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# Improving the Thermal Performance of Secondary School Buildings by Using Passive Techniques at Hyderabad

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***Abstract* - Educational domain is essential as they acquire an immense impact about student's physical well-being and studies. Mostly Building devours around 40 to 50% energy and the thermal comfort is an essential aspect of indoor environmental quality, particularly in educational buildings where students spends a significant amount of time. Poor thermal comfort can lead to negative health effects, reduced productivity, and discomfort. The study focuses to enhance the indoor environment by fostering to develop a comfortable learning environment, to accomplish the aim a particular school is selected in Hyderabad city as a case study to analyses its existing thermal performances and propose suitable passive strategies for implementation the impact of passive techniques on thermal comfort of school is further evaluated by gathering data through questionnaire surveys, interviews and analyzed on simulation tool. The study as a policy emphasizes the importance of passive techniques as a solution for creating environment friendly and energy efficient educational infrastructure, and giving valuable awareness to architects and policymakers that will form the basis for all other schools in Hyderabad city by considering both social and technical factors for optimal thermal performance in school buildings.**

***Keywords:*** thermal comfort; school building; indoor environment; passive techniques.

## I. INTRODUCTION

As the world's population rises and people are seeking to achieve an advanced standards of lives, the energy required to sustain the world also increases, consequently the accessibility of energy assets is quickly shrinking.[1]The climate variation ought to diminish carbon particles discharge and puts pressure on buildings to emerge as further economical and eco- friendly around the globe. Whereas in several advanced countries the pressure is increased about to renovate the existing building, in underdeveloped countries the modern buildings are being built rapidly, Usually these modern buildings are designed as similar as in western world. In spite of considering huge climate differences, this may leads to either a huge amount of energy required for the provision of comfortable indoor environment or an uncomfortable and undesirable indoor environment due to shortage as well as less affordance of mechanical means.[2][3]

Achieving thermal comfort in buildings requires the consideration of various design and operational parameters, such as building envelope insulation, ventilation systems, and occupant behavior.[4]As students spend half of the day in schools where they are highly vulnerable towards an adverse indoor air quality, particularly considering secondary school students.[5]Therefore it is important to thoroughly.

Examine the connection between their comfort level and indoor characteristics. The thermal comfort challenges specific to school buildings in Hyderabad, which is a region characterized by hot and arid climatic conditions, has an extreme need to promote passive design strategies because the city experiences daily and frequent power cut due to its limited electric power producing capacity.[6] Furthermore, by considering the occupant's comfort preferences and needs, the study can provide insights into the design and operation of school buildings that can improve thermal comfort conditions while reducing energy consumption and costs.[7][8]

## II. PROBLEM STAETMENT

Indoor environment of school buildings will become prime factor of public concern for two major reasons,

1) Children's education
2) Children's health

The need for obtaining comfortable indoor environment in educational sector rises frequently, as almost a significant portion of daytime specially the peaks hours students spent at school in which thermal comfort is required the most, so it is

 

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important to maintain the indoor temperature for their better academic performances and the electric power sources for maintaining the indoor temperature preferably unsuitable because of power deficiency and its rising costs on regular basis.[9] Additionally facades of existing school buildings, uninsulated building fabrics and improper positions of windows and shading devices will lead to direct exposure of solar energy inside the building's interior spaces during the day time, which causes thermal discomfort for the students and increasing the risks of numerous diseases.[10] Therefore, it is essential to maintain the thermal performances of educational buildings by adopting passive strategies to develop a healthy and comfortable indoor environment.

### 2.1 Aim of the Research

The aim of this study is to suggest the use of passive techniques by retrofitting an existing school building as a solution to achieve thermal comfort inside the building and reduce the consumption of energy loads.

### 2.2 Research Objectives

For achieving the aim of the following objectives should be focused,

i. To investigate the current thermal performance of secondary school building in Hyderabad.
ii. To suggest the solutions for improving the thermal efficiency of the existing school buildings by applying passive techniques.
iii. To analyses and promote the role of passive techniques, as an appropriate and sustainable substitute to mechanical devices.

### 2.3 Research Methodology

As the research is a case study and the methodology is employed to fulfill the research objectives is a mixed methods approached combining both the primary and secondary data collection methods. The methodology applies was more on gathering information through questioners surveys interviews and physical visits.

The primary data is carried out by conducting questionnaire surveys, interviews and physical visits and then data was compared to the perception of students and school staff on improving the thermal performances of school indoor environment by adopting suitable passive techniques. The secondary data is carried out by literature review and case studies in two different branches of dawn public high school Qasimabad Hyderabad to pursue its existing thermal conditions.

