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PROPOSED FACULTY OF AGRICULTURE FOR AMBROSE ALLI UNIVERSITY EKPOMA, EDO STATE (USE OF PASSIVE COOLING TECHNIQUES IN HOT HUMID CLIMATE)

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Abstract

The building sector is one of the largest energy consumers worldwide. Especially in the hot humid region, this sector consumes about 30% of primary energy demand. This is mainly dominated by air conditioning systems to provide space cooling and dehumidifying. Improving thermal insulation, natural ventilation, and passive cooling designs are the strategies that should help a Faculty excess. With proper planning, excessive indoor temperature can be reduced by natural ventilation or Nature Air conditioning. Besides, this technique will improve building's airtightness this can cause an obvious difference in the effect of each Area of the building and when applied appropriately and good performance of the building, including high airtightness and proper thermal insulation, is guaranteed. This study proposed the "Faculty of agriculture and the use of passive cooling technique in hot humid climate" as a solution to Sick Building Syndrome which causes ailments to the users and staffs of the building is a situation where the building or an office is considered unfit for use by function of its lack of proper cooling techniques or poor room temperature and these are several causes of Sick Building Syndrome and the most common are Inadequate cooling techniques/Poor Air Conditioning Systems these can cause issues such as condensation, mould,

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emission of volatile organic compounds, mites, fabric deterioration, draughts, heat loss, carbon emissions which, not only affect the fabric of the building but can cause illness to the occupants. These proposed solutions to all the offices in faculty of Agriculture in Ambrose Alli University by preventing these problems from occurring. The use of passive cooling techniques will help improve thermal comfort in offices/building, the trigger the encouragement of natural ventilation as so improving the health of its occupants. planning for a Modern office is needed, these encourages productivity and adequate natural Air condition for they are best for conditioning the thermal state of Buildings and should be executed in every single building in Ambrose Alli University, Ekpoma.

Introduction

The establishment of a Faculty of Agriculture at Ambrose Alli University (AAU), Ekpoma, Edo State, is a strategic imperative for addressing the intertwined challenges of food security, sustainable development, and climate change resilience in Nigeria. Agriculture's significant contribution to Nigeria's employment and GDP is well-documented, yet persistent issues such as low productivity, reliance on traditional farming methods, and vulnerability to climate variability necessitate modernized agricultural education and research (Food and Agriculture Organization [FAO], 2022; National Bureau of Statistics [NBS], 2020). A significant portion of the nation's food is supplied by smallholder farmers who often engage in unsustainable practices (Manyong et al., 2005). Ekpoma's climate, characterized by high temperatures and significant rainfall typical of a tropical savanna, demands agricultural practices tailored to these specific environmental conditions. The proposed faculty is envisioned as a dynamic hub for innovation, practical training, and community engagement, cultivating a new cadre of agricultural professionals equipped to navigate these complexities.

The urgent need to revitalize agricultural education in Nigeria is further emphasized by shifting trends, including declining enrollment in conventional tertiary agricultural programs, even as interest in vocational and technical agricultural training grows (Jobberman, 2022). This apparent contradiction underscores the critical need for curriculum reforms that are responsive to contemporary industry demands and that effectively bridge the practical skills gap (Sahel Capital, 2021). Integrating sustainable and climate-smart agricultural practices is paramount, particularly in light of escalating environmental concerns and the imperative for adopting regenerative approaches (National Agricultural Biosecurity Group [NABG], 2021). The Edo State Government, through the proactive initiatives of its Ministry of Agriculture and Food Security (Edo State Ministry of Agriculture and Food Security, 2021), has demonstrated a firm commitment to

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regenerative agriculture and agroecological practices, signaling a broader recognition of the importance of environmentally sound and sustainable agricultural development.

Given Ekpoma's prevailing hot and humid climate, the strategic integration of passive cooling techniques into the faculty's infrastructure and agricultural operations is of utmost importance. Passive cooling strategies, encompassing shading devices, natural ventilation systems, and the utilization of reflective roofing materials, offer effective and sustainable means of mitigating heat gain and enhancing indoor thermal comfort, all while minimizing dependence on energy-intensive mechanical cooling systems (Architropics, 2023; Shear Architectural Design, 2023). By incorporating these techniques into the design and construction of greenhouses, livestock housing facilities, and other essential agricultural structures, the faculty can substantially reduce its energy consumption, achieve significant operational cost savings, and champion environmentally sustainable agricultural practices. Studies have consistently highlighted the efficacy of passive cooling technologies in hot and humid climates, underscoring their potential for achieving substantial energy savings and enhancing overall thermal comfort (Bohrium, 2023).

