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Understanding Sustainability through the Lens of Energy Efficiency in Residential Buildings

Pujitha Ayinampudi[1],

1. Undergraduate student, School of Architecture, Koneru Lakshmaiah EducationFoundation, Vaddeswaram, Guntur, AP, India- 522302

Kuntamukkula Harshitha*[2]

2. Assistant Professor, School of Architecture, Koneru Lakshmaiah EducationFoundation, Vaddeswaram, Guntur, AP, India- 522302

Corresponding author details:

Kuntamukkula Harshitha

Address: Flat no 203, A Block, Srinivasam appartments, Kunchanapalli, Guntur District, Andhra Pradesh, India Pin code: 522501 Country code 91, Contact Number 9676199880

Email id: harshitha.kvv@gmail.com

Abstract

Co-living spaces have emerged from the global challenges of rapid urbanization and limited land. The research explores the timeline of co-living in the scenario of sustainable urban living and addresses the possibilities of energy efficiency through the lens of day lighting, air movement and thermal comfort. The research focused on the design parameters of the residential complex as per the site and also units. This paper delves into the challenges of energy efficient techniques adaptation and energy conservation techniques in the residential buildings. The methodology involved two fold approach, combining literature review and on site case study of the planning and user interviews in two distinct residential complexes in Hyderabad. The findings from NK Villa Green and Rainbow Vistas suggest informative insights on energy demands, thermal comfort, air movement and power consumption. The case studies highlight the need for better strategic design of the residential complexes and user behavior in achieving energy efficiency and sustainable communities. The research underscores the need for long term and short term government goals, awareness campaigns and incentives for faster adoption of energy efficient practices by the users and designers. Architects, Planner and interior designers lay vital role in formation of guidelines and construction rules based on climatic zones and as per context. The research study concludes

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with a call for future research on barriers in adaptation of energy – efficient technique, emphasizing the emergency of sustainable practices for the resilient world.

Keywords: co-living; sustainable urban living, energy efficiency, thermal comfort.

INTRODUCTION

Co-living spaces have evolved as an important choice in the constantly evolving Indian housing scenario, with a special blending of communal living and personal luxury. Among apartment residents it has become increasingly popular because co-living provides a sense of community and offers communal amenities. In this rapid growth of Urbanization, the significance of co-living cannot be emphasized as the living spaces are becoming smaller and unhealthy. In this evolution of Urban living, co- living apartments are now emphasizing on sustainable living. Energy efficiency is one of the prime objectives for sustainable living in this energy crises world. Common areas and utilities are some of the examples of shared amenities that need to be designed for energy conservation. A negligible carbon footprint is achieved by using various strategies like using eco friendly building materials, passive cooling and heating techniques, smart heating and cooling systems, effective lighting. Integrating energy efficient measures benefits users in financial and environmental responsibilities.

The civilization today depends on a variety of energy sources. The major energy is consumed in home sector. Rising living standards and shifting consumer behaviour are indeed responsible for the variation in energy usage. Energy conservation and consume reduction of emissions are essential in every part of life. Household welfare is not being decreased; rather, it is intended to utilize energy responsibly. Understanding the patterns of energy usage is made possible through data mining, which aims to unearth undiscovered and hidden knowledge in databases. The ideal tactics may be achieved by using appropriate data mining tools to expose previously unknown patterns (Mahsa Nazeriye, 2020).

The demand and supply of energy is challenged by the global energy consumption. The global environment is endangered by the global warming; urban heat island caused due to release of green house gases from the utilization of non energy efficient appliances. Government and experts have encouraged people to adopt the renewable energy resources for their energy requirements. Investment and focus by government in adoption Solar energy,

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wind energy, hydro energy can be seen from last 10 years after the Paris agreement on carbon free environment and climate change (Sandro Nizetic, 2019).

The authors (Sha Yu, 2017) have discussed about Energy and economic savings from ECBC, Energy and economic savings from energy codes in residential, commercial buildings and green building programs. The certain guidelines followed by the state government. and the development of the Gujarat state by using those policies. Building energy use accounts for 33% of India's total final energy consumption, and is increasing at around 8% annually. The key challenge for Indian policy makers are regarding the improving quality of life with building energy efficient techniques. The Energy Conservation Building Code (ECBC) in 2007 was released by Government of India.