### 2.4 Method of data analyses

The collected data, both primary and secondary data, will be analyzed using appropriate statistical techniques and analysis methods. Descriptive statistics will be used to summarize the quantitative data obtained from the case studies. The questionnaires arrange in series and data was put in the MS Excel software to data analyses. It was categorized according to the research question and accurate result of the research was drawn accordingly. For analyzing the data, descriptive statics and correlation method used to summarize the photographs. The integration of findings will provide a comprehensive understanding of the thermal comfort conditions and inform strategies for improvement.

### 2.5 Case study

The Dawn Public High School, located in Hyderabad Qasimabad, selected as a sample school for case study, it is an esteemed educational institution that has been catering to the academic needs of students for several years. Situated in a bustling neighborhood, the school holds a prominent position in the local community and is recognized for its commitment to providing quality education. The school has a total area of 35000sq ft. The school is a two story building.

It consists of 10 class rooms of different dimensions and an administrative office along feasible amenities. The designs and building materials are adjusted to local conditions as much as possible. The school's interior spaces are carefully planned to create a balance between functionality, aesthetics, but less comfortable. The layout of the classrooms is optimized to ensure proper ventilation, especially at peak hours in which the temperature rises frequently and the environment become too hot to study. Adequate artificial lighting is also provided for darker hours and to maintain a well-lit environment. This may increase the level of humidity in indoor spaces. Vibrant colors are used to develop a positive as well as a negative impact in hot days of summer the school has a centralized open ground which direct connect the class room which is the major drawback I found during the visit create a more discomfort for students in learning environment. The average outdoor temperature is measured throughout the week from 19th of June to 23rd of June which is considered the hottest time period of the year is 45°C whereas the average indoor temperature and average relative humidity throughout the week of different spaces of school is generated in graph form which are physically measured by using thermal hygrometer instrument during case study.

 

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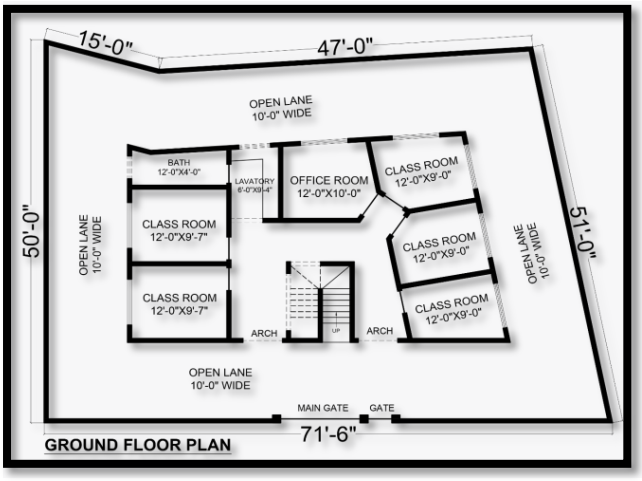


