BOOK OF PROCEEDINGS

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ENUGU STATE UNIVERSITY OF SCIENCE & TECHNOLOGY, AGBANI

FACULTY OF ENVIRONMENTAL SCIENCES (FES)

1ST Research Conference –RECONFES 001

Theme:

ONLY One Earth

On Wednesday, 8th June, 2022

At ESUT Business School, Enugu

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FORWARD

World Environment Day (WED) is an annual programme instituted 50 years ago in 1972 at Stockholm. It was formed to take place on the 5th June every year. It is aimed at living sustainably in harmony with nature, bringing transformative changes through policy and our choices towards cleaner and greener lifestyles.

The faculty organized this conference being our own way of joining the moving train and the good intentions of the proponents of WED. The conference is a gathering of intellectuals across the academic landscape of the faculty of environmental success in various universities.

In the quest to add value to our academic pursuit, this year's theme "Only One Earth" drew a lot of articles from across the universities contributing to the growth of environmental sustainability.

The conference would not have been such a resounding success without the support of eminent professors, erudite scholars; men and women who have the interest of our common good (the earth) at health. And of course our LOC ably led by Dr E. Nnadi. A conference provides a veritable meeting ground for paper presentation, discussions and socializing.

The quality papers presented in this conference will be published in our faculty journal "African Research Journal of the Environment", after they have been thoroughly reviewed.

We thank all the participants for their invaluable contributions

Arc Dr. Augusta Emenike
Ag Dean Fes

Acknowledgement

Our sincere appreciation goes to the visitor and the governor of Enugu state, Rt. Hon. Ifeanyi Ugwuayi who gave ESUT a dynamic, digital and hardworking Vice Chancellor at this critical time. The academic and body language of Prof Michael-Aloysius Okolie gave us confidence to embark on this huge task. We have confidence that the university's performance shall be applauded in the next NUC ranking.

We commend the humble and focused dean of the most online friendly faculty in ESUT, A/Prof Augusta Emenike for her strong will and teaming up with the right minds towards moving the faculty forward. We specifically appreciate the keynote speaker in person of Prof Kingsley Ogboi, the dean of Faculty of Environmental Sciences, UNEC. Thanks for making it to this event despite your tight schedule.

Appreciation also goes to the Professors in our faculty, the scientific committee members, the LOC, the authors, the delegates and most remarkably, the faculty staffs and the postgraduate students for their cooperation and contributions towards the success of this conference.

Finally we are grateful to the Director and staff of Esut Business School for perfect logistics and necessary supports provided. Any error found in this work is unintended and therefore highly regretted. Be free to send your comments to reconfes@esut.edu.ng as we look forward to future events. Kindly accept our best within the national contraints.

Thanks

Dr Ezekiel Ejiofor Nnadi

For: Editorial/LOC Team

Table of contents

EVALUATION OF CLIMATE CHANGE EFFECT ON WIND ENERGY RESOURCES IN SOUTHERN NIGERIA USING TIME SERIES FORECAST. – Emeka Augustine Chinachi

SUB-THEME 3 --
COSTING AND CONSTRUCTION FINANCING

ASSESSMENT OF COSTING AND SCHEDULING IN CONSTRUCTION PROJECT MANAGEMENT IN SOUTH EAST, NIGERIA - [1]Isaiah, O. O., [2]Iloeje A.F. and [3]Tunji-Olayeni, P.F.

ASSESSMENT OF TIME PERFORMANCE OF TERTIARY EDUCATION TRUST FUND CONSTRUCTION PROJECTS DELIVERY IN PUBLIC TERTIARY EDUCATION INSTITUTIONS IN SOUTH-EAST, NIGERIA. - Isiofia L.A[1]: Ajaelu H.C[2]: Obiefuna JN[3]

ASSESSMENT OF UNIMPLEMENTED BUDGET IN CONSTRUCTION INDUSTRY IN ENUGU STATE, NIGERIA. - F.N. Okeke[*1], C.I. Onyia[2], C.U Ekekezie[3] and E.O. Nnadi[4]

EFFECTS OF COST ESCALATION ON CONSTRUCTION PROJECTS DELIVERY IN BENUE STATE NIGERIA. - Kelechi .K. Ogugua, Christian .E. Efagwu. David .O. Egwu & Igwebuike .C. Odoh

SUB-THEME 4 --

ENVIRONMENTAL HEALTH, RISK AND SAFETY

APPRAISING THE IMPACT OF EFFECT OF WATER SOURCE, SANITATION AND HYGIENE PRACTICES ON INHABITANTS OF CALABAR SOUTH ENVIRONMENT, CROSS RIVER STATE, NIGERIA - Emmanuel Ovat Oyama

EVALUATION OF AIR POLLUTION LEVEL DUE TO DOMESTIC GENERATORS USE IN ABAKPA NIKE, ENUGU EAST LGA., ENUGU STATE. - Okwu-Delunzu, V.U. [1], Osagie, L.[2] & Chijioke, E.O.[3]

ENVIRONMENTAL IMPACT ASSESSMENT ON A PROPOSED HYDROPOWER DAM PROJECT AT AWGU, ENUGU IN EASTERN NIGERIA - Ezemerihe Anthony .N.

PETROLEUM FILLING STATIONS AND THEIR IMPACT ON THE ENVIRONMENT IN NIGERIA (A REVIEW) - Ruth Oghenerukevwe Eyankware Ulakpa[1]* Wisdom Chukwuemeke Ulakpa[2] Oghenegare Emmanuel Eyankware[3]

SUB-THEME 5 --
CONSTRUCTION PROJECT MANAGEMENT & SMART CITIES

SUB-THEME 6 --
URBAN REGENERATION AND MANAGEMENT

ONLY ONE EARTH

A keynote paper presented at the Research Conference of the Faculty of Environmental Sciences, Enugu State University of Technology held at the ESUT Business School Enugu

By

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Introduction

The Book of Genesis in the Holy Bible gives a narrative of how the earth was created and God concluded that he was pleased with what he made. Earth is a beautiful living planet in the Universe and the common habitat of more than 7 billion human population and millions of species of biodiversity (Ghimire, 2014). The earth has peculiar characteristics among the planet. It consists of biosphere, atmosphere, lithosphere and hydrosphere. Its situation, temperature, rotation and revolution, climate etc. are some of the unique characteristics of the earth. Natural resources like land, river and forest are only in the earth, with favourable environment for all living beings. Only the earth is known celestial body with existence of living things. Presence of water and oxygen as well as Ozone layer, fertile soil, non-combustible atmosphere, self-regulating environmental cycles, and many other favourable situations have made it a common habitat of various creatures (Sumon 2010).

About 71 percent of the earth is covered with water. Water is found on the surface and underground level, existing in ocean, sea, river, pond etc. Water helps in the germination, growth and development of plants, human beings, animals, birds and other creatures. Sunlight causes water cycle and rainfall from time to time on the surface of the earth. All these components of the earth (land, water, air, forests and animal) are inseparable and interrelated to each other. If one of them is destroyed, it affects another.

The important services the ecosystem provides include biogeochemical cycles, food, and environmental peace (Ghimire, 2014). Despite unavoidable free services provided by the earth to humans, we are not able to pay off her kindness to us. Rather we humans are being cruel to the

Earth with our selfish activities. *Every day we produce tons of degradable and non-degradable waste, which we discard recklessly. There are also smoke and harmful gases from our homes, vehicles and industries; and* dispose sewage and chemicals recklessly. *In addition to the huge noise by our huge population itself, entertainment, industries, airplanes, and other noisy vehicles for our luxury, we destroy forests for agriculture and settlements, build huge houses, roads and factories beyond her carrying capacity and establish nuclear reactors that affect the environment.*

The negative impacts of humans on the environment include deforestation, global warming, desertification, invasive species and overharvesting. Other ways that that humans impact the environment are pollution, genetic modification, and ocean acidification. This paper examines the impact of human activities on the earth, the consequences and measures needed to protect of the earth and its systems.

How True is It to Say the Earth is a Common home for All?

The first work of "worldwide" occupation and predation of the Earth and its inhabitants perhaps began in the sixteenth century by a number of European states (Spain, Portugal, the Netherlands, England and France). After the First World War, new actors – no less conquerors and predators than the former (the United States, Soviet Union, Japan and Germany) – extended and intensified the work of occupation and exploitation of the planet (Petrella, 2018).

Today, with China, India, Korea, Turkey, Saudi Arabia and other "minor" actors (South Africa, Brazil, Canada, Indonesia, etc.) have joined. The new wave of land (and water) grabbing – certainly the most striking form of current occupation and predation – is no longer based solely on processes of violent conquest and the force of arms, but is more profound and malicious because appropriation takes place above all through legal means of high value insofar as "legitimated", claimed by those who dominate, through science. In the space of a few years, the world of business and finance has succeeded in obtaining the recognition of several tens of thousands of patents on cells, molecules, bacteria, genes (also human), plant species, animals and microorganisms (Petrella, 2018). The financial holdings of large industrial and commercial multinational agricultural, seed, chemical, pharmaceutical, energy, mining companies have become the effective owners of the living of the Earth. Through their break- through in technologies, research, industries and lifestyles they dominate the earth leaving the rest beings including man and animals at their mercy. For the entire class of those who dominate it makes no sense to talk about the Earth and its "resources" in terms of "common home". For them, the Earth has to be seen as a source of wealth, and in the capacity for extraction.

The Earth and Human Activities

Human beings are the most intelligent and powerful creatures of the earth. They explore the earth to provide themselves food, shelter and most of their requirements for survival and comfort. But out of curiosity and greed man has over-exploited the earth resources and in the process caused a lot of damages to the earth and its ecosystems. According to Mahatma Gandhi, "*Earth provides enough to satisfy every man's needs, but not every man's greed.*" Human activities range from agriculture for food, transportation for mobility, industries for goods and services, houses for shelter, and a number of other things for curiosity and adventure. The activities include the following:

a. ***Mineral Mining***
b. Environmental impacts from extraction of minerals for energy and other goods have over the years affected the earth. Mining sector from coal to oil and gas has caused huge destruction to the earth. There are areas of increasing research efforts in the field of critical minerals. Some techniques are currently used in evaluating mineral criticality as an indicator of environmental risk associated with the industrial product supply chains (McLellan, 2020).
c. **Agriculture**: Man has over years relied on the earth for food supply through agriculture. Agriculture produces also raw materials for the industry. But it has tremendous effects on the earth through deforestation and use of chemicals.
d. **Industry**: from the age of industrial revolution the earth has been at the receiving end with numerous impacts on the environment such as land degradation, soil pollution and deforestation. Problems from industry include waste generation, pollution and deforestation.
e. **Urban Development**: To provide himself with good living environment man has developed settlements. Today, development of settlements has been associated with rapid urbanisation and urban sprawl which encroaches into the natural environments causing destruction of natural environment such as forests and rivers.
f. **Infrastructure:** Development of huge infrastructure such as ports, airports, railways, and roads cause serious impacts on land, water and air.

g. **Territoriality and Resource war:** Man out of greed engages in military expedition over resources and territorial expansion. This has led to development of arms including nuclear and biological warfare**.**

h. **Research:** While research has promoted human development, it has also led to the production of dangerous chemicals, viruses and nuclear reactors that are dangerous to the earth.

The Impacts on the Earth

Environmental impacts are changes in the natural or built environment, resulting directly from activities that can have adverse effects on the air, land, water, fish and wildlife or the inhabitants of the ecosystem (Abdallah, 2017). Human beings have through the above mentioned activities and many others caused serious destruction to the earth. Human impact the physical environment in many ways: pollution, burning fossil fuels, and deforestation. Changes like these have triggered climate change, soil erosion, poor air quality, and water pollution. The impact of human activities in the earth include the following:

1. **Ozone layer depletion**

Harmful gases emitted by ACs, refrigerators, industries and vehicles are depleting the ozone layer and increasing human exposure to very harmful UV rays of sun causing skin diseases, eye cataract and cancer (Petrella, 2018).

2. **Pollution:**

These are various pollutant and emissions in the air, land and water. A number of studies have explored data about the sources and consequences of pollutant emissions as well as how primary pollutant emissions interact with environmental components to form secondary pollutants which impact the environment and human health. A critical issue on pollution is that it respects no boundary. Scholars use models to explore how pollutants move throughout the atmosphere and factors that contribute to such movement. Pollution comes from industries, vehicles, ships and houses. For the purposes of regulation, we identified two broad categories of pollution: point-source and nonpoint-source pollution. We introduce the polluters pay and tools to measure how much is polluted in a point source and how much to pay for it.

a. **Air pollution:** Air pollution consists of chemicals or particles in the air that can harm the health of humans, animals, and plants. Approximately two billion children live in areas where air pollution levels exceed standards set by WHO, causing them to breathe toxic air and putting their health and brain development at risk. Every year, over 500,000 children under the age of 5 die from air-pollution-related causes Pneumonia remains the leading infectious cause of death among children under 5, killing approximately 2,400 children a day (unicef.org/health/childhood/diseases/pneumonia). Child deaths caused by pneumonia are linked partly to indoor air pollution. Air pollution causes airborne diseases like asthma in humans and animals and disturbs whole metabolism process in plants. For example, it is reported that the increasing rate of soot emission is causing serious damages to human and buildings in the Niger Delta.

b. **Water Pollution:** Humans have enormous impacts on water bodies including the marine ecosystems and resources through marine transportation and waste disposal. High volumes of sewage and solid wastes are disposed into water bodies daily by industries. Water pollution increases the risk of water-borne diseases like cholera, dysentery etc. and lead and arsenic highly degrade human mental ability and causes extinction of many aquatic animals. There have been reported cases of destruction of fish, whales, dolphins and other exotic marine species.

c. **Soil Pollution and Degradation:** Cropland density is increasing around the world. In the developing countries, large areas of forest are destroyed for timber or converted to agricultural use for farming. Academics have developed computational models to explore how plant nutrients from topsoil and micro-organisms are affected by pollution. Through industries and other activities soil is polluted. The experience of oil pollution in the Niger Delta has been a known case in the World.

d. **Noise pollution:** Noise pollution can cause health problems for people and wildlife, both on land and in the sea. Noise pollution causes insomnia and heart diseases in humans. From traffic noise to religious crusade, loud or inescapable sounds cause hearing loss, stress and high blood pressure. Noise from ships and other human activities in the ocean is harmful to whales and dolphins that depend on echolocation to survive.

e. **Light Pollution:** People all over the world are living under the night-time glow of artificial light, and it is causing big problems for humans, wildlife, and the environment. Is it necessary that we light up our cities continuously just for beauty and aesthetics? This affects the photosynthesis process in plants.

3. **Waste Generation:**

Wastes like plastics and other non-degradable wastes like insecticides, pesticides, chemical fertilizers etc highly degrade soil quality, decrease agricultural products and kills soil microorganisms and decomposers.

a. **Perils of Plastics:** Disposal of plastics has become man’s greatest problem with huge environmental implication. Poorly managed urban domestic and industrial plastics are increasing in volume and impacts. When incinerated they pollute the air and when disposed into water bodies they pollute the water and kill aquatic organisms.

4. **Forest and Wildlife Destruction**

Forest has diversity of resources. The forest is destroyed as man exploits this rich ecosystem. In addition to lumbering, through mining and construction of hydroelectric dams and oil and gas blocks, the organisms that inhabit the forest are destroyed. Scholars construct arguments to protect biodiversity in the rainforest. In 1960s-80s, many African nations created national Parks to preserve endangered animal species. For example, Mozambique created Gorongosa National Park to preserve the region's spectacular beauty and wildlife. The place was home to lions, zebras, elephants, cheetahs, and hippos. Then, in 1977, this African paradise became a battleground in a raging civil war that lasted 16 years and wiped out most of its inhabitants. In other areas the animals are hunted by pokers and local communities. Deforestation is leading to natural calamities like floods, soil erosion etc, temperature increase and changed rainfall distribution, drought, loss of valuable biodiversity, decreased oxygen density etc.

5. **Wildfire**

A wildfire is an uncontrolled fire that burn in wild land vegetation, often in rural areas. Yearly there are reports of wild fire in North and South America. Bush burning for farming is a serious issue in Nigeria, leading to destruction of buildings, forests, wildlife and micro-organisms. Wildfire could be human induced through farming, industrial explosion and other human careless activities.

6. **Human Induced Disasters**

Environmental disasters from 1970s have led to new developments in science, engineering, and policy. Many environmental disasters today are human induced. Common disasters include industrial explosion, traffic accidents, and flooding. The impact of the 2012 Nigerian floods has not disappeared completely. As predicted we are will be facing more disasters arising from our past activities. Imo Oil disaster

7. Health

Environmental impacts on health have long been a major concern (Brown, 2001). The huge upsurge of synthetic chemicals since World War II has altered the environment in dramatic ways, leading to increased cancers of various types and to other diseases. Actual and potential environmental hazards and catastrophes have become a significant component of the cultural milieu of many societies. Most adverse environmental impacts also have a direct link to public health and quality of life (Beck and Martinot, 2004). The environmental impacts of fossil fuels often result in real costs to society, in terms of human health (i.e., loss of work days, health care costs), infrastructure decay (i.e., from acid rain), declines in forests and fisheries, and the costs associated with climate change. Although environmental impacts and associated dollar costs are often included in economic comparisons between renewable and conventional energy, investors rarely include such environmental costs in the bottom line used to make decisions.

Impact Categories

Impacts of human activities in the earth can be broadly classified and measured in different scales as local, regional and global. Again they can be short term or long term (life-cycle) (Nieuwlaar, 2004). Table 1 shows the various categories of impact of human activities on the earth.

Table I. Impact Categories

Impact category	Scale	Factors	Characterization factor/ potentials
Climate change	Global	Carbon dioxide (CO_2)	Global warming potential (GWP)
		Dinitrogenmonoxide (N_2O)	
		Methane (CH_4)	
		Chlorofluorocarbons (CFCs)	
		Hydrochlorofluorocarbons (HCFCs)	

Impact category	Scale	Factors	Characterization factor/ potentials
Stratospheric ozone depletion	Global	Chlorofluorocarbons (CFCs)	Ozone depletion potential (ODP)
		Hydrochlorofluorocarbons (HCFCs)	
		Halons	
		Methyl bromide (CH_3Br)	
Acidification	Regional local	Sulfur oxides (SO_x)	Acidification potential (AP)
		Nitrogen oxides (NO_x)	
		Hydrochloric acid (HCl)	
		Hydrofluoric acid (HF)	
		Ammonia (NH_3)	
Eutrophication	Local	Phosphate (PO_4)	Eutrophication potential (EP)
		Nitrogen monoxide (NO)	
		Nitrogen dioxide (NO_2)	
		Nitrates (NO_3)	
		Ammonia (NH_3)	
Photochemical smog	Local	Non-methane volatile organic compounds (NMVOC)	Photochemical ozone creation Potential (POCP)
Ecotoxicity	Global continental	Releases to air, water, and soil	Fresh water aquatic ecotoxicity potential (FAETP)
			Marine aquatic ecotoxicity potential (MAETP)
			Fresh water sediment ecotoxicity potential (FSETP)
			Marine sediment ecotoxicity,

Impact category	Scale	Factors	Characterization factor/ potentials
			potential (MSETP) Terrestrial sediment ecotoxicity potential (TETP)
Human toxicity	Global continental	Releases to air, water, and soil	Human toxicity potential (HTP)
Resource depletion, abiotic	Global	Quantities of minerals/fossil fuels used	Abiotic depletion factor (ADP)
Land use	Global regional local	Land occupation	Increase of land competition

Source: U.S. Environmental Protection Agency (2001); Guinée (2002)

The Earth and Climate Change

Climate change is happening in the world today and largely caused by human emissions of greenhouse gases. Changes to the earth's climate include warming of the atmosphere and oceans, loss of sea ice, rise in sea level, intense heat waves, more frequent wildfires, longer periods of drought in some regions and changes in rainfall patterns, duration and intensity of tropical storms. Many of these observed changes are unusual or unprecedented in the last decades to millennia. In addition, the increasing CO2 in the atmosphere is causing the ocean to become more acidic, which threatens marine ecosystems, coral reefs and fisheries, with severe implications for coastal communities. The Intergovernmental Panel on Climate Change (IPCC) forecasts a temperature rise of 2.5 to 10 degrees Fahrenheit over the next century. Increasing number of persons are becoming highly exposed to the risks from extreme events (IPCC. 2007).

Droughts and changing global rainfall patterns are leading to crop failures and rising food prices, which for the poor mean food insecurity and nutritional deprivations that can have lifelong impacts. These also have the potential to destroy livelihoods, drive migration and conflict, and cripple opportunities for children and youths. Children are the most vulnerable to diseases that will become more widespread as a result of climate change, such as malaria and dengue fever. Close to 90 per cent of the burden of disease attributable to climate change is borne by children under the age of 5. As extreme weather events such as cyclones and heat waves threaten lives and destroy infrastructure critical to their well-being (Haines et al, 2006) .

As climate change makes crises more common, it becomes harder to recover from them. Poorer families have a harder time coping with shocks. They lose their homes, health and education. Today, some 785 million people lack access to basic water services. And by 2040, almost one million people are projected to live in areas where the demand for water will exceed the amount available. Frequent and widespread flood damages from hurricane, tsunami and associated disasters and social, economic, environmental and financial burden of flooding on the government, taxpayers, and flood victims.

According to IPCC (2014), we have less than 11 years to make the transformation necessary to avoid the worst impacts of climate change. The level of carbon dioxide in the atmosphere would have to be cut by 45 per cent by 2030 to prevent global warming above 1.5^{o}C ie, the threshold at which the worst impacts of climate change could be averted (Field, et al., 2014). After that the effects of human-caused global warming will be irreversible.

How to build the earth as our common Home

The concept of our common earth is only apparently paradoxical. The “common home that does not exist" is a more reality because the predatory capacities of the dominant social groups are actually enormous, based on political legitimacy, and given by juridical legitimacy, acquired through the rules set by the dominant themselves (Petrella, 2018). On the other hand, the possibilities of building the "common earth" have become considerable as three new collective consciences have been shaped and strengthened in recent years:

1. Of all the living species on the Earth, human beings are the only ones who have become capable of destroying life on the planet including themselves.
2. Human beings have now learned (in cellular and molecular biology and other fields of knowledge) that they are an integral part of the system that connect all the inhabitants of the Earth in a global community of life of the Earth.
3. Man has also realized that the life of the Earth must not be safeguarded and cured mainly to guarantee and improve the safety of the existence of the human species but of the whole of the global community of life.

It is therefore necessary to first of all de-construct the legality given to structural factors (conceptions, visions, choices, policies, mechanisms, institutions, etc.) that prevent humanity from working towards construction of the sense of common earth. This includes the concept developed and imposed by the dominant groups on the naturalness of the processes of destruction of life, such as war, domination, exclusion, and inequality. They have convinced people that the earth is meant to support man and it is an inexhaustible resource, thus cutting down consumption and use of the earth resources is "unrealisable and unnecessary". And to eradicate or reduce the state of poverty, is only possible through economic development.

These falsehoods must be fought against urgently and decisively in all fields, with the contribution of young people, women, peasants, workers and the world of education. The Earth is not a large mine of natural resources (such as human resources or energy resources) and artificial tangible and intangible resources (such as medicines, robots, drones and artificial intelligence) to be exploited to gain the highest financial value for the big investors.

Three principles have to be re-invented: the principle of equality among all human beings; the principle of fraternity among all human beings translated into respect and empathy towards other inhabitants (other species) of the global community of life: and the costs of which must be paid individually by all users by ignoring the above. It is in this context that we forge our individual and collective efforts to build the common home, both locally and at the level of the global common home.

A considerable effort that is constructive, participatory and cooperative should be the hallmark of the future. The first pillar is the promotion and protection of a set of global common public goods, in particular (to start the processes of construction of the common home) water, air, plants and knowledge. The choice of the global common goods is dictated by the fact that they are, together with the sun and the air, the crucial non-replaceable goods for the life of the Earth and its inhabitants. In this sense, the pillar of common goods means that the principle of the private ownership of the living and artificial intelligence; and the principle of the monetisation of nature are unacceptable for creation of the common home.

Reducing environmental impacts through sustainable use of natural resources is an important strategy for governments and businesses worldwide (Holden, 2012). The environmental impacts of a broad spectrum of resource use should be popularized.

Our first role is to reduce our carbon footprint (pollution, waste disposal, destruction of forests) via eco-friendly activities and reducing activities that create emissions. To raise awareness in our circles, neighbourhoods and the community about the melting earth. We can replace household energy sources like coal and firewood with biogas, electricity or solar energy. We can negotiate with factory owners and vehicle owners to use dust and smoke purification systems in industries and vehicles; we can encourage them to use solar-energy based industries and vehicles. We can appeal the government to bring eco-friendly development policies and proper planning of cities. We can organize orientation programs about climate change, its causes, and effects and mitigation measures to induce children/youths towards conservation of nature. We have the responsibility to create awareness of the local people about the importance of forests and effects of deforestation along with the new concept of carbon trade.

Through transportation planning we can change the carbon story. In general, the total volume of CO_2 emissions generated or avoided by a transport project can be calculated based on the expected changes in traffic volumes, travel distance and travel speed along a given transport corridor, and emission factors included in specific guidelines and inventories *(*Mouter, and Vassallo, 2020). CO_2 emissions which will reduce the distance travelled for the majority of the traffic. Our single efforts may seem small but if millions of us can work individually and collectively together towards nature conservation then our efforts will be a drastic step to protect Earth from destruction.

Conclusion

Climate action provides an exceptional opportunity to unlock massive economic and social benefits that can help us achieve the vision of a common earth. Addressing the challenges of environmental sustainability is imperative for man to fulfil its mandate and protect the earth. Our actions are structured around three approaches:

1. Making ourselves the centre of the change required to protect the earth.
2. Recognizing ourselves as agents of the change.
3. Protecting ourselves and other species by reducing emissions and pollution.

Taking decisive action to cut greenhouse gas emissions to slow, and ultimately stop, the advance of climate change is crucial to tackle the climate crisis before it is too late. The evidence for the impacts of climate change and pollution is growing. Scholars are working to address environmental degradation monitoring and advocacy. - to change how we work to reduce greenhouse gas emissions and environmental impact. This also includes reducing water and energy consumption, paper use, and waste. We have to implement solutions to reduce our environmental footprint worldwide and counting — for example energy efficient lighting, heating, ventilation and cooling systems, and energy systems, and more.

Ways in which people can positively build ecosystems around the world include: recycling. preserving wildlife and creating green, protecting endangered species and cleaning lakes and seas has a positive effect on the environment. At home you can help the planet by recycling waste and growing plants or vegetables. As a proactive approach, we can identify the areas where we can individually contribute. We can use information about current risks, such as early warning. And we can take into account the longer-term processes to prepare communities and ourselves for future actions.

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EVALUATION OF CLIMATE CHANGE EFFECT ON WIND ENERGY RESOURCES IN SOUTHERN NIGERIA USING TIME SERIES FORECAST

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ABSTRACT

Evaluation of climate change effect on wind energy resources in southern Nigeria using time series forecast was determined using MINITAB winter forecast method. Wind speed data from the year 1981 to 2019 for 17 state in southern Nigeria was acquired from The National Aeronautics and Space Administration (NASA). A plot of wind speed against years showed that the average monthly wind speed is gradually decreasing. A forecast analysis was carried out on these locations to further determine its behaviour for the next 31 years, the analysis showed 5.6-14% decrease in wind speed for states in the south east, 5- 31% decrease in states in the south south and 0.5- 13% decrease in wind speed in the south western Nigeria. This shows that the southern Nigeria wind speed is responding to climate change negatively, hence it is recommended that wind resource required projects such as long termed and large scale wind turbines projects should not be situated in this region. High carbon emission activities in the southern Nigeria needs to be curtailed and regulated urgently.

Keywords: climate change, Southern Nigeria, Forecast, wind speed, Time series.

1. INTRODUCTION

Climate change as defined by The National Aeronautics and Space Administration in 2014 is the long-term change in the average weather patterns that define the earth's global, regional and local climates. This change in climate involves the change in weather parameters such as wind speed, temperature etc. Wind speed is being reduced by climate change in Europe (Isabeau 2021). Wind speed is directly proportional with height (Lantz 2019). A larger amount of wind resource is experienced as height is being increased. Other factors such temperature and pressure affect wind speed. The local wind speed, the wind speed in the troposphere which is from 0-10km height is most ideal for the wind analysis of peculiar to a location. the primary is used for climate-based forecast due to its consistent nature.

There are 17 southern states in Nigeria; 6 south western states, 6 south south states and 5 south eastern states. The southern Nigeria is predominantly a rainforest region, the southwest and the southeast, mostly covered by swamp and mangrove forests, merging into highly degraded forest inland. The Niger delta is rich in crude oil and natural gas deposit hence, attracting a lot of oil exploration activities. Activities of exploration, legal and illegal refineries and the consumption of poorly refined fuel have contributed to high carbon emission in this region (Asimiea and Omokhua 2013). The Boden and Andres (2014) in their data on global emission shows how Nigerian carbon emission has increased from 1946 to 2014. The emission of green house gases has been proven to be the major cause of climate change and global warming.

Time series forecasting is the process of generating scientific forecasts based on historical time stamped data. It entails developing models based on previous data and applying them to make observations and guide future strategic decisions. Mudelsee (2019). In the review of trend analysis shows that time series can be used to predict climate change. Time series of mean monthly temperature and total monthly precipitation in the Spanish territory was carried out by Pitshu and Concepción (2021) to confirm the weather pattern of the 21 century, 50 percent of the series was modeled. Dimri et al (2020) carried out an investigation of time series and seasonal analysis of the monthly mean minimum and maximum temperatures and the precipitation for the Bhagirathi river basin situated in the state of Uttarakhand, India. The forecast result done using time series analysis are being categorized in levels which is the low, forecast and high. The low value describes the least value a trend might likely hit, the forecast is the expected behaviour a trend would exhibit based on the data set and the higher level represent the maximum value or data a trend might attain. The forecast result would help in making informed decisions for the mitigation of the factors causing the change in Climate and as well as aiding preventive measures for the preservation of the southern Nigeria ecosystem.

2. METHOD

Wind speed data at 50m height 17 states in southern Nigeria were acquired from the National Aeronautics and Space Administration (NASA). This wind speed data ranges from the year 1981 to 2019. Locations with the highest wind speed within each of the state were selected. In other to select the most optimal locations the map of each state was represented in form of a mesh. The wind speed of each point of the mesh was measured and compared with each other such that the location with the highest wind speed represented an entire state. Only onshore wind speed data was used for this analysis. These wind speed data was measured by NASA using both weather satellites and field weather reporters.

2.2. Forecast analysis procedure

2.2.1 Parametric Profiling

The data was categorized according to geopolitical zones (south east, south south and south west). A graphical representation using Minitab 19 was done to observe the wind power behavior; The average monthly wind speed data was plotted against years with a regression line establishing the trend direction. An upward regression line shows an increasing trend values while a downward regression line shows a decreasing trend value.

2.2.2 Time series Analysis

2.1 Holt-Winter's

The model of Holt-Winter can continue to forecast with the same accuracy across time. There are two types of Holt-equations: Winter's additive and multiplicative. The nature of the seasonal component differs between the two types. When the fluctuation of the seasonal component is virtually steady throughout the series, the addictive model is favored, but the multiplicative model is employed when seasonal variations alter according to the level of the series. Lt is the level at time t, Tt is the trend at time t, and St is the seasonal component at time t in the Holt winter. The addictive model is represented by the model as in eq. (1) (Preez et al 2003);

$$Y_t = L_{t-1} + T_{t-1} + S_{t-p} \quad (1)$$

the multiplicative model is represented as in (2)

$$Y_t = (L_{t-1} + T_{t-1})S_{t-p} \quad (2)$$

where, the smoothing constants are represented by α, γ and δ. Y_t is the value at time t and Y_t is the fitted value or one-period ahead forecast, at time t.

A time series analysis was used to determine the wind speed trend of the selected southern Nigeria locations for 31 years (2019 to 2050) to predict the trend and the percentage decrease in wind speed.

3. RESULT

The analysis and the forecast carried out in the southern Nigeria using winter method shows the following results.

Figure 1, 2 and 3 shows the plot of wind speed in south east, south south and south west respectively. Each of these figures shows a decrease in wind speed between the year 1981 to 2019. More evident reduction was seen in figure 3 which is the south western region. Ogun, Osun and Ondo show higher declination and lower wind speed with a declination between 5 to 10%. The south eastern region show between 3 to 3.8% decrease in wind speed, south south show between 2.5 to 2.2% decrease in wind speed. The plots of wind speed at 50m height in the southern region show a continually reduction. This reduction was higher between 1997 to 2019. A plot of green house gases emission in Nigeria shows a rapid increase in the late 90s.

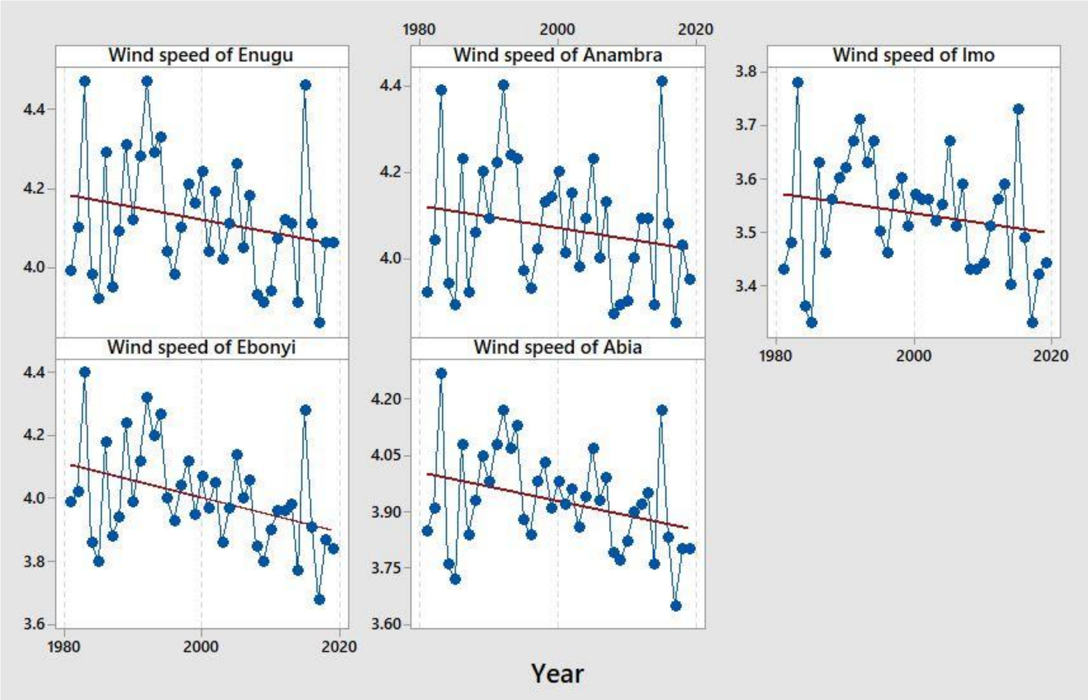

Figure 1. MINITAB plot of wind speed against year in the Southeastern region of Nigeria

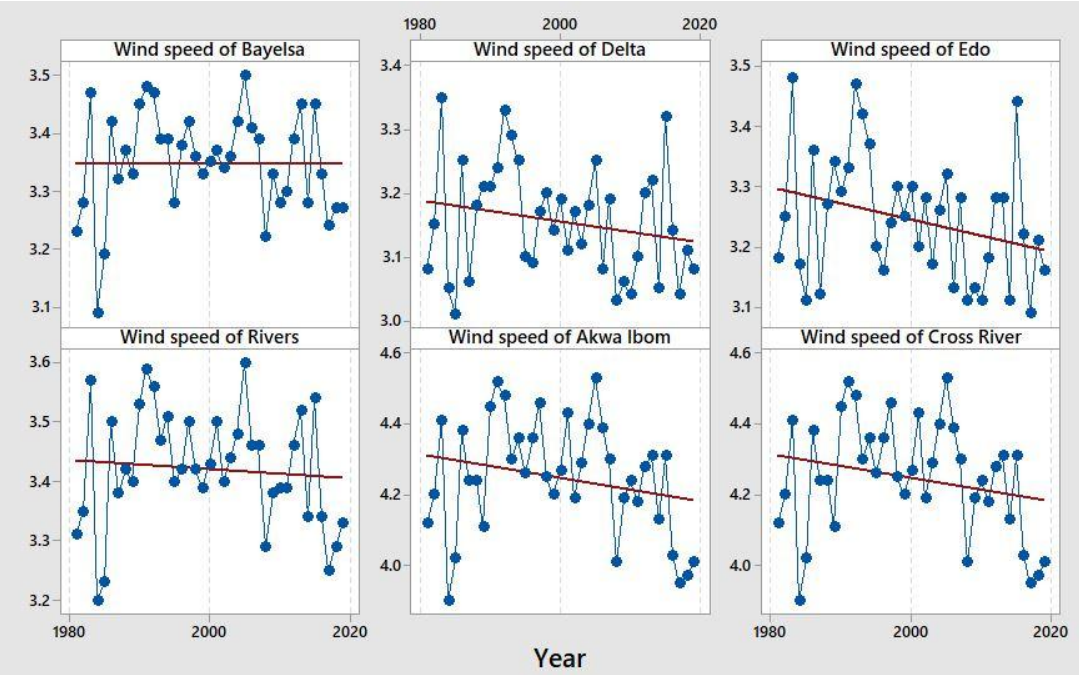

Figure 2. MINITAB plot of wind speed against year in the South south region of Nigeria

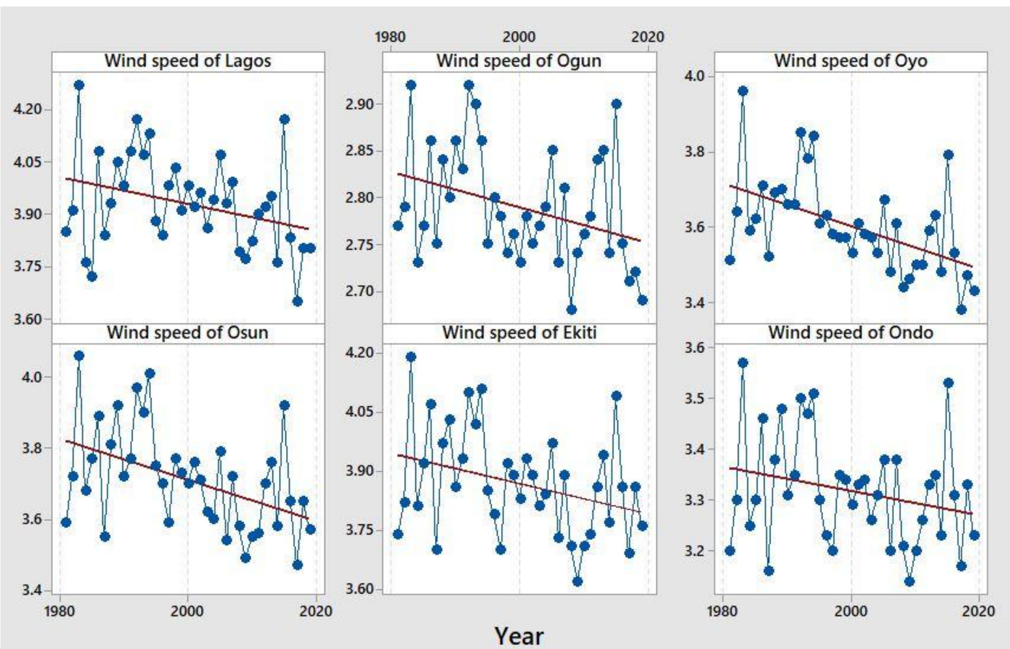

Figure 3. MINITAB plot of wind speed against year in the Southwestern region of Nigeria

Figure 4, 5,6,7, and 8 are the wind speed forecast plot of states in the south eastern Nigeria. This forecast was design to predict the wind speed in 2050. The time series plots which gave a mean absolute percent error (MAPE) of between 2.3 to 2.8. show a 5.6%, 7.25%, 11%, 14%, 13% decrease in wind speed in Enugu, Anambra, Imo, Ebonyi, Abia respectively.

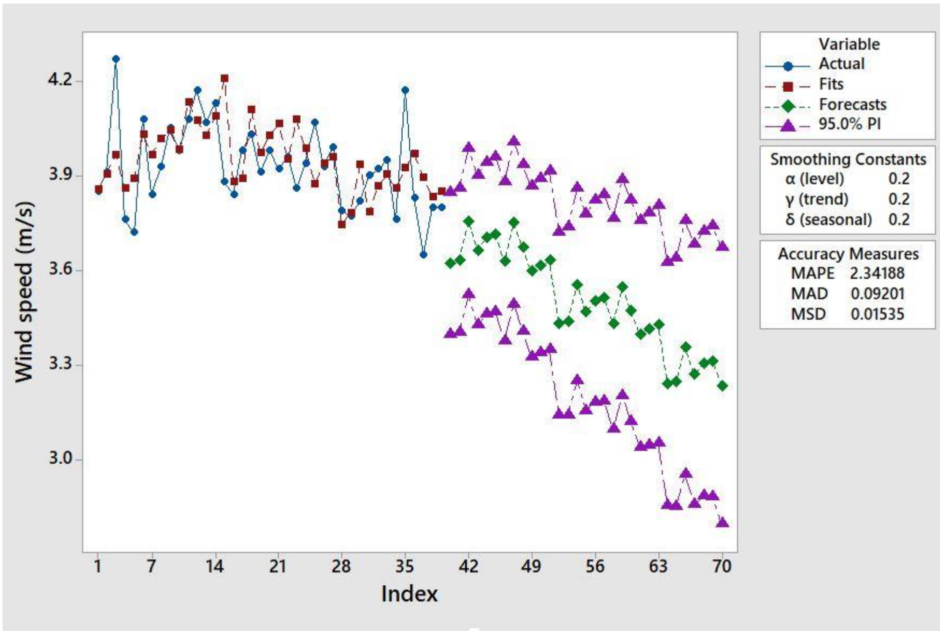

Figure 4. MINITAB Graphical Forecast when α = 0.2, γ = 0.2, δ = 0.2 of Abia

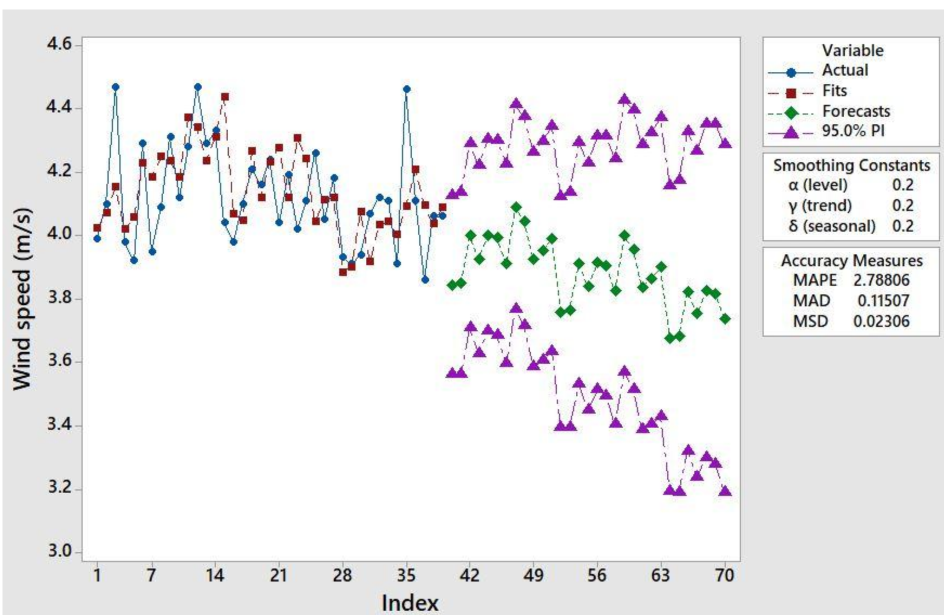

Figure 5. MINITAB Graphical Forecast when α = 0.2, γ = 0.2, δ = 0.2 of Anambra

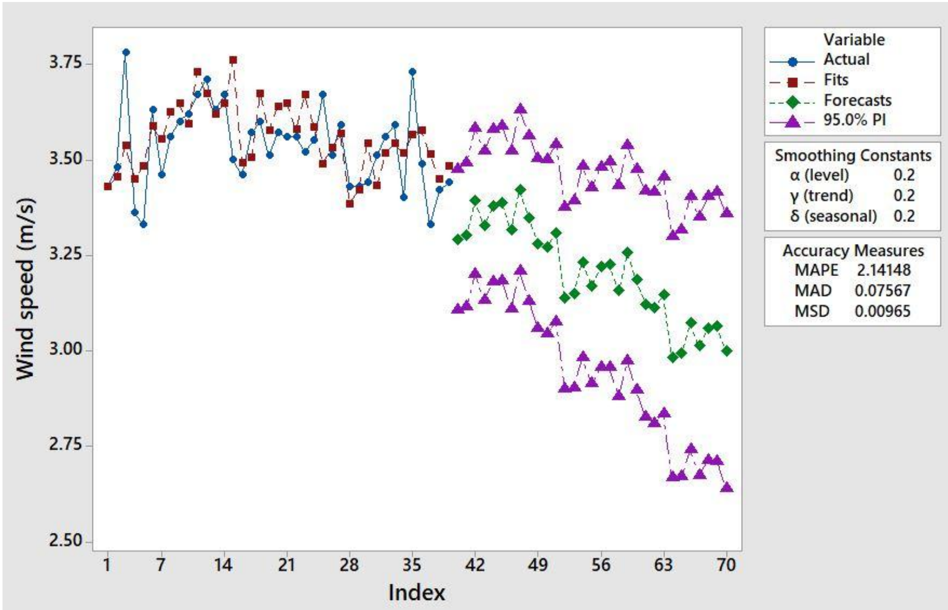

Figure 6. MINITAB Graphical Forecast when α = 0.2, γ = 0.2, δ = 0.2 of Imo

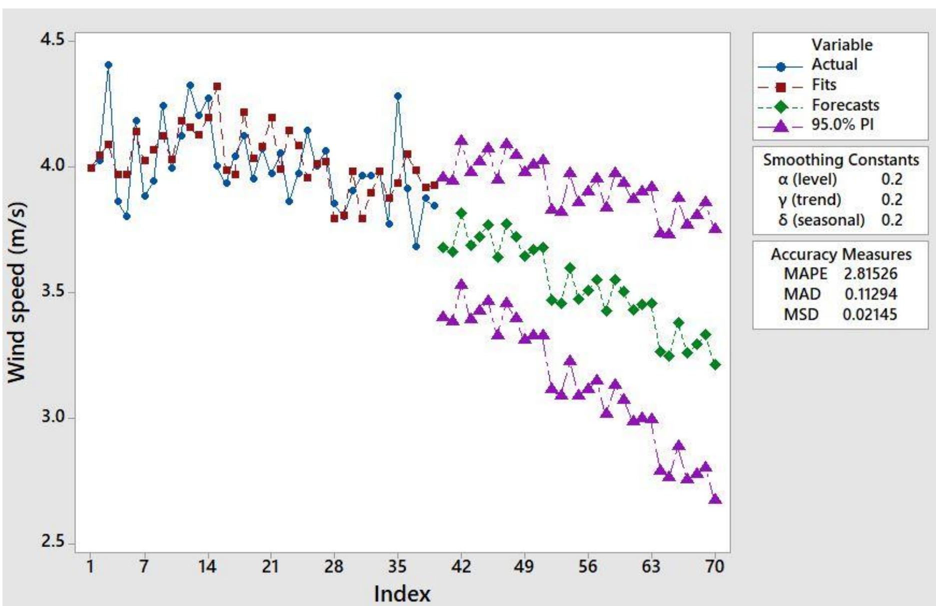

Figure 7. MINITAB Graphical Forecast when α = 0.2, γ = 0.2, δ = 0.2 of Ebonyi

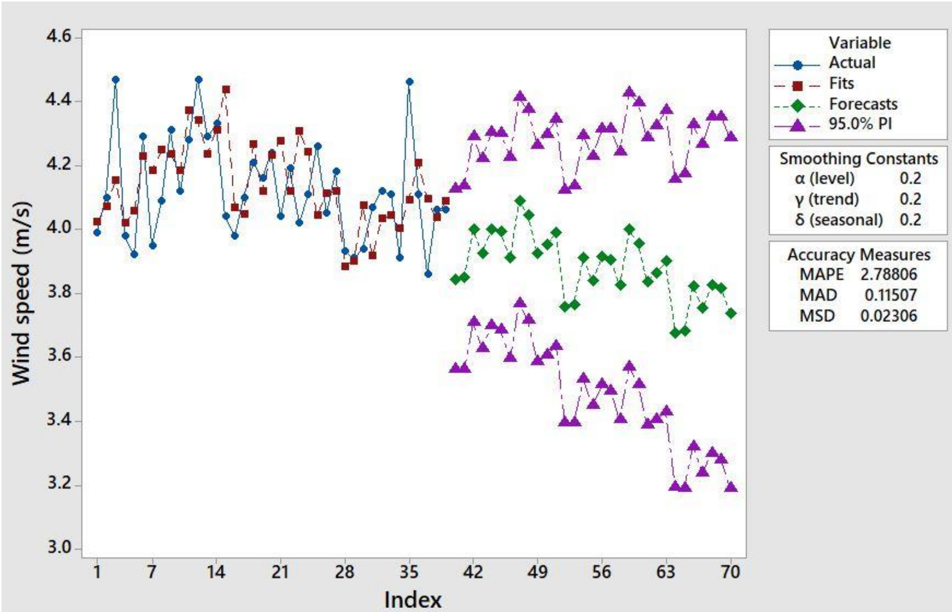

Figure 8. MINITAB Graphical Forecast when α = 0.2, γ = 0.2, δ = 0.2 of Enugu.

Figure 9, 10,11,12, 13 and 14 are the wind speed forecast plot of states in the south south of Nigeria. This forecast was design to predict the wind speed in 2050. The time series plots which gave a mean absolute percent error (MAPE) of between 2.0 to 2.8. show a 31%, 5%, 11%, 31%, 14% decrease in wind speed in Akwa Ibom, Edo, Bayelsa, Cross River, delta and Rivers respectively.

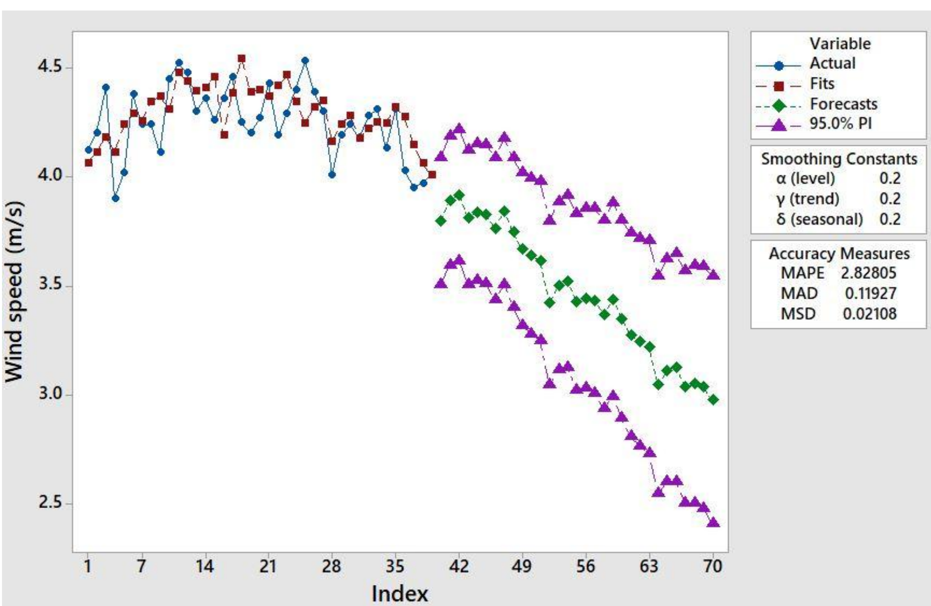

Figure 9. MINITAB Graphical Forecast when α = 0.2, γ = 0.2, δ = 0.2 of Akwa Ibom

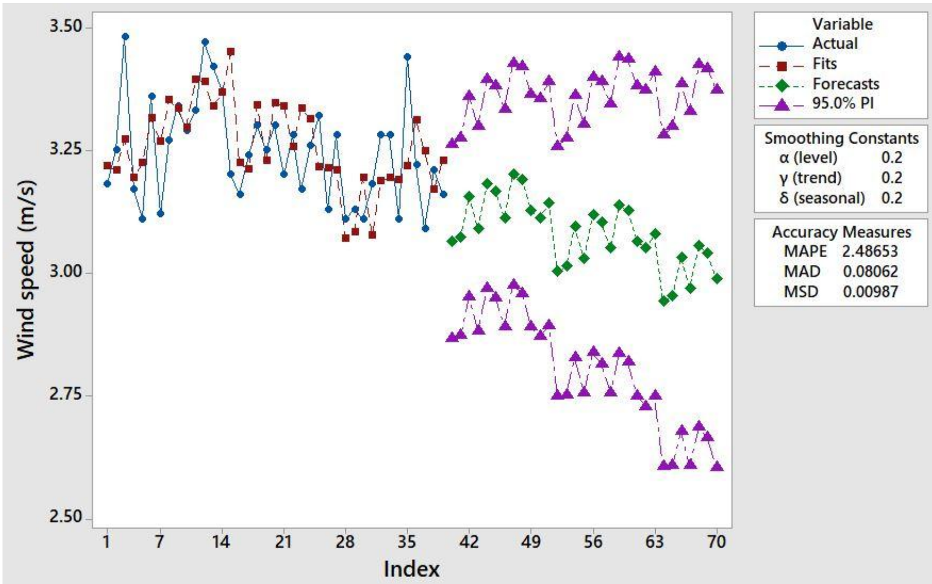

Figure 10. MINITAB Graphical Forecast when α = 0.2, γ = 0.2, δ = 0.2 of Edo

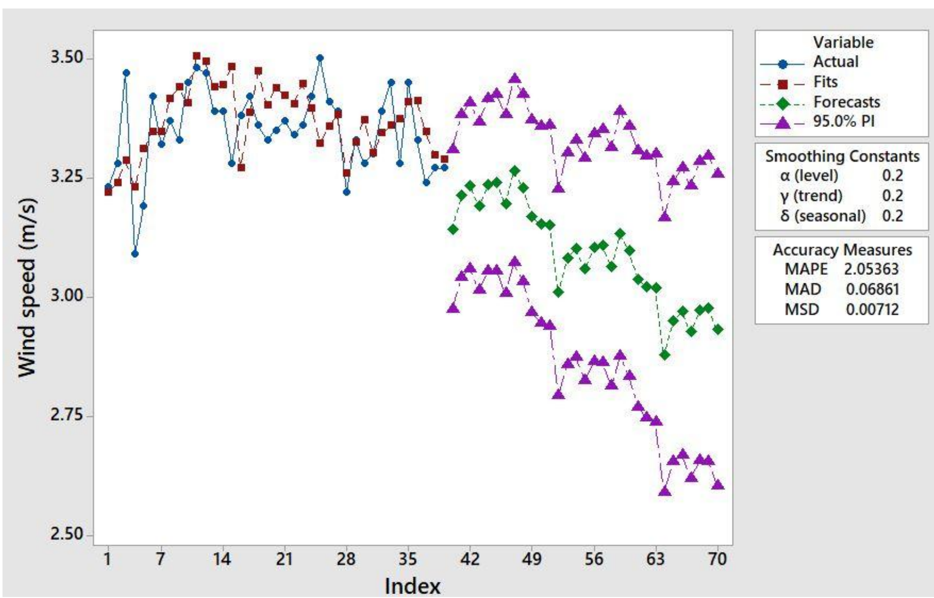

Figure 11. MINITAB Graphical Forecast when α = 0.2, γ = 0.2, δ = 0.2 of Bayelsa

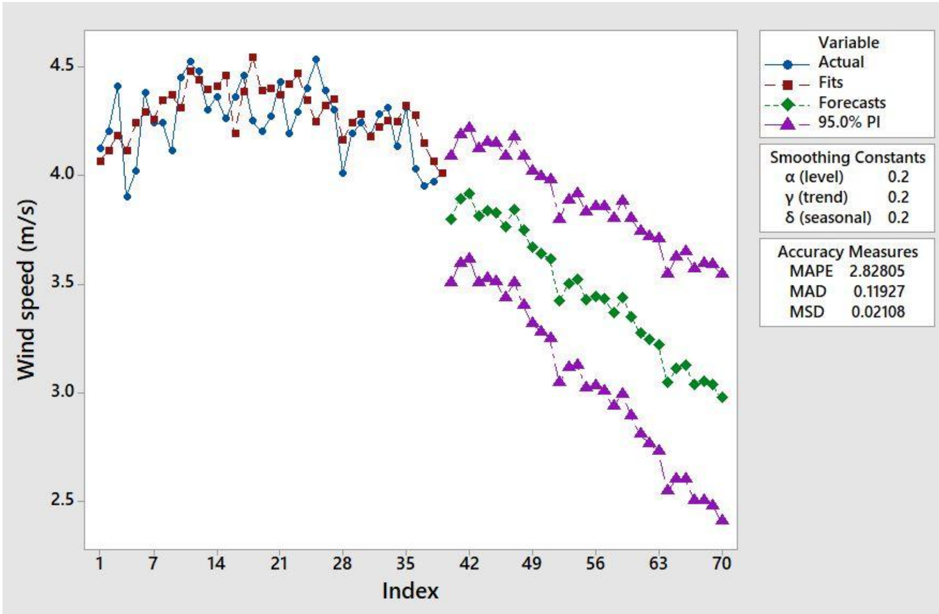

Figure 12. MINITAB Graphical Forecast when α = 0.2, γ = 0.2, δ = 0.2 of Cross river

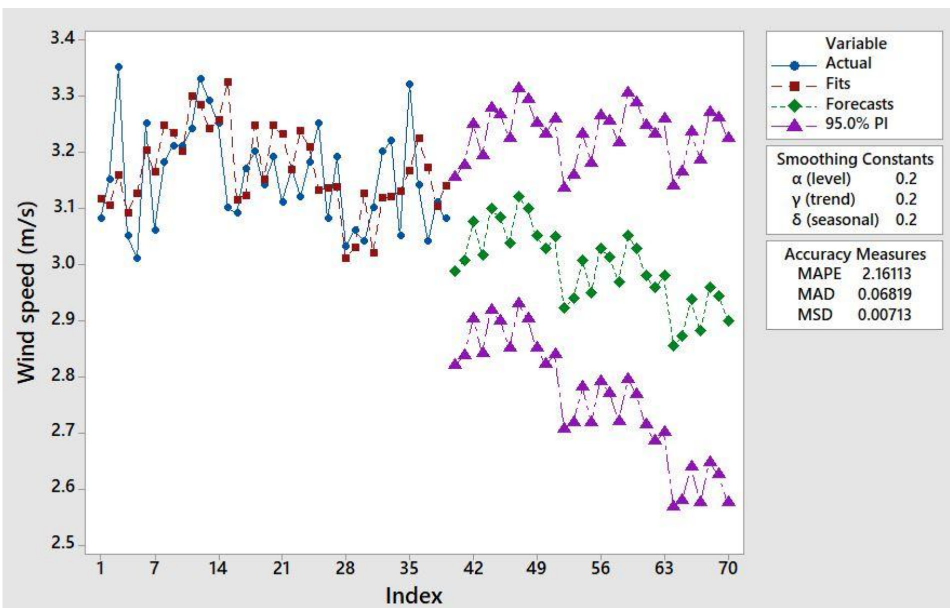

Figure 13. MINITAB Graphical Forecast when α = 0.2, γ = 0.2, δ = 0.2 of Delta

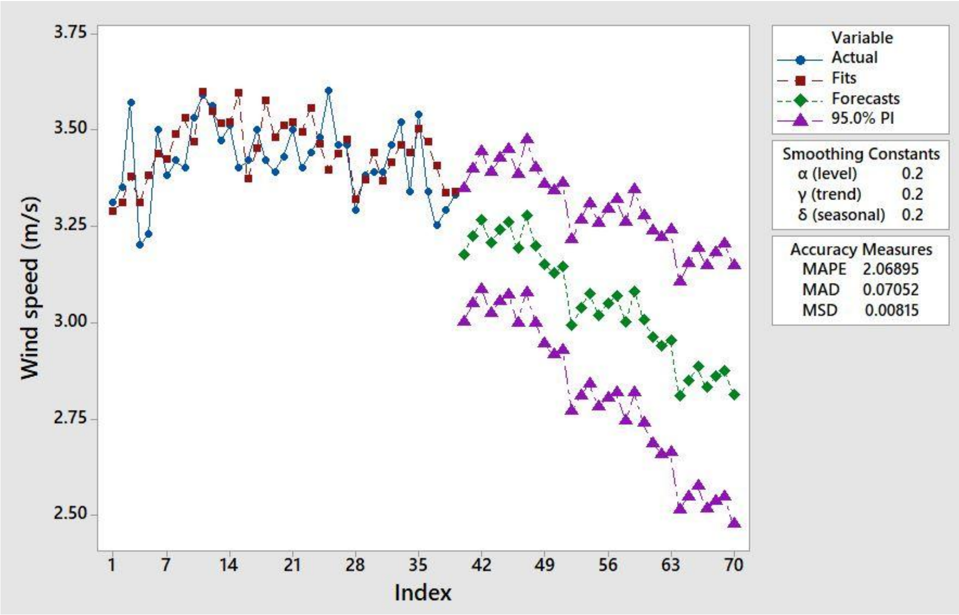

Figure 14. MINITAB Graphical Forecast when α = 0.2, γ = 0.2, δ = 0.2 of Rivers

Figure 15, 16,17,18 and 19 are the wind speed forecast plot of states in the south west of Nigeria. This forecast was design to predict the wind speed in 2050. The time series plots which gave a mean absolute percent error (MAPE) of between 1.9 to 2.9. show a 0.5%, 6.7%, 13%, 3.3%, and 3.3% decrease in wind speed in Ekiti, Ogun, Lagos, Osun and Ondo respectively.