Heating, Ventilation and Air Conditioning aspects in the building play key role for providing suitable thermal comfort, indoor air quality and also responsible for energy consumption in buildings. Incorporating energy saving ventilation systems plays vital role not only in acheiving energy efficiency, but also in providing better indoor climate for the occupants and decreasing the possibility of health issues in buildings (Behrang Chenari, 2016).

To improve human well-being and reduce poverty, it is necessary to provide enough and inexpensive energy. Energy is a necessary input in the majority of manufacturing processes; it should be seen as a crucial component in economic development. Energy usage rises in perfect agreement with economic growth and progress. The requirement for energy should be adequately and cheaply satisfied (Serap Pelin Türkoğlu, 2018).

METHODOLOGY

The methodology adopted for this paper is two-fold approach for addressing the energy efficiency significance in the residential buildings. Extensive literature study was conducted, for understanding and analyzing the possibilities of energy efficiency for sustainable living and gain insights into the current state of energy importance in today’s world. The goal of the review is the lay foundation for understanding the crucial challenges in implementation, technologies and strategies associated with residential building energy efficiency.

The research then performed case study and survey in one low rise and one high rise residential complexes in Hyderabad to understand the demands of the residents. To obtain comprehensive data on the demand and utilization of energy, a survey was conducted to gather the details on energy demands, air movements, thermal comfort, appliances usage,

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current bills within their residential units. The empirical evidence was important in assessing the challenges and real world implications for achieving energy efficiency. These studies help in highlighting the tangible benefits of energy efficiency.

FINDINGS AND DISCUSSION

Case study 1 – NK VILLA GREEN Hyderabad

The NK Villa Green, a low rise neighborhood was constructed in 2003 with much green ratio then present day neighboourhoods. The neighborhood lies in one of the peripheral areas of Hyderabad and the surrounding are developing exponentially from 2015. The climatic zone is 6 with the ratio of building plan area to total plan area is 23%. Based on the survey of the neighborhood and on-site analysis, most residents found their residential villas are well lit, well ventilated and thermally comfortable. Because of well lit and well ventilated, the energy efficiency is to larger extent achieved.

Thermal comfort: The survey resulted in 75% of the residents finding their villas comfortable throughout the year. 46% of the users expressed their discomfort during the peak summer period, and during the onside interviews, the users expressed their discomfort is due to large terrace area being exposed to solar radiation. Many houses have adopted terrace gardening which helped to resolve the heat gain problem to major extent. 18% of the users felt mild discomfort during winters, which is negligible id due to planning issues, as this was a result of lush green vegetation across the site resulting in low pressure zones and diverting cold breezes into the houses.

Air Movement: From the survey, it is found that the user feel comfortable with air temperatures. 63% of the residents preferred open windows in their villas due to the supply of fresh and cool air from the vegetation around the villas. 18 % admitted to prefer open windows but are not doing due to the concerns of privacy. 9% of the user's options differed due to overgrown vegetation and renovation in the site. All the villas are a maximum of G+1 and G+2 in height, resulting in the incoming wind speeds not being extremely high. Due to the presence of impervious materials and tree cover in the site, evaporative cooling is prevalent. Evaporative cooling benefits these low rise villas with air exchange within the villas.

Daylight: 82% of the users found their villas extremely well lit, while 18% admitted to having blinds or curtains on, despite receiving a good amount of daylight. The planning of

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this neighborhood allows foe north south orientated rows of villas, with each villa facing East- West. These direction, help the villas to minimize the solar radiation but maximizes the light penetration into the villas. The lux levels of the most of villas are around 75-150 lux, which when compared to the external luminance of 2500 lux approx.

Electrical Consumption: In this elite residential society, each villa area of the ranges from 3500-5000 square feet. Nearly all consumers replied positively to survey questions about the use of appliances. The air conditioner in each villa is by far the most energy consuming and often utilized device. During summer, the utilization of air conditioner ranges from six to nine hours. Few users have expressed they use air conditioners during monsoon.

