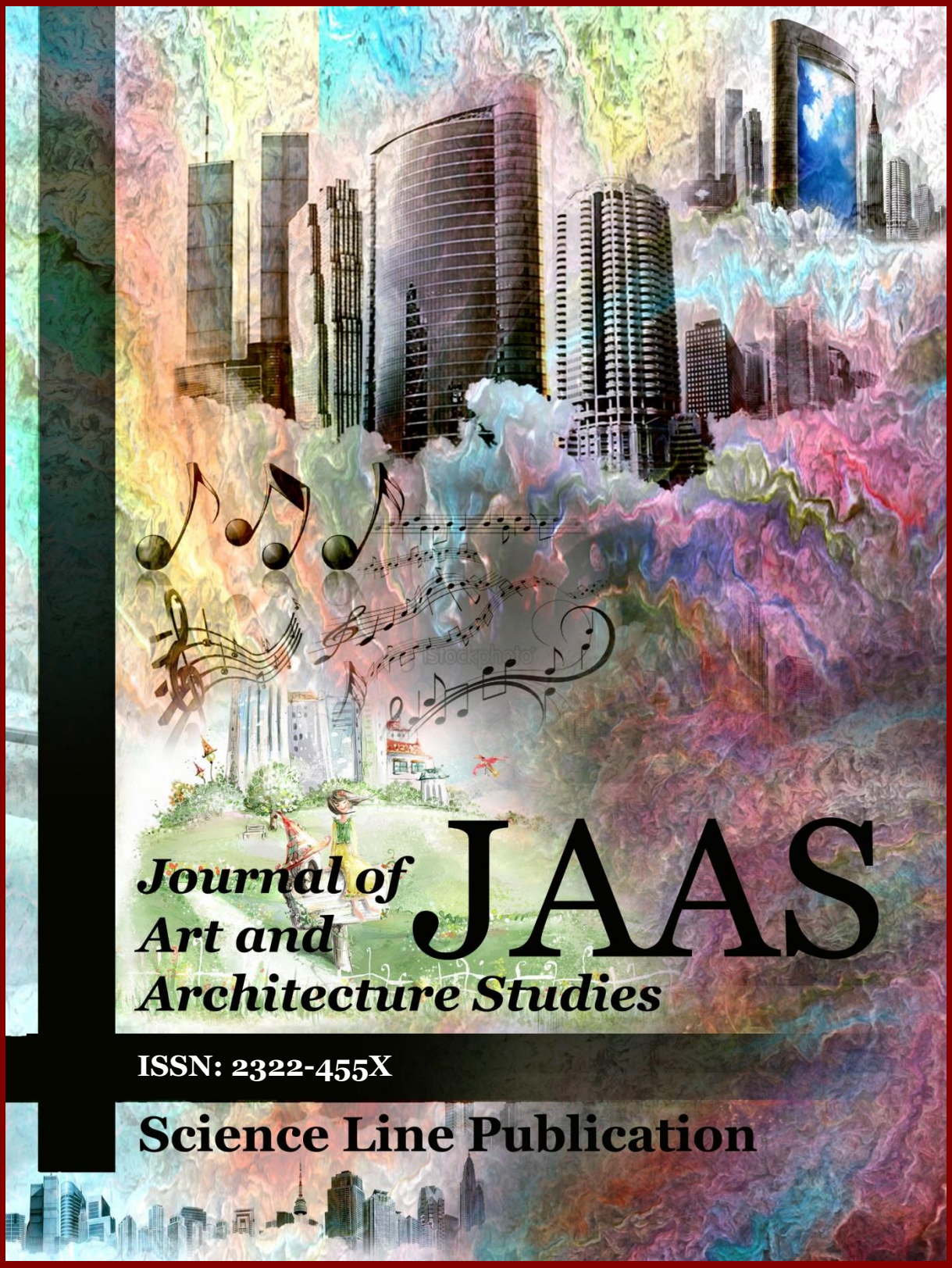
In the Name of God



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Research Paper

Artistic forms and ethnic identity in Nigerian painting

Abodunrin JA.
J. Art Arch. Stud., 10(1): 01-05, 2021;
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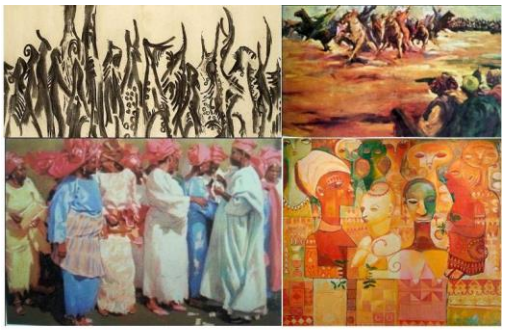

ABSTRACT
This paper discusses the artistic forms and ethnic identity of paintings in Nigerian art schools. Artists in Nigeria used diverse forms to represents images that are peculiar to their ethnic groups to achieve a distinctive identity. Data for the study were obtained from paintings of different ethnic groups found in the various regions of the Art schools in Nigeria. The art schools have been the centre for manifestation of indigenous forms in Nigeria. The Schools has been noted with individualism in form depiction that is characterized by elongation of forms, abstraction, semi-realistic with northern architecture. In the South and Eastern part of the country their paintings depict day to day activities using naturalism and symbolic representation of forms. Each region uses indigenous forms to portray ethnic identity and this invariably produced arts and artists that are regional in their practice. The paper concludes that art schools have been the centre for manifestation of indigenous forms and artistic identity among Nigerian Painters.
Keywords: Artistic Forms, Ethnicity, Nigeria, Painting

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Research Paper

Enhancing elderly health and wellbeing through the true revival of sun and wind architecture

Ghaeeni M.
J. Art Arch. Stud., 10(1): 06-13, 2021; pii:S238315532100002-10
DOI: https://dx.doi.org/10.51148/jaas.2021.2

ABSTRACT
With the indication of the rapidly aging population, it is imperative that we start planning now for how we will house and care for the senior population in the future. Retirement living providers continue to expand wellness, dining, and recreation options in response to demands for more choices and a healthier lifestyle. Options that emerged at the beginning of the century continue to develop, to provide a healthier place for the elderly. Traditional life-care models of retirement living are being challenged by more flexible entry criteria, and transition to such a community is being handled in new and novel ways. The purpose of this paper is to show that creating a senior-living facility that is integrated sustainably with their natural environments is important because it has a significant impact on improving seniors' mental health and preventing their dehumanization within institutions. With the shift in the design of senior living facilities in recent years, this paper shows how effective design can bring in positive results in geriatric mental and physical well-being and prevents the dehumanizing feeling that institutional settings often impose. New models of elderly care significantly affect healthcare outcomes, especially through designs highly integrated with nature, sun, and wind. This article will focus on how to improve the connection of indoor spaces with surrounding environment, how to consider the available natural resources in design of senior-living residence while preventing the dehumanization of patients, retaining a fulfilling community for elderly care, and ensuring sustainability.
Keywords: Senior Living, Elderly, Architecture, Nature, Daylight, Wind Direction, Sustainability, Living Building Challenge, WELL Certified Building

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Research Paper

Assessment of expanded Styrofoam and polyurethane as a sustainable building materials; Mubi general hospital Adamawa state, Nigeria

Vawa JY and Manga PM.

J. Art Arch. Stud., 10(1): 14-23, 2021; pii:S238315532100003-10

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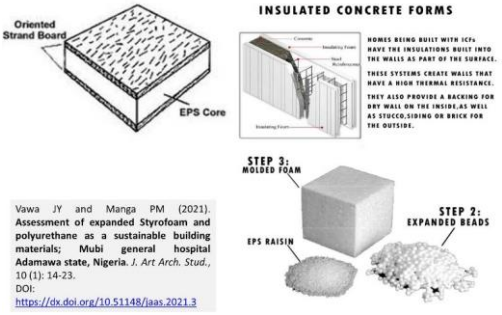

ABSTRACT
This study assesses the perception of stakeholders on the use of expanded Styrofoam (EPS) for building construction in Nigerian construction industry. It identified both organizations and individuals with great enthusiasm in the production and use of EPS for building construction but this has not been rewarded with an enabling environment. This inevitably results in the slow pace of adoption of EPS in the building construction industry. Other factors are low knowledge base of the public about the workings (source, production, installation, and variant uses) of EPS is a critical impeding factor in the adoption pace. The used of structures questionnaires was used to collect data from randomly selected respondents. The data analyzed from this study indicates that all benefits expected from the use of an EPS constructed building were mostly derived most especially its sustainable attributes.
Keywords: Expanded Styrofoam, Buildings, Environment, Sustainability, Construction and building materials.

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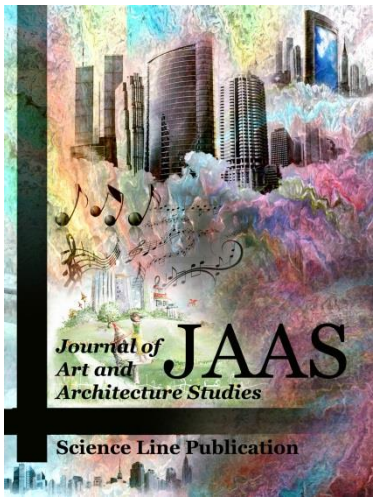

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ARTISTIC FORMS AND ETHNIC IDENTITY IN NIGERIAN PAINTING

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Research Article

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ABSTRACT

This paper discusses the artistic forms and ethnic identity of paintings in Nigerian art schools. Artists in Nigeria used diverse forms to represents images that are peculiar to their ethnic groups to achieve a distinctive identity. Data for the study were obtained from paintings of different ethnic groups found in the various regions of the Art schools in Nigeria. The art schools have been the centre for manifestation of indigenous forms in Nigeria. The Schools has been noted with individualism in form depiction that is characterized by elongation of forms, abstraction, semi-realistic with northern architecture. In the South and Eastern part of the country their paintings depict day to day activities using naturalism and symbolic representation of forms. Each region uses indigenous forms to portray ethnic identity and this invariably produced arts and artists that are regional in their practice. The paper concludes that art schools have been the centre for manifestation of indigenous forms and artistic identity among Nigerian Painters.

KEYWORDS: Artistic Forms, Ethnicity, Nigeria, Painting

INTRODUCTION

Nigeria, like many countries in sub-Sahara Africa, is made up of a complex mix of ethnic, religious, and regional groups. This diversity creates a web of individual, intersecting and recursive identities, which are considered by many to be the main sources of the violent conflicts that frequently erupt there. Nigerians are known in terms of their ethnic affinities than any other identity and it's composed of various ethnic groups and cultures. Nigeria culture is informed by various forms of artistic and social endeavour such as the arts. In Nigeria, different art traditions have thrived and are still striving in various parts of the country. Adepegba identifies the sculpture traditions to include Nok, Igbo-Ukwu, Ife, Tsoede, and Benin as well as the stone carving traditions in the Yoruba and Ekoi areas of the country.

