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Passive Design Strategies for Energy Efficiency in Film Studios: A Case Study of Nigerian Film Industry

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Abstract

It is discovered that the Nigerian film industry emits around 125,000 tonnes of CO2 - 125,000 tonnes is comparable to approximately 24,000 Nigerian households. This eliminates film and television distribution and exhibition, as well as production office travel. As a result, the aspect of green innovations and passive energy efficiency is critical to increasing the affordability of the technology and industry in the long run. On the other hand, the role of the media and energy efficient design and environmental protection is critical. In contrast, energy consumption is frequently considered as a major measure of economic prosperity, sometimes at the expense of the environment. As a result, this paper aims to provide design based solutions to tackle the issue of excessive power consumption during film production and provide passive energy efficient strategies.

Keywords: energy efficiency, passive, film industry, innovation

1. Introduction

The Nigerian Film Industry (Nollywood) is often regarded as the world's second largest film producer. The industry is a substantial component of the Arts, Entertainment, and Recreation Sector, which contributed 2.3 percent (NGN239 billion) to Nigeria's GDP in 2016. It is one of the key areas designated in the Federal Government of Nigeria's Economic Recovery and Growth Plan, with a target of $1 billion in export income by 2020. There isn't a single person who isn't aware of this form of media. Film, also known as motion pictures, has always been a part of our lives. It is a young medium in the sense that it took time to flourish, but in today's world, it plays a significant role, and its impact on our lives is undeniable. Even though films have played an important role in our lives and brought us joy for as long as we can remember, the film industry in Nigeria has not thrived as expected.

Since the first film was made in 1887, there has been a need for filmmaking facilities to be housed under a single roof so that film makers can easily create films. In 1893, Thomas Edison built the first movie studio, "Black Maria," in West Orange, New Jersey, and invited circus, vaudeville, and dramatic actors to perform for the camera. He screened these films in a variety of

theaters and arcades. Until the early 1900s, movies were shot outside in the sunlight, despite the availability of electric bulbs.

The cause of this was improper and insufficient lighting of these electric bulbs. Until recently, indoor shooting was not preferred for filmmaking. Only in the 1920s were some good production companies established, such as 20th Century Fox, RKO Pictures, and others, and they started their own studio, distribution division, theaters, and contracted with actors and other film making personnel. The Nigerian film industry has a long history, some studios, for example, the Nigerian Film Development Company. Unfortunately, they were unable to bring all of the necessary facilities for filmmakers under one roof.

Definition of Terms

"A film studio (also known as a movie studio or simply studio) is a major Entertainment Company or Motion Picture Company that has its own privately owned studio facility or facilities that are used to make films, which is handled by the production company,". A film studio includes all of the facilities and equipment needed for pre-production, production, and post-production, as well as a preview theater. It consists of various studios, sets, backlots, a wide range of production and post-production services/facilities, and other film industry services/facilities that can support several film and television projects at the same time. Several years ago, film studios had only indoor and outdoor shooting facilities. The advancement of technology brought about significant changes in the field of filmmaking.

Animation techniques such as green screen technology and the development of sound systems had added a realistic touch. In a film studio, we can find all of the necessary facilities, such as office space and housing for actors and other technicians. Here in the film studio, one can shoot a movie at a very fast pace because the workshop facilities available here allow one to quickly construct different indoor and outdoor scenes. The workshop facilities include a wood and metal workshop, a painting studio, and plastering workshop. These workshops are mostly used for the development of indoor sets.

A Film Complex is a studio complex that houses all of the equipment needed to make a film. Film development is divided into two parts: technical development and creative development. It provides a film maker with all of the technical facilities for filmmaking, as well as an atmosphere for outdoor shooting and post-production facilities, and serves as a melting pot of Nigerian silver screen artists.

2. Methodology

The descriptive research technique was employed in this study, with case studies serving as the major kind of descriptive research. To obtain information for this study, the researcher took many field excursions to several established local production studios around the country. Consequently, no international excursions were taken, but data was gathered through their websites. A comprehensive analysis of the study's books, journals, and other recorded research was conducted. The primary and secondary data employed in the study came from these sources.

