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DETERMINATION OF EFFECTS OF PLANTS ON THE RESIDENTIAL BUILDINGS IN THE CENTRAL AREA OF LOKOJA AS SUBSTITUTE FOR ARTIFICIAL COOLING AND VENTILATION IN NIGERIA

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ABSTRACT
The hotness of Lokoja affects the comfort of people especially during the heat season, and this is a problem. To reduce the problem, the effects of plants on the residential buildings in the central area of Lokoja were evaluated, in order to generate a framework to reduce the costs of the use of electric power generators for artificial cooling and ventilation in Nigeria. Random sampling method of data collection was adopted and this brought about the selection of 100 residential buildings for the study. The primary research data were obtained from the direct observations of the selected buildings with respect to the use of plants in buildings. Moreover, they were obtained from the questionnaires administered to the occupants of the selected buildings, and the focus group discussions with them. Among other results are: the majority of the buildings that were studied have no use of plants for landscape architecture; it has been very difficult for the building occupants such that the prices of purchasing, maintaining and fueling of electric power generators have skyrocketed and the commensurate income to cope with the life style is dwindling and thereby negatively affecting the standard of living or hindering an average life style from being maintained. Among other recommendations are: the architects and owners of residential buildings should emphasise on the use of plants for landscape architecture, in order to reduce the costs of making use of electric power generators to power appliances for cooling and ventilation in Nigeria; the government of Nigeria should embark on the education of the general public through media and other means with regards to the importance of natural cooling and ventilation from the use of plants around the buildings.
Keywords: Buildings, Cooling, Nigeria, Plants, Ventilation.

INTRODUCTION

Plants help the environment in many different ways. One of the things that plants produce as they make food is oxygen gas. This oxygen gas is an important part of the air to keep the cells and bodies alive when people breathe (Missouri Botanical Garden, 2009). The oxygen that is available for living organisms comes from plants. Every cell in the body uses oxygen (Govan, 2009). Oxygen that plants contain could be considered as the most crucial nutrient to the human body because without it there will be no life.

In architecture, plants help to naturally cool and ventilate buildings (Bonnefin, 2016). They also help in air pollution mitigation by manipulating quantities of trees, shrubs, green roofs and green walls (Beth and Brad, 2008). When detoxing the body, approximately 70% of it occurs through breathing, 20% through perspiration, 8% through urination and 2% through bowels (Govan, 2009). Thus, the utmost importance of having adequate air in buildings cannot be over emphasised since 70% of detoxification occurs through breathing. In a stuffy and poorly ventilated building, people generally breathe improperly because the air is so toxic. When the air is vibrant and full of life-force energy, it is naturally desired to take big deep breaths at all times. Contrary to the natural cooling and ventilation derive from plants is the artificial cooling and ventilation.

The main purpose of artificial cooling and ventilation is to help maintain good indoor air quality to provide thermal comfort (Wang, 2001). However, artificial cooling and ventilation are among the largest energy consumers in buildings (Eskom Integrated Demand Management, 2015).

Therefore, it became necessary that measures are taken to reduce the energy consumption in residential buildings through appropriate planning of landscape architecture. The study area is the eastern part of the central area of Lokoja. Lokoja is the capital city of Kogi State of Nigeria which is located at 7.80 latitude and 6.74 longitude; it is situated at elevation 53 metres above sea level (World Atlas, 2017). The weather of Lokoja is hot (Meteo365, 2017). In the hottest day of the year, average temperatures in Lokoja typically range from 74 °F to 96 °F while in the coldest day of the year, they range from 66 °F to 91 °F (Weather Spark, 2017). During the season of heat, people do not feel comfortable in the built environment as a result of the hotness of the town, especially when there are no public electric power supply. Public electric power supply in Lokoja is not a stable type like the way it is in some parts of Nigeria, and this is a problem. As a result of the problem, many people now depends on private electric power generators to power fans and air conditioning system.

The costs of purchasing electric power generators; their maintenance and fueling is a challenge to some people (Chijioke, 2017). Therefore, the aim of this study is to evaluate the effects of plants on the residential buildings in Lokoja, in order to generate a framework to reduce the costs of the use of electric power generators for artificial cooling and ventilation in Nigeria. The objectives of the study are: to find out the levels of satisfaction of the occupants with regards to comfort that is derived from the use of residential buildings in terms of natural cooling and ventilation from plants; to ascertain the levels of the dependence of people on the use of electric power generators for artificial cooling and ventilation in Lokoja; to ascertain the levels of the dependence of people on the natural cooling and ventilation that are derived from plants in Lokoja; to determine the feelings of people with regards to the use of electric power generators to power appliances for cooling and ventilation.