In the Northern Nigeria, specifically in Birnin kudu, and Geji near Bauchi, engravings depicting animals and human figures have been found. Art forms such as painting, drawing, printmaking, sculpture, photography, textile and others have reflected various cultural identities based on the regional groups. The art and culture of Nigeria embody the vivid image of the Nigerian way of life combined with the magnificent history of the past [1].

One of the major aspects of Nigerian art and culture lies in the fact that they draw their inspiration from the traditional folk heritage of the region. However, this study is limited to cultural identity of major ethnic groups in Nigeria. The largest, most populous and politically influenced ethnic groups in Nigeria: Hausa, Yoruba, Igbo, Ijaw, Kanuri and Ibibio. Within these groups, there are major groups with different languages, culture and lifestyle. Artists from each of these ethnic groups have reflected their identity through the use of forms in their painting. This invariably suggests what this paper described as regional Nigerian painting.

METHODOLOGY

Data for this study were obtained from field work and direct observations of paintings of different forms across ethnic divides in the various Nigerian Arts institutions of the various regions. It adopts qualitative approach to describe the nature of Arts among the regions of Nigeria.

RESULTS AND DISCUSSION

Regional painting: historical overview

The regional artist is anyone living and practising art in a regional location. This includes large regional centres, small towns, villages and the bush. Regionalism developed in America at a

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challenging time. The Great Depression was increasingly making life difficult for people across the country. Several artists working in the Midwest began painting the people, work atmosphere and life around them, predominantly rural and agricultural in nature. These artists were consciously pursuing a style different than the art then in fashion in urban art centers like New York City and Paris.

The work of the Regionalists was a search for distinctly American art. It was also a rejection of abstraction. Abstraction was art that didn't portray images or scenes found in the real world, and it was the major movement dominating European art at the time. Unlike abstraction, Regionalism was based on the real world of a specific place and time. In fact, some Regionalist artists described their work as having a goal of creating 'scenes of America.' While many artists working in the Midwest became known as Regionalists, three artists, in particular, became very associated with the style.

One of the most famous Regionalist artists was Grant Wood (1891 -1942), an Iowa-born artist who studied art abroad in Europe. Although he saw modern art as an abstraction, he rejected it, returning to Iowa where he was inspired by the farm life around him. Wood painted possibly the most well-known Regionalist painting, titled *American Gothic*, painted in 1930. Another Regionalist artist, Thomas Hart Benton (1889 - 1975), was born in Missouri and studied art in Chicago. Benton also spent time in Europe and painted in more modern styles before abandoning them in favor of his own style of realism. Benton portrayed farm life and working people as exaggerated curving figures. So his art was realistic in the sense of subject matter but not in rendering of form. He spent years painting and teaching in New York City before eventually returning to Missouri.

Nigeria is one nation whose culture is depicted through art forms such as dance, literature, music, arts and craft, fashion and more. Nigerian art takes to the world, where stone, wood and glass carving, pottery, wire works, and paintings are heavily explored. Each region in Nigeria reflects art that are related to their traditional culture. Nigeria draws its inspiration of their art from traditional folk heritage which are regional in nature.the Ibibio of South-South of Nigeria there is also *Insibidi* codified message form; and *Ulli*, the Igbo symbolic form among the Igbo [2]. African art, mostly before Western influence recorded many of such coded message forms [3]. The ancient Egyptian tombs and vases; as well as the Nok, Benin and Ife sculptures of Nigeria are exemplary examples of this. For instance, *the Nok pieces*, which are the oldest sculptures produced in Sub-Sahara Africa [4] communicate cultural behaviours that are peculiar to the visual arts of the people. Similarly, the artists in Ile-Ife, the sacred city of the Yoruba of South-Western Nigeria, produced masterpieces of court art. The artworks were basically used for religious, socio-political purposes. Also, many were produced mostly in terracotta, wood, copper, bronze and stone [5]. They were of high technical and artistic quality. The realism and sophistication in material techniques tactically bring these works close to the classical Greek ideals of beauty. Attempts were made at producing life-size portrait of the *Ooni* (King of Ife) in full regalia, clad in woven textiles and wearing a lavish adornment of beads. Also, Benin art and other traditional Nigerian arts, as well as the arts of many other African groups, present the courtly splendor, magnificence and the power of kingship on one hand and religion, magic and the class distinction in the society on the other [6]. Each region uses indigenous forms to portray ethnic identity. This invariably produced arts or artists that are regional in their practices. However, due to diverse forms from geographical and educational background, there is needed to identify regional painting through regional art schools.

Emergence of regional painting in Nigeria art schools

The development of regional painting in Nigeria cannot be complete without the divergent view of Aina Onabolu and Kenneth Murray. Onabolu broke with the past by adopting new pictorial modes of representing the self as he imagined a future different from that of his ancestors. Murray resolutely resisted the new because it alienated the old and, more troubling, had the potential to level the imaginary boundaries between the irrevocably yet differentially modernizing Africa and Europe. Onabolu and Murray represented two oppositional visions of modern Nigeria art during Colonial period, while Onabolu pre-empted the postcolonial modernism of the mid-century. Murray's pedagogy is the belief that students should be encouraged to create art along purely African lines rather than be made to imitate European artistic styles and forms or be subjected to British examination standards. Artists such as Uche Okeke took to their regional forms to achieve distinctive identity. This study identified regional painting by the geographical locations of each art school.

During the period leading up to and following Nigerian independence in 1960, artists appropriated

cultural and aesthetic traditions from around the country as a means of defining a new national identity. They drew upon narrates from Yoruba, Igbo, Hausa and other cultures and artistic traditions to inform the content and style of their works, manipulating tales from the past to produce a mythology for the present.This practice was defined as 'natural synthesis' by the Art Society at Zaria, an art group formed in the late 1950s by Uche Okeke, Demas Nwoko, Simon Okeke, Bruce Onobrakpeya and other art students at Zaria in the northern region of Nigeria. Moving away from traditions steeped in colonialism, 'natural synthesis' merged the best of indigenous art traditions, forms and ideas with useful ones from Western cultures to create a uniquely Nigerian aesthetic perspective. The members of Art Society were later known as the Zaria Rebels, devised a program outside the University curriculum, where they thoroughly researched indigenous cultural and artistic traditions, produced works based on ethnic findings and met regularly to discuss the outcomes.

After the war, Okeke joined University of Nigeria, Nsukka, where he ran the Department of Fine and Applied Arts from 1971 to 1983. Under his direction, Nsukka rose to prominence as a center of Nigeria's artistic creativity, drawing artists like the renowned El Anatsui to its ranks. At Nsukka, Okeke further developed his synthesis theory, encouraging students to research Nigerian art traditions to solve formal problems in their work. Under Okeke's supervision, Obiora Udechukwu manipulated *Uli*, and later *nsibidi*, another indigenous form of the region. Bruce Onobrakpeya in his case synthesized mythological, folkloric and popular themes from Urhobo as well as Yoruba cosmology. Some of his prints bear eclectic traits traceable to the *adire* motifs and ancient Benin plaques. However, Okeke's rigorous and intellectual inquiry into *Uli* influenced another generation of artists, including Tayo Adenaike, Olu Oguibe, Chika Okeke-Agulu and Marcia Kure, among others.The intensification of the search for Igbo-identity, using the *Uli* linear forms to depict radical socio-political and cultural subject matters is the hallmark of the art of this School of Art [7]. The contributions have been in the areas of propagation of visual arts as an instrument of development of society. *Uli* is known as an artistic cultural practice of the Igbo of Southeastern Nigeria [8]. This practice involves painting motif on the body and walls. *Uli* is disappearing in many Igbo villages.It should however be preserved as it communicates important cultural meaning (Plate 1). *Uli* designs were painted by lgbo women on their bodies and as murals on clay walls [9].

The Ife School developed from the Ori-Olokun workshop, an informal workshop established to develop the artistic talents of Ife indigenes. The Ife School artists were trained to use materials from their immediate environment, which can be seen in their terracotta, granite and bronze works. This style flaunts patterns and designs peculiar to the rich artistic culture of Western Nigeria. The natural synthesis concept which gave rise to the other emergent art schools such as *Ona* School influenced the artistic production of this group.The School is noted for intellectualization of its works with vigorous emphasis on theoretical content in art form. Noted with cultural inspiration drawn from the Ife location, the School explores a rather diversity of creative exploration in the use of local materials, symbols and images which later developed into the exploration of Yoruba traditional symbols, motifs, structure and concept termed *Ona* by some of the 1980s graduates.

Plate 1. Uche okeke, *March of the masquerade*. Ink and brush on paper (Art Fact, 2010).

In *Ona* art, traditional art forms are transmitted into artistic production, by using them as a point of reference to create modern forms. With good draughstmanship and a mastery of aerial and linear perspective, windows were created in the works and more interesting solidity of forms was achieved without losing the presence of patterns all over the painting. The patterns are not after thought additions, but a systemic buildup of symbols, motifs and designs integrated within the structure of the composition [10].

Ona is the process of artistry and the word *Ona* is linked with others to capture the underlying meanings. Thus, the design work is called Ona while the designer is regarded as *Oni-se-Ona* (He who makes pattern) or *Gbena-gbena* (He who carves design) which could be seen in the area of sculpture. Ona is also relevant to aesthetic appreciation. The Yoruba word, *Oju-Ona* (eyes for design) describes the position of 'design consciousness' and critical appraisal. If *Ona* could be so dynamic in use, then it

is supposed to enhance expression in painting. However, in most of the paintings of *Ona* exponents, there is a critical distortion in form and colour which actually negated the primary meaning of *Ona* concept. *Ona* concepts supposed to enhance the creativity input in contemporary Nigerian painting not only to serve as decorative object as seen in the work of Moyo Okediji, Kunle Filani (Plate 2).

Plate 2. Tola Wewe, *Race, Gender and sexuality in African art,* Oil on board (Artist Archive, 2010).

The rejection of all forms of European artistic knowledge by some students of the Ahmadu Bello University, Zaria changed the course of our visual history. The Zaria School artists focused on Nigerian cultural themes and experiences of the North where the school is located. Zaria art School which has been noted with individualism in form depiction often time has been characterized by elongation of forms, abstraction and semi-realistic with northern architecture and human Figures. Their landscapes, most times reflect the grassland and Savannah vegetation of the north.

So long as an individual artist conforms to the general norms of artistic presentation, he will not think in a way that is out of the ordinary. When an artist has his own unique point of view and a keen perception that does not conform to the regular pattern, he will come up with a creative understanding. However, individuality in art practice encourages self-reliance, initiative, persistence and unique perceptions and new visionary ideas. All these are very useful to painters and therefore it is not surprising that many painters of Zaria art School are highly individualistic in the practice of painting. For example, Yusuf Grillo makes use of western art training in many of his paintings, combining western art techniques with Yoruba sculpture characteristic of angular representations. His form of paintings has always been the elongation of forms which are mostly women with little attention to details. Jimoh Akolo uses a limited colour palette which is rendered in cubistic manner that suggests a peculiar characteristic of the artist.