3. Literature review: Cinema in Nigeria

The entrance of cinema into Nigeria as a purely economic enterprise, the absence of official interest in cinema as a national endeavor, and its presence in the informal sector of Nigeria's political economy are significant highlights in the nation's film debate (Ekwuazi, 1991; Ukadike, 1994; Haynes & Okome, 1998). Cinema in Nigeria is an industrialized but uncontrolled industry mostly influenced by Yoruba traveling theatre. The partnership of cinema veterans like Ola Balogun and acclaimed stage dramatists like Hubert Ogunde, Moses Olaiya Adejumo, and Duro Ladipo marked the troupe's first forays into filmmaking. According to Ukadike (1994), Duro Ladipo's theatrical group members mostly constituted the cast of Ajani-Ogun (1975/6), which, in addition to being shot entirely in Yoruba, accelerated its tremendous success among Yoruba audiences.Theatre companies began filming their stage acts shortly after, utilizing cinema as "an extension of their theatre practice and to increase pay" (Russell 1998:149). The Structural Adjustment Program, market limitations (since shows were mostly in Yoruba), and escalating production costs all led to the economic need that necessitated the disbandment of the majority of the troupes. The actors began their careers in mainstream English-language films, but were disgruntled with "the little they were getting paid by Igbo producers," so they rented video equipment and began their own productions. "A flood of films followed" (Haynes 2000:56). These films, which were primarily made in southern Nigeria and in English, were quickly dubbed Nollywood.

As previously stated, cinema in Nigeria is split along ethnic, but mostly regional, lines. According to Johnson (2000) and Haynes & Okome (1998), such separation has continued to define the Nigerian film industry, which now consists of multiple sectors unified as one. Bud (2014) says that the Northern industry, which is divided generally into Northern and Southern industries, is rather independent from its Southern equivalent. While ethnic differences explain this sectoring, Okome (1999), Okome & Haynes (2000), Adesanya (2000), and Lawuyi (1997) observe that a variety of setbacks hampered the growth and development of celluloid filmmaking in Nigeria in general. According to Barnard and Tuomi (2008), "the comparatively rich filmgoers were at such great risk of being assaulted by criminal gangs that the movie-going culture all but disintegrated".

The Hausa film industry is an important part of Nigerian cinema (Kanywood). Larkin (2000, 2003, 2004) has examined the business, which formed in the mid-1990s, separating itself from its Southern equivalent by focusing on themes of love and mimicking the Bollywood aesthetic rather than stressing magic and the corruptions of urban life. Larkin's (2004) ethnographic research on the industry traces the rise of the video phenomenon, the threat of Shari'a laws, and issues of piracy and copyright, concluding that, despite their differences, the Hausa film industry, with headquarters in Kano State, has evolved and benefited (in terms of distribution) from the Southern industry. While Johnson's research focuses on the Hausa film business after the creation of the video phenomenon, Larkin (2000) investigates the derivation of the video format from previous forms of popular culture, as well as the effect of Indian films. His anthropological assessment, however, overlooks celluloid cinema in Northern Nigeria.

Fig 1: Nollywood Outdoor Film Set (Source: NYTimes)

Nollywood marks a huge transformation in the Nigerian film industry from celluloid to video. With the return of celluloid, film, and high definition video technology, the period of creating films in standard definition video format is becoming outdated, traditional, or orthodox. The term "old Nollywood" refers to the industry's continued adherence to the regular production and distribution routines that it began with. Teco Benson claims that the transformation that resulted in old Nollywood is based on criticism. "They (filmmakers) got a lot of complaints, mocking, and unpleasant comments," he claims.

Motion picture facilities

In order to create a film in an efficient manner, a variety of facilities are required, including a production office, indoor and outdoor shooting areas, green studios, and more, throughout the filmmaking process. This is a list of the necessary equipment for completing every motion picture, categorized according to the stages of filmmaking.