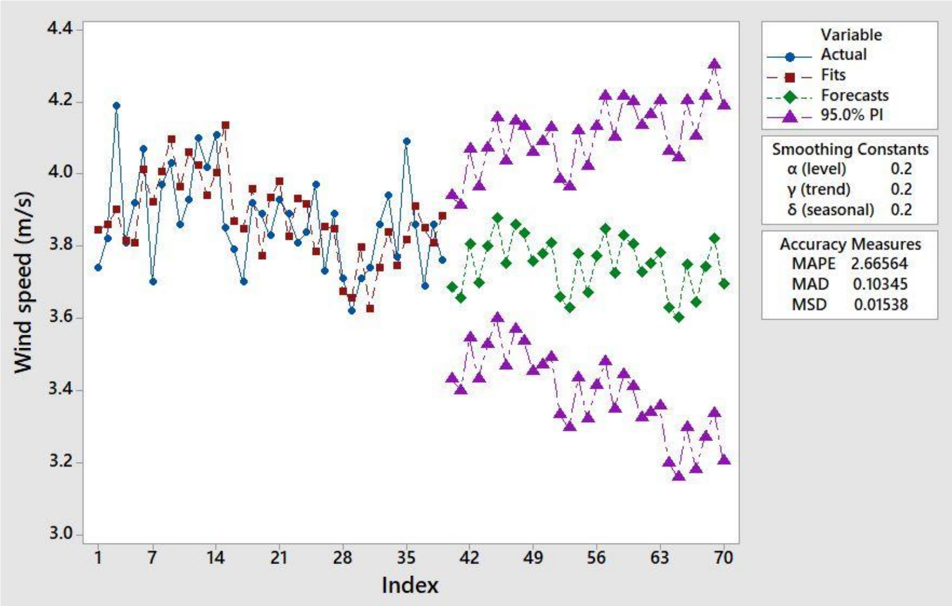

Figure 15. MINITAB Graphical Forecast when α = 0.2, γ = 0.2, δ = 0.2 of Ekiti

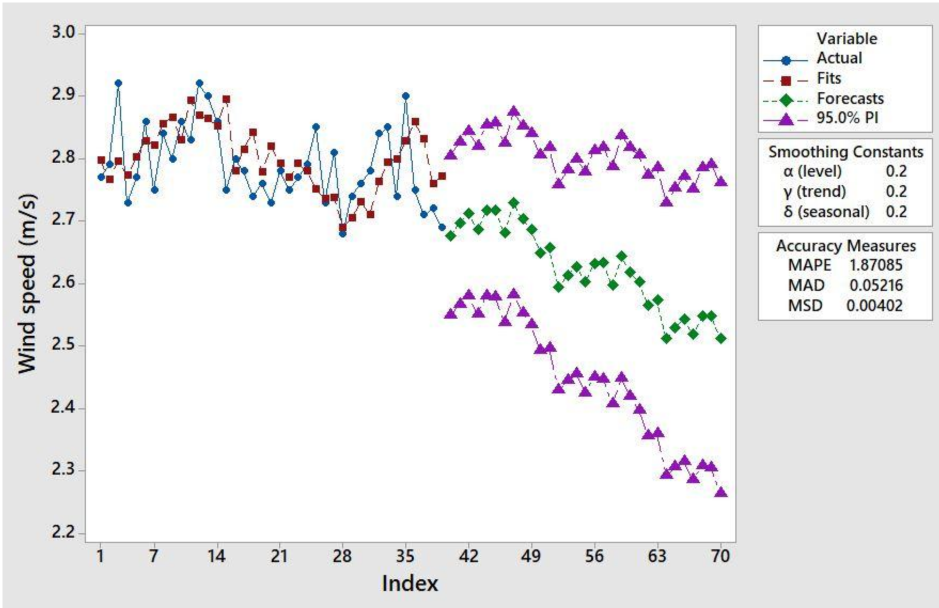

Figure 16. MINITAB Graphical Forecast when α = 0.2, γ = 0.2, δ = 0.2 of Ogun

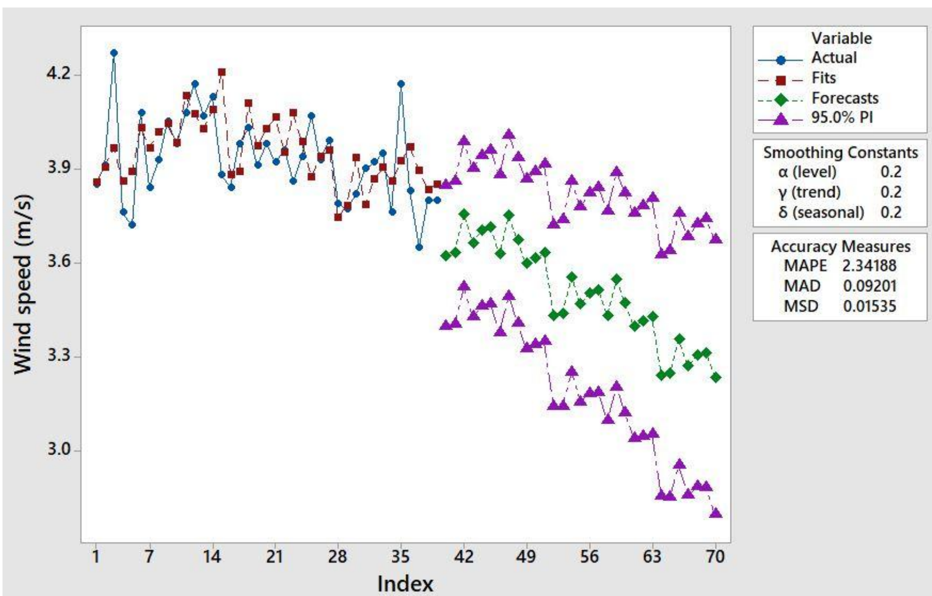

Figure 17. MINITAB Graphical Forecast when α = 0.2, γ = 0.2, δ = 0.2 of Lagos

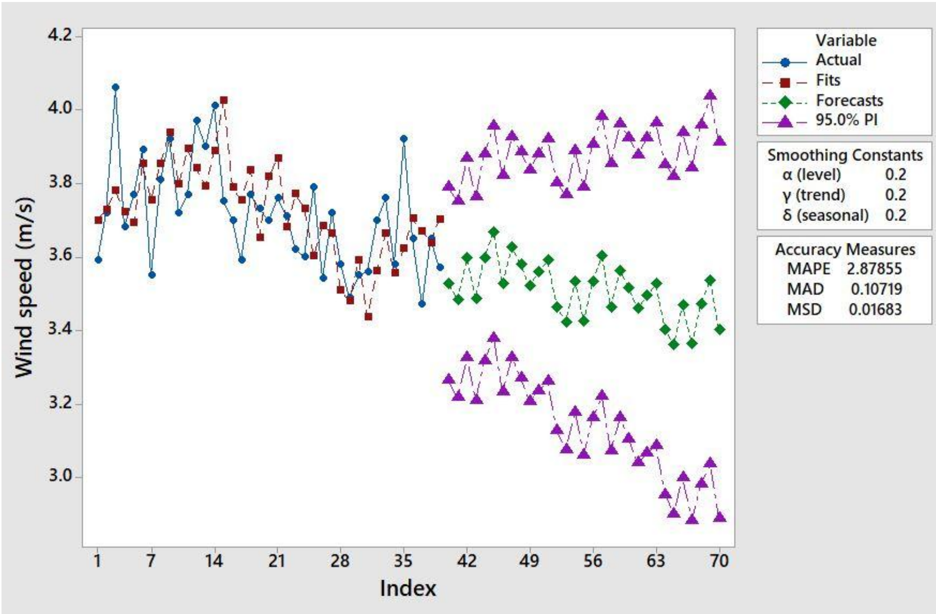

Figure 18. MINITAB Graphical Forecast when α = 0.2, γ = 0.2, δ = 0.2 of Osun

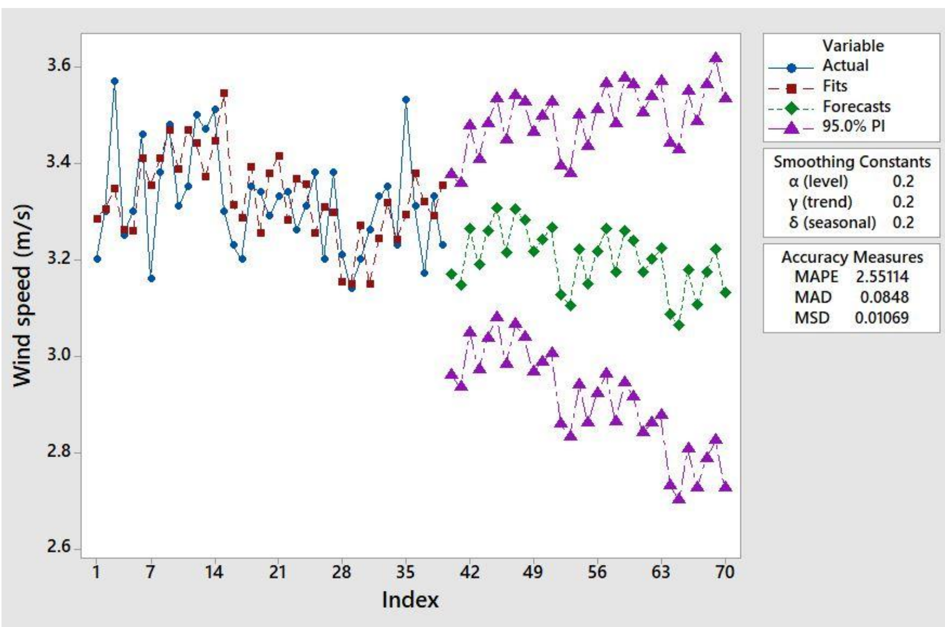

Figure 19. MINITAB Graphical Forecast when α = 0.2, γ = 0.2, δ = 0.2 of Ondo

4. CONCLUSION

The time series analysis which was done using winter forecast method shows that the wind speed of the southern region of Nigeria is experiencing a reduction and the forecast analysis further shows more reduction in 2050 if all conditions are being kept constant. The south south region shows more reduction in wind speed than other southern region. Hence, if climate change and global warming affects the weather pattern as stated by the National Aeronautics and Space Administration, therefore the wind speed data which was represented in the earlier figure 1 to 3 has shown declining wind pattern in the southern. Furthermore, the time series simulation shows further reduction in wind speed. This analysis showed 5.6-14% decrease in wind speed for states in the south east, 5- 31% decrease in states in the south south and 0.5- 13% decrease in wind speed in the south western Nigeria. These locations are not ideal for the installation of sustainable wind turbines.

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IDENTIFYING PRECONDITIONS FOR ESTIMATING BUILDING PROJECT COST IN DESIGN AND MANAGEMENT CONTRACT

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A B S T R A C T

Nigeria's design and management (D&M) contracts records averagely 41% cost overrun. This could be ascribed to weak institutions, poor practices and policies, ineffective, and inefficient planning. The overruns can be curbed by employing preconditions in project estimation; this entails acquiring the potential and resources necessary for cost estimation. Hence, this study identifies preconditions for estimating building project cost in D&M contract with a view to attaining value for money in D&M contract. Exploratory design was employed through literature review as a stand-alone approach to identify twelve preconditions: applicable statutory charges, client's requirements, construction estimating skills, construction project management skills, contracts execution scheduling skills, contractor's proposal, entrepreneurial skills, task resource scheduling skills, professional scale of fees, proficiency in construction procurements law, proficiency in construction procurements and, scope design. The application of these preconditions will inform an inclusive design that will facilitates value for money attainment in D&M contract. Hence, it is recommended that contractors' should acquire and possess all the preconditions necessary for estimating building project cost in a D&M contract for value for money attainment.

Keywords: Building project, Cost, Design & Management contract, Estimating, Value for money

1.0 INTRODUCTION

Design and management contract is one of the variances of the non-traditional procurement system that was introduced to curtail the weaknesses of the traditional procurement contract (Mathonsi & Thwala, 2012). The D&M contract commissioned a single firm with the responsibility of managing the design and construction of a construction project (Babatunde, Opawole, & Ujaddughe, 2010; Rashid, et al., 2006). It ensures the attainment of more efficient and speedier project delivery systems and better project performance and as such, guarantees value for money (Babatunde et al., 2010; Rashid, et al., 2006). Nonetheless, empirical evidence have shown that inadequate understanding of the procurement system, inadequate project management practices, numerous variation orders, communication lapses, cultural issues, differing interests of participants, poor labour productivity, and lack of skilled contractors are still militating against the attainment of better construction projects performance (Toor & Ogunlana, 2008; Hasanzadeha, Mujtaba, & Hafezi, 2014). Jafar and Radzi (2013) advised developing countries like Nigeria that are using the traditional procurement system to exert significant efforts to improve the public procurement system to be able to take full advantages of using the non-traditional procurement contract. This is because according to Babatunde *et al.* (2010), the different procurement contracts differ from each other in term of allocation of responsibilities, activities sequencing, process and procedure and organizational approach in project delivery, and as such invariably affects project performance. This is in addition to the factors that influence the selection of building procurement contracts that are associated to risks allocation, project size and technical complexity (Mathonsi & Thwala, 2012).

The type of a procurement variant and the factors influencing its selection plays a significant role in determining its cost (Rashid, et al., 2006). According to Azhar *et al.* (2008), cost is a major consideration throughout the project management life cycle and is one of the most important parameters of a project and the driving force of project success. This makes estimation which is the process of computing the probable cost of a building project an important part of the procurement process. Estimation of a building project cost forms the basis of the price upon which a contract is let (Laryea, 2010). Though, in practice, estimating building project cost is not always accurate (Laryea, 2010); achieving an effective cost of building projects through cost effective techniques has become very difficult due to the complex nature of building process and systems (Hughes, 2012; Inuwa, 2014). Consequently, when estimating building project cost in a D&M contract certain factors like key stakeholders' relationship, management style, different contract arrangement, as well as different sources of information for project cost estimating need to be considered (Inuwa, 2014). Hence, all the necessary requirements for the estimation of project cost in a D&M contract should be assembled to attain an effective project cost estimation. The process of assembling the necessary requirements for accomplishing a task is called preconditions.

In Nigeria, building projects cost more than similar ones in other parts of the world; an average building project costs over 50% more in Nigeria than in Ghana, and 77% more in Nigeria than in Senegal, and all these countries are located in West Africa (QSRBN, 2012). Idoro (2012b) revealed that the application of the variances of the non-traditional procurement systems like D&M contract in Nigeria records high time and cost overruns. Likewise, Inuwa (2014) discovered that the D&M contract in Nigeria records almost 41% cost overruns. Aniekwu and Audu (2010), and Idoro (2012b) ascribed causes of cost overruns in non-traditional procurement systems to weak institutions, poor practices and policies, ineffective and inefficient planning, among other things. Moreover, the private sector of the Nigerian economy which is expected to lead the economy when fully liberalized, procures 78% of their building projects through non-traditional procurement systems (Inuwa, 2014). Nonetheless, a review of several studies on project cost management focused on contractors estimates verse consultants estimates, project planning success indicators, controlling cost overrun factors, and cost reduction (Mathonsi & Thwala, 2012; Babatunde et al., 2010; Rashid, et al., 2006; Idoro, 2012b). While studies on building procurement contracts focused on factors influencing the selection of procurement systems, appraisal of procurement methods, effects of procurement systems on performance of construction project, and influence of project documents on the outcome of projects procured by traditional methods (Aniekwu & Audu, 2010; Laryea, 2010; Inuwa et al., 2014; Abdul Azis, Memon , & Rahman, 2013; Mahadik, 2015; Samarah & Bekr, 2016). Despite highlighting vital findings none of these studies focused on the preconditions for estimating building project cost in D&M contract. Hence, this study sought to identify the preconditions for estimating building project cost in D&M contract with a view to attaining value for money procurement in a D&M building contract in Nigeria.

3.0 RESEARCH METHOD

This study employs an exploratory research design through extant literature review to examine findings of other researchers. According to McNabb (2015), an exploratory design is used as a stand-alone approach to provide managerial information for providing information upon which to base a decision. The review explore the role of D&M contractor in the light of business management and contract management. The review was guided by the 3 higher levels of the cognitive domain of Blooms revised Taxonomy of Educational Objectives: analysing, evaluating, and creating (Guthrie, 2010). The review process began by *analysing* the whole concept of D&M in light of business management and contract management, followed by *evaluating* the various activities and resources required for the business management and contract management of D&M contract. Thereafter, the various activities and resources involved in business management and contract management of D&M contract were used as the basis to *create* (*identify)* the factors that constitute preconditions for estimating building project cost in D&M building contract.

2.0 REVIEW OF RELATED LITERATURE

2.1 THEORETICAL FRAMEWORK

This study is guided by two concepts from the management theory of project management: precondition and value (Kraemer et al., 2014). The concept of precondition is concern with identifying the pre-requirements for conducting any task before commencing the task (Lindhard & Wandahl, 2012). The essence of identifying preconditions for conducting any task is to attain performance efficiency (Koskela, 2004; Kraemer et al., 2014). Thus, preconditions for estimating building project cost in D&M contract can be construed as the pre-requirements necessary for the task of estimating the building project cost in D&M contract that ensures the attainment of project cost effectiveness; value for money (performance efficiency). While the concept of value is concerned with how best to match customer and end users' requirement in any given task (Kraemer et al., 2014). Value in light of project estimating entails attaining project cost effectiveness. Project cost effectiveness is construed as the degree to which the proposed or estimated cost of a project is successful in producing a desired result (Oxford Dictionary of English, 2013). This value can only be achieved if the estimated cost of a propose project equals the final project cost, and serve as an effective basis for: performance monitoring and control. This study therefore is based on the concepts of preconditions and value; for building project cost in a D&M contract to be effective it must identify pre-requirements for estimating that ensures value for money, and establish a baseline for effective project cost management.

ESTIMATING BUILDING PROJECT COST

Proposed building project cost is a requirements that all prospective clients will like to know in advance. It includes: cost of construction works carried out by the contractor, professional fees, taxes and statutory charges, cost of site (plot), and other development costs (Ashworth et al., 2013) (Ashworth & Perera, 2015). The process of arriving at the building project cost is termed estimation. An estimate for building project is defined as the process of calculating the quantities and cost of the various items required in connection with the building work. Adeyemo (Adeyemo, 2009) noted that cost estimating is the technical process or function undertaken to assess and predict the total cost of executing an item or items of work in a given time using all available project information and resources. An estimate of a building project is a forecast of its probable cost and is a tool for planning and controlling the proposed project with respect to quality, time, and finance (Kirkham, 2007; Singh & Singh, 2004; Musa et al., 2011). Musa *et al.* (2011) opined that the success or failure of a building project depends on the accuracy of the cost estimate. Besides project cost estimating being crucial to construction contract tendering, it provides a basis for establishing the likely cost of resource elements of the tender price for building works (Akintoye, 2000). Hence, it is in no doubt that accurate cost estimates optimize good building contracting. However, estimating building project cost depends on the type of contract adopted and its preconditions (Hughes et al., 2005). According to Iro, Inuwa and Dantong (2013), the cost we estimate must be as accurate as possible. They asserts that construction business and their personnel survival in an organization depends on this accuracy. (Akintoye & Fitzgerald, 2000), identified a serious lack of generally accepted estimating guidelines and preconditions, despite the availability of literature on the format, procedures and principles involved in cost estimating. A cost estimate is made up of many elements that may not be completely defined at the time it is prepared. It assists in the making of financial decisions on a proposed building project at a given time or period. In other words, an estimate is key or central to establishing the basis for key project decisions, for establishing the benchmark on which project success will be measured and for communicating financial status of a project at any point in time. Hence it must be prepared accurately using the best information at the appropriate time (Musa, Ibrahim, & Ibrahim, 2011).

NON-TRADITIONAL PROCUREMENT SYSTEMS

The non-traditional procurement system is a common term used to refer to all emerging or contemporary procurement systems of the construction industry other than the traditional procurement system. It was introduced in the construction industry to counter the flaws in the traditional procurement system which fragments the procurement process into two mutually exclusive entities of design and construction; this creates room for ineffective communication and coordination that often results in conflict between the designers and the contractors, and often affects the quality of a project by not taking into consideration buildability/constructability and life-cycle costing (Ojo, Adeyemi, & Ikpo, 2000; Oyegoke, 2006). This in addition to the increased size and complexity of construction projects, financial challenges, political and social consideration, and information technology that are proofing difficult manage by the traditional procurement system (Mathonsi & Thwala, 2012). Thus, it is believed that the introduction of the non-traditional procurement system will result in the achievement of an efficient and speedier project delivery systems for better project performance (Inuwa, 2014; Babatunde et al., 2010). The non-traditional procurement system variances are broadly subdivided into the following types: management-oriented approach, integrated approach, and special task organization (discretionary contract) (see Mathonsi & Thwala, 2012; Harris & McCaffer, 2005).

D&M Contract

The D&M contract is a variant of the management oriented approach under the non-traditional procurement system that entrust the responsibility of designing and managing a construction project to a single contractor (Rashid, et al., 2006; Harris & McCaffer, 2005). Before engaging a contractor for D&M building contract, the project client contracts an independent designer to produce scope design and his requirements to form the basis for inviting tenders (Harris & McCaffer, 2005; Inuwa, 2014). Afterward, contractors are invited to submit their proposal (contractor's proposal) as a response to how they intend to execute the project, as well as their contract sum analysis capturing the main cost items in the project (Ramus et al., 2006). Then the contractor that is awarded the D&M contract becomes part of the client consulting and project team respectively (Rashid, et al., 2006). The D&M firm does not carry out the work itself; both design and construction are entirely sub-let by the D&M contractor to subcontractors and suppliers, who enter into contract with the client (Harris & McCaffer, 2005; Rashid, et al., 2006). According to Atkinson (2015), a consultant quantity surveyor or similar financial expert is still needed to oversee placing and financial management of the D&M building project. Figure 1 shows the D&M contractor's contractual obligation.

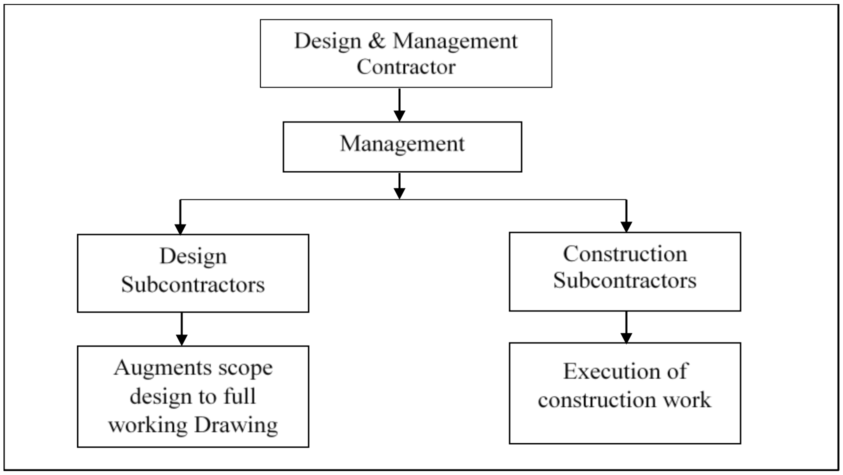

FIGURE I. D&M contractor's contractual obligation (Inuwa, 2014)

Preconditions for Estimating Building project Cost in D&M Contract

The idea of preconditions to work tasks is to itemize the pre-requirements (potentials and resources) to start any activity in construction (Inuwa, 2014). According to Lindhard and Wandahl (2012), for any task to be successfully conducted certain prerequisites for conducting the task must be fulfilled; it entails itemizing all the necessary activities and potentials that are required to actualize a task (Koskela, 2004). Therefore, preconditions for estimating building project cost in D&M contract is the identification and possession of the necessary potentials and resources that are necessary for the effective and efficient computation of the probable building project cost of a D&M contract (Inuwa, 2014; Lindhard & Wandahl, 2012). The essence of employing preconditions when estimating project cost is to avoid ineffective project cost estimation. This is achieved by avoiding a making-do-waste in the project cost estimation process (Koskela, 2004). A making-do-waste in relations to estimating project cost, is a situation where the process of estimating project cost commenced without completely identifying the preconditions that will ensure the effective attainment of the estimating process (Lindhard &

Wandahl, 2012). A making-do-waste in estimating project cost could affect building project performance due to poor cost management, variation, time and cost overruns, and client dissatisfaction.

To completely identify the preconditions for an effective and efficient building project cost estimate in a D&M contract, a comprehensive work breakdown of the system should be developed and reviewed. This will results in a comprehensive identification of the potential and resources that constitute building project cost factors in a D&M contract, as well as serve as preconditions for its cost estimate. Thus, going by the above detailed explanation of the building project procedure in D&M contract and the required documentation for its actualization, the preconditions for estimating building project cost in a D&M contract will includes: applicable statutory charges, client's requirements, construction estimating skills, construction project management skills, contract execution scheduling skills, contractor's proposal, entrepreneurial skills, task resource scheduling skills, D&M project consultants' professional scale of fees, proficiency in construction procurements law, proficiency in construction procurements and, scope design (Mathonsi & Thwala, 2012; Inuwa, 2014; Ramus et al., 2006; Rashid et al., 2006; Harris & McCaffer, 2005).

Construction Estimating Skill

Construction estimating is the process of computing the probable cost of a construction work item or an entire construction project. While a skill, according to Oxford Dictionary of England (Oxford Dictionary of English, 2013), is the ability to do something well; expertise. Hence, construction estimating skill is the possession of the expertise to optimally accomplish the task of construction estimating process (Inuwa, Silas, & Musa, 2018). The D&M contractor is expected to have the potential of organizing a comprehensive estimating organization for project cost estimation in a D&M contract. The organization should be responsible for predicting the most economic project costs estimation in a way that is both clear and consistent. Moreover, the organization must continuously have an update on government labour policies and current prices of construction materials (Brook, 2011; Inuwa, 2014).

Construction Project Management Skills

Project management is the art of directing and coordinating human and material resources through the life of a project by using modern management techniques to achieve pre-determined goals of scope, cost, time, quality and participant satisfaction (Smith, 2003). Construction project management skills are the potential that a project manager should possess in order to attain project success. It is concern with the capacity to perform executive duties in an organization while avoiding crisis situations and promptly solving problems when they occur. Project management skills enables one to look ahead at the needs and risks, assess progress and trends, get quality and value for money, and change the plans if necessary, to achieve the needed objectives (Smith, 2003). The possession of project management skills will facilitate an effective estimation of building project cost in D&M building contract.

Contracts Execution Schedule

The statutory obligation of D&M building contract entrusts a D&M contractor to enter into contracts with the project client, designers, work package subcontractors, and suppliers (see Inuwa, 2014). Moreover, the client enters into a separate contract with other parties and, all of these contracts are executed in a network within the context of the D&M contract (Harris & McCaffer, 2005). This network of contracts is executed within an organizational setting (Harris & McCaffer, 2005). Figure 2 shows the network and the organizational setting of the contracts in a D&M contract. The ability to schedule the network of contracts involve in a D&M contract and, how they are coordinated within the organizational setting will enhance an effective estimation of a building project cost in D&M contract.

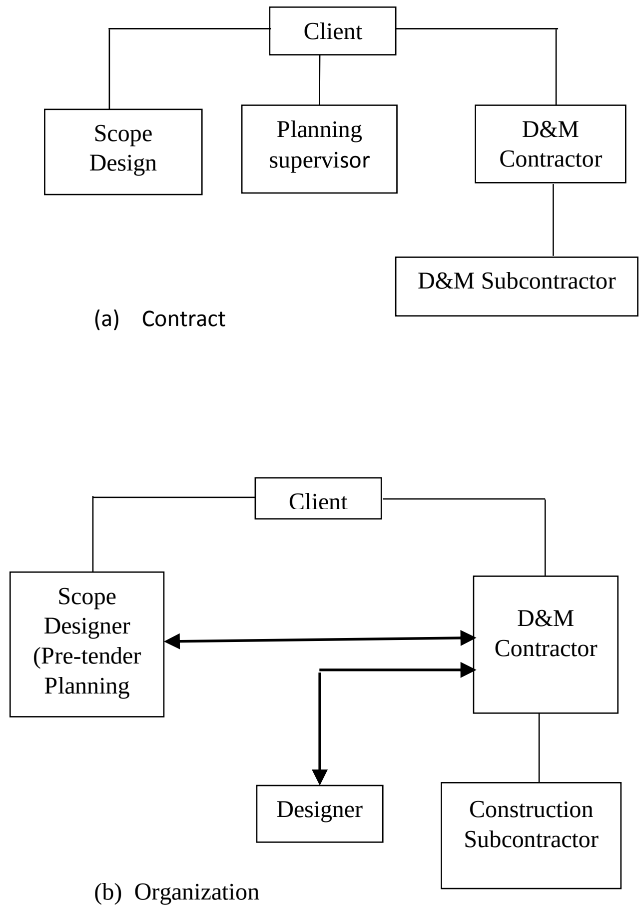

FIGURE II. D&M contractual and organizational setting (Harris & McCaffer, 2005)

Entrepreneurial Skills

According to the EU Skills Panorama (EU Skills Panorama, 2014), entrepreneurial skills is the ability of an individual to turn ideas into action through creativity, innovation and risk-taking, as well as the ability to plan and manage projects in order to achieve objectives. Entrepreneurial skills equipped an individual with the potential to exploit an idea for the creation and development of an enterprise for personal gain as well as for, social and developmental gain (Adeyemo, 2009). Entrepreneurial skills are perceived as vital to promoting innovation, competitiveness and economic growth (EU Skills Panorama, 2014). D&M building contractors are in business and, as such, should exhibits entrepreneurs skills to understandings how a D&M contract is created, the processes involved for its realization, as well as the ability to steer it resources effectively and efficiently. The possession of the requisite skills of a D&M entrepreneurial is also a prerequisite for attaining effective estimation of its cost.

Task Resource Schedule

Resource schedule refers to the set of actions and methodology used by organizations to efficiently assign the resources they have to jobs, tasks or projects they need to complete, and schedule start and end dates for each task or project based on resource availability. Depending on industry, resources can be people (either employees or independent contractors), equipment and machines (this is frequent for construction, manufacturing or maintenance businesses) or rooms and facilities. There may also be a need for consumable resources (for instance, materials and parts for manufacturing). Task resource schedule is a management function that entails optimal organization of resources into a cohesive structure in accordance with the intended plan requirement. Thus, the ability of the D&M contractor to effectively organize their resource schedule will assist in arriving at an effective estimating of building project cost in D&M contract.

Professional Scale of Fees

A D&M contract client enters into contracts with consultants for executing specific task accordingly (Harris & McCaffer, 2005). The fees charge by these consultants for the services rendered are classified in a professional scale of fees or, negotiated by the contracting parties. The level of some of these fees are fixed by professional bodies or government statute. These fees form part of a project cost. Hence, the appropriate identification of the consultants involved in a D&M contract and the aggregation of their respective professional fees is very vital in estimating building project cost in D&M contract.

Proficiency in Construction Law

According to Ramus, Birchall and Griffiths (2006), the principle of establishing a contractual relationship in the construction industry is not different from other business or industry (Ramus et al., 2006). To establish a contractual relationship for a building project procurement, an offer must be made by a contractor who tenders to carry out specified construction works in return for a money payment and upon the acceptance of that offer by the client promoting the project (Ramus et al., 2006). The parties to a construction contract are bound by their obligations as enshrined in the contract documents. This document includes all or some of the following: form of contract, bills of quantities, specification, schedules of works, drawings, employer's requirements, scope design, etc. (Ramus et al., 2006). Each of these documents are very important and as such, ambiguities, discrepancies or contradictions in them could be very detrimental in achieving an effective estimation of building project cost in a D&M contract.

Proficiency in Construction Procurements

Ashworth and Perera (Ashworth & Perera, 2015) defines procurement as the process that is used to deliver construction projects. There are wide range of project procurement options now available and, any of the options may have a significant bearing on the outcome of a project. The successful delivery of a building project using a specific project procurement option requires experience, vested interest and familiarity (Ashworth et al., 2013). The understanding of the most appropriate procurement options to adopt base on the prevailing circumstances surrounding the projects is a prerequisite to success as well as an effective estimation of project cost.

4.0 CONCLUSION

Evidences advanced on the underperformances of construction projects procured through variances of the non-traditional procurement systems in Nigeria brought to fore the need to identify preconditions for estimating building project cost in D&M building contract. The study employs exploratory design through literature review as a stand-alone approach. The review was guided by the 3 higher levels of Bloom's Taxonomy of Educational Objective to identify preconditions for estimating building project cost in D&M building contract. In this light, 12 preconditions were identified: scope design, applicable statutory charges, client's requirements, construction estimating skills, construction project management skills, contract execution scheduling skills, contractor's proposal, entrepreneurial skills, task resource scheduling skills, D&M project consultants' professional scale of fees, proficiency in construction procurements law, and proficiency in construction procurements. These preconditions if properly applied in estimating building project cost in D&M contract will guide the development of an inclusive design that captures the requisite components required for effective project cost estimates that will facilitates value for money attainment in D&M contracts. Hence, it is recommended that contractors' should acquire and possess all the preconditions necessary for estimating building project cost in a D&M contract for value for money attainment.

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EFFECT OF RAINFALL VARIABILITY ON LANDUSE/LANDCOVER DYNAMICS WITHIN ENUGU URBAN

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Abstract

The importance of rainfall variability in successfully understanding the dynamics of climate change and landuse/landcover changes in any region cannot be overemphasized. This study examined rainfall variability in Enugu urban and metropolis as it affects landuse landcover change and climate change. The study used secondary rainfall data collected from the archives of the Meteorology unit, Enugu State University of Technology, from January to December through the years 1971-2020. The rainfall data collected were tabulated and analyses in decadal format using descriptive statistics; frequency table, mean and graphical representations. The annual mean rainfall from 1971 to 2020 was determine by the use of line graph which shows normal and abnormal trend of rainfall within the period of study. Result shows there was more rainfall (1995, 1997, 2008, 2012, 2018, and 2020) with the total amount of rainfall (2170.9mm, 2284.6mm, 2170.3mm, 2137.7mm, 2393.4mm and 2173.9mm) respectively. Decrease in rainfall in the study area was notice from the year (1973, 1976, 1983,1972,1971 and 1974) with the amount of rainfall (813.4mm, 889mm, 917.1mm,928.3mm,987.9mm and 1104.4mm) respectively. The findings revealed significant variations of rainfall pattern in Enugu and a significant reduction in landcover overtime. Also, the result shows a significant relationship between rainfall trend and landcover dynamics in Enugu urban area, though the study recommends further study on the landuse landcover using Remotely generated images and GIS software to ascertain if the decrease noticed in the landuse/landcover in the study area is only due to rainfall variability. Thus, the study recommends needs to embark on robust education and enlightenment programs as to increase the awareness of the populace on the current trend of rainfall in the study area for maximum use of the natural resources from weather and climate of the environment and further understanding the landuse/landcover dynamics which will enable future researchers understand rainfall variability effectively and its effect on landcover properly.

KEYWORDS: Rainfall variability, Landuse/landcover, decadal analysis, Enugu Urban

1.1 INTRODUCTION

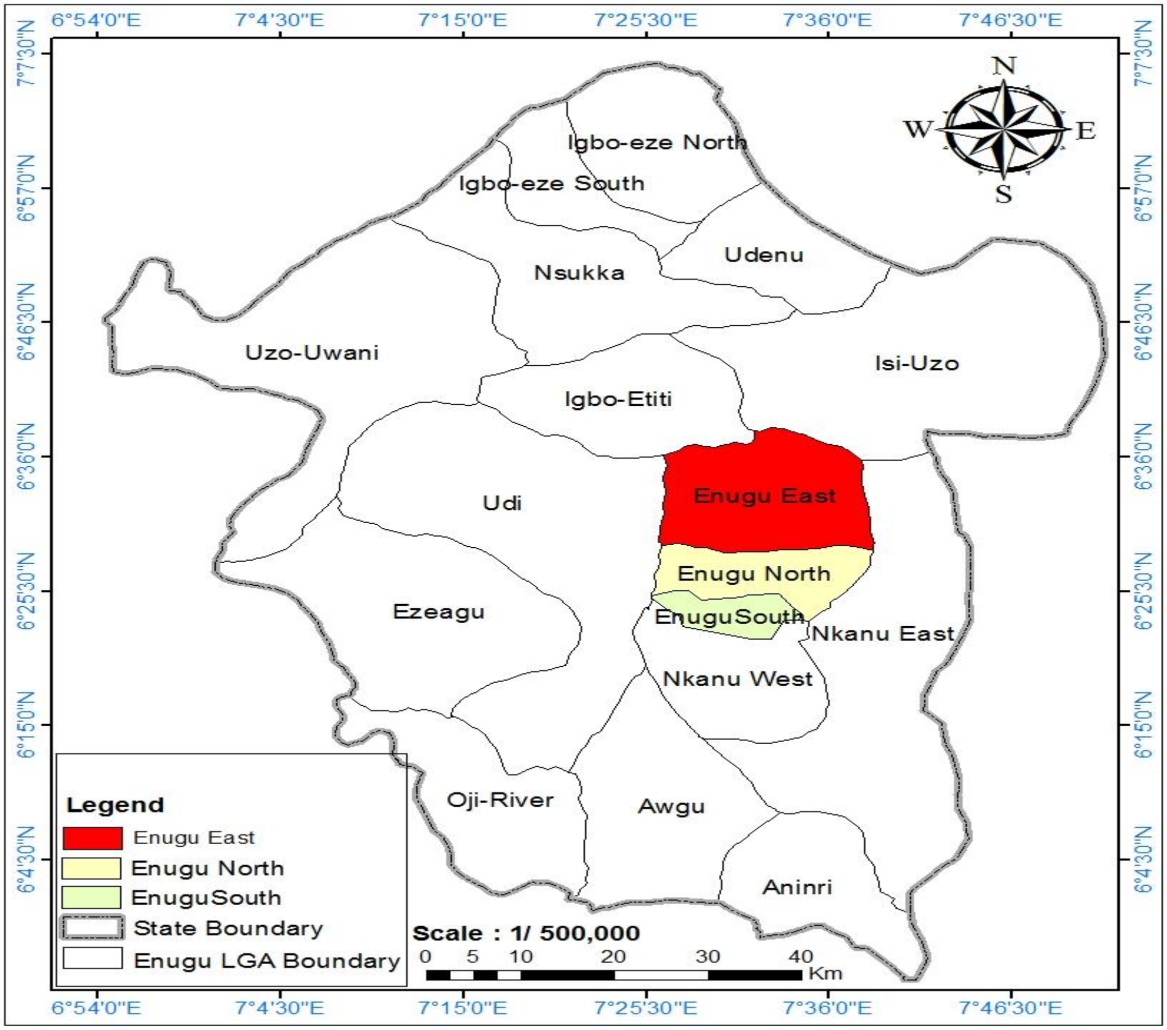
Rainfall variability is a climatic feature that impacts Africa's agricultural productivity and food production (Mensah et al., 2019; Ogundari & Onyeaghala, 2021; Schlenker & Lobell, 2010). It is also a serious threat to poverty eradication and sustainable development in Nigeria. This is because the country has a large rural population who depends directly on rainfall sensitive economic and development sector as well as natural resources for their subsistence and livelihood, (Oladipo, 2008; Osang, 2013). Many studies have investigated rainfall trends and variability over the years in Nigeria, with most studies using tables and graphical plots to shed light on the dynamics of rainfall trends and variability over time (Adenodi 2018; Akinsanota & Ogunjobi 2014; Animashaun et al., 2020; Nnaji et al., 2016). In addition to this, some studies used time series analysis to investigate long fluctuation patterns in rainfall over an extended period (Ogbuene, 2010), while others used a non-parametric test to study rainfall trends in Nigeria (Obot et al., 2011).

Furthermore, there is increasing evidence that climate change is exacerbating rainfall variability and the frequency of extreme events such as reduction of landcovers, floods, drought, and hurricanes (IPCC, 2007). Rainfall is one meteorological parameter that affects virtually all human activities. (Obot, N.I., Chendo, M.A., Udo, S.O. and Ewona, I.O. “2010”) or instance, the amount of rainfall received in an area is an important determining factor in estimating or quantifying the amount of water available to meet various demands, such as agricultural, domestic, industrial and power generation. (Sharad, J. and Vijay, K. “2012”).

According to Olatunde, A.F. (2012) availability or non-availability of rainfall is normally employed to determine the level of wetness or dryness during the growing season which makes rainfall the single most important element of the climate system affecting the agricultural and water resource management of any region. However, in recent time, the reduction of landcover in some part of Enugu metropolis has increased public concern that the urban central might be undergoing serious climatic shift. This is due to the high variability rainfall that has adverse impact on agricultural output and economic activities of the city (Mark, O. and Kishtawa, C.M. “2014”). Rising from above, it is pertinent to emphasize that studies of rainfall variability are crucial in mitigating the consequences of extreme climate hazards such as droughts, landcover and floods (IPCC, 2007). This is premised on the fact that the amount of water available in the soil which crops utilize is dependent on important rainfall characteristics such as onset, length and cessation which influence the success and failure of the cropping season (Kisaka, M.O., Mucheru-Muna, M., Ngetich, F., Mugendi, D. and Mairua, F. “2015”).

2.0 STUDY LOCATION

Enugu is located approximately between 6°22'30"to 6°39'10" in Latitude Northing of the Equator and 7°25'35" to 7°40'45" in Longitude Easting of Greenwich Meridian. The state is made up of 17 local government areas (See Figure 2.1). Enugu State is one of the states in the eastern part of Nigeria located at the foot of the Udi Plateau. The state shares borders with Abia State and Imo State to the south, Ebonyi State to the east, Benue State to the northeast, Kogi State to the northwest and Anambra State to the west (Enugu State, Nigeria Britannica, 2022)

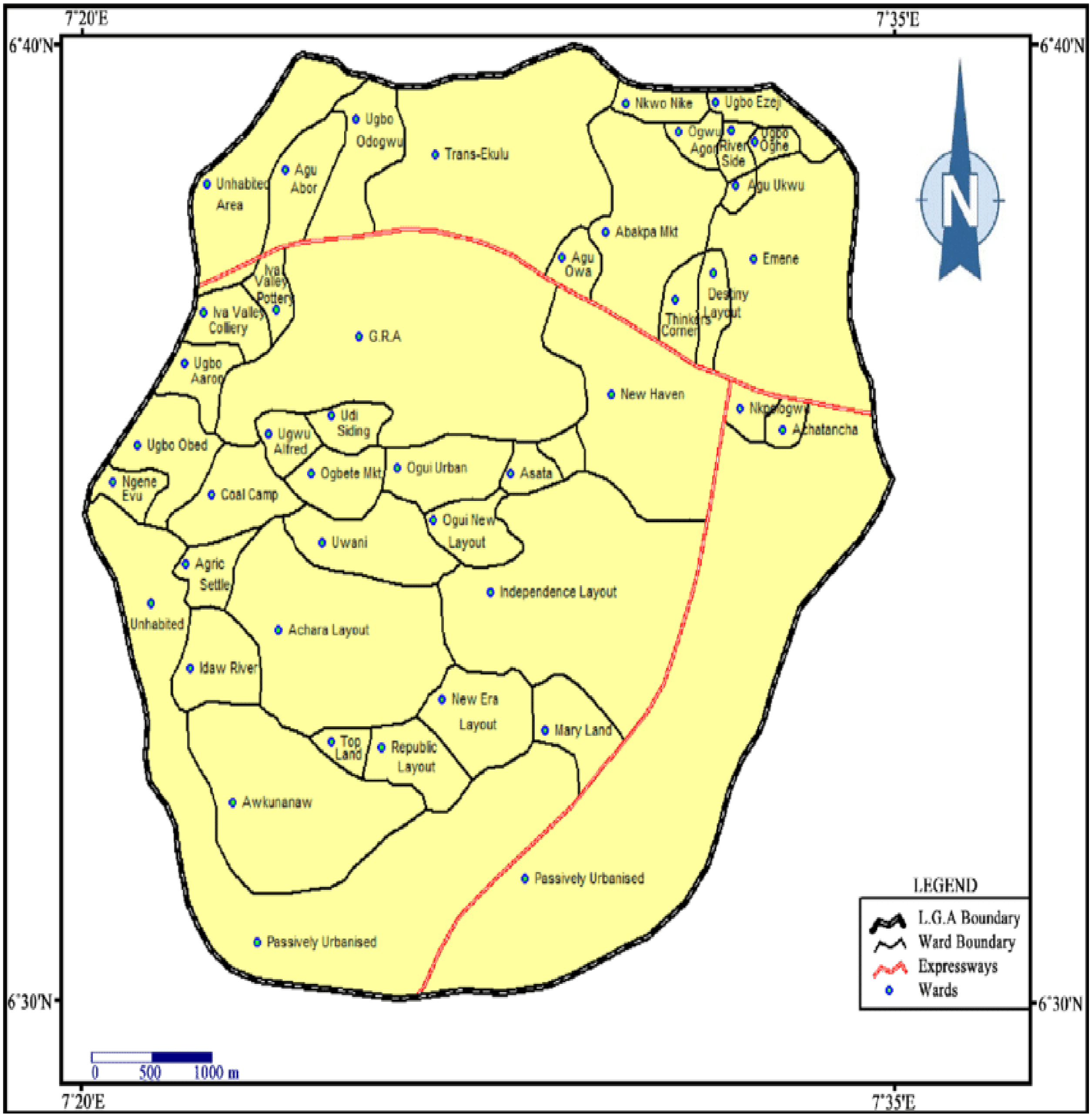


Source: Enugu State Ministry of Lands & Survey (2020)

Figrue 2.1: Map of Enugu State, showing the study area (Enugu Urban, comprising, Enugu East, Enugu North and Enugu South)

2.1 Enugu Urban

Enugu urban area is around the capital of Enugu state and is located in the Eastern part of Nigeria. The area lies between longitude 7°20°E and Latitude 6°40°N.



Source: https://www.researchgate.net

Figure 2.2 Map showing Enugu urban area.

Enugu, the capital city of Enugu State, is on the railroad from Port Harcourt, 150 miles (240 km) south-southwest, and at the intersection of roads from Aba, Onitsha, and Abakaliki. It is approximately 4 driving hours away from Port Harcourt, where coal shipments exited in Nigeria.

Enugu is also located within an hour's drive from Onitsha, one of the biggest commercial cities in Africa and two hour's drive from Aba, another very large commercial city, both of which are trading centres in Nigeria. The average temperature in this city is cooler to mild ~17°C (60°F) in its cooler months and gets warmer to hot in its warmer months ~28°C (upper 80°F). Enugu has good soil-land and climatic conditions all year round, sitting at about 223 metres (732 ft) above sea level, and the soil is well drained during its rainy seasons. The mean temperature in Enugu State in the hottest month of February is about 87.16 °F (30.64 °C), while the lowest temperatures occur in the month of November, reaching 60.54 °F (15.86 °C). The lowest rainfall of about 0.16 cubic centimetres (0.0098 cu in) is normal in February, while the highest is about 35.7 cubic centimetres (2.18 cu in) in July. (Enugu State, Nigeria". Encyclopedia Britannica "2021").

3.0 Materials and methods

This study employed the use of descriptive statistics in the data analysis and secondary data collected from relevant websites and Government offices was used.

3.1 Method of data collections

The Rainfall data for this research is from January to December through the year 1971-2020 and was obtained from the archives of the Meteorology unit, Enugu State University of Technology, Enugu, Nigeria.

3.2 Method of data Analysis

The rainfall data collected was analysed using descriptive statistics. The data was tabulated and graphical representations was used to analyse the rainfall trench of 10 years per table from 1971 to 2020.

The annual rainfall from 1971 to 2020 was analyzed using decadal rainfall format, to clarify and show what the rainfall was, and check the variability in each of the decades, to ascertain if it corresponds with landuse/landcover change in the study area.

4.0 Presentation of Result

4.1 Analysis and result discussion

Table 4.1 Rainfall variability from 1971 to 1980

YEAR	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUGUST	SEPT	OCT	NOV	DEC
1971	0	0	6.9	0.3	94	161	122.9	334.5	235.5	32.8	0	0
1972	0	0	3	25.1	123.4	154.2	165.4	224.8	213.9	18.5	0	0
1973	0	0	0	42.7	11.2	98.3	151.4	305.3	158.5	46	0	0
1974	0	0	0.3	18	60.5	174.5	431.1	129.2	251.7	39.1	0	0
1975	0	0	0	37.6	81.8	158.9	252.5	224.8	186.9	31	0	0
1976	0	0	0	1.3	174.5	96.8	150.9	201.4	121.8	135.4	6.9	0
1977	22.1	3.1	54.8	29.9	205.6	321.4	158.5	182.9	298.6	267.1	0	2
1978	1.8	2	102.3	236.4	239.5	489.6	87	183.8	364.6	260.4	15.4	0.3
1979	0.5	75.1	64.3	29.4	199	237.1	365.2	305.4	208.1	165.8	46.9	0
1980	0	24.2	56.7	76	257	228.7	228.6	326.7	594.6	176.8	74.4	0

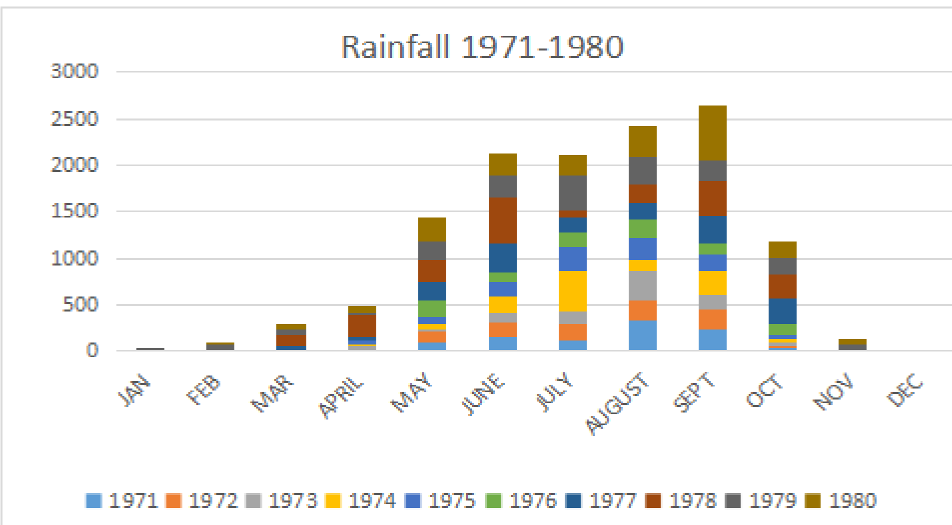


Figure 4.1 Rainfall variability graph from 1971 to 1980

Figure 4.1 above showed the variability of rainfall from the 1971 to 1980, the rain fall during this period has a minimum rainfall at January with 2.3mm and increases to the maximum every September above 2500mm. This implies that there is availability of rainfall in the study area from May to October as the rainfall amount ranges above 1000mm during these months while there is inadequate rainfall from November to April with the amount below 500mm which would result to deductions in landuse/landcovers of the study area within the trench period.

Table 4.2 showing rainfall variability from 1981 to 1990

YEAR	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUGUST	SEPT	OCT	NOV	DEC
1981	4.3	1.6	30.9	83.8	194.6	219.2	270.6	182.4	395.9	327.6	0	0
1982	27	57.3	49.3	106	315.5	216.2	264.6	92.3	218.1	199.7	3.6	0
1983	0	0	4	3.3	190	101.1	251.4	92.2	248.2	24.2	0	2.7
1984	0	0	16.1	137.9	130.6	350.5	305.6	385.8	311.2	122.5	20.9	0
1985	16.6	0	206.1	127.8	291.7	202.8	193.5	462.6	259.4	157.8	21.6	0
1986	2.1	9.8	127.1	97.8	238.9	141.9	270.4	198.8	206.3	101.6	55.9	0
1987	0	15.7	33	148.7	173.6	200.5	245.1	292.3	222.7	135.7	0	0
1988	7.1	0	46.4	95.3	154.9	220.3	219.3	226.4	285.2	206.1	0	71.4
1989	0	0	4.4	167.9	278.7	182.6	162.2	413.4	217.4	217.1	0	0
1990	0.5	0.5	0	181.5	89.7	279.4	508.3	359.1	317.5	318.8	2.3	25.8

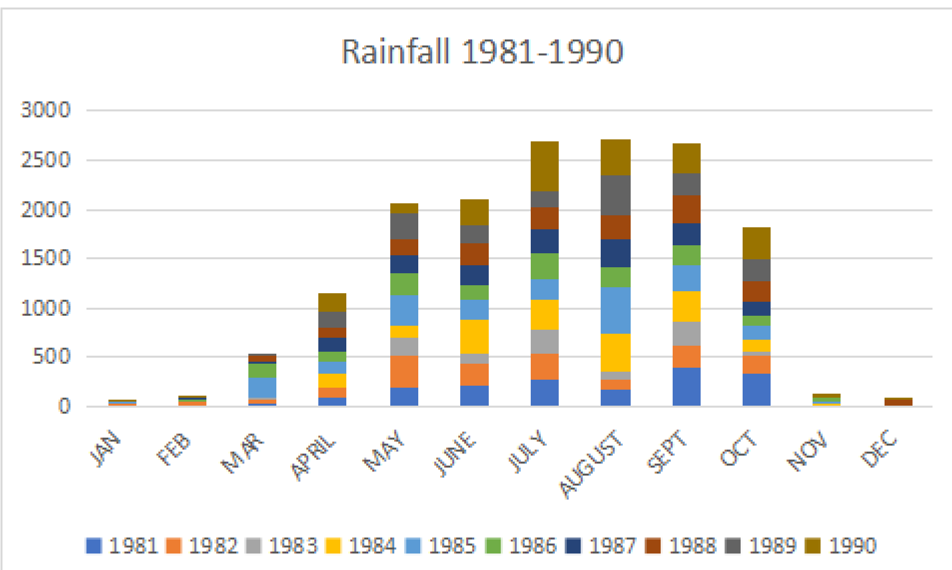


Figure 4.2 Chart showing Rainfall variability from 1981 to 1990

Figure 4.2 shows rainfall variability from 1981 to 1990. The above graph shows maximum rainfall in the month of April to October with the amount above 1000mm which could result to increase in landcover and, a decrease in rainfall in the months January, December, February, November, and March with rainfall amount below 500mm which could also result to drought and degradations.

Table 4.3 Rainfall variability from 1991 to 2000

YEAR	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUGUST	SEPT	OCT	NOV	DEC
1991	0	37.6	62.4	198.1	346.4	244.8	320.2	264.5	230.5	253.5	2.5	1.4
1992	0	0	111.5	200.9	194	354	313	149.3	249.7	105.3	28.8	0
1993	0	5.1	62.7	148.9	109.9	263.7	186.7	389.8	243.5	72.9	82.9	11.6
1994	33.8	0	9.7	150.7	211.2	140	216	388.2	331.9	181.6	0	0
1995	1.6	0	90.2	194.1	263.9	356.7	340.2	435.1	192.4	261.7	35	0
1996	0	26.7	48.6	160.9	277.2	289.6	368.3	268.4	176.3	303.4	0	0
1997	0	0	111.6	261.3	376.1	345	226.8	235	392.3	264.3	68.1	4.1
1998	0	6.1	25.8	161.1	188.7	285	259.2	96.2	256.6	217.4	0	0
1999	18.4	15.7	30	103.6	223.5	316.8	206.4	200.2	195.1	313.4	0	0
2000	32.4	0	32.3	201.8	357.5	206.1	298.4	331.8	339.7	226.5	0	0

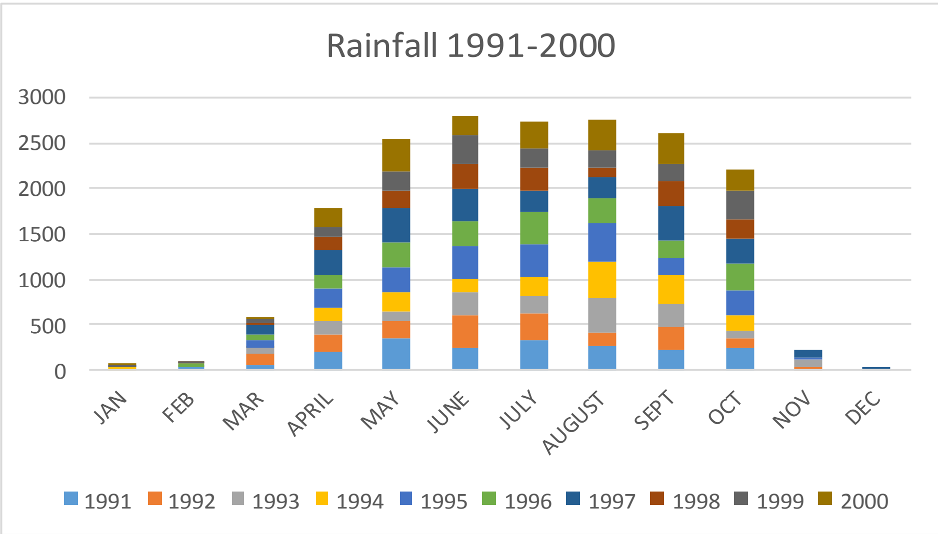
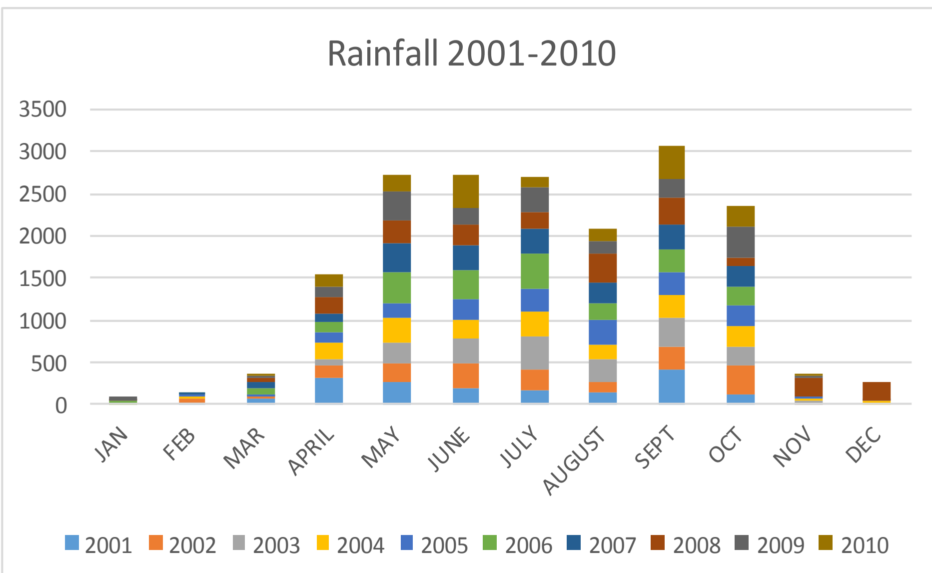


Figure 4.3 Rainfall variability graph from 1991 to 2000

Figure 4.3 shows rainfall variability from the year 1991 to 2000. There is a very high rainfall in August 1995 with the amount above 4000mm as shown in figure 4.3 above while there are similarities in the rain between 1993 August, 1994 August with 389.8mm and 388.2mm respectively. This implies rapid landcover during high rainfall period and deduction in landcover at the period of rain decrease.

Table 4.4 showing rainfall variability from 2001 to 2010



YEAR	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUGUST	SEPT	OCT	NOV	DEC
2001	0	28	72.5	305.5	273.8	188.8	152	130.6	407.9	118.1	0	0
2002	0	46.5	14	159.1	219.7	296.4	263.3	121.9	270.9	332.5	1.5	0
2003	0	0	2.9	74.6	234.3	287	400.4	290.2	334.4	227.4	39.8	0
2004	0.6	6.4	4.8	186.8	305.5	222.3	284.7	174.1	272.3	258.1	22.1	33.1
2005	0	26.9	20.8	115.6	170	258.3	277.6	292	283.6	228.5	24.1	19.1
2006	43.9	4.6	78.9	138.4	375	339.2	420.5	188.3	261.8	233.7	0	0
2007	0	9.4	70	105.7	325	296.3	290.3	255.1	299.7	240.2	0	0
2008	1.2	0	56.6	191.6	281.2	244.6	196	328.6	332.5	96.4	235.7	205.9
2009	50.1	0	11.1	112.4	347.1	206	280.5	154.3	204.7	384.6	18.9	0
2010	0	0	2.2	162.8	199.3	392.5	137.6	150	398.1	226	1	0

Figure 4.4 Chart showing Rainfall variability from 2001 to 2010

Figure 4.4 shows rainfall variability from 2001 to 2010. This period of trend shows a very low rainfall and posies serious hazard on the environment as the maximum rainfall amount is below

500mm. The maximum rainfall occurred through the month July with the amount above 400mm while the minimum rainfall occurs within month that the rainfalls are below 100mm and might have resulted to drought and rapid degradation which also affect landuse/landcover of the study area.