Also, Gani Odutokun engages in semi-abstraction using aggressive brush strokes to suggest form in his painting. He also excludes detail representation in his painting but uses colour to dazzle the attention of the perceiving audience. Going by individuality perception of various graduates of the institution, therefore it is clear that there are diverse ethnic attributes in the works of different artists of the school (Plate 3).

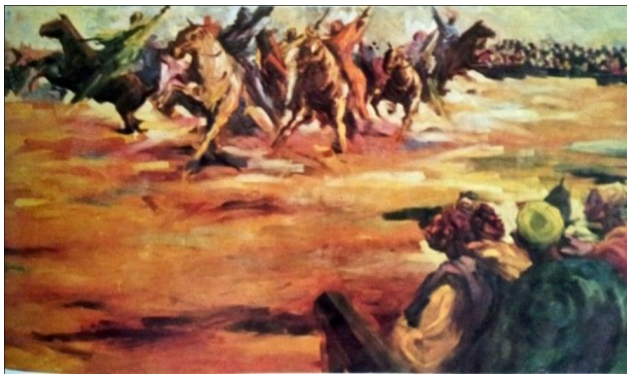

Plate 3. Gani Odutokun, *Dubar*. (Oil on board Greeting card Unicef, 1983).

Yaba school of thought in art practices has adopted the technique or style of naturalism and realism from inception through the efforts of the foremost teachers of the School. This school employs a realistic art form that is done in the narrative, and descriptive style is mostly done in accurate photographic realism. The School which is located in Lagos State, southwestern Nigeria, is based on an exceptional understanding of colour, and it is distinct for its almost accurate realistic representation of the activities of the area. Example of this can be found in the paintings of Kolade Oshinowo, Samuel Ajobiewe, Ebenezer Akinola, John Akintunde, Edosa Oguigo, Olumide Oresegun and others (Plate 4).

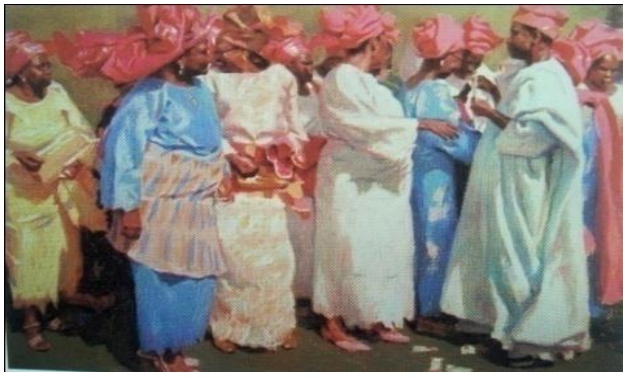

Plate 4. Samuel Ajobiewe, *Baba Alaye*. (Oil on Canvas) (Artist Archive, 2010).

The ideologies of self-identity in contemporary Nigerian art is to be able to create an independent style that will be able to reflect true understanding of the process not to entirely abuse the process. For example, Onobrakpeya has discovered, innovated and perfected several techniques both in printmaking and relief sculpture that are uniquely Nigerian. Generally, printmaking is a fine art process of producing pictures from a plate which the artist has previously created. He has increased the techniques tremendously to reflect his unique self-identity. So also in painting, artists have distinguished themselves in terms of styles in order to pick an identity that will uniquely be acceptable to the audience.

CONCLUSION

This paper established that each ethnic region in Nigeria has its own iconic identity that is manifested in various forms. The art schools of each region have been the centre for manifestation of forms of paintings in Nigeria. The Schools of art in Nigeria has distinctive style to depict elongation of forms, abstraction, semi-realistic with northern architecture that reflects grassland and savannah vegetation. Each region uses indigenous forms to portray ethnic identity and this invariably produced arts and artists that are regional in their practice. It concludes that ethnic identification was manifest in the use of forms in various regional art schools in Nigeria. Artists of different art schools reflect on various environmental issues which makes their painting distinctive.

Competing interests

The authors declare that they have no competing interests.

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ENHANCING ELDERLY HEALTH AND WELLBEING THROUGH THE TRUE REVIVAL OF SUN AND WIND ARCHITECTURE

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Research Article

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ABSTRACT: With the indication of the rapidly aging population, it is imperative that we start planning now for how we will house and care for the senior population in the future. Retirement living providers continue to expand wellness, dining, and recreation options in response to demands for more choices and a healthier lifestyle. Options that emerged at the beginning of the century continue to develop, to provide a healthier place for the elderly. Traditional life-care models of retirement living are being challenged by more flexible entry criteria, and transition to such a community is being handled in new and novel ways. The purpose of this paper is to show that creating a senior-living facility that is integrated sustainably with their natural environments is important because it has a significant impact on improving seniors' mental health and preventing their dehumanization within institutions. With the shift in the design of senior living facilities in recent years, this paper shows how effective design can bring in positive results in geriatric mental and physical well-being and prevents the dehumanizing feeling that institutional settings often impose. New models of elderly care significantly affect healthcare outcomes, especially through designs highly integrated with nature, sun, and wind. This article will focus on how to improve the connection of indoor spaces with surrounding environment, how to consider the available natural resources in design of senior-living residence while preventing the dehumanization of patients, retaining a fulfilling community for elderly care, and ensuring sustainability.

KEYWORDS: Senior Living, Elderly, Architecture, Nature, Daylight, Wind Direction, Sustainability, Living Building Challenge, WELL Certified Building

INTRODUCTION

Although communication with friends and families across the world is virtually effortless with advanced technology and the connectedness it brings, as a society, we are lonelier and feeling less connected than ever. Perhaps no other age group feels the keen sting of loneliness more than the elderly. Less social connection, physical weakness, movement difficulties, and transportation challenges can result in isolation for older adults. This isolation eventually can lead to loneliness, which has a destructive impact on health and quality of life. Senior Living Centers are places that can help the elderly stay socially connected and receive all the comforts of home, plus the focused attention that comes from personal care services. However, living in a community is not enough to counteract the potential effects of loneliness and other social ills. Human needs balanced environments that connect them to nature. Connection to nature and natural systems is a prescribed healer of stress and has the potential to increase life span. The sustainable design process for senior living communities should embrace this idea as a "natural medication," and it's something that needs to be kept top of mind when designing for seniors.

Care for the elderly can be fostered consciously through meaningful architectural design. This paper focuses on analyzing a vital and healthy assisted senior-living residence for 65+ seniors that integrates the needs of living in a community with the health benefits that come from a deep connection to nature, sun radiation, and wind direction. This research will illustrate how architectural design can be an effective tool for problem-solving, respond to every community's needs, and is a crucial factor in creating a durable and stable environment for seniors.

The goal of this research is to explore the relationship between living spaces and nature. The roles of sunlight and wind are analyzed in enhancing design to promote better performance standards. This research will explore models that encourage newer aesthetic approaches that seek to highly integrate natural features with living spaces.

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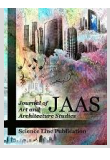

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Human- Nature - Architecture

Nature has been a focus on the human mind from prehistoric times. All over the world today, from indigenous tribes to urban metropolises, human lives are intertwined with the environment around them. Separation of the individual and nature is impossible. On the other hand, efficient immersion of human dwellings with nature can facilitate personal healing and growth.

Questions surrounding the origins of human attachment to nature have fascinated the minds of many academics. The evolutionary biologist E.O. Wilson provided one answer. His theory of "biophilia" states that humans are drawn to nature experiences due to evolution. The abundance of resources found in natural environments fostered an evolutionary attachment in the human mind to nature. These desires were driven by the human need for survival and the entity that provides for humanity—nature. Thus, when human civilization began, and societies began to urbanize, architecture also intertwined itself with nature [1].

History has shown us that environments and climates shape their respective human settlements. Design and urban organization in every city heavily adjust to the surrounding forces of nature. Up until fairly recently, architectural design and human relationships to places were dependent on the forces of the sun and wind to sustain life. However, within the last century, humans have freed themselves from this dependency by using fossil fuels, electric lighting, and ventilation. A side effect of this process has been the loss of natural forces as the main form-givers. Alienation from nature has become the norm. Our cities no longer coexist with their environments but rather try to outgrow their surroundings. Many cities focus on gaining autonomy through a fossil-fuel paradigm. Even though much ecological progress has been made lately in sustainable design, it is still dependent on improving fossil fuel use to make it more efficient [2].

The recent call by architect Ed Mazria in the Architecture 2030 Challenge to move toward carbon-neutral design dramatically raises the bar for energy performance and demands profound changes in design thinking and practice. The looming threat of climate change behooves architects to change their role radically. The focus must be shifted towards making the design carbon-neutral. In order to solve our current ecological problems, sustainable design must also develop a broader ecological consciousness. Human dwellings need to be designed in a way that solves instead of contributes to environmental destruction. Architecture must view the sun and wind as active tools for design. Ecological and sustainable benefits are effortlessly achieved by harnessing these two forces. Design that maximizes the sun and wind's power by viewing them as generative sources can optimize the integration of light and air, thus profoundly impacting health and well-being. An ecological relationship can only be created when the necessity of light and air in living spaces is truly acknowledged and realized. By considering how cities reflect the ecological relationship inhabitants have with nature, one can deduce and understand the collective history within a place. To progress beyond our current fossil-fuel paradigm, light and air must be brought mainly from the sun and wind once again to eventually eliminate dependency on unsustainable sources. Architecture is an essential bridge to this new ecological ethos with our natural surroundings [2].

Light

Light is an essential essence of architecture. Masterful usage of light can bring unrivalled harmony to space. It can be the difference between making the quality of an architectural space habitable or hostile. The concept of aesthetic beauty relies on the symbolic bond with light across all cultures. Light informs us how much activity a certain time of day calls for, and which mood a space accommodates. A potential reason for this can be due to how humans associate brightness with different times throughout the 24 hour day. Light can also be used to enhance feelings of relaxation and encourage productivity. One of the most potent characteristics of light is its capability to combat feelings of sadness. Different seasons are associated with varying levels of brightness, and as such, winter is seen as the darkest one. Lack of light during the winter months brings melancholy and depression. Thus, creating spaces that purposefully maximize the potential for light to enter directly affects our physiology [3].

An example of the effect of light upon an architectural space, as indicated in Figure 1 and Figure 2, is the presence of a large glass window that permits the entry of copious amounts of sunlight. Thus, the space feels roomy, making it breathable and liberating for inhabitants. Preventing the mind from feeling suffocated must be the goal of effective usage of light. Additionally, the more natural light is used, the less artificial light will be used; this reduction of artificial light diminishes energy waste. Another positive impact on our health further promoted by the addition of natural light is reducing eye strain.

