Fig. No. | Element of tropical modernism | User experience | User Behaviour | Logical reasoning based on analysis due to the applied tropical element/ technique |
|----------|--|--|--|---|
| a | Basic built shell with doors and windows | Comfortable | Satisfied | Availability of natural light and ventilation via fenestrations |
| b | Courtyard | Connected to Nature via a space open to the sky | Pleasing | The stack effect causes the hot air to rise and exit the building and the cold air to stay in the usable space. |
| c | Waterbody, pond at the entrance | Landscape connecting the building at the right moment | More Welcoming | Waterbody inside the house would raise the humidity causing discomfort, but placed outside would act differently. |
| d | Perforations (Walls or part of walls) | The porosity of the built shell adds to the interactivity between the user and the surroundings. | Light and breathing | There is continuous movement of air, and there is a visual and physical connectivity; it keeps the humidity, airflow and temperature difference more comfortable. |
| e | Enough greenery around the landscape | More connectivity to the natural surroundings with its benefits | Innate, corresponding to the biosphere | Vegetation acts as a heat diffuser and creates a time lag between the in and out, causing an increase in the user comfort levels. |
| f | Gabled roofing | More effectively responsive to climate | Focused and available | Less heat reflection, less heat transmitting from roof to indoors, lesser energy spent to reduce the temperature inside. |

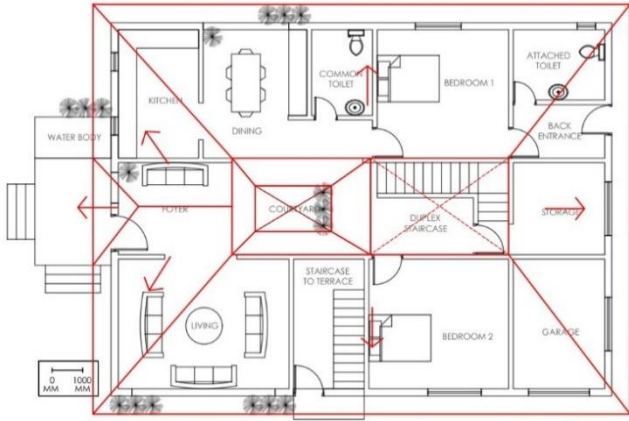


Fig. 3f) Incorporating an appropriate roofing system that regulates the climate responsiveness of the built shell indirectly has an impact on the behavioural aspects of the user group

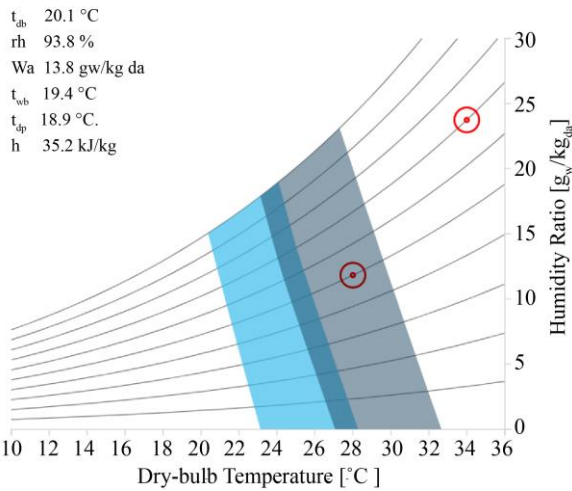


Fig. 4 The comparative psychrometric chart for both cases and the temperature comfort achieved

6. Comparative Analysis

This is to identify and analyse from the above study incorporating various elements of regional architecture to verify how there is a growth in the character of the user group, the behaviour advantages and hence, how there is an increase in the productivity of the associated group. The elements in the table below [Table 4] are in the order of increasing user comfort levels as per the study.

References

- [1] Charles Correa, “Climate Responsive Architecture,” Architecture Thesis from Glasgow School of Architecture.
- [2] Camilla Kirstine Elisabeth Bay Brix Nielsen, Jaap Daalhuizen, and Philip J. Cash, “Defining the Behavioural Design Space,” *International Journal of Design*, vol. 15, no. 1, pp. 1-16, 2021. [Google Scholar] [Publisher Link]
- [3] Hannah le Roux “The Networks of Tropical Architecture,” *The Journal of Architecture*, vol. 8, no. 3, pp. 337-354, 2003. [CrossRef] [Google Scholar] [Publisher Link]
- [4] Christhina Candido, Prithwi Chakraborty, and Dian Tjondronegoro, “The Rise of Office Design in High-Performance, Open-Plan Environments” *Buildings*, vol. 9, no. 4, pp. 1-16, 2019. [CrossRef] [Google Scholar] [Publisher Link]
- [5] Lepore Michele, “Design E Comfort in Office Space,” *Vitruvio*, vol. 2, no. 2, pp. 15-23, 2017. [Google Scholar] [Publisher Link]

7. Comparing Comfort levels in a conventional building and a tropically designed building

By using passive strategies integrated with the design, it is evident that there is a difference in the indoor dry bulb temperature between a building that is designed conventionally with glass and RCC and a building that is designed with Tropical modern principles. Below is a table considering two scenarios, option 1 being conventional and option 2 being tropical modern. [Figure 4] Considering the average outdoor temperature in summer is 38 deg., the dry bulb temperature in option 1 is 34 deg. Moreover, option 2 is 28 deg. The Comparative psychrometric chart for both options proves that design incorporating tropical modern principles can increase the comfort index of the users, giving them a better experience whatever typology of the building.

