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Addressing Energy Efficient Lighting and Ventilation in Libraries: A Case Study of Peckham Library, London, UK

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ABSTRACT

Lighting and ventilation are the main factors which influences the amount of energy consumed in a Library, as human comfort within a space requires a reasonable amount of light and airflow. Buildings that are not energy efficient require more mechanical/electrical devices to achieve thermal cooling in tropical areas and thermal heating for cold regions. In Nigeria, most buildings hardly take energy efficiency into consideration due to ignorance, poverty, lack of awareness and/or improper policy on building regulations by Government. But as a cultural service institution, libraries should take the initiative to protect the environment, rather than adding to the continuous degradation of the natural environment.

Use of mechanical devices to attain thermal comfort in buildings is not only capital intensive but also generate greenhouse gases, air and noise pollution amongst others. Apart from the use of energy efficient lighting fixtures, Libraries should be designed to be energy efficient by providing large windows for natural ventilation and natural light. And provision of naturally ventilated open spaces such as court yards for proper airflow within the habitable spaces.

This paper looks at measures to effectively reduce the amount of energy consumed in a Library, by reviewing the case study of Peckham Library; which was designed to be energy efficient by relying more on natural lighting and ventilation, rather than mechanical means. The data collected is structured, analysed and interpreted to understand practical ways on how energy efficient lighting and ventilation can be achieved in libraries. Therefore the scope of this paper aims at: Promoting energy efficiency in the design and construction of libraries.

Key words: Library building, Energy Efficiency, HVAC Systems, Green House Gases (GHG)

INTRODUCTION

In Nigeria, libraries over the years have been built on its original mission, which is to provide the intellectual ammunition to aid government officers in policy implementation and to act as the intellectual memory of the nation. Libraries according to Carl Sagan Cosmos, connects us with the insight and knowledge of great minds that ever were, with the best teachers, drawn from the entire planet and from all our history, to instruct us without tiring, and to inspire us to make our own contribution to the collective knowledge of the human species (Sule, 2014). He also stated that the health of our civilization, the depth of our awareness about the underpinnings of our culture and our concern for the future can all be tested by how well we support our libraries. (Sule, 2014)

Public libraries have been intended to hold the perusing interest of the users. This is done through exceptional show of materials that fill in as perusing assets both print and electronic. Public library likewise fills in as a road for in-house narrating hours and other expansion administrations like the foundation of book clubs, book services, organized discusses, symposia, dramatization, and verse.

Library users require a reasonable amount of light for visual comfort in reading spaces for comfortable reading experience as human tends to function in response to its environment. People do not perform well in spaces that are too hot or too cold. Proper lighting, appropriate to each task, is essential. Background noise from people or devices such as fans can be distracting and damage readers' hearing. Acoustic and visual privacy also need to be considered, as well as fresh air through windows or clean air ducts is vital to the well-being of library users. The benefits of fresh air go beyond the need for oxygen. Continuous recirculation of interior air exposes people to concentrated levels of bacteria and chemicals within the building. Most public libraries in developing countries consumes a lot of energy to power lighting and HVAC systems in order to enhance visual and thermal comfort within its spaces to make users more relaxed and enhance reading culture. And this makes public libraries one of the major consumers of energy.

RESEARCH AIM

This research looks at measures to effectively reduce the amount of energy consumed without affecting the indoor climatic conditions. Therefore the scope of this paper aims at: Promoting energy efficiency in the design and construction of libraries.

RESEARCH OBJECTIVES

- To enlighten the public on how energy efficient lighting and ventilation can be achieved in public libraries.
- To enlighten the public on the benefits of energy efficient design and construction
- To promote the design of climate responsive buildings that consumes lesser energy

RESEARCH QUESTIONS

- What are the impacts of energy efficiency on the built environment?
- How can energy efficient lighting and ventilation can be achieved in libraries?