**Figure 1: Shows the map of ground floor of dawn public high school Qasimabad Hyderabad**

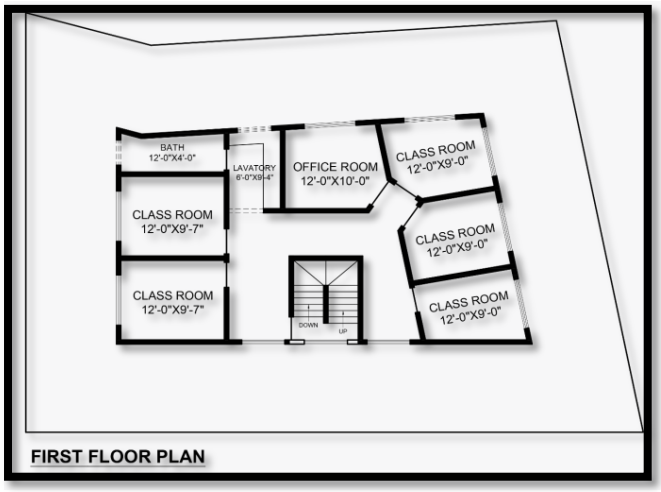


**Figure 2: Shows the map of 1st floor of dawn public high school Qasimabad Hyderabad**

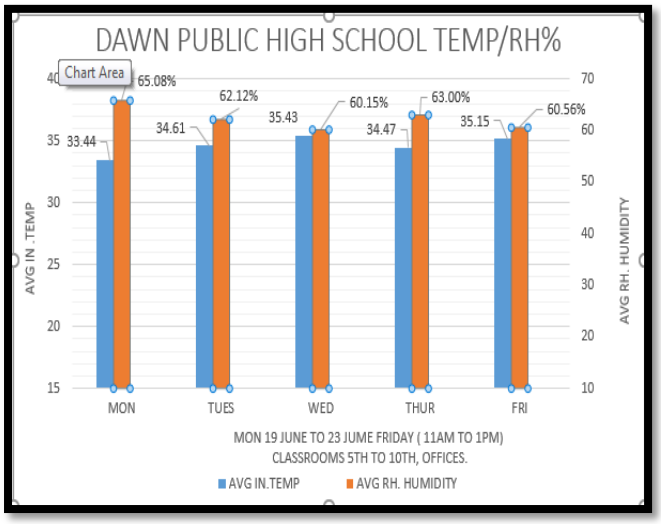


**Figure 3: Shows the graph of average temperature and humidity of dawn public high school Qasimabad Hyderabad throughout the week**

From the above graph it is clear that The Dawn Public High School in Hyderabad Qasimabad currently lacks the necessary facilities to ensure optimal thermal comfort for its students and staff. The school's infrastructure does not adequately address the challenges posed by extreme temperatures and varying weather conditions. Poor building design contribute to significant temperature fluctuations within the school premises.

## III. RESULTS AND DISCUSSIONS

### 3.1 Proposal of recommendation of passive techniques

The secondary phase of the study starts here and the interviews were conducted from professionals and school administration for implementing suitable passive techniques in the school, at last some suitable passive cooling strategies were suggested to be implemented in dawn public high school as a model of assumption, and there follows a short description for its use.

**Wind source**

Natural ventilation is an efficient way to reduce energy consumption as well as providing a healthy indoor environment. [14] It includes the proper provision of cross ventilated window, the windows should be operable along with double glazed glass of 16mm thickness having cavity of argon material instead of air to avoid direct exposure of sun rays to be enter in the class and also maintain the indoor environment comfortable and well ventilated.[14]

**Sun source**

Using shading devices is another way to cool the indoor environment of building as visited in the case study none of the shading device is noticed during visit , so overhang shades and horizontal projection should be provided in the front façade and west side of the building to avoid the exposure of heat.[18]

**Material sources**

Insulated materials, green roofing, high reflective color coating materials, plantation and water bodies are also suggested to be implemented for getting comfortable indoor environment these techniques are applied in the assumption model of the school building.

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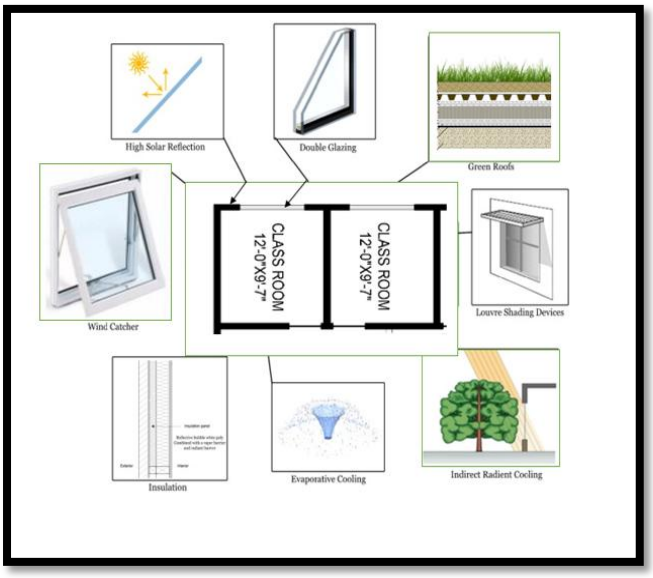


**Figure 4: Shows the implemented passive techniques**

### 3.2 Thermal analysis

The analysis regarding temperature difference is to be done on ecotect simulation software after implementation of passive techniques. Fig 5 shows the temperature difference from 19th June to 23rd of June which would be considered the hottest week of the year.

