Post Occupancy Study of Human Comfort in A Traditional House As Against A Newly Designed Modern House

Ar. Mahesh Bangad
Assistant Professor, Dr. Bhanuben Nanavati College of Architecture for Women, Pune

Ar. Siddhi Joshi
Assistant Professor, Dr. Bhanuben Nanavati College of Architecture for Women, Pune

Abstract:- **For over centuries the built manifestation of architecture has been a resonant outcome of caution response to the climate & its agents. The nomadic man built his first residential unit from materials which were local, with design that responded not just to the need of housing but primarily to the climate that it was built in. From the ancient caves to the primitive defined housing, man has looked for his comfort – physical & metaphysical. The constant search for the right kind of environment to comfortably live in & sustain has been one of the prime motives.**

Human comfort & its definition has not really changed over several centuries though it has evolved to envelope many other aspects associated with environment. Man when built houses have looked at achieving a nominal degree of physical comfort for its occupants through the optimum usage of light, ventilation, local materials, etc.Over the years this need for comfort has given rise to several strategies, means, machines that have been used consciously or unconsciously in designing of houses across various climate types.

This paper primarily looks at the change in design over the years in planning of houses with two case studies from moderate climate of Pune city, additionally it examines the human comfort factors in these two houses which are built century apart and lastly, it documents & analyzes post occupancy human comfort in these two buildings & tries to compare the changes in those factors.

Keywords – Human comfort, Thermal comfort, Traditional, Contemporary, Climate change, Post occupancy study

I. INTRODUCTION

Human comfort is a combination of subjective sensation and interaction of humans with the physical environment and depends upon several physical magnitudes that can be grouped into human related and environment related parameters. It is thus an amalgamation of built envelope along with its surroundings, vegetation, micro and micro climate, thermal mass, heat gain and loss, impacts of radiation along with the inherent biological functions of an individual/ person. The way thermal comfort gets defined at a built level depends upon variations in the materials, orientation, size and number of openings, shading devices, colors and textures, heights and volumes; at a human level can be understood as a combination of clothing, acclimatization, age and gender, body type and shape, subcutaneous fat, health conditions, eating habits, rate of metabolism and skin color. Thus, of the above parameters and combinations, the thermal comfort of the occupants is most affected and impacted by four environmental parameters [1]. These are air temperature, air velocity, mean radiant temperature and relative humidity.

The thermal comfort determines levels of productivity, levels and duration of interaction within the built environments, mental and physical behavioral patterns and circadian rhythms. Under Indian climate, a reasonable thermal comfort temperature inside a house is between 21^0C to 28.5^0 C [1]. The effect of wind velocity too determines the levels of thermal comfort and acts as an important parameter for post-occupancy analysis. For comfort, the recommended range of indoor air velocity varies between 0.15 to 1.5m/s [2]. Though various indices developed by researchers, in an attempt to describe the thermal comfort experienced in the indoor environments developed effectively in the past four-five decades, the meanings and descriptions have not really changed over centuries.

Over the last few centuries, the housing patterns and conditions have drastically changed in the urban areas. The Indian cities have witnessed radical transformations in the urban morphology, tissue and density. The growth in the population density has given rise to vertical cities and impacts of globalization have altered perceptions about ideal living conditions, thereby promoting gated communities and cluster planning over large parcels of land [3] With a significant change in the nature and narratives of living spaces, the ideals of thermal comfort have remained identical over decades, thereby increase in the factors and indices of adaptability index. The paper analyses houses' in the city of Pune, built almost a century apart to study these indices and parameters of thermal comfort.

II. THE CITY AND NARRATIVES OF HOUSING

In the tier two Indian cities, the migration of residents from rural to urban areas has created great demands of housing. Pune is one such city that has witnessed the transformations in the past few decades, with radical alterations in the urban morphology, density, tissue, grain and spatial organizations. These changes in the urban areas thereby refers to the long lasting spatial dynamics and is characterized by transformation of city objects that depend upon the choices made by the residents and the policy makers [3]. The houses built about centuries ago show congruence with the climatic conditions and responsive designs, the residences today reflect the city dynamics, social and political to a larger extent. The emerging pattern

thus showcases similarities in the use of materials across different cities, nature and type of openings, nature of external and internal built envelopes etc.

The city of Pune falls under hot-semi arid climate zone bordering with tropical wet and dry, with average temperature ranging between 19^0 C to 33^0 C and also determines the macro climatic conditions. The micro climate though depends upon the context, orientation, vegetation and proximity to the water body. The case-examples selected for the analysis have thus been selected in proximity of each other, about a km apart and in the periphery of same *peth*.