Siloko and Siloko (2023) conducted an in-depth investigation into the interdependence of rainfall and temperature patterns in Ekpoma, emphasizing the critical importance of understanding these climatic variables for optimizing agricultural productivity in the region. Furthermore, the Edo State Ministry of Agriculture and Food Security is actively spearheading the promotion of climate-smart agricultural techniques and sustainable crop production programs, thereby fostering a supportive policy environment conducive to the success of the proposed faculty (Vemar Farms, 2023). The integration of global best practices in agricultural education, as strongly advocated by Essien et al. (2023), is also of paramount importance in ensuring that the faculty's curriculum remains aligned with international standards and effectively addresses the ever-evolving needs of the agricultural sector. Therefore, the establishment of a Faculty of Agriculture at Ambrose Alli University, Ekpoma, with a dedicated focus on the implementation of passive cooling techniques, represents a timely and strategic investment in the long-term sustainability of agriculture and the enhancement of food security in Nigeria.

Objectives of the Study

The primary aim of this project is to use passive cooling technique for propose Faculty of Agriculture in Ambrose Alli University, in improving natural Air conditioning in Edo State. As well as, to minimize energy costs.

i. To create awareness of the use of passive cooling techniques in hot humid climate and also through the proper integration of passive cooling design, ensure the functioning of it Air conditioning.

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ii. To study the methods that bring natural Air conditioning into the interior in order to determine the best strategies for enhancing natural air in the building.
iii. To create effectiveness of passive cooling techniques as the sole source of illumination during hot weather as opposed to the common practice of leaving electric light on during the day with a view to conserving electrical energy and saving costs.
iv. To study the architectural implications and possibilities involved in channeling passive cooling techniques into interior spaces.
v. To provide outstanding facilities with the use of passive cooling techniques for formal intersection between staff and student, as well as for informal and peer-to-peer learning.

Site planning consideration

Architectural designs begins with the site planning, related functions are grouped together to produce harmony both in entering and movement within the site. However locational demands are imposed by site realities and specific requirements of different function on site. These demands have to be met for proper utilization and proper working of various functions on site. Considering the nature of operation in the faculty, the various activities can be zoned into noisy, semi-noisy and quiet areas. In planning these zones, the noisy area is separated from the quiet zone by the semi – noisy zones to achieve a graduation of noisy to semi – noisy to quiet zones. Sometimes, planting of trees or shrubs, use of courtyards, screen and floors can be used to separate these zones. For proper integration of functions within the site, the noisy areas should have a closer affinity for the sources of site noise; this area can then be classified as noisy zone.

Design Concept

The design concept is thought up by the guiding principles of passive cooling techniques and the authors perceived vision for the project. Good passive design should reduce or eliminate the need for additional heating or cooling depending on your location and often relies on an active occupant to work properly. The sole aim of the research work is to achieve effective passive cooling techniques on the building spaces. This puts the author's mind focused on forms that would allow the achieving of the primary goal. Firstly, the building would adopt a basic simple from that permits the proper penetration of ambient, diffused and passive cooling into its interior space. The form chosen by the author would revolve around the highlighted forms, modifying out of the selected original form to produce a variant that would the ideology or philosophy of the author.

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Design philosophy

To achieve the specific objectives of this project; the broad-based guiding principles have to be anchored on a well thought out design philosophy. This philosophy is one that has to touch on the fundamentals of the Academic building and the characteristics of its location and the peculiarities of its environment. An academic building as a unit, is a learning and recreational environment. It thus combines the function of learning, producing, accommodating, feeding, recreational, entertainment, etc. these are not isolated activities but have to be integrated to provide for the comfort and well-being of the users.

A renowned Architect, John Portman noted the importance of design philosophy when he said that "A design philosophy is the rudder for the boat, it makes possible a continuing course in a meaningful direction" Bohrium. (2023). He went further stating that for a building to meet the needs of all the people, the Architect must look for some common grounds and experiences. The need for this common ground led him back to people as creature of nature, perceiving their environment that all people would instinctively find harmonious; these shall constitute the ingredients of any design philosophy. Thus, the general philosophy guiding the design is described in 1 words, **COMFORT**.

Site Analysis

The building around the site designated for the faculty of agriculture is the faculty of engineering, faculty of management science.

Prevailing winds: The prevailing winds-north east and south west trades wind interface themselves, their intensity and duration over a particular area varies. Landscaping and planting of trees to shield the structure from harmful effects of winds will be affected early in design development. Orientation would also be a tool aimed at making the best of the wind direction so as to achieve maximum comfort of the user and protection of structure. The building is properly oriented so as to best use the prevailing winds.