Table 4.5 Rainfall variability from 2011 to 2020

YEAR	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUGUST	SEPT	OCT	NOV	DEC
2011	0	44.6	118.4	118.1	220.2	188.5	195.4	237	439	166.1	2	0
2012	39	35.7	13	86.9	288.7	282.5	388	309.1	393.2	227.7	73.9	0
2013	35.1	0	31.7	146	296.7	279.4	173.9	336.4	430.1	113.5	0	98.3
2014	1.2	5.2	120.3	183.7	241.3	229.6	308.3	311.6	297.8	172.8	57.8	0
2015	0	82.8	117.5	21.6	239.4	260.4	363.5	302.3	380.3	198.9	42.2	0
2016	1	0	53.8	93.3	269.7	207.1	334.3	395.8	326.6	137.3	0	0
2017	1.9	0	10.8	284.5	168	319.3	362.4	37.1	285.2	176.3	56.3	0
2018	6.3	0.9	63.9	230.4	250.6	320	389.7	302.3	434.3	311.5	83.5	0
2019	0	0	130	197.4	212.4	86.4	258.5	191.3	326.3	224.4	78.6	0
2020	0	0	150	260.6	230.8	310.2	350.3	138	370	287.6	67	8.8

Figure 4.5 showing rainfall variability graph from 2011 to 2020

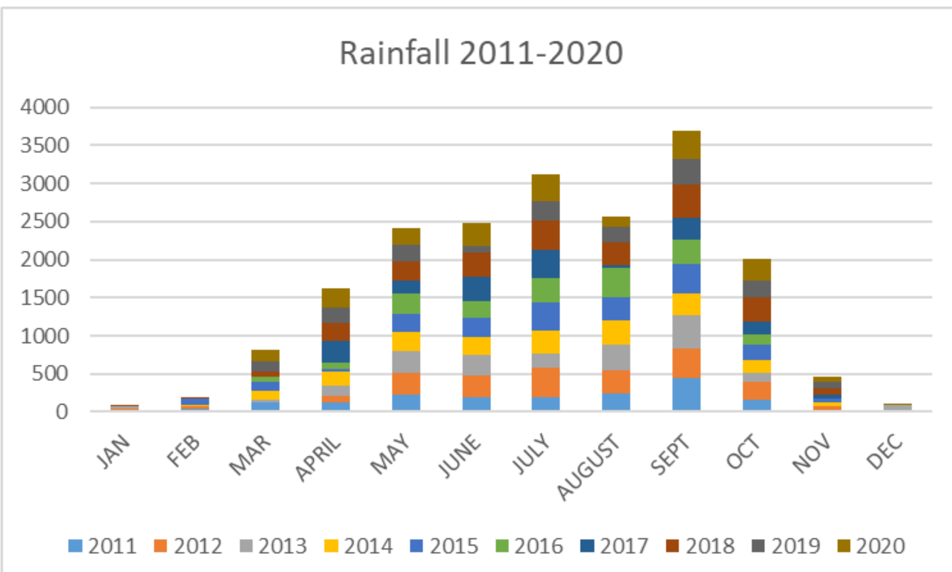


Figure 4.5 shows rainfall variability from 2011 to 2020. During this period there is rapidly high rainfalls in the month of September with amount above 3500mm while the minimum rainfall occurs in the month of January and December with 84.5mm and 1007.1mm respectively. These shows that there might be some negative impact in high rainfall such as erosions, flooding and other economic activities and the month with least rain requires other source of water supply to aid landcover and agricultural activities in the study area.

Table 4.6 showing Annual and mean rainfall variability from 1971 to 2020

YEAR	Annual Rainfall	Mean Rainfall
1971	987.9	82.325
1972	928.3	77.35833333
1973	813.4	67.78333333
1974	1104.4	92.03333333
1975	973.5	81.125
1976	889	74.08333333
1977	1546	128.8333333
1978	1983.1	165.2583333
1979	1696.8	141.4
1980	2043.7	170.3083333
1981	1710.9	142.575
1982	1549.6	129.1333333
1983	917.1	76.425
1984	1781.1	148.425
1985	1939.9	161.6583333
1986	1450.6	120.8833333
1987	1467.3	122.275
1988	1532.4	127.7
1989	1643.7	136.975
1990	2083.4	173.6166667
1991	1961.9	163.4916667
1992	1706.5	142.2083333
1993	1577.7	131.475
1994	1663.1	138.5916667
1995	2170.9	180.9083333
1996	1919.4	159.95
1997	2284.6	190.3833333
1998	1496.1	124.675
1999	1623.1	135.2583333
2000	2026.5	168.875
2001	1677.2	139.7666667
2002	1725.8	143.8166667
2003	1891	157.5833333
2004	1770.8	147.5666667
2005	1716.5	143.0416667
2006	2084.3	173.6916667
2007	1891.7	157.6416667
2008	2170.3	180.8583333
2009	1769.7	147.475
2010	1669.5	139.125
2011	1729.3	144.1083333
2012	2137.7	178.1416667
2013	1941.1	161.7583333
2014	1929.6	160.8
2015	2008.9	167.4083333
2016	1818.9	151.575
2017	1701.8	141.8166667
2018	2393.4	199.45
2019	1705.3	142.1083333
2020	2173.3	181.1083333

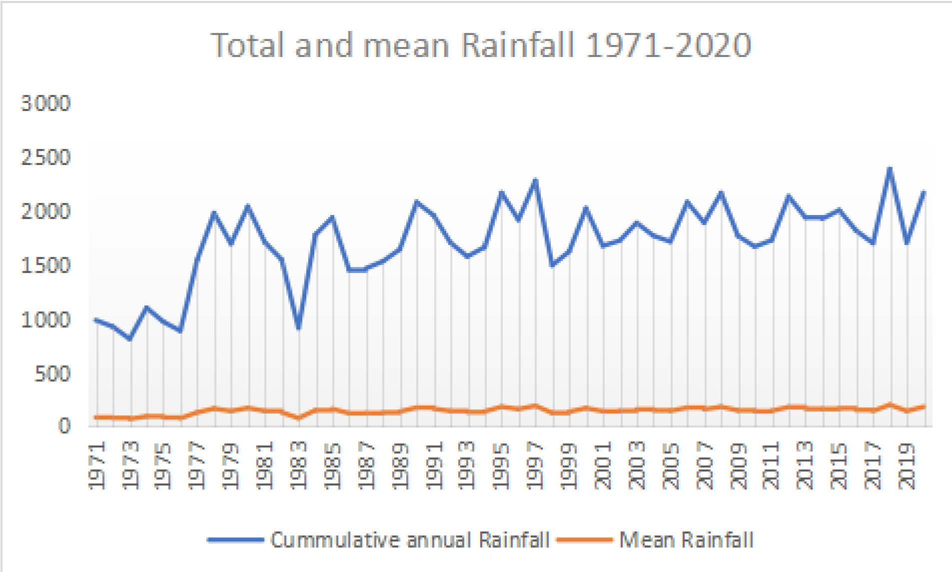


Figure 4.6 Annual and mean Rainfall variability graph from 1971 to 2020

From Figure 4.6 above, The period of high rainfall in the urban area was within the year (1977,1978,1979,1980,1981,1982,1983,1984,1985,1986,1987,1988,1989,1990,1991,1992,1993,1994,1995,1996,1997,1998,1999,2000,2001,2002,2003,2004,2005,2006,2007,2008,2009,2010,2011,2012,2013,2014,2015,2016,2017,2018,2019,2020) with the amount of (1546mm,1983.1mm,1696.8mm,2043.7mm,1710.9mm,1549.6mm,917.1mm,1781.1mm,1939.9mm,1450.6mm,1467.3mm,1532.4mm,1643.7mm,2083.4mm,1961.9mm,1706.5mm,1577.7mm,1663.1mm,2170.9mm,1919.4mm,2284.6mm,1496.1mm,1623.1mm,2026.5mm,1677.2mm,1725.8mm,1891mm,1770.8mm,1716.5mm,2084.3mm,1891.7mm,2170.3mm,1769.7mm,1669.5mm,1729.3mm,2137.7mm,1941mm.1,1929.6mm,2008.9mm,1818.9mm,1701.8mm,2393.4mm,1705.3mm,2173.3mm) rainfall respectively.

The decrease in rainfall occurs within the year (1973, 1976, 1983,1972,1971 and 1974) with the amount of rainfall (813.4mm, 889mm, 917.1mm,928.3mm,987.9mm and 1104.4mm) respectively.

5.0 Summary, Recommendations and conclusion

5.1 Summary of finding

Table 4.6 and figure 4.6 shows the annual and mean rainfall variability from 1971 to 2020 in one trench, Result shows there was more rainfall (1995,1997, 2008, 2012, 2018, and 2020) with the total amount of rainfall (2170.9mm,2284.6mm,2170.3mm,2137.7mm,2393.4mm and 2173.9mm) respectively. Decrease in rainfall in the study area was notice from the year (1973, 1976, 1983,1972,1971 and 1974) with the amount of rainfall (813.4mm, 889mm, 917.1mm,928.3mm,987.9mm and 1104.4mm) respectively. highest rainfall during this period is in the year 2018 with the amount of (2393.4mm) which signifies that 2018 from the trench of 50 years has the highest rain fall, which might have resulted to flooding, erosion and other impacts on landcovers of the city and has also in a way or the other affected famers and some other economic activities during this period. This is validated according to Okwu-Delunzu., Ogbonna and Ike. (2015) in their study of rainfall Variation and Gully Erosion in Nyaba River Basin of Enugu, South-Eastern Nigeria, that the increasing rainfall amount in the area during the high period of rainfall, contributed to erosion and land degradation in the study area. The rainfall showed greater causative effect as the cause of soil erosion. In addition, the degraded area covered 51% of total land area, implying that other land uses, made up the rest. The high positive Correlation of 0.8 between cumulative rainfall and percentage degraded area, further shows that rainfall highly affects the rate of soil erosion and land degradation. These also implies that the low amount of rainfall (813.4mm) in 1973 might has resulted to drought and degradations which directly affects landuse/landcover in the study area.

This increase and decreases in rainfall might be as a result of pollution on the earth atmosphere due to human inadvertent incursion into nature by ways of socio-economic activities that result to developmental initiatives, population growth, agricultural activities as well as growth in science and technology (Alexander, 2012). The 50 years' rainfall trench from the analysis implies significant variations of rainfall pattern in Enugu and a significant reduction in landuse/landcover overtime in the urban area.

5.2 Recommendation

This study recommends the following:

1. There is need to embark on robust education and enlightenment programs so as to increase the awareness of the populace on adverse effect of human activities which result to pollutant on the atmosphere and result to climate change, which directly affect the rainfall trend on landcover of the urban area.
2. More meteorological stations should be established in the region in other to closely monitor the changing pattern and trend of rainfall fluctuation.

3. Individual in the metropolis should be enlightened and encouraged to tolerant flooding and a way to manage the drought period in the urban area to improve economic activities.

5.3 Conclusions

The use of statistical tools to analyses rainfall variability has proven to be successful in various studies. According to Animashaun et al., (2020), Many studies have investigated rainfall trends and variability over the years in Nigeria, with most studies using tables and graphical plots to shed light on the dynamics of rainfall trends and variability over time. This study was conducted with the use of descriptive statistics such as frequency table and graphical tools. The study affirms that there is substantial evidence of rainfall variability in the study area within the period of investigation. Results of the analysis presented in this study affirm that rainfall is on an upward trend in Enugu urban area which is considered a good source for landcover and vegetation as well as plant growth. The high variability in rainfall in this urban centre is another confirmation of shift in rainfall during this period of trench while the low years of rainfall also signify the present of deductions in landuse/landcover and other impact on farming and economic actives.

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ASSESSMENT OF COSTING AND SCHEDULING IN CONSTRUCTION PROJECT MANAGEMENT IN SOUTH EAST, NIGERIA

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ABSTRACT

The study examined the costing and scheduling in the environmental industries, costing refers to the integration of environmental, social and economic considerations into construction business strategies and practices. It is the application of the principles of sustainable development to the comprehensive construction cycle from the extraction of raw materials, through the planning, design and construction of buildings and infrastructure, until their final demolition and management of the resultant waste. The broad objectives of the study is to examine the costing and scheduling in the environmental industries whereas the specific objectives are; to examine the impact of costing and scheduling in the environmental industries; to determine the effect of owner decision in design and construction of projects. The study adopted both survey and ex-post facto research design. The study used two states from the South East Nigeria (Anambra State and Enugu State). The use of linear regression and the application of ordinary least square (OLS) technique, graphs, t- statistics and the scatter plot analysis were adopted. The study shows that application of costing has very significant effect on the total cost of building projects up to and including the end of its useful life and disposal. The researcher recommends that there is need for the stakeholders in the building industry to empower the proper use of life cycle costing in their building cost profile so as to enable them have proper check and accountability of any problems in the building.

Keywords: ***Construction Costing, design,Environmental industries, Scheduling***

INTRODUCTION.

Costing is often brought forward as a potential facilitator and enhancer of competitiveness in construction industry when sustainable building is discussed. The construction industry is one of the biggest contributors to pollution and waste through its life cycle (Horvath, 2004). Construction projects investors before focused simply on acquisition costs during decisions making and often neglect future operation and maintenance costs, (Renanta, 2018). The trend has now changed significantly as greater attentiveness to consider costs over the life cycle of buildings have predominated. In the south east of Nigeria, particularly Enugu, and Anambra states, investors are often lamenting their shortsightedness as they often lose sight of Costing in some series of investment decisions.

The alternative is the use of Costing, which is a method of economic analysis directed at all costs related to constructing, operating, and maintaining a facility over a defined period of time,(Renanta, 2018).There is global concern about the consequences of human activities within our environment including building structures for commercial and residential purposes.

The global trend today in the construction industry is for the procurement experts to consider at inception and design stages, the application of life cycle tools in arriving at the estimated total cost of projects up to and including the eventual end of its useful life. This study tends to assess the sustainable Costing for building projects in South Eastern States. It will show the inter-relationship between the positive and negative impact on the residential development cost and also if the contractor/client will have any gain or loss during its use. This will also enable the reader, student and professionals have in-depth knowledge of sustainable costing methodology.

Statement of the Problem

Despite the fact that there are various benefit in costing, Nigerian constructing industry are yet to start implementing it. According to Kishk (2006) and Wu (2006), the failure of most construction engineers in adopting a proper integration of operational and maintenance cost into the business plan has led to several abandonment project, obsolesce, dilapidation, incomplete building project and several other negative activities going on in the construction industry. Lack of Lifecycle costing has rendered many building projects in state of regrettable condition.

Based on the aforementioned research problems, this study seeks to assess the relevance of costing for sustainable building project in the South Eastern states of Nigeria.

Aim of the Study

The aim of this research is to examine the costing and scheduling in the environmental industries with the objectives of:

1. Examining the impact of costing and scheduling in the environmental industries

2. Determining the effect of owner decision in design and construction of projects

Research Hypothesis

H_2 o Costing and Scheduling have no impact in the environmental industries.

Scope of the Study

The study is specifically delimited to two south eastern states of Nigeria, Enugu and Anambra state respectively. On the overall, nine organized sites were selected for the study.

LITERATURE REVIEW

Costing as a Tool

Costing is a tool for finding the lowest costs by analyzing this trade-offs. Depending on the asset that is being analyzed, the problems in quantifying the cost are different. If a large investment such as newspaper machine is analyzed, the problem is the amount of data that has been processed. If it is a small sub-system the costs and benefits might not be fully grasped. The nation's construction related materials end up in landfills, contributing to our solid waste management challenges. Some demolition derived wastes are recycled at relatively high rates and become valuable inputs to other materials. For example concrete incorporated into the aggregate material used for road construction, asphalt shingles become a component of the asphalt used to pave roadways, and gypsum wallboard becomes an input into the manufacture of Portland cement.

If projections are accurate, the scale of construction, renovation, demolition activity in the first 30 years of this nation will be substantial. By one estimate, the amount of built up space in Nigeria will continue to grow by approximate percentage of its current status, (Sire, 2004). In addition to the expected increase of new construction that will occur, more than a quarter of the buildings that existed in 1990 will be expected to be replaced by the year 2050.

Importance of Costing For Construction Projects

Fegebele (2004) affirms that most studies revealed that the output of the industry in Nigeria is quite low when compared with the construction industry of many developing countries on the imported input such as materials, machineries and skilled manpower. According to Pietroforle and Gregory (2003) the construction industry in some developed economies of Canada, France, Germany, Japan and USA contributed about 13%, 6%, 9%, 11%, 17% respectively to their gross domestic formation.

Chan (2001) stated that construction is the most sensitive to changes in both fiscal and monetary distributions. Chan (2002) the distinctive features of construction industry in developing countries are their heavy dependence on imported construction materials and components.

Structure of Sustainable Life Cycle Costing

Life cycle costing is a method of assisting in estimating the total cost of ownership. The technique is able to help make decisions within building investment projects and is particularly useful for estimating total costs in the early stages of a project.

Structure of Sustainable Costing

Source: Building and Environmental management site

Cost Analysis for Buildings

Costing is an economic estimation method that evaluates the entire cost of a building over its operating life, including initial capital costs, maintenance costs, operating costs and the ultimate disposal of the asset at the end of its life (Flanagan 1989). Kirk and Dell'Isola (1995) referred to costing as a management tool and a decision making tool; a management tool because it can be used to forecast the total costs that will be incurred during a building's life and a decision making technique because it can be used to pick amongst alternate projects. Unfortunately costing has not been practiced in Nigeria construction industry, not to talk of full implementation. Shade, (2018) opined that there are different terms used in the literature today like, "cost in use", "life cycle costs" (LCC), "whole life costing" (WLC) and "whole life appraisal" (WLA). Where (Flanagan and Jewell, 2005) defined that the terminology has changed over the years from "cost in use" to "life cycle costing" and further to "whole life costing". They defined the new term "whole life appraisal" which is globally used today and which contains consideration of the cost benefits and performance of the facility/asset over its lifetime.The draft of the Standard 15686-5 ISO(2005) instead makes a difference between the expressions WLC and LCC. Their contention is that WLC is equivalent to LCC plus external cost. Even there it is admitted that sometimes all terms are used interchangeably, but the Standard does try to interpret those terms more narrowly. The model from the American Society for Testing Materials, for example, distinguishes between energy and other running cost, which is useful in adopting different discount rates for different cost items.

NPV = C+R+S+A+M+E

C = investment costs

R = replacement costs

S = the resale value at the end of study period

A = annually recurring operating, maintenance and repair costs (except energy costs)

M = non-annually recurring operating, maintenance and repair cost (except energy costs)

E = energy costs

RESEARCH METHODOLOGY

Research Design

Research design includes the practical procedures adopted for accessing the subjects of the study. It is a broad plan of how the researcher intends to go about answering the research questions made the researcher to use survey research method. The researcher used survey design and *Ex post facto* research design for the research. The use of survey research method makes the data generated directly from respondents to be more distinct and finite whereas the *Ex post facto* research design is gathered from an already existing data site.

Types and Sources of Data:

Data for the research was sourced through primary and secondary data. The data was collected expressly to help solve the research problems.

Population of the Study

Preliminary survey of the study revealed that a total of one thousand and seventy one (1071) professionals, managers, directors and consultants, comprising of four hundred and sixty sx (466) in Anambra state, six hundred and five (605) in Enugu were used in the study area.

Table 4.1: Table showing the distribution of the respondents across the selected states in the South Eastern region.

	Anambra State	**Enugu State**	**Total**
Managers, consultants, directors and professionals	466	**605**	**1071**

Source: Ministry of Works and housing, Abia, Ebonyi and Enugu (2021)

These are the distribution of the respondents in the 2 South-Eastern state of Nigeria. Therefore, the population for this study covered 1071 respondents. These staff are believed to have adequate knowledge and experience on costing in their firms. Okolie, (2011) states that, a population is the aggregation of elements from which a sample is actually selected.

Determination of Sample Size

To get the sample size of the study, the researcher used Taro Yamane's principles of arriving at a sample size which is given as

$$\frac{N}{n = 1 + N(e)^2}$$

Where: n= Desired sample size

N= the entire population

e= level of significance or limit of tolerable error assumed to be 5% or 0.05

I= unit, constant figure

Therefore

$N=\frac{N}{1+N(e)^2}$

$n=\frac{1071}{1+1071(0.05)^2}$

$n=\frac{1071}{1+1071(0.0025)}$

n= 291.23

n= 291

Table 4.2 Distribution of Questionnaire

Group	Anambra	Enugu	Total
	143	**148**	**291**
%	**49**	**51**	**100**

Source: Researcher's field study (2018)

Regression Model

A four variables multiple linear regression will be used for this research; with the dependent variables as estimated total cost while the independent variables include capital cost, operating cost and maintenance cost; using the following mathematical expression;

Y =a +bx

Where y = dependent variable

a =the intercept

x_1, $x_{2,}$ x_3 =independent variables

b =coefficient of x or the slope

The difference between the actual and predicted values of y for each case is called the residual, that is the error in prediction and may be represented by the expression;

Testing of hypotheses

Hypotheses postulated are put in null (Ho) and was tested as follows.

One way Anova was employed to validate hypothesis one. It was used to find out variance between the two groups and variance of the observations within groups. The one way Anova was used to assess the respondent's opinion (Staff of SMCFs) on the TQM implementation in SMCFS in South-East of Nigeria.

Decision rule: The predetermine level at which the hypothesis could be rejected or accepted was fixed at 0.05 (5% significance level) such that if the probability value in the Anova table is > 0.05 level of significance, we accept the null hypothesis, otherwise we reject the null hypothesis.

DATA PRESENTATION, ANALYSIS AND DISCUSSION OF FINDINGS

Main Analyses

Analysis of the first objective

To examine the impact of costing on cost profile of building project

5.4.1 Descriptive Statistics

	Mean	Std. Deviation	N
Estimated total cost	120234000	.92013	10
Capital cost	88918000	.22500	10
Operational cost	72991000	.61319	10
Maintenance cost	21735000	.38645	10

Source: Field survey (SPSS Computations)

The result of the descriptive statistics above is set to determine the estimated mean and standard deviation of each component for 10yrs. The result shows that the mean value of the estimated total cost is 120234000 with a corresponding standard deviation of 0.92013. Also, the mean value of the capital cost is 88918000 with a corresponding standard deviation of 0.22500. More so, the mean value of operational cost is 72991000 with a corresponding standard deviation of 0.61319. Finally, the mean value of maintenance cost is 21735000 with a corresponding standard deviation of 0.38645

Regression result used for measuring the impact of costing on elemental cost profile of building

Dependent Variable: ETC				
Method: Least Squares				
Date: 06/22/20 Time: 20:10				
Sample (adjusted): 1981 2017				
Included observations: 37 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	20567.07	9765.136	2.106173	0.0431
CC	1.200775	40733.31	2.947896	0.0059
OC	5.104792	9049.358	0.564105	0.0066
MC	7.918684	4486.167	1.765134	0.0071
R-squared	0.772129	Mean dependent var		32737.66
Adjusted R-squared	0.968645	S.D. dependent var		18865.42
S.E. of regression	3340.544	Akaike info criterion		19.19074
Sum squared resid	3.57E+08	Schwarz criterion		19.40844
Log likelihood	-350.0288	Hannan-Quinn criter.		19.26749
F-statistic	279.0391	Durbin-Watson stat		0.675714
Prob(F-statistic)	0.000000			

Source: Field survey (E views Computations)

The regression result above indicates that all the variables under study (capital cost, operating cost and maintenance cost) has a positive relationship on the estimated total cost of a building project such that a unit increase in capital cost will lead to 1.200775 increase in the estimated total cost of a building project, whereas a unit increase in the operational cost will lead to 5.104792 increase in the estimated cost of a building. Finally, a unit increase in the maintenance cost will lead to 7.918684 increase in the estimated cost of a building on the average. This implies that an increase in either the capital cost, operational cost and maintenance cost will lead to increase in the estimated total cost of a building.

The result of the t-statistics shows that both capital cost, operational cost and maintenance cost have significant impact on the estimated total cost of a building because the probability value is <0.05

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.772a	.972	.969	3340.54432	.972	279.039	4	32	.000	.676

a. Predictors: (Constant), Average monthly payment, Value of time currency, Average rent time, Value of time new user

b. Dependent Variable: Lease time gain

R square used in measuring the rate the independent variables (capital cost, operational cost and maintenance cost) explains what happens on the dependent (estimated total cost). The result of the R square shows that the rate the independent variables explains what happens on the dependent is 77%. This implies that capital cost, operational cost and maintenance cost controls 77% of the estimated total cost on the average.

ANOVA[a]

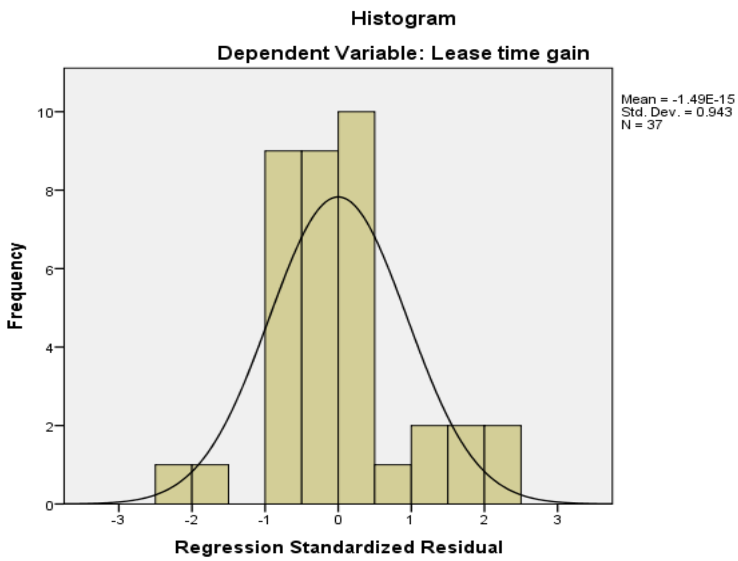
Model		Sum of Squares	Df	Mean Square	F	Sig.
	Regression	12455451192.122	4	3113862798.030	2.039	.000[b]
1	Residual	357095562.598	32	11159236.331		
	Total	12812546754.719	36			

a. Dependent Variable: Lease time gain

b. Predictors: (Constant), Average monthly payment, Value of time currency, Average rent time, Value of time new user

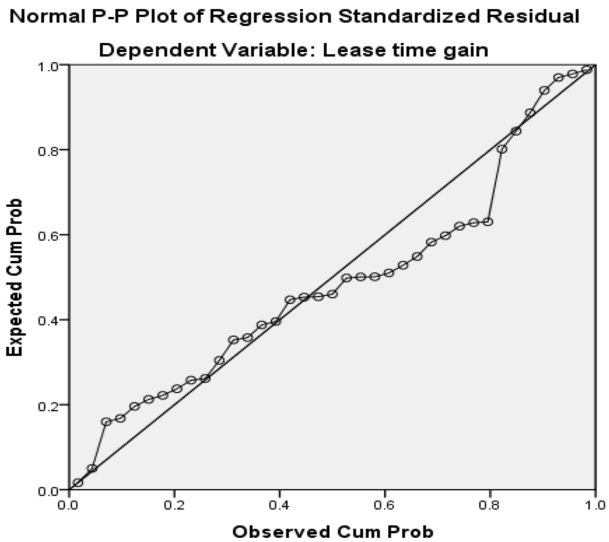
f-statistics which examines the joint influence of all the independent variables on the dependent. The test of f-statistics above shows that the independent variables (capital cost, operational cost and maintenance cost) jointly have significant impact on the dependent (estimated total cost)

Measurement of the Normality distribution of the residual



The histogram graph presented above which is used to examining the normality of the residuals. As stipulated by Gujarati (2004) under the residual diagnostic, if the residual of the observed statistics are not normally distributed, the estimated value of the parameters cannot be used in making future predictions. As can be vividly seen, the histogram normality is in bell shape curve, spreading evenly around the bars which is an indication that the residuals are normally distributed.

Examining the residual plot of the variables under study



The line of fit probability plot which is used in checking the normality of the residual in the observed variables, as can be vividly seen in the two charts, the residuals is normally distributed around its mean value. More so, the scatter dots are perfectly fitted in the regression line with a minor variations which is believed by the researcher to be insignificant.

Analysis of the second objective

To determine the effect of owner decision making in design and construction of projects

4.2 Presentation of base Data

Data on questionnaire response as well as socio-economic characteristic of respondents were presented in this section.

Group	Population	Sample Size	Questionnaire distributed	Questionnaire Returned	Questionnaire not returned	Percentage of Questionnaire Returned
Anambra	466	**143**	**143**	**100**	**43**	**70%**
Enugu	**605**	**148**	**148**	**130**	**18**	**87%**
Total	**1071**	**291**	**291**	**230**	**61**	

The above table shows that a total of 291 copies of questionnaire were administered. A total of 230 were completely field and returned while 61 questionnaire were not returned by the respondents

To determine the effect of owner decision making in design and construction of projects

		ENUGU STATE								ANAMBRA STATE							
S/N	***Owner decision making***		***VGE***	***GE***	***LE***	***VLE***	***∑FX***	***$\bar{x}$***	***Result***		***VGE***	***GE***	***LE***	***VLE***	***∑FX***	***$\bar{x}$***	***Result***
1	Owner's decision making helps the construction engineers to know the taste of the owner	F WF	44 176	25 75	15 30	16 16	100 297	2.97	ACCEPT	F WF	57 228	35 105	20 40	18 18	130 391	3.00	ACCEPT
2	Owner's decision making can slow down the pace of the building	F WF	50 200	20 60	12 24	18 18	100 302	3.02	ACCEPT	F WF	49 196	38 114	23 46	20 20	130 376	2.89	ACCEPT
3	Owner's decision making can lead to alteration in the building designs	F WF	46 184	27 81	16 32	11 11	100 308	3.08	ACCEPT	F WF	50 200	30 90	25 50	25 25	130 365	2.80	ACCEPT
4	Decision of the owner can promotes inaccurate building plans and designs	F WF	15 60	15 45	10 20	60 60	100 185	1.85	REJECT	F WF	22 88	18 54	55 110	35 35	130 287	2.20	ACCEPT
5	Decision of the owner can instigate the choice of using inferior materials due to finance	F WF	38 152	28 84	19 38	15 15	100 289	2.89	ACCEPT	F WF	45 180	35 105	18 36	32 32	130 353	2.71	ACCEPT

6	Owner's decision in building construction can lead to collapse of the building	F WF	25 100	16 48	30 60	29 29	100 237	2.37	ACCEPT	F WF	39 156	49 147	25 50	17 17	130 370	2.84	ACCEPT
7	Owner's decision can promotes project abandonment	F WF	39 156	30 90	15 30	16 16	100 292	2.92	ACCEPT	F WF	44 176	34 102	28 56	24 24	130 358	2.75	ACCEPT
8	Owner's decision can enhance mistakes in the building plan	F WF	44 176	20 60	18 36	18 18	100 290	2.90	ACCEPT	F WF	52 208	41 123	17 34	20 20	130 385	2.96	ACCEPT
9	Decision of the owner can bring confusion to the construction engineers	F WF	33 132	35 105	20 40	12 12	100 289	2.89	ACCEPT	F WF	47 188	36 108	24 48	23 23	130 367	2.82	ACCEPT
10	Decision of the owner can help in aligning the thought of the builder	F WF	13 52	18 54	20 40	49 49	100 195	1.95	REJECT	F WF	18 72	21 63	30 60	61 61	130 256	1.96	REJECT
	Total																

Source: Filed survey

The table above shows the opinion of the respondents on the effect of owners decision making in design and construction of projects in the two states under study. the total number of respondents in Enugu is 100 whereas the total number of respondents in Anambra is 130. The researcher has four likert questionnaire options with 2.0 criterion mean baseline. All the mean values in Enugu state are above the criterion baseline of 2.0 except questionnaire 4 and 10 which has the mean value of 1.85 and 1.95 respectively. This implies that owners decision effect the designs and construction of project in Enugu state.

More so, all the mean values in Anambra state are above the criterion baseline of 2.0 except questionnaire number 10 which has a mean value of 1.96. this implies that owners decision has impact on the designs and construction of project in Anambra state.

TEST OF HYPOTHESES

Hypotheses Two

Ho: *Sustainable costing does not have impact or effect on elemental cost profile in building.*

One-Sample Test

	Test Value = 0					
					95% Confidence Interval of the Difference	
Null Hypothesis	T	Df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Sustainable Life Cycle Costing does not have impact or effect on elemental cost profile in buildings.	0.013	10	.041	0.00130	0.12	0.34

Source: SPSS Computation 2021

From the test of hypothesis above using one sample test t-statistics, based on the decision rule, accept null hypothesis if the value of the t-statistics is greater than 0.05, from the result; the value of the t-statistics (0.013) is less than 0.05 hence we reject the null hypothesis and conclude that Sustainable Life Cycle Costing have impact or effect on elemental cost profile in buildings..

CONCLUSION AND RECOMMENDATION

5.1 Summary of key Findings

(1) Capital cost, operating cost and maintenance cost have positive impact on estimated total cost of a building.
(2) The rate at which the capital cost, operating cost and maintenance cost impacts on estimated total cost of building is 77%
(3) Owners decision making affects the designs and construction of project in Enugu and Anambra state.
(4) The result of the hypothesis indicates that life cycle cost have significant impact on elemental cost profile of buildings.

Discussions

This research is based on the application of life cycle cost on the elemental cost profile of building construction. The research explored qualitative and quantitative method of data generation which comprised the design, pre-test and administration of structured questionnaire to the sampled states in South-East (Enugu State and Anambra state). This was followed by qualitative instruments like interviews and direct observation which were used to generate important constructs from the target population. Data and information obtained from the quantitative research instruments were used to test the hypotheses postulated by the researcher.

Conclusion

The signs of some of the variable coefficient from the estimated framework are totally in line with a priori expectations. It is expected that an increase in capital cost, operating cost and maintenance cost will lead to increase in elemental cost profile in the sampled states.

The constant term is estimated at 20567.07 which means that the model passes through the point 20567.07 mechanically, if the independent variables are zero, elemental cost profile in the sampled states would be 20567.07 (Gujarati and Sangeetha, 2007).

The estimated coefficient for capital cost, operating cost and maintenance cost is positive which indicates that they have positive impact on elemental cost profile of a building.

The P.P. plots indicates that the residuals are normally distributed as the scatter dots are seen to be trending around the regression line. Owner’s decision has significant impact on the two states sampled in south East (Enugu state and Anambra state)

6.4: Recommendations.

1. The study having indicated that sustainable life cycle costing have significant impact on the cost profile of building project, there is need for the stakeholders in the building industry to empower the proper use of life cycle costing in their building cost profile so as to enable them have proper check and accountability of any problems in the building.
2. The result of the study indicating that the owner decision making affect designs and construction of projects is a strong indication that the owner have to be sensitive to any decision being made in the building so as to avoid future regrets and building failures which will have a long run impact on the cost and maintenance of the building.

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ASSESSMENT OF UNIMPLEMENTED BUDGET IN CONSTRUCTION INDUSTRY IN ENUGU STATE, NIGERIA

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ABSTRACT

The Nigerian construction industry has drastically faced with housing challenges in term of allocation, deficit and its implementation. This is due to delays in projects delivery as well as resulted in low budget implementation and performance; this has also limited the executive arm's ability to effectively execute state based projects; increase in crime and other immorality in Enugu state Nigeria. This paper examines the challenges and its impact on unimplemented budget on housing in Enugu State, Nigeria**.** Secondary data were collected from experts working in state civil servants concerned with budgeting and housing matters in Enugu State. Two hundred and seventy seven (277) well questionnaires were properly completed, formed the basis of the study and were analyzed by model specification, regression and ranking. The result of the objectives revealed that the identified challenges of unimplemented housing budget on housing provision are its limits to the provision of social and economic needs of the masses; high cost of building materials; excessive project abandonment; it promote mushrooming squatters around the town; and increases numbers of unemployed youths in overcrowded squatter area. The study finally recommended that government should know that housing sector is one of the basic necessities of life based on recent precedence apart from job creation, provision of basic amenities etc; the government should be the regulator of housing sector to ensure sustainable/efficient contribution toward housing provision and its implementation Enugu state, Nigeria.

KEYWORDS

Budget Allocation, Construction Industry, Cost, Housing, Implementation

1.0 Introduction

Many scholars have given different definitions depending on their perspectives and field of study such as Gladys (2019) defines budget as an estimation of revenue and expenses over a specified future period of time; it is compiled and re-evaluated on a periodic basis. A budget is seen as the road map that can guide you to where you want to go; it can direct you in making expenditure which will help you to meet your set goals (Chartered Institute of Cost and Management Accountants (CICMA), 2003). Besides, the budget document is the mechanism through which government establishes its economic and social priorities, sets the direction for the entire economy, determines who gets what and when, as well as provides funds to implement new initiatives/policies (Bengali, 2004).

The ultimate aim of budgeting in every organisations is to maximize resources in the best possible way so as to achieve a workable goal Cunneen, (2006). Government budget is a public document that sets how a government in power particularly, a country proposes to collect and spend money. In outlining its plans for spending money, a government explains how it intends spending money that belongs to the public (Shultz, 2002). While Housing (shelter) is undoubtedly a major welfare concern to the inhabitants of any geographical location on earth. It is of supreme importance to man and one of the best indicators of a person's standard of living and his place in society (Ugonabo and Emoh, 2013). It is unarguably one of the first and basic necessities of man and ranks second after food in the hierarchy of man's needs (Ebie 2009; Ugochukwu, Okolie, Alintah-Abel, and Keke, 2018). It embraces all social services and utilities that make a community or neighbourhood a livable environment; which makes it a human right. Furthermore, appropriate allocation of housing projects can enhance economic growth and reduce poverty through the provision of social services and infrastructure facilities. Economists expect any budget that is properly formulated and implemented to be comprehensive, transparent and to be characterized by probity, accountability and measurability.

While budget implementation is the process of disbursement and collection of funds/values Ugochukwu (2018). Meyers (1999) emphasizes that, since wealth and time are scarce resources to all organizations and government. Again, it obvious that no federal budget since 1999 has been fully implemented arising from incompetence and the fact that the budgets are ‘’unimplemented’’. Therefore, effective utilization of these resources ensures careful planning and control, hence, the need for an effective budgeting implementation is to necessitate a careful provision of scarce resources to vital sectors of an economy.

It is harder task than the preparation because budget as a distributive policy can only make its deliberate impact only when the implementation is even, smooth and strictly carried out. This is the most crucial aspect of budget which is implementation. This is where the success or failure of the entire budget is determined/ depended on when the project are met, but when reverse are not met; it cause a great havoc to the community and to the Nigeria at large especially in an economic impact. More often, if a state projects are solely dependent on revenue projections of the state and unfortunately, they are not met, with the expenditure projection, it stands the chances of failing. Therefore, it will be better if a state has various ways of generating revenue including different taxes like income tax, pay-as- you- earn and Value Added tax (VAT) so as to avert the chaos in the country.

Importantly , government’s aim is to set an effective and efficient budget allocation system in order to necessitate the fact that even with the recent rebased GDP which makes Nigeria the 26th largest economy in the world and 121st in terms of GDP per capital, the poverty is still becoming high (Adio, 2014). Unfortunately, Centre for Social Justice (CSJ)(2016) certified that FGN budgeted 0.65%, 0.46%, 0.16% and 1.13% of its overall budget for the housing sector in the years 2018, 2019, 2020 and 2021 respectively which have become more negligence to the provision of housing thereby causing inequality between allocation and its deficits. Un-implementation of budget toward housing have generated Maku(2009) attributes increase to the lack of government and monitoring of the contract awarding process of capital projects, the ineffective deployment of government funds to construction projects, and the lack of transparency and accountability of budget allocation and management by the government regarding government's spending (Oluwatobi and Ogunrinola, 2011).

Improper budget allocation management have been a consistent issue in Enugu State, Nigeria and this has triggered delays in projects delivery as well as resulted in low budget implementation and performance; this has also limited the executive arm's ability to effectively execute state based projects in the south east (Ugonabo and Emoh ,2013). Moreover, in some developing countries like Nigeria, it has become increasingly complex to manage budgets, as the roles of the government keep expanding despite scarce financial resources needed to meet its ever-increasing population, this limitations has warranted to ineffective construction projects delivery which have left an indelible mark on the nation(Mohammed, 2015). This research therefore intends to fill this obvious and identified gaps such as, determine certain challenges; its impacting unimplemented budget towards housing in the state and finally, possible solution of unimplemented budget in Enugu State, Nigeria.

On this premise, there is need to assess an effective and stratified standard for budget allocation for construction projects in Enugu state which serve as an holistic approach in addressing the housing projects budget implementation problems identified as well as improved construction projects delivery.

2.0 Related literature

2.1 The Housing Scenario in Enugu State

The problem of housing is obviously a global one. The housing need of every single individual or organization may be impossible to meet, since financial resources are limited**.** The Bureau which put the nation's housing shortage at 18 million, described the situation as unhealthy for a developing country such as Nigeria. The present day Enugu metropolis is made up of three local government areas comprising of eighteen (18) formal neighborhood layouts with over seven informal neighborhood settlements and is internationally ranked as the 553rd city in the world and increases at a growth rate of 2.55% and net migration rate of -0.22 migrant(s)/ 1,000 populations (Demographia, 2013); Enugu State like every other state across the federation has its own housing challenges. The problem is so pronounced, that over 75percent of the state workers/civil servants still operate from Nsukka, Anambra State; a journey of at least two hour to Enugu and other cities outside the state. This has led to low productivity, lateness and truancy. To corroborate this assertion, Ikejiofor (2009) stressed that the gory picture and deplorable condition of housing in Nigeria as discussed earlier applies to a large extent to Enugu State, considering that more than 70% of the State's population live in urban areas.

Thus, Enugu State shares in this global developmental reality; and hence one of the most important challenges facing the State is how to provide adequate and affordable housing for both poor and low-income groups. People demonstrated in huge numbers to make the government aware of their needs, and to show how desperate the citizens needed the government's support. Recently, In Enugu State, the Governor presented keys of 100 apartments to some civil servants in the State in 2016. In 2017, the Federal Government inaugurated 91 units of 3 bedroom bungalows in Vivian Estate, Abakpa Nike, in Enugu East local Government Area. While, according to the Enugu State Housing Development Corporation, (ESDC 2018) Governor pledged his commitment to affordable Housing. Unfortunately, despite all efforts of the state government at achieving sustained housing delivery to the common people, existing realities indicate that the goal is far from being achieved. The major problems is the inability of organizations to plan and accomplish goals which can be traced to their inability to apply controls and accountability in the budgeting allocation system as asserted by Okeke, F.N. , Okoye, P.U., Obiora C.O and Bert - Okonkwo C.B.N (2022).

Since the creation of Enugu State, the housing situation in the state could be described as deplorable, and this requires a declaration of state of emergency in the sector. Residential accommodation and public buildings are very scarce that even some government offices are still operating in rented houses Aka, (1993). This scarcity of housing has pushed the cost of rented buildings very high as an average 2 bedroom flat rents between N212, 000.00 – N250, 000.00 per annum and 3 bedroom flat rents between N250, 000.00 – N350, 000.00 per annum a bungalow lets for between 470,000.00 – 650,000.00 per annum a duplex lets for between N750, 000.00 – N1,400,000.00 per annum in the major locations of Enugu urban, as stated by Chukwu, Aniagolu and Obodo (2016). Unfortunately, it is incomparable to the previous due to skyrocketing of building materials, foreign exchange, rise and fall in dollar rate and etc.

Obviously these rents are not affordable to majority of the civil servants resulting in emergence of squatter settlements as alternative accommodation. Extensive illegal and unregulated building patterns dominate the urban towns in the state. Buildings are put up without regard to existing building and health codes or zoning and subdivision regulations - thus creating slum and squatter conditions in which most residents in the state now live. This ugly situation still persists today and not much has been done by government to increase the housing stock in relation to demand for residential accommodations in the state. Cost of building houses is on the increase every day and it is becoming increasingly difficult for an average civil servant to build their own houses unless the government embarks on a massive execution of low cost housing estates/schemes in Enugu North, East and South, due to an ever increasing urban population and rise in both commercial and administrative activities Idu (2009).

Realizing this fact, the only means to secure access to land has become a fundamental challenge to housing delivery in urban areas, successive governments in Enugu State have developed / created government residential estate/layouts in the three major zones of the Enugu through public - private partnership namely Enugu North, Enugu East, Enugu South. Some of these residential layouts were fully/partly developed with housing units and sold to the public while the rest were developed/ created as site and services schemes atrer allocated to members of the public. Similarly, there are some housing estates promoted and developed by the State Government parastatals/corporations like ESHDC, and Ministry of Works and Housing Enugu State.

This involves the provision of land by the state government to the corporation, issuing certificate of occupancy, handing over land, granting planning approval and providing necessary support to facilitate the execution of the housing project. Armed with the certificate of occupancy, the corporation develops the estate either as fully/partly developed housing units or as site and services scheme and sell the plots of varying sizes to members of the public. The corporation grants lease of the extent terms to the prospective purchasers who register same at the lands registry as bona fide lessees (ESHDC 2019 and MWH 2019)

One characteristic of these government residential layouts including those developed by the ESHDC, sometimes lacks infrastructural facilities like roads, drains, electricity, water etc. The absence of infrastructural facilities in these layouts has further compounded the problem of housing shortage in Enugu State. Table 2.8 shows some existing housing schemes developed and under develop by the ESDHC and Ministry of Works and Housing Enugu State and Ministry of lands that was gathered for this study.

Table 2.1: Existing State Government Residential Layouts/Estates in Enugu State

S/N	Name of Estate and Location	No of Residential Plots	Status of Development
1	Old GRA	1071	Fully developed and functional
2	New GRA, Enugu	473	Fully developed and functional
3	Independent Layout	2725	Fully developed/ functional.
4	Independent layout Phase	2725	Fully developed/ functional.
5	Trans Ekulu Phase 1-111, Enugu	739	Fully developed and functional. Managed by the Housing Corporation
6	Gulf Cost Ernest Layout Estate	541	Fully developed and functional. Managed by the Housing Corporation.
7	Maryland Estate , Enugu	696	Partly developed. Managed by the Housing Corporation.
8	Liberty Estate Enugu	10	Developed, managed by the Housing Corporation.
9	Trinity Estate	1223	Developed, managed by the Housing Corporation. a settled layout..
10	Coal City View Enugu	2000	Developed, managed by the Housing Corporation. Returned to natives

11	Akpogu Satellite Estate	369	Allocated, not develop and no infrastructure
12	Codial Estate Iyiagu Layout	410	Allocated, not develop and no infrastructure
13	Rehoboth Estate Enugu	232	Allocated, not develop and no infrastructure
14	Satellite Estate Gariki Enugu	25	Settled, but no infrastructure. The layout is dormant.
15	Ogbonnaya Onovo Police Station	330	Settled, but no infrastructure in place. Yet to be allocated to the general public.
16	Ikenga Estate Ogurugu Road	333	Not settled, dormant and non functional.
17	Heritage Estate	700	Fully developed and functional. Managed by the Housing Corporation..
18	Valley Estate	112	Fully developed and functional, managed by the Housing Corporation
19	Ehocol Estate Phase 1-111	54	Fully developed and functional, managed by the Housing Corporation
20	Ivory Quarter A, B & C	248	Developed, managed by the Housing Corporation
21	Pocket Layout Ind. Avenue	8	Fully developed and functional, managed by the Housing Corporation
22	Citadel Phase 1&11	420	Fully developed and functional, managed by the Housing Corporation
23	Lakeside	71	Not developed, managed by the Housing Corporation
24	Transparency	400	Partly developed, managed by the Housing Corporation
25	CCG	32	No infrastructure, partly developed and functional and managed by Housing Co.
26	Ekulu East	369	Not settled, dormant and non functional.
27	Trinity Estate	1315	Not developed, managed by the Housing Corporation
28	Sunrise Estate .	80	Not developed and functional.
29	Real Estate	269	Not developed and functional.
30	Sandview	423	Fully sold, no infrastructure, not developed and not yet functional
31	Fidelity	370	Fully sold, no infrastructure, not developed

			and not yet functional
32	Divine	123	Fully sold, development ongoing
33	Demand Layout	200	Fully developed/ functional.
34	Vivian Estate,91housing units, Abakpa Nike, Enugu	91	Yet to kick-off, non-release of funds by the Government.
35	Phase I1 Extension Indep. Layout		Allocated, not develop and no infrastructure
36	Ebeno Housing Estate 25 units , Enugu	25	Fully developed/ functional

Source: Adopted from ESHDC and MWH (2019) and updated by the researcher

2.2 Causes of Unimplemented Budget Toward Housing Projects

Over the years, the implementation of the annual budget has been a source of concern for successive governments in Nigeria. It is pertinent to note that the Nigerian budgeting process suffers; so much from lack of technical expertise or design, poor performance, lack of commitment to good governance for the effective implementation of the budget, inadequate budgeting and budget deficit, increment of taxation on basic building materials Mogbo (2001). Earlier than now, the curse of the successive budgets implementation in Enugu State, Nigeria includes planning and policies, budget indiscipline, political instability, inconsistent economic non accountability, inadequate monitoring framework, ignorance of inputs from interest groups, allocation of huge amounts to debt service, use of in accurate data, allocation of more fund to recurrent expenditure than capital expenditure, depending on market mechanism and increase in money supply through high deficit financing (Kayode, 1991; Aluko, 1994; Oniore, 2014).

In the opinion of Inang (1997) and Asiodu (2000), the budgeting process and its implementation in Nigeria has suffered from lack of transparency, openness, Budget deficit**,** Excessive corruption, accountability, reduced bureaucracy, Incomprehensive, un-implementable and unsustainable programmes on housing development and adherence to established financial rules and regulations to the extent that ministries and agencies were hardly aware of allocations made to them in a given year.

Obviously, Lack of a good mortgage finance system as such in Nigeria is largely responsible for the incremental housing construction cost, a trade mark of Nigerian urban housing markets, where houses take many years to complete, sometimes never (Sa-Aadu & Malpezzi, 1996). Moreover, the bank lending capacity does not favour low-income households in Nigeria. A well-planned housing finance structure with good funding mechanisms can make a significant impact toward an inexpensive housing provision to all Nigerians regardless of their social standing or position

2.3 Effect of Unimplemented Budget towards Housing in the state

The capital budget is mostly centered on national budget that determines the allocation of funds to finance capital projects and critical infrastructures, such as the construction of roads, bridges, hospitals, schools, prisons, public administrative buildings, highways, dams, and irrigation systems; the purchase of machinery and equipment; and the supply of water, electricity, and transport, health, and educational facilities (Asghar, Hussain, and Rehman, 2012).
For a public budget to effectively perform its role, it should be well designed, effectively and efficiently allocated, and adequately monitor and implemented (Faleti and Myrick 2012).A well-functioning budget allocation and implementation system is vital for the formulation of sustainable fiscal policy and the facilitation of economic growth (Ohanele, 2010) (Olomola, 2006b). But unimplemented budget in all aspect especially in housing have seriously deepen the acceleration economic growth, dwarfing the employment opportunities, and increases the poverty and reduces income inequality Othman (2012); Iyi and Odoh (2009); Edeme and Nkalu (2017);Oniore,(2014) and Ikejiofor (2009) and others are as follows;

a) Basic needs such as social and economic sustainable developmental objectives will not be provided to the society by the government.
b) High cost of building materials out of reach of countless people.
c) Lack of a coordinated system to provide housing to the fast growing population of urban dwellers.
d) Excessive projects abandonment.
e) Excessive of mushrooming squatters around the towns.
f) Overcrowding in various dwellings emancipates due to rapid growth of population in cities and towns, looking for better jobs and community service in order to earn their living.
g) Poor conditions of service infrastructure and basic services of water and sanitation pose another challenge of health wellbeing of populations involved.
h) Increased numbers of unemployed youths in overcrowded squatter areas has led to another social challenge.

3.0 Research Methodology.

To achieve the aim of this study, a survey design approach was conducted and data was collected from experts from state civil servants concerned with budgeting and housing matters in Enugu State, Nigeria. such as Enugu State Economic Planning and Commission, Ministry of Budget and Economic Planning, Enugu State Housing Development Corporation and Ministry of Lands and that was conducted in Enugu town. Hence, stratified simple random sampling technique was used in selecting the professionals from the target population of 903 using Taro Yamanes formular to ascertain survey size of nine hundred and three obtained from related text books, journals and book of proceedings were used while some face and content interview with MDGs and most of questionnaires were relied on the review of related literature, published budget estimates of Enugu State (2018 – 2021).Meanwhile, statically ranking, simple regression andE-view computation were used to analyze the data collected, thus embracing the objectives of the study.

Sample Size Determination

According to Taro Yamane (1964), states that the sampling of population of a large size will be time consuming and exorbitant. However, the researcher applied Yamane statistical formula to reduce the population to a researchable size, to determine sample size from the population, the formula is given thus:

$$N= \frac{N}{1+N(e^2)}$$

$1 + N(e)^2$

Therefore: N = 903 e = 0.05

The formula becomes:

$$n = \frac{903}{1 + 903(0.05)^2}$$

$$n = \frac{903}{1+903(0.0025)}$$

$$n = \frac{903}{1+2.2575}$$

$$n = \frac{903}{3.2575}$$

n= 277.2064467

n= 277 by Approximation.

Therefore, the sample size for the study is 277.

The sample size was two hundred and seventy seven (277), selected from the population.

Model Specification

This study shall build a simple regression model in order to examine the impact of unimplemented budget on housing provision in Enugu state.

HP = F(UNIMPHB)

HP = β_o + β_1UNIMPHB + μ

Where

HP = Housing provision

UNIMPHB = Unimplemented Housing Budget

4.0 Data Analysis and Discussions.

Most of the questions in the questionnaire relied on the review of related literature, published budget estimates of Enugu State (2018 – 2021) with some face and content interview with MDGs about the determine certain causes; its effects of unimplemented budget towards housing in the state and finally, possible solution of unimplemented budget in Enugu State, Nigeria. The data analysis thereby will employ the following**:**

Analyses of the first Objectives

Table 4.1*To determine the challenges of unimplemented housing budget on housing provision*

NO		SA 4	3	2	SD 1	Total	∑FX	$\bar{x}$	Rank
1	It limits the provision of social and economic needs of the masses	**102**	**86**	**46**	**21**	**255**			**1**
		408	**258**	**92**	**21**		**779**	**3.05**	
2	It promotes high cost of building materials	**99**	**87**	**46**	**23**	**255**			**2**
		396	**261**	**92**	**23**		**772**	**3.02**	
3	It leads to excessive project abandonment	**98**	**84**	**49**	**24**	**255**			**3**
		392	**252**	**98**	**24**		**766**	**3.00**	
4	It promote mushrooming squatters around the town	**101**	**68**	**45**	**41**	**255**			**4**
		404	**204**	**90**	**41**		**739**	**2.89**	
5	It increases numbers of unemployed youths in overcrowded squatter areas	**98**	**70**	**43**	**44**	**255**			**5**
		392	**210**	**86**	**44**		**732**	**2.87**	
	Grand Total								**2.85**

Source: field survey computation

The result of the first objective reveals that the identified challenges of unimplemented housing budget on housing provision are it limits the provision of social and economic needs of the masses; it promotes high cost of building materials; it leads to excessive project abandonment; it promote mushrooming squatters around the town; it increases numbers of unemployed youths in overcrowded squatter area.

Analyses of the Second Objective

Table 4.2: ***To determine the impact of unimplemented budget on housing provision in Enugu State.***

Year	**Overall Federal Budget**	**Total Allocation to housing**	**% of Vote to housing to overall vote**	**Funding Projection**	**Variance between allocation and the projection**
2018	**4,987,382,196,690**	**32,179,108,276**	**0.65**	**833,000,000,000**	**800,820,891,724.00**
2019	**4,695,190,000,000**	**21,381,376,410**	**0.46**	**833,000,000,000**	**811,618,623,590.00**
2020	**4,493,363,957,158**	**7,312,088,618**	**0.16**	**833,000,000,000**	**825,687,911,382.00**
2021	**6,060,677,358,227**	**68,540,521,680**	**1.13**	**833,000,000,000**	**764,459,478,320.00**

Source: Budget Office of the Federation and Retrogressive View on the Mortgage Refinancing Company

FGN budgeted 0.65%, 0.46%, 0.16% and 1.13% for the years 2018, 2019, 2020 and 2021 respectively. This is an average of 0.60% for the four years. This is a very low percentage of the budget voted for the sector. The total sum budget for the sector in four years comes up N129.413 billion which is an average of N32.35 billion a year. The funding gap for the four years comes up to N3.202 trillion and a yearly average of N800.64billion. It seems that this projection includes private sector funds. This informs the wide gulf between the projections and budgetary votes.

Table 4.3: Regression result showing the impact of unimplemented budget on housing provision in Enugu State

Dependent Variable: HP
Method: Least Squares
Date: 04/28/22 Time: 08:13
Sample: 2018 2022
Included observations: 12

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	267.7911	281.2432	0.952169	0.3778
UNIMPHB	-0.004379	0.006586	-0.664811	0.5309

R-squared	0.947331	Mean dependent var	634.7008
Adjusted R-squared	0.903441	S.D. dependent var	80.55113
S.E. of regression	25.03044	Akaike info criterion	9.584915
Sum squared resid	3759.137	Schwarz criterion	9.827368
Log likelihood	-51.50949	Hannan-Quinn criter.	9.495150
F-statistic	21.58395	Durbin-Watson stat	1.357600
Prob(F-statistic)	0.000903		

Source: E views Computations (2022)

Where

UNIMPHB = Unimplemented Housing Budget

HP = Housing Provision

This subsection is concerned with evaluating the regression results based on a priori expectations. The signs and magnitude of each variable coefficient is evaluated against theoretical expectations.

The signs of the variable coefficient from the estimated model are in line with a priori expectations, unimplemented housing budget is seen to have a negative relationship with housing provision indicating that an increases in unimplemented housing budget will lead to decrease in housing provision in Enugu State on the average.

The constant term is 267.7911, which means that the model passes through the point 267.7911 mechanically. If the independent variable (unimplemented housing budget) is zero, housing provision would be 267.7911, (Gujarati, 2007).

The estimated coefficient for unimplemented housing budget is -0.004379. This implies that if we hold all other variables affecting housing provision constant, a unit increase in unimplemented housing budget will lead to a 0.004379 units decrease in housing provision on the average.

This subsection applies the R^2, the t-test and the f-test to determine the statistical reliability of the estimated parameters. These tests are performed as follows;

The coefficient of determinations, R^2, from the regression result is given as 94.7331. This implies that 94.7331% of the variation in housing provision is being explained by the variations in annual housing budget on the average.

Discussion of Result

The study reveals that there is a significant variation between housing budget allocation and execution in Enugu state which resulted to lack of housing provision in Enugu state. The study further reveals that unimplemented housing budget has a significant negative impact on the housing provision in Enugu state such that an increase in unimplemented budget will lead to decrease in housing provision in Enugu state. More so, the study reveals that estimated coefficient for unimplemented housing budget is -0.004379. This implies that if we hold all other variables affecting housing provision constant, a unit increase in unimplemented housing budget will lead to a 0.004379 units decrease in housing provision on the average.

The result of the second objective reveals that the identified challenges of unimplemented housing budget on housing provision are it limits the provision of social and economic needs of the masses; it promotes high cost of building materials; it leads to excessive project abandonment; it promote mushrooming squatters around the town; it increases numbers of unemployed youths in overcrowded squatter area.

Conclusion

Having seen that housing is one of the basic necessities of life, the housing sector in Nigeria is not sufficient enough to accommodate the demand. The housing sector is vital for job creation and improved capacity utilization of local industries. Nigeria's housing policies are good on paper but suffer from poor implementation. There seems to be a policy summersault recorded in the 2016 housing budget. Experiences from previous failures were not brought on board in designing the 2016 budget in terms of government's direct participation in housing construction.

Recommendation

The FGN should withdraw from direct construction of houses. It should act as a regulator and set policies for individuals, communities, cooperatives and the private sector to implement direct housing construction. It should facilitate the pooling of resources through the NHF and other channels. FGN's projects are notorious for being over-valued, delayed in implementation and poor workmanship. Such notoriety should not be transferred and mainstreamed in the housing sector through direct construction by government.

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EFFECTS OF COST ESCALATION ON CONSTRUCTION PROJECTS DELIVERY IN BENUE STATE NIGERIA

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ABSTRACT

This study investigates the effects of cost escalation on delivery of construction projects in Nigeria. The descriptive survey design was adopted for this study in which 50 respondents were selected by stratified random sampling technique. A questionnaire comprising of 25 items was used to collect data. Analysis was carried out using mean ratings and standard deviation. Results indicated that variation and fluctuation are the most factors responsible for cost escalation; tarnishing the contractor reputations and jeopardizing the contractor chances of winning contracts are the effects of cost escalation; pre - purchase of materials to limit the inflation and recognizing inflation during the design process and modifying the design appropriately, where it may be needed are the ways of reducing cost escalation on the delivery of construction project in Nigeria .The researcher therefore recommends that Government should implement price control system in the market; A clear and thorough client brief should be taken to the inception of the projects so as to avoid or minimize excess variation order; The contractor should be constantly guided by the consultant to adhere to the proposed programme schedule time of work in other to minimize the instance of extension of time and to reduce period of fluctuation.

Keywords: cost escalation, delivery, construction projects.