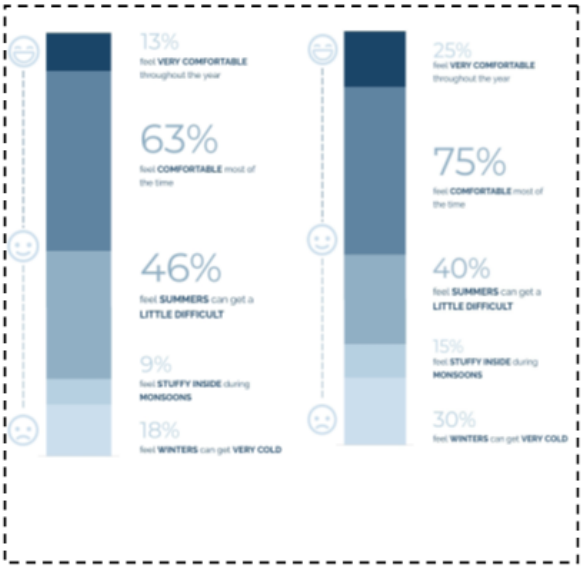

Figure 1 Air Flow (left side Case study 1 - and Right side- Casestudy 2)

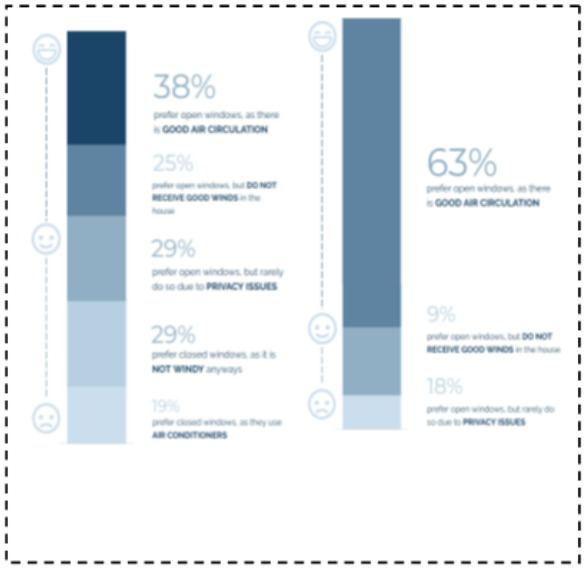

Figure 2 Thermal Comfort (left side Case study 1 and Right side- Casestudy 2)

Case study 2 – RAINBOW VISTAS Hyderabad

Rainbow Vistas is a high rise apartment that got constructed in 2017 with an area of 89,580 square meters and total built up area of 4,20,900 square meters however the last phase still under construction. The location is in the north Hyderabd, area known as Kukatpally. This complex has thirteen blacks, each with twenty storey's high and surrounded by open gardens. The residential complex consists of all the amenities and hoses ranging from 2BHKs to 4BHKs. This complex won Indian Green Building Council, Green Homes Precertification, LEED GOLD in December 2012. The complex is located in local climatic zone 4. It has two large water bodies, a natural and an artificial lake on its south west and south east directions. These water bodies have created significant influence on its mice climate wind patterns.

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Thermal Comfort: The survey reveals, that the users are comfortable due to the mutual shading units of the complex that are 20 story high. 25% of the subjects showed no concern on thermal comfort. Considering the fact that all blocks are 70m in height, there are various recurrences of mutual shading of blocks during the day. However, the corner units and units on floors above 20m (6th-7th floor) are directly exposed to sun. The arrangement of blocks doesn't let winds into the buildings. Consequently, users prefer their windows closed as the air inside the units tends to get humid.

Air Movement: The survey reveals varied user behaviors on preferences of window operation. The users of units located in the corners of blocks, either in windward areas or on the upper floors where there is a better, unobstructed wind flow prefer to open windows. It is also observed that about 25% of residents prefer to have their windows open, but it stops from doing so because of the lack of ample airflow in their units. Similarly, 30%of them prefer their windows shut because of similar reasons, and the added concern of privacy. The issue of privacy is felt specifically in the ground floor units, as one finds many vacant units or units with their openings shut due to the active user activities of the ground floor.

Day lighting: The highest number of unanimously decided negative feedback given by the residents on daylighting. Majority of the users, around 60%, feel that only few rooms in their flat receive a ample amount of natural light while most of the other rooms can be termed 'poorly lit'. This was further backed up by the alarmingly low lux levels inside units of different floors during the on-site study. As opposed to the healthy range of 70-120 lux in Villa Greens, the units in this case study had lux levels ranging from 5-60 lux. This may be a clear reflection of the fact that the blocks being oriented in the North-South direction mutually shade each other to a large extent, resulting in dim and dark interior spaces. The issue is further worse by the fact that about three quarters of all the units are tightly closed between other adjacent units.