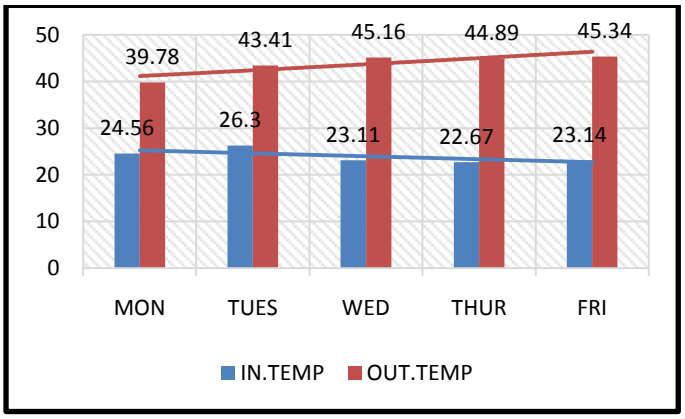


**Figure 5: Shows the graph of temperature difference between indoor and outdoor temperature after implementation of passive techniques.**

From figure 5 it is cleared that the outdoor temperature rises up to 45 °C in the hottest week. After getting suggestion and implementing suitable passive strategies, the temperature inside the school's classrooms, property reduced from about 23 to 25 °C. According to ASHARAE 55 the indoor temperature lies in between the range of about 20 °C to 25 °C which can be considered as a comfortable zone. It may also be observed that the passive strategies have had a significant effect on the reduction of temperature.

### 3.3 Results of Question are Surveys

**Distribution Of students according to their grade**

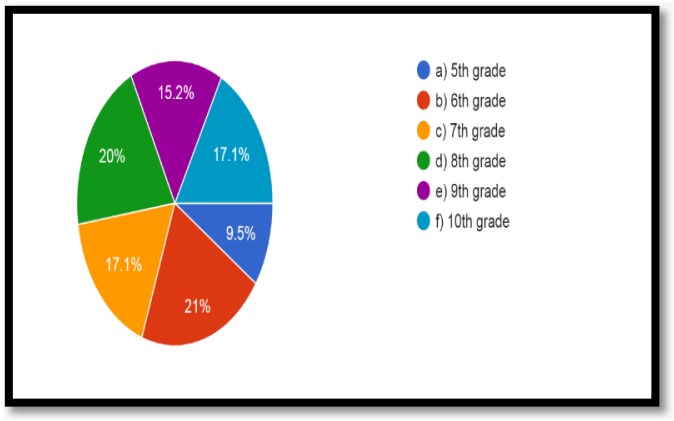


**Figure 6: Data analyzed through questionnaire to obtain the results about students studying in dawn public high school according to their grades**

**Duration of studying in the school**

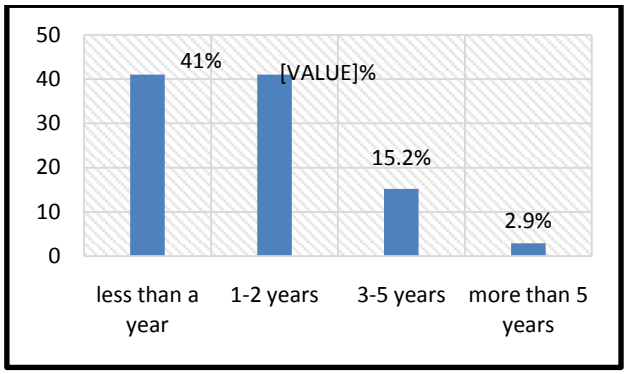


**Figure 7: Data analyzed through questionnaire to obtain results about the duration of studying in dawn public high school**

**How would you rate the overall thermal comfort in your school according to ASHRAE 7-point scale?**

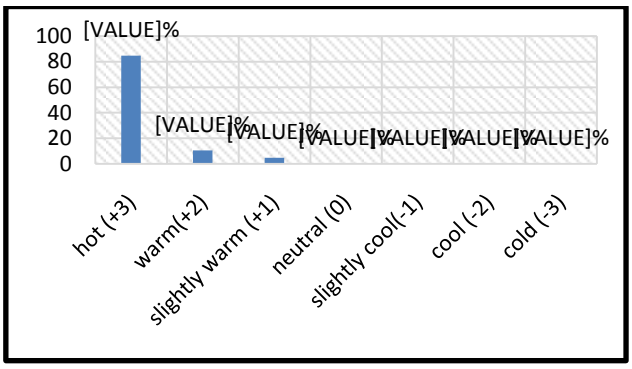


**Figure 8: Data analyzed through questionnaire to obtain the age of students studying in dawn public high school**

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**During the summer season, how do you feel in terms of temperature in your classroom?**