1.0 INTRODUCTION

Background of the Study

The construction industry is very wide and involvement of multinational and national companies, wealthy individuals are increasing at an alarming rate. The current rise in the need of construction projects is accompanied by huge expenditure in terms of physical cash and equipment. As a result of these there are different prices attached to different type of building projects. A number of studies have been done on cost of construction projects. Achuenu (1998) observed that in the past few decades construction project cost in Nigeria has shown a continuous upward trend. Nsam (2001) concluded that construction cost in Nigeria is among the highest in the world. This research will concentrate more on the project parties who are more concerned about the project to be completed within their cost estimate by providing some strategies the owners will use in reducing cost escalation in the success of their projects.

Escalation in the cost of projects in the construction industry all over the world in recent years has been extremely volatile, and this trend is expected to continue in the near future due to competition for resources and skilled workers. This situation has created a great deal of uncertainty and nervousness among project owners (Morris & Wilson, 2006). One of the major problems facing the Nigerian construction industry is the fact that almost all projects are being completed at sums much higher than their initial contract sums (Achuenu 2007). This is the gap that the researcher is trying to fill by examining the causes and effects of cost escalation of building projects with the aim of proffering probable solution to it.

Aim and Objectives

The aim of this research is to examine the various effect of cost escalation on delivery of construction project in Nigeria

The objectives of the study are:

- To identify the various causes of cost escalation on project delivery
- To identify the effect of cost escalation on delivery of construction project.
- To proffer solution ways of reducing cost escalation on delivery of construction project.

Research Question

- What are the various causes of cost escalation on project delivery
- What are the effects of cost escalation on delivery of construction project.
- What are the ways of reducing cost escalation on delivery of construction project

2.0 LITERATURE REVIEW

The construction industry is seen as the second oldest industry in the world with agriculture being the oldest. It is the sector responsible for planning, designing and procurement of construction and delivery of building and Civil Engineering works for government and private institution as well as individual(Ene, 2009). Boye (1991) stated that the price or cost of materials which are on high cost of project cannot be underestimated. Also Oyewande (2005) asserts that the excessive demand on the construction resources and projects due to massive increment in population and urban migration contributed to high construction project prices. That is generally the theory of demand and supply from economics. High demand in construction resources reflects high cost of construction prices. This kind of situation permits contractors to add higher mark-up on their rates.

Omoujine (1994) observed that since the introduction of Structural Adjustment Programme (SAP) in Nigeria in 1986, construction cost has risen continuously.

According to Ayeni (1991), the importation of construction materials from overseas is not solving the problems on the ground that their prices will be influenced by extraneous forces. For example, in the importation of bulk materials, the freight added on rates increases the cost of project.

Okafor (2007) states that Nigeria's dependence on imported materials for her construction has generated certain key problems like cost implication and maintenance.

Nyenke (2004) stated that one of the greatest challenges during construction is the direct involvement of the clients. They give instructions to contractors sometimes without recourse to the consultant or professional advisers. Such instruction sometimes amounted to variation which requires additional cost to be paid by the client.

In recent years it has become increasingly difficult to predict the total outcome of a construction projects through the estimate. The construction industry has entered into a period of high market volatility, and mitigating the associated risk has become a challenge for owners and consultants alike.

Component of construction cost

The cost of construction projects is a combination of individual elements of cost which makes up the total cost. According to Ayeni (1996) elements of construction prices are divided into four (4) which includes: Labour element, Material element, Plant element, Profit and overhead element.

Labour Element

The expenses incurred on labour vary according to whether the employee is a permanent or casual one. This is because all existing statutory and trade agreement may apply to a permanent employee, the same is not the case with casual employee for both permanent and casual staff. The cost can be divided into indirect and direct labour cost. The indirect labour cost include natural provident fund allowance, sickness benefits, hospital visits, government training scheme, annual holiday, public holiday, rain leave allowance and travelling expenses, while direct labour costs are categorized into skilled, unskilled and semi-skilled employees. These serve as a basis for evaluation of direct payment given the class of each worker.

Material Element

This costing of the material elements of project must be handled with lot of care because the quantity and type of material required on any given project is defined by the volume or details of work involved shown on the project drawing and ascertained through site investigation of project. In this respect, it is advisable for a contractor purchasing department to liaise with major suppliers or dealers of materials so that an up-to-date list of prices can periodically be furnished to the contractor. Material costing is however somewhat delicate and has to be approached with maturity, knowledge and experience to ensure that due allowance is made for the following factors: Damage during delivery haulage, Theft, Delay expenses, lost during usage.

An important consideration in material costing is the classification into consumable and non-consumable materials such as cement, sand, aggregate doors and windows etc. which have their capital cost and other expenses charged to the particular project on which they are employed. Non-consumable such as formwork, scaffolding etc. The proportion of a material cost to be charged to a given project depend on; Total cost of material, Span of material, Number of time it can be re-used, Duration of usage on a project, Material susceptuality to damage.

Plant Element

Plants elements are considered to be either mechanical or hand tools. The hand tools are wholly charged in the estimate as a percentage of labour cost for operatives that will employ these tools. This percentage charges is calculated by the management based on the: Type of tools, Cost of obtaining tools, Labour intensiveness of job, Cost of labour, Degree of risk associated with job where there is a high livelihood of tools getting damage on the job, the management will change a higher percentage.

The charge on mechanical plant depends on whether the plant is owned by the contractor or it is hired. If plant is hired, the contractor will charge on his estimate of the hiring rate plus the operating and maintenance cost per hour. Where the plant is owned by the contractor, the hire rate will now be replaced by capital cost (cost per hour) of the plant which is then charged along with the cost of maintenance of capital maintenance and mining cost of plant.

Overhead and profit

According to (Ayeni 1991) overhead is an administrative expense to the contractor for running of his office distinct from site administrative expenses. Most of which have been included in the preliminary section of the bill of quantities. The cost of maintaining site supervision, purchasing clerk, storekeeper and like including furnishing of the office, provision of transport and other cost will be fully chargeable by the contractors in the appropriate section of the preliminaries of each given contract.

Causes of Cost Escalation on Construction Project Delivery

They two main causes of cost escalations are the contractual causes of cost escalation and the non contractual causes of cost escalation. The contractual causes of cost escalation as identified by Gundiri (2005)included; Fluctuations, Shortage of materials/scarcity, Delay, Government policy, Architect instruction or variation, Re-measurement of provisional quantities in contract bills, Importation of building materials while the non-contractual causes of cost escalation include: Corruption, Lack of proper application of cost control technique, Foreign firms, Market volatility.

Fluctuations

Achuenu (2007) opined that fluctuation as used in the context of building contract therefore means “change” in the price of materials and rates of labour. This change could be in the form of an “increase” called inflation or “decrease” in very rare cases called “deflation”. Clause 31 of the JCT 1963 and the Federal Ministry of Works forms of contract deals extensively with fluctuation and various ways and means by which they could be calculated.

Shortage of materials or scarcity of materials

Boye (1990) expressed that the excessive demand on construction resources due to general economic situation most especially during the oil boom contributed to the high cost of project. Generally, following the economic theory of demand and supply, shortage of material will definitely lead to high prices as many people will be chasing the inadequate supplies. This kind of situation permits contractors to add higher mark upon their rate.

Delay in project delivery

Ajbacchi (1999) said delay could occur at various phases of project implementation but subsequently they are bound to affect the final date of completion and stipulated cost. However, some other losses cannot be avoided when there is delay because during the period of delay, cost of materials, labour, plants and equipment may be increased significantly and the changes of preliminary items in the overhead cost are extended.

Aqua group (1994) stated that "delay is one of the most common causes of trouble encountered during the Administration of building contract". This delay can be classified under the following headings:

Delay caused by the employer or his consultants, Delay caused by the contractor or his representative and team and Delay due to factors outside the control of the parties or their representative.

Government policies

At this juncture, the issue of inconsistence in government policies cannot be left out in this discussion. Oyewande (2006) reported that government policies in terms of increase in charges on importation and local building materials is not considered e.g. import license, increase in tariff charges, minimum wage and lately economic reform. All these factors lead directly to inflation which results to cost of project to escalate. The fact remains that because all sectors of the economy are intervention, what affects one sector would have a ripple effect down to the other sector. For example, an increase in interest rates or measures by the apex bank to regulate some aspects of the financial sector would affect general prices in the construction industry.

Architect instruction or variation

Despite complete planning and documentation however it will probably be necessary from time to time for Architect to issue further drawings details and instructions which are collectively known as "Architect instruction". Architects instruction must often lead to variation. The term "variation" as contained in the contract condition clause II (2), is the alteration or modification of the design, quality or quantity of works as shown upon the contract drawings as described by or referred to in the contract bills, and include the addition, omission or substitution of any work. This can also be in respect of standard of any materials or goods executed or brought to the site by the contractor for works other than such materials or goods which are not in accordance with the contract. Variation often leads to cost escalation in contracts; since it has the tendency of increasing the contract sums on which the architect fees are based. Architects deliberately issue costly variation with a view of inflating their fees.

Re-measurement of provisional quantities in contract bills

There are certain conditions where it becomes necessary to indulge in preplanning of work with re-measurement. In such situations variation becomes meaningless. However, it may happen that there might be variation throughout the whole work; it is far more straightforward to start measurement again.

Importation of building materials

Honoabi (2005) reported that import is simply the act of bringing goods and materials from another country. Hence the availability of building materials and goods depends on the availability of transportation facilities to carry large and bulk load. These include large ships, aircraft and fast trains. Achuenu (2005) found out that in a developing economy like ours, a lot of the components for construction from materials to equipment are imported. Importation depends largely on the foreign exchange mechanism, and is principally responsible for cost-push inflation. The cost components of buildings and construction materials consist of the following: Basic cost (factory price), Haulage and delivery charges, Off-loading and storage, Waste allowance, Insurance cost, Import duty tax amongst others.

Corruption

Corruption has taken its toll in the society such that money or gift presented as part of incentive in securing a project or manipulation of product are essentially recovered back from the first cost of project. Hoarding causing artificial scarcity of building components have also contributed to the high cost of building component with the production of low standard products or workmanship, which will invariably lead to failure of the structure even before the completion of the project.

Gundiri (2005) stated that some government officials are very corrupt and they in collision with some immoral and irresponsible contractors inflate contract sum. The result of this is the abandonment of most of the buildings halfway constructed in every corner of the nation.

Lack of proper application of cost control technique

According Boye (1990) cost control in a plain language definition means the controlling measures that can be taken to ensure that the contract sum of the project is not exceeded. It is observed that most clients do not allow consultant to exercise control at all the stages of construction. Effective cost control is a process that identifies all risk of all times. The ability to effectively forecast and control construction cost starts with the quality of the field budget.

According to Nwuba (2002), all forms of a cost have three sections and these are the establishment of the budget, the cost plan and the cost checking.

Multi-national firms

Abiola (2006) stated that the domination of construction industry by multi-national firms cannot be undermined when considering high cost of construction project in Nigeria. Some of the big companies executing project in Nigeria are been sponsored by multinationals, an example of this is Julius Berger handling New National Assembly Complex Project, Abuja. Most of these firms import everything in terms of materials and plant for the construction from their countries. The sponsors monitor the execution of these projects and use every means to influence the cost of the project in order to yield maximum profit.

Market volatility

While direct changes in the cost of materials and labour have relatively small impact on the cost of construction, the uncertainty over prices has created significant disruption in the bidding environment.

Cement market in Nigeria is a peculiar one with historical seasonal characteristics. The market is characterized by significant behavioral complexity and strategy self-positioning by major stakeholders to manipulate the market to their own advantage at the expense of the helpless consumers. The sustained price increase in the past week is about the highest in the history of the market. As at this year, price of 50kg bag of cement had risen to about N5000 in Benue State.

Effect of Cost Escalation on Construction Project Delivery

It could tarnish the contractor reputations

The contractors' accomplishment as a good and successful project may easily be forgotten but once he makes a mistake, it is remembered even if they were committed years ago, such is the sad nature of man. Clients will remember a company's errors after they have been long solved. People will refuse to award it any construction project even if it offers them the best services or the cheapest price. The smallest of incidents or mistakes may be communicated from one client to another, the latter may communicate the same thing to someone else. That is how the company's reputation is gradually going to be destroyed, through the spreading of words.

It may jeopardize the contractor chances of winning further jobs

Cost escalation of construction projects may have another negative impact on the contractor undertaking the construction project. The contractor is a business man and the dream of every businessman is to start business and remain in business. Cost escalation of projects may have the adverse effect of jeopardizing the chances of the contractor from winning further jobs in the future. This is because of the prequalification criteria of the contractor for successful bidding and winning jobs in the construction industry includes amongst other experience and previous jobs executed in the past. And if the jobs executed in the past encountered cost escalation thereby being delayed, unfinished or abandoned, this could affect his chances of winning future job.

It may lead to loss of profit for non-completion

Cost escalation may also lead to loss of profit for non-completion of projects. Loss of profit is the loss accruing to the contractor on account of reduction in the profit margin caused by prolongation of the contract or on account of the profit the contractor could not earn during the extended period by being unable to deploy resources and manpower in some other project due to prolongation of the current contract or when Contractor failed to execute the work due to breach of terms and condition of the Contract by the Employer.

It may result in loss of confidence reposed in the contractor by his clients

Another effect of cost escalation is the loss of confidence of the contractor by his client. When some corrupt government officials collude with some immoral and irresponsible contractors to inflate contract sum. This is very common during the construction of many of the government owned projects across the country. The result of this is the abandonment of most of the buildings halfway constructed in every corner of the nation. The lack of proper application of Cost Control technique by the contractor could lead to cost escalation of the project. This could cost the contractor his confidents in the sight of his client.

It leads to less return on investment

Cost escalation of construction projects could lead to less return on investment. Return on investment (ROI) is a performance measure used to evaluate the efficiency or profitability of an investment or compare the efficiency of a number of different investments. ROI tries to directly measure the amount of return on a particular investment, relative to the investment's cost. There when a project which is executed as an investment encounters cost escalation, the return on that project could be reduced.ROI can be used to make apples-to-apples comparisons and rank investments in different projects or assets. It does not take into account the holding period or passage of time, and so it can miss opportunity costs of investing elsewhere.

Strategies for Reducing Cost Escalation

As can be seen, cost escalation in the construction project is a cumulative effect of a number of different factors. According to (Kelly & Brown, 2014) some of the ways of reducing cost escalation on delivery of construction project includes among the following

Pre – purchase materials to limit the inflation.

Contractors have options related to the procurement of materials, and a strategic delivery/storage plan may reduce escalation risk. They may facilitate this via payment for stored materials. The related challenges must be considered: cost, contract, insurance, and a variety of logistical implications. The materials needed from other nations should be pre ordered before inflation catches up with it. Purchasing materials on time before inflation sets in could curb the mayhem of cost escalation.

Recognizing inflation during the design process and modifying the design appropriately, where it may be needed.

Contractors are typically aware of general inflation as an escalation risk and build it into pricing using historical data and forward-looking trends. Unfortunately, accounting for general inflation may not address the issue of cost escalation. When cost increases are due to factors like those related to the ones contained therein at the causes of cost escalation, sharp changes in the cost of a single input can have a significant impact.

Fluctuation clauses.

The term "fluctuation provisions", or "fluctuation clauses", refers to compensatory clauses in construction contracts that allow the contract price to be adjusted to reflect changes in the cost of materials or labour during the contract period. You may also see them described elsewhere as "variation of price", "variation in cost", "rise and fall" and "cost-adjustment". In most construction contracts where fluctuation provisions have not been used, the risk of price rises are borne primarily by the Contractor. With fluctuation provisions, the risk of price rises is transferred to the Employer by adjustment of the final contract price.

Negotiating sub – contacts along with the contractors.

Negotiating with the sub-contractor alongside the main contractor is another strategy to reduce the cost escalation of projects. The subcontractor prequalification criteria are checked alongside that of the main contractor.

Reducing the bid award period to accommodate shorter price lock

To remove some exposure to escalation, consider identifying high-risk scopes, educating owners on the risk, collaborating to get the related design early, and expediting buying these scopes to lock in pricing as early as possible. Focused, phased bidding may eliminate the need to wait for complete documents for all scopes prior to procurement. The downside is that later scopes are more exposed to escalation if the overall procurement time frame stretches out, so approach this with the big picture in mind

S**cheduling considerations**

The construction schedules you engage are a key to escalation risks that will be encountered. Contractors should examine their schedules for areas where cost escalation risks can be mitigated. This could entail accelerating some or all of the projects to reduce the duration and limit exposure to forces contributing to escalation. It could also entail building additional time into the schedule or increasing float to allow for a more reliable or cost-effective supply chain or subcontractor to be used. Time truly may be money in this situation.

3.0 RESEARCH METHODOLOGY

Research Design

The qualitative research technique was used for this study where the researcher conducted intensive individual interview with the correspondents to explore their perspectives on the project method. The design is considered suitable to enable the researcher collect information directly from the various parties.

Area of the Study

This research was carried out in Benue state. Benue State is one of the 36 states of Nigeria and lies in the North Central of Nigeria with Makurdi as its capital and largest city. Benue State is named after the Benue River and was formed from the former Benue-Plateau State in 1976, along with Igala and some part of Kwara State. Benue State lies within the lower river Benue trough in the middle belt region of Nigeria. Its geographic coordinates are longitude 7° 47' and 10° 0' East. Latitude 6° 25' and 8° 8' North; and shares boundaries with five other states namely:

Nasarawa State to the north, Taraba State to the east, Cross-River State to the south, Enugu State to the south-west and Kogi State to the west. The state also shares a common boundary with the Republic of Cameroon on the south-east. Benue occupies a landmass of 34,059 square kilometres. Benue State as it exists today is a surviving legacy of an administrative entity which was carved out of the protectorate of northern Nigeria at the beginning of the twentieth century. The territory was initially known as Munshi Province until 1918 when the name of its dominant geographical feature, the 'Benue River' was adopted.

Population of the Study

The population of the study consists of 84 selected professionals and parties who were involved in some ongoing projects in Makurdi town.

Sample and Sampling Procedures

Out of the population of 84 persons in Dantata and Sawoe construction company, 50 persons were selected using the simple random sampling technique. The logic behind this is in conformity with the views of Okoh (2005) in his book, the principles of educational research. He opined that for any population below 100 persons or object at least more than 50% of the population is adopted as its sample to enhance effective representation so that conclusions from the study can be generalized.

Instrumentation

The major instrument used for this study is the questionnaire. The questionnaire consists of well-structured questions in a pre-determined manner in which all the respondents answer in the same order. They were asked question concerning the cost escalation on projects and their answers where written down for analytical procession. The questionnaire was structured in a five like scale measuring attitude of Strongly Agreed, Agreed, Undecided, Disagree and Strongly Disagreed.

Procedure for Data Collection

The researcher personally collected data from the respondents through the help of the human resource manager. After distribution of the questionnaire, respondents were given three days to fill out the questionnaire. This time frame was given in order to give enough time to the respondents to reflect on the items on the questionnaire to facilitate valid responses.

Procedure for Data Analysis

Simple Percentile for general information and descriptive statistics will be used to answer the research questions. The cut-off point of 50% and above was considered accepted while 49% and below will be considered not accepted for the answers to the items on the instrument.

RESULTS

Presentation of Data and Analysis

All data are presented in tabular form to show the response obtained from the respondents.

Table 1 Area of Specialization

S/N	Profession	Response	% Response
1	Architecture	14	35.9
2	Quantity survey	12	30.8
3	Engineering	8	20.5
4	Building	5	12.8
5	Others	0	0.0
	TOTAL	**39**	**100**

From the table above, the result shows that 35.9% of the respondents are architects, 30.8% of the respondents are Quantity surveyors, 20.5% of the respondents are engineers while 12.8% of the respondents are builders. Below is the chart showing the percentage distribution

Table 2 Working Experience

S/N	Year	F	% Response
1	1 – 5	2	5
2	5 – 10	19	49
3	10 – 15	10	26
4	15 – 20	6	15
5	20 – 25	2	5
6	25 – 30	0	0
	TOTAL	**39**	**100**

From the above analysis, it was found that the majority of the respondents have an average mean of 11 years working experience; therefore they are quite experienced in the building construction projects to give reliable information for this research work.

Table 3 Experiencing Cost Escalation

Response	No. of responses	% response
Yes	36	92%
No	3	8%
TOTAL	**39**	**100**

From the table above, 92% of the respondents have experienced cost escalation in their projects while 8% of the respondents did not experience cost escalation. Respondents that have experienced cost escalation in their projects have the highest percentage of 92%. This implies that the respondents are reliable enough to give a fair judgment about cost escalation in building projects.

Research question 1

What are the factors responsible for cost escalation? To answer this research question, analysis for factors responsible for cost escalation are shown below in table 4

Table 4. Causes of Cost Escalation.

ITEM NO	ITEM DESCRIPTION	1	2	3	4	5	MEAN (X)	STD	Rank	DECISION
1	Variation	36	3	0	0	0	4.92	0.07	1	Accepted
2	Fluctuation	35	4	0	0	0	4.90	0.09	2	Accepted
3	Delay	32	5	2	0	0	4.77	0.28	3	Accepted
4	Re-measurement of provisional quantities	29	8	2	0	0	4.69	0.32	4	Accepted
5	Corruption	27	9	3	0	0	4.62	0.39	5	Accepted
6	Government policy	26	9	4	0	0	4.56	0.45	6	Accepted
7	Domination of foreign firms	32	7	0	0	0	4.82	0.15	7	Accepted

8	Market volatility	20	16	3	0	0	4.44	0.40	8	Accepted
	Cluster Mean						**4.71**	**0.27**		

Table 4 shows the factors responsible for cost escalation. As shown in these tables, respondents ranked variation and fluctuation as the two most factors responsible for cost escalation. The cluster mean and standard deviation are 4.71 and 0.27 respectively; since the cluster mean is above 2.5, hence it is accepted.

Research question 2

What are the effects of cost escalation on delivery of construction project?

To answer this research question, analysis of effect of cost escalation is shown below in table 5

Table 5. Effect of Cost Escalation on Delivery of Construction Project.

ITEM NO	ITEM DESCRIPTION	1	2	3	4	5	MEAN (X)	STD	Rank	DECISION
1	It could tarnish the contractor reputations	32	5	2	0	0	4.77	0.28	1	Accepted
2	It may jeopardize the contractor chances of winning further jobs	30	8	1	0	0	4.74	0.24	2	Accepted
3	It may lead to loss of profit for non-completion	29	6	2	2	0	4.59	0.65	3	Accepted
4	It may result in loss of confidence reposed in the contractor by his clients	24	14	1	0	0	4.59	0.29	4	Accepted
5	It leads to less returns on investment	20	9	7	0	3	4.10	1.37	5	Accepted
	Cluster Mean						**4.56**	**0.57**		

Table 5 shows the effect of cost escalation on delivery of construction project. As shown in these tables, respondents ranked it could tarnish the contractor reputations and it may jeopardize the contractor chances of winning contract as the two most effect of cost escalation on delivery of construction project. The cluster mean and standard deviation are 4.56 and 0.57 respectively; since the cluster mean is above 2.5, hence it is accepted.

Research question 3

What are the ways of reducing cost escalation on delivery of construction project?

To answer this research question, analysis of ways of reducing cost escalation on delivery of construction project is shown below in table 6

Table 6. Ways of Reducing Cost Escalation on Delivery of Construction Project.

ITEM NO	ITEM DESCRIPTION	1	2	3	4	5	MEAN (X)	STD	Rank	DECISION
1	Pre – purchase materials to limit the inflation.	37	2	0	0	0	4.95	0.05	1	Accepted
2	Recognizing inflation during the design process and modifying the design appropriately, where it may be needed.	36	3	0	0	0	4.92	0.07	2	Accepted
3	Use of fluctuation clauses..	35	4	0	0	0	4.90	0.09	3	Accepted
4	Negotiating sub – contacts along with the contractors.	32	5	0	2	0	4.72	0.51	4	Accepted
5	Reducing the bid award period to accommodate shorter price lock	29	8	0	0	0	4.78	0.17	5	Accepted
	Cluster Mean						**4.85**	**0.18**		

Table 6 shows the ways of reducing cost escalation on delivery of construction project. As shown in this table, respondents ranked pre-purchase of materials to limit the inflation and recognizing inflation during the design process and modifying the design appropriately, where necessary. as the two most significant ways of reducing cost escalation on delivery of construction project. The cluster mean and standard deviation are 4.85 and 0.18 respectively; since the cluster mean is above 2.5, hence it is accepted.

4.0 DISCUSSION OF FINDINGS

The first findings revealed that variation and fluctuation are the highest factors responsible for cost escalation. This finding is in agreement with that of Morris and Wilson (2006) who is of this opinion.

The second finding of this study revealed that effect of cost escalation on delivery of construction project includes tarnish the contractor reputations and it may jeopardize the contractor chances of winning contract as the effect of cost escalation on delivery of construction project. This finding agrees with that of Nwuba (2007) who attested to this fact.

The third finding of this study revealed that pre - purchase of materials to limit the inflation and recognizing inflation during the design process and modifying the design appropriately, where it may be needed as the ways of reducing cost escalation on delivery of construction project. This finding agrees with that of Kelly and Brown (2014) who attested to these facts.

5.0 SUMMARY, CONCLUSION AND RECOMMENDATION

Summary of findings

The following are the findings from the analysis carried out

1. Variation and fluctuation are the most factors responsible for cost escalation
2. Effect of cost escalation on delivery of construction project includes tarnishing the contractor reputations and it may jeopardize the contractor chances of winning contract.
3. Ways of reducing cost escalation on delivery of construction project includes pre - purchase of materials to limit the inflation and recognizing inflation during the design process and modifying the design appropriately, where it may be needed.

Conclusion

Based on the findings, the following conclusions were drawn; Variation and fluctuation are the highest factors responsible for cost escalation; tarnishing the contractor's reputations and jeopardizing the contractor's chances of winning contracts are the effects of cost escalation; pre - purchase of materials to limit the inflation and recognizing inflation during the design process and modifying the design appropriately, where it may be needed are the ways of reducing cost escalation on the delivery of construction project in Nigeria.

Recommendation

The following recommendations are made from the findings of the study

1. Government should implement price control system in the market

2. A clear and thorough client brief should be taken to the inception of the projects so as to avoid or minimize excess variation order.

3. The contractor should be constantly guided by the consultant to adhere to the proposed programme schedule time of work in other to minimize the instance of extension of time and to reduce period of fluctuation.

Contribution to knowledge

According to Achuenu (2010) Nigeria is among the poorest countries in the world and Nigerians are not the highest paid workers, then why should construction cost be so high? Okere (2000) stated that Nigeria is one of the countries with the highest contract cost. He noted that the cost of construction in Nigeria is about twice that of Britain and about four times that of Kenya. The cost of construction is always rising continuously, hence the need to know the effect of cost escalation in construction project delivery is appropriate to educate the professionals in the construction industry and other scholars who may wish to use the research work in preventing the mayhem of cost escalation. We have only one earth to nurture and sustain, our activities have corresponding effect on that earth with a resultant impact on us. Therefore construction projects must be delivery accordingly in order to sustain our earth.

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ASSESSMENT OF TIME PERFORMANCE OF TERTIARY EDUCATION TRUST FUND CONSTRUCTION PROJECTS DELIVERY IN PUBLIC TERTIARY EDUCATION INSTITUTIONS IN SOUTH-EAST, NIGERIA.

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Abstract
Tertiary Education Trust Fund (TETFund) construction project delivery in Nigeria is the biggest benefactor to its public tertiary education institutions. To measure the Fund's delivery performance, an important factor in measuring project performance is timely completion at an agreed price and in specified quality. However, despite the growing concerns on the poor time performances of the Fund's construction projects delivery, time overrun still a common problem without effective solution. Hence, the study interrogated the Fund's projects delivery in the southeast. The objectives of this analysis aim at establishing the time performance of TETFund construction project delivery in the public tertiary education institutions in Southeast, Nigeria from 2015 to 2021. 119 TETFund construction projects in the 7 public tertiary institutions in Enugu State were sampled using single-stage cluster sampling technique. 140 structured questionnaires were developed and distributed to Consultants, contractors and other key Personnel involved in each TETFund intervention projects. The data was analysed using frequency, percent student's t test. The result revealed that the prevalence of time overrun on the Fund's project is 72% out of the 119 TETFund sponsored construction projects in Enugu state public tertiary education. Of the total, 28% (33) were completed on schedule, 29% (35) experienced time overruns, 39% (46) were ongoing beyond their project schedule while 4% (5) were abandoned. The mean estimated project cost by consultants was significantly lower than the awarded sums ($t = 2.411$, $p = 0.018$). The paper concludes that to improve the Fund's projects time performance regarding fixed price and materials price escalation, the materials' component of the bill should be extracted and paid to the contractor in advance, for procurement.

Keywords: TETFund, Public tertiary education, Construction projects, performance.

1.0 Introduction

Public tertiary education institutions in Nigeria have endured physical and academic infrastructure decay over years due to inadequate funding for the provision of these facilities and rehabilitation of decaying ones (Isa and Yusoff, 2015; Mukhtar, Abdussalam and Mustapha, 2021). To ensure that the Nigerian government is alive to the responsibility of funding its education sector, the Academic Staff Union of University (ASUU) and the Ministry of Education have have been in continuous dialogue resulting in serial industrial actions. To address this problem, the Tertiary Education Trust Fund (TETFund) was established. The Fund was set up to administer and disburse education tax collections to all public tertiary educational institutions in Nigeria. TETFund operates with the 2% education tax paid from the assessable profit of registered companies in Nigeria. The Act setting up the Fund also issued guidelines for dispensing the education tax accruals to Universities, Polytechnics and Colleges, in the ratio 2:1:1, respectively (TETFund, 2020). Since the Act in 2011, TETFund has been responsible for the development, provision and delivery of these infrastructure in Nigeria public tertiary institutions. Although, Fund's intervention have impacted positively on these institutions (Mangvwat, Ewuga and Izam 2018, TETFund, 2020), poor performances has been observed in the Funds projects delivery in these institutions in Nigeria (Gambo Ibrahim, Iliyasu, Shakantu and Lamina, 2017; Aghimien and Aigbavboa., 2018; Mangvwat, et al., 2018; Zailani, Kolo and Abubkar., 2019; Mukhtar, et al., 2021). Recent studies (Gambo et al., 2017; Aghimien et al, 2018; Zailani et al., 2019; Mukhtar et al., 2021) have reported time overrun on the Fund's projects. Aghimien et al., 2018 reported that the time overrun experienced in 12 out of 14 of the fund's projects in Ondo State, Nigeria, within 2006 to 2016, was beyound double of the initial scheduled time. Following that, a number of studies have been carried out both nationally and internationally to establish the causes of overruns in the construction industry. The role of Construction industry in the development of any given nations is significant (Al Khudhuri, 2020) and provision of these physical facilities such as lecture hall and theatres, seminar rooms and halls, academic offices, laboratories and hostels to mention a few, in academic institutions have impacted positively on the academic performance, safety and comfort of students (Saeed and Kayani, 2019). Doing so timeously, within budget and quality, is one of the key indicators of successful performance in the construction industry (Kadiri and Shittu 2015; Gupta and Kumar, 2020; Oluyemi-Ayibiowu and Omolayo., 2022). However, construction projects delivery, in most cases, are marked with serious time overruns (Amu, and Adesanya, 2011; Oluyemi-Ayibiowu, et al., 2022). Time overruns, aside being common in construction industry world over, Ojo, (2021) observed that it is rampant across TETFund projects. In Construction industry, Time overrun is the Lateness in completion of work or extension of the completion time of a project from its scheduled duration (Elinwa and Joshua., 2001; Akhund, Imad, Memon, Siddiqui, Khoso and Panhwar., 2018; Luvara, Phoya, Tesha and Lyimo, 2018). Time overrun is a global problem amounting to more than 100% of the scheduled project time (Sinesilassie, Tabisha and Jha., 2017; Hassan, Suleiman and Malik., 2014; Ndunguru, Niyonyungu and Yang, 2019).

Although studies have been carried out on the TETFund project delivery performance (Gambo et al., 2017; Aghimien et al., 2018; Khudhuri, 2020; Mukhtar et al., 2021), none have assessed the Fund's time performance in its project delivery in public tertiary education institutions in the Southeast, Nigeria. Therefore, this study aim to establish the performance success or otherwise of the Fund's construction project delivery in public tertiary education trust fund (TETFund) projects in south east Nigeria through following objectives: 1. Determination of the Characteristics of TETFund Projects, 2. Determination of prevalence of Time Overruns in TETFund Projects, 3. To make recommendations to stakeholders on strategies for improving the Fund's time performance in construction project delivery.

2.0 Literature Review

2.1 Overruns in construction projects

Poor time and cost performances in construction industry is a global problem (Emam, et al., 2014; Johnson and Babu, 2018; Al Khudhuri 2020). Akhund et al., (2018) studied the factors contributing to time overrun in public sector construction projects in Pakistan and ranked financial difficulties faced by constructors, inadequate planning and scheduling, client's financial difficulties and delayed payments by the client, as the most significant factors of time overrun. Othman, Nair and Nuruddin (2017) studied the critical factors that lead to time overrun in construction project in Malaysia and reported pre-contract issues, project management and contractor's site management as responsible. In India, Pourrostam and Ismail (2012) reported that 52.1 % of projects ran behind their original/contract schedule. Gupta and Kumar (2020) studied the factors causing cost and time overrun in construction projects, and concluded that the top five factors responsible for time overrun include; Material selection and changes in types and specifications during construction, Poor equipment maintenance, Shortage of materials, Financing between the client and the contractor, labour shortage. Those of cost include; Inflation and escalation of material prices, variation, high transportation cost, frequent breakdowns of plant and equipment and rework due to errors during construction. Hatkar and Hedaoo (2016), opined that time overrun is caused delay in progress payments by client, improper project planning and scheduling, inadequate fund allocation and escalation of material prices were responsible. Akal1, Abu El-Marty and El-Hamrawy (2017) **linked** Insufficient and ineligible contractor's technical staff to accomplish the project, Delay in freeing the main contractor's financial payments by clients, equipment inefficiency, Contractor's difficulties in financing the project and Equipment and construction materials shortage to the poor performances in the Egyptian construction industry. In Dar-Es-Salaam, Tanzania, Jongo, Tesha, Kasonga, Teyanga1 Kenan and Limo, (2019) reported that project schedule overrun is a common problem occurring frequently in project cycle while observing that construction project is a high risk venture which must be effectively managed at all stages to avoid overruns.

2.2 Overruns in construction projects in Nigeria

Oluyemi-Ayibiowu et al., (2022) Studied the critical factors responsible for time overruns in Nigeria building construction industry using literature review and questionnaire survey and identified Inaccurate evaluation of projects time/duration (91.9%), Risk and uncertainty associated with projects (91.6%), Complexity of works (87.6%), Weak regulation and control (86.8%) and Lack of financial power with severity (86.3%) as the five (5) most severe factors influencing project overrun in Nigeria construction industries. in attempt to model schedule overruns in south-western Nigeria, Amu and Adesanya (2011) reported that of 3, 407 civil engineering projects executed, only 24 were completed on schedule. 1571 suffered schedule overrun while 1812 were abandoned.

2.3 Time overruns in TETFund construction projects

In Nigeria, Aghimien et al, 2018 studied the Performance of Selected Funding Schemes Used in Delivering Educational Buildings in Nigeria and reported general poor time performance on educational buildings delivered through TETFund interventions. Mangvwat, et al., (2018) interrogated the performance of firm price building contracts in tertiary institutions in Plateau State, and reported that all the 23 building projects in three tertiary institutions in the State contracted and completed under the Fund's intervention programme between 2005 and 2014, suffered time overrun while 5 out of the 23, suffered cost-overrun. Gambo, et al., (2017) Evaluated stakeholders' perception on TETFund construction projects in Ahmadu Bello University, Zaria from 2009 – 2011 and reported unsuccessful performance. They observed that delay in progress payment, materials price escalation, shortage of materials and low technical skill of the project leader were the leading factors responsible for the poor project performance. Emenike (2010) had submitted that late and non-payment results in liquidity problems, Ojo and Babalola (2018) blamed delayed payment on clients, Odenigbo, Odusami, Okolie and Okafor (2020) linked client's withholding payment, clients' bad financial sources, client's inadequate fund management and client's cumbersome administrative process accounted for the delay payment. Time overrun on TETFund a sponsored project in Nigeria is sometimes caused by delayed a payment which, in turn, affects the contractor's cash flow, negatively (Odenigbo et al., 2020). Contractor's liquidity requires serious attention regarding payments (as and when due) as Ojo (2021) has shown that irregular payment pattern occasioned by the Institution's bureaucracy is responsible for contractor's negative liquidity and as such resulting in projects delay.

3.0 Materials and Method

The study was carried out in Enugu State. The public tertiary education institutions sampled include: Universities (University of Nigeria (UNN), Nsukka and Enugu campuses, Enugu State University of Science and Technology (ESUT), Agbani), polytechnics (Institute of Management and Technology (IMT), Enugu, Federal Dental School, Enugu) Colleges (Federal College of Education, Eha-Amufu, College of Agriculture, Iwollo and Enugu State College of Education Technology (ESCET), Enugu).

The study was carried out using descriptive survey research design. 119 TETFund projects in the 7 public tertiary education institutions were sampled using single-stage cluster sampling technique. In achieving the objectives of the study, structured questionnaires are designed from a review of current literature. The questionnaire was pre-tested for validity and reliability before administering. The questionnaires were distributed amongst consultants, contractors, key TETFund staff, TETFund desk officers and host institution's Physical Planning units within the sample. A case study of the Funds' construction projects awarded between 2015 and 2021 in all the tertiary institutions in the state was carried out to ascertain their time performances. Descriptive statistics which include frequency and percentages were used to summarise categorical variables while means and standard deviations were obtained for continuous variables. Mean comparisons were done using student's t test. P value less than 0.05 was regarded as significant and results were presented in tables and charts. All the analysis were done using the IBM SPSS version 23 for windows

4.0 Results

There were more male respondents (62.2%) than females (37.8%) and most of them are married (86.6%). More than half of the respondents (61.4%) are less than 45 years of age, 41.2% are civil servants and 31.1% are Architects while 21% are public servants. The respondents were educated up to tertiary level (99%), professionally trained (100%), registered members to respective bodies in the built environment (72%) and as such, informs that majority of the respondents possessed adequate knowledge and cognate experience on the subject matter enough to provide needed information and justify the robustness of the data used for the study (table 1).

Table 1: **Demographic Characteristics of the Respondents**

	Frequency	Percent
Title		
Prof.	2	1.7
Dr.	7	5.9
Mr.	71	59.7
Mrs.	39	32.8
Level of Education		
Secondary	1	0.8
Tertiary	118	99.2
Sex		
Male	74	62.2
Female	45	37.8
Marital Status		
Single	16	13.4
Married	103	86.6
Age group		
30 -34	7	5.9
35 - 39	52	43.7
40 -44	14	11.8
45 - 49	10	8.4

50 -54	15	12.6
55 - 59	7	5.9
60 and above	14	11.8
Occupation		
Civil servant	49	41.2
Architect	37	31.1
Engineering	5	4.2
Public servant	25	21.0
Site electrician	2	1.7
Contractor	1	0.8
Professional training		
Architect	62	52.1
Structural Engineer	21	17.6
Electrical Engineer	8	6.7
Mechanical Engineer	2	1.7
Quantity Surveyor	4	3.4
Builder	18	15.1
Others	4	3.4
Registration with professional body		
Yes	86	72.3
No	33	27.7
Current position		
Heads of departments	1	0.8
director of work & service	7	5.9
Principal Technical Officer	16	13.4
Executive officer	1	0.8
Principal partner	33	27.7
Project supervisor	2	1.7
Principal engineer	2	1.7
Senior engineer	2	1.7
Principal planning officer	1	0.8

Engineer 1	1	0.8
Architect 1	3	2.5
Higher Technical Officer	5	4.2
Principal architect	4	3.4
Assistant chief engineer	1	0.8
Senior architect	1	0.8
Deputy director	2	1.7
Director physical planning	9	7.6
Member	8	6.7
Staff	12	10.1
Chief Quantity Surveyor	3	2.5
Site manager	5	4.2
Condition of service		
career	68	57.1
tenured	14	11.8
others	37	31.1

The projects were initiated by either the host institution (43%) or by TETFund in collaboration with host the institution (41%) and funded wholly by the TETFund (100%). Project funds were released to host institution in 3 tranches (99%) and mostly at TETFund's discretion (66.4%) as shown in *table 2*.

Table 2: **PROJECT FUNDING**

	Frequency	Percent
How are TETFund projects initiated		
By TETFund	12	10.1
By host institution	51	42.9
TETFund in collaboration with host institution	49	41.2
By an influencer	7	5.9
How are TETFund projects funded		
wholly by TETFund	119	100.0
How are the project funds released to host institution		

Wholly	1	0.8
in tranches	118	99.2
How many tranches		
2 – tranche	2	1.7
3 – tranche	110	93.2
as need arise	6	5.1
Time interval (weeks) before release of funds		
not greater than 8 weeks	6	5.0
at TETFund discretion	79	**66.4**
any time they are ready	26	21.8
any time fund is available	8	6.7

The projects were executed at fixed price contract (84.9%) and open tendering were used for both the selection and execution of the contracts *(table 3*). while *table 4* showed that the consultants estimated project costs were significantly lower than their awarded sums ($t = 2.411$, $p = 0.018$).

Table 3**: PROJECT INFORMATION**

	Frequency	Percent
Designed by professionals		
Yes	119	100.0
No	0	0.0
Contract type		
Measurement	10	8.4
Firm price	101	84.9
Turnkey	8	6.7
Selection of consultants and contractors		
Open	82	68.9
Selective	37	31.1
Mode of tendering		

Open	91	76.5
Selective	28	23.5

Table 4 shows that the mean estimated project cost by consultants was significantly lower than the awarded sum (t = 2.411, p = 0.018).

Table 4: Comparison of Mean Consultant's Estimated Total Cost and Award Sum

	Consultant's Estimated total Cost Mean ± SD	Award sum Mean ± SD	t	P value
Project Cost	220023453.3 ± 165722068.7	241960224.6 ± 147504384.6	2.411	0.018

TABLE 5 shows that out of 119 TETFund sponsored projects sampled in Enugu State, 28% were completed on schedule, 29% were completed after the scheduled date, and 39% are ongoing while 4% were abandoned.

TABLE 5: Performance Status of TETFund Projects in Enugu State in the last six (6) years

Project status	Frequency	Percent
Completed as scheduled	33	28
Completed beyond scheduled date	35	29
Still ongoing	46	39
Abandoned	5	4

86 (72%) of the TETFund projects executed from 2015 to 2021 in public tertiary education institutions in Enugu State suffered time overruns (figure 1).

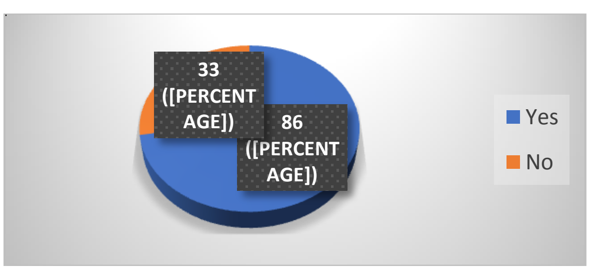

Fig 1: Time Overrun

5.0 Discussions

TETFund construction Projects follow due diligence plus extra measures to ensure compliance and safety of funds released for projects. The procurement guidelines and requirements leading to ultimate awards, apparently stringent, aim at providing level playfield amongst qualified and competent contractors, constituted a delay between initiation and awards, and as consequence responsible for award sums being significantly higher than their consultants ETC as economic/inflationary activities escalates material prices in the region. In some of the cases interviewed, respondents opined that the time between financial bid and contract awards took more than 60 days while the time between award and release of funds to contractors took more than 30 days. In fixed price construction contracts, awards and execution of construction projects in economy that depended on dollar inflow, experiencing inflation resulting in material price escalation is akin to standing reason its head. Fund releases at the Fund's discretion (table 2, Para. 5.2) suggests waiting patiently (delayed payment) which indicates non-compliance to prompt payment within the stipulated time as observed in Mukuka, et al., (2014), Gambo et al., (2017), Odenigbo et al., 2020, Mukhtar et al, 2021 and Ojo (2021). The Results in table 4 showed that the consultants estimated project cost on most of the projects were significantly lower than their awarded sums ($t = 2.411$, $p = 0.018$). This suggests that time windows between pre and post contract affected the consultants estimated project costs. The poor time performance (72%) experienced in the fund's construction project delivery system (table 6 and figure 1) can be linked to tables 3, (2.2 and 4.2) which can best be analysed that because the projects were awarded through open bid/tender based on the lowest price basis (Olatunji, 2008; Mangvwat, et al., 2018) and at a firm (rigid) price, idle contractors chasing the few jobs could have bided at low rates. lowest bidder without adequate considerations to inflationary rates is acceptable since the contract prequalification has conferred qualification and competence on the contractor. As a consequence, the projects results in poor time performances at slight fluctuation, poor quality work and workmanship. This is in agreement with Olatunji 2008 and Mangvwat, et al., (2018) that public projects in Nigeria awarded based on the lowest price weakens competition and has led to contractors bidding with ridiculous rates while delivering very low-quality work and workmanship. Furthermore, because the project costs are rigidly fixed, the quantity performance of the project is either ignored or traded-off with poor time performance which agreed with Mangvwat, et al., (2018) that there is a trade-off in the quality performance of TETFund project as contractors tries to meet the fixed price target and the trade-off, in turn, will be succeeded by higher maintenance cost of the facility.

TETFund Projects are characterised by Time-overrun as observed in Gambo et al., 2017; Aghimien et al., 2018 and Mukhtar et al., 2021 and have seriously affected the Fund's projects delivery performances negatively. Table 5 shows that out of 119 TETFund projects in the sample, only 33 (28%) were completed on schedule, 35 (29%) suffered time overrun while 46 (39%) are still ongoing beyond their initial project schedule while 5 (4%) were abandoned. For clarity, Table 6 and Figure 1 showed that 86 (72%) of the TETFund projects executed from 2015 to 2021 in public tertiary education institutions in Enugu State suffered serious time overruns. Ojo, 2021 described the insistent time overrun in the Fund's construction project delivery and blamed it on delayed payment at institutions' bursary bureaucracy. He recommended orientation program bursary department and the management to enlighten them on the imperatives of time in processing payment certificates. Reasons for this high prevalence may be related to type of project bidding and award system used by the Fund which is consistent with Mukhtar et al., (2021) and inflationary rates as corroborated by Diugwu, et al., (2017). Because the contract price is firm (fixed), the concomitant cost effects of the high schedule overruns are left for either the contractor or the recipient institution to fill the cost gap amounting to $14, 423.59/month time overrun from their IGRs (Mangvwat, et al., 2018). This indicates a trade-off in the specs and project quality which agrees with Mangvwat et al., (2018) that the practice which allows time to overrun without adequate allowance in the cost element of buildings, and yet expecting to have a building as specified in the design, scope and quality stands the basis of its objectives on its head.

5.0 Conclusion

General Poor-time performances were observed across the Fund's projects delivery in tertiary education institutions in south-east, Nigeria with surprising good cost performances as no difference existed between their initial costs and the final construction costs. This is possible because the project costs are rigidly fixed. The Poor-time performances observed can be associated with the fixed price contract regime in the Nigerian turbulent economy without adequate considerations high inflation rate, construction materials price escalation add delayed payments to contractors. To improve the Fund's projects time performance regarding fixed price and materials price escalation, materials' component of the bill should be extracted and paid, in advance, to the contractor for material procurement. This can be made possible by ensuring that contractors launch materials to sites and receiving others into warehouses (where pilfering is anticipated). The other way round is for TETFund to update the award sums with inflation rates prevailing within the period in accordance with the project time schedule.

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APPRAISING THE IMPACT OF EFFECT OF WATER SOURCE, SANITATION AND HYGIENE PRACTICES ON INHABITANTS OF CALABAR SOUTH ENVIRONMENT, CROSS RIVER STATE, NIGERIA

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Abstract

This study assessed the impact of effective water, sanitation and hygiene practices on Calabar South environment in Cross River State, Nigeria. A research question guided the study while one hypothesis was formulated and tested for the study. A descriptive research design was adopted for the study. The population of the study comprised all the households in the study area. A total of 200 households out of 2350 households were selected for the study through accidental sampling technique. Questionnaire titled "Water source, Sanitation and Hygiene Practices Questionnaire" **(**WSSHPQ) was used to collect data. The instruments were validated by experts in Language Education and Measurement and Evaluation. The reliability coefficient of WSSHPQ yielded a high-reliability coefficient of .81 and it was obtained via Cronbach alpha reliability. Mean and Standard Deviation, Linear Regression Analysis were used to analyze collected data for all the hypothesis at 0.05 level of significance. One hypothesis was tested at 0.05 level of significance. The result of the analysis revealed that effective water, sanitation and hygiene practices have significant impact on the environment causing health concerns to the inhabitants. Sequel to the findings of this study, it was recommended, among others that, government and all the stakeholders in Water, Sanitation and Hygiene should make efforts to improved sources of water and improved sanitation activities especially in the rural areas of Calabar South to improve human health and environment. This would help to improve the health status of residents.

Keywords: Water, Sanitation, Hygiene, Environment, Calabar South, Nigeria

Introduction

Water is essential to human health and a healthy community environment. The environment has direct effects on our health status and plays a major role in quality of life, years of healthy life lived, and health disparities. Globally, nearly 25% of all deaths and the total disease burden can be attributed to environmental factors (Prüss-Üstün & Corvalán, 2006). This is because adequate water, sanitation and hygiene, clean air, stable climate, safe use of chemicals, protection from radiation, healthy and safe workplaces, sound agricultural practices, health-supportive cities and built environments, and a preserved nature are all prerequisites for good health (WHO, 2018).

The vital role that water is playing in improving human health and environment cannot be overlooked. It is in this light that Sustainable Development Goal target 6.1 calls for universal and equitable access to safe and affordable drinking water. The target is tracked with the indicator of “safely managed drinking water services” – drinking water from an improved water source that is located on premises, available when needed, and free from faecal and priority chemical contamination (Who 2022). Adequate sanitation, together with good hygiene and safe water, are fundamental to good health environment and to social and economic development (Mara, Lane, Scott & Trouba, 2010). Water is one of the most priceless resource of Earth and under constant and variate anthropogenic impact (Flörke, Kynast, Bärlund, Eisner, Wimmer & Alcamo, 2013; Hutton & Chase, 2017). The needs of safe water supply, sanitation and hygiene are all unable to keep pace with urban growth followed by poor housing, poor drainage and garbage accumulation, and cause serious pollution problems (Mara, Lane, Scott & Trouba, 2010). It finally has adverse effects on the health of people (Kumar, Kar& Jain, 2011; Benova, Cumming & Campbell, 2014).

In another vein, the report by UNICEF and the World Health Organization (2019) revealed that billions of people around the world are continuing to suffer from poor access to water, sanitation and hygiene. The report further revealed that some 2.2 billion people around the world do not have safely managed drinking water services, 4.2 billion people do not have safely managed sanitation services, and 3 billion lack basic handwashing facilities. The Joint Monitoring Programme report, *Progress on drinking water, sanitation and hygiene: 2000-2017: Special focus on inequalities* finds that, while significant progress has been made toward achieving universal access to basic water, sanitation and hygiene, there are huge gaps in the quality of services provided (UNICEF & WHO, 2019).

In addition, Water Sanitation and Hygiene is a critical component that should be given serious attention it deserved to maintain a healthy environment. It is in this light that the Federal Government in their quest to improve sustainable access to good sanitation and hygiene officially declared a state of emergency on Water Sanitation and Hygiene (WASH) in the Federal Capital Territory (FCT) on the November 10, 2021. The declaration was made by Dr Ramatu Aliyu, FCT Minister of State in her keynote address on Tuesday in Abuja. The Minister stated that 39.4 per cent of the FCT population and a total of 47 million people in the country still actively practice open defecation. The Minister went further that the unhealthy practice is at an alarming rate and totally unacceptable (The Guardian, 2021). The ugly situation is also reflected in the study area of Calabar as observed by the researcher. The unhealthy practices of open defecation in some communities such as Mbukpa, Afokang, Anantigha, New Airport Road, among other that are surrounded by the rivers. Therefore, the success of a healthy environment requires conscious efforts and dedication from government agencies, Community-based Organizations, religious and traditional leaders, organized private sector, including the children, the youth, women and the elderly, all have important roles to play. It is on this background that the present study explored the impact of effective water, sanitation and hygiene practices on the environment in Calabar, Cross River State, Nigeria with the intention to make recommendations that will support safe environment for all residents.

Research problem

The researchers observed that a remarkable percentage of households are exposed to unhealthy environment due to the fact that they do not have access to safe water, good sanitation and hygiene practices. Many of the residents are at risk of infection and disease when water, sanitation and hygiene services are lacking in the environment. Contaminated water and poor sanitation are linked to transmission of diseases such as cholera, diarrhea, dysentery, hepatitis A, typhoid, polio, among others acute respiratory infections and numerous neglected tropical diseases. Absent, inadequate, or inappropriately managed water and sanitation services expose individuals to preventable health risks. Microbiologically contaminated drinking water can transmit diseases such as diarrhea, cholera, dysentery, typhoid and polio and is estimated to cause 485,000 diarrheal deaths each year (WHO, 2022). All these diseases are linked to unsafe water, poor sanitation and hygiene on the environment. Therefore, for healthy environment, good water, sanitation and hygiene should be encouraged. Thus, the problem of this study investigated the impact of effective water, sanitation and hygiene practices on the environment.

Literature review

The quality of water that an individual takes has a lot to do with the person's wellbeing. This may be so because water is very important to man. Having access to safe water, sanitation and hygiene activities in any environment promotes the well-being of an individual. Access to water and sanitation is a fundamental human right and every individual has a right to a potable source of water (Ngugi, Home & Mutwiwa, 2014). Access to water and sanitation is a fundamental human right and every individual has a right to a potable source of water. The third target under Millennium Development Goal (MDG) 7 (environmental sustainability) seeks to improve access to sustainable water and improved sanitation. Access to safe drinking water and sanitation is estimated by the percentage of the population using improved drinking water sources and improved sanitation facilities (WHO, 2022). Improved drinking water technologies are those more likely to provide safe drinking water than those characterized as unimproved while improved sanitation facilities are those more likely to ensure privacy and hygienic use, (WHO, 2022). Improvements in one or more of these three components of good health can substantially reduce the rates of morbidity and the severity of various diseases and improve the quality of life of huge numbers of people, particularly children, in developing countries (Merchant, Jones, Kiure, Kupka, Fitzmaurice, Herrera &Fawzi, 2003).

Previous researches have carried out by different scholars in different dimensions, for instance Rumana and Sharma (2019) carried out a case study to access drinking water quality, sanitation and its impact on environment and human being in the city of Jodhpur, Rajasthan, India. A total of 165 representative water samples were collected from different localities of the city. Out of 165 water samples, 123 were from household drinking water, six from the outlet of waterworks, nine from surface water sources and 36 from ground waters (open wells, step wells, hand pumps and tube wells) were collected Water quality was determined for physical, chemical, and bacteriological characteristics. Parameters measured for water pollution studies include pH, temperature, turbidity, conductivity and total dissolved solids (TDS), alkalinity, hardness, chlorides, fluorides, nitrates, phosphates, and sulphates for chemical, lead, cadmium, iron, dissolved oxygen, biological oxygen demand-BOD, total coliforms (TC), faecal coliform (FC) and faecal streptococci (FS).

The findings of the study revealed that physical and chemical parameters of ground water were above the drinking water standards, whereas in the case of household drinking water were within standard limits. The presence of total coliform, faecal coliform and faecal streptococci were showing water contamination which may be the cause of significant prevalence 5.0% ($p < 0.001$) of gastrointestinal infections. About 89.8% of houses use household drinking water from supply, and the remaining 10.2% houses depend on public taps or other water sources. Similar results for sanitation and hygiene observed as 97% of houses did not have any garbage disposal facility and in all 10.6% did not have easy access to a sanitary facility. The human health is adversely affected by the pollution of water and bad sanitation, which is more marked in developing countries like India.

The relevance of this study to the present study hinges on the fact that both studies examined the impact of drinking water quality, sanitation on environment. However, one of the differences in the two studies is on the location, because the reviewed study was carried out in the city of Jodhpur, Rajasthan, India, the present study was carried in Calabar South, Cross River State, Nigeria. Also, the approach employed in the reviewed study was experimental in nature whereas the design utilized present study was descriptive survey.

Similarly, Ngugi, Home and Mutwiwa (2014) carried out a study on the impacts of Water and Sanitation Activities on the Environment in the Upper Mara Basin. Sampled water and sanitation projects were identified by observation and Geographic Information System (GIS) was used to map and report on these projects. Impacts of the projects on land and environmental quality were assessed using Land Quality Indicators (LQI); fresh water quality, solid and liquid waste generation and management and soil erosion.

Water samples were analyzed for physical, chemical and bacteriological parameters and only 23.4% of sampled water sources were found suitable as domestic water sources.The findings of the study revealed that most open water sources were contaminated with E. Coli caused by open defecation in the basin which on average was 38%. The study showed that, 21.3% of the sampled water supply projects had evidence of soil erosion around them which was mainly caused by livestock overcrowding at water points. Among the wastewater generating and management activities in upper Mara basin, Bomet municipal stabilization pond posed the greatest pollution threat to the environment since it lacked capacity to treat waste water to standards before it overflowed into the environment. The relevance of this study to the present study lies in the fact that both studies focused on the on the impacts of Water and Sanitation Activities on the Environment.

The World Health Organization (2022) reported that in 2020, 5.8 billion people used safely managed drinking-water services – that is, they used improved water sources located on premises, available when needed, and free from contamination. The remaining 2 billion people without safely managed services in 2020 included:

- 1.2 billion people with *basic* services, meaning an improved water source located within a round trip of 30 minutes;
- 282 million people with *limited* services, or an improved water source requiring more than 30 minutes to collect water;
- 368 million people taking water from unprotected wells and springs; and
- 122 million people collecting untreated surface water from lakes, ponds, rivers and streams.

Sharp geographic, sociocultural and economic inequalities persist, not only between rural and urban areas but also in towns and cities where people living in low-income, informal or illegal settlements usually have less access to improved sources of drinking-water than other residents (WHO, 2022). Water, Sanitation and Hygiene (WASH) is imperative for health, and is also an important part of the livelihood of any household. Health is also affected by environmental management in that, disposal of domestic and other wastes is the cause of many water borne diseases such as diarrhea, (Wetlands International, 2010).

The global, Millennium Development Goal (MDG) era definition for an 'improved' drinking-water source is one that, by the nature of its construction and when properly used, adequately protects the source from outside contamination, particularly faecal matter (WHO/UNICEF, 2015a). Improved sources include piped water to the plot or household, public taps or standpipes, tube wells or boreholes, protected dug wells, protected springs, or rainwater. However, these provide varying degrees of safety, according to their differentiated ability to protect from outside contamination. For example, systematically managed piped water from an improved point source of water reduces diarrheal disease risk by an estimated 73%, while that same water source is likely only to provide a 28% reduction if treated at point of use and stored in the household (WHO, 2014a). The evidence suggests that improving water quality at the point of consumption can protect children from diarrheal and many other diseases. A review by Wolf and colleagues in 2014, which included 61 studies for meta analysis, suggests that water interventions could reduce diarrhea by 34% (Wolf, Prüss-Ustün, Cumming, Bartram, Bonjour, Cairncross, & Higgins, 2014). A subsequent prospective longitudinal cohort study, which examined the association between water quality and subsequent diarrhoea in children of the same household, found that each 10-fold increase in E.coli contamination in drinking water was associated with a 16% increase in diarrhea (Luby, Halder, Huda, Unicomb, Islam, Arnold & Johnston, 2015).

Similarly, the global definition of an 'improved' sanitation facility is one that hygienically separates human excreta from human contact (WHO/UNICEF, 2015). A number of sanitation solutions fall within this category: the flush toilet, piped sewer system, septic tank, flush/pour flush to pit latrine, ventilated improved pit latrine, pit latrine with slab and a composting toilet. However, similar to the definitions for water, these are safe to varying degrees; the WHO has recently estimated that effective sewer connections provide an estimated 69% reduction in diarrheal and other disease compared to an estimated 16% reduction from improved sanitation without sewer connections – although this is based on limited evidence and should therefore be considered preliminary (WHO, 2014a). A systematic review by Wolf et al. (2014) which included 11 studies of a randomized, quasi-randomized, case control or observational design, and addressed bias through statistical methodologies, found that improved sanitation can decrease diarrheal disease by 28%, and also that there are notable differences in illness reduction according to the type of improved water and sanitation implemented. On the other hand, lack of hygiene and access to water plays an important role in trachoma transmission. Musca sorbens flies act as mechanical vectors of the trachoma. It has been estimated that Musca sorbens flies that breed in scattered human faeces account for over 70% of trachoma incidence (Montgomery & Bartram, 2010). Inadequate personal hygiene, which is often predicated on the lack of enough water, leads to child-to-child transmission of trachoma as well as attracting the trachoma-carrying flies to unclean faces.

MATERIAL AND METHODS

2.1 Description of the Study Area

The study area is Calabar, the capital of Cross River State of Nigeria. It comprises of two local government areas; Calabar South and Calabar Municipality. The climate is tropical and the vegetation is prominently tropical rain forest. Calabar South is located within longitude 8° 15’ East and 8° 25’ and latitude 4° 54’ North and 4° 58’ North. Calabar South is one of the 18 Local Government Areas in Cross River State. It has a total land area of 264 square kilometers and a population of 191,630 (National Population Commission, 2006). The report further revealed that Calabar South recorded 191,515 as its population with 94,584 for male and 96,931 for female.