LITERATURE REVIEW

Aesthetical values has been the major emphasis of most buildings in Nigeria, with little or no consideration for energy efficiency. But according to (Oyedepo, 2012), recent studies reveals that in order to enhance thermal comfort in buildings in hot-dry climatic conditions; building materials should be carefully selected, as over 40% of the world's total energy use is consumed by buildings compared to other sectors of the economy. Most buildings in Nigeria are noted for high level of energy consumption, which are mainly due to the building envelope, the occupants, HVAC systems, lighting and appliances (Dr. Ekele & Ahmad). But can all be reduced through the adoption of energy efficiency measures.

This increasing energy consumption of the buildings sector contributes significantly to global warming due to greenhouse gas emissions, which is also responsible for approximately one-third of energy-related CO2 emissions, two-thirds of halocarbon, and approximately 25–33% of black carbon emissions.

Besides being aggravated by GHG emissions from buildings, the climate change itself has its own implications on the buildings sector worldwide. Due to the rising temperature, the cooling demand increases in some hot and arid parts of the world, making passive cooling approaches as overnight ventilation or shadowing less effective, and obliging to rely more on active cooling systems.

Global electricity consumption in buildings is predicted to increase as cities in growing nations continue to modernize and per capita profits levels proceed to increase. Despite this excessive electricity consumption, residential, public, and commercial constructions also offer unparalleled possibilities for strength savings. According to the International Energy Agency, structures

account for some 41 percentage of world electricity financial savings achievable by 2035, in contrast with the industrial quarter (24 percent) and the transport sector (21 percent).

RESEARCH, ANALYSIS, AND STRATEGY

In Nigeria some facility managers, in their bid to conserve energy, would turn off some HVAC systems in order to reduce the amount of energy consumed in running the facility, thereby reducing the indoor air quality; which is very unprofessional. A public or commercial facility should be well-functioned to meet the human comfort criteria, as well as a good environment should be provided.

A library is supposed to be a facility or place where people go to gain knowledge and encourage the reading culture among the community; where most of information and references are kept systematically. Therefore, the architects and governments have to evaluate every aspect of its provision to ensure that the services provided meet the demands of the library users (H, A, Mannan, & Adenan, 2013). It is also important to incorporate a sense of youthful vibe into the design in order to make it attractive to both younger and older generations.

CASE STUDY: PECKHAM LIBRARY, SOUTHWARK, LONDON

Figure 1: Picture Showing Night View of Peckham Location

LOCATION:	**London, UK**
CLIENT:	**London Borough of Southwark**
ARCHITECT:	**Alsop & Stormer**
PROJECT VALUE:	**€4.5 million**
FLOOOR AREA:	**2,300m^2**
MATERIALS:	**Concrete, Copper Cladding, Glazed Façade, Steel Columns**
STATUS:	**Completed 1999**

Figure 2: Showing the Location

PROJECT INFORMATION

One of the troubles with buildings, says Cedric Price, Will Alsop's old mentor, is that you have to stroll round them. Even earlier than you've had an opportunity to look at them, to admire the delights they provide or to look at their proportional systems and axial relations, they have incurred so much irritation (Jeremy, 2013).

DESIGN COMPOSITION

The library was conceived with sustainability in mind, with provision for natural lighting and air flow systems which influentially diminishes the building's electricity consumption. The