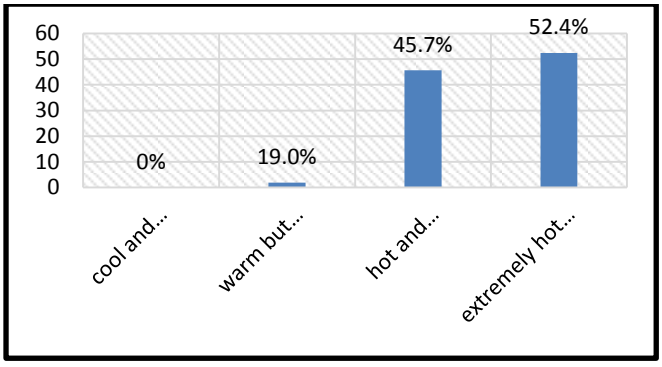


**Figure 9: Data analyzed through questionnaire to obtain the results about temperature of school in summer season**

**How would you describe the overall environment of your classroom?**

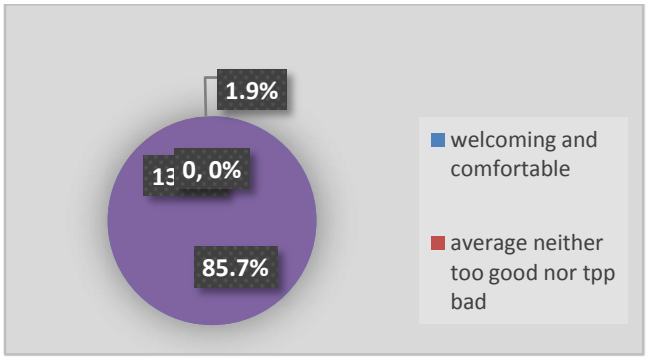


**Figure 10: Data analyzed through questionnaire to obtain the results about overall environment of school**

**Are there enough windows in your classrooms to allow natural air and light to enter?**

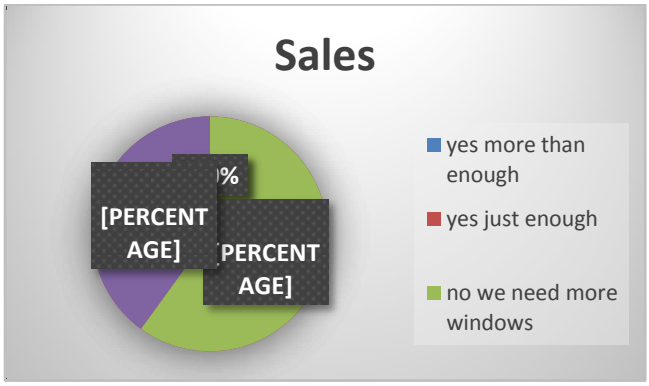


**Figure 11: Data analyzed through questionnaire to obtain the results about windows in class room**

**Do you feel that the colors used in the classrooms are pleasant and stimulating?**

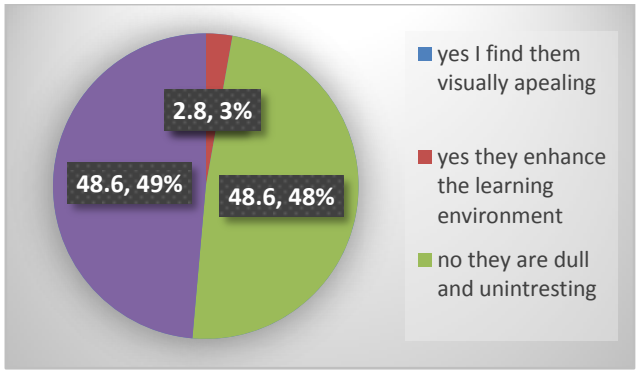


**Figure 12: Data analyzed through questionnaire to obtain the results about effects of color scheme in class room**

**How comfortable are the chairs and desks in your classrooms?**

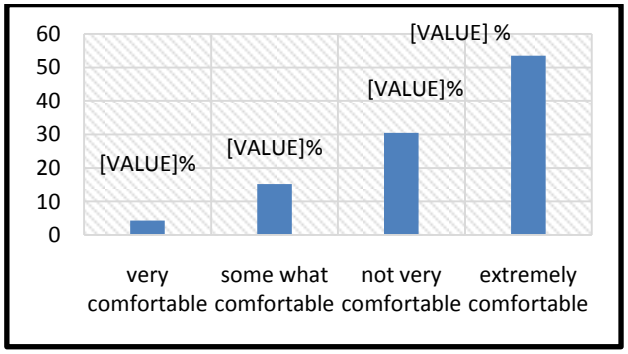