Calabar South is bounded by Calabar Municipality to the North, Kwa river to the East, Marina River to the West and Creek town to the South.

2.2 Research questions

How do source of water, sanitation and hygiene practices influence the environment?

2.3 Statement of hypothesis

There is no significant influence of source of water, sanitation and hygiene practices on the environment.

2.4 Sample

The participants of the study are households between the ages of 18-40 years old in some selected rural communities in Calabar South, Cross River State. The communities selected were Bayside, Obufa Esuk Orok, Duke Town, Henshaw Town, and Anantigha. The study adopted descriptive survey design. A sample of 200 households was drawn from the population 2350 households through accidental sampling technique.

2.5 Instrumentation

The researcher developed a questionnaire titled "Water Source, Sanitation and Hygiene Practices Questionnaire **(**WSSHPQ). WSSHPQ was designed to find out households' available effective water, sanitation status and their hygiene practices in the environment. It was constructed using a four-point Likert scale of Strongly Agree (SA), Agree (A), Disagree (D) Strongly Disagree (SD). The questionnaire had two sections: A and B. Section A contained the personal data of the respondent such as the sex, age and occupation while section B had thirty items. The instruments were validated by experts in Language Education and Measurement and Evaluation. The reliability coefficient of WSSHPQ yielded a high-reliability coefficient of .81 and it was obtained via Cronbach alpha reliability.

Data Analysis and Results

The study identified three factors to have exerted enormous influence on the environment. The factors are: sources of water, sanitation and hygiene practices are discussed below. The Frequency (F), Percentage (%), Average (Avr) distribution, standard deviation, F-ratio and independent t-test of these factors are represented in Table 1, and Figures 1 below.

The composition effect of factors such as sources of water, sanitation and hygiene practices on environment is significant. Table 1 shows that the sources of water, sanitation and hygiene practices collectively gave R^2 = .102. This implies that water, sanitation and hygiene practices collectively accounted for 10 percentage of the factors that influenced the environment. The ANOVA table of the regression obtained (F=7,326: p=0.000)indicates that the composite influence of the sources of water, sanitation and hygiene practices were significant. Therefore, the null hypothesis was rejected at .05 level of significance. This implies that there was significant interaction effect of sources of water, sanitation and hygiene practices on Environment.

Meanwhile, comparing the average mean of sources of water, sanitation and hygiene practices as indicated in Table 1. This implies that hygiene practices has the highest influence on environment with the mean score of 15.78 and standard deviation of 3.67, followed by sanitation practices with the mean score of 14.67 and standard deviation of 3.34, then followed by sources of water with mean score of 13.78 and standard deviation of 3.12. Also, Table 1 shows the significant t-value of sources of water influence (t=5.056; p=.000), sanitation practices influence (t=5.379; p=.000) and hygiene practices (t=5.500; p=.000). This implies that taking individual factors, they accounted for significant influence on the environment.

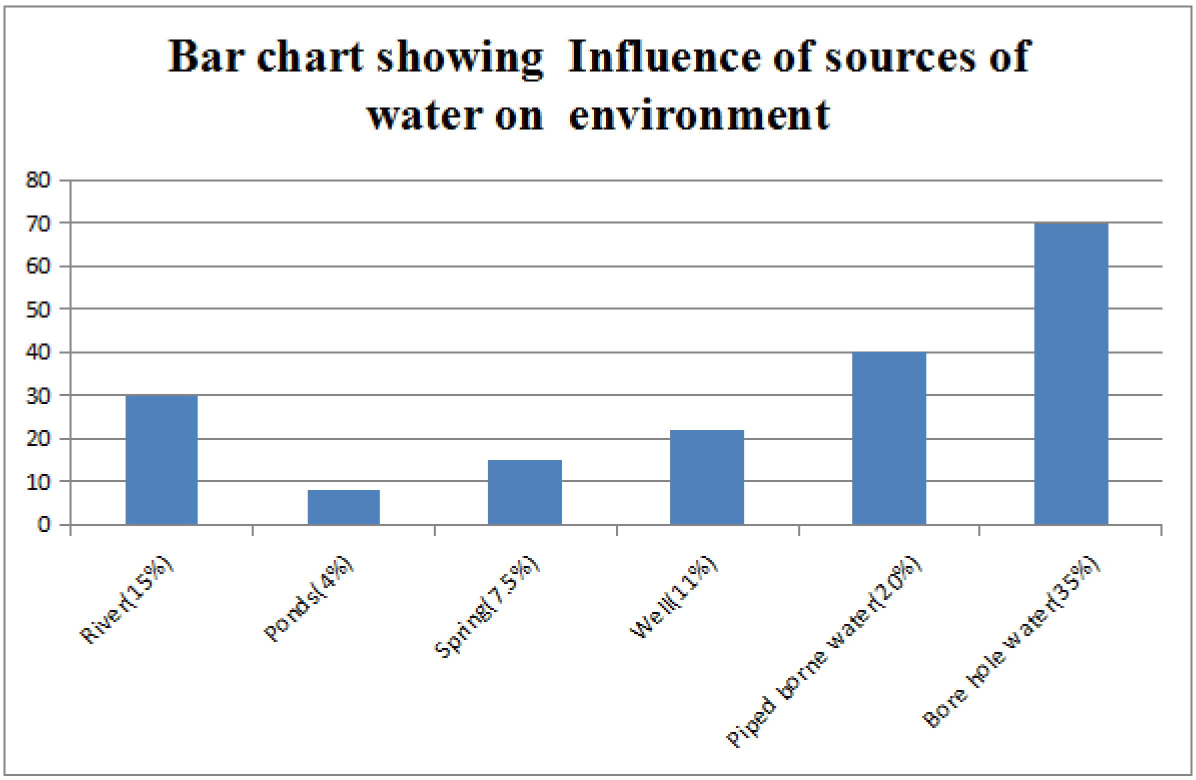
TABLE 1
Analysis of Multiple linear regression analysis of interaction effect of sources of water, sanitation, hygiene practices on environment

Factors		**Mean**		**Standard deviation**	
Sources of water		13.78		3.12	
Sanitation		14.67		3.34	
Hygiene		15.78		3.67	
Sources of variation	**Sum of Squares**	**Df**	**Mean Square**	**F-ratio**	**P-value**
Regression Residual Total	1067.891 9378.123 10446.014	3 196 199	355.964 48.591	7.326	.000
Model	**Unstandardized Coefficient** **B**	**Std Error**	**Standardized Coefficients Bata**	**T**	**p-value**

Constant	22.456	2.834	-	7.924	.000
Water	.546	.108	.099	5.056	.000
Sanitation	.624	.116	.123	5.379	.000
Hygiene	.605	.110	.097	5.500	.000 .

R=.319; R^2 = .102

FIGURE 1: Bar chart showing influence sources of water on environment



The figure 1above shows that out 200 respondents, 70(35%) respondents agreed that borehole water has the highest influence on environment, followed by piped borne water with respondent rate of 40(20%), followed by River with respondent rate of 30(15%), followed by well with respondents' rate of 22(15%), followed by spring water with respondents' rate 15(7.5%), then follow by Pond water with respondents' rate 8(4%) respondents.

Discussion of findings

The result as shown in Table 1 revealed a significant influence of sources of water, sanitation and hygiene practices on environment. Therefore, the adoption of safe and reliable source of water for domestic use by the residents, good sanitation and hygiene practices would promote good environment health. On the other hand, unsafe and contaminated water, poor sanitation and hygiene have negative influence on the environment and health of the residents to include transmission of diseases such as cholera, diarrhea, dysentery, hepatitis A, typhoid, polio, among others acute respiratory infections and numerous neglected tropical diseases.

The study's finding agrees with that of Wolf, Prüss-Ustün, Cumming, Bartram, Bonjour, Cairncross, and Higgins (2014) whose study revealed that improving water quality at the point of consumption can protect children from diarrhea and many other diseases. WHO (2014a) reported that systematically managed piped water from an improved point source of water reduces diarrheal disease risk by an estimated 73%, while that same water source is likely only to provide a 28% reduction if treated at point of use and stored in the household. Similarly, Wolf et al. (2014) found that improved sanitation can decrease diarrheal, cholera, dysentery, typhoid disease by 28%, and also that there are notable differences in illness reduction according to the type of improved water and sanitation implemented. Montgomery and Bartram (2010) revealed that inadequate personal hygiene, leads to child-to-child transmission of trachoma as well as attracting the trachoma-carrying flies to unclean faces.

Conclusion

Access to good water, sanitation and hygiene practices promotes good health of residents in the environment in Calabar South, Cross River State, Nigeria. It is evident from the study that the environment status could be improve upon through access to safe water, good sanitation exercises and hygiene practices in order to improve residents' health status and well-being. Poor access to adequate portable water, Poor access to sanitation and unhygienic environment unimproved and unhealthy live of the residents.

Recommendations

1. Government and all the stakeholders in Water, Sanitation and Hygiene should make efforts to improved sources of water and improved sanitation activities to all residents especially in the rural areas to improve human health and environment.

2.The implementation of Water, Sanitation and Hygiene activities project should be improved upon to sustain environment.

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ASCERTAINING THE EXISTENCE OF MAINTENANCE POLICIES IN THE MANAGEMENT OF HOSTEL BUILDINGS IN THE PUBLIC UNIVERSITIES IN SOUTH EAST NIGERIA

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ABSTRACT

The emergent population of students in tertiary institutions is rising annually, hence, it is imperative to make sure that buildings are performing not only optimally but functionally throughout their life-cycles. Poor maintenance policy framework has been identified as core issue confronting hostel buildings in Nigeria, thus this research is aimed to evaluate the hostel building maintenance practices employed in Nigeria federal universities. This research met its objectives through documentary analysis from direct field observation and a survey questionnaire. A reconnaissance survey was undertaken in other to have adequate knowledge of the issues under investigation. Findings shown further that there is no functional maintenance practice and culture in any of the institutions. Meanwhile, emergency maintenance are more carried out in the final year medical hostel while the male hostels received least attention in all the three institutions. The work thus recommended good maintenance policy and proper funding of hostel building.

Keywords: Dilapidation, Hostel building, Infrasturcture, Maintenance, Policy

1.0 INTRODUCTION

Buildings are fundamental part of a nation's heritage, skyline and distinct character. They are designed and built to sustain their initial functions and beauty for both the present and future users. The condition and quality of buildings in which we live, work and learn reflects a nation's well-being (Wordsworth, 2001). A very important educational asset that characterise virtually all institutions of higher learning across the global north and south is student's hostel building. Ezeigweneme and Egolum, (2020) alluded that at the point of securing admission into the university, students becomes very anxious about the possibility of where to reside so as to have full focus of their academic activities. It is in this context that Price, Matzdorf, Smith and Agahi,

(2003) as cited in Odaudu and Yahaya (2019) highlighted that students' hostel form part of the major facilities that prospective students consider before making a choice of the school they desire to attend amongst other considerations. Essentially, the hostel system according to Ezeigweneme and Egolum, (2020) has become very influential in the modern day pedagogic system, by its usefulness in providing lodging to students at a reasonable price and sociable environment that gives students the opportunity of interacting academically with their fellow students.

According to Olagunju (2012), buildings cannot remain new all through their entire lifetime. Maintenance problems start to creep in once building projects are completed and maintenance needs to be carried out on them in order to sustain the performance of the buildings and keep them in good condition. Dahal and Dahal (2020) also acknowledged that maintaining public building at regular functional state is becoming a challenging job for developing nations. In Nigerian for instance, building maintenance plan according to Odediran, Opatunji, and Eghenure (2012) has received little attention in the past because emphasis is most often placed on new constructions. The emergent population of students in tertiary institutions is rising annually, hence, it is imperative to make sure that buildings are performing not only optimally but are functional throughout their life-cycles. However, educational process and learning activities may be interrupted if the buildings experience poor performance conditions, thus affecting the students' academic achievement (Khalil & Husin, 2011). According to the National Universities Commission (NUC) (2003), the numbers of students who seek admission into Nigeria Universities are terrifically increasing on an annual basis with no analogous improvement in the hostel's facilities to accommodate the teeming population of the students.However, Buys, Cumberledge, and Crawford (2009) indicated that the performance of tertiary institutions, in terms of maintenance management, is far below best practice. It has been observed that housing managers prefer carrying out reactive maintenance works rather than proactive works and sometimes do not consider the clients satisfaction and also the performance of services. Adenuga, Olufowobi, and Raheem (2010) avowed that public buildings in the Nigeria, including higher institution buildings, are in very poor and deplorable conditions. He further noted that though millions of Naira is spent to erect these buildings, they are left, immediately after commissioning to face steady and rapid deterioration, decay and dilapidation. One of the major challenges that confront hostel buildings is poor maintenance policy framework. The maintenance of public buildings in Nigeria has not been giventhe required attention it deserves. The government focuses more on the construction of new buildings, while the maintenance of the old structures which commences immediately after the construction is completed is not given much attention. Olagunju (2012) revealed that poor maintenance of residential buildings is very pronounced in developing countries, such as Nigeria, where little emphasis is placed on maintenance function and management. A preliminary survey conducted in University of Nigeria, Enugu campus; Nnamdi Azikiwe University, Awka campus and Federal University of Technology, Owerri respectively revealed the appalling state of some of the hostel buildings facilities in these three federal universities. The more critical and distressing aspect of it, is the fact that the dilapidated nature of some of the hostel facilities has left most occupants at the mercy of weather and other health related factors. This is an aberration given the existence best practices in hostel buildings maintenance around the world. The findings of the study will be used as a reference point for universities in the southeast to establish a working policies towards effective hostel maintenance.

2.0 LITERATURE REVIEW

Oxford Advanced Learner's Dictionary (2013) defines hostel as a building in which cheap food and lodging is provided for students. Thus, it is a temporal shelter and refuge for the students - providing a bed and sometimes food. In this direction, hostel management incorporates the provision and control of cheap accommodation for students with its related facilities like steady power supply, television set, set of mattress, steady water supply, toilet facilities, kitchen facilities, reading tables and chairs, and enough space to ensure proper care of every student, to enhance their comfort and focus in the academic learning process. In other words, a well-managed hostel is that in which these facilities are functional, with regular updating of obsolete accessories and periodic maintenance or replacement of defaulted accessories. This in no small measure has a significant influence on the comforts of students who live in university hostels, which will ultimately impart positively on their academic achievements (Lateef, Khimidi & Idris, 2010). Badu and Amalov (2006) defined a student hostel to mean student-housing facility built by private developers either alone or in partnership with the university to accommodate and cater for student needs. In the same vein, Hornby (2000) sees hostel as a building in which boarding and lodging are provided (with the support of the authorities concerned) for students, workmen in training. Zubairu and Noralfishah, (2017) see hostel as a housing unit for college students to live for the purpose of studies where many young students leave their homes and parents, reside in student housing without parental monitoring and control. In the same vein, Najib, Yusof, and Abidin, (2011) perceives student housing (hostel) as a place that offers security and privacy in which the university housing administrators can meet the student needs and expectations by renting such spaces to them. However, student housing is seen as an integral part of facilities provided by higher institutions to enable students expand their intellectual capabilities. Owolabi

(2015) describes student hostel as a place where students reside within or outside the campus. Students residing within the houses on the campus are known as on-campus students, while those residing in housing outside the campus are known as off-campus students. Maintenance as a concept has been defined in a number of ways by various scholars, organisations, to mention but a few. . According to British Standard Institution (BSI 3811, 1993), maintenance can be defined as "the combination of all technical and administrative actions, including supervision actions, intended to retain an item in, or restore it to a state in which it can perform a required function". Puķīte and Geipele (2017) describes maintenance as the sequence of actions carried out to take care of a structure and to guarantee the envisioned functions and optimum performance of a structure's life cycle. Olanrewaju et. al. (2011) asserted that building maintenance is 'processes and services to preserve, repair, protect and care for a building's fabric and engineering services after completion, repair, refurbishment or replacement to current standards to enable it to serve its intended functions throughout its entire life span without drastically upsetting its basic features and use'. However, from all the aforementioned definitions and many others, it all revolves around and within the phrase restoring, maintaining, or repairing a building so as to improve the value of the built assets. When viewed from the perspective of sustainability, Sustainable building maintenance as emphasised by Wood (2005) is the maintenance practice that considers both the sustainability of the building and the sustainability of the operations. Therefore, sustainable hostel building maintenance is that which embraces all operational processes to enhance the physical, functional and economic value of the hostel building harmoniously and will not infringe on the health, safety and comfort of any individual in the built environment.

It is necessary as a result of material decay due to these differential rates of weather conditions. Physical breakdown of materials or elements as well as deterioration appearance may necessitate replacements. However, this brings the problem of distinguishing between maintenance and improvement, which has not been resolved satisfactorily by many definitions. However, it is generally conceded that maintenance should include reasonable elements of improvement, for example, the replacement of worn out component with up-to-date version with the intention of work done to increase efficiency in the use of the building by adding facilities, which were not previously present, should be classified as improvement.

A number of studies have acknowledged that the physical environment and the learning experience cannot be separated and are considered to be integral parts of each other. Since universities arecommitted to improving and enhancing its educational facilities, as well as to ensuring the educational success of its students, this present study is geared towards contributing to this effort by evaluating how hostel buildings are maintained in UNEC, UNIZIK and FUTO.

The relationship between hostel building conditions and student satisfaction or achievement is intricate.There are a number of variables that might affect the quality of building conditions and student contentment.

2.1 Hostel Building Maintenance Practices and Challenges in Nigerian Universities

Maintenance is considered a principal phase in the life cycle of built assets. For high performance of buildings, maintenance should be given serious thought, knowing fully well that maintenance management issues play a major role in the performance of built facilities. Shohet and Sarel (2003). According to Olanrewaju et al. (2009), a building requires maintenance to ensure its optimal performance over its life cycle. According to him, the value of a building from the user's perspective can be viewed as the measure of how efficiently and effectively a building meets the users' needs with the available resources. In his analysis, birth, growth, maturity, decline, decay, death, and rebirth are fundamental stages in all natural cycles and so too with buildings, although humans like to keep the cycle under control through maintenance until death (Allen, 2005).

Elements of buildings deteriorate at a greater or lesser rate dependent on materials and methods of construction, environmental conditions and the use of the buildings. The safety of occupants who live in a regularly maintained building can always be assured. When buildings are neglected, defects occur and they result in extensive and avoidable damage to the building fabric. Some residential buildings of public institutions have not seen any significant maintenance since they were constructed, some dating back from the pre-colonial and post-colonial era. This has resulted in damages and deterioration to some public residential buildings in the country. The physical appearance of public institutional buildings particularly hostels in Nigeria's institution of higher learning gives an impression of the quality of service they offer. Maintenance of hostel buildings is imperative, for the rationale behind the maintenance of such buildings is to serve both designed, social and aesthetic functions. According to Adenuga Odusami, & Faremi, (2006) building construction projects in Nigeria are worth billions of Naira, but after construction little or nothing is done to keep the life span of such projects durable by proper maintenance practice. Cobbinah, (2010) observed that public buildings are allowed to dilapidate to unusable levels before maintenance plans are made to preserve its economic value and durability. Sometimes such buildings are left without any form of maintenance for a long time and this leads to total overhaul and reconstruction of the previously constructed project, resulting in a serious economic waste.

Ezeigweneme and Egolum (2020) analysed the challenges in managing students' hostel facilities in Nnamdi Azikiwe University, Awka Anambra State, Nigeria. Findings of the study revealed that the management of students' hostel facilities has been affected by a number of challenges namely misappropriation of funds provided for the maintenance of students' hostel facilities; low supervision and monitoring of workmanship on the hostel facilities; students' disregard for hostel rules and regulations; lack of effective students' complaint system about deficient facilities and delays in the release of funds, among others. The study however recommended that there is need for the University management to engage professional bodies like estate managers who would advise the students' hostel managers on appropriate methods to manage the hostel facilities. Segun, Sharafadeen and Owolabi (2015) carried out a study on the challenges of building maintenance in Nigeria. Survey research design was employed by the study. The findings revealed that in the level of dilapidation of services in the facilities, kerosene cooking system ranked first (68% significance) followed by flush toilet (66%), while the pail system ranked least with (50%) significance. Considering the severity of defects in facilities, peeling of wall surface ranked first (50.8% significance) while foundation failure and sagging of beams were ranked least with (42.8%). The causes of defects in the facilities were investigated and the use of untested or inferior materials (56.8%) was the most devastating factor. The study further highlighted that availability of qualified and competent construction industry professionals was generally believed to be the most significant factor that would impact on the drive to achieve quality of maintenance operations in Nigeria.

2.2 Summary of Literature Review and Research Gap

Several studies in the course of this review have dealt extensively on the issue of hostel building maintenance practices in universities both within and outside Nigeria. Essentially, studies geared towards collectively evaluating hostel building maintenance practices in federal universities specifically UNEC, UNIZIK and FUTO in south-eastern Nigeria indicates a noteworthy lacuna. It is true that there are studies conducted by authors on building maintenance, but none has exploited the concept of buildability and maintainability analysis of hostel building. Maintenance of tertiary institutional hostel buildings is far below international best practices hence: more research needs to be done in this regard. Presently studies on maintenance of hostel buildings have not been conducted in sufficient details in Nigeria, particularly, buildings in UNEC, UNIZIK and FUTO. This apparent gap in research is what the study proposes to fill. In addition, this present study is equally an attempt to address.

3.0 METHODOLOGY

Primary data were acquired through field surveys in the three universities (UNEC, UNIZIK and FUTO). The target stakeholders are students residing in the school hostels, hostel porters, physical planning unit (works department) and students' affairs department staff in the three universities. The methods gather data using questionnaire survey, direct observation and personal interview. A well-structured questionnaire was designed to seek respondents' (students residing in the school hostels, hostel porters, physical planning unit (works department staff) and staff of students' affairs department) opinions on hostel building maintenance practices in their institutions. However, direct field observation was carried out so as to supplement and substantiate the data obtained from the questionnaires. A reconnaissance survey undertaken in other to have adequate knowledge of the issues under investigation.

A total student population of 1050 persons. In UNIZIK, Dora Akunyili hostel and Basil Oli hostel were selected and they also have a total population of 1100 person. While in Futo, Hostels 'A' and 'D' were selected and they have a total population of 1250 persons. However, summation of the aforementioned student population for the three universities served as sample frame for the study. To calculate the optimum sample size for the study, William's (1978) model of sample size determination as adopted by Kerlinger and Lee (2000) was employed.

The formula is given as: $SSn = \frac{N}{1 + (Ne^2)}$

Where: S.Sn = required sample size; N = Population; E = error margin of 0.05 and 1 = constant

A tests of validity and reliability of the questionnaire will be conducted. A pilot survey will also be conducted to ascertain the clarity of the questions from a layman perspective.

4.0 DATA PRESENTATION, ANALYSIS AND DISCUSSION OF FINDINGS

Table 1: Rate of administered questionnaire

S/N	Universities	Number of Questionnaires administered	Number of successfully completed and returned	Percentage of successfully completed Questionnaire
1	Enugu state University of Science and Technology (ESUT)	220	165	75%
2	Nnamdi Azikiwe University, Awka	220	179	81.%
3	University of Technology (FUTO), Owerri	220	175	79.5%
		660	520	78.7%

Table 1 shows the rate of questionnaire distruibuted to differnce categories of respondents in the selected institution. The responses were good enough for the purpose of the research work.

Table 2: Evaluation of Maintenance Policies on building elements

S/N	Rate of Deterioration of Hostel Building Element/Components	Very High	High	Fairly High	Low	Very Low
A	Foundation	5	13	1	3	9
B	Floor Slap and Finishes	3	5	_	8	7
C	Walls	4	13	2	5	7
D	Columns	_	5	2	16	8
E	Beams	5	_	11	3	11
F	Doors and Windows	_	15	8	8	_
G	Plumbing Fittings	12	8	7	4	_
H	Electrical Fittings	9	14	1	7	_
J	Roof/Ceiling	12	7	12	9	_
K	Painting	2	4	3	22	_

Table 2 revealed that attention are often paid to plumbing, electrical and roofing building elements while painting and finishes are the most neglected.

Table 3: Building Maintenance Policies And Practices

			NO		
S/N	TYPE		ESUT	NAU	FUTO
1	Type of Building Maintenance Policies/Practice	Planned Maintenance	5	27	33
		Unplanned Maintenance	13	15	3
		Planned and Unplanned	1	21	17
		No Building Maintenance	12	20	8
		Don’t Know	_	2	15
2	Which Planned Building Maintenance Policy is Applicable	Preventive Maintenance Only	_	4	2
		Predictive Maintenance Only	4	12	3

		Proactive Maintenance Only	1	15	1
		Preventive and Predictive	_	6	34
		Preventive and Proactive	13	13	12
		Predictive and Proactive	_	12	-
		Avoid Collapse of Components	1	27	12
		To Forestall Complaints from Students	24	24	15
		Don't Know	1	5	15
		Others	1	-	-

Table 3 shows different forms of maintenance program with no definite standard adopted by any of tghe institutions.

Conclusion

The spate of poor maintenance and dilapidated structures in south east Nigeria is not as a result of lack of maintenance policy but the stakeholders did not adhere to implemtation of any policy thus left the hostels uncared for. The problem with maintenance starts with the quality of materials used for construction. A poorly constructed Project would definitely bring about early dilapidation as asserted by the authors cited in the literatura. This work therefore recommend quality Project execution and adoption of good maintenance policies that would promote durability and lifespan of the facility.

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EXAMINATION OF MAINTENANCE OF BUILDINGS IN PRIVATE HOUSING ESTATES IN ENUGU METROPOLIS, ENUGU, NIGERIA

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ABSTRACT

Private housing developers complement government efforts in Nigeria and all over the world are taking steps to address the problem of providing adequate and affordable housing to the people. There have been series of housing estate developments in Enugu since the state was created in 1991; following established standards, the housing is supposed to be designed, constructed and managed to ensure maintenance of the buildings and facilities. This research examined and reported findings from a research conducted on the maintenance level of buildings and facilities in private housing estates in Enugu metropolis, Enugu state Nigeria. The objective of this study was to appraise the maintenance level of buildings and facilities in private housing estates with a view to noting improvements required in the design of future private housing developments in Enugu Metropolis and generally in Nigeria. The methodology adopted for this research was survey design. The focus was on four private housing estates in Enugu metropolis randomly selected from the research population. After stratification, based on housing type, two hundred and fifty six occupied housing units were randomly selected. Data was collected from primary sources using questionnaires and observation schedules. Analysis of Variance (ANAVO) tool was used to test the significance of the difference between the estates in the maintenance level of buildings and facilities. It was established that there is significant difference in the maintenance of buildings and facilities in the private housing estates in Enugu metropolis. Integrated action and co-operation of relevant professionals and all stakeholders involved in the development and management of private housing estates in Enugu are recommended to ensure adequate maintenance. The maintenance of residential buildings (public or private) is imperative for any investor involved with buildings, and the ill consequences of not maintaining a building in a housing estate would be noticeable as soon as the building is occupied or put to use. So this should be taken into consideration

Keywords: Examination, facilities, housing estates, maintenance, private

INTRODUCTION

During the pre-colonial era in Nigeria, housing was mainly for accommodating family members in compounds which comprises a number of shelters. The colonial masters introduced quarters (in form of housing estates) to house their employees in towns near their places of work. When Nigeria gained independence, governments as well as private and public organizations continued with the trend and expanded the housing estates in terms of number and structure. To ensure that housing suit the way of life of users to attain satisfaction, residents' participation is key (Fakere, Arayela & Folorunso, 2017). Nigeria as a developing country is utterly challenged with scarce resources for establishment of infrastructure, housing developments, among others which are essential for developmental purposes (Uma, Obidike & Ihezukwu, 2014).

The state of repair of buildings is a vital influential aspect of the habitability of buildings as this exposes the resident's level of satisfaction, well-being and safety which could be attributed to maintenance culture (Umeora, 2020). Maintenance culture which incorporates provisions meant for suitable care of the housing developments and infrastructure have not gained enough ground in the consciousness of developers over the years. Consequently, one can see some buildings and facilities in housing estates at the brink of collapse which emanated from little problems that could have been corrected. These actions in numerous means have resulted to an enormous waste of scarce resources. The essence of maintenance is to return or keep buildings or infrastructure in a functioning or operational condition culture of adequate maintenance enhances life span of items. Maduka (2021). It is the skill of keeping things available for normal use and the designed life span of many infrastructure are at current low in Nigeria. Bamgboye (2006) however noted that maintenance is the art of bringing back the working condition of an item into regular functioning state at a minimal cost capable of enhancing the life span of the item.

For residents to carry out different activities in any housing scheme, the housing is supposed to be developed to offer the residents comfort, safe, healthy, conducive and secured environment (indoor and outdoor). To realize this, housing is supposed to be designed and built in addition to its management being centred on established standards. Professionals in the housing sector, guided by these standards are meant to be familiar with users' preferences. However, sometimes the professionals do not stick to these standards and this leads to dissatisfaction during housing occupation stage (Meir, Garb, Jiao & Cicelsey, 2009). The outcome of this dissatisfaction is manifested in a number of ways. On the one hand, it is reflected on the widely spread need for remodelling of buildings at additional cost. On the other hand in worst case scenario, dissatisfaction in housing could lead to complete desertion of housing by some of the residents leading to voids and desolation in the estate. While the residents that could neither afford remodelling nor relocation costs remain in unsatisfactory housing condition with the resident's perceived physiological, protective and social limitations of the housing estate (Kim, Yang, Yeo & Kim, 2005). These cause waste of energy and resources, inadequate maintenance of the buildings, damages to the surrounding environment and reduce the regard for architects (Nwankwo, Diogu & Nwankwo, 2014; Mitterer, Kuznel, Herkel & Holm, 2012).

There have been series of private housing estate developments in Enugu since the State was created, thus, the need to appraise the maintenance level of facilities in the estates. It is for the reason that housing forms a key element of man's development that this study was carried out. The aim of this study was to appraise the maintenance level of facilities in private housing estates with a view to noting improvements required in the design of future private housing developments in Enugu Metropolis and generally in Nigeria. A null hypothesis was put forward which sought to establish the significant difference in maintenance of facilities in the private housing estates in Enugu metropolis. It stated that there is no significant difference in the maintenance of facilities in the private housing estates in Enugu metropolis.

METHODOLOGY

The data presented in this paper were drawn from a bigger research project designed to assess level of residents' satisfaction in private housing estates in Enugu State, Nigeria. The research design adopted for this study was survey method; this was done through use of questionnaire to obtain data from respondents in the area of study. The research population for included completed private housing estates within Enugu city, built and inhabited before the year 2016. Stratified random sampling of the estates based on building type was the adopted sampling method for the study. The building types in the estates were: 1-bedroom and 2-bedroom bungalows combined, 2-bedroom blocks of flats and 3-bedroom blocks of flats combined, 1-bedroom, 2-bedroom and 3-bedroom bungalows combined as shown in Table 1.

Table 1: List of Private estates in Enugu metropolis stratified by housing type as it exists in the estates

S/N	1-bedroom and 2-bedroom bungalows combined	1-bedroom, 2-bedroom and 3-bedroom bungalows combined	1-bedroom and 2-bedroom flats	2-bedroom and 3-bedroom flats combined
1	Nwannedinamba estate	Goshen estate	Elim estate	COSCO estate
2		Bethel estate		Refiners Estate
3		Elim estate		Central Bank quarters
4				Elim estate

Source: (Field work 2018)

Following this stratification, random sampling by balloting was done and the following estates were picked to represent the different building types:

1. 1-bedroom and 2-bedroom bungalows combined:- Nwannedinamba estate
2. 1-bedroom, 2-bedroom and 3-bedroom bungalows combined:- Bethel estate and Elim estate
3. 1-bedroom and 2-bedroom terrace flats:- Elim estate
4. 2-bedroom and 3-bedroom flats combined:- Central Bank quarters

Sampling size was derived using Cochran formula for finite population:

$$n = \frac{Z^2 \times \sigma^2_p \times N}{(N-1)\, e^2 + Z^2 \times \sigma^2_p}$$

Where:

n = size of sample for finite population

N = research population = 766 housing units

σ_p = standard deviation of population assumed = 0.5

e = significance level (precision/acceptable error) chosen = 0.05

Z = standard variate at a given confidence level (1.96) for a confidence level of 95% (Kothari, 2004)

Sample size of 256 respondents was derived and distributed to the estates in ratio of their contribution as shown in Table 2.

Table 2: Respondents Population in Sampled Estates

number	Nwannedinamba estate	Bethel estate	Elim estate	CBN Quarters	Total
Existing	50	131	324	261	766
Sampled	17	44	108	87	256

Source: Field work, 2018

RESULTS AND DISCUSSION

Descriptive summary measures and frequency distribution for each of the variables studied were calculated. ANOVA test of analysis was also conducted to test significant difference from the research data using Statistical Package for Social Sciences.

Analysis of facilities maintenance in the estate

The aggregated results from the analysis show that facilities maintenance in the estates was majorly done by the residents as shown in Table 3. This result implied that residents undertake maintenance of facilities, sometimes they do this reluctantly as they reported in private interviews in the course of administration of questionnaire. That could be the reason why some of the facilities are in poor state.

Table 3: Aggregated data on facilities maintenance in the estates

Value label	Frequency	Valid Percent	Cumulative Percent
Estate Managers	12	5.1	5.1
Residents	160	67.8	72.9
Both parties	64	27.1	100.0
Total	236	100.0	

Source: Fieldwork, 2018

Test of Hypothesis

The hypothesis: ‘there is no significant difference in the maintenance of facilities in the private housing estates in Enugu metropolis’ was tested. Table 4.90 also shows the one-way ANOVA test results for the differences between the estates in maintenance of facilities. The results show a significance probability point of 0.011. It implies that there is a significant difference between the four groups in maintenance of facilities in the private housing estates. The null hypothesis is thus, rejected and the alternate hypothesis accepted; which is that: ‘there is significant difference in the maintenance of buildings and facilities in the private housing estates in Enugu metropolis’ This difference in maintenance of facilities in the private housing estates lies between CBN quarters and ‘Nwannedinamba’ estate. The results of the Tukey HSD posthoc test was also done to find the level of significance added by each unit of the group as shown in Table 4. The inference is that there is significant difference between some of the pairs of the groups.

Table 4: One-way ANOVA analysis test results showing the difference between groups in the Maintenance of facilities in the estate

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
Maintenance of facilities in the estate	Between Groups	3.036	3	1.012	3.817	.011
	Within Groups	61.506	232	.265		
	Total	64.542	235			

Source: Fieldwork, 2018

The results from the table 5 also showed that Nwanne di na mba estate had a much higher maintenance of facilities than CBN quarters (.464), Bethel estate had a higher maintenance of facilities than CBN quarters (.164) and Elim estate also had a much lower maintenance of facilities than CBN quarters (.064).

Table 5: Tukey HSD Post Hoc analysis test results showing the nature of difference between Maintenance of facilities in the estate

Multiple Comparisons							
Tukey HSD							
Dependent Variable	(I) Housing estate	(J) Housing estate	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Maintenance of facilities in the estate	CBN Quarters	Bethel Estate	-.164	.100	.353	-.42	.09
		Elim Estate	-.064	.077	.838	-.26	.13
		Nwannedinamba Estate	-.464	.145	.008	-.84	-.09
	Bethel Estate	CBN Quarters	.164	.100	.353	-.09	.42
		Elim Estate	.100	.096	.727	-.15	.35

		Nwanne di na mba Estate	-.300	.156	.221	-.70	.10
	Elim Estate	CBN Quarters	.064	.077	.838	-.13	.26
		Bethel Estate	-.100*	.096	.727	-.35	.15
		Nwannedinamba Estate	-.400*	.143	.028	-.77	-.03
	Nwannedinamba Estate	CBN Quarters	.464	.145	.008	.09	.84
		Bethel Estate	.300*	.156	.221	-.10	.70
		Elim Estate	.400	.143	.028	.03	.77

Source: Fieldwork, 2018

The results were further exposed to a Tukey HSD post hoc test to determine the level of significance within the groups. The outcome showed that CBN quarters had a significant difference in maintenance of facilities with ‘Nwannedinamba’ estate. It was found also that there was significant difference between Elim estate and ‘Nwannedinamba’ estate in maintenance of facilities. The implications were namely:

i. CBN quarters was inferior to other estates in the enumerated categories in the maintenance of facilities.

ii. ‘Nwannedinamba’ estate was superior to other estates in the maintenance of facilities.

iii. There seemed, therefore, to be an additional regular effort by ‘Nwannedinamba’ estate towards maintenance of facilities as the variable investigated

CONCLUSION

The research has statistically proven that there is a significant difference between the private housing estates in Enugu metropolis, in maintenance of facilities in the estates. Reaveled also are the post hoc test results which additionally showed that ‘Nwannedinamba’ estate was superior to other estates in the maintenance of facilities. It was followed by Bethel and Elim estates and lastly by the CBN quarters in the variable investigated. Okoye (2020) stated that the maintenance of residential buildings (public or private) is imperative for any investor involved with buildings, and the ill consequences of not maintaining a building in a housing estate would be noticeable as soon as the building is occupied or put to use. So this should be taken into consideration while developing private housing estates.

Umeora, Olotuah and Ezeji, (2019) established that average monthly income affects maintenance level of facilities in private housing estates. This implies that amount of money earned by residents affects their level of satisfaction with maintenance of facilities within the population of study. It was recommended that private housing rent be made affordable (i.e. 30% of average monthly income), so that the residents can afford maintenance of facilities in the estate, thereby achieve satisfaction. This is because inadequate maintenance fund has been recognized as the major factor which hinders the effectiveness and efficiency of most maintenance programs. (Maduka, Olotuah & Ezeji 2019). The implication, therefore, is that stakeholders in the housing sector should vigorously engage with the estate managers whose responsibility it is to run the estates to see the necessity to maintain facilities within the estates. Estate managers should also track performance by regular visits and interactions with the residents. The information gained through this feedback system would then be used for guiding them towards achieving effective management system. Policy guidelines and integrated action and co-operation of relevant professionals and all stakeholders involved in the planning, development and management of private housing estates in Enugu are recommended to ensure adequate maintenance level.

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ISSUES AND CHALLENGES IN LAND OWNERSHIP IN ENUGU STATE NIGERIA: A GENDER PERSPECTIVE.

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Abstract

Land is pivotal to every human activity. In the South East Nigeria in general and Enugu State in particular, women face a lot of issues and challenges in land accessibility and ownership. The aim of this paper is to identify and discuss the major issues and challenges facing women in land access/ownership in the study area with a view to suggesting ways of reducing and/or eliminating the identified challenges. The survey research approach was adopted in data collection while a sample of 900 respondents was selected from men and women in different fields of endeavor in the study area to generate data. Data generated from 720 correctly filled and returned questionnaires representing 80 percent of the distributed questionnaires were presented in tables and analyzed using simple percentages, frequencies and weighted mean. Data analysis reveals that the major issue is that women level of land ownership in Enugu State is very low compared to men (2.5%) and women hardly acquire/own land through inheritance. The challenges facing women ownership/access to land ranges from socio cultural, economic, legal, political and educational factors. The specific challenges include; men preferences in inheritance practice, (3.28), women lack the required collateral to secure finance (3.15), there is no prescription of women land rights in customary/statutory laws of the state (3.28), overburden of domestic responsibilities that does not allow women to be active politically in order to influence decisions concerning them (3.24) and poor investment in female education that has put them in disadvantaged position. The study therefore recommends that all the stakeholders in the state should put conscientious efforts in reducing/eliminating the identified challenges while government and the traditional institutions prescribe women land rights in the statutory and customary laws of the state.
Key words: Challenges, Gender, Inheritance, Land, Ownership,

1. Introduction

Land is a scarce resource and one of the major factors of production. It is a primary source of wealth, social status and power. It is the foundation for food production, shelter provision, economic activities and as such virtually every individual depends directly or indirectly on land for their survival.

In Igbo land and Enugu state in particular, land is seen as a critical resource because people's economic life depends on it. In nearly every part of Igbo land, land is seen to belong to the people and the male child by virtue of being a member of the family, is expected to inherit the father’s land/property (Acholonu and Ochiabutor, 2021). The above situation puts the female gender into some disadvantaged position as it concerns ownership and access to land.

Ifediora (2014), states that land tenure (land access) has to do with rules invented by societies to regulate behavior with regards to land. It defines how property rights to land are to be allocated within societies. It further defines how access is granted; the right to use, control and transfer land as well as associated responsibilities and restrain

In recent times, gender related issues and matters have been areas of discuss in both literature and academic world. This is because of the recognition that, for there to be sustainable economic development, the role of both men and women (gender) have to be harnessed. Equality in all its ramifications of life in gender issues has been advocated for in many articles and journals. This is in recognition of the potentials and opportunities for both masculine and famine genders that if maximally harnessed will contribute meaningfully to the growth and development (Ekenta, Mohammed and Afolabi, 2012). Daley, Flower, Maggiano and Pallas (2013) identified women’s land rights and gender justice in land governance as fundamental pillars in the promotion and protection of women’s human rights especially in rural areas. They noted that not only are they human rights themselves, being closely linked to women’s status, legal capacity and inheritance and property rights, their position in family law and marriage, and their participation in public life. It has been identified by many authors that women land rights are key determinants in women empowerment, especially in rural areas and have profound implications in women’s ability to enjoy in practice, civil and political rights, social and economic rights as well as to escape poverty and social exclusion.

Generally, access to land in Enugu state is such that land use and its control in the pre-colonial , colonial and post-colonial eras was mostly in the hands of men. Women in the pre-colonial era in Enugu state had some form of land rights for agricultural production through their husbands and male children. They could farm on their husbands; children or male relatives land but not own such lands. Women’s primary responsibilities were seen as child bearing and rearing as well as housekeeping..

In the colonial era, Abdulraheen (2010) noted that women were engaged more in growing crops and domestic chores as they were considered subordinate to men. Hence, men dominated the process of cash crops cultivation which was not the case in pre-colonial era. This is because the colonialists saw cash crops as crops that will give them financial resources. Colonial administration placed a lot of restrictions on women and introduced assumptions of European Patriarchy into the Nigerian society. Women were marginalized even more in granting land rights during the colonial period in Enugu state even though they were the main agricultural producers before the advent of colonialism and discovery of coal led to mass movement of able bodied men to the urban centers in search of white collar jobs. Rights of women to land in the post-colonial era were under the customary and statutory laws. These laws were silent on women's land rights. The statutory laws (The Land Use Act 1978) which aims at giving access to land to all Nigerians compounded the problem as the Act gave the absolute right to land to the state governors, whose consent has to be sought before one can gain access to land..

Again in the post-colonial era, while recognizing the need to eradicate all forms of discrimination against women, land ownership, the Supreme Court of Nigeria voided the Igbo age long customs and tradition in inheritance rights where it upheld the right of female child inheritance to the father's land/property (vanguard.com. 2020). However, Acholonu etal (2021 noted that the decision from the Supreme Court can never be taken seriously by a typical Igbo man because of the believe that Igbo customs and tradition is as strong as diamond. The above scenario poses challenges to women's active involvement and the harness of their potentials in sustainable development of Enugu state and Nigeria in general.

2. Literature Review

Concept of Land

Land means different things to different people. The meaning of land can be seen from the perceptions of different professionals, individuals, countries etc. In this regard concepts of land include the physical, spiritual, socio-political, economic, abstract and legal concepts of land. The physical concepts of land includes buildings, trees and plants, animals, soils, streams and other water bodies and the air space above the land. The physical concept of land is very useful in land use decisions and as Egbenta (2012) opined that it is the aspect that people see and which acquisition leads other concepts of land to be acquired. Land involves not only the soil, the trees, the grass, the buildings etc. but the rights that people may have in land.

The economic concept of land looks at land as a factor of production thereby referring to land as the entire natural and man-made resources which possession of the earth's surface gives control over. In this light land can rightly be said to be the foundation of all wealth. This definition therefore implies that land includes the ground, water, ice, mineral deposits and forests. The man-made improvements can be understood to be buildings and other improvements on land. The spiritual concept of land highlights the spiritual attachment that people have over land which comes into play in the reverence of land as a deity in some parts of Africa and Nigeria (Emoh and Nwachukwu, 2016). The religious concept of land also highlights the spiritual bond between the living and the dead. The socio-political concept of land views land as a people, a village, and a nation which constitutes a social political entity. This means that when people are from the same land, they are a race from the same community. (Egbenta, 2012)

The abstract concept of land are the bundle of rights which an individual or group have in, on, over or under land depending on the private and public restrictions in that locality. It is these bundle of rights that gives people the authority to use, manage, alienate and claim ownership of land. The legal concept of land can be defined as the rule and regulations governing the use of land in any nation. This implies that the legal concept of land treats the nature, extent and duration of the various interests that exist on land. All the concepts of land are related to themselves in one way or the other and may not function independent of themselves. The main concern of this study is the issue of control of rights which possessions of land gives the owner as it is this right that distinguishes land from other types of property. Control of right may come in form of statutory legislations indigenous or customary laws and religious laws and some local norms and regulations which may not be explicit but which still governs property rights in localities. This leads to who owns what rights in land and the tenure of such rights and consequently land tenure.

Land is one of the most fundamental resources to man. Women in most developing countries play a major role in food production where they make up more than 70% of the small scale farmers and provide about 80% of the workforce in production and processing. Women's contributions, especially in food production and family income generation are greatly impaired by the wanton disparity in land ownership skewed in favour of men. This is so because the productivity of women especially in the supply of family food and generation of income for households in the semi-urban and the rural areas revolve largely around land. As noted by Kameri-mbote (2005) with agriculture and other land based natural resources being the main source of livelihood the consequences for women not owning, controlling or accessing land are grave. Lack of adequate productive land seriously undermines women's contributions which tend to deny the society the benefits of their productive efforts. Indications are that most policies, practices, traditions and laws relating to land in Nigeria are either silent on women's disadvantaged status or are gender biased against women.

The right of women to own property, including land is recognized under international human rights law yet formal laws, traditional legal systems and societal norms including customary and religious laws, may deny women the right to acquire and inherit proprietary rights of ownership in land.

Ownership and Possession of Land

Ownership: Ownership can be described as the totality of or bundle of the rights of an owner over a thing owned. Such exercise of rights and powers implies exclusive enjoyment of the thing owned. In other words one can only transfer what one owns. Ownership can be described as the right of exclusive use of property. It can imply the fullest amplitude of rights of enjoyment, management and disposed over property.

Ownership means the totality of right and powers that are capable of being exercised over a thing or property. Ownership is always subject to the rule that a person must use his property in such a way that it does not cause harm to his neighbours. In all it is understood that ownership can be said to be best and highest relationship that a person or group can have with respect to property or land. In other words ownership is a superior, permanent and inheritable right that gives an owner the right to enjoy, use, manage and dispose of his property though subject to laws and regulations existing in his state.

Possession: Possession is the state of having, owning, or controlling something. It implies manual custody, physical control that is coupled with the intention to exercise such rights. In other words possession means visible power or control over something or occupancy as district from ownership.

Land Tenure

Land tenure is the relationship, whether legally or customarily defined, among people, as individuals or groups, with respect to land. Land tenure refers to the rules, authorities, institutions, rights and norms that govern access and control over land and related resources. It defines the rules and rights that govern the appropriation, cultivation and use of natural resources in a given space or piece of land. Land tenure systems determine who can use what resources for how long, and under what considerations. It is an important part of social, political and economic structures. Land tenure is multi-dimensional, bringing into play social, technical, economic, institutional, legal and political aspects that are often ignored but must be taken into account. (Briregard, 1993; Bromley, 1991) Quansah (undated) defines land tenure as a concept that considers how people gain access to land and they use it. Land tenure can be described as a systematization of the rules which function by specifying what different classes of persons may or may not, must or must not do, with reference to the occupancy, use, abuse of disposition of land. Agyei – Boaterg (2010) states that land tenure entail the various laws, rules and obligations governing the ownership rights and interests in land. The control and governing of property rights stem from the fact that there is increase in population and therefore a need to control the use of such rights. As land tenure defines access to and use of land resources, it has become the focus in identifying the causes of Africa’s food production and environmental degradation problems. This is in line with (G12, 1998) study where they provided details of how deficiencies in land tenure systems deter economic growth, poverty alleviation, environmental preservation, employment, socio-political stability and socio-political participation.

However, it is important to acknowledge that where insecurity of customary tenure exists in an agrarian economy like in Enugu State, as in the case of women’s non access to land it can be a major factor in poor agricultural production and environmental management. Bob, Mtshali, Moodley Mutanga and Rugege (2007) asserted that land tenure is a key factor in any economy since it conferred property rights and defined access to and control over land assets, including natural resources that existed in or on the land. Land tenure conferred rights in relation to the manner in which people own land. This also entails decisions pertaining to residential and business development, agricultural production and mining, and the use of other natural resources. It is for these reasons that it is important to study how individuals and groups access land in different communities and nations.

Issues and Challenges in Land Ownership by Women

Land ownership has special features that endear it to both men and women more than other forms of investment. There exists sparse literature in this aspect as very few works conducted earlier focused on women and real estate ownership. Most works in this direction focused on women land rights in Nigeria as well as housing. Aluko and Amidu (2006) identified that women’s land rights in Nigeria are fragile and transient being dependent upon age and marital status (including type of marriage and success of marriage), whether they had children (including number and sex of these children) and their sexual conduct. They argued that gender is central to understanding organization and transformation of land holding in Nigeria, shaping women's differential experience of tenure insecurity not only as wives but also as sisters, daughters and as divorced or widowed heads of households. Clarrisca (2005) observes that 2 percent of the registered lands right in the developing world are held by women, which has implications for democracy, governance, conflict and sustainability. Concurring with the above view Aluko and Amidu (2006) found out that in the context of globalization, occasioning greater market integration, women could context claims on their land but their ability to negotiate access to land needs to be supported and harnessed into land policies. Earlier works like Berry (1993) and Umezurike (2004) observed that under customary land tenure system, which is still very much p prevalent, the distribution of rights is based on socio-political system (the political history of the village and region from which the alliances and hierarchical relationship between lineages are derived) and on family relationship (access to land and resources) depending on one's social status within the family, so that social networks govern access rights. In most customary land holding systems, community level decisions about land are taken by chiefs or headmen on behalf and in trust for the clan or family. Hence chiefly authority is generally ascribed to a patriarchal linage and major decision taken by men (Ntsebeza 1999). However, concurring with the above view Tripp (2003), Whitehead and Tsikata (2003) and Hillhorst (2000) agreed that women claims to land within customary systems are generally obtained through their husbands or male kinsfolk and therefore may be considered secondary. Emeasoba (2012) argues that despite the indispensability of land to human existence across the globe, women face discrimination in land inheritance under both customary and formal systems of land tenure. Quan (2006) also stated that only in few cases are women's right to hold land and own property recognized in legislation. However, the intervention of the state through the promulgation of the Land Use Act (LUA) 1978 now CAP 202 L.F.N 1990, to ensure equal access to land has not yielded the desired result. Amankwa (1989) and Aluko and Amidu (2006) observed that because indigenous system does not admit that land can never be without an owner, there persist confusion either in theory or practice on where lies the allodial title to land. This led to various criticism of the act such as Fabiyi (1990) who sees the Act as an urban legislation which only superficially touches on the tenure problems in the rural areas in the country. The above views suggest that the Land Use Act CAP 202 L.F.N 1990 has not solved the problem of customary land tenure system which has been identified by various authors especially as it concerns women. Also Gbadegesin (2012) assessed the cultural and traditional implication of women's right to land for development and this was limited to land and women in Oke- Ogun area of Oyo State Nigeria.

In spite of the above works bothering on land rights, there are some few specific works on women and ownership especially as it concerns Enugu State.

Patel and Patel (2012) identified that females invest their savings less in land as compared to their male counterparts in India. Concurring to the above view, Oriye, Owoefe and Weje (2012) stated that due to gender based law which grants men direct access to housing and property, women generally lack security of tenure. Asiimwe (2010) studied gender; homosexuals and the dynamic of marriage in Kampala Uganda and concluded that there was an indication of male dominancy in home ownership in the study area. Also UBS Investor Watch (2014) observed that women are engaged in many wealth management decisions but not investing. They found out that men's responsibility in making financial decisions include; investing, insurance, long term planning and paying bills while women's responsibility in financial decision include; paying bills, day to day expenses and charitable donations. The reason behind the above situation according to Clark and Straus (2008), as well as Patel and Patel (2012) is because women are more risk averse than men. The above few works points out to the fact that women lag behind in terms of real estate ownership. The factors that impede the active participation of women in real estate ownership in South East, Nigeria are the concern of this research work.

Hora (2014) also identified lack of adequate educational status required from women, absence of commitment by concerned (top decision making) body, backward socio-cultural attitudes, lack of sufficient experiences from women to hold leading position, overburden of domestic responsibility, negative attitudes of men towards women and lack of confidence from women themselves as major socio-cultural factors hindering women from leadership and decision making position. The view of the above authors shows that socio-cultural factors pose threats to women active participation in different sectors of human activities. This work adopted some of the identified social factors/variables to examine the socio-cultural factors that constrain real estate ownership by women in Enugu State Nigeria.

3. Methodology

The study employed the survey research approach in generating data for the study. This approach allowed the selection of samples to represent the entire population where the data generated from the samples were used to generalize on the entire population. The population was made up of men and women in both rural and urban areas of Enugu state. One community from each of the senatorial zones that made up Enugu state was selected for the study based on population and geographical spread. Hence Affa Community in Enugu West, Enugu Ezike in Enugu North and Akpugo in Enugu East Senatorial zones were selected whereas the urban areas were represented by the communities hosting the local government areas in Enugu urban. Hence, men and women residing/working or doing business in Enugu North, Enugu East and Enugu South local government areas and the aforementioned rural communities were selected for the study. Krejcie and Morgan (1970) Sample Size Technique was adopted in selecting 900 samples to whom questionnaire were distributed

4. Results and Discussion

Table 1: Questionnaire Distribution

Category of Respondents	**Number Distributed**	**Number Collected**	**Percentage of Response (%)**
Men	450	350	38.89
Women	450	370	41.11
Total	900	720	80

Table 1 shows that out of 900 questionnaires distributed to both men and women in the study area, 720 were correctly filled and returned representing 80% of the total distributed questionnaire which is adjudged high enough to be used for analysis.

Table 2: Response on whether Women own Land in Enugu State

S/N	Responses	Frequency
1	Agree	80(11%)
2	Disagree	619(86%)
3	undecided	21(3%)
	Total	720

Source: Field Survey, 2021

From the analysis in Table 2, it shows that 11 percent of the respondents agree that there are women ownership of the land in the Enugu State; 86 percent disagree that there are women ownership of land in the study area while 3 percent were undecided. The above analysis indicates that land ownership by women in Enugu State is low. Table 3 strengthened the result of table 2 above by showing the number of women with registered title in the study area.

Table 3: Distribution of registered titles in Enugu State from 2002 - 2018

Period	Total Number of Registered Instruments	Number of instruments registered in the name of Men and others	Number of Instruments in the Name of Women	% for Men and others	% for Women
2002	1729	1678	51	97.05	2.95
2003	1662	1633	29	98.26	1.74
2004	718	700	18	97.49	2.51
2005	2136	2096	40	98.13	1.87
2006	2132	2112	20	99.06	0.94
2007	1871	1855	16	99.14	0.86
2008	1424	1416	8	99.44	0.56
2009	990	956	34	96.57	3.43
2010	1074	1036	38	96.46	3.54
2011	874	830	44	94.97	5.03
2012	1172	1106	66	94.37	5.63
2013	827	790	37	95.53	4.47
2014	915	883	32	96.50	3.50
2015	891	855	36	95.96	4.04
2016	806	777	29	96.40	3.60
2017	2021	1937	48	97.24	2.61
2018	2357	2288	69	97.07	2.93
Total	**23,599**	**22,948**	**615**	**97.24**	**2.61**

Source: Field study, 2021.

Table 3 above indicates that out of the registered titles in Enugu State from 2002 – 2018, 97.24% of them were registered in the name of men and others like companies and other organizations, while 2.61% of the registered titles were in the name of women. This shows a wide gap between ownership rights by men and women in Enugu State.

Table 4: Means of Land Acquisition by women

S/N	Responses	Frequency
1	Land purchase	228 (32%)
2	Gift	120(16%)
3	Family Inheritance	30(4%)
4	Communal Inheritance	0 (0%)
5	Government allocation	65((%)
6	Land on lease	279(39%)
	Total	720

Source: Field Survey, 2021

From the analysis in Table 4 above, 32 percent of the respondents agree that land purchase is the means of land acquisition, 16 percent agreed on gift, 4 percent agree on family inheritance, none agreed on communal inheritance 65 percent agree on government while 40 percent of the respondents agree on land on lease The implication of the above analysis is that women do not own land through inheritance in the study area..

Table 5: Challenges to Women Access/Ownership of Land in Enugu State

S/N	Challenges	Very Significant	Significant	Insignificant	Very Insignificant	Mean	Rank
	Socio-cultural factors						
1	Land are redistributed in favour of male	356(49%)	172(24%)	112(16%)	80(11%)	3.12	4th
2	Gender inequality in the land market	344(48%)	205(29%)	125(17%)	46(6%)	3.18	3rd
3	Men are preference in inheritance practice	368(51%)	217(30%)	105(15%)	30(4%)	3.28	1st
4	Lack of support from spouse and fellow women	220(31%)	350(49%)	94(13%)	56(7%)	3.02	5th
5	Cultural biases about women	340(47%)	233(33%)	102(14%)	45(6%)	3.21	2nd
	Economic factors						
1	Women carry out heavy burden of unpaid domestic work	340(47%)	220(31%)	110(15%)	50(7%)	3.18	2nd
2	Women lack the required collateral to access finance	338(47%)	228(32%)	110(15%)	44(6%)	3.19	1st
3	Unemployment	311(43%)	215(30%)	125(17%)	69(10%)	3.07	5th
4	Lack of resources to access land	331(46%)	205(28%)	113(16%)	71(10%)	3.11	3rd
5	Lack of time to engage in income earning activities due to child bearing/rearing activities	318(44%)	220(30%)	113(16%)	69(10%)	3.09	4th
	Legal factors						
1	Land tenure system is unfavourable to women	221(31%)	325(45%)	112(15%)	62(9%)	2.98	3rd
2	Women are constrained in seeking access to justice	220(30%)	340(47%)	91(13%)	69(10%)	2.99	2nd
3	Women lack the right to own and manage land	76(10%)	92(13%)	350(49%)	202(28%)	2.06	5th
4	There is no prescription of women land right in customary laws	367(51%)	218(30%)	105(15%)	30(4%)	3.28	1st
5	Women participation in influential level of power is low.	150(21%)	335(47%)	145(20%)	90(12%)	2.76	4th
	Political factors						
1	Socio-cultural attitude	340(47%)	206(29%)	97(13%)	77(11%)	3.12	2nd
2	Women lack the required experience	202(28%)	345(48%)	88(12%)	85(12%)	2.92	3rd
3	Low participation of women in influential echelons of power	104(14%)	186(26%)	336(47%)	94(13%)	2.42	4th
4	Overburden of domestic responsibilities	355(49%)	231(32%)	88(12%)	46(7%)	3.24	1st
	Educational factors						
1	Parents give their daughters out for early marriage	321(45%)	223(31%)	110(15%)	66(9%)	3.11	4th
2	Poor investment in female education	345(48%)	220(30%)	105(15%)	50(7%)	3.19	1st
3	Female child is not valued	124(17%)	231(32%)	285(40%)	80(11%)	2.55	5th
4	Women lack of knowledge of their land rights	334(44%)	265(37%)	88(12%)	53(7%)	3.17	2nd
5	Women are constrained by long societal rules	320(44%)	250(35%)	82(11%)	68(10%)	3.14	3rd

Source: Field Survey, 2021

From the analysis in Table 5.above, it shows that the challenges faced by women in land ownership/ access are categorized into socio- cultural , economic, , legal , political and educational factors.

In socio-cultural factor, it shows from the mean ratings and rankings that men are preference in inheritance practice is ranking 1st (3.28), cultural biases about women ranking 2nd(3.21), gender inequality in the land market ranking 3rd(3.18), land are redistributed in favour of male ranking 4th (3.12) and lack of support from spouse and fellow women ranking 5th(3.02).

In economic/financial factors, the ratings and the rankings shows that women lack the required collateral to access finance is the 1st (3.19), lack of resources to access land ranking 2nd (3.18), lack of time to engage in income earning activities due to child bearing/rearing activities 3rd (311), Women carryout heavy burden of unpaid domestic work ranking 4th (3.09) and Unemployment 5th (3.07).

In Law/legal factors, the rating and the ranking shows that there is no prescription of women land right in customary laws is ranking 1s t(3.28), women are constrained in seeking access to justice ranking 2nd(2.99), women participation in influential level of power is low ranking 3rd (2.98), land tenure system is unfavourable to women ranking 4th (2.76) and women lack the right to own and manage land is ranking 5th(2.06).

In political factors**,** the mean rating and the ranking shows that overburden of domestic responsibilities affects the women ranking 1st(3.24), socio-cultural attitude ranking 2nd (3.12), women lack the required experience ranking 3rd(2.92) and low participation of women in influential echelons of power 4th(2.42).

In educational factors, the rating and the ranking shows that poor investment in female education is ranking 1st (3.19), parents give their daughters out for early marriage ranking 2nd (3.17), women lack of knowledge of their land rights ranking 3rd (3.14), women are constrained by long societal rules ranking 4th(3.11) and female child is not valued ranking 5th (2.17)..