Humans are creatures of the day; the human's internal clock and health are dependent upon adequate exposure to sunlight [4]. Studies consistently show the impact of sunlight. Once the eyes are exposed to sunlight, a flood of the hormone cortisol fills the system, providing a boost to the body, thus essentially waking it up for the day. A dark space or one lit by artificial light cannot provide the same boost of energy. The constant exposure to artificial light that is common in today's world wreaks havoc on the body over long periods [5].

Figure 1. Bedroom with morning day light (Source: [5]).

Figure 2. Daylight in the bedroom (Source: [5])

Serotonin is also another hormone that is activated by sunlight. It plays a role in depression regulation. As such, during the winter months, when sunlight exposure is decreased, seasonal depression becomes dominant. An increased amount of serotonin is associated with improved, better and happier moods. Providing more natural light can directly target seasonal depression. Also, the quality of sleep and the production of vitamin D are affected by sunlight. Our bodies are engineered to be in tune with the sun. Furthermore, the ability of sunlight to bring warmth can be a sustainable method of temperature control in spaces. The reduction of energy waste is imperative now more than ever when the threat of climate change is imminent. How much light is allowed inside space should be optimized according to energy efficiency and temperature [4].

To understand light's role in human physiology and psychology, one must know the circadian rhythm. Human bodies react to the amount of light the sun emits at different hours of the day. At dawn, the body is at its coolest temperatures, and as the day progresses, it releases cortisol to energize the body. The body's temperature peaks at noon and once again cools down at dusk. In the evening, the reduction of light signals to the brain prepares the body for sleep by releasing melatonin. However, with tech devices and screens cementing their positions as permanent fixtures in everyday life, artificial light interferes with the circadian rhythm's natural cycle. Thus, bright light exposure at dark hours prevents melatonin production and prevents our bodies from producing restful sleep. Over time, this constant disruption can wreak havoc on physiological and psychological health [6].

For my masters' thesis, I designed a Senior Living Facility in Rockville, Maryland. I conducted a comprehensive review of circadian rhythms in older adults alongside a site analysis to determine which direction provides the maximum advantage from daylight (Figure 4 shows building component allocation based on this study). As indicated in Figure 3and 4, the sleeping rooms are located on the South-East and south side of the building to get maximum benefit of morning daylight till noon. The ground floor offices are located on the southeast too since it has light from morning to afternoon. Dining areas are located in the west, as they get evening light, whereas breakfast areas get the advantage of morning daylight from the east and through the open courtyard.

WIND

The second factor in nature that plays a fundamental role in architecture is wind. Air circulation is necessary to provide healthy air for indoors. Air from the outdoors brings higher amounts of oxygen. Breeze offers the natural force that creates healthy breathing atmospheres.

We spend almost 90% of our time indoors, yet we may not know that the air quality is often poor and unhealthy. The stuffiness of an indoor space can be exacerbated if the air inside is not consistently circulated. A stagnant flow of air will make the presence of allergens and dangerous microscopic

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pollutants remain in a space for extended periods of time, posing a risk for inhabitants. A replenishing of air through wind will benefit health by ridding the indoor air of contaminants that have built up over time.

Incorporating natural ventilation has several advantages: low running cost, low energy consumption, low maintenance, and low initial cost. Additionally, its inherent integration with nature provides psychological benefits. The prevailing outdoor conditions are the main key element in determining the effectiveness of natural ventilation: microclimate (wind speed, temperature, humidity, and surrounding topography) and the building itself (orientation, number of windows or openings, size, and location). How much advantage is gained from natural ventilation throughout the year primarily depends on the design of fenestration and the arrangement of windows and doors on the elevations of a building [7].

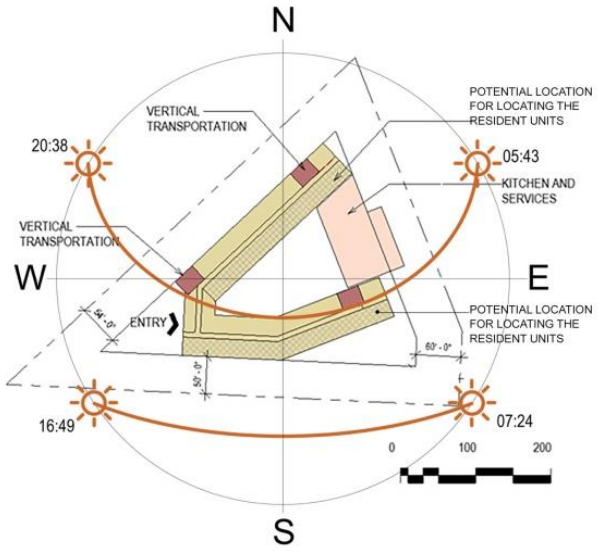

Figure 3. Building Form and Orientation (Source: By author – From thesis book)

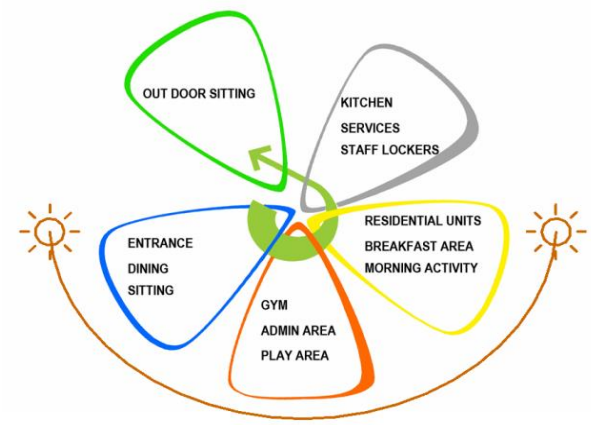

Figure 3. Building Component Allocation (Source: By author – From thesis book)

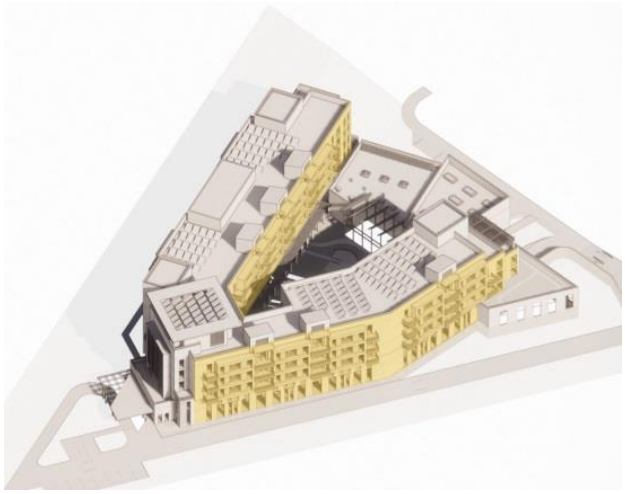

Figure 5. Location of Bedrooms on South and South-East (Source: By author – From thesis book)

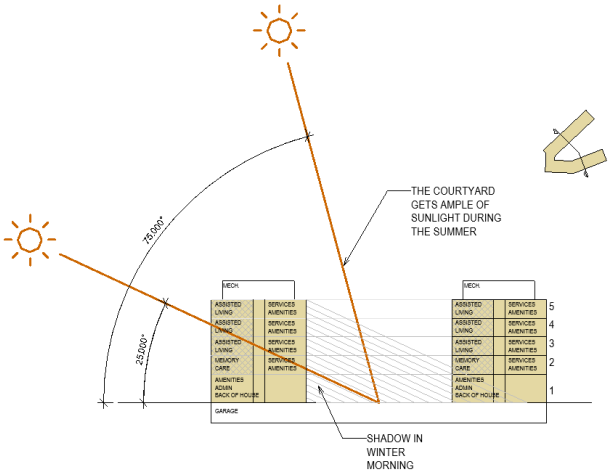

Figure 4. Section Diagram (Source: By author – From thesis book)

METHODOLOGY

What can designers do to improve ventilation in nursing home?

Interior air quality is particularly important for frail seniors, who spend long periods of the day indoors. Consideration of two design strategies is required for having healthier indoor spaces: avoiding toxic material and providing efficient ventilation [8].

An air quality detector that can reliably measure CO_2 levels is a simple step to achieve adequate ventilation. CO2 detector can demonstrate the air quality in each space and whether ventilation needs to be improved in the room. Most nursing homes are heated by reverse-cycle split-system air conditioners or warm air heating systems. These units do not introduce fresh air. Opening the windows to bring the fresh air in is essential for the well-being of residents, even though this may make maintaining a

comfortable temperature more difficult. Creating a flow of warmed and filtered fresh air from central corridor spaces into rooms and out through windows would be ideal; however, it would probably require investment in mechanical ventilation. Using radiant heaters in rooms instead of recirculating heat pump air conditioners is one of the temporary solutions for improving the quality inside a room. Besides using a radiant heater, windows must open far enough to lower CO_2 levels consistently below 850ppm in rooms and corridors [9].

RESULTS AND DISCUSSION

Connection to nature as a healing factor for elderly

When an elderly person is placed in a senior living facility, a sense of loss and shock may be felt. Moving from a familiar space to a new—sometimes even smaller, stifling—space can negatively affect mental health. For many seniors who are in delicate physical conditions, the design of their apartments must be approached with sensitivity to their well-being. The provision of a vista significantly diminishes feelings of isolation and loneliness. Living in a stuffy apartment suffocates the mind. Large windows provide the additional comfort of a view. Feeling a connection to nature is a fundamental need of humanity. Through a wide view, the indoor space will not feel brutally disjointed from an outdoor space. The mind must also be in harmony with the outside space and with the inside one.

Witnessing the coming and going of seasons prevents losing touch with nature. Isolation comes in many forms, each of which devastates equally and mercilessly. Designs must cater to the innate human need for connection. Not seeing the changes that take place around oneself can unwittingly make one feel as if they have been ostracized from society and that the world at large has shoved them away to a corner as if their presence burdens others. In the same way a key driver of social isolation is unawareness of new developments in the lives of those around oneself, unawareness of the cyclical changes in nature compound upon other isolating forces in senior living facilities.

A University of Michigan study looked at the link between “lower depression” and “enhanced mental well-being” and frequent walks in nature. The results showed that the participants who spent more time in nature had better overall health, lower blood pressure, and reduced stress than those who did not spend significant amounts of time out in nature. Also, spending more time outside can produce higher levels of Vitamin D in humans. Even if the time spent outside is short, studies show that individuals exposed more to nature have better overall energy levels and moods. In many elderly adults, studies have shown frequent walks in nature have a strong correlation with improvement in memory retention. By offering a distraction to our minds through nature, humans can allocate more energy and time to tasks that require focus and memory [10]. Rates of cardiovascular disease and sleep disorders are much lower amongst people who dedicate part of their day to interacting with nature. Overall, health outcomes tend to be higher in these people. Adults that enjoy nature more also live longer on average. This can be attributed to how spending time outdoors requires a higher amount of physical activity. Moreover, other studies have demonstrated that elderly adults that spend more time interacting with nature have better immune systems [10].