Pre-production facilities

- Office space

Production facilities

- Workshops
- Dressing room
- Animation studio
- Equipment rental
- Backlot
- Sound stage

Post production facilities

- Post production studio
- Photography studio
- Film development lab

Other Facilities

- Screening room
- Restaurant
- Parking
- Film Museum and archives
- Retail outlets

4. Discussion: Passive Design Strategies for Energy Efficiency in Buildings

Buildings utilize 42 percent more power than any other industry on a global scale. It's no surprise, given that we spend more than 90% of our time indoors. The number and size of buildings in urban areas will grow as urbanization grows, especially in emerging nations, resulting in increased demand for electricity and other kinds of energy widely utilized in buildings. Africa has the greatest pace of urbanization in the world, at 3.5 percent each year, resulting in new urban areas with larger inhabitants and the development of existing urban centers. There are now 40 cities in Africa with populations of more than a million people, with seventy cities predicted to have populations of more than a million people by 2015.

4.1 Energy efficient buildings

The energy efficiency of a building measures how closely its energy consumption per square metre of floor area corresponds to recognized energy consumption standards for that kind of structure under certain climatic circumstances. Building energy consumption benchmarks are typical numbers for common building types that may be used to assess a structure's real performance. The benchmarks are developed from data on various building kinds in a specific nation. The usual benchmark indicates the highest quartile performance of all the buildings in a certain category, and excellent practice is the median level of performance of all the buildings in that category. By comparing the standard of energy efficiency to basic benchmarks such as yearly energy usage per square metre of floor space or treated floor area (kWh/m2/annum), the standard of energy efficiency may be examined and priority areas for change highlighted.
Heating, cooling, air-conditioning, ventilation, lighting, fans, pumps, and controls, office or other electrical equipment, and power usage for exterior illumination are all areas where benchmarks are used. The benchmarks utilized differ depending on the nation and kind of structure.

4.2 Importance of energy efficiency in buildings

Governments must guarantee that there is a reliable supply of energy to support economic growth. There is usually relatively little gap between present power supply and electricity

demand in many developing nations. To fulfill rising demand, additional generation must be brought online to meet rising demand from existing users and new connections. Furthermore, nations that rely heavily on hydroelectric power as their primary source of energy are losing much of their generating capacity as a result of shifting climatic patterns and the increased danger of drought, resulting in extensive power rationing.

Fig 2: (Source: Sustainable energy regulation and policymaking for Africa)

Although renewable energy sources such as hydro, geothermal, and wind deliver power at a cheaper cost than petroleum-based energy, they need a big upfront investment, are complicated, and take a long time to deploy. To accommodate this need, petroleum-based power is frequently brought in on a short-term basis, resulting in higher electricity costs, overdependence on petroleum, and hence vulnerability to oil price changes. Lower energy costs are the primary benefit of efforts to enhance energy efficiency in buildings, but there are frequently additional advantages to consider as well. The goal of energy efficiency measures is to minimize energy consumption while preserving or increasing the level of services delivered in the facility. The following are some of the advantages that are anticipated to result from building energy efficiency investments:

- Decreasing energy use for space heating, cooling, and water heating;
- Reducing power consumption for lighting, workplace machines, and household appliances;
- Minimal building maintenance;
- Improved Comfort.
- Increased Property Value.

End-users in developing nations with intermittent electricity and frequent power rationing have a high need for diesel or renewable energy-based backup/standby power generation. The initial

outlay and operating expenses of these stand-by systems are reduced when power and energy demand in buildings are reduced.