The implication of the above analysis is that women face enormous challenges in land access and ownership in Enugu State

Table 6: Response on what could be done to enhance land ownership by women in Enugu State. (SD = Strongly Disagree, D = Disagree, UN = Undecided, A = Agree, SA = Strongly Agree)

Response option	SD		D		UN		A		SA	
	N	%	N	%	N	%	N	%	N	%
1. Creation of awareness on the benefits of land ownership by women to the society	55	8	82	11	22	3	245	34	316	44
2. Educating women on their rights to property ownership	30	4	72	10	30	4	255	36	333	46
3. Empowering women by providing enabling environment for wealth creation and better employment opportunities	62	8	107	15	22	3	215	30	314	46
4. Strengthening the laws and legal framework on women rights to property ownership	60	8	121	17	15	2	221	31	303	42
5. Eradication of customary practices which are repugnant to women ownership of real properties	45	6	102	14	31	4	235	33	307	43
6. Eradication of gender inequality in the land market	103	14	159	22	39	5	222	30	212	29
7. Removal of challenges faced by women in accessing finance through the mortgage institution	55	8	114	16	31	4	220	30	300	42
8. Giving women more opportunities in the high echelon of power	141	19	113	16	20	3	214	30	232	32
9. Elimination of all discriminatory practices against women in real estate ownership	132	18	114	16	21	3	223	31	230	32
10. Improving women's access to education	22	3	102	14	41	6	214	30	341	47

Source: Field Survey 2021

Table 6 above shows the respondents view on what could be done to improve women land ownership in the study area. It shows that the respondents agreed that all the options are acceptable things to be done to improve women ownership of land in the state since those who either strongly agreed/ agreed to all the options are above 50 percent. However, creation of awareness on the benefits of land ownership by women to the society is adjudged the most critical factor as 78 percent of the respondents agreed to the option.

5. Conclusion and Recommendations

Land being a scarce and important resource should be made available as far as practicable to all individuals both male and female. Hence, the present situation where women's level of land ownership is low is not acceptable in the 21st century era. The situation also negates the third millennium goal of gender equality. There should be conscientious efforts by all the stakeholders (government, custodians of culture and traditions and the general public) in helping to reduce/eradicate the numerous challenges faced by women in accessing and owning land. This is necessary so as to harness women's potentials and capabilities in achieving sustainable economic development of Nigeria generally and Enugu State in particular.

It is therefore recommended that all the discriminatory practices against women in land ownership should be eliminated by concerned stakeholders. Again, government and traditional institutions should prescribe women land rights in the statutory and customary laws of Enugu State.

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COST ESTIMATION AS GUIDE TO REAL ESTATE DEVELOPMENT PLAN IN A DEPRESSED ECONOMY

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Abstracts

Real Estate development refers to the application of capital and labour to land in such a manner that will bring about increase in the yields accruing from the land. Change in the use of a property or modification of the physical structure of a property is also considered as development. Therefore, real estate development essentially entails conversion, alteration and/or adaptation of land and landed property to meet certain use requirement which increases the overall yields of the property. Real Estate development requires a colossal amount of money to be executed. The capital requirement (which is the cost of such development) is so huge that most often, equity funds alone may not be sufficient to carry o the development. It then requires a plan which should be long term or short term in nature in order to achieve such development. In a depressed economy, just like that of ours, it requires plan to bring about real Estate development which actually is one key area that can pull any economy out of its depressed state. Cost Estimation is one of such tool which guides developers, be it valuers, private or public developers in their real Estate development plan.

Keywords: Real Estate Development Plan, Cost Estimation, Depressed Economy.

1.0 Introduction

Cost Estimation in project management is the process of forecasting the financial and other resources needed to complete a project within a defined scope. Cost estimation accounts for each element required for the projects-from materials to labour- and calculates a total amount that determines a projects budget. Therefore, it is the summation of the individual cost elements, using established estimating methods and valid data to do so. The techniques/tools for cost estimation include but not limited to: Expert judgment, Analogous Estimating, parametric Estimation, three-point Estimating, bottom –up Estimating formulas and calculation etc

In Egolum, (2002), Real Estate Development refers to the application of capital and labour to land in such a manner that will bring about increase in the yields accruing from the land. Change in the use of a property or modification of the physical structure of a property is also considered as development. The Capital requirement is so huge that most often equity funds alone may not be sufficient to carry on the development. Real Estate development- investors source and obtain credit facilities to enable them to fund the development to completion. Without credit facilities, very large real estate developments would be rarely possible. Loan funds are, therefore, necessary for efficient operation of real estate development in any economy (Egolum, 2002).

This paper focused on the cost estimation especially from professionals, as a guide to Real Estate development plan in a depressed economy like ours. It is no gain saying that one does not have to embark on project development without property analyzing the cost implication of such development. Real Estate development is always capital intensive. It requires professional guide- stage bay stage (Materials and Labour Cost) by the requisite professional to ensure the completion of such development. This developments when completed, should impact positively to our economy by the way of profits and income returns from such investment.

2.0 Background to the problem

The concept of Real property and Real Estate should be clearly stated here. Real property includes: land buildings, and other improvements plus the rights of use and enjoyment of that land and all its improvements. Real Estate is one of the oldest and a popular asset class in the world. It refers to property made up of land and the buildings on it, as well as the natural resources of that land, including uncultivated flora and fauna, farmed crops, and livestocks, water, and any other additional mineral deposits (Umeh and Mamuda, 2020). They opined that real Estate is “real” meaning that it is tangible assets. According to Evans and Evans, (2007), Real Estate means Land and everything above and below the soil.

Real Estate investment can be described as the giving up of a capital sum to acquire investment directly or indirectly, for the purpose of earning income returns and enjoying capital gain (Umeh and Mamuda, 2020). Hence, real Estate investments are undertaken when an investor directly or indirectly risks capita on real estate with the intention of making future returns. Accordingly, Enever and Isaac (2002) opined that investment in real Estate is the giving up of a capital sum in exchange for a future benefit from the real estate, which takes the form of income flow and capital gain. The income and the capital return on real Estate investments are what make up the total or the holding period return also referred to as Money Weighted Rate of Return (MWRR).

According to Egolum (2002), real Estate Development refers to the application of capital and Labour to land in such a manner that will bring about increase in the yields accruing from the land. Change in the use of a property or modification of the property physical structure is also considered as development. Hence, we can say that real Estate development essentially entails conversion, alteration and/or adaptation of land or landed property to meet certain use requirement which increases the overall yields of the property (Egolum, 2002).

Furthermore, from the above, it is seen that the cost of development of any real property is always high. It requires huge capital quantity. Therefore, it is imperative to plan such development. In the concept of sustainable development, it has tripartite stand (the environmental, economical and social dimension) (AKPU, 2014). The economic dimension of sustainable development can be assessed as follows:

- Steady, continuous stream of income at difference levels individual households, communities, countries.
- Increased food availability, real income and cash.
- Maintenance of productivity in the face of stress or stocks like human health, natural disasters, economic conjecture, social conflicts.
- Real benefits derived from land management.
- Efficiency of investment through cost/benefit analysis.
- Maintenance of a given level of expenditure over time. (AKPU, 2014).

Reliable cost estimates are necessary for all projects. Without a cost estimates, it would be impossible to prepare a business plan, establish detailed budgets, predict resource requirement or control project costs. In the process of cost Estimation, the project cost Engineer/Quantity surveyor uses either one or the combination of the techniques applicable. These techniques include: Expert judgment Analogous estimating, Parametric estimating, Bottom-up Estimating, Three – Point Estimating Data Analysis (Alternative analysis/Reserve analysis) etc. in development plan, projects that are capital intensive requires detailed cost Estimates from qualified professional. The Quantity Surveyors are the trained professionals for such trades. When there is detailed cost Estimation on a particular project, it would assist the developers and investors to make plans on the stage by stage financial involvements and make arrangement on how to achieve such enormous task.

3.0 Cost Estimation

3.1 Estimation format structure

It is important that the format of all estimates be as consistent as possible. Two formats have been established for this purpose: Work Breakdown Structure (WBS) and uniform at all 11 (ASTM Standard E1557-97). They are hierarchical presentation of the scope of work. They provide a common, ordered hierarchy framework for summarizing information and for quantitative reporting to customers and management. The purposes of the format are to:

(i) Provide on organised manner of collecting project cost data in a standard format for cost reporting and cost tracking;

(ii) Provide a checklist for categorizing costs; and

(iii) Provide basis to maintain historical cost data in a standard format. The appropriate format is to be used in accordance with cognizant design agency requirement (Nwachukwu and Echeme, 2016).

3.2 Methods of cost estimation

The Association for the Advancement of cost Engineering (AACE) international publishes cost engineering community recommended practices. AACE publishes matrix of acceptable levels of cost accuracy for various stages of project definition. The matrixes show positive and negative values. There are four general methods used to estimate construction costs, described in order from least – to most – accurate (Nwachukwu and Echeme, 2016)

(a) Project comparison Estimating: Project comparison estimating is used in early planning stages when little information is known about the project other than overall project parameters. Project comparison estimating uses historical information on total costs from past projects of similar Building type. For instance, the number of beds in a hospital or number of spaces in a parking garage, or number of personnels in an administration building can form the basis of a project comparison estimate by comparing them to recent projects of similar scope in the same geographic region. The supporting facilities are estimated as a percentage of total facilities cost. The method is considered “preliminary” and is accurate only from – 25% to + 40% notwithstanding abnormal market conditions.

(b) Square foot/square meter estimating square foot/square meter estimating is another method of developing both preliminary and intermediate budgets based on historical data. This method is effective in preparing fairly accurate estimates if the design is developed enough to allow measurement and calculation of floor areas and volumes of the proposed spaces. There are several historical databases such as UFC 3-701 for the current year, RSMeans, Tn-Service, Parametric adjusted models (PACES) available to support this ($/SF). More accurate estimates made with this method make adjustments and addition for regional cost indices, escalation rates, for regional cost indices, escalation rates, and size adjustment constables. Further adjustment may be made to account for other unique aspects of the design such as special site condition or design features being planned. Estimates made with this method can be expected to be accurate between -15% to + 25% notwithstanding abnormal market conditions (ie natural disasters, market volitality, etc). The unit cost table supports a square foot/square meter estimating method and is generally applicable during the planning phase of a project. The unit costs in the table are national average historical cost with a known standard deviation for each facility type.

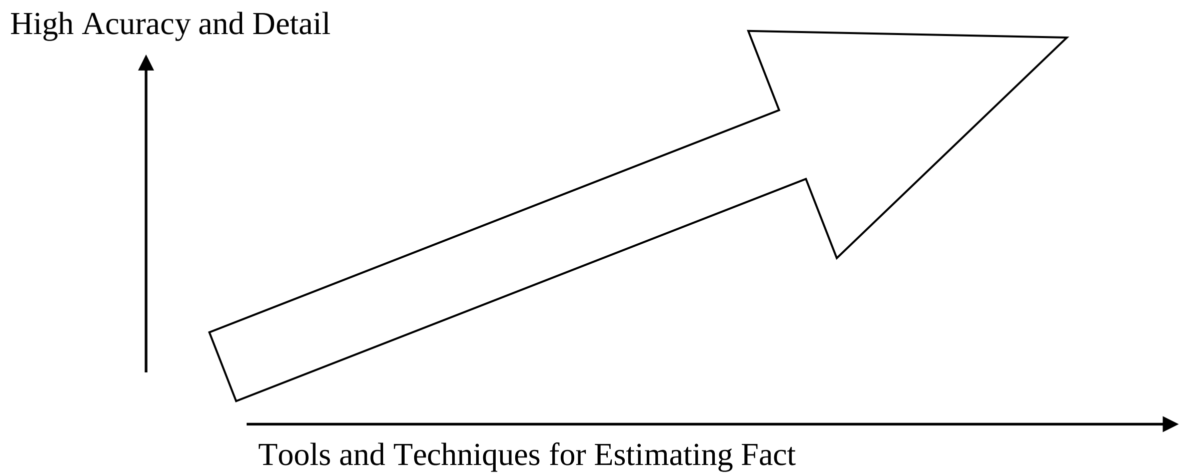
(c) Parametric cost estimating: Parametric cost estimating is an intermediate – level typically between 10% and 35% complete. Parametric costs are based on assemblies or systems group work items into a single unit for estimating purpose, for instance, a foundation usually requires excavation, formwork, rein forcing, concrete, including placement, finish and backfill. A parametric cost estimate prices all of these elements together by applying engineered values developed in assemblies cost data bases. These databases are based on historical data, typically organised in uniform format. Estimates made with this method can be expected to be accurate between – 10% to +15% notwistanding abnormal market conditions (ie natural disasters, market volatility etc).

(d) Quantity take off (QTO) Estimating: in quantity take off (QTO) Estimating, the work is divided into the smallest possible work increments, and a “unit price” is established for each piece.

These work increments are typically organized by master format. The unit price is then multiplied by the required quantity to find the cost for the increment of work. All costs are summed to obtain the total estimated cost. For instance, the cost to erect a masonry wall can be accurately determined by finding the number of bricks required and estimating all costs related to delivering, storing, staging, cutting, installing, and cleaning the brick along with related units of accessories such as reinforcing ties, weep-holes, likely to be affected by supply and demand forces in the current market. QTO can be based on a site adapt design cost estimate or using a 35% or more of the design, This method provides the most accurate estimate which is typically between – 7.5% to +10% of construction cost notwithstanding abnormal market conditions (ie natural disasters, market volatility etc)

1.1 Tools and techniques in Estimate costs

In the process of cost estimation, the project cost engineer uses either one or the combination of the following tools and techniques which is graphically represented



(i) Expert Judgment: Cost Estimates are influenced by numerous variables such as labour rates, material costs, inflation risk factors and other variables. Expert judgment, guided by historical information, provides valuable insight about the environment and information from prior similar projects. Expert judgment can be used to determine whether to combine methods of estimating and how to reconcile differences between them.

(ii) Analogous Estimating: This model uses the values of parameters, such as scope, cost, budget, and duration or measures of scale such as size, weight and complexity, from a previous, similar project as the basis for estimating the same parameter or measure for a current project. When estimating costs, this technique relies on the actual cost of previous, similar projects as the basis for estimating the cost of the current project. It is a gross value estimating approach, sometimes adjusted for known differences in project complexity. It is most reliable when the previous projects are similar in fact and not just in appearance, and the project team members preparing the estimates have the needed expertise (AKShay,2019).

Analogous cost estimating is generally less costly and time consuming than other techniques, but it is also generally less accurate, ?Analogous cost Estimates can be applied to a total projector to a segment of a project used in conjunction with other estimating methods.

(iii) Parametric Estimating: Parametric Estimating uses an algorithm or a statistical relationship between historical data and other variables (eg square footage in construction) to calculate resource quantities needed for activities, based on historical data and project parameters. For instance, if an activity needs 4,000 hours of coding and it needs to finish it in 1 year, it will require two people to code (each doing 2,000 hours yearly). This technique can produce higher level accuracy depending on the sophistication and underlying data built into the model. This method can be applied to a total project or to segment of a project in conjunction with other estimating methods.

(iv) Bottom-up Estimating: This is method of Estimating component of work. The cost of individual work packages or activities is estimated with the greatest level of specified details. The detailed cost is then summarized or rolled up to higher levels for subsequent reporting and tracking purposes. The cost and accuracy of bottom-up cost estimating is typically influenced by the size and complexity of the individual activity or work package, Here, team and physical resources are estimated at the activity level and then aggregated to develop the estimates for work packages, control accounts and summary project levels.

(v) Three-point Estimating method: The accuracy of single-point activity cost estimates may be improved by considering estimation uncertainty and risk and using three estimates to define and approximate range for an activity cost.

- Most likely (M): The cost of the activity, based on realistic effort assessment for the required work and any predicted expenses.
- Optimistic (O): The activity cost based on analysis of the best-case seenerior for the activity.
- Pessimistic (P): The activity cost based on the analysis of the worst-case scenerior for the activity.

Depending on the assured distribution of values, within the range of the three estimates, the expected cost can be calculated on expected (CE) activity cost a weighted average of these three estimates:

$$CE = \frac{Co+4Cm+Cp.}{6}$$

Cost estimates based on this equation (or even on a simple average of the three points) may provide more accuracy, and the three points clarify the range of uncertainty of the cost estimates.

(vi) Reserve Analysis: Cost estimates may include contingency reserve (sometimes called contingency allowances) to account for uncertainty. The contingency reserve may be a percentage of the estimated cost, a fixed number or may be developed by using quantitative analysis methods. As more precise information about the project becomes available, the contingency should be clearly identified in cost documentation. Contingency reserves are part of funding requirements.

(vii) Cost of Quality: Assumptions about cost of quality may be used to prepare the activity cost estimates.

(viii) Project management Estimation software: Cost Estimation software applications, computerized spreadsheets, simulation and statistical tools are becoming more widely accepted to assist with cost estimating techniques and thereby facilitate rapid consideration of cost alternatives.

(ix) Vendor Bid Analysis: Cost Estimation methods may include analysis of what the project should cost based on the responsive bids from qualified vendors.

3.4 Cost Estimating- a guide to development plan

The elements of cost estimating include formed deliverable oriented work packages (usually in the form of well defined work breakdown structure) historical data, chart of accounts, risks, duration of activities, resources and unit rates of resources.

Based on these input, cost estimating utilizes estimating techniques and tools to produce an estimation of the cost of each project deliverables (Westland,2022).where projects are awarded to a vendor under competitive processes, additional cost estimating work can be required of the project team to examine the price of individual deliverables and to derive a cost that supports the final total project cost.

4.0 Conclusions

Real estate development/project management encompasses different knowledge areas, properly integrated and coordinated to ensure that a project meets the stakeholders' expectations and is completed within a set timeframe and under a specified budget. The project management knowledge areas include integration and communication management, risk management, quality management human resource management and cost management.

Cost management includes the processes require to ensure that the project is completed within the approved budget. It embraces activities such as resource planning, cost estimating, budget and cost control. These activities are repeated in a closed loop and take place during the whole project lifecycle. Cost estimation forms a pylon in the cost management process and as a result in project management.

Cost estimation is key to delivering a sole project plan. Being able to make accurate cost estimates is key to delivering a solid project plan. Cost estimating utilizes many techniques that translates the project scope into deliverables and develop an approximation of costs of the resources needed to complete project activities.

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INVESTIGATION OF THE CAUSES, EFFECTS AND PREVENTIVE MEASURES OF DAMPNESS IN BUILDINGS IN ENUGU METROPOLIS

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Abstract
Water plays a major role in the deterioration of masonry materials and often has a negative and devastating influence on buildings. The penetration of water is one of the most damaging defects that can occur in both old and modern constructions, the faces of our built environment is littered with ugly stains of damp surfaces. The aim of this study is to examine the causes, effects and preventive measures for dampness in buildings in Enugu metropolis. Survey method was adopted for the collection of primary data through a well-structured questionnaire distributed to seventy-two (72) registered professionals in the building industry. The population of the study is 87. The sample size was got using Taro Yamane (1973) formular. Data obtained were analyzed using simple percentage, relative important index and weighted mean. This study has revealed that the factor with the most significant impact in causing dampness is flooding followed by leakages in roof and plumbing system; while, the factors with the most insignificant impact in causing dampness in building is moisture trapped during construction and defective building orientation. Effects of dampness: It reduces the whole life of the structure; blistering, bleaching of paints & disfiguring of wall; causes rots to the wooden members; destruction of floor carpets; floors of the building remain ugly; deterioration, peeling off of plaster; corrosion of metals used in building; mould growth; unhygienic conditions; unpleasant smell and poor air quality. The study recommends that provision of good roof, integral water proofing, special construction techniques, avoidance of leakage of water; provision of damp proof membrane and provision of damp proof course are good preventive measures for dampness in buildings.

Keywords: Buildings, Causes, Dampness, Effects, Preventive measures.

1. INTRODUCTION
The building envelope separates living environment from the outdoor environment and protects occupants from the elements of climate and environmental influences (Alhorr, 2016). A well-constructed building with quality or durable structural components using the appropriate constructional method is expected to last for a long period of time before there would be any major deterioration or defect on the building (Trotman, 2019).

As the most frequently reported problem associated with buildings, dampness in all its forms has assumed an alarming proportion in developed countries including Nigeria (WHO, 2009). Dampness is the presence of unwanted moisture in the structure of a residential or commercial building which occurs mainly in old buildings, either as a result of water over running from outside or condensation from within the structure (Ubi, Obun & Agbor, 2020). It is the presence of hygroscopic or gravitational moisture in the structure of a building through its walls, floors and roof. Water plays a major role in the deterioration of masonry materials and often has a negative and devastating influence on buildings (Hetreed, 2008). The penetration of water is one of the most damaging defects that can occur in both old and modern constructions (Burkinshaw and Parrett, 2004). Haverinen, (2007) in support of this view opined that accumulation of moisture or dampness in buildings or components of a building leads to physical, biological or chemical deterioration of the building or its materials.

Suryakanta, (2015) suggested that dampness can arise from the following external sources: rain penetration, rising dampness and condensation. In addition, leaking plumbing, roof leakages, heating system and spillage of water in use are also significant causes of dampness. Moisture finds an easy access through the voids of granular materials and this aided by capillary action assists the moisture to travel in different directions. Sandrolini, (2006) also, opined that through faulty design of structures or bad workmanship or by use of defective materials, moisture may find its way into interior of the building either through the wall, floor or the roof.
Moreover, building structures are founded on soils, and the substructure is embedded into it. If the soil is pervious, moisture constantly travels through it. Even in the case of impervious soils, lot of soil moisture may be present. This moisture may rise up into the wall and the floor through capillary action. Therefore there is need to investigate the causes, effects and preventive measures of buildings.

2. LITERATURE REVIEW

Shad (2020) defined dampness as the access or penetration of moisture content inside a building through its walls, floors, or roof. Dampness can be described as an excessive quantity of moisture contained within building materials and components which cause adverse movements or deterioration and results in unacceptable internal environmental conditions (Briffett, 1994). Burkinshaw & Parrett (2004) opined that dampness is the amount of moisture content present in a material and can be classified as capillary moisture content, equilibrium moisture content, hygroscopic moisture content, total moisture content and potential moisture content. It is the wetting of structural elements through moisture rise by capillary action (Cotgrave, 2005). Suryakanta, (2015) also ascertained that dampness is the presence of moisture in the structure of a building through its walls, floors and roof etc. As an indication of the moisture content of the air present in a space, dampness is an important factor which determines the quality of air in relation to human health and comfort and more importantly, its effects on the structural integrity of materials in buildings (Hyvarinen, 2002). Dampness is inextricably linked to most building deterioration. This is because, water contributes to oxidation of metal leading to the corrosion of steel reinforcement in concrete and the proportion of fungal decay or beetle infestation in timber. Water also facilitates chemical changes in the component of a building as well as being source of damage where it penetrates into a building (Hollis, 2002). The objectives of this study is to

1. assess the causes of dampness in buildings in Enugu north L.G.A
2. assess the effects of dampness on buildings and
3. determine the preventive measures for dampness in buildings in the study area

2.1 Categories of Dampness

Hollis, (2002) classified sources of dampness into four (4) categories, namely:

i. Rising dampness
ii. Penetrating dampness
iii. Condensation and
iv. Pipe and roof leakages

Burkinshaw & Parrett, (2004) supported this view by affirming that dampness can also be classified as air moisture condensation, penetrating dampness and internal plumbing leaks, below ground moisture or building specific sources

i. Rising Dampness

Rising dampness occurs as a result of capillary suction of moisture from the ground into porous masonry building materials such as stone, brick, blocks, earth and mortar (Ahmed & Rahman, 2010). It is a problem that is very common in older buildings, particularly those constructed without damp proof courses. However, it is gradually becoming a common issue with modern types of buildings as well (Rirsch, 2010). Burkinshaw and Parrett (2004) comprehensively defined rising damp as moisture that travels upwards through the pore structure or through small fissures or cracks, or as water vapour against the forces of gravity, typically up a wall or through a floor from a source below the ground'. Trotman et al. (2004) in their book 'Understanding dampness' defined rising damp to 'normally mean the upward transfer of moisture in a porous material due to capillary action'. According to Rirsch (2010), it is caused by ground water rising upwards through a wall, much in the same way as oil would rise through the wick of a lamp. Rising dampness is a strange phenomenon because experts in dampness issues do not agree on exactly what it is and some deny its existence (Burkinshaw, 2012). Kportufe (2015) identified the main causes of rising damp as follows: failure to provide damp proof course, and high external ground bridging existing damp proof course. Others are internal plaster works bridging existing damp proof course, bridging of damp proof course due to a buildup of mortar works inside a cavity wall and leaking water pipes at the base of a wall.

In the same vein Agyekum, Ayarkwa, & Koranteng, (2014), identified the causes of rising damp as follows: salt attack, porosity of Building Materials, workmanship. However, the visible symptoms of rising damp include dampness on the lower parts of walls, sometimes up to 1.5m in horizontal bands (Rirsch, 2010). Rising damp may also present itself as salty yellowy browny patches of plaster just above the height of skirting boards (Burkinshaw, 2010). It tends to cause many problems to a building with associated health, environmental, social and economic implications. Rising dampness serves as a platform for the growth of fungi in wood which causes rot, deterioration of wall plasters and paints, loosening of wall papers, staining of wall surfaces, crumbling of mortar, rusting of steel and iron fasteners, etc.

ii Penetration Dampness

Penetrating dampness is the term applied to the penetration of moisture laterally through the fabric of a building from the outside, typically as a result of defective roof coverings or damaged guttering, cracks in walls and opening (e.g windows). Dampness from rain penetration will vary with the weather conditions, including the direction and strength of the wind. Penetration damp is the term applied to the penetration of moisture through the fabric of buildings over a period of time. It is usually characterized by localized areas of damp or saturated wall/ceiling finishes (Latta, 2005). Water penetration through a building enclosure depends on the simultaneous occurrence of three things: the presence of water; an opening through which water can enter and a physical force to move the water (Beall, 2000).

Penetration damp is caused by plumbing issues in a building or where a problem allows water to enter a building. Symptoms associated with penetration damp usually occur during wet weather. Though penetration dampness may look harmless but can cause damages to buildings even if it does not penetrate all walls of the building. Penetration dampness can lead to moss growth, heat loss, frost damage into masonry, etc.

iii. Condensation

Dampness resulting from condensation occurs where water in the air of a room condenses on a cooler surface (Curtis, 2007). This is usually indicative of cold spots in the building, sometimes called cold bridges (Curtis, 2007). Condensation frequently results in severe mold growth which can in turn results in health hazards. Damp patches can appear on plastered walls in odd places, especially on outside walls, often appearing and disappearing on a regular basis (Burns, 2010). Condensation is mostly accompanied by mould which is black but can virtually be of any colour and is very common on walls and ceiling, underneath bay windows, etc. (Burns, 2010). Running water on windows and walls is the most immediate indication of a condensation problem. This problem leads to deterioration in the decorative condition of a property, stained curtains and decaying window frames. Condensation is also associated with the appearance of molds on the surface of wall papers and paints in poorly ventilated areas (Curtis, 2007).

iv. Pipe and Roof leakage

Rain water may percolate through defective roof covering. In addition, faulty eaves and valley gutters may allow the rain water to descend through the top supporting wall thereby causing dampness. Inadequate roof sloping of the roof may results to water ponds formed on flat roof, improper rainwater pipe connections, and defective junction between roof slab and parapet wall may prove to be the source of dampness. Peter Brett (2004), opined that roof-loose or missing tiles including the hip and ridge will allow rain water to run down rafters, causing dampness patches on the ceiling and tops of walls. Also, leakages from faulty plumbing pipes is a serious source of dampness in buildings.

2.2 Causes of Dampness in Building

Kportufe, (2015) identified the following as causes of dampness in buildings: rain penetration, level of site, drain ability of soil, Climate condition, defective orientation of building, moisture entrapped during construction and defective construction. In the same vein, Suryakanta (2015) stated that the primary causes of dampness in buildings include: poor quality of construction materials, bad design and, faulty construction or bad workmanship

1.**Poor quality of construction material**: concrete, brick or plaster possess within them interconnected void. When these come in contact with water, aided by capillary action, water moves in different directions.

2.**Bad design:** it is important to consider the source of water that can penetrate through the building and the type of damp proof course to be provided mentioned during the design stage of the building.

3.**Faulty construction or bad workmanship:** if 15mm damp-proof-course is specified and 10mm used instead, it will not serve the purpose for which it was constructed and consequently lead to dampness.

For easy assessment, this study summarizes the causes of dampness as follows:

i) Rain penetration, (ii) Defective construction, (iii) Defective orientation of building (iv) Poor quality of building materials (v) Climate condition leading to condensation, (vi) Rising damp from soil (vii) Leakages from roof and plumbing system, (viii) Moisture entrapped during construction

2.3 Effects of Dampness in Building:

Dampness in buildings can cause a variety of effects, such as wall staining, mold growth, impairment of air quality and respiratory problems in humans (Ahmed and Rahman, 2010; Riley & Cotgrave, 2005). According to Hollis (2000), dampness is inextricably linked to most building deterioration. A source of water close to a building could be one of the problems associated with dampness. These problems include symptoms such as dirty spots on the building, biological plants like the growth of fungi, mosses and creeping plants, paint flaking, blistering etc. (Halim et al., 2012). In the vein, dampness in buildings can cause a number of problems, including the destruction of timber, blocks, bricks, ineffective insulation due to cold bridging and the increased risk of mold growth (Hyvarinen et al., 2002).

Zeeshan (2016) stated the effects of dampness in building include the following: (i) dry rot (a fungal disease that causes timber to become brittle and crumble into powder) to the wooden portion of the building, (ii) Corrosion of metals used in construction, (iii) peeling off or removal of plaster, (iv) blistering of paints, (v) Destruction of electrical installations, (vi) reduction of life of the structure, (vii) Unhygienic conditions for the occupants of the building.

In line with the opinions of Kportufe, (2015) and Shad Muhammad, (2020) and for easy assessment, this study summarizes the effects of dampness as follows:

a) It causes rots to the wooden members provided in the building.

b) It causes corrosion of the metals, used in the construction of a building.

c) It causes peeling off and removal of plaster.

d) Blistering and bleaching of paints and disfiguring of wall surfaces.

e) Floors of the building remain ugly, since they cannot be cleaned well.

f) Destruction of carpets used on the floors of a damped building.
g) Destruction of all electric installations.
h) It reduces the life of the structure as a whole.
i) It causes unhygienic conditions which adversely affect the building occupants
j) Dampness produces unpleasant smell and poor air quality.

Some of these effects are briefly explained below:

Efflorescence on building surface.

The presence of dampness condition causes efflorescence on building surfaces which ultimately results in the disintegration of bricks, stones, tiles etc. and hence reduction of strength of the building component. Efflorescence occurs as a result of the presence of an appreciable quantity of salts in a rising dampness. When rising dampness carry the salts up into the walls of the structure at the level where the moisture evaporates leaving behind the salts, this salt can often be seen as a whitish powder paint on the surfaces of walls. This situation decolorizes buildings (Kubal, 2008).

Bleaching and flaking off of paint and wallpaper.

Dampness in building causes bleaching and flaking off of paints which results in the formation of coloured patches on the wall surfaces. This is as a result of the loss of adhesion between the paint and the wall surfaces because of the presence of moisture (Marshall, 2003).

Creates unhealthy living

Marshall, (2003) opined that dampness in building creates unhealthy living and working conditions for the occupants. Healthy indoor air is recognized as a basic right. People spend a large part of their time each day indoors: in homes, offices, schools or other private or public buildings. The quality of the air they breathe in these buildings is an important determinant of their health and well-being. The inadequate control of indoor air quality therefore creates a considerable health burden (World Health Organisation, 2009).

Softening and peeling off plaster from wall.

It is the softening and crumbling of plaster into smaller particles or powder. This is as a result of non-quality materials or chemical reaction in the presence moisture
(Marshall, 2003).

Corrosion of metals used in the construction of buildings

Corrosion has direct effects on reinforced concrete structures. It weakens the structure; reduces the bonding strength of the materials, limits the ductility, and reduces the shear capacity of the buildings. When corrosion occurs, the entire structure loses its strength and becomes very weak to the loads it was originally built to carry. It starts by reducing the effectiveness of each structural component, which in turn reduces the axial, and flexural strength of each element and makes it structurally weak. Corrosion also affects the iron rods which provide strength to the concrete by eating and smoothing their grooves and cross-section. As a result of this, the bond strength is often compromised. This leads to slippage of the concrete and eventual collapse of the building or structure. Corrosion is also capable of significantly reducing the ductility of the overall structure, exposing it to crumbling under stress. Corroded sections of a building have lower ductility which have their response to earthquake and other natural disasters. Corrosion reduces shear capacity in beams and columns, concrete slabs and footings. This reduces the shear strength of the slabs close to the columns and increases the possibility of shear failure. Also in footings, corrosion can result to shear failure of the footing, anchorage failure, or flexural yielding of steel reinforcement.

Plates a-i show pictorial views of some of the effects of dampness in buildings.

a) Stain in horizontal band

b) stain in horizontal band

c) water run marks on windows

d) Surface efflorescence

e) Surface efflorescence

f) Water run marks on window

g) Damp at the base of wall

h) decayed skirting

i) mould growth on wall

Plates a - i: Effects of dampness in buildings

2.4 Dampness Preventive Techniques in building:

Dampness prevention in construction is any type of treatment applied to buildings to prevent moisture from having access to the fabric of the building Oxley, (2011). For a new building construction site, the following procedures should be adhered to in order to avoid letting in water into the building components:

i. Select a site to make sure that the first point at which water is struck in a pit is at least 10ft below the surface of the ground even in the wet season.
ii. Make the ground surface surrounding the building slope away from the house so that rain water drains away, before it has time to collect.
iii. If the building is on a hill side, make sure that the land above the house is adequately drained around the building and not through it.

Suryakanta, (2017) recommended the following as the preventive methods of dampness in building:

i.Surface treatment, by providing damp proof paint (emulsion asphalt).
ii integral water proofing treatment.
iii provision of damp proof membrane.
iv. avoidance of leakage of water pipes.
v. avoidance of condensation in the building.
vi.Provision of good roofing.
vii. Provision of DPC (Damp proof course).

Some of these preventive measures are briefly explained below:

Surface Treatment

The surface treatment consists of filling or blinding the pores of the material exposed to moisture by painting a water-repellent material over the surface. Some of the materials employed are: Sodium or potassium silicate, aluminium or zinc sulphates, barium hydroxide and magnesium sulphate in alternate applications, soft soap and alum also in alternate applications, lime and linseed oil, coal- tar, bitumen, waxes and fats, shellacs, resins and gums etc.

Integral Damp-Proofing Treatment:

The integral treatment consists of adding certain components to the concrete or mortar during the process of mixing, to make it denser by filling the pores through chemical action or mechanical effect. Compounds like chalk, talc, and fuller's earth etc. act mechanically and compounds like alkaline silicates, aluminium or zinc sulphates, calcium, aluminium or ammonium chlorides, iron fillings etc. act chemically. If 5% soap is added in the water to be used for preparing the mortar, the pores get clogged and coating of water repellent substance stick to the wall surface which makes it sufficiently damp proof.

Special Constructional Techniques

The following techniques can help prevent dampness in buildings:

i. By constructing the external walls of sufficient thickness.
ii. By using the bricks of good quality for constructing the external walls.
iii. By building the walls in rich cement mortar.
iv. By providing string courses and cornices.
v. By fixing down water pipes sufficiently so that water may not leak through the junction of walls and roof.
vi. By constructing hollow brick walls. (these walls are built, usually with nine inches inside, the air space of about 2inches between and the outer skin of four and half inches outside. The two skins are boned together by means of galvanized iron wall ties). As there is no contact between outer and inner walls of cavity wall, possibility of moisture penetration is reduced to a minimum. It prevents the transmission of heat through wall. The cavity wall tends to reduce the nuisance of efflorescence.

Guniting (shotcrete)

This entails forming an imperious layer of rich cement mortar (1:3) or fine aggregate mix for water proofing over the exposed concrete surface or over the pipes, cisterns etc. for resisting the water pressure. By this technique, an impervious layer of high compressive strength (600 to 700 kg/cm2) is obtained and is also very useful for reconditioning or repairing old concrete works.

Pressure Grouting (Cementation)

This is mixture of cement, sand and water under pressure into cracks, voids or fissures present in the structural component or the ground. In general, the foundations are given this treatment to avoid the moisture penetration. This technique is also used for repairing structures, consolidating ground to improve bearing capacity, forming water cut-offs to prevent seepage etc.

Use of Damp Proof Courses (DPC)

It is the continuous layer of an impervious material, which is provided in between the source of dampness and part of the structure. These layers or membranes of water repellent materials such as bituminous felts, mastic asphalt, plastic sheets, cement, concrete, mortar, metal sheets, stones etc. are interposed in the building structure at all locations wherever water entry is anticipated or suspected. It should be laid at least 15cm above ground level. The damp proof course is provided horizontally and vertically in floors, walls etc.

Horizontal DPC

It is provided in the walls at plinth level in the form of 1 ½ in. thick layer of 1:2:4 cement concrete covered with two coat of hot bitumen or a polythene sheet or metal sheets of lead, copper or aluminum. It is also provided in the roofs in the form of two coats of hot bitumen, bitumen felt, mastic asphalt or sheets of polythene, lead, copper, or aluminum over the R.C.C. slab. Horizontal D.P.C. is also provided in floors if the sub-soil water table is high and moisture is likely to rise in the floors by seepage, added by the capillary action of the soil.

Vertical DPC

Vertical D.P.C. is mostly provided in the external walls in the form of ¾ in. thick
1:3 cement sand plaster, coated with two washings of hot bitumen. It is also provided to prevent the dampness into the walls of the basements from the adjacent soils.

3.0. RESEARCH METHODOLOGY

3.1 The population of the study was 87. Using Taro Yamane (1967):

$$n = \frac{N}{I + N(e)^2}$$ Taro Yamane (1973)

where n = sample

N = population size = 87

e = Error limit / level of significance =0.05

$$n = \frac{N}{1+N(e)^2} \qquad (1)$$

$$n = \frac{87}{1+87(0.05)^2} =$$

$$n = \frac{87}{1.2175} = 71.45 = 72$$

The study adopted survey method for the collection of primary data through a well-structured questionnaire distributed to seventy-five (75) registered professionals in the building industry which consists of Architects (15), Builders (15), Civil Engineers (15), Estate Valuers(15) and Quantity Surveyors(15) in Enugu North local Government Area.

Out of seventy-five (75) questionnaires distributed, seventy-two (72) representing 96% were properly filled and returned.

Method of Data Analysis

The questions in the questionnaire involve assessing the factors on a five (5) point likert scale and using weighted Mean and Related importance index (RII) for their analysis. The five likert scale is rated as follows: strongly disagree=1, disagree=2, neutral=3, agree 4, strongly agree =5. The computing formula is as follows:

Relative important index (RII) =Mean/K. (2)

Where K the maximum point on the likert scale (5).

Weighted mean (X) = $\sum f x / \sum f$ (3)

Where x= points on the Likert's scale (1, 2, 3, 4 &5) and f= frequency of respondent's choice of each point on the scale.

The data were analyzed using simple percentage, Relative important index (RII) and weighted mean.

Rule for Rating of Indices

The item with the highest RII is ranked first and so on. Interpretation of RII value is as follows: if RII < 0.60, item will be graded as having low rating. If 0.60 ≤ RII<0.80, item will be graded as having high rating and if RII ≥ 0.80, item will be graded as having very high rating

4.0 DATA ANALYSIS AND PRESENTATION

Table 1 shows the perception of construction professionals in Enugu metropolis on the major causes of dampness in the area while Table 2 shows the Analysis of Effects of Dampness in Buildings. The analysis of preventive measures for dampness in buildings is shown in Table 3

Table 1: The perception of construction professionals in Enugu metropolis on the major causes of dampness in the area.

Causes of dampness	**1**	**2**	**3**	**4**	**5**	$\sum fx$	$\sum f$	**Mean**	**RII**	**Rank**
Rain penetration	0	1	4	39	28	310	72	4.3	0.86	3rd
Defective construction	4	5	15	22	26	277	72	3.8	0.77	5th
Defective orientation of building	11	25	24	7	5	186	72	2.6	0.52	8th
Poor quality of Building Materials	9	7	12	26	18	253	72	3.5	0.70	6th
Flooding	0	2	3	31	36	317	72	4.4	0.88	1st
Condensation	8	12	14	22	16	242	72	3.4	0.67	7th
Rising damp from soil	3	5	7	25	32	294	72	4.1	0.82	4th
Leakages from roof & plumbing	2	4	1	24	41	314	72	4.4	0.87	2nd
Moisture trapped during construction	28	21	8	9	6	160	72	2.2	0.44	9th

Source: Researcher's field survey, 2022

From table 1 above, four items assessed have Relative Importance Index (RII) >0.8 and are therefore rated very high. These implies that these factors are the most outstanding causes of dampness in building in Enugu North local Government Area. These factors ranked accordingly include: flooding ranked 1st with RII = 0.88; leakages from roof and plumbing system ranked 2nd with RII = 0.87; rain penetration ranked 3rd with RII =0.86; while rising damp from soil ranked 4th with RII = 0.82.

Furthermore, three of the factors have 0.6 < RII <0.8 and are therefore rated high. This implies that, although they are causes of dampness in building, however, their impact is not as high as the first group of factors with RII > 0.8. These factors ranked accordingly include: defective construction ranked 5th with RII of 0.77; poor quality of building materials ranked 6th with RII of 0.70; while, climate condition (condensation) ranked 7th with RII of 0.67.

Above all, two of the factors have RII < 0.6 and are rated very low. The implication is that; these factors have no significant impact in causing dampness in building in some rural areas in Enugu. These factors ranked accordingly are: defective orientation of building ranked 8th with RII of 0.52; while moisture trapped during construction ranked 9th with RII of 0.44.

Conclusively, the factor with the most significant impact in causing dampness is flooding followed by leakages in roof and plumbing system. But the factors with the most insignificant impact in causing dampness in building is moisture trapped during construction and defective building orientation.

Table 2. Analysis of Effects of Dampness in Buildings

Effects of Dampness	1	2	3	4	5	∑Fx	∑f	Mean	RII	Rank
Causes rots to the wooden members	0	0	0	19	53	341	72	4.7	0.95	3rd
Corrosion of metals used in building	0	0	0	29	43	331	72	4.6	0.92	6th
Deterioration of plaster	0	0	0	24	48	336	72	4.7	0.93	5th
Blistering, bleaching of paints & disfiguring of wall	0	0	0	13	59	347	72	4.8	0.96	2nd
Floors of the building ugly	0	1	1	19	51	336	72	4.7	0.93	5th
Destruction of floor Carpets	0	0	0	23	49	337	72	4.8	0.94	4th
Destruction of all electric installations	10	13	9	11	29	252	72	3.5	0.70	10th
Surface efflorescence	12	16	25	12	7	202	72	2.8	0.56	11th
Reduces the whole life of the structure	7	13	5	20	27	363	72	5.0	1.0	1st
Mold growth	0	2	4	17	49	329	72	4.6	0.91	7th

Unhygienic conditions	1	0	2	36	33	316	72	4.4	0.88	8th
Unpleasant smell and poor air quality.	3	5	8	27	29	290	72	4.0	0.81	9th

Source: Researcher's field survey, 2022

From the twelve indices assessed in table 2 above as effects of dampness in building; ten have RII > 0.8 and are rated very high. This implies that these indices are very strong and very significant effects of dampness in buildings. These indices ranked accordingly include: reduces the whole life of the structure; blistering, bleaching of paints, disfiguring of wall, Causes rots to the wooden members, destruction of floor carpets; floors of the building remain ugly; deterioration & peeling off of plaster; Corrosion of metals used in building; Mold growth; Unhygienic conditions; Unpleasant smell and poor air quality.

However, destruction of electrical installation has RII of 0.7 which falls within (0.6< RII <0.8) and is therefore rated high. Meaning that; although it is an effect of dampness but its impact is not as significant as the ten above with RII > 0.8. But, surface efflorescence ranked 12th with RII of 0.56 which is less than 0.6 and is therefore rated very low. This implies that; surface efflorescence is an insignificant effect of dampness in buildings.

Table 3: Analysis of Preventive Measures for Dampness in Buildings

Preventive Measures	1	2	3	4	5	∑fx	∑f	Mean	RII	Rank
Provision of DPC	2	7	4	28	31	295	72	4.1	0.82	6th
Surface treatment	7	8	12	20	25	264	72	3.7	0.73	7th
Integral water Proofing	0	2	4	24	42	322	72	4.5	0.89	2nd
Provision of DPM	3	6	5	19	39	301	72	4.2	0.84	5th
Avoidance of leakage of H2O pipes	3	2	0	32	35	310	72	4.3	0.86	4th
Avoidance of condensation	19	18	7	15	13	201	72	2.8	0.56	8th
Provision of good Roofing	1	2	0	20	49	330	72	4.6	0.92	1st
Special construction Techniques	2	1	5	26	38	313	72	4.3	0.87	3rd

Source: Researcher's field survey, 2022

Among the eight preventive measures assessed in table 4.8 above, six have RII > 0.8 and are therefore rated very high as acceptable measures for dampness prevention. These measures ranked in descending order of significance include: provision of good roofing; integral water proofing; special construction techniques; avoidance of leakage of water; provision of DPM and provision of DPC. Only avoidance of condensation in building has RII < 0.6 and is rated very low. Meaning that; it is not a significant measure for damp prevention in the study area.

5.2 Conclusion

Dampness has a very significant impact on buildings especially in rural areas of Enugu state. The most impactful effects being reduction of the whole life of the structure and blistering, bleaching of paints and disfiguring of walls. Moreover, the most significant causes of dampness in buildings are flooding and leakages from roofs and plumbing systems. Above all, provision of good roofing stood out as the most acceptable measure for damp prevention in buildings

5.3 Recommendation

In line with the findings of this research, the researcher hereby recommends that building developers, construction professionals and building occupants should collectively adopt the following measures for damp prevention in buildings:

- provision of good roofing
- integral water proofing
- special construction techniques
- avoidance of leakage of water
- provision of DPM and provision of DPC

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DESIGN OF MOTION DETECTION SYSTEM FOR THE SECURITY OF POWER TRANSMISSION TOWERS USING ARDUINO AND GSM MODULE

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ABSTRACT

This study examined the design and construction of a motion detection system for safety and security around power transmission towers. The system was designed using a PIR sensor, Arduino, and GSM module. The system was able to detect the motion of an intruder within the sensing range of the sensor and then notify the authorized person through an SMS message. The microcontroller used in this design is the Arduino UNO R3 microcontroller board based on the ATmega 328p microchip, When the controller receives the signal sent by the PIR sensor, it sends the signal to the SIM800L GSM module which then sends a notification SMS to the authorized person. The maximum sensing speed of this device was observed to be 3.8m/s, and this speed decreased as the tower is moved farther away from the detection system.

Keywords: Design, Motion Detection, Arduino, Security, Transmission Towers,

1.0 INTRODUCTION

Motion detection has become one of the many ways to monitor intrusion within restricted places over the years. Starting with a pioneering design by Samuel Bango in 1950 which was named "Burglar Alarm" (Patil, 2020), the design of motion detection systems has seen tremendous improvement in the type of materials used as transducers, and now with the advance in technology, incorporates microcontrollers, storage facilities, and image capturing and processing systems to make the process of motion detection more reliable as a security strategy. These new systems can now detect motion and also inform residents and owners of the protected facility irrespective of their location. In this research work, the proposed system will consist of a motion detector (PIR SENSOR), integrated with a Global System for Telecommunication (GSM) module and a microcontroller. A working prototype will be developed and applied to the area covered under the scope of this research. Various sensors have been designed to detect motion following the first design. Motion sensors are appropriate for security frameworks utilized in offices, banks, shopping centers, and as perimeter security for gates. Motion sensors have been applied in varying conditions.

In (Defense Advanced Research Projects Agency(DARPA), 1998) several monitoring systems, were discussed. Some of which include mechanical switches, magnetic switches, balanced magnetic switches, photoelectric beams, microwave sensors, passive and active infrared sensors. The development of a microcontroller-based security system for indoor geolocation using a motion detector was the focus of (Nosiri, Akwiwu-Uzoma, Nmaju, & Elumeziem, 2018). The system performed intruder detection, which complements surveillance technology to offer critical security, as well as control and alarm functions. The integration of cameras and motion detectors into a web application is critical for security. The Raspberry Pi, a smart surveillance system, receives input from the motion detector and controls (actuates) the pi camera for remote sensing and surveillance. It then sends the footage to a web server, allowing the user or homeowner to view the videos using a web application. When the system detects an intruder, it sends an SMS to the owner and buzzes the alarm situated at a comfortable distance. The designed security system is distinguished by an effective video camera for remote sensing and surveillance, as well as the ability to stream live video and record it for later replay, and it provides a cost-effective, universal surveillance solution that is both efficient and simple to implement. The sensor implemented in the design is the Passive Infrared (PIR) motion sensor HC-SR501. It uses infrared sound and vibration to detect moving objects or people. When any motion is detected, the PIR sensor outputs a HIGH signal on its output pin, which can be read by a microcontroller and then drive a transistor to switch a higher current load. The detection range is 7 meters by 140(degrees) coning angles. It has a delay time of 16 seconds but is adjustable. The ambient temperature is 253K-323K. It was powered directly from the Pi through the 5V dc supply pin. Its output was connected as the input to the programmable GPIO pin. The Raspberry Pi camera is connected to the Raspberry Pi through a camera board, which is mounted to a tiny printed circuit board. The camera has a 5-megapixel resolution and can shoot video in 1080HD. It's linked to the Raspberry Pi's port opposite the Ethernet port. The extensible ribbon cable allows for the installation of a Printed Circuit Board (PCB) and the connecting of the camera to the Raspberry Pi through its port. The camera is imported and installed from the Raspbian operating system to activate the device. The Raspbian software is installed in the system to interface the pi camera, buzzer, and PIR sensor through the Raspberry pi.

According to (Munawir, Ahmad, & Eka, 2019), a smart indoor security system uses general electronic components and networking technology that is easy to use and cost-effective. The system was designed as a combination of GSM Technology and Wifi Technology for communicating with the house owner or authorized personnel (see fig.1). The wifi connection is used for controlling the units and gadgets in the house from a remote location such as the office while the GSM connection is utilized by the system to communicate with the homeowner of an intruder's presence in the house.

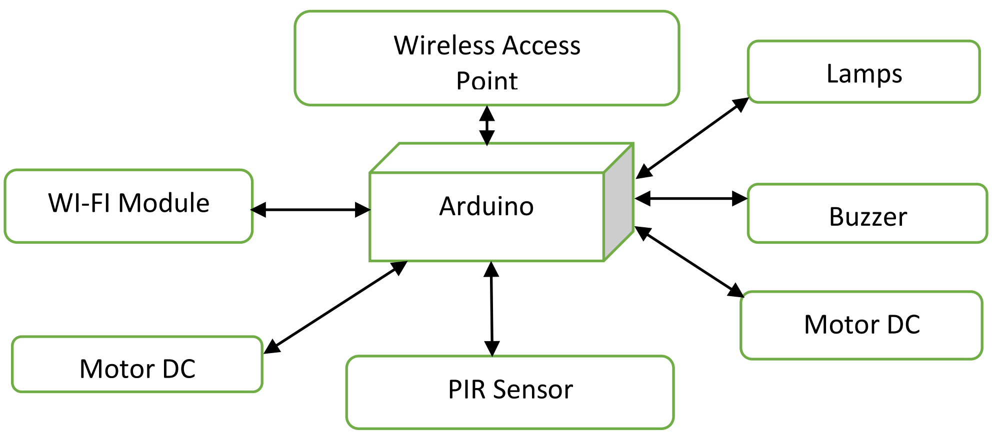


Fig.1. *WIFi based security system* (Munawir, Ahmad, & Eka, 2019)

2.0 MATERIALS AND METHOD

2.1 Materials

In this project, the system will be realized using the following devices;

a. the PIR (pyroelectric infrared) Sensor,
b. Arduino UNO R3 Microcontroller,
c. GSM module, and
d. Low cost, efficient power requirements, ease of assembly, and accessible electronics.

2.2 Method

This system will be designed to be mounted on the body of the transmission tower at a suitable position such that movement around or within it would be detected thereby triggering the alarm system. The method chosen for this project is adopted from that used by (Santoso, Jeffri, & Muhammad , 2014). But some adjustments were made to the design to fit into the scope and constraints of the project. The method described in the work utilizes two Arduino UNO boards to integrate the wifi module and GSM module, but in this work, we would use only the GSM module to save cost and also because the system is intended to deliver notification to a very long-range or location, the GSM communication system serves the purpose best. The connectivity of the system to be realized and the corresponding flow-chart is depicted in fig.2 and fig.3 respectively.

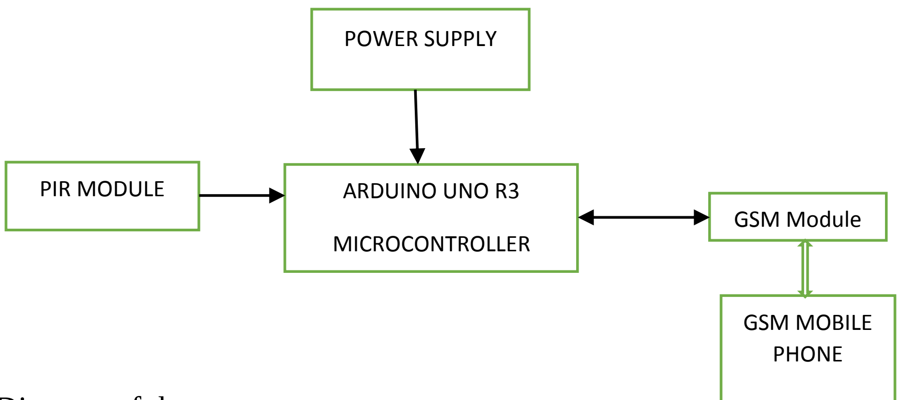


Fig.2. Block Diagram of the system

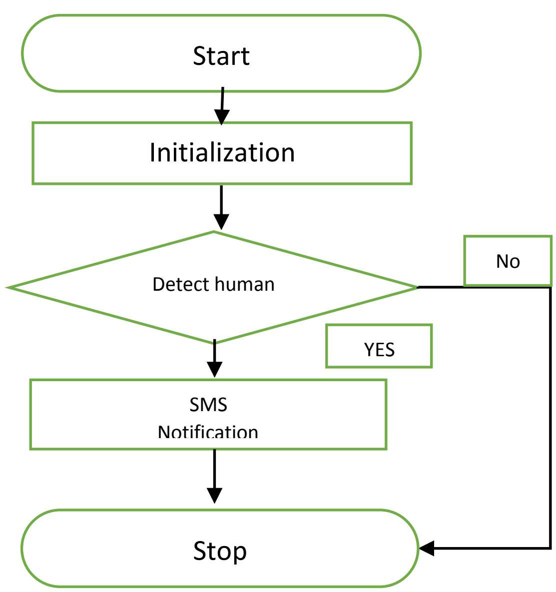
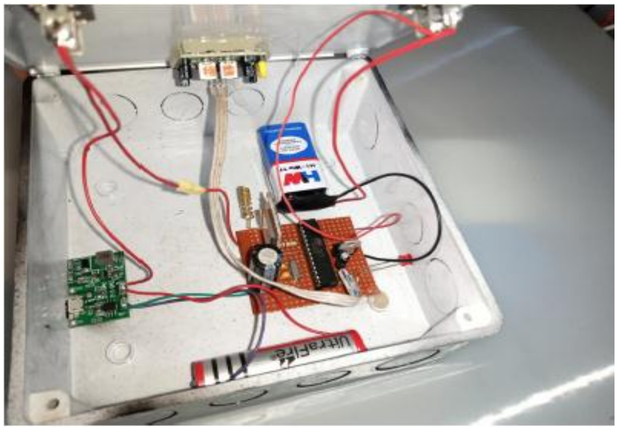


Fig.3. functional flow-chart of the system

In general, the physical components of the system comprising the PIR (pyroelectric infrared) Sensor, Arduino UNO R3 Microcontroller, power source, GSM module, and other electronics are wired as shown in fig.4 (a).



(a) Components connectivity

(b) The prototype in Operation

Fig.4. The Detection system.

3.0 RESULTS AND DISCUSSION

3.1 Results

In this section, we would take a look at the results obtained by operating the designed system and how well the performance fits the stated objectives of this project.

Table 1: The duration of detection of objects by the system at different distances

S/N	Distance	Detection time (Seconds)	Object detected
1	0.00m	0.01	YES
2	1.00m	0.26	YES
3	2.00m	1.5	YES
4	3.00m	2.5	YES
5	4.00m	3.6	YES
6	5.00m	4.7	YES
7	6.00m	5.7	YES

8	7.0m	6.6	NO

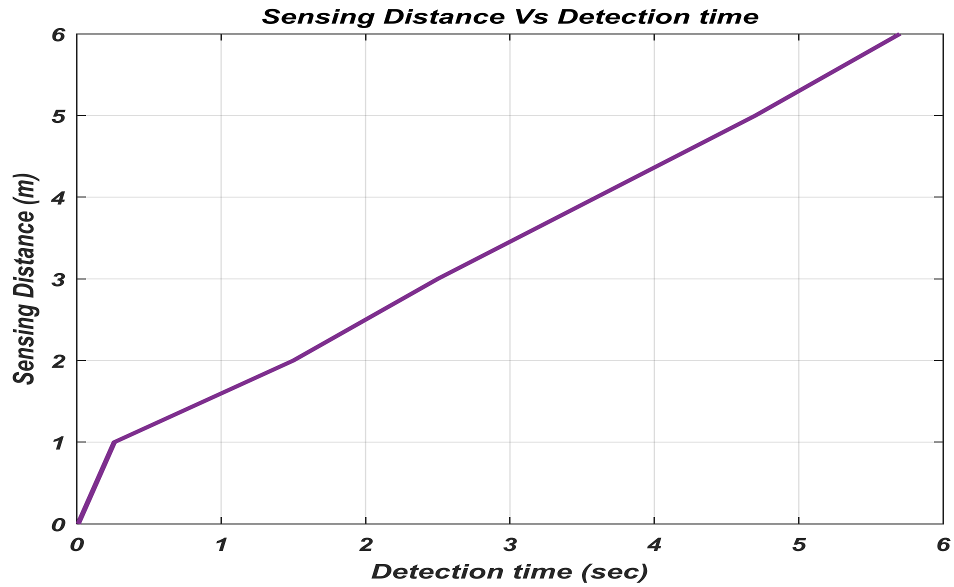


Fig.5. The relationship between the sensing distance and the duration of detection

3.2 Discussion

As we tested the intruder SMS alarm system, the results were successful, as the device was able to send SMS, to alert a user about an intruder in the preset position. This implies that once an intruder gets in between the PIR sensor, which is facing the case of the system, the sim module instantly sends an SMS to the user about that and as such securing the proposed positions.

After the system is activated, a motion is detected, the authorized person receives the SMS notification. When the system, is triggered as a result of intruder detection, the red LED glows to indicate danger. The LED glows along with the SMS module, which sends the required message. The prototype in fig.4 (b) shows such a state of the system when is in triggered mode. Table 1 highlights the sensing distance and the time taken of detection a mobile phone SMS received to inform the owner of the intrusion. From this result, the maximum sensing speed of this device was deduced to be 3.8m/s, and this speed decreased as the distance moved farther away from the detection system. Between 6 and 7m, the detection is not guaranteed while at a distance above 7m, the device does not detect any object. From fig.5, the system is more sensitive when the object distance is close compared to when the object is far of. Based on this result, we can say that the system would be more efficient when the object is close therefore the system should be mounted in a position where it can detect intruders before they approach the tower.

4.0 CONCLUSION AND RECOMMENDATION

4.1 Conclusion

In this report, we developed and tested a device that monitors the presence of an intruder in transmission towers, and sends a notification once an unauthorized person is detected in the preset position. The performance of the system was examined using configurations sensor electronics (infra-red), the transducer principle, and a program to carry out the specified task. The complete assembly and testing of the motion detection system were made, and the result was a positive one. This prototype effectively detects objects within 6m around an improvised transmission tower. A limitation of the system is the sensing range of the system due to the capacity of the PIR. To overcome this, a PIR sensor of higher capacity would cover a longer sensing range.

4.2 Recommendation

Bearing in mind that no system is perfect, there are possible adjustments and further improvements that can be introduced to this system to make it more efficient; some of these improvements include

I. Integration of facial recognition software to enhance the accuracy of the system when an intruder is detected and also help in identifying the authorized personnel when they approach the secured location. Due to the cost of getting the software and the time such was not included in the design.

II. Inclusion of a moveable stand for the sensing system to enhance the sensing range.

III. Including a PIR sensor with a higher capacity in order to eliminate the possibilities of the system not detecting motion in the secured location due to low IR radiation

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ASSESSMENT OF THE RISKS ASSOCIATED WITH THE PRE-CONTRACT STAGE OF CONSTRUCTION PROJECTS IN ABUJA, NIGERIA

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ABSTRACT

The construction industry is catalytic to smooth economic growth and development. Construction projects are risks laden due to the complexity, unique features, dynamics and challenging operating business environment. The risks discovered at the construction phase of a project are those hidden and unobserved at the pre-contract stage. This study assessed the risks considered by contractors during the tendering (pre-contract) stage of construction projects. A survey approach was adopted using a well-structured questionnaire and purposive sampling procedure to collect data from construction professionals in Abuja, Nigeria. Cronbach's Alpha coefficient analysis performed on the data showed a reliability index of 0.883, and further analysis was done using frequency, percentage and mean score. It was found that the major risks considered by contractors during the tendering (pre-contract) stage of construction projects are; Defective design (mean=4.28), Poor quality of work (mean=4.27), Unforeseen site condition (mean=4.230, Deficiencies in the description of work (mean=4.22), Labour, material & equipment availability (mean=4.21), Variation of work (mean=4.20), Corrupt practices such as collusion amongst contractors (mean=4.20), Inflation (Volatility of general price levels in the country) (men=4.18), Contractors competence (mean=4.18), Changes of the original design (mean=4.12), and Inadequate cash flow (mean=4.12). The major risk categorisation showed that Design risks, financial risk, construction risks, estimating risks and Political risks are given a higher consideration by the contractors during the pre-contract period. This study recommends that detailed project designs should be produced prior to tendering. Adequate planning of work should be done and the contractor should be experienced enough to handle the Construction related risks.