Energy Consumption: Flat areas ranges from 1250 to 2795 square feet, accommodating two to six occupants on an average. Survey reveals the relationship of unit energy consumption to its size and occupant density. The survey considered the past four month electric bills. 50% of users electric bills are higher in summer then compared to other seasons. Major part of the users admits of using Air conditions throughout the year. On further on-site interviews, it was realized that the residents were keen on saving energy by using appliances when direly needed and have been conscious of choosing the energy star rating of all appliances

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purchased. Rainbow Vistas lacked any kind of renewable energy provisions, especially solar, considering the large portions of horizontal surfaces available on site. Various solar applications like corridor lighting, solar water heaters, lift operations solar-powered streetlamps etc. were also suggested by the residents

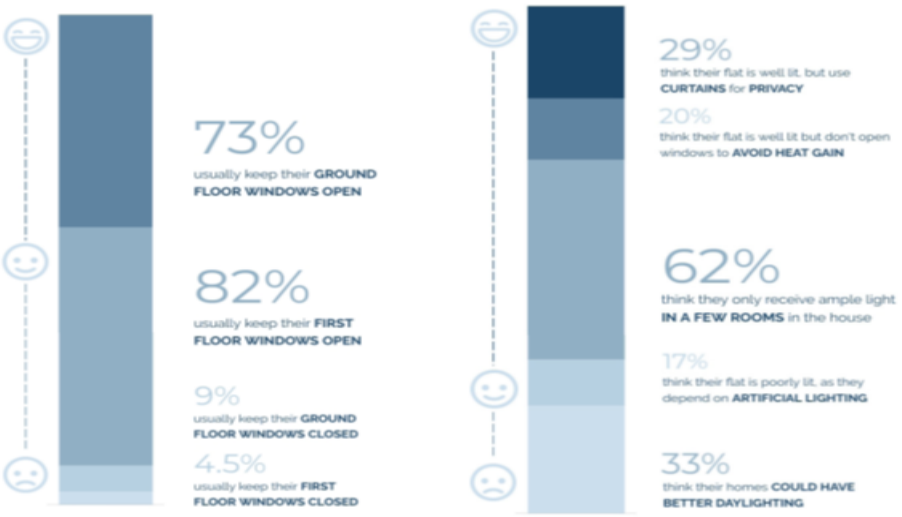

Figure 3 Daylighting (left side Case study 1 and Right side– Casestudy 2)

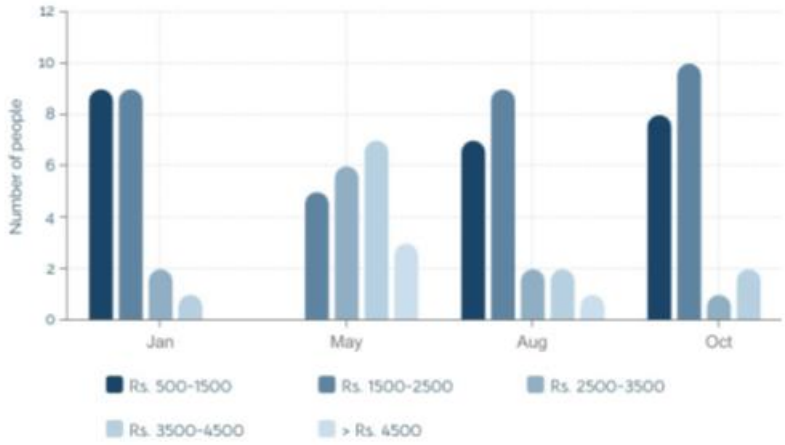

Figure 4 Current Bill

CONCLUSION

The research devolves into the depth of residential building energy efficiency through a

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comprehensive study. The case studies NK Green Villas and Rainbow Vistas in Hyderabad shed light on enhancing energy efficiency by addressing the user appliances usage and ventilation operation in the residential units. The challenges in thermal comfort in the Rainbow Villas high rise apartment are evident and the designer has to understand the user comfort while designing. Air movement, Day light and energy consumption of air conditioner throughout the year, indicates the need for future design considerations. NK Villa Green, have designed environmentally conscious low rise residential complex which is well lit and well ventilated. The direction of the villas play vital role in day lighting and the opportunities of roof gardening have decreased the energy consumption indirectly due to low heat gain from solar radiation on roofs. Awareness on the energy efficiency have to be implemented from the younger ages for sustainable future. Long term goals and short terms goals have to be prepared by the government to meet the needs of Paris agreement and should create awareness champs and give incentives, for the fast adaptation of the energy efficient techniques and technologies. Architects and interior designers play vital role, so the rules for construction have to be well states according to the climatic zones and considering macro and micro climate for each city. Case studies on understanding the barriers for adoption of energy efficient techniques have to be well researched.

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