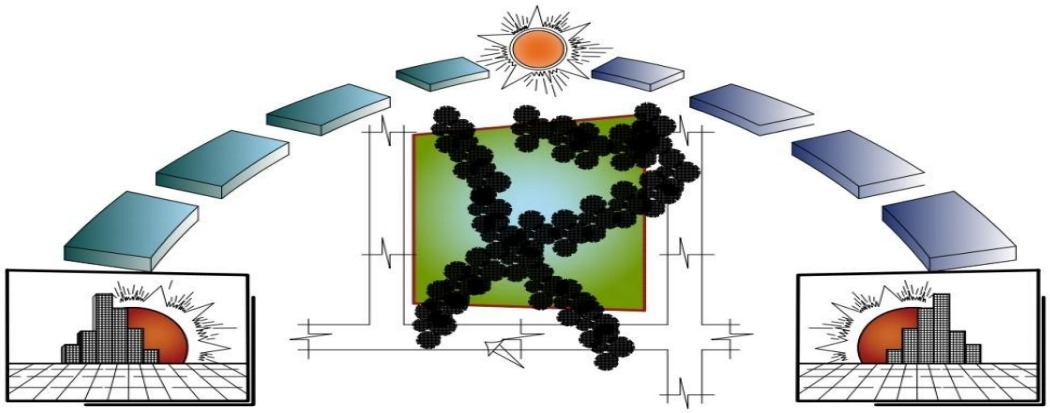

Fig.1: The site plan showing the physical analyses. (**Source:** Greg Mgbanugo 2021)

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Orientation:

The prevailing wind in the site is the southwest and the northeast trade winds. Therefore, orienting building in east-west direction will not allow good airflow through it. The wind will be heating the building at angle 45°, forcing a part of it to go parallel to the building, while the rest will go through the building. The east or west end of the building (depending on the direction of the wind) will be without air movement, Orienting buildings at 45° to the horizontal, will allow the two prevailing winds pass through them undisturbed. It's being undisturbed means that it will be moving with its normal speed, (which may be high or low). If the speed is high it may not be good for people and as well will pass without proper circulation in the building. However, if the speed is low and acceptable it will be the best orientation for ventilation purposes, All the same the solar radiation incident on the building will be too much and as such not a good orientation in the tropics.

A third arrangement involves positioning the building at an angle of 22°30° to the horizontal. At this position the wind speed is lowered causing it to circulate more evenly of sun radiation is lowered to a manageable quantity. This quantity of solar energy allowed into the buildings help in deodorizing the building interiors. It heats up the air inside the building interiors, which is then displaced by cooler air from outside-this is most obtainable in the morning hours.

Answers to Research Questions

i. Increased admission of passive cooling techniques into a design space affects its architecture in that it makes every space "come to life" with increase in human activity and perceived beauty of the space. Note that cooling and light plays a strong part in human perception. "Man seeing only what he knows and understands as a perquisite for seeing". This interpretation changes his perception. The term is known as selective attention (Mckeanchie and Doyle, 1070, pg 163-164). Most people feel day is safe and night dangerous. This perception makes people feel safer in a properly lit environment making them conscious it is daytime while it's daytime.

ii. The relationship between naturally ventilating a building and its building design is based on principle that natural ventilation when used effectively in the building is proportional to less strain on it. The architectural consequences of designing for natural ventilation is that it increases the initial cost of the building design as well as the level of creativity needed at the design stage but reduces the cost of maintenance of the building in the long run.

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iii. The concept of adding window hoods and fins to the building because it is located in the tropics cannot enhance ventilation in the interiors but reduce heat. Besides they are much more architectural elements that would improve the aesthetic appeal of the building.

Recommendations and Conclusion

With today's renewed interest in sustainability, passive cooling techniques should be a necessary consideration. New developments in design strategies are becoming popular. The most obvious reason for the development of common sense regarding passive cooling as primary source of ventilation during the working hours, is the high cost of energy. This makes the notion that not all spaces can be ventilated invalid. With this development of the effective use of passive cooling, ventilation can penetrate deep into spaces, from floor level to lower floor levels. There is no restriction security reason, site constraints as before. There is no more excuse for designing spaces that cannot capture one's imagination through the play of ventilation on space, color, and human interaction. This is important because throughout history, passive cooling techniques in building has impacted human behavior and human factors and has reduced the stress and discomfort of users (Hanan M. Taleb, 2014), along with directly influencing the design of buildings including layout of space. Passive cooling techniques is a constantly changing and variable phenomenon requiring the use of good ventilating design process based on sound architectural and interior design principles.

In addition, this paper has proven beyond every doubt that seeking 'effective means of natural ventilation on architecture design spaces requires a well planned and strategized passive cooling techniques design which could not only save energy and cost in critical working environment but make it psychologically balanced and architecturally pleasing as well.

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