An example of beneficial interaction with nature for older adults is therapeutic horticulture (TH). TH consists of activities in which participants are involved in gardening to improve their mental and physical health specifically. Since many studies have shown its positive impacts on the well-being of elderly health, it has been rapidly gaining popularity in many senior living spaces. TH has been linked in some studies with lower levels of anxiety and depression and reduced feelings of alienation [11].

Open courtyards and roof gardens are two promising outdoor design strategies that need to be considered in the design of senior facilities. According to a National Research Council of Canada study, Roof gardens result in cost savings in many ways. During summer, rooftops become excessively hot, sometimes hitting 150 degrees Fahrenheit. Thus, they create a need for more air-conditioning. Whereas in winter, roofs allow heat to escape, depriving buildings of retaining warmth. The installation of a roof garden serves as a form of thermal insulation [12]. A common belief is that seniors must give up gardening and other outdoor hobbies once they move into a senior living community. However, the reality does not need to be as dour. Senior living homes can provide gardens to ensure seniors still have the ability to interact with nature. As for seniors who do not have prior experience with gardening, it can be a new hobby for them to pick up and entertain themselves once they move into a facility. One specific type of gardening that is particularly useful for senior living communities is vertical farming. It consists of

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growing herbs and plants on platforms stacked above each other in order to optimize both the amount of space and nutrients used. These elevated platforms allow for more creative gardening and support any mobility issues a senior might have, as it does not require bending or difficult maneuvers. Pots that go into these platforms can be placed on a table and later placed in the platforms, thus also accommodating seniors confined to seated positions.

Figure 5. Gardens keep seniors busy at St. John's on the Lake [11].

Figure 6. Roof Gardens at St. Patrick's Residence, Naperville [11].

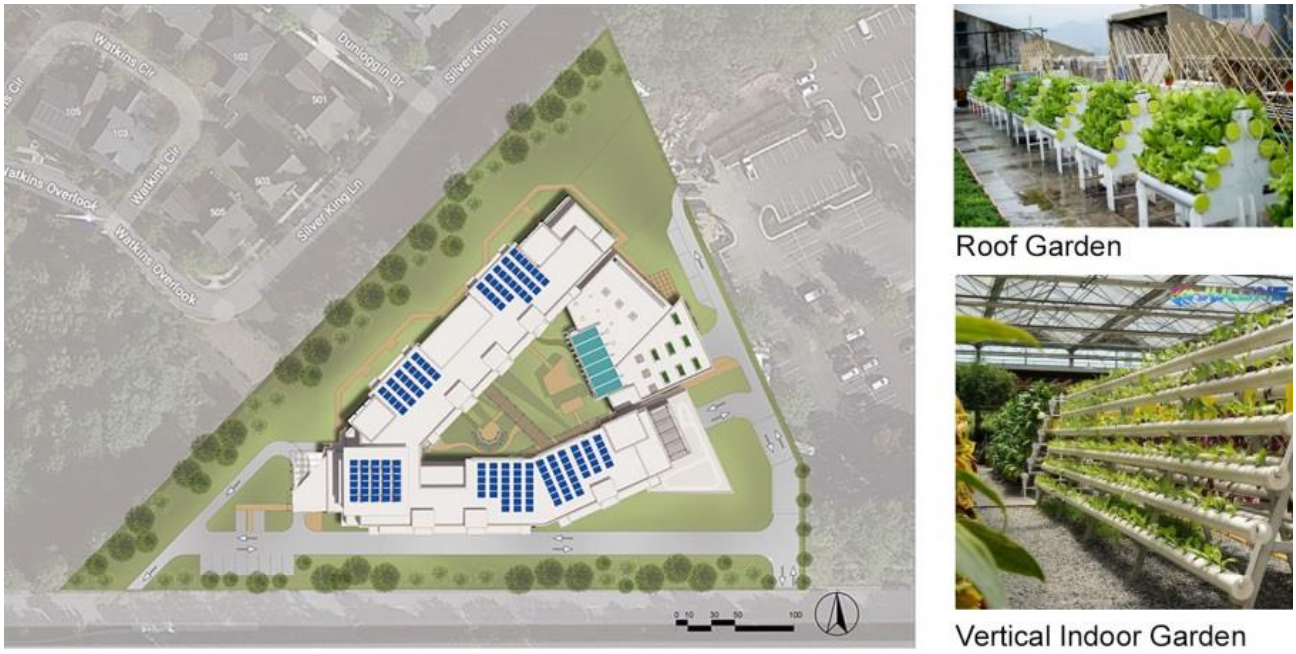

Figure 7. Roof Garden and Indoor Vertical garden can serve as a self-sufficient source of legumes for the facility (Source: By author – From thesis book).

Sustainable Architecture Strategies

A marker of a society's advancement is how much sustainability is incorporated into design strategies. Since the beginnings of the notion of sustainability in the late 80s, focus has also been placed upon individuals' mental well-being rather than solely on the effect of designs on the local environment and economy. A human-centered approach has become central to sustainability. Thus, sustainability has also started to focus on the quality of life for seniors. As populations in countries gradually age, sustainable design strategies more closely examine how to be more accommodating of senior populations as well.

LEED is one of the most used sustainability certification programs which provides a framework for healthy, highly efficient, and cost-saving green buildings [13]. Access to nature (connecting building occupant with outdoor), reinforce circadian rhythms through (considering sun direction in design), introducing daylight into space, and natural and hybrid ventilation can help the building project earn points under the LEED certification program.

The following categories contain opportunities to earn points under the LEED certification program by incorporating nature, sun, and wind into the design [13]:

- Sustainable site
- Energy and atmosphere
- Materials and resources
- Indoor environmental quality
- Regional priority

Points could be earned when evaluated the following within the above categories [13]:

- Heat island reduction
- Minimum energy performance
- Optimize energy performance
- Demand response
- Building life-cycle impact reduction
- Minimum indoor air quality performance
- Enhanced indoor air quality strategies
- Thermal comfort
- Interior lighting
- Daylight
- Quality views
- Regional Priority: Renewable Energy Production

While LEED places its focus on the impact of buildings in relation to sustainability, WELL focuses on people's health within the building and promote the health of the human body, including its cardiovascular, immune, and respiratory systems. Like in the LEED system, points are earned through optional credits and all mandatory credits must be met. WELL certification is based on ten performance categories [14]: Air, Water, Nourishment, Light, Movement, Thermal Comfort, Sound, Materials, Mind, and Community. Each category consists of features with distinct health intents. Features are either preconditions or optimizations. Exposure to appropriate amounts of natural light, limiting pollutant and contaminant concentrations, access to fresh fruits and vegetables, neighborhood walkability, and connectivity will help to earn points under all of the WELL categories [14].

The Living Building Challenge is another internationally acknowledged building rating system that visualizes the built environment ideal. It uses the metaphor of a flower because the ideal built environment should function as cleanly and efficiently as a flower [15]. Nowadays, the demands upon what spaces must provide to their occupants have changed. Spaces must now integrate multiple elements—mainly light, air, and community. Elements of a space must function together to promote health, beauty, and well-being. The Living Building Challenge inherently requires these qualities.

CONCLUSION

Promoting nature and well-being in the design of senior living facilities

Aging should not necessarily inhibit one's mobility. Youth can more easily remain connected with nature by engaging in outdoor activities. Younger people can go for a stroll or ride a bike without requiring any additional assistance, making the elderly more prone to disconnecting from their environment. While retaining a similar level of engagement with nature is more difficult for the elderly, it does not have to be impossible. Senior living facility designers must utilize strategies to ensure a drastic decrease of connection to nature does not occur. One potential approach is Biophilic Design to facilitate a greater ease in remaining connected with the outside world for senior residents.

Biophilic design calls for the integration of nature, the sun, and the wind. By taking advantage of the generative sources already present in a site, the forces of the sun and wind can optimize light and air. To promote sustainability, an architect must enhance illumination and ventilation through fostering design rooted in incorporating naturally occurring light and air. By diminishing dependency on fossil fuels and instead using renewable sources, senior living facilities can coexist in harmony with their natural environments. Since one of the main roles of senior living facilities is to maintain seniors' health, maximizing illumination and ventilation balances a building's relationship with nature; thus, ensuring seniors can remain connected to their surroundings. A true architecture of the sun and wind strives to improve the social, psychological, and ecological health of a space and its occupants.

Competing interests

The author declares that there are no competing interests.

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ASSESSMENT OF EXPANDED STYROFOAM AND POLYURETHANE AS A SUSTAINABLE BUILDING MATERIALS; MUBI GENERAL HOSPITAL ADAMAWA STATE, NIGERIA

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ABSTRACT: This study assesses the perception of stakeholders on the use of expanded Styrofoam (EPS) for building construction in Nigerian construction industry. It identified both organizations and individuals with great enthusiasm in the production and use of EPS for building construction but this has not been rewarded with an enabling environment. This inevitably results in the slow pace of adoption of EPS in the building construction industry. Other factors are low knowledge base of the public about the workings (source, production, installation, and variant uses) of EPS is a critical impeding factor in the adoption pace. The used of structures questionnaires was used to collect data from randomly selected respondents. The data analyzed from this study indicates that all benefits expected from the use of an EPS constructed building were mostly derived most especially its sustainable attributes.

KEYWORDS: Expanded Styrofoam, Buildings, Environment, Sustainability, Construction and building materials.

INTRODUCTION

The use of building materials is very vital in all phases of life as no field of building and engineering is conceivable without their use and there is always a new technology to replace an outgoing technology due to mans' technological advancement. The use of building materials has changed from one material to another over the period of time due to technological advancement. The eco-friendly nature of Expanded Polystyrene Systems (EPS) has increased its versatility and use in commercial and residential construction [1, 2]. Hence, it is expected that waste will occur. In a bid to enhance resource conservation and sustainable development, Adedeji and Fa [3] gives an overview on Recycled Foam and Cement Composites in Insulating Concrete Forms (ICF). EPS can be recycled until infinity times [4, 5]. A "foam" with the ability to undergo recycling after use is the Expanded Styrofoam [6].

Goodier [7] stated that after man has eaten, the next line of struggle is shelter against various climatic conditions (sun/rain, wind/heat). The quest for shelter has made man in seek for number of materials varying from clay/mud, grass, stones, metals, plastics, blocks/bricks even Styrofoam. According to John [8] building materials are those materials that are used in construction of building. He further explained that the use of materials is vital aspect in which no field of engineering survive without their use as there is always need for replacement for the outgoing technology due to man's advancement in technology.

Over the time, the use of building materials has shifted ground from the conventional one to modern ones due to the advancement in the technology which has turn out to the production and use of expanded Styrofoam blocks in construction of building.