**Figure 13: Data analyzed through questionnaire to obtain the results about furniture in class room**

**How satisfied are you with the airflow and ventilation in your classroom?**

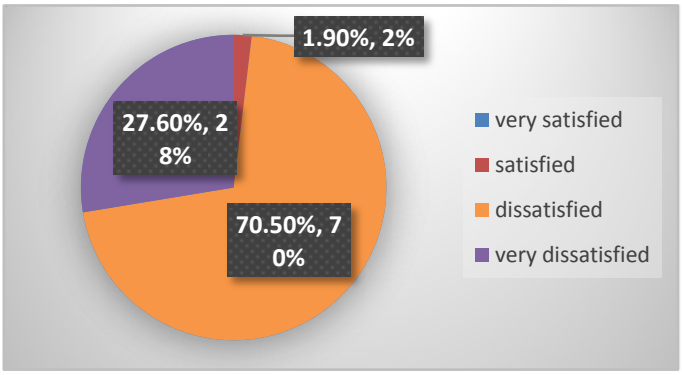


**Figure 14: Data analyzed through questionnaire to obtain the results about airflow and ventilation in class room**

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**Does the indoor environment, including temperature, lighting, and air quality, affect your ability to concentrate and focus in class?**

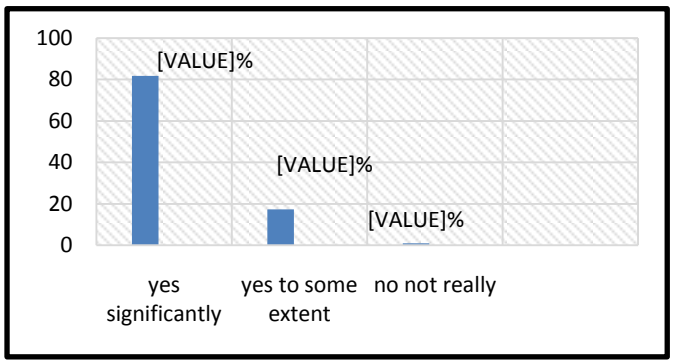


**Figure 15: Data analyzed through questionnaire to obtain the results about windows in class room**

**How effective do you find the blinds or curtains in your classroom for controlling sunlight and heat?**

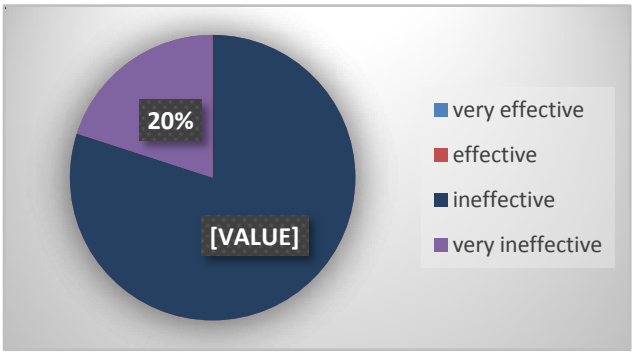


**Figure 16: Data analyzed through questionnaire to obtain the results about effectiveness of blinds and curtains in class room**