MATERIAL AND METHODS

Random sampling method of data collection was adopted for this study. According to Lavrakas (2008); Watson and English (2016), random sampling is a selection technique in which sample members are selected from a larger group (a population) by chance but with a known probability of selection. The target population for this study is all the residential buildings in the eastern part of the central area of Lokoja. According to the staff of Lokoja Town Planning Office, there are about 500 registered residential buildings in the eastern part of the central area of Lokoja. 20% sample size of the target population of the study is a good recommended sample size (Prashant and Supriya, 2010; Steve, 2011; Suresh and Chandrashekara, 2012). In line with this immediate statement, 100 registered residential buildings in the study area were randomly selected after the confirmation of their registrations.

The instruments used for the collection of the primary research data are direct observation schedule, questionnaires and discussions. Direct observations of the selected buildings were carried out with respect to the landscapes and general uses of plants in buildings. In each of the selected building, a questionnaire was administered to its occupant for the study. This means that a total of 100 questionnaires were administered to the occupants of the residential buildings in the study area. The minimum standard number of the participants in focus group for a research is 10 to 12 (Masadeh, 2012 and Morgan *et al.,* 2002). Giving consideration to this immediate statement, 10 number focus group discussions that are made up of 10 participants were organised in the study area by getting one participant from each of the selected buildings.

The minimum size of the research instruments of a pilot study should be 10% of the total size of the research instruments of the proposed full study (Department for Business Innovation and Skills, 2012; Osama and Issa, 2015; Ravi, 2017). In line with this immediate statement, 10% of the total size of all the research instruments for this study were tested during the pilot study, in order to demonstrate the availability of the respondents or volunteers, practicality of the research procedures, instrument reliability as a basis to determine the capabilities of the research instruments, participants and skills of the researchers.

RESULTS AND DISCUSSION

According to Govan (2009), the oxygen that plants contain could be considered as the most crucial nutrient to the human body. However, it was observed that 60% of the buildings that were studied have no plants for landscape architecture. This means that the majority of the buildings that were studied have no plants for landscape architecture and by this, there is insufficient oxygen from plants around the buildings; as a result of this, some of the respondents revealed that there is no adequate fresh air circulation in and around the buildings.

Thus, during the heat season, the air from the natural ventilation is very hot and even though the people put on fans, after some times the blowing air from the fans gets very hot because of the absence of plants (trees) to bring fresh air into their rooms. Plates I and II show residential buildings in Lokoja without plants for landscape architecture.

Plate I: Residential Storey Building in Lokoja without Plants for Landscape Architecture (Source: Researcher's Field Work, 2017).

Plate II: Semi-Detached Residential Building in Lokoja without Plants for Landscape Architecture (Source: Researcher's Field Work, 2017).

It was also revealed from the discussions with the people that absence of plants in their houses is because they need clean environment to discourage snakes from coming to their houses. In addition, people revealed that the fear of branches of trees from falling on them or on their buildings during strong breeze is the reason for lack of planted trees around the houses. Some people attributed the lack of planted trees around the houses to the fear of breaking of the walls of buildings and fences as a result of the growth of the roots of trees around the buildings. In architecture, plants help to naturally cool and ventilate buildings (Bonnefin, 2016). However, from the discussions with the residents of some of the selected buildings, it was revealed that the absence of plants around the buildings have caused poor natural ventilation and the high dependence on the use of electric power generators to power appliances for artificial ventilation.

From all the buildings that were studied, 40% of the buildings have plants for landscape architecture but 25% of them are not well landscaped. This means that almost half of the buildings that were studied have plants for landscape architecture but more than half of this total number are not well landscaped. Table 1 shows the use of plants for landscape architecture. From the discussions, some people from this group responded that they are comfortable and feel ease with the natural ventilation; the group also stated that trees around their houses bring desired coldness at night for good sleep, and they protect roofs of buildings from being destroyed by breeze. It was also revealed that people stay under the planted trees around their houses for natural ventilation in the afternoon when there is no supply of public electric power to run fans or air conditioning system during the heat season.

Table 1: Use of Plants for Landscape Architecture

Percentage of non-landscaped buildings	Percentage of landscaped buildings
60	40

Source: Researcher's Field Work, 2017.

In terms of the ventilation derived from the plants, 30% of people responded that they are very satisfied with buildings. This means that this set of people have adequate trees for natural ventilation around their houses. 20% of people responded that they are averagely satisfied with buildings in terms of the ventilation derived from plants. This means that this set of people do not have adequate trees for natural ventilation around their houses. 50% of people responded that they are not satisfied with buildings in terms of the ventilation derived from plants. This means that this set of people have no trees for the natural ventilation around their houses. Table 2 shows the levels of satisfaction with respect to the residential buildings in terms of ventilation derived from plants.

Table 2: Levels of Satisfaction with Respect to the Residential Buildings in Terms of Ventilation Derived from Plants.

Percentage of the people that are very satisfied	Percentage of the people that are averagely satisfied	Percentages of the people that are not satisfied
30	20	50

Source: Researcher's Field Work, 2017.