4.3 Typical energy flow in buildings

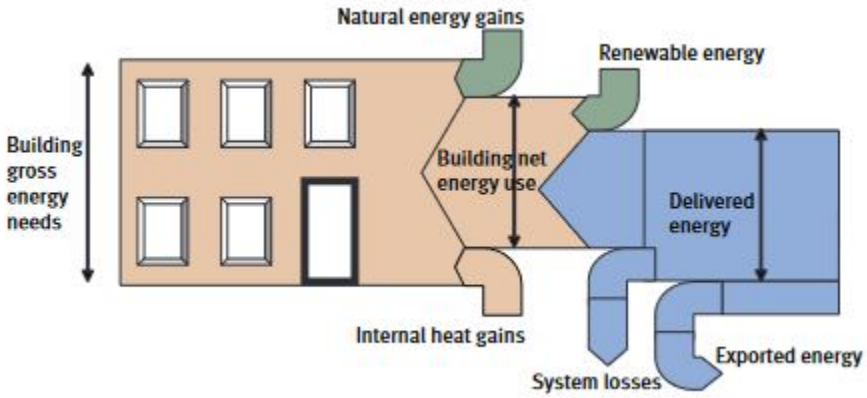

Fig 3: (Image Source: EU Energy Performance in Buildings – Directive Implementation Advisory Group, Explanation of the General Relationship between various standards from the European Committee for Standardization and the Energy Performance of Buildings Directive (EPBD))

The usual energy fluxes in a structure are depicted in Figure III. The expected building's heating, lighting, cooling, ventilation, air conditioning, and humidification demands are represented by the building's gross energy needs. The criteria utilized to determine the gross energy demands of the building are the indoor climate requirements, outside climatic conditions, and building attributes (surface/transmission heat transfer and heat transfer owing to air leakage). Delivered energy, natural energy gains, and internal heat gains all contribute to meeting a building's energy demands, as shown in the figure above.

4.4 Natural Energy Gains

Reduction in the amount of provided energy needed to fulfill a building's energy requirements.
Buildings that are environmentally savvy make efficient use of energy resources while reducing waste. Natural energy benefits may be enhanced by utilizing the site's and its surroundings' potential contribution to a building's performance through:

- A building layout that arranges functions in places that need the least amount of applied energy;
- A form that enhances the utilization of natural light and ventilation while reducing heat loss;
- An orientation that maximizes the benefits of solar gains while minimizing the danger of glare and overheating;
- Optimal utilization of natural light while avoiding glare and undesired solar gains;
- Natural ventilation should be used wherever possible and suitable, with ventilating and/or air conditioning used only when absolutely necessary.
- Internally efficient and well-controlled facility services, well-matched to the building fabric and planned usage;

This is best accomplished during the design phase of the structure, but it may also be accomplished after renovation.

Internal Heat Gain

Internal heat is the thermal energy that is released into the internal environment by humans, lights, and appliances. While this is advantageous in cold weather since it decreases the amount of energy required for heating, it increases the amount of energy required for cooling in hot weather. Much of the overheating problem in summer can be caused by heat created by equipment or by a high degree of artificial lighting in office buildings, commercial businesses, shopping malls, entertainment halls, and so on. When there are a lot of people in a room or a lot of clients, their metabolic heat might add to the problem.

4.5 Energy Efficiency Measures for Buildings

Building energy efficiency techniques are methods for reducing a building's energy usage while maintaining or increasing its comfort level. They are commonly classified as follows:

- Reducing heating and cooling demand;
- Reducing ventilation energy needs;
- Reducing energy usage for lighting;
- Reducing energy required for water heating;
- Reducing power consumption of office equipment and appliances;

Reducing Demands for Cooling

The energy consumption of a typical air-conditioned office building is roughly double that of a naturally ventilated office building. The requirement for air conditioning, as well as the size of the systems installed, may be minimized by doing the following:

- Controlling solar gains through glazing; lowering internal heat gains;
- Using thermal mass and night ventilation to minimize peak temperatures; and providing adequate natural ventilation
- Lighting load reduction and the installation of suitable lighting controls.

- ***Avoiding Excessive Glazing***
  Windows should be sized to allow adequate day light while minimizing solar gains. Large amounts of glass will enhance solar heat gains in the summer and heat losses in the winter, making it more difficult to maintain a suitable inside atmosphere.

- ***Use of Shading Devices***

Exterior shading, mid pane blinds (where blinds are fitted between the panes of a double or triple glazing unit), or internal blinds can all be used to limit solar gains. Internal blinds are the least efficient way to limit solar gains since the heat has already entered the area. External shades are the most effective, but they can be difficult to maintain and are more difficult to regulate for glare control. Mid-pane blinds are frequently an effective compromise. They can be elevated when solar gains and glare aren't a problem, and reduced when they are. Overhangs and permanent shade devices can be used to manage high angle summer sun on south facing heights. Solar gains to east and west glass are more difficult to manage and will necessitate the use of adjustable shading devices.