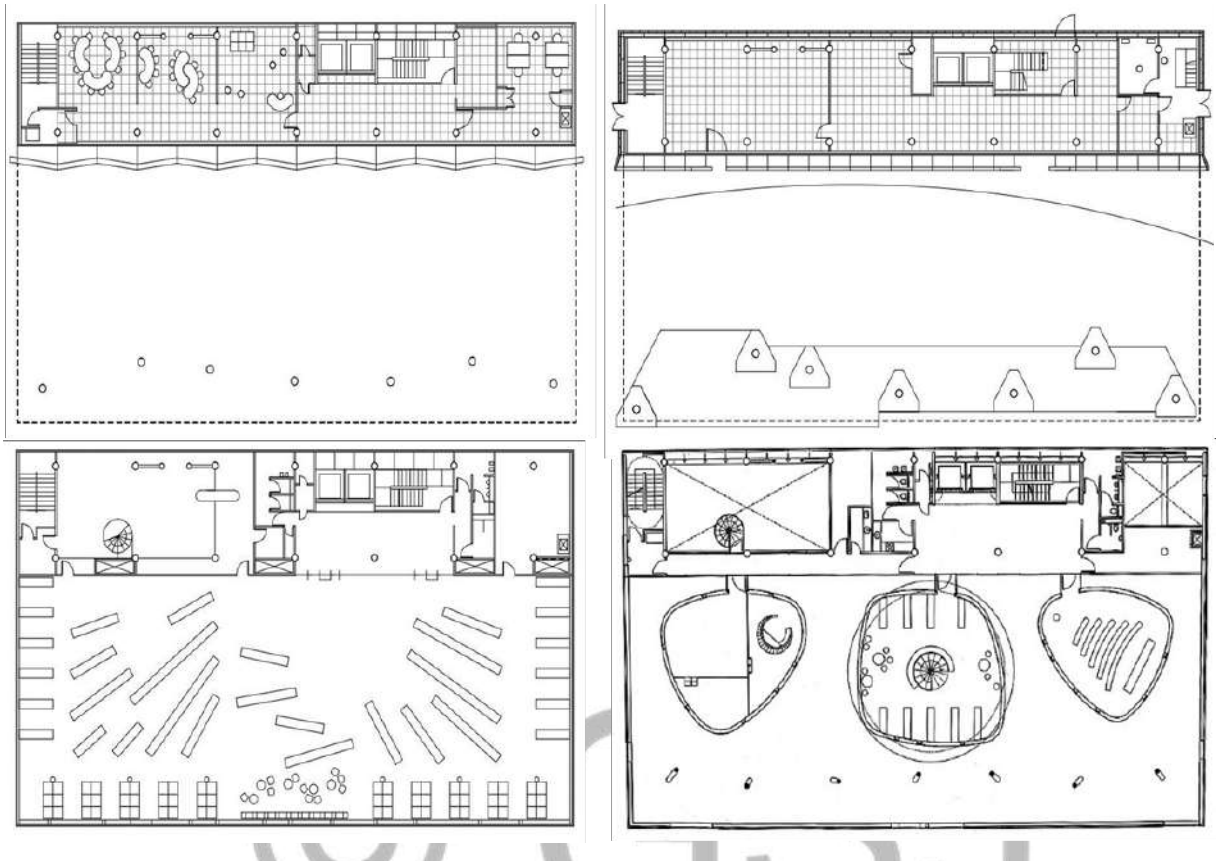

Figure 3: Peckham Library's Floor Plans

building's inverted "L" shaped form generates a natural, harborage meeting point simply in the front of the facility, accompanied by the open area round it, which makes the facility a core of a busy center. Entering it is intentionally dislocating: aside from incorporating a borough information center, its foyer is small and leads without delay to an elevator which rises via the office region to the reading room at the top. Its measurement alone is unexpected, and its form appears to change: you enter a long thin building and emerge into an area which is nearly square. Despite its exceedingly simple, cuboid volume, it unveils itself via movement.

The Peckham Library composition resembles an open book, with one of end resting on the ground and the other balanced on a set of extraordinarily slender and amazingly slanted columns some 12m up (Jeremy, 2013).