Table 5. The spatial comfort levels arrived from the analysis

| | #1 | #2 |
|------------|---------|---------|
| Compliance | ✘ | ✓ |
| PMV | 2.50 | 0.17 |
| PPD | 94% | 6% |
| Sensation | Hot | Neutral |
| SET | 34.3 °C | 25.4 °C |

8. Conclusion

From the case studies and surveys conducted by various authors, it is non-negotiable that the ambience of the place on the user group creates an impact. Tropical it becomes, more will be the time they spend in any place, be it office or a restaurant. The time spent without distraction and discomfort has an impact on productivity in an office and customer satisfaction in a restaurant or a café. This extends to any public place like hotels, libraries, parks, convention centres, resorts and cottages, educational institutions, hospitality centers, health care centers, etc. In residences, it goes without saying that climate-responsive building materials and the environment created by a building in tropical architectural style bring maximum comfort and enhance the positive effects of behavioural attributes.

It is hence derived from the conducted research that adding modern tropical features into any space increases its functional efficiency and expands the scope and potential of the built entity.

- [6] K. Aswini, and B. Sreeya, "Customer Preference towards Restaurants with Special Reference to Chennai," *Test Engineering & Management*, vol. 81, pp. 4876-4881, 2019. [[Google Scholar](#)] [[Publisher Link](#)]
- [7] Muhamad Saufiyudin Omar, Hashim Fadzil Ariffin, and Rozila Ahmad, "The Relationship between Restaurant Ambience and Customers' Satisfaction in Shah Alam Arabic Restaurants, Selangor," *International Journal of Administration and Governance*, vol. 1, no. 14, pp. 1-8, 2015. [[Google Scholar](#)]
- [8] Sri Astuti Indriyati, "Behavior Approach for Designing in Architecture," *International Journal of Innovative Science Research Technology*, vol. 7, no. 8, pp. 865-869, 2022. [[CrossRef](#)] [[Google Scholar](#)] [[Publisher Link](#)]
- [9] Barry P. Haynes, "The Impact of the Behavioural Environment on Office Productivity," *Journal of Facilities Management*, vol. 5, no. 3, pp. 158-171, 2007. [[CrossRef](#)] [[Google Scholar](#)] [[Publisher Link](#)]
- [10] Office Architecture Concepts: How Workplace Design Affects Human Behavior, HMC Architects, 2019. [Online]. Available: <https://hmcarchitects.com/news/office-architecture-concepts-how-workplace-design-affects-human-behavior-2019-07-05/>
- [11] Customer Satisfaction and Behavioural Intentions in Restaurant Service, Vedatya Institute, 2022. [Online]. Available: <https://www.vedatya.ac.in/research/blog/customer-satisfaction-and-behavioural-intentions-in-restaurant-service/>
- [12] Amitava Sarkar, and Shivashish Bose, "Thermal Performance Design Criteria for Bio-Climatic Architecture in Himachal Pradesh," *Current Science*, vol. 109, no. 9, pp. 1590-1600, 2015. [[Google Scholar](#)] [[Publisher Link](#)]
- [13] L.K.K. Allen, S. Elias, and C.H Lim, "The Thermal Performance of Evaluation of Roofing Systems and Materials in Malaysian Residential Development," *Proceedings of SENVAR, ISESEE, Humanity and Technology*, pp. 387-395, 2008. [[Google Scholar](#)]
- [14] George Anthony Atkinson, *Tropical Architecture and Building Standards*, Architecture and Climate, pp. 1-21, 1953. [[Google Scholar](#)] [[Publisher Link](#)]
- [15] I.R Edmonds, and P.J Greenup, "Daylighting in the Tropics," *Solar Energy*, vol. 73, no. 2, pp. 111-121, 2002. [[CrossRef](#)] [[Google Scholar](#)] [[Publisher Link](#)]
- [16] Abha Haval, *The Impact of Architecture in Our Lives*, Rethinking the Future, 2021. [Online]. Available: <https://www.re-thinkingthefuture.com/narratives/a5201-the-impact-of-architecture-in-our-lives/#:~:text=Architecture%20has%20the%20means%20to,and%20cold%2C%20diminishing%20the%20mood>
- [17] Mohammadjavad Mahdavejad, and Sima Mansoori, "Architectural Design Criteria of Socio-Behavioral Approach Toward Healthy Model," *Procedia-Social and Behavioral Sciences*, vol. 35, pp. 475-482, 2012. [[CrossRef](#)] [[Google Scholar](#)] [[Publisher Link](#)]