The costs of purchasing electric power generators; their maintenance and fueling is a challenge to some people (Chijioke, 2017). However, 60% of the respondents majorly depend on the electric power generators to power fans or air conditioning system for artificial ventilation. This means that more than half of the respondents majorly depends on electric power generators to power fans or air conditioning system for artificial ventilation. From the discussions with the people in this group, it was revealed that it has been very difficult for some people in the sense that the prices of purchasing, maintenance and fueling of electric power generators have skyrocketed and the commensurate income to cope with the life style is dwindling and thereby negatively affecting the standard of living or hindering an average life style from being maintained. It was also revealed that some people feel bad for using generators to power appliances for ventilation because they spend a lot of money as a result of economic recession in Nigeria. Also, the noise from powering of the generators affects the sleep of people in the compound or neighbouring compound, and the smoke from the generators contaminate air in their atmospheric environment. When windows are closed to reduce the noise from electric power generators and to stop the smoke from entering the rooms of buildings, the air that fans are blowing will become hot for people and thereby negatively affecting the health of people; also, there will be no exchange of oxygen and carbon dioxide between human beings and plants around the buildings. Constant use of generators increases expenditures and sometimes electric power generators burns fans due to unstable power supply from them.

From the total number of the respondents, 40% of them do not majorly depend on the electric power generators to power fans or air conditioning system for artificial ventilation. This means that almost half of the occupants are not majorly depending on electric power generators to power appliances for ventilation. Table 3 shows the use of electric power generators for artificial ventilation.

The People in this group revealed that the reason is lack of enough money to majorly depend on electric power generators as some of them have not fuel their electric power generators since three months ago and thereby making life to be difficult when there is no supply of public electric power to power appliances for ventilation and however, the hot weather is not making them to feel comfortable. However, some people in this group revealed that they have money to constantly power generators but they feel that it is a waste of money. Some people that are constantly making use of electric power generators to power appliances for cooling and ventilation complained that they are not satisfied for buying fuel to power generators at all times because of epileptic nature of public electric power supply in the town. Spending 500 naira to 1000 naira on fuel every day to power generators is not easy.

Table 3: Use of Electric Power Generators for Artificial Ventilation.

PERCENTAGE OF MAJORLY DEPENDENCE ON THE ELECTRIC POWER GENERATORS	PERCENTAGE OF NON-MAJORLY DEPENDENCE ON THE ELECTRIC POWER GENERATORS
60	40

Source: Researcher's Field Work, 2017.

CONCLUSION AND RECOMMENDATIONS

The importance of plants for landscape architecture were overviewed. Plants help to naturally cool and ventilate buildings. They also help in air pollution mitigation by manipulating the quantities of trees, shrubs, green roofs and green walls. One of the things that plants produce as they make food is oxygen gas. This oxygen gas is an important part of the air to keep the cells and bodies alive when people breathe. Thus, the aim of this study was to evaluate the effects of plants on the residential buildings in Lokoja, in order to generate a framework to reduce the costs of the use of electric power generators for artificial cooling and ventilation in Nigeria. The random sampling method of data collection was adopted and this brought about the selection of 100 residential buildings in the study area. The primary research data were obtained from the direct observations of the selected buildings with respect to the use of plants in buildings. Moreover, they were obtained from the questionnaires administered to the occupants of the selected buildings, and the focus group discussions with them.

The results showed that the majority of buildings that were studied have no use of plants for landscape architecture and as a result of this, there is no adequate fresh air circulation in and around the buildings. The absence of plants (trees) around the buildings has caused poor natural ventilation and the high dependence on the use of electric power generators to power appliances for artificial ventilation. Almost half of the buildings that were studied have plants for landscape architecture but more than half of this total number are not well landscaped. More than half of the respondents majorly depends on electric power generators to power fans or air conditioning system for artificial ventilation.

Also, when the windows are closed to reduce the noise from electric power generators and to stop the smoke from entering the rooms of buildings, there will be no exchange of oxygen and carbon dioxide between human beings and plants around the buildings. It is recommended that the architects and owners of residential buildings should emphasise on the use of plants for landscape architecture, in order to reduce the costs of making use of electric power generators to power appliances for cooling and ventilation in Nigeria; it should be ensured by the architects and building owners that all the residential buildings in Nigeria are well landscaped, in order to achieve proper natural ventilation in buildings; no design of building should be approved by the approval authorities in Nigeria without incorporation of adequate plants for landscape architecture; there should be active monitoring team to ensure that all the approved residential building plans are properly constructed with respect to their approve landscape design; the government of Nigeria should embark on the education of the general public through media and other means with regards to the importance of natural cooling and ventilation from the use of plants around the buildings. This study only covered the eastern part of the central area of Lokoja; it did not consider the different types of plants and their spacing around the buildings to aid natural ventilation. Therefore, in subsequent research of this nature, the other parts of the central area of Lokoja should be covered. Also, the different types of plants and their spacing around the buildings to aid natural ventilation should be addressed.

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