Styrofoam is a thermoplastic material obtained by the polymerization of styrene and is used in Packaging electronics, food items and building houses. Polystyrene is a light synthetic material which cannot be used in building houses unless it has been expanded to form a block. Sustainability means meeting our own needs without compromising the ability of future generations to meet their own needs. In addition to natural resources, we also need social and economic resources.

Sustainable materials are used in many industries as they create fewer long-term environmental problems and lead to a healthier planet. Awareness and use of sustainable materials are important to your small business: Besides being better for the earth, customers like them too.

Goodier [7] indicated that Expanded Polystyrene Systems (EPS) is sustainable material as the

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excellent acoustic, fire resistance, excellent thermal resistance and structural strength of it are considerably resilient due to the monolithic nature that amount it an exceptional building material. Despite the uniqueness, merit and significant of Expanded Polystyrene Systems (EPS) material, the use in building construction in Nigeria building industry is still precisely low.

Expanded Styrofoam or EPS, an organic insulation that demonstrates a positive eco-balance, is a rigid cellular plastic which is made from expandable Styrofoam containing an expansion agent, pentane. As a building material, Expanded Styrofoam Systems (EPS) has found applications in many aspects of building works including large structures such as roads, bridges, railway lines and public buildings. In addition to its eco-friendly nature, Expanded Polystyrene Systems (EPS) exhibits low thermal conductivity, lightweight, mechanical resistance, moisture and chemical resistance, ease of handling and installation and versatility, which makes it more suitable for building construction than the conventional sandcrete system [9, 10].

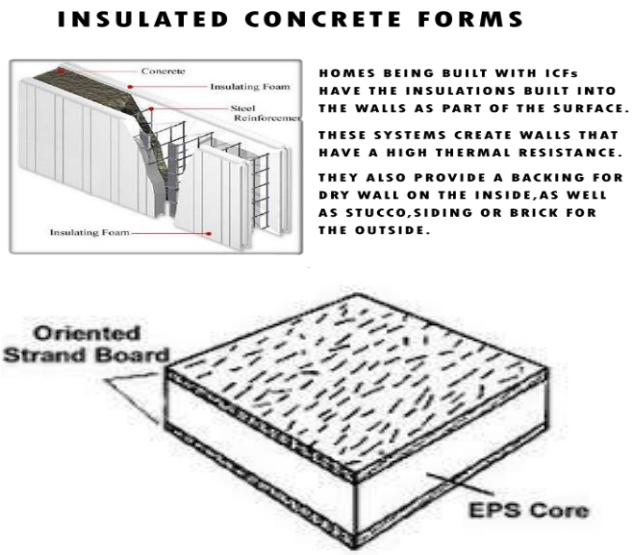
For construction purposes Drysdale [11] noted that two energy-efficient systems relying on EPS are insulating concrete forms (ICFs) and structural insulated panels (SIPs). Both are recognized as innovative product solutions used to construct building envelopes and are gaining wide acceptance by leaders in sustainable designs, shown in fig. 2.0 &2.1. Expanded polystyrene has been found to offer substantial environmental advantages through energy saving and greenhouse gases emission reduction and is therefore ideally suited to the creation of environmentally-friendly new building projects [12].

The aim of this study is to assert that there is a need for the use of Expanded Polystyrene Systems (EPS) as a sustainable substitute to the traditional building material (block and brick) in the building industry. For the purpose of achieving the aim of this research the following objectives are as follows:

1- To evaluate the usability of Expanded Polystyrene Systems (EPS) as a material for construction;

2- To assess the effectiveness of Expanded Polystyrene Systems (EPS) as a material for construction;

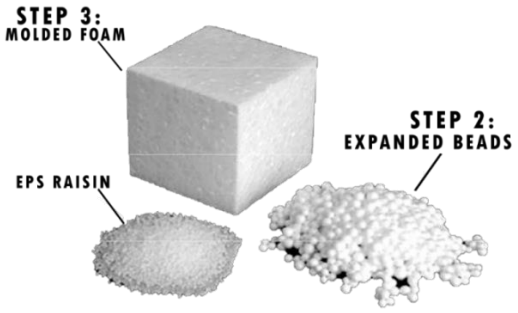
3- To assess the cost effectiveness of Expanded polystyrene System (EPS) as a material for construction.



Sulong et al. [13].

In recent years, there has been an explosive growth of interest in the application of expanded polystyrene (EPS) for construction industry. EPS is a well-established insulation material used for various applications as it has a light yet rigid foam with good thermal insulation and high impact resistance. Apart from that, it possesses high load-bearing capacity at low weight, absolute water and vapor barrier, air tightness for controlled environments, long life, low maintenance, fast, and economic construction. The foam in EPS is a lightweight cellular plastic consisting of small spherical-shaped particles containing about 98% air. This microcellular closed cell construction provides Expanded Polystyrene Systems (EPS) with its excellent insulating and shock absorbing characteristics [13].

Expanded Polystyrene Systems (EPS) consists of small polystyrene beads that derived from styrene via polymerization process [9]. The foam quality of EPS is affected by the size distribution of the beads. After the polymerization, EPS is infused with blowing agent such as pentane and hexane.



Ogundiran and Adedeji [9].

Small polystyrene beads and a molded form of ESP after polymerization

The conversion of polystyrene beads to EPS is carried out in three stages: 1) pre-expansion; 2) intermediate maturing and stabilization; and 3) expansion and final molding.

In the first stage, the raw material is heated in pre-expanders with steam at temperature between 80℃ and 100℃ to create a relatively uniform cellular structure with small closed cells that hold air in their interior. According to Kellenberger et al. [10] during this process, the beads' internal gas experience volume expansion that generates air-penetrable cellular structure. This process is carried out in aerated silos during the material's intermediate maturing. Based on the air temperature, size, and density of the beads, the aging time is calculated. The beads achieve greater mechanical elasticity and improved expansion capacity. Through the expansion process, the stabilized pre-expanded beads are molded and re-exposed to steam in order to bind the beads. Blocks created using this process is further enhanced in terms of dimensional stability prior to separation into required shape.

Significance of the study

Due to man's insatiable desire to enhance on the present, revolution and improvement on the current is an unavoidable action. The use of building materials changes with time due to increased options of building materials to choose from as a result of technological advancement. This advancement has led to the production and use of polystyrene in building construction.

Expanded Polystyrene System (EPS) has been proven to possess all functional requirements that contribute to the overall integrity of any building in both form and content. Comparative test and analysis of Expanded Polystyrene Systems (EPS) and Sandcrete hollow blocks in wall have conclusively validated that EPS has advantage over Sandcrete block in urban housing delivery in Nigeria. However, according to Ogundiran and Adedeji [9] its slow pace of adoption in Nigeria construction industry is a cause for concern.

Ogundiran and Adedeji [9] endorses the intensification of research efforts on the material towards achieving sustainable housing delivery in Nigeria. The study further emphasizes that mass production should be given to the material to ensure cost efficiency and better patronage in the construction of housing units. To achieve a boost in the Nigerian construction industry and better urban housing delivery in Nigeria, there is the need to investigate into the causes of the slow pace of adoption and course a path for further research to tackle such reasons. This in turn will enhance proper resource conservation that invariably leads to sustainable development. This research therefore intends to create awareness, examine the factors associated with Expanded Polystyrene Systems (EPS) and the conscious understanding of those with keen interest of the Expanded Polystyrene Systems (EPS) technology.

Scope of the study

This study examined the sustainability and effectiveness of the use of Expanded Polystyrene Systems (EPS) in the research location which is Mubi General Hospital Adamawa state. The work will examine the buildings against the Green Building Index (GBI) checklist to determine its sustainability.

The concept of sustainable development and green architecture

The topical issue of sustainable development which encompasses sustainable design and construction as it relates to architecture is not new and has witnessed considerable growth in literature over the last two decades [16]. Sustainable development has now become a worldwide trend to scale down the negative impact of man's activity on the environment [17]. It has been widely asserted by many authors that sustainable development is about "meeting the needs of the present without compromising the ability of future generations to meet their own needs" [18]. It is in this regard Ilesanmi [16] remarked that the concept of sustainability attempts to achieve simultaneously the goals of an improved environment, a better economy, and a more just and participative society, rather than trading off any one of these against the others. In relation to the field of architecture, sustainability or sustainable development has given birth to the concept of sustainable architecture or green architecture. Green architecture is a general term that describes environmentally-conscious design techniques in the field of architecture and it is framed within the larger context of the discussion of sustainability [19].

Today, interest in sustainable "green" building is growing worldwide and the movement began as a result of the need and desire for more energy efficient and environmentally friendly construction practice by taking advantage of renewable resources and energy. Green buildings often include measures to reduce energy use and increase the efficiency of

the building envelope. A number of excellent and well proven environmental evaluation schemes such as the Building Research Establishment Environmental Assessment Method (BREEAM) of Building Research Establishment (BRE) of the UK, the Leadership in Energy and Environmental Design (LEED) of the United States Green Building Council (USGBC) of the USA, Haute Qualite Environmental (HQE) of France and the Green Star of Australia are already in existence. They all set standards for the best practice in sustainable design and have become the modern yardstick for measuring and describing a building's environmental performances. Green buildings therefore often include measures to reduce energy use and increase the efficiency of the building envelope [19, 20].

According to Manual for Expanded Polystyrene (EPS) core panel system and its field application (June 2017) Expanded Polystyrene (EPS) core panel system is a modern, efficient, safe and economic construction system for the construction of buildings. These panels can be used both as load bearing as well as non-load bearing elements. Expanded Polystyrene Systems (EPS) core panel is a 3D panel consisting of 3-dimensional welded wire space frame provided with the polystyrene insulation core. Panel is placed in position and shotcrete on both the sides. The EPS panels consist of a 3-dimensional welded wire space frame utilizing a truss concept for stress transfer and stiffness.

EPS panel includes welded reinforcing meshes of high-strength wire, diagonal wire and self-extinguishing expanded polystyrene uncoated concrete, manufactured in the factory and shotcrete is applied to the panel assembled at the construction site, which gives the bearing capacity of the structure.

Properties of EPS

Fire behavior and thermal insulation properties of EPS

Polystyrene foam has similar fire behavior to most organic materials where both are easily combustible. Thus, tiny amount (<1%) of fire-retardant material is added to the EPS insulation product in order to enhance the fire retardancy of EPS. Besides fillers such as SiO_2, Fe_2O_3, and clay, waste such as fly ash can also be used as cheaper alternative to increase the flame retardant of EPS foams [18]. Wang et al. [21] introduced fly ash into phenolic resin-hydrated aluminium hydroxide binder which is the incorporated into EPS foam. This insulation material is reported to increase the loss on ignition (LOI) value of EPS foam up to 29.6% and acquired the V-0 rating. The leaching of fire-retardant material into environment is prevented since it is polymerized into the molecular structure of EPS.