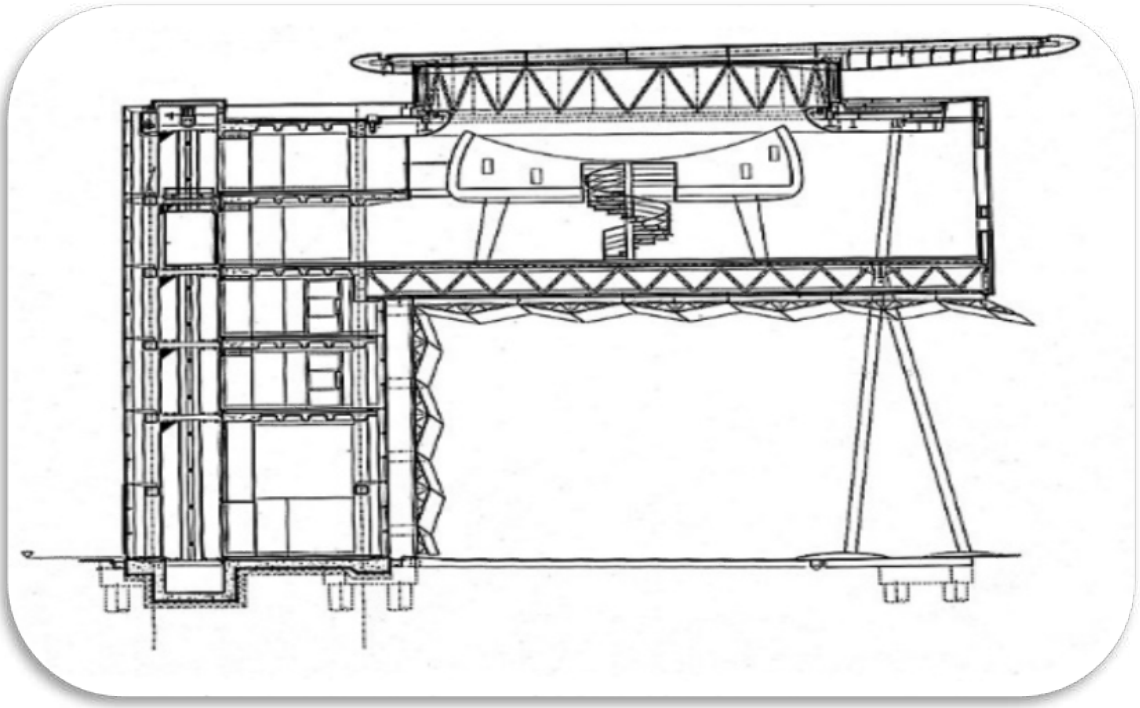

Figure 4: Section Drawings

LIGHTING AND VENTILATION

The claddings used on the external had been chosen for durability and for their expressive texture and colors. Other materials includes, pre-paginated copper and metal mesh distinction

Figure 5: The Library's Reading area

with colored glass. The main reading region is at the fourth floor level, the short arm of an inverted 'L', with offices, meeting rooms and other ancillary facilities on the lower floors.

Figure 6: The Library's Reading area

Overhead, at mezzanine level in the studying room, are three pods of blob-like forms which rest on tripods. The central one is open to the clerestory allowing sunlight to enter the main space. Above it is the low velocity extract fan which also helps in ventilating the area. Also, as a means of reducing running cost, the vivid glass on the north facet allows for ample amount of natural sunlight to illuminate the building, while facing the direction of the sun, making the entire facility a large greenhouse.

ENERGY EFFICIENCY

The library was designed to limit the need for mechanical HVAC systems and fossil fuels for lighting fixtures and ventilation. The vertical block is naturally ventilated through the curtain wall. In the deep double-height areas of the library, air is drawn in from below the soffit to create a stack impact with air extruded through the pod skylight and clerestory drum.

The cantilevered overhang additionally shades the façade from the sun, an essential aspect as the running charges had to be saved to a minimum, ruling out the need of an air-conditioning system.