III. THE TRADITIONAL HOUSE

The traditional housing units in Pune, popularly known as *Wadas'* symbolize Pune's rich cultural and built heritage. They reflect a typical character, material palette with variations in terms of area, opulence and context. The unit selected for research is a typical *wada*, set in *Kasba peth*. The *wada* reflects the typical planning with a small central courtyard with rooms planned around it, with a verandah and a backyard. The average room size varies between 100-130sq.ft with a typical window opening size of about 10-12 sq.ft. The *wada* selected for the research is a typical ground floor structure with sloping roof with all the rooms and functions designed around the central courtyard and built in the early 90's.The primary construction materials include bricks, lime mortar and basalt along with use of lime plaster for the interiors and kota for flooring, with wooden doors and windows. Fig 1 represents a schematic plan of the unit depicting the spatial planning and arrangement of rooms, location of the courtyard and the activity flow.

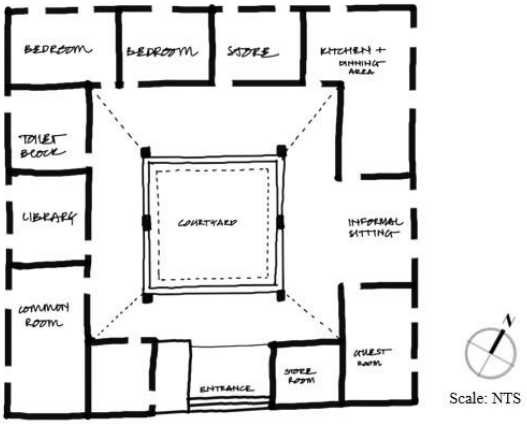

Fig 01: Schematic Plan of the traditional house (Source: Author)

Readings for the analysis of the thermal comfort were taken across 3 days, measuring the temperature, humidity, sound and velocity, mentioned in the table below. The readings were followed by a questionnaire aimed at gaining a better insight about meanings of comfort and its cognitive understanding. The questionnaire aimed at understanding the meanings and associations spaces hold in relation to the indoor environment, degrees of adaptability and familiarity with the spaces through the diurnal variations.

	Day 01	Day 02	Day 03
Time	11.25 am	9.20 am	8.45 am
Temperature	29.1	28	27.7
Wind Velocity	0.4km/hr	0.3 km/hr	0.3 km/hr
Humidity	52%	54.90%	64.70%
Sound	62 dB	67 dB	60 dB
Time	2.40 pm	5.15 pm	4.40 pm
Temperature	31.2	30.4	29.8
Wind Velocity	1 km/hr	1.1 km/hr	1.1 km/hr
Humidity	57.60%	60%	62.50%
Sound	61dB	65 dB	63 dB

Table 01: Readings for Traditional house (Source: Author)

IV. THE MODERN HOUSE

The rapid urbanization has transformed not just the city's skyline but also its fabric and morphology with alteration in the spatial and functional organizational. The modern or contemporary houses reflect the narratives of globalization, urbanization with homogeneity in materials, planning and styles [4]. The growth in the population density has given rise to vertical cities and ever changing spatial dynamics. The scenarios vary in the present times defined by socio-economic and socio-cultural/political scenarios. The type of house selected for research is a 2bhk residential unit, built around in 2010, with an area of around 950sq.ft, located in *Kasba Peth*. The residence represents the present day narratives, with specific and modular plans, typical spatial organizations and formulated room sizes. The schematic plan of the house in fig 02 represents the planning and organization of spaces and functions.

Readings for the analysis of the thermal comfort were taken across 3 days, measuring the temperature, humidity, sound and velocity, mentioned in the table below; similar to that of the traditional house. The readings were followed by questionnaire to study and analyze meanings and notions of comfort and understand in both the research contexts. Though the unit presents transformation of the built envelope, the notions of comfort, home and family have not transformed drastically but present transformation of the mediums for achieving it. Mechanical measures to achieve optimum and comfortable temperature, adjust the air flow, curb the outdoor decibel levels have presented opportunities of achieving an individual's comfort through alteration of micro climate.

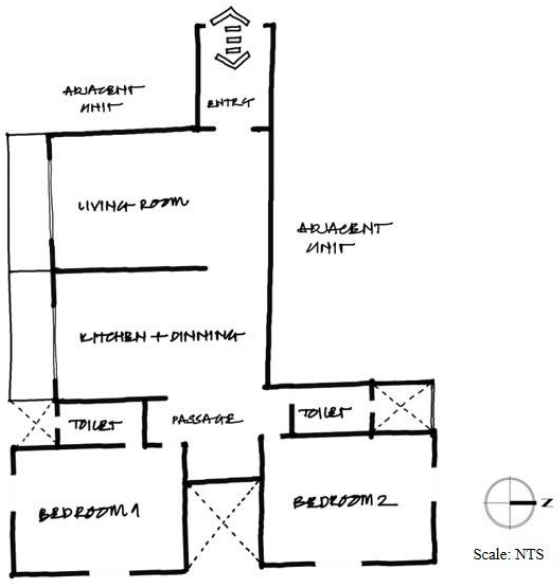

Fig 02: Schematic Plan of the traditional house (Source: Author)