Keywords: Competitive bidding, Construction projects, Construction risks, Tendering risks, Pre-contract.

INTRODUCTION

The construction industry is catalytic to smooth economic growth and development. The industry is a stimulator and driver to job creation, infrastructure provision, and influences growth in other non-construction related sectors (Onyejeakor, Eze, Onyeagam, & Adegboyega 2020; Onyeagam, Eze, & Adegboyega, 2019). Despite the enormous benefits of the industry, it is risks laden and this is because of the complexity, unique features, dynamics and challenging operating business environment of the industry (Dosumu, 2016). In the same vein, Mill (2001) posit that construction projects are exposed to various predictable and unpredictable risks and uncertainties, that impact project success and the performance of contractors. Risks are unforeseen events and uncertainty that impact project success. When construction activities are exposed to risks, the results are; economic losses, delays, cost overruns, claims and dispute (Oyewobi, Ibrahim & Ganiyu, 2012). Most of the risks discovered at the construction phase of a project are hidden and unobserved at the pre-contract stage, that is, during the tender stages.

Tendering is the administrative procedure of sending out drawings, specifications and bills of quantities to construction firms with the intention to submit a price for the construction of the project. Besides the price for a project, other considerations such as contractor's competence, financial capability, technical competence, and other factors are used in selecting a contractor for executing a construction project. Different tendering methods have been used in construction projects for inviting tenders. Saaidin, Endut, Samah, Ridzuan, and Razak (2016) had established that risk exposure is highest during the pre-contract stage, without showing if the risks observed in the post-contract stage are the same as those in the pre-contract stage. Skitmore and Drew (2003) considered that the dichotomy between the pre-contract and post-contract stages of a construction project renders estimating and pricing at the tender stage more difficult. This arises in part from a contractor trying to put a price on a design that the contractor had no part in producing (Urquhart and Whyte, 2020).

Construction projects in the developing world, whether publicly or privately owned, are rarely completed within their planned schedules and budgets. The level of risk and uncertainty under which construction projects are delivered in developing countries is very high. Construction projects are delivered in stages; from project conception through design, construction and maintenance/facility operation. Construction risks are traceable to various factors which include risks of estimating and pricing, time and cost overruns, amongst others (Oyewobi et al, 2012). These risks, which are at their peak during the tendering phase of projects, have to be dealt with by governments, consultants and contractors, who, according to Tipili and Yakubu (2016), are the parties that are mostly involved in construction activities in Nigeria. The low-cost mentality of construction contractors has put them under pressure to win enough bids to ensure the growth and survival of their companies (Oke et al., 2017; Ajayi et al., 2012), more so given the lowest bid culture of the industry, which impacts on the successful contractors’ capability to meet key project performance objectives (Xiaohong, 2011). More research is necessary to highlight the risks inherent in the pre-contract stage of construction projects, especially in Nigeria.

It is based on this knowledge that this study assesses the risks considered by contractors during the tendering (pre-contract) stage of construction projects. The outcome of this would give a clear insight into the various factors affecting tenders and their effects on contractors' efficiency and chances of winning a contract in Nigeria. It will also add to the existing body of knowledge on tender related risks on construction projects.

LITERATURE REVIEW

The Tendering Process in Nigeria

Tendering is a Procurement Procedure whereby potential Suppliers are invited to make a Firm and unequivocal offer on the price and terms in which they will supply specified goods, Services or works which on acceptance shall be the basis of a subsequent contract (Lysons and Farrington, 2006). Tendering is based on the principles of competitiveness, fairness and accessibility, transparency, openness and probity (World Bank, 2008). Internationally, all Public entities are subjected to open tendering by law so as to prevent fraud, waste, unethical practices or local protectionism (global trade negotiation.2006).

Tendering language in Nigeria is very similar to that employed by the World Bank. The Nigerian Ministry of Finance and Ministry for Works are the ministries responsible for government procurement of consulting work. Although in the past the rules concerning procurement were very complicated and open to conflicting interpretations. In 2007 these rules were simplified and consolidated under one law: the Public Procurement Act 2007sposal Act. Under this law, the Central Tender Board has renamed Public Procurement. The main aim of the Nigerian procurement policy is to ensure that the system is not corrupt. Nevertheless, a system of granting of preferences is permitted in the Nigeria tendering system. As the race is downplayed as a factor in Nigeria society, such preferences do not depend on race, disability or gender (Jodie, 2004).

Tendering categories in the Nigerian public sector

The Nigeria government draws a distinction between contractors and consultants. In order to qualify for the preferences, consultants and contractors are required to register on separate service provider databases, and to obtain a registration number (World Bank, 2008). The Nigeria government recognizes 3 categories of tenders: restricted tender - i.e. tenders reserved for Nigeria citizens only, up to a maximum value of N 10 million, National competitive bid - i.e. where citizens of other countries may bid but preference may be granted according to the shareholding or composition of the tendering consortium. (Shash and Abdul-Hadi, 1992) Before being allowed to tender for government contracts in Nigeria, a consultant must register on the PP&ADB database of consultants.

Before being permitted to register as an independent consultant in Nigeria, a foreign national must have worked in Nigeria for 1 year. Only consultants and contractors who are registered with the Ministry of Works are permitted to tender for restricted tenders and national competitive bids.

Open competitive bidding is open to all companies, even those without a presence within Nigeria. To register with the Ministry of Interior Ministerial Tender Board (MTB), Nigeria citizens fill in BPP Form, while foreign nationals fill in BPP Form No 7. All government tenders are published in the National newspapers, which comes out once a week on Fridays. All IT tenders are advertised on the Nigeria government website as well. Government tenders are also published in the local Nigerian newspapers (Jodie, 2004).

Risks in the Tendering Process of Projects

Contractors need to win tenders to survive in the construction industry. Contractors must be able to deal with various bidding situations successfully in today's highly competitive construction market. The first step that the companies need to consider is whether to bid or not to bid before deciding on an effective tender strategy to win the tender.

Risk is inherent in all human endeavours, including construction activities, and the risk elements involved are diverse and varied. Risk can be viewed as a psychological phenomenon that is meaningful in terms of human reaction and experience. Samson et al. (2008) say that general risk definition does not exist, these authors argue that a new definition is established every time an organisation faces a new decision problem. Their statement is in accordance with the research of Grimvall et al. (2003) on the same subject. They claimed that most people's risk definition will to a high extent be dependent on the situation in which the risks may occur. Also, they argue that this state of knowledge will have some impractical consequences in projects where risks often occur in a number of different situations and with a lot of different actors involved.

According to Oyewobi et al (2012), there are four key risks in tendering process of a project by contractors.

(i) Design risk variables
(ii) Financial risk variables
(iii) Construction risk variables
(iv) Political risk variables

Design risk variables: Defective design, Variation of work, Changes of original design and Deficiencies in the description of work.

Financial risk variables: Inflation, Inadequate cash flow, Exchange rates, Cost overruns due to schedule delay, and Contractors default.

Construction risk variables: Contractors competence, Defective material, Poor performance of the supplier, Poor quality of work, Productivity of equipment, Labor, material & equipment availability, and unforeseen site conditions.

Political risk variables: Political uncertainty, Banks policy, Changes in government regulations, Permits and Ordinances, and Force majeure.

Oke et al. (2017) reported that the risk factors that could impact on the contractors success at the pre-contract stage are Technical background of contractor's personnel, level and quality of workmanship to be delivered, Availability of required technology and expertise, Level of intended profit to be made by the contractor, Management capability of the contractor. However, the client is interested in awarding contract on an agreed upon contract type and prices that will produced a minimal risks that will not impact the success of the project and the performance of the contractor.

In Malaysia, Saaidin et al. (2016) found that the major risks associated with the tender stages of the construction projects that influence the contractors' tender figure are; Quality expectation, Price inflation of construction materials, Risk involved in the project, Financial capability of client, Payment condition attached to the project, and Design Variation.

Project Quality expectation cost money to achieve and the client has the responsibility of clearly defining the level of quality requirement of the project. This is important to enable the contractor allocate adequate cost to achieve the standard of quality needed (Saaidin et al., 2016; Adenuga, 2013). The effect of price fluctuation can be minimized through proper forecast of the economy. This becomes important particularly on government-controlled construction materials. The dynamics of demand and supply has the capacity to increase the prices of construction materials. Perera & Kuganesan (2007) submitted that it has been agreed that construction materials should be stock piled to minimize the effect of price fluctuation.

Construction projects involve a lot of risks, and these risks can be categorized into four according to (Zou et al., 2007; Mark et al., 2004), these risks are;

i) Client risks; such as quality, adequacy of budget, and time constraint.
ii) Consultant risks; such as changes in drawings, variations, discrepancies in drawings, among others
iii) Sub-contractor risks; such as manpower, quality, time constraint,
iv) Government policies and Local authority risks; government changes, policies instability, bureaucracy issues, local authority policies.

In the Indonesian construction sector, Yuni et al. (2017) found 39 risks associated with tender documents; 18 risks representing 46.2% fell under unacceptable risks category after assessment. These risks include mismatch between drawing and plan, changes in materials specification, variations and additional works. Furthermore, 21 risks (53.8%) after assessment were found to be undesirable category. Some of these risks are arithmetic errors, unavailability of materials in the market, wrong and mismatch information from consultants, Given documents are unclear, Inaccuracy of estimated costs, The lack of detailed drawings in the plan drawings, Mistakes in planning the execution time, Lack of experience in reading the plan drawings at the time of the initial planning, and among other. It was concluded that risks that are associated with tender documents should get the attention of the contractors, project owner, consultants and other professional involved in the delivery of construction projects.

Bala and Ibrahim (2007) have earlier reported defective or inadequate design caused up to 43% increase to the initial cost of a project. The effect is large enough to cause total loss of revenue and profit to the contractors, and such defective design risks may be borne by the contractors wholly. Oyewobi et al. (2012) advocated for a proper attention to design coordination between the design teams to minimise this effect of the risks.

THE STUDY GAP

Extant literature showed that there is a dearth of studies on tender-related risks in the Nigerian context (e.g. Oke et al., 2017; Oyewobi et al., 2012). A good number of the exiting studies on tender risks were carried out outside the boundaries of Nigeria (e.g. In Indonesia (Yuni et al., 2019), in Malaysia (Saaidin et al., 2016), in Hong Kong (Skitmore and Drew, 2003); In Sri LAngka (Perera & Kuganesan, 2007)). This is inspite of the high level of risks that are associated with the pre-contract state (Saaidin et al., 2016; Skitmore and Drew, 2003). It is this gap in literature that this study has filled.

RESEARCH METHODOLOGY

This study adopted a quantitative approach in achieving its aim. The purpose of this study is to assess the risks considered by contractors during the tendering (pre-contract) stage of construction projects. The study was carried out in Abuja, Nigeria and data were drawn from construction professionals employed by consultants and contractors organisations. These professionals include Architects, Builders, Civil Engineers, and Quantity Surveyors. According to Adegboyega et al. (2021), "Abuja is the seat of power of Nigeria and the rate of infrastructural and building provision by both the government and private sector is unprecedented". This attracts large and SMEs construction organisations as well as other firms into citing the head office or annexe in Abuja. Contractors were chosen because the failures in the performance of construction projects are blamed on the contractors. This is due to the understanding that the contractors are responsible for the execution of the building works, thus, their performance influences the success of the projects (Onyejeakor et al., 2019).

A total of 250 well-structured questionnaires were administered on the participants using purposive sampling technique. The questionnaire gathered information on the respondents' background information and data on the risks considered by contractors during the tendering (pre-contract) stage of construction projects. After the survey period, a total of 102 questionnaires were retrieved out of 250 distributed, and were found suitable for the analysis. This represents a response rate of 40.80%. The reliability evaluation result indicates that the questionnaire is reliable and has high internal consistency. This is based on the Cronbach's alpha value of 0.883 obtained for the 31 variables assessed. This is in line with the suggestion of (Pallant, 2005). The data garnered on the background information of the respondents were analysed using frequencies and percentages. Data gathered on the risks considered by contractors during the tendering (pre-contract) stage of construction were analysed using the mean score.

RESULTS AND DISCUSSION

Background Information of the Respondents

From table 1, the distribution of the ages of the participants showed that 14.71% are aged less than 25years, 53.92% have are 25-35years old, 17.65% are 36-45years old, and 13.73% are more than 45years old. 59.8% of the respondents are males and 40.20% are females. In terms of employer type, 59.8% are employed by contractors and 40.20% are employed by consultants.

It can be seen that based on the profession of the participants' Architects are (14.71%), Builders (12.75%), Engineers (43.14%), and Quantity surveyors (29.41%). In terms of academic qualification, 67.65% holds HND/ BSc/M.Tech, 27.45% hold MSc./M.Tech and 4.90% hold a PhD. Based on their year of working experience, 13.73% have less than 5years experience, 41.18% have 5-10years experience, 32.35% have 11-15years, and 12.75% have more than 15years experience.

Overall, the respondents have qualified academically, professionally and have the requite experience that will aid this study.

Table 1: Respondent particulars

Category	Classification	Freq.	Per cent	Cumm. Per cent
Age	Less than 25 yrs	15	14.71%	14.71%
	25 yrs – 35 yrs	55	53.92%	68.63%
	36 yrs – 45 yrs	18	17.65%	86.27%
	More than 45 yrs	14	13.73%	100.00%
	TOTAL	**102**	**100%**	
Gender	Female	41	40.20%	40.20%
	Male	61	59.80%	100.00%
	TOTAL	**102**	**100%**	
Employer type	Contractor	61	59.80%	59.80%
	Consultant	41	40.20%	100.00%
	TOTAL	**102**	**100%**	

Type of work (Professionals)	Architecture	15	14.71%	14.71%
	Building	13	12.75%	27.45%
	Civil Engineering	44	43.14%	70.59%
	Quantity Surveying	30	29.41%	100.00%
	TOTAL	**102**	**100%**	
Education	HND/B.Sc	69	67.65%	67.65%
	M.Sc	28	27.45%	95.10%
	PhD	5	4.90%	100.00%
	TOTAL	**102**	**100%**	
Work experience	Less than 5 yrs	14	13.73%	13.73%
	5 yrs – 10 yrs	42	41.18%	54.90%
	11 yrs – 15 yrs	33	32.35%	87.25%
	More than 15 yrs	13	12.75%	100.00%
	TOTAL	**102**	**100%**	

Risks considered by contractors during the tendering (pre-contract) stage of construction projects

Table 2 shows the ranking of the Risks considered by contractors during the tendering (pre-contract) stage of construction projects**.** Under the design risks category, the relative ranking of the risks considered by contractors during the tendering (pre-contract) stage of construction projects are; Defective design (mean=4.28), Deficiencies in the description of work (mean=4.22), Variation of work (mean=4.2), and Changes of the original design (mean=4.12).

Under the Financial risks category, the top Risks considered by contractors during the tendering (pre-contract) stage of construction projects are; Corrupt practices such as collusion amongst contractors (mean=4.20), Inflation (Volatility of general price levels in the country) (mean=4.18), Inadequate cash flow (mean=4.12), and Accuracy of quotations from suppliers and subcontractors (mean=4.11). Under the Construction risks category, the top Risks considered by contractors during the tendering (pre-contract) stage of construction projects are; Poor quality of work (mean=4.27), Unforeseen site condition (mean=4.23), Labour, material & equipment availability (mean=4.21), and Contractors competence (mean=4.18).

Under the Political risks category, the top Risks considered by contractors during the tendering (pre-contract) stage of construction projects are; Political uncertainty (mean=4.07), Changes in government regulations (mean=3.94), Banks policy (mean=3.82), and Force majeure (mean=3.51). Under the Quantity Surveying risks category, the top Risks considered by contractors during the tendering (pre-contract) stage of construction projects are; the Shortness of time available to prepare tender (mean=4.03), Familiarity of contractor/contractor's QS with the system of construction to be adopted for the proposed works (mean=3.95), Likelihood of obtaining current prices of construction resources through the market survey (mean=3.90), and Pressure arising from the current workload of the contractor's QS (mean=3.70).

Overall, the top-ranked Risks considered by contractors during the tendering (pre-contract) stage of construction projects are; Defective design (mean=4.28), Poor quality of work (mean=4.27), Unforeseen site condition (mean=4.230, Deficiencies in the description of work (mean=4.22), Labour, material & equipment availability (mean=4.21), Variation of work (mean=4.20), Corrupt practices such as collusion amongst contractors (mean=4.20), Inflation (Volatility of general price levels in the country) (men=4.18), Contractors competence (mean=4.18), Changes of the original design (mean=4.12), and Inadequate cash flow (mean=4.12). While the least 10 Risks considered by contractors during the tendering (pre-contract) stage of construction projects are; Banks policy (mean=3.82), Poor performance of supplier (mean=3.75), Defective material (mean=3.74), Pressure arising from the current workload of the contractor's QS (mean=3.70), Awareness of current prices of construction resources (mean=3.67) Level of experience of Contractor's quantity surveyor (QS) (mean=3.60), Complexity of the works detailed in the tender documents (mean=3.58), Force majeure (mean=3.51), Cost overruns due to schedule delay (mean=3.37), and Permits and Ordinances (men=3.23).

The finding of this study supports the findings of previous studies (Yuni et al., 2017; Oke et al., 2017; Saaidin et al., 2016; Oyewobi et al., 2012). Some of the pre-contract risks found by (Yuni et al., 2017) are arithmetic errors, unavailability of materials in the market, wrong and mismatch information from consultants, Given documents are unclear, Inaccuracy of estimated costs, and among others. Oyewobi et al. (2012) reported that defects in design, inflation, contractor’s competence and political uncertainty, changes in government had wages rates over the period, excessive approval procedure in administration government department, unavailability of sufficient amount of unskilled labour and technical manpower and resources of the company; are the major pre-contract risks of the contractors. For the study of Saaidin et al. (2016), the major risks associated with the tender stages of the construction projects that influence the contractors’ tender figure are; Quality expectation, Price inflation of construction materials, Risk involved in the project, Financial capability of client, Payment condition attached to the project, and Design Variation. Oke et al. (2017) found that the technical background of contractor's personnel, level and quality of workmanship to be delivered, Availability of required technology and expertise, Level of intended profit to be made by the contractor, Management capability of the contractor, and among others.

From figure 1, it can be seen that based on the Average weighting of the major category of pre-contract risks factors, Design risks (mean=4.20) is ranked 1st, flowed by Financial risks (mean=4.00), then in the 3rd position is Construction risks (mean=3.99), Quantity Surveying risks (mean=3.81) is ranked 4th and lastly, Political risks (mean=3.71) is ranked 5th. These major risks categories regardless of their ranking are given adequate consideration by the contractor at the pre-contract stage as their average mean score is more than 3.50 (70.00%). They have an impact on construction project outcomes.

Table 2 Risks considered by contractors during the tendering (pre-contract) stage of construction projects

S/N	Tendering risks	Mean score	S.D	Rank	Overall Rank
	Design risks				
1	Defective design	4.28	0.8603	1	1
2	Variation of work	4.20	0.9548	3	6
3	Changes to the original design	4.12	0.9259	4	10
4	Deficiencies in the description of work	4.22	0.8399	2	4
	Financial risks				
5	Inflation (Volatility of general price levels in the country)	4.18	0.9378	2	8
6	Inadequate cash flow	4.12	1.1798	3	10
7	Exchange rates	3.98	1.0339	6	17
8	Cost overruns due to schedule delay	3.37	1.2099	7	30
9	Contractors default	4.08	0.8976	5	14
10	Corrupt practices such as collusion amongst contractors	4.20	0.7583	1	6
11	Accuracy of quotations from suppliers and subcontractors	4.11	0.9889	4	12
	Construction risks				
12	Contractors competence	4.18	0.8134	4	8

13	Defective material	3.74	1.4137	8	24
14	Poor performance of the supplier	3.75	1.3693	7	23
15	Poor quality of work	4.27	0.6916	1	2
16	Productivity of equipment	4.11	0.8194	5	13
17	Labour, material & equipment availability	4.21	0.9784	3	5
18	Unforeseen site condition	4.23	0.7566	2	3
19	Pressure from the current workload of the contractor	3.87	1.0017	6	21
20	The complexity of the works detailed in the tender documents	3.58	1.2059	9	28
	Political risks				
21	Political uncertainty	4.07	0.8474	1	15
22	Banks policy	3.82	1.0475	3	22
23	Changes in government regulations	3.94	0.9316	2	19
24	Permits and Ordinances	3.23	1.0427	5	31
25	Force majeure	3.51	1.0024	4	29
	Quantity Surveying risks				
26	Shortness of time available to prepare tender	4.03	1.3384	1	16
27	Level of experience of Contractor's quantity surveyor (QS)	3.60	1.3443	6	27
28	Familiarity of contractor/contractor's QS with the system of construction to be adopted for the proposed works	3.95	1.0377	2	18
29	Pressure arising from the current workload of the contractor's QS	3.70	1.2411	4	25
30	Awareness of current prices of construction resources	3.67	1.1110	5	26
31	Likelihood of obtaining current prices of construction resources through market survey	3.90	1.2469	3	20

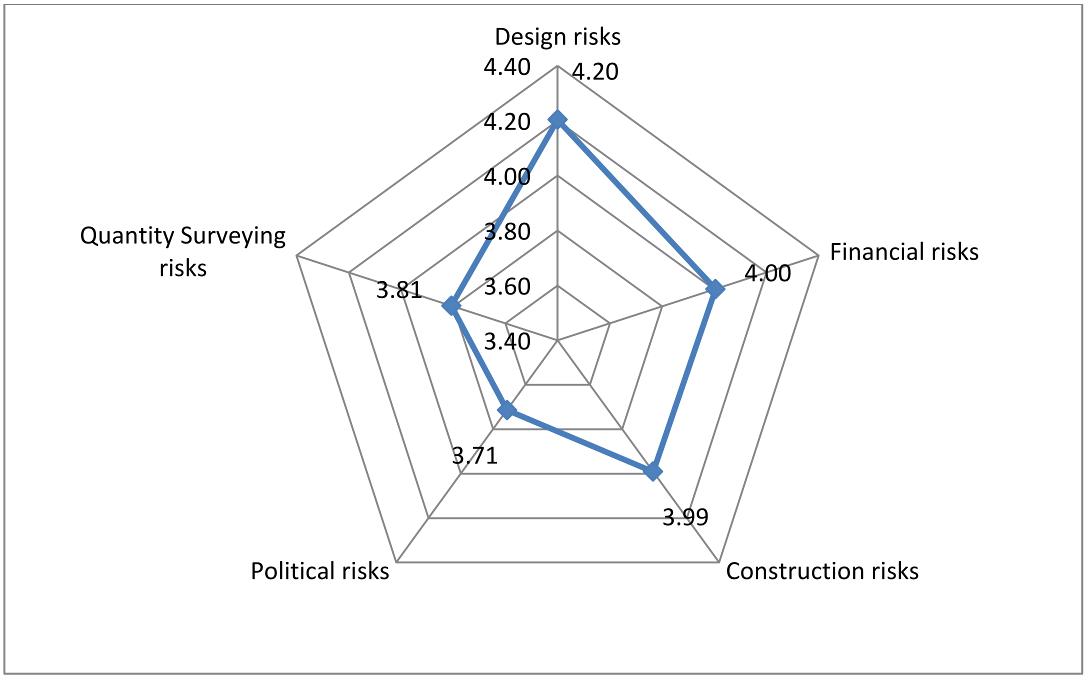

Figure 1: Average weighting of the major category of pre-contract risks factors

Source: Researchers' analysis (2022)

Conclusions

The purpose of this study is to assess the risks considered by contractors during the tendering (pre-contract) stage of construction projects. A survey approach was adopted in the study using a well-structured questionnaire and purposive sampling procedure to collect data from construction professionals in Abuja, Nigeria. The data were analysed and some critical findings were made and research questions answered.

It was found that the major risks considered by contractors during the tendering (pre-contract) stage of construction projects are; Defective design, Poor quality of work, Unforeseen site condition, Deficiencies in the description of work, Labour, material & equipment availability, Variation of work, Corrupt practices such as collusion amongst contractors, Inflation (Volatility of general price levels in the country), Contractors competence, Changes of the original design, and Inadequate cash flow. The major risk categorisation showed that Design risks, financial risks, construction risks, Quantity Surveying risks and Political risks are given a higher consideration by the contractors during the pre-contract period. This study recommends the following based on the major findings; detailed construction project design should be produced prior to tendering. This is vital to avoid design-related risks. Adequate budgetary provision and cash flow system should be put in place to avoid or mitigate the effect of financial risks.

Adequate planning of work, the contractor should be experienced enough to handle the Construction related risks.

The outcome of this study will aid contractors and other decision-makers in making the appropriate decision regarding the risk mitigation strategies to curtail the effect of pre-tender. It also added to the existing body of knowledge on risks within the global construction industry. This study is however limited by geographical boundary, sample size and sampling techniques. A similar study is recommended to be carried out in a different state, region or country using a randomised sampling technique and considering a larger sampled size. This will provide results for comparison purposes.

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Assessing Barriers to Implementation of Lean Construction Techniques for Safety Improvement on Construction Sites in Nigeria

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ABSTRACT

Implementing lean construction techniques for safety improvement has become crucial to successful completion of construction projects. As no broad unanimity exist in literature regarding factors which are barriers to implementing lean techniques for safety improvement on construction sites, this study aimed to assess barriers to application of lean construction techniques for safety improvement on construction sites in Nigeria. To achieve this aim, a total of forty (40) barriers were identified through an extensive literature review. Thereafter, data relating to these barriers were collected via a questionnaire survey administered on 176 construction professionals. Descriptive statistics and ANOVA was used to analyse the data retrieved from the survey. The results revealed the strongest barriers to implementing Lean Construction (LC) techniques for improving safety in construction sites in Nigeria to be "lack of LC concept understanding, lack of knowledge on how to apply LC techniques for safety improvement, lack of awareness programs, lack of education and training". Likewise, the least barriers are "low tender price, incomplete design and logistics' problem". The study concludes that regular sensitization on LC techniques for improving construction safety should be provided to all construction practitioners. The study's findings provide valuable basis for improved application of LC techniques for safety improvement on construction projects in Nigeria.

Keywords: Lean construction, safety improvement, barriers, construction sites, Nigeria

1.0 INTRODUCTION

Globally, the construction industry has been considered to be the most hazardous industry. Hence, the significance of providing it with a safe working environment cannot be over emphasized (Olutuase, 2014). Improving safety on construction sites remains a priority in almost every country around the world, since the construction industry stands out among all other industries as the main contributor to severe and fatal accidents (Ghosh Young-Corbett, 2009; Awada *et al.*, 2016). All construction companies adopt safety management and comply with safety regulations to lower accidents. However, these have proved insufficient to completely eliminate accidents and assure a sound safe working environment (Gambetese and Pestana, 2014; Awada *et al*., 2016).

In recent times, as poor safety represents a form of waste on construction sites, lean construction has been shown to improve construction safety. Essentially, waste on construction sites often result in accidents, leading to major disruption of the construction flow which lean construction aims to stabilize (Gambetese and Pestana, 2014; Awada *et al*., 2016). Lean construction considers safe workflow in construction operation. In addition, the application of its tools such as 5s (sort, straighten, shine, standardize, sustain) could reduce hazards such as slips, trips and falls which are the major causes of onsite of accidents. (Teo *et al*. 2005; Schafer *et al*. 2008; Bashir *et al*. 2011; Salem *et al*., 2007; Bashir *et al*., 2011). Lean construction techniques and tools implementation for safety improvement is however, still in its early stage (Enshassi *et al*., 2019).

Towards improving implementation of lean construction techniques for safety improvement, several studies have been carried out to identify the implementation barriers. However, no broad unanimity exists regarding factors which are barriers to implementing lean techniques for safety improvement in construction. In Gaza strip, Enshassi (2019) found the strongest barriers to implementing LC techniques and for safety improvement to be; lack of LC concept understanding, lack of government support for applying innovative strategies in construction projects and lack of knowledge on how to apply LC techniques for safety improvement. In the UK, Bashir (2013) found the most significant barriers to lean construction techniques implementation for safety improvement to be; lean construction knowledge and misconception about lean construction practice. Awada et al. (2016) stated that lack of knowledge and understanding of the lean philosophy and concepts, and the lack of transparency among project participants acts as major barriers to implementing Last Planner System, Visualization and 5s to improve safety in the Lebanese construction industry.

In Nigeria, efforts exist to assess barriers to implementation of lean construction (Olamilokun 2014; Olatunji 2019) but no existing research has identified barriers to lean construction techniques implementation for safety improvement. To address this gap in knowledge, this study attempts to identify and assess these barriers specifically in the context of Nigerian construction sites.

2.0 LITERATURE REVIEW

Barriers to implementation of LC techniques for safety improvement are classified into; management barriers, educational barriers, technical barriers, financial barriers, human-attitudinal barriers and governmental barriers (Bashir, 2012; Bashir et al., 2015; Enshassi et al., 2019). Table 1 presents synthesis of barriers reported by previous studies in each category.

Table 1: Barriers to Application of LC Techniques

BARRIERS	SOURCES										
	Bashir et al. (2015)	Cano et al. (2015)	Mehra et al. (2015)	Gade (2016)	Sandeep and Panwar (2016)	Zhou (2016)	Awada et al. (2016)	Attri et al. (2017)	Small et al. (2017)	Camuffo et al. (2017)	A Enshassi et. al (2019)
MANAGEMENT BARRIERS											
Top management support and commitment	□		□		□			□	□		□
Poor project definition									□		□
Centralization of decision under single authority										□	□

Lengthy approval procedure from top management								□	□
Lack of time for innovation					□				□
Lack of transparency						□			□
Poor communication among participants of the production process			□		□		□	□	□
poor coordination between the project parties			□				□		□
Absence of long-term forecast and investment by the top management	□							□	□
Inadequate planning		□	□	□			□	□	□
Logistics' problems									□
FINANCIAL BARRIERS									
Inadequate funding of the project to provide the required resources and training	□	□			□			□	□
Low tender prices								□	□
Implementation cost of LC	□			□					□
Poor salaries of professional								□	□

s										
Lack of incentives and motivation			□		□			□		□
Inflation in material prices due to unsafe markets condition for construction				□						
EDUCATIONAL BARRIERS										
Lack of LC concept understanding							□		□	□
Lack of knowledge					□	□	□			□
Lack of technical skills									□	□
Lack of education and training	□	□	□		□			□	□	□
Lack of awareness programs	□		□					□		□
Lack of experiences and information sharing	□									□
GOVERNMENTAL BARRIERS										
Lack of government support towards the construction industry	□	□								□
Government bureaucracy and instablity									□	□
Inconsistency in the	□								□	

government policies										
Unsteady price of commodities	□									□
TECHNICAL BARRIERS										
Lack of agreed implementation methodology									□	□
Complexity of LC implementation	□			□						□
Long implementation period	□				□				□	□
Incomplete designs	□									□
Poor performance measurement strategies	□								□	□
Fragmented nature of the construction industry									□	□
Lack of Integrity of the production chain including client, materials' suppliers and subcontractors		□				□				□
HUMAN ATTITUDINAL BARRIERS										
Poor leadership	□		□					□		□
Employees' resistance to change			□		□	□	□	□		□

Cultural issues		□		□	□		□
Inability to change the organizational culture		□	□	□	□	□	□
Fear of unfamiliar practices	□						□
Lack of teamwork	□	□					□

3.0 RESEARCH METHODOLOGY

The research adopted a quantitative research approach and involved collection and analysis of purely numerical data. A total of forty barriers to implementation of lean construction were identified via extensive review of literature. A questionnaire was then used to elicit information relating to level of influence of each barrier to implementation of lean construction for safety improvement in construction sites in Nigeria. The questionnaire comprised two sections. The first section sought demographic details of the respondents. The second section on the other hand requested respondent's assessment of barriers to implementation of lean construction for safety improvement. it comprised the barriers identified from previous literature as well as a five point likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

The questionnaire was administered on construction professionals namely; Architects, Builders, Quantity Surveyors, Engineers and Project Managers. A total number of 560 construction professionals was computed as the sample size, using Krejices and Morgan (1970) sample size formula. As the study's sample comprised different professionals, stratified random sampling was used to administer the questionnaires to avoid bias. Prior to administering the questionnaires, it was pretested with five professionals to determine if it was clear enough for respondents to understand.

A total of 176 valid responses were retrieved from respondents and analysed using descriptive statistics and ANOVA.

4.0 RESULTS AND DISCUSSION

4.1 Information relating to study respondents

Table 2: Demographic Information of Respondents

VARIABLES	CATEGORIES	FREQUENCY	PERCENTAGE
RESPONDENTS' EDUCATION	ND	18	10.2
	BSc/HND	45	25.6
	MSc	75	42.6
	PhD	38	21.6
	TOTAL	**176**	**100.0**
RESPONDENTS' PROFESSION	Quantity Surveyor	40	22.7
	Project Manager	16	9.1
	Architect	40	22.7
	Builder	40	22.7
	Engineer	40	22.7
	TOTAL	**176**	**100.0**
RESPONDENTS' RANK	Senior Management Level	52	29.5
	Middle Management Level	86	48.9
	Operational Management Level	38	21.6
	TOTAL	**176**	**100.0**
RESPONDENTS' YEARS	0-5 Years	35	19.9

OF EXPERIENCE			
	6-10 Years	57	32.4
	11-15 Years	33	18.8
	16-20 Years	21	11.9
	Over 20 Years	30	17.0
	TOTAL	**176**	**100.0**
RESPONDENTS' TYPE OF PROJECT	Building Project	75	42.6
	Civil Engineering Project	101	57.4
	TOTAL	**176**	**100.0**

4.2 Assessing Barriers to Implementing LC for Safety Improvement on Construction Sites in Nigeria

Table 3 presents respondent's assessment of the barriers to application of lean construction techniques to improve safety on construction sites in Nigeria. It shows the mean scores of each professional for the barriers and significant difference in the responses of each professional for each barrier. Similar to Odeyinka (2008), a mean score of 3.00 was defined as critical and 5.00 as extremely critical. One-Way ANOVA at 5% level of significance was used to test for significant difference in professionals' ranking of each barrier.

Table 3: Assessing Barriers to Implementing LC for Safety Improvement on Construction Sites in Nigeria

	OVERALL PROFESSIONALS		QUANTITY SURVEYORS		ARCHITECTS		BUILDERS		ENGINEERS		PROJECT MANAGERS		SIG.
BARRIERS	MEAN	RANK	MEAN	RANK	MEAN	RANK	MEAN	RANK	MEAN	RANK	MEAN	RANK	
Top management support and commitment	3.44	1	3.94	2	3.25	20	3.50	6	3.55	9	3.38	11	0.000
Poor project definition	2.89	2	2.44	40	2.88	34	2.85	29	2.60	37	2.50	38	0.205
Centralization of decision under single authority	3.34	3	2.71	35	3.28	19	3.23	15	3.05	27	2.81	30	0.014
Lengthy approval procedure from top management	3.41	4	3.41	8	3.25	21	3.28	12	3.45	10	3.56	6	0.278
Lack of time for innovation	3.31	5	3.12	19	3.28	18	3.15	19	3.23	18	3.19	16	0.287
Lack of transparency	3.34	6	3.06	22	3.40	16	3.45	8	3.10	26	3.00	22	0.229
Poor communication among participants of the production process (managers, administrators, foreme, etc.)	3.57	7	3.15	17	3.63	10	3.55	5	3.65	7	3.50	7	0.954
Poor coordination betweeen the	3.29	7	3.06	20	3.18	23	3.08	21	3.30	14	3.13	18	0.070

project parties													
Absence of long-term forecast and investment by the top management	2.98	9	2.76	33	2.98	28	2.85	29	2.70	36	2.88	26	0.028
Inadequate planning	3.08	10	2.97	29	2.88	33	2.90	27	3.05	27	2.75	33	0.003
Logistics' problems	2.43	11	2.81	31	1.93	40	2.53	38	2.43	40	1.69	40	0.000
Inadequate funding of the project to provide the required resources and training	3.38	12	3.29	11	3.68	7	3.08	21	3.40	11	3.63	5	0.383
Low tender prices	2.67	13	2.50	38	2.88	32	2.78	34	2.60	38	2.50	38	0.330
Implementation cost of LC	3.26	14	3.03	25	3.63	10	3.25	13	3.23	18	3.25	15	0.065
Poor salaries of professionals	3.46	15	3.32	10	3.63	9	3.33	11	3.30	15	3.50	8	0.600
Lack of incentives and motivation	3.13	16	3.18	16	3.43	13	2.85	31	3.05	27	3.19	16	0.238
Inflation in material prices due to unsafe markets' condition for construction	3.16	17	2.97	28	3.43	14	2.93	26	3.33	13	3.00	24	0.077
Lack of LC	4.06	18	4.03	1	4.28	1	4.03	1	4.08	1	4.00	1	0.556

concept understanding													
Lack of knowledge	3.98	19	3.76	3	4.18	2	4.03	1	3.93	2	3.81	4	0.706
Lack of technical skills	3.46	20	3.03	24	3.73	6	3.58	4	3.28	16	3.50	9	0.111
Lack of education and training	3.76	21	3.56	6	3.98	3	3.65	3	3.73	5	3.88	3	0.443
Lack of awareness programs	3.77	22	3.56	5	3.93	4	3.48	7	3.90	3	3.94	2	0.293
Lack of experiences and information sharing	3.26	23	3.47	7	3.18	22	3.23	14	3.25	17	2.88	26	0.267
Lack of government support towards the construction industry	2.84	24	2.91	30	3.08	27	2.38	39	2.78	33	3.13	19	0.000
Government bureaucracy and instability	3.02	25	3.00	26	3.35	17	2.90	28	2.93	32	2.81	28	0.279
Inconsistency in the government policies	2.89	26	3.12	18	2.65	38	2.83	33	3.13	23	2.75	34	0.145
Unsteady price of commodities	2.93	27	3.21	15	2.95	30	2.30	40	3.40	12	3.06	20	0.000
Lack of agreed implementation methodology	3.05	28	3.29	12	3.13	25	2.93	25	3.23	18	2.81	30	0.685
Complexity of LC implementation	2.97	29	3.06	22	2.95	30	2.78	36	3.20	21	2.69	36	0.345

Long implementation period	3.24	30	3.24	14	3.55	12	3.13	20	3.13	24	3.38	11	0.25 3
Incomplete design	2.64	31	2.62	36	2.75	37	2.83	32	2.53	39	2.63	37	0.31 5
Poor performance measurement strategies	3.09	32	2.56	37	3.78	5	3.15	17	2.95	30	3.31	13	0.00 0
Fragmented nature of the construction industry	2.76	33	2.74	34	2.83	35	2.98	23	2.70	35	2.75	32	0.62 4
Lack of integrity of the production chain including clien, materials suppliers and sub-contractors	2.72	34	2.47	39	2.95	29	2.78	34	2.75	34	2.69	35	0.17 4
Poor leadership	3.25	35	3.00	26	3.40	15	3.43	9	3.18	22	3.25	14	0.31 7
Employees' resistance to change	3.10	36	3.35	9	2.83	35	3.15	17	3.10	25	2.94	25	0.03 9
Cultural issues	2.97	37	2.79	32	3.15	24	2.93	24	2.95	31	3.00	22	0.66 7
Inability to change the organizational culture	3.20	38	3.06	20	3.13	26	3.20	16	3.58	8	3.06	20	0.10 7
Fear of unfamiliar practices	3.17	39	3.71	4	2.58	39	2.65	37	3.78	4	2.81	28	0.00 0
Lack of teamwork	3.51	40	3.26	13	3.65	8	3.43	9	3.70	6	3.44	10	0.33 3

Table 3 shows that out of 40 barriers to implementation of LC for safety improvement, all the professionals agreed on 28 barriers to be the most critical barriers to the application of lean construction techniques to improve safety on construction sites in Nigeria with mean scores of 3.00 and above. These barriers are “top management support and commitment, centralization of decision under single authority, lengthy approval procedure from top management, lack of time for innovation, lack of transparency, poor communication among participants of the production process, poor coordination between the project parties, inadequate planning, inadequate funding of the project to provide the required resources and training, implementation cost of LC, poor salaries of professionals, lack of incentives and motivation, inflation in materials’ prices due to unsafe market condition for construction, lack of LC concept understanding, lack of knowledge, lack of technical skills, lack of education and training, lack of awareness programs, lack of experiences and information sharing, government bureaucracy and instability, lack of agreed implementation methodology, long implementation period, poor performance measurement strategies, poor leadership, employees’ resistance to change, inability to change the organizational culture, fear of unfamiliar practices as well as lack of teamwork”.

Table 3 further reveals that Quantity surveyors ranked the five most critical barriers as “lack of LC concept understanding, top management support and commitment, lack of knowledge, fear of unfamiliar practice and lack of awareness program” with mean scores of 4.06, 3.94, 3.76, 3.71 and 3.56 respectively. Architects ranked the five most critical barriers as “lack of LC concept understanding, lack of knowledge, lack of education and training, lack of awareness programs and poor performance measurement strategies” with mean scores of 4.28, 4.18, 3.98, 3.93 and 3.78 respectively. Builders ranked the five most critical barriers as “lack of LC concept understanding, lack of knowledge, lack of education and training, lack of technical skills and poor communication among participants of the production process”, with mean scores of 4.03, 3.65, 3.58 and 3.55 respectively. Engineers ranked the five most critical barriers as “lack of LC concept understanding, lack of knowledge, lack of awareness programs, fear of unfamiliar practices and lack of education and training,” with mean scores of 4.08, 3.93, 3.90, 3.78 and 3.73 respectively. Project managers ranked “lack of LC concept understanding, lack of awareness programs, lack of education and training, lack of knowledge and inadequate funding of the project to provide the required resources and training” with respective mean scores of 4.00, 3.94, 3.88, 3.81 and 3.63 as the five most critical barriers to implementation of LC for safety improvement on construction sites in Nigeria.

From Table 3, it is evident that professionals agreed in their scoring of the barriers as opinion pertaining to only 9 barriers are shown to have statistical significant difference ($P < 0.05$). These barriers are top management support and commitment, centralization of decision under single authority, absence of long-term forecast and investment by the top management, inadequate planning, logistics problems, lack of government support towards the construction industry, unsteady price of commodities, poor performance measurement strategies, employees’ resistance to change and fear of unfamiliar practices with p values of 0.000, 0.014, 0.028, 0.003, 0.000, 0.000, 0.000, 0.000 and 0.000 respectively.

4.3 DISCUSSION

Enshassi (2019) stated that Lack of LC concept understanding was the most critical barrier of all barriers, lack of government support towards the construction project to apply any innovative strategy as second most critical barrier, the third most critical ranking barrier was lack of knowledge to apply LC techniques to improve safety, cultural issues was the 38th ranking barrier and fragmented nature of the construction industry was ranked the lowest. From this study, respondents’ ranked lack of LC concept understanding as the most critical barrier, lack of LC knowledge as the second most critical barrier, lack of awareness program as third most critical barrier, lack of education and training as the fourth most critical barrier, poor communication among participants of the production process as the fifth most critical barrier. Fragmented nature of the construction industry was ranked the 36th most critical barrier, lack of integrity of the production chain including client, materials' suppliers and subcontractors was ranked 37th, low tender price as 38th, incomplete design as 39th and logistics problems as the 40th. It can be seen that there are similarities and differences in the findings of the two researches and indeed, no broad unanimity exist as regards the barriers.

5.0 CONCLUSION

In Nigeria, the construction industry suffers from lack of safety and large amount of accidents on construction sites. Lean Construction is considered as an innovative approach used to improve safety in construction projects. However, previous researches have shown that Lean Construction is yet to be implemented for safety improvement in Nigeria, which stress the need to investigate the barriers to its implementation. This study thus aimed to assess barriers to application of lean construction techniques for safety improvement on construction sites in Nigeria. To achieve this aim, a total of forty (40) barriers were identified through an extensive literature review. The most critical barriers to application of Lean Construction techniques to improve safety on construction sites in Nigeria were found to be "lack of LC concept understanding, lack of knowledge, lack of awareness program, lack of education and training and poor communication among participants of the production process. The study recommends adoption of measures such as training and education for employers, to inform them about the benefits of adopting LC techniques to improve safety in construction projects. Regular training should be provided to all construction practitioners to ensure they know the appropriate LC techniques in Nigeria that could be used to improve safety.

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RISK OF PUBLIC PROJECT ABANDONMENT IN FEDERAL CAPITAL TERRITORY, ABUJA

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ABSTRACT

The study focuses on public project abandonment in federal capital territory, Abuja, Nigeria. The aim of the study is to assess the public project abandonment in Nigeria. The study reviewed some of the major literatures on the causes of project abandonment of public buildings. The research design adopted for this study followed a pattern of both descriptive survey research design. The number of sampled respondents are one hundred and seventy five (175). The study reveals that factors responsible for public project abandonment in Abuja FCT includes lack of fund, inconsistent government policies, lack of accountabilities, high level of corruption, incompetent contractors, non-availability of building materials, lack of utilities, wrong materials, lack of infrastructural facilities, poor planning and undefined contracts. More so the study further indicates that the identified challenges of construction project abandonment in the study area includes the level of technical knowledge, it promotes corruption and embezzlement of public/private fund, loss of asset utilization, loss of finance, and it discourages innovation and encourages risk transfer. The researcher recommends that there is need for stakeholders in the building construction industries to assess the identified challenges of building construction that leads to project abandonment in the construction industries and enhances the stability of the sector for proper building management.

Keywords:* *Construction industry, government policies, Project Abandonment, Public Project, Risk.

INTRODUCTION

Project abandonment is a global challenge but a country like United Kingdom and other European countries are continually modernizing their Construction Industry in order to minimise the endemic effects on the construction industry. In the United Kingdom, the Modernizing Construction Report (MCR, 2001) is a document from the two committees set up by the government of United Kingdom on modernizing construction: "Construction Team" by Latham (1994) and "Rethinking Construction" by Egan (1998). These reports used to formulate the Construction Regulations and Standards instituted in United Kingdom. Meanwhile, in Nigeria, it is unfortunate, that specifications, standards and construction regulations as drivers of good standard of construction are suffused with a lot of challenges (Fadason, Danladi & Jatau, 2017).

The Construction Industry in Nigeria is a collection of loosely integrated sub-sectors that collectively construct, alter and repair buildings and civil engineering works. The uniqueness of the industry is derived from the type of physical products, demands patterns, novelty and varying site conditions it operates (Andawei and Nyeke, 2001). Arguably, the

Construction Industry in Nigeria is also one of the biggest employers of labour in the country after governments at the federal, state, and local levels (Nwaogu, 1988). The Industry makes a significant contribution to the country's gross capital formation and gross domestic product (National Bureau of Statistics, 2015). The Construction Industry in Nigeria is patterned after the United Kingdom Construction Industry, however, without its diversification and advancement (Gidado, 1995).

The delivery of services and works to prospective clients in the construction Industry follows a variety of processes. It is often the case that the mostly used procurement option in the country is the traditional one or two stage method (Ogunsanmi and Bamisile, 1997). This method emphasizes the separation of the design and the construction stages of a project. Recent developments have shown the adoption of more integrated system encouraged by Value Management, Risk and Partnering which are at their infancy in the country (Babatunde et al, 2007). Projects delivered by Governments at all levels (Federal, states and local governments) in Nigeria have suffered set back due to lack of adequate inclusion and rigorous consultation with major stakeholders amidst other factors such poor choice of location, improper needs analysis, project imposition, lack of finacial analysis, wrong choice of procurement route, inadequate social analysis and corruption (Hanachor, 2012; Ingwe et al., 2012). Projects like the Tinapa Business Resort, Calabar ((Eja and Eni, 2014) and Eyo C. (2011)); The Gateway International Market, Owode Yewa (Punch, 2012), Gateway International Market, Sagamu are examples of projects where inadequate consultations with key stakeholders at inception have led to near failure of the projects after delivery. Other projects were not delivered at all as they fall under the category of abandoned projects (Ingwe et al, 2012). Notwithstanding the foregoing, strong institutions are what we need in Africa and Nigeria in particular. Nigerian Construction Industry needs a paradigm shift, new orientation and another thinking that will lead to building strong institutions in construction industry.

Statement of the Research Problem

The major identified risk in building and Construction project in Nigeria is abandonments which is caused by cost and time overruns, and poor quality control (Olalusi & Otunola, 2012) and the same situations was obtainable in Egypt Construction Industry, until Value management (VM) was introduced and used in reducing the gap between the estimated/planned time and actual time and cost of residential constructional projects implementation, especially in the completion of 3343 housing units in the new housing complex in Helwan and Mansheyet Nasser Housing Project in New Cairo (Khodeir & Ghandour, 2019). Risk Management tool was deployed as building project abandonment mitigation strategy in RSSB Multi Storey buildings projects of RSSB, Rwanda (Aimable, 2015). Notwithstanding the fact that performance of a project is hinged on quality, cost and time of completion, Kerzner (2001) added two more criteria to determine the performance of project, which are efficient management of risks and that it should be accepted by the end-users.

The reverse is the case in Nigerian, where the irony is that in spite of this growth, the landscape is regrettably littered with abandoned building projects. Several construction projects which would have impacted positively on the economic and overall social development of the nation litters the corners and open spaces of the company (Olabusi, Otunola, 2012). Risk Management processes involves risk identification and analysis in order to ensure that the value gained during the value planning lasts throughout the useful lifecycle of the building (Russell, 2019). The amalgamation of risk management (RM) and value management (VM) into risk and value management (RVM) comes from the relative similarity of the objectives of these two aspects of construction management. Focusing on RM only can erode value while focusing on VM only can introduce high risks to the project. There are paucity of research works on value management and risk management in Nigeria, Nevertheless, none was done on Integration of the two of them as a framework for Implementation of value management in Nigerian construction, which equally highlighted their critical success factors. The paradigm shift to apply the integration of value management as developed and practiced all over the world will help as a remedy to incessant cases of abandoned and/or white elephant projects in Nigeria construction industry.

Aim and Objectives

The aim of this research is to assess public project abandonment in Nigeria. Specifically, this study seeks to:

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1. To identify the risk factors responsible for public building projects abandonment in Abuja FCT.
2. To assess the effect of construction project abandonment in the Nigerian Construction industry

Scope of the Research Study

This study focused on the development of the framework and critical success factors for integration of value management and risk management at the appropriate stage(s) of construction projects among the professionals in the federal capital development authority (FCDA) public building projects and private sectors within the Abuja federal capital territory only. The public buildings projects are the government building construction being undertaken by the building department in the federal capital development authority for the area councils within the federal capital territory, and they develop these buildings, as the clients' representatives for the ministerial departments and agencies of the federal government within the federal capital territory.

LITERATURE REVIEW

Causative Factors of Building Project Abandonment.

Abandoned building projects can be described as the project that has started at an earlier date, but which the construction work for one reason or the other has stopped and such are not limited to buildings alone; it can include roads, industrial structures, bridges, dams, electricity, communication projects (Olalusi & Otunola, 2012). Studies by Kolawole (2006], have shown that a good number of Construction project initiated with good intentions are abandoned at different stages of the design and construction process in Abuja FCT and Nigeria in general. Some reasons advanced by Makalah (2008) and Oyelola (2010) for failed construction projects in Nigeria are: incorrect estimation; lack of skilled personnel; inadequate planning; poor risk management; misunderstanding of the work requirement; poor quality control by regulatory agencies; corruption and communication gap among the personnel. Other factors are cost; the developer and the contractors; inability of clients to engage contractors or designers capability to do the work; failure on the part of contractors to obtain vital inputs such as materials, manpower and machines.

On the other hand, Dawodu (1987), sees abandoned projects as a project in which all activities are totally suspended. While, Akindoyemi (2005) observed that a project is never considered totally abandoned, rather the project must have been suspended as a result of some of these causative factors which are: 1) the proprietor's lack of funds; 2) Inconsistent government policy; 3) lack of accountability; 4) high level of corruption; 5) incompetent contractors; 6) non availability of building materials; 7) lack of utilities or infrastructural facilities; 8) wrong location. The above reasons invariably leads to waste of resources in the form of capital, material, human power, promotion of illegal activities, adverse effect on community and aesthetics. Hence Rwelamila and Lobelo (2000)], advocated that construction firms should inculcate operational, strategic, personal, technological, marketing and environmental strategies in order to cushion the effect of financial predicament associated with project abandonment. Project abandonment is not restricted to Nigeria or developing countries only; "abandonment is a well-known concept on construction projects in global construction industry (!Hicks, 2008). It generally arises in different situations. One example is when the project's design is so deficient that the contractor performs a massive amount of change orders and extra work. "The socio-economic effect of abandoned projects is overwhelming when considering the huge amount of money and resources on the part of the client has been invested.

Adequate planning, feasibility, viability and effective monitoring of financial outlay for construction projects should be put in place by various agencies concerned to reduce instances of project abandonment. Construction works involving huge capital outlay are prone to being forced to remain in the shelf for long as there is simply no cash in sight for people to buy. The Government agencies through her numerous inconsistent policies, consultants and selection procedures are pointers to abandonment of housing projects that litters the whole country. Provision of infrastructural facilities before, during and after the completion of housing project is very important to forestall abandonment. The continued neglect of on-going projects of previous governments by newly elected governments without considering the importance's of such project to National development. Many factors accounted for this, ranging from errors in pre-qualification and procurement procedure, to misappropriation of finance to incompetent consultants.

There are several factors affecting project implementation process, which invariably result in construction projects abandonment and these have been discussed from different perspectives by different authors. Metzger (1983) listed some of these as: Poor planning, undefined contract, unstable problem definition, inexperienced management, political pressure, ineffective change control and unrealistic deadline. In the views of this author, the successful project implementation may depend to an extent on careful regulation of these factors: Insufficient capital Inflation Poor planning Political pressures and Government Bureaucracy Contractor competence and organization Variation of project scope and design Changes in consultancy service providers Change in the original design Business/Geographical environment Project complexity. There is a tendency for successive governments to discontinue projects initiated by their predecessors (Fubera, 1985). Rather than do this, the new regimes prefer to start their own projects altogether. A major reason for this is that many contracts are awarded to serve political purposes and so continue to be credited to the regime that awarded it, even if they did not complete it. Again, because many contracts are actually inflated, rather than continue to fund ongoing projects, successive governments tend to use this knowledge to discredit past governments in order to score political points. This has led to a dive in confidence in the public sector, such that funding partners approach long term public sector projects with a lot of caution. (Nwachukwu, 1988). This greatly erodes the operation of public-private funding partnerships. Sometimes, this lack of continuity derives from more sincere reasons like inflation, which affects the cost of raw materials and changes the amount of money required to complete a project by many orders of magnitude. For projects which have been going on for a long time, several cost variations may be occasioned by this, which greatly increases the temptation to abandon them.

Causes of Project Abandonments of Public Buildings
There are allots of causes and reasons for contractors abandoning their sites.

Inadequate Funding or Bankruptcy: Public properties are abandoned where the contractor or whoever is constructing the project becomes bankrupt and has no means of raising money where government does not provide adequate funding and other fund.

Lack of Payment :Projects are abandoned due to lack of payment e.g. where there is no provision for mobilization fee and the contractor after reaching certain level demands for (part payment) valuation and he is not given, the site naturally becomes abandoned.

High Interest Rate: Another cause of abandonment is where the interest placed on the borrower is so high that the contractor or client will lose.

Inflation: Although there are clauses in the Bill of Quantities (BOQ) that takes care of possible inflation or fluctuation of prices, one finds that the inflation in Nigeria is higher than the approved rate in case of rising costs.

Improper Planning: Abandonment also happens if the clients, the contractor or developer does not plan his work and follow it judiciously e.g. he should have targets for each stage of work and should restrict himself to the projects only as some people are in the habit of borrowing money for specific projects and using it in other things e.g. buying a car, marriage, at or embarking money for other projects to other projects.

Political Reasons: Projects can be abandoned where there is political and social disorder especially after starting the projects.

Lack of Special Materials: Lack of materials, especially specialized materials or special skills that is not easily or readily available within or near the project location is another cause.

Delay in Payment: Projects can be abandoned where there is delay in granting the contractor loan or delay in releasing funds to him because even if he is given the money after long delay there will be inflation and the abandonment could cause extra amendments before continuing the project so it will be a loss.

Corruption
Some civil servants and money leading agents are in the habit of demanding huge sums before payment or granting the loan which will then make it impossible for the contractor client or developer to reach his target so, he will have no option but to abandon the works.

Bureaucracy
Administrative bureaucracy of passing file from this officer to another officer, usually taking long time and contractor waiting for the payment also cause abandonment of public projects.

METHODOLOGY
Research Design

The research design adopted for this study followed a pattern of both descriptive survey research and *ex post facto* research design. The research design refers to the overall strategy that you choose to integrate the different components of the study in coherent and logical way, thereby (Solomon, 2013). This study focuses on the assessment of causes and impacts of rework on public building construction project performance in Nigeria. Survey research design and *ex post facto* research design was deemed necessary by the researcher because of the nature of the research objectives.

Survey research provided the researcher with the accurate description of the respondents' opinion, and uses multi-variant statistics to analyze the data.

ANALYSES OF DATA

Table 1: Risk Factors Responsible for Public Building Projects Abandonment in Abuja FCT

S/No	Factors affecting labour productivity	SA 1	A 2	UD 3	D 4	SD 5	∑FX	INDEX	RANK
1	Lack of fund	25	28	30	40	52	175		
		25	56	90	160	260	591	3.37	1
2	Inconsistent government policies	27	30	35	43	40	175		
		27	60	105	172	200	564	3.22	2
3	Lack of accountabilities	29	31	37	44	34	175		
		29	62	111	176	170	548	3.13	3
4	High level of corruption	30	32	40	45	28	175		
		30	64	120	180	140	534	3.05	4
5	Incompetent contractors	32	34	43	48	18	175		
		32	68	129	192	90	511	2.92	5
6	Non availability of building materials	33	36	45	48	13	175		
		33	72	135	192	65	497	2.84	6
7	Lack of utilities	35	36	48	50	6	175		
		35	72	144	200	30	481	2.74	7
8	Wrong materials	37	37	49	50	2	175		
		37	74	147	200	10	468	2.67	8
9	Lack of infrastructural facilities	40	35	48	50	2	175		
		40	70	144	200	10	469	2.66	9
10	Poor planning	42	36	49	48		175		
		42	72	147	192		453	2.58	10
11	Undefined contracts	44	35	46	47	3	175		
		44	70	136	188	15	453	2.58	11
12	Inexperienced management	44	36	46	47	2	175		
		44	72	136	188	5	445	2.54	12
13	Political pressure	46	40	40	46	3	175		
		46	80	120	184	15	445	2.54	13

14	Unrealistic deadline	47	41	40	43	4	175		
		47	82	120	172	20	441	2.52	14
15	Ineffective change	49	40	40	40	6	175		
	control	49	80	120	160	30	439	2.50	15
	Grand Mean							**2.79**	

Table 1 above shows that the cumulative factors responsible for public project abandonment in Abuja FCT includes lack of fund, inconsistent government policies, lack of accountabilities, high level of corruption, incompetent contractors, non-availability of building materials, lack of utilities, wrong materials, lack of infrastructural facilities, poor planning and undefined contracts. The study further indicates that the highest ranking factor is the lack of fund and lowest ranking factor is the ineffective change control.

Analysis of the Second Research Question

Table 2: Effect of construction project abandonment in the Nigerian Construction Industry

S/N	EFFECT		SA-------------------			--SD	∑FX	$\bar{X}$	DECISION
		W	4	3	2	1			
1	It reveals the level of technical knowledge	F	80	65	15	10	175		ACCEPT
		WF	320	195	30	10	555	3.17	
2	It promotes corruption and embezzlement of public/private fund	F	85	60	13	17	175		ACCEPT
		WF	340	180	26	17	563	3.21	
3	Loss of asset utilization	F	79	58	18	20	175		ACCEPT
		WF	316	174	36	20	546	3.12	
4	Loss of finance	F	66	77	20	12	175		ACCEPT
		WF	264	231	40	12	547	3.12	
5	It discourages innovation	F	59	79	16	21	175		ACCEPT
		WF	236	237	32	21	526	3.00	
6	It encourages risk transfer	F	63	71	19	22	175		ACCEPT
		WF	252	213	38	22	525	3.00	
7	Grand Total							3.10	ACCEPT

From the study and shown in table 2, the mean value of all the identified factors are above 2.5 benchmark indicating that the challenges of construction project abandonment in the Nigerian construction industry includes it reveals the level of technical knowledge, it promotes corruption and embezzlement of public/private fund, loss of asset utilization, loss of finance, it discourages innovation and encourages risk transfer.

Discussion of the Results

The result of the research questions one indicates that the cumulative factors responsible for public project abandonment in Abuja FCT includes lack of fund, inconsistent government policies, lack of accountabilities, high level of corruption, incompetent contractors, non availability of building materials, lack of utilities, wrong materials, lack of infrastructural facilities, poor planning and undefined contracts. The study further indicates that the highest ranking factor is the lack of fund and lowest ranking factor is the ineffective change control.