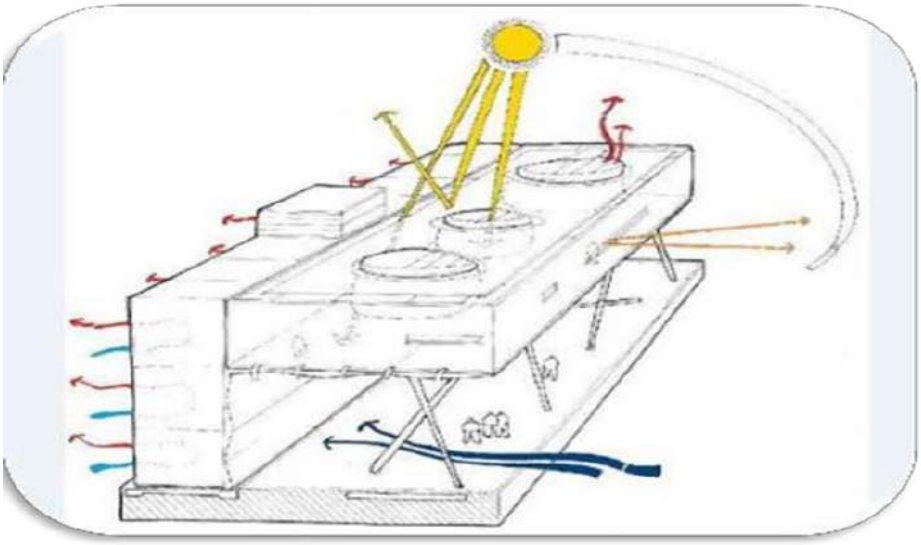

Figure 7: Climatic analysis of Peckham library

AESTHETICS

Peckham Library portrays an urban rejuvenation on a reduced scale in contrast to the Modernist housing schemes and its youthful appearance, places it outside the regions of the Modernist Movement. The Peckham layout proposes that the contemporary day libraries must aesthetically appealing to the neighborhood where it is located, thereby encouraging frequent access to

Figure 8: The Library's exterior

knowledge.

The library adds a modest transformation of its own. Visible from a distance at night time via its colored illumination, or in the course of the day due to the fact of its aesthetically appealing patinated copper cladding, it is an obvious nearby landmark. At floor level its arcade suggests a cross axis to the Arch, leading in front of the library between the Pulse and Peckham Hill Street, making a round hub for a network of pedestrian routes which would in any other case stay implicit.