- ***Solar Controlled Glass***

  Glazing is provided with a variety of selective coatings that vary the qualities of the glass; ideally, glazing with the best light penetration and the lowest solar heat gain factor should be used. This will aid in the provision of daylight while lowering solar gains. All of the main glass producers publish data on the qualities of their goods, including those with coatings like the ones detailed below.

- ***Selecting Equipment with Reduced Heat Output***

  Adopting office equipment with a lower heat output and ensuring that equipment has appropriate controls that immediately shut it off when not in use helps minimize cooling demands. The usage of flat screen monitors may dramatically minimize heat gains while also decreasing energy use for the equipment and making better use of office space. These advantages often outweigh the greater expense of flat-screen displays.

- ***Using Thermal Mass and Night Ventilation to Lower Peak Temperatures***

  Thermal mass is a material's ability to absorb heat energy. To regulate the temperature of high-density materials like concrete, bricks, and tiles, a large amount of heat energy is required. As a result, they are considered to have a large thermal mass. Thermal mass is minimal in lightweight materials such as wood. Thermal mass is especially useful when there is a significant fluctuation in external temperature between day and night. Correct thermal mass utilization may delay heat flow through the external walls by up to 12 hours, resulting in a relatively warm house at night in winter and a cooler house during the day in hot seasons. A heavy mass structure requires a big quantity of energy gain or loss to modify its internal temperature, whereas a lightweight building requires only a little amount of energy gain or loss. Allowing chilly night breezes and/or convection currents to pass over the thermal mass releases all of the stored energy.

- ***Lighting Heat Gain Reduction***

  Heat gains from lighting may be avoided by making the most use of natural light and installing energy-efficient lighting with adequate controls.

- ***Predicting the Effectiveness of Passive Cooling Techniques***

Building comfort can be predicted using computer simulation techniques, and glazing and shading layouts can be optimized.

- ***Lowering the Energy Required for Ventilation***
  When cooling demand is sufficiently lowered by applying the aforementioned methods, it may be feasible to minimize heat gains to the point where air conditioning is no longer required and comfort conditions may be maintained by the use of natural ventilation. The energy required for ventilation can be reduced by doing the following: A building design that optimizes natural ventilation;

- Effective window design;
- The use of mixed mode ventilation; and
- The use of efficient mechanical ventilation systems

4.6 Building Design

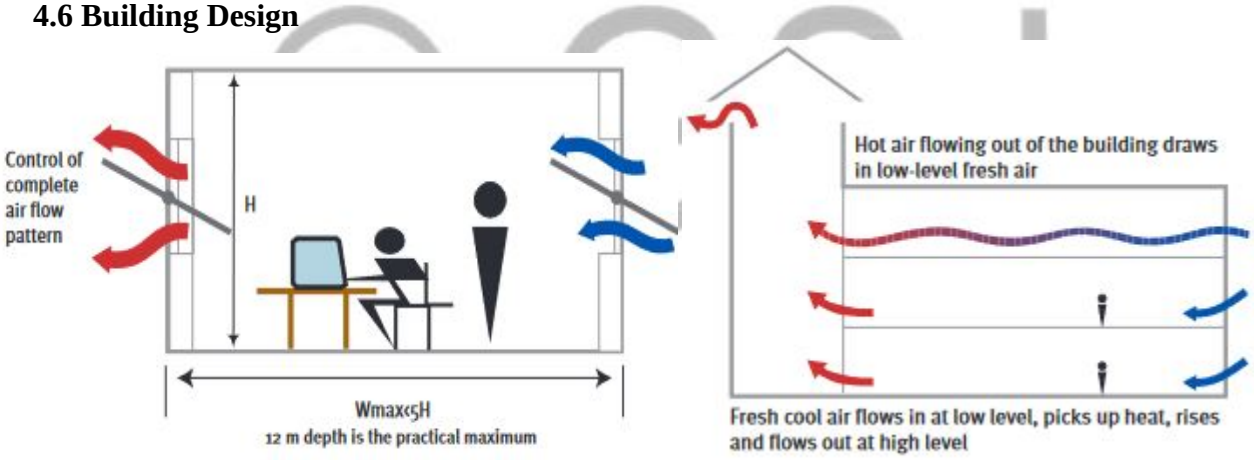

Fig 4: Building Research Energy Conservation Support Unit for the Energy Efficiency Best Practice programme Good Practice Guide 290 Ventilation and cooling option appraisal—a client's guide