**Do you think the classrooms need better insulation to maintain a comfortable temperature?**

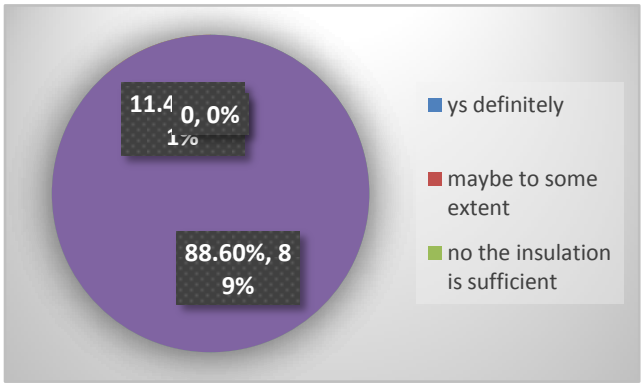


**Figure 17: Data analyzed through questionnaire to obtain the results about needs of insulation in class room**

**How often do you feel too hot in your classroom?**

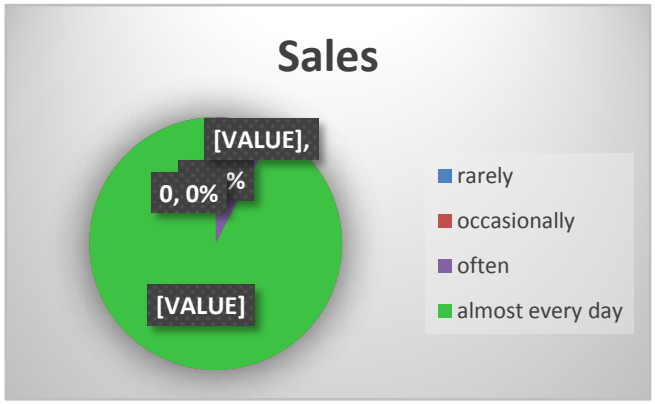


**Figure 18: Data analyzed through questionnaire to obtain the results about frequency of hotness in class room**

**Do you believe that improving thermal comfort in your classroom would positively impact your academic performance?**

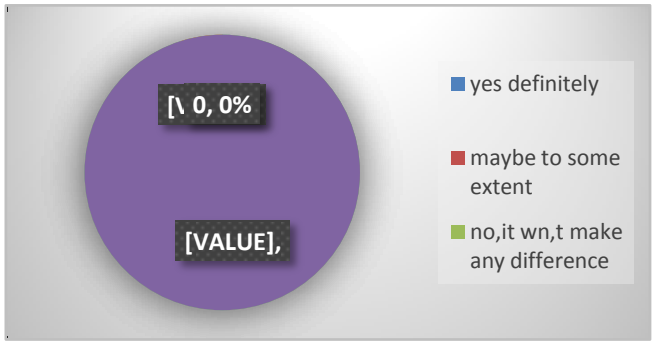


**Figure 19: Data analyzed through questionnaire to obtain the results about preference of students regarding improving thermal comfort through passive means**

**Are you satisfied with the current cooling systems (e.g., fans, air conditioning) in your classroom?**

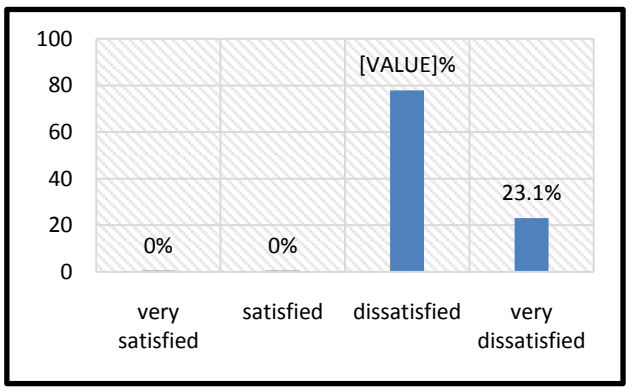


**Figure 20: Data analyzed through questionnaire to obtain the results about current cooling system in class room**

 

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**Would you prefer natural ventilation methods (e.g., opening windows, air vents) over mechanical cooling systems?**

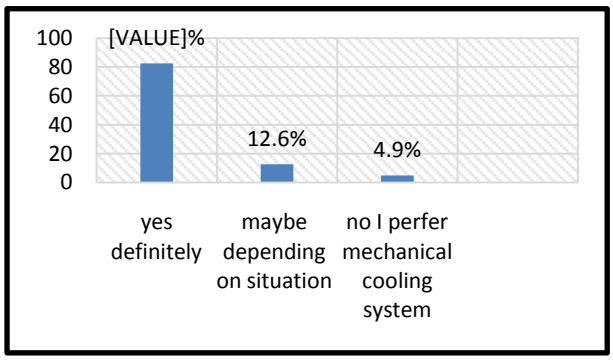


**Figure 21: Data analyzed through questionnaire to obtain the results about preferences of natural means of ventilation over mechanical means in class room**