Miao et al. [22] studies were conducted on thermal insulation properties of EPS as construction and insulating materials. Thermal conductivity test provides information that determines the performance and suitable application for the insulating material. As construction equipment, insulation material has to comply with parameters such as temperature, humidity, and overall assembly condition.

Production of smoke

Smoke is described as visible suspension of solid or liquid particles in the gas as product of combustion and pyrolysis. Production of smoke can be suppressed by restricting the ability of material to ignite and reducing the flame spread and heat released.

The surface area of EPS insulation must be protected using non-combustible material in order to minimize smoke production during event of fire [11]. EPS begins to soften at temperature above 100℃ and upon further heat exposure, it will shrink, melt, and decompose to produce flammable gases which ignitable by spark or flame at certain condition and temperature.

Mechanical strength of EPS

Studies were conducted to understand how grain size of EPS and additives such as fly ash and silica fume can enhance the mechanical properties of EPS-aggregated concrete [23]. performed research on the durability of EPS mortar. In this article, several methods were used to observe microstructure in order to analyze the effect of EPS type and concentration on the strength of Portland cement mortars. Methods employed were capillary absorption of water, mercury intrusion porosimetry, impendence spectroscopy, and open porosity.

The EPS product is classified based on compressive strength and compressive stress. Compressive strength is maximum uniaxial compressive stress that material can bear before fracturing. Number is assigned to EPS product based on its compressive stress at 10% compression.

Water and moisture absorption

EPS has very poor water absorption which decreases as density increases. EPS with 9–12 years

of usage period has 8% –9% of its volume filled under groundwater table [24]. The cellular structure of EPS is water resistant, vapor permeable, and possesses zero capillarity though neither liquid water nor water vapor influences its mechanical properties. However, absorption of moisture is still possible upon complete immersion of EPS due to fine interstitial channels between molded beads.

EPS geofoam is prone to moisture absorption which causes deterioration of thermal properties. Less than 10% volume of lightweight-fill geofoam is absorbed during its lifetime usage [25]. Also, high density EPS possesses high water vapor diffusion resistance factor due to better moisture properties.

Chemical resistance

Chemical resistance of EPS is affected by the reaction time, temperature, and applied stress. It has identical resistance to general polystyrene. EPS is sensitive toward solvent attack which leads to softening and cracking of itself due to its thin cell walls and large exposed surface.

EPS does not react with water, salt, or alkali solution. The insolubility of EPS in most organic solvent influences the selection of adhesive, label, and coating of EPS product. In general, substance is tested for its compatibility with EPS by exposing molded polystyrene to it at 120–140 F. Despite the ultraviolet radiation resulted in superficial yellowing and friability on molded polystyrene, its physical properties remain unaltered.

Toxicity and environmental effect

EPS is a polymer derived from styrene monomer, a hydrocarbon with molecular compound of C_8H_8 that burns completely in the presence of excess oxygen to produce carbon dioxide, CO_2, and water as shown in eq. (1).

$$C_8H_8 + 10O_2 ! 8CO_2 + 4H_2O \quad ð1Þ$$

As reported by Doroudiani and Omidian,[2] the amount of oxygen available during combustion affects the volume of soot and carbon monoxide, CO evolved. In theory, the complete combustion of 1 g of polystyrene requires roughly 2150 cm^3 of oxygen. Since this huge amount of oxygen is not usually accessible during combustion, polystyrene burns partially to produce more soot and CO as shown in eq. (2).

$$C_8H_8 + 10ð -0:75xÞO_2 ! xC + xCO + 8ð -2xÞCO_2 + 4H_2O \quad ð2Þ$$

The volume of smoke and toxic gases released by EPS insulation material is determined by the material quantity and density. Normally, the surface of EPS insulation is fire-protected using gypsum, stone, wood or steel to prevent flame from spreading to EPS. Under normal fire situation, EPS melts due to heat flow. However, EPS might ignite when surface protection material is fully incinerated thus exposing it to direct fire followed by emission of smoke and combustion gases. The effect of fire-retardant material on the toxicity of EPS is negligible due to only small addition (0.5–0.1%) of the material is required. Hence, EPS produces significantly less toxic fumes as compared to natural material, for example, wood, wool, or cork [26].

Table 1. The properties EPS panels

S/N	PROPERTIES	
1	Density of EPS	16-640kg/m^3
2	Young's Modulus	3000-3600MPa
3	Tensile strength (st)	46-60MPa
4	Elongation at break	3-4%
5	Notch test	2-5kj/m^2
6	Glass transition temperature	100°C
7	Vicat B	90°C
8	Linear expansion coefficient(a)	8x10^{-5}/k
9	Specific heat	1.3kj/(kg.K)
10	Water absorption (ASTM)	0.03-0.1
11	Decomposition	X years, still decaying

Source: EVG, (2001)

Acoustic Properties

Expanded polystyrene, when used in combination with other building materials effectively reduces the transmission of airborne sound through partitioned walls, ceilings and floors. EPS has the advantage of being lightweight and effective in thicknesses as low as 0.625 cm it can replace thicker, heavier materials.

Recyclability

EPS is 100% recyclable. There are two main types of plastic resins mainly thermoplastics and thermosets. Thermosets cannot be re-melted but thermoplastics can be recycled and changed into various types. Polystyrene is a thermoplastic family and is suitable for recycling [26].

Recycling has been an area of concern coupled with eco-efficiency [28]. The process can take various forms; it can be reused in non-foam

applications such as lightweight concrete. The recycling process of EPS is carried out such that it transforms into polystyrene plastic after the process.

MATERIAL AND METHOD

Study Area

Mubi city and its immediate environment constitute the study area for this research. **Mubi**, town, northeastern Adamawa state, northeastern Nigeria. It lies on the west bank of the Yedseram River, a stream that flows north into Lake Chad, and is situated on the western flanks of the Mandara Mountains.

Probably founded in the late 18th century by the Fulani people, Mubi remained under the jurisdiction of the sultanate of Mandara until conquered in the Fulani jihad (holy war) by Modibbo Adama. By the 1820s the peoples of Mubi and the surrounding area were incorporated into Adama's Fulani kingdom of Fumbina, later called Adamawa; in the 1890s they were subjected to slave raids by Adamawa's emir Zubeiru. The town was taken by German forces in 1903 and served as a frontier post and administrative centre of German Kamerun until its capture by the British in 1914. Mubi and its surrounding region were placed in the British Cameroons by a League of Nations mandate in 1922. In 1961 it became part of Nigeria. The town is the site of a federal polytechnic college. Pop. (2006) local government area, 280,009.

Between 305 to 610 meters above the sea level. To the south-east of jalingo, the land rises to the peak of about 914 meters, which forms the watershed for river benue. There are also pockets of hills to the north including jalingo hill, Hosere hill, Jauro Ashe hill, and Dambature hills ranging from the heights of 323 to 349 meters. There hills form interesting features in the landscape of jalingo city. The city slopes gently in nature, hence making it self-draining to River Lamurde.

The study tends to find out the opinion of respondents on the use of expanded polystyrene in construction and its level of acceptability in the Nigerian society while also considering its architectural implications. Hence, respondents will give their opinions based on the usability and effectiveness of expanded polystyrene.

The researcher will collect data using questionnaires which will be administered by the respondents. All the respondents are expected to give maximum cooperation as the information on the questionnaire are all on things that revolve around the study. Hence, time will be taken to explain how to tick or indicate their opinion on the items stated on the research questionnaires. The data obtained through questionnaires will be analyzed and tabulated based on descriptive, statistical methods using frequency and remarks. In this study, mean was used to analyze the data collected. A four point Likert scale was used to analysis each of the questionnaire items.

RESULTS

The purpose of this study was assessment of stakeholders on the use of expanded polystyrene (EPS) for building construction in Nigeria, requires that data be obtained from the under listed stakeholders; 1) Architects; 2) Engineers; 3) Builders; 4) Quantity surveyors.

The analysis will be categorized according to data obtained, which are sequentially arrange. The data collected for this study were analyzed statistically and presented in this chapter. The data collected were organized in consonance with the research questions on the questionnaire. This was followed by data analysis that resulted in some findings. The result of data collected by the researcher through the use of questionnaire are therefore presented below.

The form of administration of the questionnaire to the respondents by the researcher is by hand. However, among the 40 respondents who questionnaires were distributed to; only 25 (twenty-five) questionnaires were recovered. Therefore, only the questionnaire of 25 respondents which represents about 62.5% response rates was recovered. However, fifteen questionnaires were unable to be recovered which represents about 37.5%,

What is the usability of Expanded Polystyrene Systems (EPS) as a material for construction?

Table 2 shows 20% of respondents were engineers, 56% are Architects, 8% quantity surveyors and 12% builders. We can therefore deduce that virtually all the professions in the construction industries are well represented and as such elicit a uniform and unbiased response.

According to table 3, the result obtained from the field is that ESP is the easiest material to use when compared to other building material. Again, it has some merits over other materials such as: fast erection time/installation. Going by the mean decision rule the mean response is 3.72, the respondent agrees that it is the easiest to use.

Table 4 shows the response of respondents rating the durability of ESP in construction. The mean rule of the above table is 3.04, according to the adopted decision rule the mean response is 3.04 rates makes it a more durable material in construction.

Table 2. Demography of respondent profession of respondents

Variable	Frequency	Percentage
Architects	14	56
Quantity surveyors	2	8
Builders	3	12
Engineers	5	20
Non professionals	1	4
Total	25	100

Source: Researchers field study, (2021)

Table 3. Compared to other building material EPS is the easiest to use

Response	X	Frequency	F(x)	Percentage
Strongly Agree	4	18	72	72
Agree	3	7	21	28
Disagree	2	0	0	0
Strongly disagree	1	0	0	0
Total	10	25	93	100

Source: Researchers field study, (2021)

Table 4. Expanded polystyrene (EPS) is a more durable building material in construction

Response	X	Frequency	F(x)	Percentage
Strongly Agree	4	10	40	40
Agree	3	8	24	32
Disagree	2	5	10	20
Strongly disagree	1	2	2	8
Total	10	25	76	100

Source: Researchers field study, (2021)

How effective is the use of Expanded Polystyrene Systems (EPS) in construction of building?

Table 5 shows the response of respondents rating the effectiveness of ESP in construction. The mean rule of the above table is 2.76, according to the adopted decision rule the mean response is 2.76 rates makes it a more effective material when compared to other building material (block and brick) construction. Base on the table 6 the response obtained from the respondent is that expanded polystyrene is a more sustainable building material, Other EPS empirical merits from various perspective outlined in the literature review such as: fast erection time/installation, improved technology, save cost, quality of product and reduced weight, shorter construction time, costs savings both at initial level and whole life cycle, thermal and sound Insulation, water-tight nature, recyclability, perfect in-fill and finishing material, durable nature and strength also reflects from the responds of the respondents. According to the adopted decision rule the mean response is 3.08 rates makes it a more sustainable material in construction.