- ***Effective Window Design***
  Windows should be easy for building occupants to adjust and provide regulated air that does not blow papers off tables or generate draughts. In the summer, night ventilation can be an efficient way to maintain comfort levels. Where night ventilation is employed, it is critical that building occupants understand how the facility is supposed to be run or that effective control systems be implemented, as opening windows before leaving a building at night is counterintuitive.

- ***Mixed Mode Ventilation***

Natural ventilation can be employed for most of the year or to service certain areas of a building using mixed mode ventilation systems. Mechanical cooling is only employed to deal with peak summer design circumstances or to service portions of the building that experience a larger buildup of heat.

- ***Reducing Energy Use for Mechanical Ventilation***
  The fans used to circulate the air consume the most energy in both mechanical cooling and air conditioning. Mechanical ventilation fan energy consumption may be minimized by: designing the system to minimize pressure drops; selecting efficient fans; using variable speed fans to adapt to fluctuating load needs; and avoiding excessive air supply volumes.

- ***Reducing Energy Use for Lighting***
  This can be done by:
  - Maximizing daylight while avoiding unnecessary solar heat gain;
  - Using task lighting to prevent high levels of background brightness;
  - Installing energy-saving luminaries with a high light output-to-energy ratio;
  - Choosing lights with high luminous efficacy;
  - Providing appropriate controls to prevent lights from being left on inadvertently

- ***Maximizing the Use of Daylight***
  Natural light in buildings not only saves energy but also provides an appealing environment that increases the well-being of building inhabitants. The provision of effective daylight in buildings may be evaluated by utilizing average daylight factors and ensuring that inhabitants have a view of the sky. The average daylight factor is affected by the size and area of windows in relation to the room, the light emissivity of the glass, the brightness of internal surfaces and finishes, the depth of reveals, and the presence of overhangs and other external obstructions that may limit the amount of day lighting entering the room.

- ***Energy-Efficient Lighting System***
  The design of windows has a significant influence on day illumination. As a general rule, a window will let effective daylight into a room up to twice the head height of the aperture. High ceilings and clerestory windows might help to provide adequate lighting. Sun pipes and skylights can be utilized to bring daylight into regions with no windows.

5. Conclusion

Analyzing the data obtained, there is no question that there is a need for filmmaking facilities which prioritize energy efficiency. The most crucial factor for the development of the film industry is a film industry space. As seen by diverse and contemporary films, the usage of green/blue screens and various visual effects is on the rise. These kinds of filmmaking techniques necessitate the use of large-scale film facilities; small-scale studios might limit the picture's scope. There is no doubt, as proven by professionals in the field, that outdoor shooting

areas are very important, and there is a need for outdoor areas with various types of elements for shooting, so it can be deduced that outdoor film making spaces that would provide the crew members with freedom and flexibility. There is a lot of released emission caused by the Nigerian film industry which needs to be checked. The first step in lowering emissions is determining what has the greatest impact on the industry's carbon footprint. Carbon emissions may be reduced at every level of manufacturing. Scripts are produced, sets are built, and the process is completed with capture and post-production.

6. Recommendations

- Despite the industry's specialists and technology, it lacks and requires suitable indoor and outdoor film production locations.
- Sound stages with adequate spaces and features, primarily acoustic, should be constructed.
- Working places for sectors other than major production should be constructed in accordance with their requirements.
- Authorities should be more concerned about this massive business and assist filmmakers and other connected workers in providing suitable film industry locations.
- Recycling and energy management facilities for production firms and others that use the studio, as well as information on carbon-saving options
- Give accurate meter readings to manufacturing businesses in order to assist them optimize their energy management
- Provide office spaces with large openings for ventilation and lighting.

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