	Day 01	Day 02	Day 03
Time	11.25 am	9.20 am	8.45 am
Temperature	34.3	31.1	28.6
Wind Velocity	2.3km/hr	3km/hr	5.2km/hr
Humidity	39.50 %	42.2%	64.70%
Sound	55dB	54dB	60
Time	2.40 pm	5.15 pm	4.40 pm
Temperature	32.7	29.9	31.1
Wind Velocity	3km/hr	5.2km/hr	3.4km/hr
Humidity	31.10%	42.2%	54.40%
Sound	49dB	54dB	55dB

Table 02: Readings for Modern house (Source: Author)

V. OBSERVATIONS AND ANALYSIS

The readings present major variations in the temperature and wind velocity along with light conditions in the traditional and modern house. The variations in the temperature are seen to be dependent on the building materials and orientation of the building along with the height of the built envelope. The temperature variations in the traditional house define the rooms used during the day hours and the one's used during the later hours of the day. The functions associated with learning and cognitive work, primarily face the internal courtyards, thereby adapting to the light conditions. The air circulation and lux levels along with drop in the decibel make the rooms adjoining the courtyard favorable spaces with maximum thermal comfort. The orientation of activities based on the types of comfort define flexibility in the organization within the residential units and in response to both micro and macro climates. The levels of discomfort in *wadas* are marked by drop in the temperature and light conditions due to the variation and types of openings, materials that affect the biological and cognitive responses. The adaptions to these conditions are adopted by mechanical measures to achieve maximum comfort conditions and suitable micro climates. With transformation of lifestyles over the years, when combined with certain mechanical measures, the traditional housing units depict the ability to achieve maximum human comfort thereby giving credibility to the spatial organization, materials, vegetation around etc.

The readings of the modern house represent increase in the temperature, with good light conditions and ability to control the sound and humidity levels owing to the use of mechanical measures [5]. The levels of human comfort in present scenarios offer more opportunities of adaptability and flexibility thereby indicating increase in the index. The mechanical measures aid in achieving and controlling micro climate to suit the biological and psychological needs. Larger openings, materials show surge in the temperature and wind velocity levels, with increased dependency on the mechanical systems. The dependency further increases based on the orientation of the building, urban contexts, development zones.

The post-occupancy survey indicates more comfortable conditions in the traditional house when compared with the modern house, exception being the light conditions. The comfort factor also highlights about associations with the spaces which too are a major indicator in defining the levels of human comfort with psychological factors overpowering the biology under certain conditions. The survey and the analysis also highlight increase in the dependency on the mechanical levels and an urge to maintain a constant temperature to achieve maximum comfort. In the modern houses, building envelopes play the least role in maintaining the micro climates whereas in the traditional houses they play a significant role thereby adapting to the outside environments.

CONCLUSION

The study and analysis indicate the transformation in the planning and spatial organization with variations and increased homogeneity in the use of materials across cities and greater dependency on the mechanical measures to achieve maximum human comfort. Though the research indicates a little change in the definition and meaning of human comfort at the biological level but indicates transformation at a psychological and cognitive level, with an increase in the need to have an optimum temperature through the diurnal variations. The finding agreed that the thermal comfort in the traditional house attributed to the design which promoted good air movement and temperature control. According to the research, uncomfortable thermal conditions in the modern house when compared with the traditional house were recorded. The analysis showed that with doors and windows closed, high internal temperatures were recorded and when combined with low air speeds, the thermal comfort reduced. Once all doors and windows in thehouse were opened, allowing the air movement to increase, then although air temperatures remained high and thermal comfort was achieved.

The work, although limited at present highlights the fact that modern houses lack sufficient parameters to achieve maximum human comfort. This presents a need to consider the parameters adopted and with adaption to the present

needs design units to achieve the acceptable levels of human comfort. When understood at a macro context, the traditional units highlight the factors of adaptability through use of materials, ventilation and stacking strategies along with native and sustainable planning while the modern houses indicate replication like legos ignoring the environments and climatic conditions.

REFERENCES

[1] Markus, T.A., and E.N. Morris, Building, Climate and Energy. London, UK, 1980
[2] Olgyay, V, Design with Climate. Princeton University, USA, 1963
[3] NagapurkarShilpa, Energizing the Future with Memories of the Past: The Wadas of Pune City, 2020
[4] Rohinton Emmanuel; GishanRathnayake, Indoor thermal comfort in contemporary Sri Lankan urban houses: A Simulation Study, 2002
[5] Du, X., Bokel, R.; Van den Dobbelsteen, Spatial configuration, building microclimate and thermal comfort, 2019