Figure 9: Interior views of Peckham library

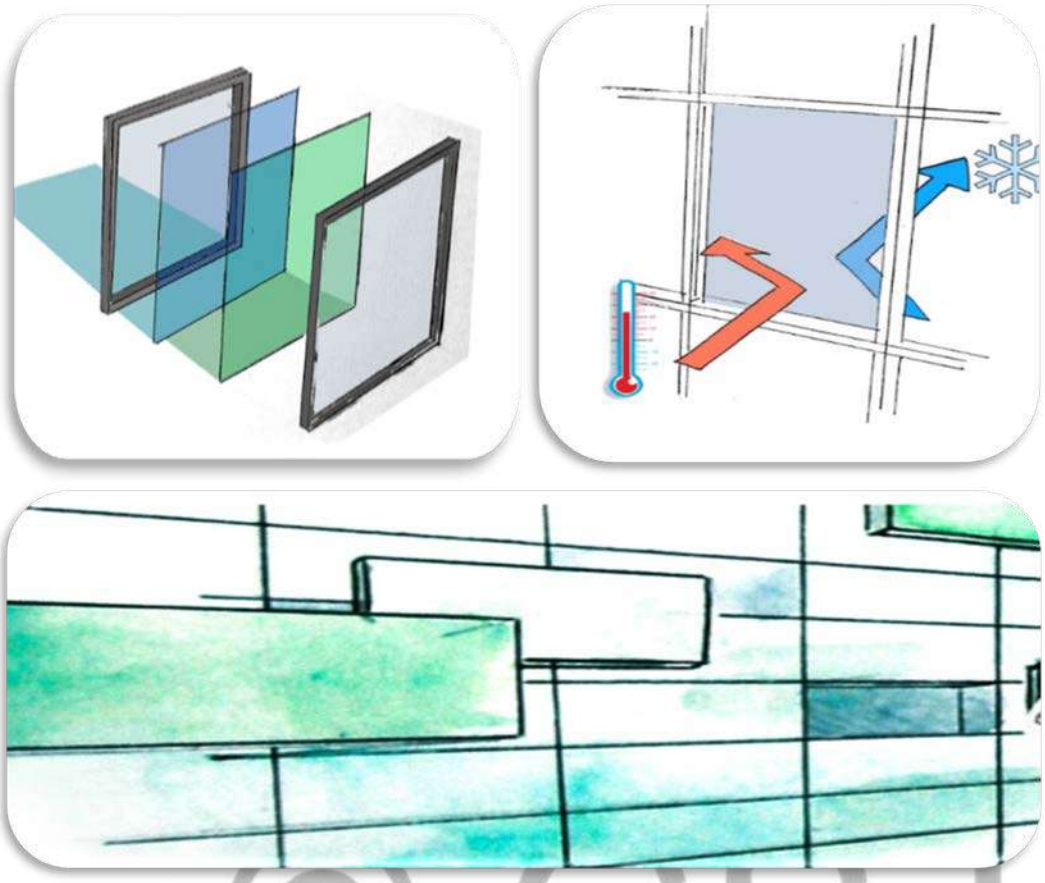

Figure 10: Glass and Copper cladding material

DERIVATIONS FROM CASE STUDY

The case study analyzed was chosen because it present some technical design solutions that can be adopted and modified to produce a more functional and sustainable Public Library design. And based on the case study and other literature analyzed, the following design strategies were discovered to be most effective measures for the sustainable design and operation of an energy efficient Public Library.

1. Passive cooling
2. Passive ventilation
3. Daylighting
4. Passive heating
5. Tropical architecture

Whereas for energy conservation, the following strategies were discovered to be have more effects in ensuring energy conservation.

1. Reducing heating & cooling demand
2. Using natural ventilation where possible

3. Reducing energy used for lighting

ENERGY EFFICIENCY DESIGN MEASURES

PASSIVE COOLING

Passive cooling strategies prevent the building from overheating by blocking solar gains and removing internal heat gains (e.g cooler outdoor air for ventilation, storing excess heat in thermal mass). This can be achieved through the use of elements such as external shading devices, Thermal mass, low window to wall area ratio(S/W), passive ventilation, nocturnal cooling, stacked windows, passive evaporating cooling, earth-tempering ducts, etc.

PASSIVE VENTILATION

Passive ventilation strategies are naturally occurring air flow patterns around and within the building's envelope to introduce natural air into the space. Wind and buoyancy caused by air temperature differences creates air pressure differences throughout occupied spaces. Buildings can be designed to enhance these natural airflows and take advantage of them rather than being against them.

Passive elements that are very effective in achieving passive ventilation includes; Building shape, orientation, strategic architectural features, operable windows, central lobbies, space planning, buffer spaces and double façades building orientation, etc.

DAYLIGHTING

Day lighting maximizes the use and distribution of sunlight throughout a building's interior to reduce the need for artificial electric lighting. Features which contribute to this includes: Space planning, window to wall area ratio, skylights and light tubes, light shelves, high ceiling paired with tall windows, interior surface color and finishes, strategic space articulation, clerestories.

PASSIVE HEATING

Using building design to harness to solar radiation and capture the internal heat gains is the only passive way to add thermal energy to a building. Passive solar heating combines a well-insulated envelope with other elements that minimizes energy losses and harness and store solar gains to offset the energy requirements of the mechanical heating and ventilation systems.

Passive heating can be achieved through the application of the following elements: Building Orientation, minimized infiltration, operable external shading, space planning, buffer spaces and double façade, proper space planning, building shape, low window to wall ratio(S/W), high window to wall ratio(N/E).

TROPICAL ARCHITECTURE

Tropical architecture is said to be a type of green building applicable explicitly for tropical temperatures, using design to drastically diminish buildings' energy depletion, predominantly the cooling load.