**Are you familiar with the concept of passive techniques for enhancing the indoor environment in your classroom?**

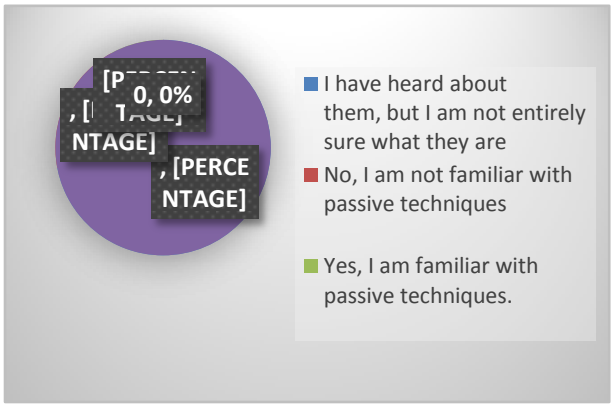


**Figure 22: Data analyzed through questionnaire to obtain the results about airflow and ventilation in class room**

**Do you think passive techniques contribute to better air quality and ventilation in your classroom?**

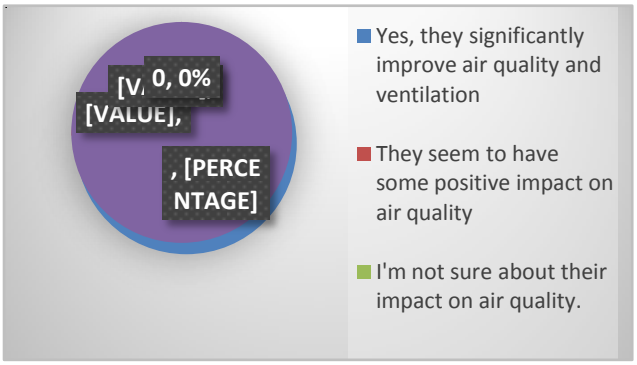


**Figure 23: Data analyzed through questionnaire to obtain the results about preferences of students on the contribution of passive techniques to obtain better ventilation in class room**

**Have you noticed any passive techniques, such as shading devices or insulated windows, implemented in your classroom?**

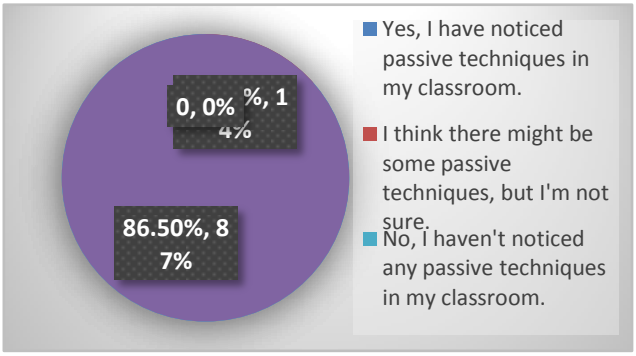


**Figure 24: Data analyzed through questionnaire to obtain the results about implementation of any passive strategy before in class room**

**How important do you think it is for your school to invest in passive techniques to improve the overall indoor environment?**

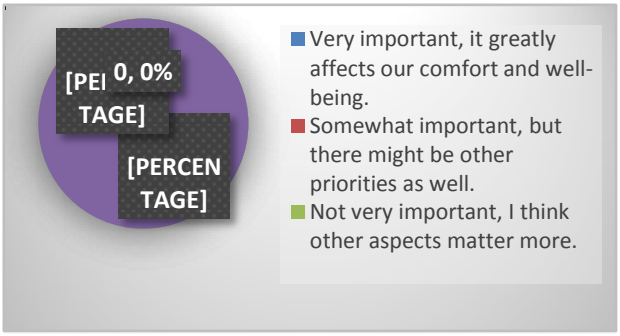


**Figure 25: Data analyzed through questionnaire to obtain the results about investment of school administration in passive techniques for better indoor environment of class room**

**Would you prefer passive techniques over mechanical cooling or heating systems in your classroom?**

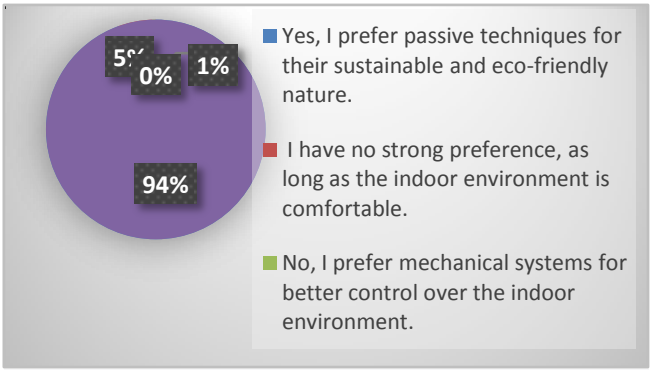


**Figure 26: Data analyzed through questionnaire to obtain the results about preferences of passive techniques over mechanical means to achieve comfortable environment**

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## IV. CONCLUSION

The continuous raised issues of energy demand raises several prolonged questions and problems and solution demanded. Prime focus of the study is given on passive cooling techniques of the schools as cooling has been identified as a more crucial issue in Hyderabad than heating. Passive cooling systems uses natural energy sources instead of mechanical techniques to provide a comfortable indoor environment and that is the significant key factor in moderating the effect of buildings on the built environment.

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