Table 5. EPS as a building material is more effective than other building material (block & brick)

Response	X	Frequency	F(x)	Percentage
Strongly Agree	4	6	24	24
Agree	3	10	30	40
Disagree	2	6	12	48
Strongly disagree	1	3	3	12
Total	10	25	69	100

Source: Researchers field study, (2021)

Table 6. EPS is a more sustainable building material

Response	X	Frequency	F(x)	Percentage
Strongly Agree	4	4	16	16
Agree	3	19	57	76
Disagree	2	2	4	8
Strongly disagree	1	0	0	0
Total	10	25	77	100

Source: Researchers field study, (2021)

Table 7 indicates that the response of the respondents rating the range at which ESP covers in necessary elements for construction. Here 32% strongly agree to it while 40% agree, 24% disagree, 4% strongly disagree. Judging by our decision rule the mean response of 3.08 makes it a necessary material for construction.

Table 7. EPS covers a wider range of construction elements necessary for a building

Response	X	Frequency	F(x)	Percentage
Strongly Agree	4	8	32	32
Agree	3	10	30	40
Disagree	2	6	12	24
Strongly disagree	1	1	1	4
Total	10	25	77	100

Source: Researchers field study, (2021)

According to table 8, the result obtained from the field is that ESP is can be molded into whateer

form, making its application versatile various areas of building such as: concrete facial, monuments e.t.c. Again it has some merits over other materials such as: fast erection time/installation. Going by the mean decision rule the mean response is 3.24, the respondent agrees that it is flexible to use.

Table 8. EPS can be molded into whatever form as desired by the user and that gives it an advantage over other building materials

Response	X	Frequency	F(x)	Percentage
Strongly Agree	4	6	24	24
Agree	3	19	57	76
Disagree	2	0	0	0
Strongly disagree	1	0	0	0
Total	10	25	81	100

Source: Researchers field study, (2021)

What is cost level of expanded polystyrene system (EPS) as a material for construction?

Table 9 shows the response of respondents rating the building when it comes to affordability of materials in the construction industry. The mean rule of the above table is 2.76, according to the adopted decision rule the mean response is 2.76 rates makes it a more affordable material for construction in the building industry.

Table 9. EPS is a more affordable construction material

Response	X	Frequency	F(x)	Percentage
Strongly Agree	4	3	12	12
Agree	3	15	45	60
Disagree	2	5	10	20
Strongly disagree	1	2	2	8
Total	10	25	46	100

Source: Researchers field study, (2021)

Table 10 shows the response of respondents rating the building when it to maintenance of ESP in construction. The mean rule of the above table is 1.84, according to the adopted decision rule the mean response is 1.84 rates makes it a poor when it comes to maintenance of the building in construction.

Base on the result from the table 11, the response of respondents rating about the availability of ESP in construction industry is poor. The mean rule of the above table is 2.0 rates which makes it a poor when it comes to availability of ESP as a material in building construction.

Table 10. The use of EPS as building material makes building maintenance easier

Response	X	Frequency	F(x)	Percentage
Strongly Agree	4	0	0	0
Agree	3	3	9	12
Disagree	2	15	30	60
Strongly disagree	1	7	7	28
Total	10	25	46	100

Source: Researchers field study, (2021)

Table 11. It is a readily available building material

Response	X	Frequency	F(x)	Percentage
Strongly Agree	4	0	0	0
Agree	3	5	15	20
Disagree	2	15	30	60
Strongly disagree	1	5	5	20
Total	10	25	50	100

Source: Researchers field study, (2021)

DISCUSSION

On the perception of stakeholders on the usage of EPS as a building material, A good number of the respondents have appreciable knowledge about both the manufacture and use of EPS in building construction. They are aware of a variety of uses to which EPS can be put: in walls, ceiling or floor, beads for decorative purposes in buildings such as: furniture, dado rails, cornices, bean bags, throw pillows and use it as in -fill core for flush doors. Innovation is still in progress as the technology is driven towards other potential uses of the material.

Findings indicated that the cause of slow adoption pace of EPS for building construction in Nigeria mainly stems from the awareness of the public, the petrochemical sector and the power sector of the Nigeria.

On the issue of awareness, respondents suggest that EPS should be introduced into Nigerian universities to further study the other factors that can enhance its usage in Nigeria, enlighten the general public about the benefits that can be derived from EPS panels, and furthermore train individuals on how to handle and install EPS panels on sites.

The factors that influence the usage of EPS as a building material largely merits the erection time of the panels, the life span of the material, the structural stability, the versatility of EPS panels and

its economic viability as a building material. Environmental friendliness, recyclability and the cost effectiveness of EPS panels also impacted largely on the factors influencing its usage.

The purpose of this research is to establish that Expanded Polystyrene Systems (ESP) is a sustainable building material with various uses as well as application on the building construction industry. It is of great importance not to talk for the eco-system friendliness to the environment. The aim of this study is to assert that there is a need for the use of Expanded Polystyrene Systems (EPS) as a sustainable substitute to the traditional building material (block and brick) in the building industry. Hence this research attempts to create awareness on the importance and various use of polystyrene in the construction industry, ranging from floor, roof, and wall respectively. This research took on the descriptive method of research. Data was collected through questionnaire. The form of questionnaire adopted was the likert ordinal scale, proceeding ranked into strongly agreed, agreed, disagreed strongly disagreed. The form of administration of the questionnaire to the respondents by the researcher is by hand. However, among the forty respondents who questionnaires were distributed to; only twenty-five questionnaires were recovered. Therefore, only the questionnaire of 25 respondents which represents about 62.5% response rate were recovered. However, fifteen questionnaires were unable to be recovered which represents about 37.5%. The research data gathered was analysed through the use of descriptive statistic method (mean and standard deviation) and a decision rule was adopted to analyze the calculated mean of each table. Results from the findings of this research shows that expanded polystyrene system (EPS) is a better and sustainable substitute to block and brick.

CONCLUSION

This study has attempted to evaluate the perception of stakeholders on the use of expanded polystyrene (EPS) for building construction in Nigerian construction industry. It identified individuals with great enthusiasm in the production and use of EPS for building construction but this has not been rewarded with an enabling environment. This inevitably results in the slow pace of adoption of EPS in the building construction. Hence, this study fixed its focus on assessing the factors responsible for the slow adoption pace first by assessing the perception of stakeholders at different levels.

Further study on the use of EPS urged that progress be made by government and other critical stakeholders to conduct proper orientation on EPS use and its adoption as a major component in building construction it has proven to be a more sustainable material.

Other factors are low knowledge base of the public about the workings (source, production, installation, and variant uses) of EPS is a critical impeding factor in the adoption pace. Data analyzed from this study indicates that all benefits expected from the use of an EPS constructed building were mostly derived.

Recommendations

Having carried out this research, I recommend that:

Government should embark on increasing awareness of EPS to the general public and encourage universities to include EPS study on their teaching and research curriculum.

Government should enforce purposeful reforms aimed at revitalizing the petrochemical industry that will among other objectives, henceforth make it account for styrene, for the domestic market. This will ultimately reduce if not totally stop importation of styrene to achieve resource conservation.

Standard Organizational of Nigeria (SON) should enforce standard in EPS products and also broaden its scope to partnering with Universities and Research Institutions for optimal results towards consumer safety.

EPS manufacturers themselves must engage in self-regulation/governance in addition to SON's regulation, through regular training of their staff on manufacturing best practices and keep abreast of recent developments in fault detection and risk management.

Users alike must place quality assurance in top priority through collaboration in workshop and training of builders and artisans towards client satisfaction and promotion of institutional integrity.

Manufactures should sensitize the public on awareness of EPS through collaboration with government at all level, organized private sector, and other key stakeholders in order to quicken the adoption rate and broaden its market share.

This research further intensifies efforts on EPS towards achieving sustainable housing delivery in Nigeria which was previously recommended by Ogundiran and Adedeji [9]. This in turn, enhances proper resource conservation and leads to sustainable development.

Contributions

At the end of this research, it is expected that an awareness on the use of polystyrene to be created, retrospectively causing a lesser overall cost of projects, lesser time for completion of various milestones in projects. This will be beneficial to all building construction stake holders with an aim of maximising satisfaction and minimize cost. From a bigger picture, it benefits the construction industry at large with its easier, time saving and better structural properties.

DECLARATIONS

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Competing interests

The authors declare that they have no competing interests.

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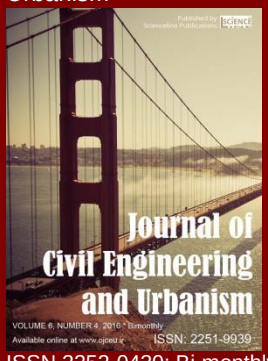

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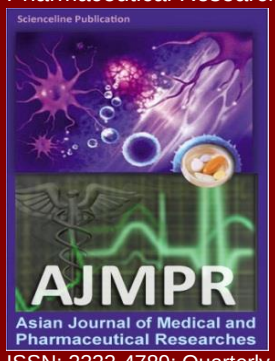

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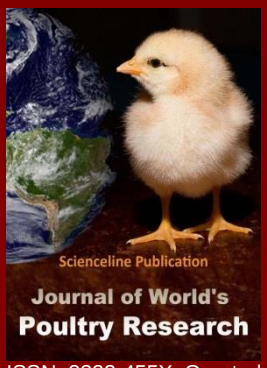

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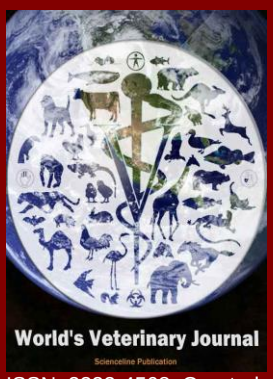

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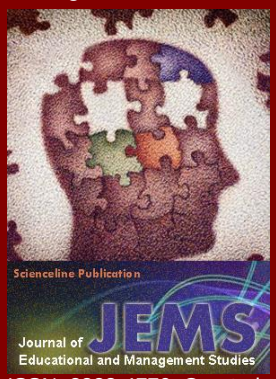

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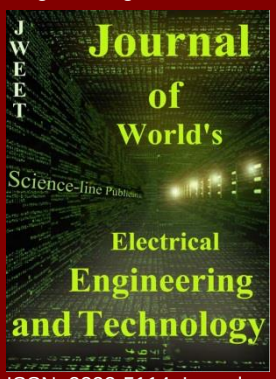

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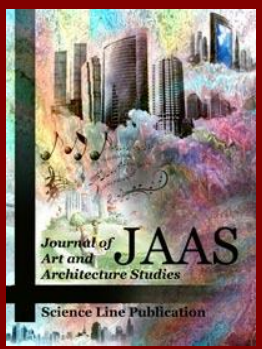

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