Tropical architecture is not a new but has been in existence for many centuries in some part of the world. Particularly countries in the Asia-Pacific region have adopted vernacular designs adapting to their climatic needs for many centuries.

For example, a high ceiling shows a kind of the stack effect. The West Indians use porticos to reduce solar heat gains, whereas Malay homes uses a large roof overhang. These design solutions allow windows to remain open for natural ventilation in a building during rainy season.

Tropical architecture helps to attain thermal comfort via the use of design elements, such as sunshades, cavity walls, light shelves, overhangs, roof and wall insulation and even shading from trees. The design principles of tropical architecture include: regional evaluation; climatic elements; site selection; sol-air orientation; solar control on the environment and building; forms, wind effects and air flow patterns; thermal effects of materials. In addition, maximum cross ventilation, natural lighting, louvers and natural materials are key elements for optimizing natural ventilation to cool tropical buildings.

EHNERGY CONSERVATION MEASURES

REDUCING HEATING AND COOLING DEMAND

This can be achieved by limiting the unprotected surface of the building, improving the insulation of the building's fabric, also by decreasing ventilation losses, and by choosing efficient heating systems with effective controls. The shape of a building regulates how much area is exposed to the climate via exterior walls and ceilings. To save energy, try to keep this exposed areas to a minimum.

USING NATURAL VENTILATION WHERE POSSIBLE

The energy required for ventilation can be minimized by: a building design that maximizes natural ventilation; an effective window design; use of mixed mode ventilation; using efficient mechanical ventilation systems.

The most effective means of natural ventilation is cross ventilation, where air is allowed to pass from one side of a building to the other. For this to work efficiently, the buildings usually are no more than 12-15 m in depth. However, in deeper plan spaces, natural ventilation can be attained by making use of central lobby and making use of the "stack effect" to draw air from the outside and up through the centre of the building.

Windows should permit simplicity of control by building occupants and controlled ventilation that won't cause draughts. Where night ventilation is used, it is essential that building occupants know how the building is designed to function, or that active control measures are provided, as it is natural to open windows before leaving a building at night.

REDUCING ENERGY USED FOR LIGHTING

This can be achieved by: Ensuring optimum use of the sun while eluding unnecessary heat gain; via task lighting to avoid unnecessary interior luminance levels; installing energy-efficient light fittings with a high luminance to energy ratio; and providing smart controls to prevent lights being left on without use. Making use of natural light in buildings is not only energy efficient, but also a means of creating a striking environment that improves the occupant's well-being. The introduction of effective daylight in buildings can be assessed using average daylight factors and by ensuring that occupants have a view of the sky.

Windows have a key impact on day lighting within spaces. A window will introduce effective daylight into a room to a distance twice the head height of the opening. Whereas introduction of high ceilings and clerestory windows can be very effective in providing good daylight. The average presence of daylight within spaces will is subjective to the size and area of windows with respect to the room, and presence of overhangs and other external obstructions that may control the amount of sunlight entering the room.

CONCLUSION

All inventions and innovations in the world is based on existing theories; information researched by bright minds. And Carl Sagan Cosmos explained that libraries connects us with the intuition

and knowledge of great minds that ever existed from around the world and from all our history, to educate us without tiring, and to motivate us to make our own impact to the collective knowledge of humans.

Libraries, being one of the oldest institutions in the society, should not just be conceived as an ancient hub for knowledge and literacy, it should also be a physical example of sustainability. A Public Library should be well-functioned to meet the design criteria as well as human comfort criteria, and a good environment that does not harm or cause danger to the natural environment.

RECOMMENDATIONS

Spatial organisation of space and proper fenestration pattern is very important in order to achieve proper air circulation in internal spaces this might lead to the provision of a courtyard to attain maximum circulation of natural air and day light for effective functionality and thus enhancing indoor comfort and day lighting. This design consideration points that the project should improve natural ventilation of internal spaces, increase natural day lighting within spaces, comfort and sustainability, therefor reducing the need for energy.