In the second research question, the study reveals that the challenges of construction project abandonment in the Nigerian construction industry includes it reveals the level of technical knowledge, it promotes corruption and embezzlement of public/private fund, loss of asset utilization, loss of finance, it discourages innovation and encourages risk transfer.

Summary of key Findings

(5) The study reveals that the identified cumulative factors responsible for the cumulative factors responsible for public project abandonment in Abuja FCT includes lack of fund, inconsistent government policies, lack of accountabilities, high level of corruption, incompetent contractors, non-availability of building materials, lack of utilities, wrong materials, lack of infrastructural facilities, poor planning and undefined contracts. The study further indicates that the highest ranking factor is the lack of fund and lowest ranking factor is the ineffective change control.

(6) The identified challenges confronting construction project abandonment in the Nigerian construction industry includes technical knowledge, promoting corruption and embezzlement of public/private fund, loss of asset utilization, loss of finance, it discourages innovation and encourages risk transfer.

CONCLUSION

Based on the decision rule, which states that if the value of the t-statistics is greater than 0.05, from the result; the value of the t-statistics (0.035) is less than 0.05 hence we reject the null hypothesis and conclude that there is significant effect of value and risk management analysis in mitigating the cumulative factors responsible for public building project abandonment in Abuja FCT.

RECOMMENDATIONS

There is need for stakeholders in the building construction industries to assess the identified challenges of building construction that leads to project abandonment in the construction industries and enhances the stability of the sector for proper building management.

There is need to enforce to the applicability of the integrated value and risk management as a strategy for mitigating abandonment of construction project in Abuja.

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Strengthening Mortar by Using a Ternary Geopolymer Binder Made of Cassava Peel Ash, Metakaolin, and Rice Husk Ash

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Abstract

An alternative new ternary geopolymer mortar was developed to resolve a traditional mortar problem which exhibits several disadvantages, including poor strengths and surface microcracks and the CO_2 air pollution. The ternary binder was produced using Cassava peel ash (CPA), Metakaolin (MK), and Rice husk ash (RHA) activated with an alkaline mixture of sodium silicate (Na_2SiO_3) and 9 M NaOH in a mass ratio of 2.5. Five different mix proportions of CPA, MK, and RHA were used to fabricate the ternary geopolymer mortars (TGPM's). The water-to-binder ratio was 0.35. The mortars were heat cured for 24 h at 60℃ and then aged under room temperature. Mortar flow and compressive strength was tested. The results showed that the sample C70M20R10, which contained 70% CPA, 20% MK, and 10% RHA, exhibited high compressive strength (50.02 N/mm^2 and 54.74 N/mm^2) without any crack at 28 days and 56 days respectively, after being cured for 24 hours at 60°C; however, the C90M07R03 mortar with optimal strength of 55.32 N/mm^2 and 58.93N/mm^2 for 28 days and 56 days respectively, showed some surface cracks. This ternary binder will be useful from an environmental viewpoint, as it reduces the waste disposed in landfills and helps prevent global warming. Production of new geopolymer binder of mortar as alternative to traditional cement binder with high early and normal strength from low cost waste materials and earth explored materials, less potential of cracking, less energy consumption need and low carbon dioxide emission.

Keywords: Alkaline mixture, Cassava peel ash, Strength, Metakaolin, Rice husk ash Ternary geopolymer mortars,

1 Introduction

Many waste products are produced in the agricultural and industrial sectors, causing disposal issues as well as the most serious environmental threat, global warming. The cement industry is another energy-intensive business that contributes to the problem by emitting greenhouse gases such as carbon dioxide (Heath et al., 2014). As a result, several writers are focused on the use of agricultural and industrial waste products, as well as earth explored materials, as a substitute to ordinary Portland cement (OPC) to overcome problems like disposal and global warming for the sake of sustainable development. Waste products such as cassava peel ash, rice husk ash, bagasse ash, silica fume, fly ash, metakaolin, and others have been found to be beneficial in mortar and concrete applications; however, these wastes can only be used as a partial replacement for OPC and cannot completely replace it (Chalee *et al.*, 2013; Chalee *et al.*, 2010; Krammart & Tangtermsirikul, 2004). This as lead to the quest for geopolymer technology.

Cassava peel is produced at a rate of 6.8 million tonnes per year, with 12 million tonnes tageted in 2020. (Raheem *et al*., 2020). CPA fits the requirements for a pozzolana, according to studies, and meets the ASTM C618 (2020) criterion of a minimum of 70% for pozzolanas (Ofuyatan *et al*., 2018 & Ogunbode and Akanmu, 2012). Due to alkali activated materials and amorphous products, modern cement concrete binders are a very complex chemical material. However, modern geopolymer concrete is being investigated as an alternative to cement concrete, and geopolymer binders with improved strength are being produced using various alternative materials. Davidovits (1991) established the notion of geopolymers, which can be made by reacting silica and alumina with alkali-activating solutions.

The creation of strong alumina-silicate polymeric structures is caused by the reaction of silica with alumina, which is freed by hydroxides and silicates of sodium or potassium as the alkali-activating solution. The alkali-activating solution frequently requires additional heat to speed the dissolution process, which can improve the characteristics of geopolymers due to the delayed reactivity of the source materials (Kovalchuk *et al.*, 2007). The qualities of each source materials can be advantageously exploited in ternary binders, for example, through interactions between the ternary beginning components, resulting in better compressive strength, stability, and durability (Xu and Van Deventer 2002). This research aims to show that employing a ternary geopolymer binder (TGPMs) based on CPA, MK, and RHA instead of single or binary binders or Portland cement can improve the strength of geopolymer mortars.

2 Materials and Methods

2.1 Geopolymer Precursor - CPA, MK, and RHA

As stated previously, CPA, MK, and RHA were used as precursor to produce the ternary geopolymer binder in this study.

The CPA used in this study was gotten from dried Cassava peel calcinated at 750°C in an electrical furnace for 2 hours and it is Dark Ash in colour. The specific gravity of CPA is 2.3. The Cassava peel was collected as a waste material generated from cassava plant from Doko village in Lavun LGA of Niger state. Table 1 summarizes the chemical composition of CPA.

The MK sample used was produced in the laboratory by the calcination of earth explored kaolin, sourced from Alkaleri Local Government of Bauchi State, Nigeria. The calcination was performed at 750°C in an electrical furnace for 2 hour, yielding calcined kaolin clay or MK. The sample is grinded to 75 micrometers. MK has a distinctive off-white colour close to that of the parent kaolin. The appearance of kaolin has changed from pure white to floral whitish after dehydrocyclization process. The specific gravity of MK is 2.2 the chemical compositions of MK were determined using X-ray Fluorescence Spectroscopy (XRF). The XRF results revealed that the major constituents of MK are silicon oxide (SiO_2) and alumina oxide (Al_2O_3). Other components include ferric oxide (Fe_2O_3), calcium oxide, magnesium oxide, potassium oxide, etc. The typical chemical composition of MK is depicted in Table 1.

Table 1: Chemical compositions of CPA, MK and RHA (mass%).

Materials	SiO_2	Al_2O_3	CaO	SO_3	Fe2O3	Na2O	K2O	TiO2	MnO	MgO	LOI
MK	72.39	20.35	7.01	-	1.12	0.34	3.12	0.90	0.02	0.12	2.35
CPA	80.83	14.77	34.24	0.83	1.55	0.06	5.50	-	0.05	0.05	0.20
RHA	83.76	10.54	1.26	0.00	1.32	0.00	1.50	0.20	0.00	1.55	2.92

The Rice husk used was obtained from a local grain mill in Garatu village along Minna-Bida Road, Bosso LGA, in Niger State. The collected rice husk was then burnt in open air with a locally fabricated incinerator. The resulting RHA was dried and sieved to eliminate larger materials and to lessen the carbon content. A local milling device was used to ground the resulting burnt RHA particles to a size smaller than 150µm. Finally, the grounded ash was sieved with a 75µm sieve and particles passing through were used as the RHA for the experiment. Figure 1 presents the pictorial view of CPA, MK and RHA.

Figure 1: Sample of CPA, MK and RHA

Figure 2 illustrates the XRD patterns of CPA MK and RHA. The XRD pattern of CPA revealed a pronounced broad hump with diffraction peaks at 2α values in the range of 27-56°. Few sharp crystalline diffraction peaks indicates its dominant amorphous phase and crystalline phases of 111,220,330. The XRD pattern of MK and RHA demonstrates an outstanding crystalline phase material with obvious detectable quantities of kaolinites and silica.

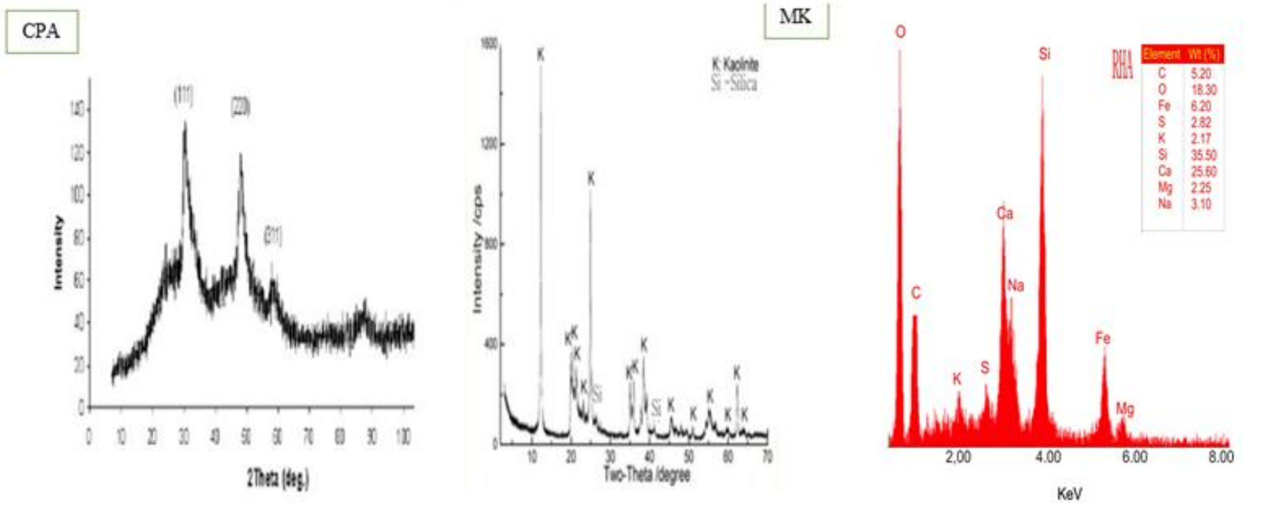

Figure 2: XRD of (a) CPA (b) Mk and (c) RHA

Figure 3 displays the SEM images of CPA MK and RHA used in this study. The surface morphology of CPA clearly revealed gelatinous appearance with irregular globular shaped particles as shown in Figure 3a, whereas MK and RHA manifested irregular pellet-like and angular particles arranged disorderly (Figure 3b&c).

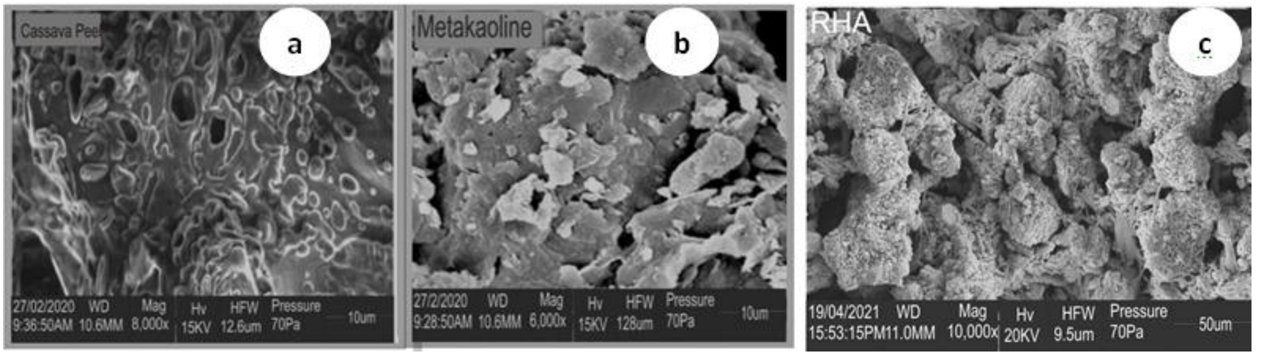

Figure 3: SEM of (a) CPA (b) MK and (c) RHA

2.2 Fine aggregate

Siliceous River Sand was used to prepare all mortar specimens. Finess modulus of the aggregate and specific gravity were discerned to be 2.6 and 2.4 respectively.

2.3. Alkali solution

Sodium hydroxide (NaOH) and sodium silicate (Na_2SiO_3) were obtained commercially. The NaOH pellets used had a purity of 99%. A Na_2SiO_3 solution with a silica ratio (Ms) of 2 was added to 9 M of NaOH, and the final mixture was used as the alkaline activator. Further, CEM II cement (42.5 N) of Dangote brand was used as the reference to compare the properties of the fresh and hardened mortar samples produced using the developed binder.

Moreover, natural river sand was used as the fine aggregates for the geopolymer mortar.

2.4 Design of mixing proportion of GPM's binder

The research investigated the varying composition of solid binder as independent variable on the engineering properties of ternary blend Alkali Activator mortar. The control variable of this research is the variation in binder composite, total five mortar samples were cast with increasing CPA content of 10 %, 30 %, 50 %, 70 % and 90 %. While the remaining contents was two-third of MK and one-third of SHA as shown in Table 2

Table 2: Mix proportion of Alkali Activator Mortar for optimum CPA content

Mix ID	CPA (%)	MK (%)	SHA (%)	W/B Ratio	FA	Na_2SiO_3	NaOH
C90M07R03	90	7	3	0.35	2.5	0.25	0.1
C70M20R10	70	20	10	0.35	2.5	0.25	0.1
C50M33R17	50	33	17	0.35	2.5	0.25	0.1
C30M47R2	3	4	2	0.3	2.	0.25	0.1

3	0	7	3	5	5		
C10M60R3 0	1 0	6 0	3 0	0.3 5	2. 5	0.25	0.1

2.5 Preparation of specimens

The solid binder (CPA, RHA & MK) was blended prior to mixing of mortar. Each material was weighted precisely according to the experimental program to ensure the accuracy of mixing proportion. After that, the blended binder was further mixed with fine aggregate (river sand). The mixing process was continued until the binder and sand were uniformly blended. Alkali activator and water was then added into the prepared binder to form the alkali actvated fresh mortar. Demoulding oil was coated on the steel moulds prior to the moulding process to ensure the ease of demoulding process of hardened specimens, in order to prevent any possible damage to occur on the specimens. Next, adequate compaction on the specimen during the moulding process until a smooth and leveled surface was achieved was done to minimize the presence of trapped air voids within the fresh mortar. The specimens were then placed for hardening process at room temperature for 24 hours (resting period). After that, all the hardened AAM's was demoulded on the next day, and cured in oven at 60^{o}C for 24 hours. Afterwards, the samples were cured in ambient temperature for the remaining curing days. The strength properties of specimens was tested at different ages of curing (3, 7, 28 and 56 days), in concomitant with the control and constant variable of the mortar mix as shown in Table 3.

Table 3: Control and constant variable of the mortar mix

Variable	
Constant Variable	**Control Variable**
Water/binder ratio: 0.35 Binder-Sand ratio: 1:2.5	**CPA Content** (10 %, 30 %, 50 %, 70 %, 90 %)
Alkali dosage: 0.35 Na_2SiO_3/ NaOH = 2.5 Curing method: Oven curing	

2.6 Experimental testing method

The flow table test was carried out to study the flow ability (BS EN 1015-3:1999) of readily mixed fresh AAM's. The strength properties of alkali-activated (CPA-MK-RHA) ternary blended AAM with varying replacement level of the solid binder was tested by compressive test (ASTM C109/C109M, 2020). The compressive strength properties of AAM was collected at day 7, 28 and 56 using 50 mm mortar cube specimen.

3. Results and Discussion

3.1 Flowability and setting time test

Throughout the experiment, the rapid setting of ternary-based GPM was noticed as shown in the Table 4. The fresh mortar began to set within five to twenty minutes (5-20 mins) right after thorough mixing for the C90M07R03 mix followed by C70M20R10, C50M33R17, C30M47R23 and C10M60R30 with the initial and final setting times of twenty and sixty minutes (20-60 mins), twenty-five and sixty-five minutes (25-65 mins), thirty and hundred minutes (30-100 mins), forty-five and one-twenty minutes (45-120 mins) respectively.

It was later discovered that the GPM had a very flash setting in comparison with the reference mortar (CGPM) having it initial and final setting times to be one and half hours and three hours respectively. Hence, the results also revealed that at a decrease in the CPA content then the setting time increases.

Furthermore, the result also showed a descending trend in the spreading width as observed with a decrease in the replacement levels of CPA. Higher CPA content exhibits higher workability and faster settings of the GPM. Hence, it was discovered that the RHA incorporation contributed to the reduction in the spreading width as a result of its hygroscopic nature and thereby accelerate the geopolymerization of the specimens This is similar to the of Gao *et al*., 2016. Lower spreading width achieved by increasing the replacement level of MK-RHA attributed to the content of CaO and thus accelerate the geopolymerization as its rapid reaction with alkali activator (Khan *et al*., 2016).

The initial flow table result for C90M7R3 was 220 mm as shown in plate 1 and table 4. However, the spreading width of the subsequent mixes were found to be slightly reducing from 220 mm to 210 mm, 200 mm, 190 mm, 150 mm and 140 mm for C70M20R10, C50M33R17, C30M47R23 and C10M60R30 respectively. This can be explained by rapid dissolution of CaO as reacted with the activator and on the other hand, the inclusion of the RHA prolong the setting times due to the slow rate of decomposition in RHA particles at ambient temperature (Wang *et al.,* 2015).

Table 0: Fresh Properties of ternary blended GPMs

Variables	Spreading Width (mm)	Setting time (min)	
		Initia	Final

		l	
PCM	220	90	180
C90M07R03	210	5	20
C70M20R10	200	20	60
C50M33R17	190	25	65
C30M47R23	150	30	100
C10M60R30	140	45	120

3.2 Compressive Strength Test.

Compressive strength of control mortar cubes and geopolymer cubes cured at 3, 7, 28, and 56 days were illustrated in Table 5, all the data have been averaged by three numbers of specimens among the different specimens. It was observed from Table 5 that the compressive strength increases as the curing period increases. From the table it is observed that geopolymer mortar has shown higher compressive strength than control specimens. The results showed that the sample C70M20R10, which contained 70% CPA, 20% MK, and 10% RHA, exhibited high compressive strength (50.02 N/mm^2 and 54.74 N/mm^2) without any crack at 28 days and 56 days respectively, after being cured for 24 hours at 60°C. However, the C90M07R03 mortar with optimal strength of 55.32 N/mm^2 and 58.93N/mm^2 for 28 days and 56 days respectively, showed some surface cracks.

Table 5: Compressive Strength Test

Mix ID	3 days	7 days	28 days	56 Days
PCM	9.00	24.00	42.07	44.55
C10M60R30	11.22	19.00	30.21	34.58
C30M47R23	15.90	32.10	41.16	43.62
C50M33R17	22.32	39.17	47.32	48.01
C70M20R10	36.43	43.23	50.02	54.74
C90M07R03	36.12	47.30	55.32	58.93

Refering to Table 5, an upward trend in the compressive strength was observed with the increase in replacement level of CPA. Highest compressive strength achieved was C90M07R03 of 58.93 N/mm^2 at 56 days. As the CPA contents increased from 10% to 90% at every 20% interval, the compressive strength thus increased by 26.60%, 13.02%, 5.34%, and 9.58%, respectively at 28 days. This can be explained by the addition of CPA content, which contributed higher rate of Ca^{2+} ions in the geopolymer matrix (Nath and Sarker, 2014). Hence, higher rate of geopolymerization in forming calcium-alumina-silicate-hydrate gel (C-A-S-H) with higher Ca/Si ratio (Soutsos *et al.*, 2016). Not only that, CPA dissolved high amount of Ca^{2+} and Al ions to the system, it allowed the substitution of Al into (C-S-H) chain, thus turning it into (C-A-S-H) matrix. Hence, it may lead to formation of complex matrix with crosslinking between the tobermorite chains (Salih et al., 2015).

The 7days compressive strength of C70M20R10 and C90M07R03 had achieved 84.29 and 83.04% of the 28 days strength. Higher initial strength development in C70M20R10 and C90M07R03 attributed to high reactivity of CPA as a calcium (Ca) bearing material accelerated the dissolution and hydration process of geopolymer at early stage (Nath and Kumar, 2013). In the contrary, the lowest initial strength was achieved to be 11.22 N/mm^2 at 3 days of C10M60R30 mix, with about 67.55% of its 56 days strength. Approximately 68.94% lower in 3 days compressive strength as in compared to C90M07R03. The synthesis of chemical composition in C10M60R30 was high in SiO_2/Al_2O_3 and low Ca/SiO_2 ratio attributed to abundant of Si in RHA. Silicon component tend to dissolve in slower rate as compared to Al component, resulting in gradual strength development (Ranjbar, Mehrali, Alengaram, *et al.*, 2014). Geopolymer with high SiO_2/Al_2O_3 ratio tends to prolong its final strength development to later stage, by condensation between silicates species due to different rate of dissolution with Al and Ca components (Yusuf *et al.*, 2014). However, C30M47R23 and C50M33R17 developed higher initial strength at 3 days with relatively high replacement level of PFA at ambient temperature can be explained by the two possible mechanism of geopolymer hydration reaction. Firstly, the high reactivity of CPA particles tend to accelerate the hydration process, thus separate hydration reaction from one another can be seen by formation of CPA matrix around the unreacted MK, which was much likely to be seen in C10M60R30 as shown in Table 5. Secondly, both of the binders" reactions had occurred simultaneously, whereby the reactions of GGBS particles have activated the fly ash at ambient temperature.

4. Conclusions

The following deductions can be drawn out of this study;

- The results revealed that the setting time prolonged as the replacement levels of RHA-MK increased at a decrease in replacement levels of CPA.
- Compressive strength test results indicated that alkali-activated ternary blended binder (CPA-MK-RHA) geopolymer mortars have shown superior performance to the control system (CEM II - portland cement mortar).
- By considering the good strength obtained from this investigation, alkali-activated ternary blended binder (CPA-MK-RHA) geopolymer mortars can be used as a substitute material for OPC.
- The use of NaOH in combination with Na_2SiO_3 improved the curing efficiency and resulted in accelerated curing. The strength of the ternary blended GP mortars was determined by the mixing proportion of the starting materials, their degrees of fineness, and the alkaline activators used. Mortar C70M20R10 and C90M07R03 exhibited high compressive strengths of 54.74 N/mm^2 and 58.93N/mm^2. Thus, the optimal mixing proportion for producing the TGPM's was determined to be 70% CPA, 20% MK, and 10% RHA (without cracks) and 90% CPA, 7% MK, and 3% RHA (with surface microcracks). However, further investigations must be performed to gain a better understanding of the formation of microcracks in the TGPM's that showed high strength.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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EFFECTIVE PUBLIC CONTRACTS MANAGEMENT AND PROJECTS DELIVERY-A CASE STUDY OF EBONYI STATE, NIGERIA, 2015-2020

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Abstract

"Effective Public Contracts Management and Projects Delivery-A Case Study of Ebonyi State, Nigeria, 2015-2020," assessed how Ebonyi State Government successfully managed and delivered 100 roads in the period under review. It has two research objectives and two questions and one null hypothesis. Survey research method was used. Population and sample size was 143 construction professionals in government and construction firms in Ebonyi State. Data were collected with the aid of structured questionnaire containing 12 items in two sections. Analysis of research questions were done with mean and standard deviation while the null hypothesis was tested using Chi-square statistic. Result of analysis was that contract planning and preparation were responsible for effective public contracts management and project delivery by Ebonyi State Government from 2015 to 2020 (χ^2 =14.92 at $P<0.05$) It was concluded that contract planning and preparation and contract management system helped Ebonyi State Government to deliver 100 road projects from 2015 to 2020.The study recommended that the state should continue to use them and that other states in Nigeria should adopt and use them.

Key Words: **Effective, Public Contracts, Contract Management, Projects Delivery**

1.0: INTRODUCTION

Background of the Study

Governments all over the world use contracts to create social infrastructures for sustainable development through the conception and execution of viable public projects. Thus, contracts are the building blocks used by governments to create productive assets that enable other sectors of the national economy to grow (Sunjka and Jacob, 2013). Poor public contract management and delivery leading to contract failures are global phenomena in developing and developed nations (Byaruhanga, 2014; Othoman, 2015; Othman, 2013; Shrestha, Burns and Shield, 2013). Abandonment and non-execution of public contracts such as construction of roads, housing projects, power supply stations, steel mills, hospitals abound in Nigeria at states and federal levels (Ejohwomu, Oshodi and Onifade, 2016; Agundu, Okwandu and Owuala, 2015; Owolabi, Amusan, Oloke, Olusanya, Tunji-Olayeni, Owolabi, Peter and Omuh, 2014; Olalusi and Otunola, 2012).

A contract is a written or oral binding agreement between parties identified in the agreement to fulfill certain conditions and terms outlined therein. When a contract has been signed and executed and it is being implemented, it could be called a project. The project must be properly managed to ensure successful execution and delivery. There are three types of projects-public sector projects, private sector projects and joint venture projects (Nagarajan, 2013). Public sector projects are projects owned by the state (local government, municipal, provincial, state, federal or central government). Public projects include construction of roads, markets, public buildings, dams, electricity or power plants and water schemes. This study focused on public projects especially on roads' projects executed by Ebonyi State Government in Nigeria from 29^{th} May, 2015 to 29^{th} May, 2020.

Ebonyi State was created on 1^{st} October, 1996 from the present Enugu and Abia States by the Federal Military Government of Nigeria to give the people a sense of belonging, self-identity and to become the architects of their destinies and socio-economic development. Aside roads, the first executive governor of the state from 29^{th} May, 1999 to 28^{th} May,2007 focused more on manpower development, socio-economic and financial empowerment of all sections of the state. The second executive governor from 29^{th} May, 2007 to 28^{th} May, 2015 focused on building bridges across Ebonyi Rivers in different parts of the state to ensure that every part of the state could be reached by car. He also built a new state secretariat, embarked on gigantic water and market development, power plant, building of modern rice mills, rehabilitation of state and missionary hospitals to bring affordable health care to the indigenes and others living in the state aside roads

The third and present executive governor of the state from 29^{th} May 2015 to date, His Excellency, Engr. Chief Dr. David Nweze Umahi (FNSE,FNATE), made road infrastructure his number one project priority. He developed roads evenly all over the state and has put Ebonyi State on national and global map of states with first class roads infrastructure. He has also brought an unprecedented dynamism to public project management and delivery in the state in particular and Nigeria in general by personally going out to inspect all road projects weekly rather than sit in his office to receive monitoring reports from government project supervisors. Ebonyi State Government under the present administration, has conceived, planned, managed and delivered over 100 road projects that cost N100billion (US$200million) between 29^{th} May,2015 and 29^{th} May, 2020 aside other projects. The number of road projects completed and delivered successfully during the period under review was 100 out of 104 road projects and the state under the governor has embarked on another 200 road projects throughout the entire state through direct labour (Iduma, 2020).The study would be of immense benefits to public projects executioners (local, municipal, provincial, states and the federal governments), private and joint projects' executors within and outside Nigeria, to learn strategies for effective public contract management and delivery of their projects. These were the justifications for the study on Effective Public Contracts Management and Project Delivery in Ebonyi State.

Statement of the Problem

Serious concern has been expressed by the members of the public about Ebonyi State Government's contracts that have failed from 1999 to 2014 such as Ebonyi World Trade Center at Presco Junction, Abakaliki and Ebonyi International Hotel at Ugwuachara; Oferekpe and Ukawu Water Schemes and Ebonyi Power Projects at Centenary City. All the failed or abandoned contracts gulped billions of naira. Failed contracts rob citizens of social amenities that should have been used in producing and providing goods and social services. They retard socio-economic development and without successful contract management, execution and delivery, development plans by Ebonyi State Government in particular and other states in Nigeria in general will be a mirage and no more than wishful thinking as the states and nation will continue to remain stagnant and retrogressive.

Consequently, if the problems of poor public contract management and projects delivery in Ebonyi State, Nigeria is not tackled or solved, the state will continue to lag behind other states in Nigeria in the areas of socio-economic development. Secondly, poor management of road contract projects will continue to hamper the movement of goods and services within the state, between the state and other states in south-east zone and other zones of the country. The state will be uncompetitive and may not be attractive to investors due to dearth of good road networks in all the nooks and crannies of the state. It means that unemployment and underemployment of the youths of the state will continue to grow until it will reach crisis stage that will precipitate social unrest. Also poor road contract implementation will lead to cost overruns or variations in contract sums which inevitably leads to higher contract costs for the state that is fourth among states with the least federal allocation in Nigeria. It is, therefore, against this background that the study examined "Effective Public Contracts Management and Project Delivery-A Case Study of Ebonyi State, Nigeria, 2015-2020".

Objectives of the Study

The main objective of the study is to determine effective public contracts management and project delivery in Ebonyi State, Nigeria from 2015 to 2020. The specific objectives are to:

i. Determine contract planning and preparation activities responsible for effective public contracts management and project delivery in Ebonyi State, Nigeria from 2015-2020; and

ii. Assess contract management system activities responsible for effective public contracts management and project delivery in Ebonyi State, Nigeria from 2015 to 2020.

Research Questions

The research questions that guided the study were:

1. What are the contract planning and preparation activities responsible for effective public contracts management and project delivery in Ebonyi State, Nigeria from 2015-2020?
2. What are the contract management system activities responsible for effective public contracts management and project delivery in Ebonyi State, Nigeria from 2015 to 2020?

Statement of Hypotheses

The null hypothesis that guided the study is:

Ho_1: Contract planning and preparation activities are not responsible for effective public contracts management and project delivery in Ebonyi State, Nigeria from 2015-2020.

2.0: LITERATURE REVIEW

Conceptual Review

Meaning of Contract

A contract is a written or orally binding agreement between parties identified in the agreement to fulfill certain terms and conditions outlined in the agreement. It is a legal agreement that is enforceable in law. A prerequisite requirement for the enforcement of a contract among other things is the condition that the parties to the contract accept the terms of the claimed contract (Nagarjan, 2013). A valid contract must be signed, executed and delivered. An executed contract is a legal document that has been signed off by the authorized representatives of the parties to make it effective. Execution involves the appending and witnessing of signatures of the right signatories to the contract document. After a contract has been signed and executed, no changes can be made to the contract language. A contract for the execution of a project can be called a project contract.

A public contract is one between the government, its agencies and a contractor/vendor for the execution of a public project such as road, bridge, airport, seaport, canal, water and power plant construction or for supply of goods and provision of services. In Nigeria, most of the public projects like road construction, building of airports, seaports, housing estates, higher institutions, office blocks, power and water projects, parks, markets, hospitals and industries to mention but a few owned by the State Governments and the Federal Government are usually executed through contracts. The contractor is the person, a firm or a company that undertakes the contract.

A contract is valid in law if it meets the essentials of a valid contract (Nagarajan, 2013): namely: Offer and Acceptance; There must be an intention to create a legal relationship between the parties to the contract; The consent of the parties to the contract shall be free and genuine; The parties to the contract must have legal capacity to contract. They must not be minors or lunatics; There must be lawful consideration between the parties to the contract; The object of the contract must be lawful and not the one the law disapproves or illegal; The contract must not have been declared as void by any law in force in the country; The meaning of the contract must be certain without any room for ambiguity or different interpretations; The terms of the contract must be capable of performance; The contract must fulfill the necessary legal formalities, that is, it must be in writing or oral.

Contract Management

Contract management is the application of management principles such as planning, organizing, staffing, controlling, co-ordination and other resources to road construction projects. The researchers define contract management as the application of processes, methods, knowledge, skills and experience to achieve the project objectives. It utilizes project management methodologies, aptitudes and information to control, arrange and execute a contract project by fulfilling all the requirements within deadline using the resources provided by the organization or government (Burke, 2013; Akash, 2016).

The successful completion of a road contract project depends on the skilful and proper management of the six phases or stages of a project by a competent project manager, namely: initiation, definition, design, development, implementation and follow-up. Some of the common problems that give rise to conflicts in a road contract or project management include: delay in getting site; insufficient equipment capacity; lack of construction materials; difficulty in communicating with the parties involved in the project; appointment of inexperienced contractors; inability to follow work programme; contractor not understanding the diagrammes properly; problem with suppliers; lack of qualified local labour; changes in contract documents and delays in getting approval from local authorities (Akash, 2016; Burke, 2013; Badwi, 2016 and Binder, 2016).

Poor contract management is one of the reasons for cost overruns and delay in project implementation. Contract management in a road project covers scope, quality, time, cost, risk, resources, change and communication (Akash, 2016; Binder, 2016). It is the duty of the project manager to manage these issues. Effective contract management, whether public or private sector contract, involves the presence of the following elements (Tracy,2015; Acharya *et al*,2014; Landrum *et al*,2014; and Alnasser *et al*,2013): Clearly defined project objectives or goals; Project plans/schedules; Competent project manager; Top management or EXCO support; Competent project team members; Sufficient resource allocation; Adequate communication channels; Control mechanisms; Monitoring and feedback capabilities; Responsiveness to client; Client consultation; Technical tasks-it must be managed by people who understand it and possess technical skills to perform their tasks; Trouble shooting; Clear responsibility and accountability of team members; and Client acceptance.

Project

A project is a one-time activity that produces a specific outcome, eg a road. It is synonymous with a signed and executed contract that is being implemented. The contract becomes a project at the stage of ongoing implementation. Project has been defined by Nagarajan (2013) as an organized programme of pre-determined group of activities that are non-routine in nature and that must be completed using the available resources within the given time limit. The Project Management Institute defines a project as a system involving coordination of a number of separate department entities throughout the organization and which must be completed within prescribed schedules and time constraints (PMI in Nagarajan, 2013). It can also be defined in terms of characteristics: a project has a defined beginning and end with specified time for completion; a specific preordained goal or set of goals; a series of complex or interrelated activities and a limited budget (Pinto and Slevin, 2012). It is a one-time activity that produces a specific output, example a house or road.

A project can be the construction of a building, a road, a dam, hospital, an airport, school, church or electricity generating plant to mention a few. Every project must have objectives, life cycle and definite time limit. Characteristics of projects are uniqueness, team work, complexity, risk and uncertainty. Poor project execution is a worldwide problem that has attracted the attention of construction professionals, researchers and academic scholars.

Problems of project completion have been examined by many experts and they have identified some of the causative factors. Ikediasio, Ogunlana and Alotaibi (2014) found that ineffective project planning and preparation, faulty appraisal and selection processes; defective project design, problems in start-up and activations were some of the causes of projects delays and non-completion. Other causes identified by them include project management deficiencies, poor risk analysis, lack of team commitment, unethical practices, government interference, stakeholders imposed constraints; financial and schedule challenges and user requirement.

Theoretical Review

This study was guided by the theory of complete contract. The Theory of Complete Contract was propounded by Oliver Williamson in 1975 (Hart, 2017). The theory states that contracts are always obligationally complete. This is because in order for the court to enforce the contract, it must conclude that the material terms are sufficiently complete so that the intents of the parties can be determined. In other words, everything that can ever happen in a contract is written into it. There are no unanticipated contingencies.

There are five basic assumptions of the theory, namely: 1) Every conceivable contractual arrangement between the contracting parties is allowed in the contract provided it is feasible given the relevant technological and information constraints. 2) The parties in the complete contract specify optimally, their rights and obligations in every future state of the world. 3) Contracts are always complete since either the court will fill any incomplete terms for the parties or the contract is unenforceable. 4) The parties never need to alter their obligations in the contract in the light of new information or the resolution of uncertainties because the original contract lays out the optimal set of obligations and rights in every future contingency. 5) Parties never renegotiate or breach the contract.

The theory related to the present study in the following ways: Ebonyi State Government and contractors usually signed and executed roads and bridges' construction contracts that contained all obligations and rights of the parties fully spelt out. The contracts usually had specific objectives, time limits for their executions, amounts and provisions for penalties for breach. The contracts were enforceable in courts within the specified jurisdictions and applicable laws.

Empirical Review

Planning and preparation are essential to contract or project success. Without planning, the contract will fail. Many researchers have carried out studies on the issue of planning and preparation that affect contract management and project delivery or execution in many countries and Nigeria. Some of these studies have been reviewed here.

Gitau (2015) carried out a study titled "The Effects of Risk Management at Project Planning Phase on Performance of Construction Projects in Rwanada." The study targeted architects, engineers, project managers, quantity surveyors, contractors and regulatory authorities in operation in Rwanda and key clients with major investments in the construction industry. The study used both qualitative and quantitative methods of data collection. Literature review, physical and email delivered copies of the questionnaire to respondents and structured interviews were used to collect data. The data were processed using SPSS and Correlation Analysis was used to analyze the relationships between the dependent and independent variables. The research result indicated that risk management practices at planning stage had an effect on project performance.

Hoseini (2015), conducted a study titled “Project Time Planning in Norwegian Construction Industry.” A survey design using questionnaire was conducted in partnership with Speed Up project using a sample size of 141. Sixty two (62) respondents or 44% was the response rate. Respondents were asked different questions about their background, project time planning personnel, project time planning tools and the relation between project time planning and project delay. The study concluded that poor time project planning has a harsher effect on delay in project execution phase and that the best phases to improve the project schedule is in the planning phase of the projects.

Brian, Lines, Kenneth, Kristen, Hurtado and John Savicky (2014), conducted a study titled “Planning in Construction: Longitudinal Study of Pre-Contract Planning Model Demonstrates Reduction in Project Cost and Schedule Growth,” in the United States of America. The aim of the study was to demonstrate that a brief yet rigorous project planning method, known as pre-contract planning model, will increase project team alignment and facilitate greater risk transfer from the owner to the contractor. Results from a multi-case longitudinal study showed that pre-contract planning model may be a viable planning mechanism to be implemented in the construction industry.

Othman (2013) conducted a study titled, “Challenges of Mega Construction Projects (MCP) in Developing Countries.” The country of study was Egypt. The major aim of study was to identify, validate and classify the challenges of delivering mega construction projects in developing countries. The study employed literature review and case studies as methods. The study collected data on available mega construction projects worldwide which was 348 projects, excluding non- construction projects such as information technology, military, science, oil and gas. The 36 mega construction projects (MCPs) in developing countries were grouped as follows: dams canals, hydroelectric and water infrastructure projects – 8; planned cities, stadia and urban renewal projects – 7; bridges and highway projects – 7; rail and rapid transit projects – 5 and airport projects – 9. The study found 45 challenges of developing mega construction projects in developing countries and was that poor project planning or lack of strategic project planning knowledge caused problems in project implementation and completion in developing countries. .

Idoro (2012), carried out a study titled “Evaluating Levels of Project Planning and their Effects on Performance in the Nigerian Construction Industry,” aimed at creating awareness of the levels and effectiveness of the planning done by public and private clients in the delivery of construction projects. A questionnaire survey administered to a sample of 130 clients selected by stratified random sampling from the population of public and private clients in the Nigerian construction industry was used and analysed using descriptive statistics, the student's t-test and Spearman Correlation test. The results showed that the level of preconstruction planning on private sector projects was higher than that of public sector projects while the level of contract planning done by the latter was higher than that of the former.

METHODS

The study used survey design. The area of study was Ebonyi State, in Southeast Region in Nigeria. The population of study was 143 building professionals made up of architects, builders, civil engineers and quantity surveyors working as civil servants and in construction firms in Ebonyi State. There was no sample size as the whole population was used. The instrument for data collection was a questionnaire structured on a five point Likert Type scale of Strongly Agree (SA), Agree (A), Undecided (UD), Strongly Disagree (SD) and Disagree (D).They were assigned weights of 5,4,3,2 and 1 respectively. It had two sections with 6 questions each. The research questions were analysed using mean and standard deviation while the null hypothesis was tested using Chi-square statistic. 143 copies of the questionnaire were distributed to the respondents but only 140copies were returned and used for analysis.

RESULTS

Contract planning and preparation activities responsible for effective public contracts management and project delivery by Ebonyi State Government of Nigeria, 2015-2020

Table 1 showed that there were six contract planning activities responsible for public contract management and project delivery by Ebonyi State Government in Nigeria from 2015-2020. These included the following: Ability of Ebonyi State Government to commit enough resources for feasibility studies; Appropriate project identification and preparation procedures within the state's ministry of works and transport; Adequate analysis of the absorptive capacity of the state governments' revenue to finance and execute specific projects by the State Ministry of Works and Transport simultaneously; Ebonyi State Governor initiates projects only after proper planning and preparation; Ebonyi State Governor awards contracts only after proper planning and preparation for the project and Ebonyi State Government starts road projects in a year only when there is capital outlay to fund them.

The mean ratings for construction professionals in government and those working in construction firms ranged from 3.92 to 4.47 with their standard deviation scores ranging from 0.26 to 0.32. Their grand mean score was 4.35 and greater than 3.50. Each item mean rating was also greater than 3.50, thus, meeting the criterion that civil servants and contractors agreed. Standard deviation value for each project planning activity was less than 0.5. The standard deviation values clustered around each mean value tightly, showing homogeneity in agreement. Construction professionals in government and contracting firms agreed that the above listed six planning activities were responsible for public contract management and project delivery by Ebonyi State Government of Nigeria from 2015 to 2020. In conclusion, this result answered the research question one in the affirmative that there were six contract planning and preparation activities responsible for public contract management and project delivery by Ebonyi State Government of Nigeria from 2015 to 2020.

Table 1: Contract planning and preparation activities responsible for effective public contracts management and project delivery by Ebonyi State Government from 2015-2020

Planning Activities		Construction Professionals		
S/N	Planning Activities	X	SD	Remark
1	Ability of Ebonyi State Government to commit enough resources for feasibility studies	4.47	0.32	Agreed
2	Appropriate project identification and preparation procedures within Ebonyi State Ministry of Works and Transport	4.37	0.31	Agreed
3	Adequate analysis of the absorptive capacity of Ebonyi State Government revenue to finance and execute specific road projects by the State Ministry of Works and Transport at the same time	4.34	0.30	Agreed
4	Ebonyi State Governor initiates projects only after proper planning and preparation	3.92	0.26	Agreed
5	Ebonyi State Governor awards road contracts only after proper planning and preparation for the project	4.29	0.30	Agreed
6	Ebonyi State Government starts many road projects in a year only when there is capital outlay to fund them	4.09	0.28	Agreed
	Grand Total	**25.48**	**1.77**	

	Grand Mean	**4.35**	**0.30**	**Agreed**

Source: Field Survey, 2022

Contract management system activities responsible for public contract management and project delivery by Ebonyi State Government, 2015-2020

Table 2 shows that there were six contract management activities responsible for public contract management and project delivery by Ebonyi State Government in Nigeria from 2015-2020. These included the following: Competent team members; EXCO Support; Sufficient resource allocation; Monitoring feedback capabilities; Technical tasks; and Adequate communication channels.

The mean ratings for construction professionals in government and those working in construction firms ranged from 3.82 to 4.07 with their standard deviation scores ranging from 0.21 to 0.23. Their grand mean score was 3.91 and greater than 3.50. Each item mean rating was also greater than 3.50, thus, meeting the criterion that construction professionals in government and contracting firms agreed. Standard deviation value for each project management activity was less than 0.5. The standard deviation values clustered around each mean value tightly, showing homogeneity in agreement. Construction professionals agreed that the above listed six contract management activities are responsible for public contract management and project delivery by Ebonyi State Government of Nigeria from 2015 to 2020. In conclusion, this result answered the second research question in the affirmative that there were six contract management activities responsible for public contract management and project delivery by Ebonyi State Government of Nigeria from 2015 to 2020.

Table 2: Contract management system activities responsible for public contract management and project delivery by Ebonyi State Government of Nigeria from 2015-2020

Effective Contract Management System Activities		Construction Professionals		
S/N	Effective Contract Management System Activities	X	SD	Remark
1	Competent team members	3.84	0.21	Agreed
2	EXCO Support	4.09	0.23	Agreed
3	Sufficient resource allocation	4.00	0.22	Agreed
4	Monitoring feedback capabilities	3.87	0.21	Agreed

5	Technical tasks	3.83	0.21	Agreed
6	Adequate communication channels	3.82	0.21	Agreed
	Grand Total	**23.45**	**1.29**	
	Grand Mean	**3.91**	**0.22**	**Agreed**

Source: Field Survey, 2022

Test of Hypothesis 1

$H0_1$: Contract planning and preparation activities were not responsible for public contract management and project delivery in Ebonyi State, Nigeria from 2015-2020

Table 3: Observed and Expected Frequency for Testing Hypothesis 1

Responses	Observed Frequency (O)	Expected Frequency (E)	O-E	$(O-E)^2$	$\sum \frac{(O-E)^2}{E}$
Agreed	115	70	45	2025	14.46
Disagreed	25	70	-45	2025	14.46
Total	140	140		χ^2	14.92

Source: Researcher's Compilation, 2022

***Decision**: Since Chi-square calculated value of 14.92 was greater than Chi-square table value of 11.070, we could not accept Ho (null hypothesis). Ho was rejected and Hi (alternative hypothesis) was accepted.*

***Conclusion**: It was concluded at 5% level of confidence and with 5 degrees of freedom that "Contract planning and preparation activities were responsible for public contact management and project delivery by Ebonyi State Government of Nigeria from 2015-2020." The result of the test was statistically significant. In other words, contract planning and* *preparation were responsible for public contract management and project delivery by Ebonyi State Government from 2015 to 2020.*

Discussion of Findings

Planning and preparation activities responsible for public contract management and project delivery

Test of Hypothesis found that "Planning and preparation activities were responsible for public contract management and project delivery in Ebonyi State from 2015 to 2020". This was the same finding in the analysis of research question where construction professionals in government and contracting firms agreed that planning and preparation activities were responsible for public contract management and project delivery in Ebonyi State, Nigeria from 2015 to 2020. The analysis of research question found six project planning and preparation activities that were responsible for public contract management and project delivery in Ebonyi State as follows: Ability of Ebonyi State Government to commit enough resources for feasibility studies; Appropriate project identification and preparation procedures within the state's ministry of works and transport; Adequate analysis of the absorptive capacity of the state governments' revenue to finance and execute specific projects by the State Ministry of Works and Transport simultaneously; Ebonyi State Governor initiates projects only after proper planning and preparation; Ebonyi State Governor awards contracts only after proper planning and preparation for the project and Ebonyi State Government starts road projects in a year only when there is capital outlay to fund them.

The implication of the finding was that project planning and preparation was one of the causes of contract/project success. A contract or project is adjudged to be a success or must have been successfully implemented, no matter the implementation challenges met, if it meets four criteria, namely: time criterion, monetary criterion, effectiveness criterion and client satisfaction criterion (Akash, 2016; Badwi, 2016; Barclay and Barclay, 2016; Binder, 2016 and Burke, 2013). In other words, a contract is successful if it is: completed on schedule thereby meeting time criterion; completed within approved budget, thereby meeting its monetary criterion; achieves basically all goals originally set for it, thereby meeting its effectiveness criterion; and it is accepted and used by the clients for whom the project is intended, thereby meeting its client satisfaction criterion. All the road projects conceived, planned, awarded, executed, managed and delivered by Ebonyi State Government between

29th May, 2015 and 29th May, 2020 met all the internationally accepted criteria for successful contract execution and project delivery.

The above result is consistent with the finding of the study by Egbe (2016), in Nigeria that project planning and engagement of project officers enhanced project performance. Kim, Lee, Part and Jeong and Lee (2016), found in their study, that there was synergy between project planning and project successes in South Korea. It is also consistent with the findings of Gitau (2015), in Rwanda, that risk management practices at planning stage had an effect on project performance. The finding of the study is also supported by the findings of study by Soziier and Spang (2014), in Germany that project planning enhances project success and that failure to plan leads to projects' failures. Finally, study by Othman (2013), in Egypt using case studies, found that lack of project planning caused problems in project implementation and completion in developing countries.

CONCLUSION

The findings of the study based on the objectives were: contract planning and preparation and contract management system were responsible for public contract management and project delivery by Ebonyi State Government from 2015 to 2020. The conclusion was that Ebonyi State Government delivered the road projects because it used contract planning and preparation; and contract management system. Based on the findings and conclusion of the study, it was recommended that Ebonyi State Government should continue to ensure that proper planning and preparation are done for all their projects before the signing of contracts with contractors and that other states in Nigeria should adopt the same method. They can do this by engaging external consultants to carry out feasibility studies to assess the viability and socio-economic benefits of the projects; projects must have state EXCO support and approval; they must commit enough funds for the execution of the projects through adequate budgetary provisions; contracts should not be awarded unless they have been properly planned for and many projects should not be started in a year without adequate capital outlay to fund them.

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IMPACT OF THERMAL STRESS IN FLEXIBLE PAVEMENT PERFORMANCE AND LIFE

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ABSTRACT

There is need to assess the impact of notable failed road pavement have on its growth and economic stability of the state. Most of the road in the state failed functionally, because of the stress concentration is derived from temperature variation resulted from high traffic volume, oxidation and chemical disintegration of aggregated non-crystalline solid viscous material to be vulnerable to raveling, cuttings, potholes and cracking, asphalt becomes soft and more viscous and thus it is more prone to raveling. The aim and objectives of this research is to critically analysis pavement failures in state roads and the factors responsible for it. While this study will help to create the awareness for state ministry of works on the need for pavement modernization and need for strategies which can be successfully applied to boost urban road modernization and maintenance development of the state roads. The research design comprised extensive literature. This was facilitating the measurement of variables on affected areas causing surface defects from rehabilitation and reconstruction of the respective road projects. The data collected was presented in tables and analyzed using correlation analysis, percentage and pie chat. The finding was established on the rate of oxidation and gradual disintegration in non-crystalline solid viscous materials keep increase by 1.04 and 1.50 respectively as resulted from potential climate changes scenarios, the values indicate strong and positive increases with daily temperature on pavement surface. The results indicate the need for proactive policy planning to avoid costly impacts later in the state urban roads.

Keynote: *Stress values, Stress severity effects and pavement life*

1.0 INTRODUCTION

1.1Background of the study

Pavement performance in km per square km area of developing country like Nigeria has low road density of 21 sq km, the justification for this is that pavements in Nigeria road usually constructed on weak small embankments and a little above the general ground level and acceleration lane of roads constructed with insufficient width to enable vehicles to accelerate to the design speed, virtually making the pavements not to hold its original shapes and have a tendency to develops functional failures that resulted into material stress, functional disability, tensile stress, material aging and loss of cohesion. This is the primarily responsible for thermal stress in flexible pavement.

Thermal stress in pavement is a symptom of functional failures in state pave roads and remains an endemic problem which has not been solved. The fact is atmospheric condition of a state varies by temperature change which disintegrate flexible pavement this is the reason for thermal stress. The implications for this includes material stiffness, tensile stress, material ageing and loss of cohesion

The stress concentration in state pave roads was inherited from many vehicles of all types in insufficient width in acceleration lane of difference magnitude occupying, passing in direction and in definite section of the road per unit time at any suitable period subjecting the paved area into stress and temperature variations. It encompass landscape to be littered with congestions, higher rate of accidents, higher fuel consumptions and high cost of arranging road maintenance works.

Most of the defects like cracks, potholes and ruts in the state paved roads are characterized by temperature variation in climate changes scenario all over the world or globally by World Bank Data 2010, which revealed temperature increase from 1.4 ^{0}C to 5.8 ^{0}C over the next 100years, if no action is taken globally to control it. It will definitely lead to progressive rise in temperature and rainfall (Teerefoe, et al 2015).

Asphalt mixtures are viscous elastic plastic materials, the strength and modulus of these materials clearly change under thermal stress resulted from temperature and rainfall. Thus, the choice of asphalt binder is closely related to the local temperature conditions to satisfy structural and functional requirements. For instance, at low temperature, asphalt becomes hard and the asphalt layers are exposed to thermal and fatigue cracking. On the contrary, at high temperatures resulted from high traffic volume, low speed produces thermal stress causing asphalt to be vulnerable to rutting and cracking, asphalt becomes soft and more viscous and thus it is more prone to rutting. The variation in temperature effect on pavement cannot be ignored. (Abu El-Maaty, 2012)

The variation in temperature directly influences dimensional changes in materials by stiffness of the asphalt layers, rutting failures and fatique which alters the stress, strain and deflection conditions through the pavement.

An estimated 53 urban roads in Aba and Umuahia, that will cost #1.05 trillion have failed, abandoned, deviated and deteriorating from providing access and mobility for transports, freight and emergency services which are vital to the state. Road pavement infrastructure is a long-lived investment and has design lives of 20 – 40years. Changes can alter dimensional change in materials, pavements foundation and the age of pavement (Abdel-Motaleb, 2007)

The aim and objectives of this research is to critically analysis pavement failures in state roads and the factors responsible for it. While this study will help to create the awareness for state ministry of works on the need for pavement modernization and need for strategies which can be successfully applied to boost urban road modernization and maintenance development and it is hoped that this research study such will help enrich the indigenous literature on the concept.

2.0 Conceptual Framework and Review of Related Literature

2.1 Conceptual Framework

2.1.2 Concept of Pavement Failures

Pavement performances depend on functional ability of structures, under applied loads, pavement conditions and environmental factors, such as asphalt mix temperature and moisture content in unbound materials (Flavio & Leadro, 2012). The temperature of an asphalt mix is a determining factor of its performances. Asphalt mix properties changes depended on temperature, hereby it response to traffic loads will also be different (Gang, Eric & Roger, 2007)

Abu El-Maaty (2017) highlighted on temperature change implications for flexible pavement performances and life in Egypt. It was analyzed and structured the stress concentration on temperature variations, improper choice of materials, respective proportions, excessive traffic loading (more or heavier loads than anticipated in design, environmental effects (temperature and moisture condition), aging of asphalt layer and among others. It allows information to be focus on the areas that is key for the development of the country for a large portion of transportation of goods and peoples. In Nigeria low road density, low intensity, temperature differences and maintenance culture lacks agreement with regard to non-conventional material and flow of vehicles

Jassal (2008) studied the development of potholes from cracks in flexible pavement in Motereal, Qusbec. The explained on the impacts of stress concentration that are produce from functional failures made up of both cohesion and internal friction. It maintained that functional failures in pavement are resulted from frost thawing, poor base, repetitive vehicle loading and temperature variation. Jassal (2008) plotted a set of graphs, which show stresses and deflection from various strengths of pavement materials. The study lack agreement with regard to moisture attacked, waste material, disposal around the paved area and high temperature.

Smith (2018) opined on rutting: causes, prevention and repairs in Callape. It was analyzed and explored the functional failures of pavement in Callape and listed five most important factors that negatively affect pavement as lack of compaction, insufficient pavement thickness and weak asphalt mixture (Walker, 2018). The study revealed that good construction practices can sustained and prevent rutting into future.

Mackiewicz (2018) revealed fatique cracking in road pavement at Poland. It explained the functional failures in pavement and derived from adequate interlayer bonding, concentration of repetitive tensile stresses, aging, hardening of asphalt intensify these cracks and inhomogeneous distribution of stress over strain begin to appear. The size of cracking in thin and thicker asphalt layers will allows in determining future methods of repair and reinforcement that will be carry out on the pavement.

Osorio (2015) said that the development of performance models and maintenance standards of urban pavements for network management in Chile. The study expresses the affect of stresses caused by traffic (axle group, loads, tire types & pressure), Environmental (moisture, radiation, temperature (maximum & minimum), freeze – thaw cycles), structure (variations in thickness & propertics), sub grade types & properties, layer thickness layer and types construction (timing, method & variance, quality) and maintenance (TAC, 2013 & Tigh et al 2007). It revealed pavement performance at a certain time of service life can be characterized and assessed in terms of particular distresses or a combined index that represents the pavement overall condition.

Vitanen (2011) highlighted on moisture and bio-deterioration risk of materials and structure in Finland. The stress concentration in pavement was analyzed and structured from water leakage, ambient temperature, natural ageing of material, exposure time and convection of damp air & moisture condensation. There are several factors involved with the bio-deterioration of materials and mathematic modeling was used to understand the complicated interaction of many factors. The numerical mould growth and decay development models are based on experimental results from several research projects.

Gorken (2009) revealed moisture penetration can cause stripping five different mechanisms such as loss of adhesion, poor materials, under inadequate control and traffic. The moisture penetration in pavement can cause detachment, displacement, spontaneous, emulsification, pore pressure and hydraulic scour.

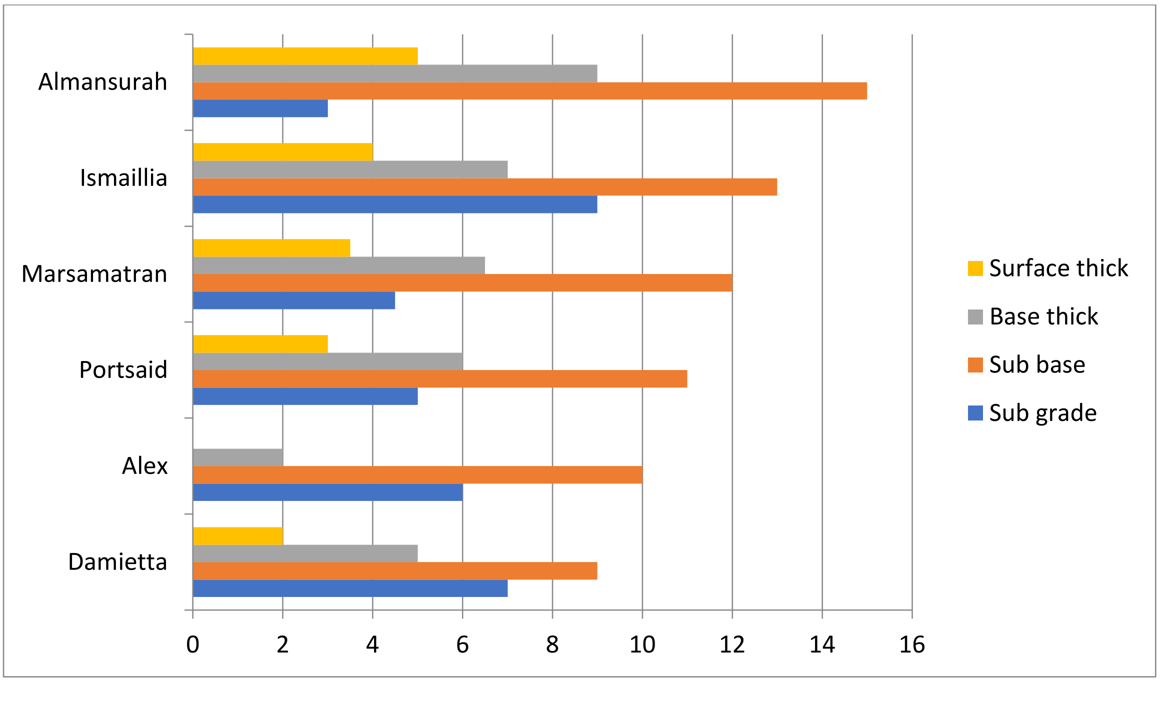
2.2 Theoretical Frame work

2.2.1 Pavement Models

Temperature variations in pavement

Abu Ei-Maaty (2017) asserts that temperature change implications for flexible pavement performance and life. It provides in details to explored change in temperature variation and how it affect functional behavioral failure of pavement in roads. It means that North Africa like Egypt will provide vital information to understand the alteration in stress can influence the stiffness of the underlying unbound layers since they generally show stress reliance. Due to these relations are nonlinear, the additional pavement life cost at higher than average temperature is not replaced by savings at lower than average temperature. Foe than, the deterioration amount are overvalues when average pavement temperature throughout the year in Egypt on performance and life of seven pavement sections with different stiffness using mechanistic –empirical method to investigate the most influential characteristics under temperature change for improving the design of pavement structures.

Section No	**1**	**2**	**3**	**4**	**5**	**6**
Surface Thick	2	2.5	3	3.5	4	5
Base Thick	5	5.5	6	6.5	7	9
Sub base Thickness	9	10	11	12	13	15
Sub grade Thickness	7	6	5	4.5	9	3



This account for the effects of temperature on flexible pavement behavior, the internal temperature of the asphalt layer must be known. The temperature can be measured directly by drilling holes into the pavement but the procedure is time – consuming and multiple holes are needed to capture the temperature gradient. The result show that variation temperature in Egypt predicted pavement damage ration and life as well as the changes in pavement performance measured in terms of stress, strain and deflection distributions of the pavement surface and through layers.

Cracks in Pavement

Jassal (2008) asserts that development of potholes from cracks in flexible pavements. It provides the details needed to information on depression on road pavement surface. The development of cracks and the formation of potholes on roads surface are widespread problem in road construction and maintenance. Public enlightenment is required to be provided on the deflection associated with the cracking and formation of the potholes. The pavement will have a concave or convex portion. The maximum support will reach saturation peak.

$$Y = f(X)$$
$$Y = k(X)$$
$$K = modulus\ of\ support$$
$$Y = intensity\ or\ force\ or\ Pressure$$
$$x = area\ or\ volume\ of\ support$$

Suppose an infinite small element is enclosed between vertical cross-section at a distance at a distance dx apart.

Let forces acting on the pavement are shown to be

$$Y = F(X)$$
$$\frac{dy}{dx} = \frac{Fdy}{dx} + dx + 1$$

Let Q = Shear forces
M = Bending moment

$$Q - (Q + dQ) + Bydx = o$$
$$\frac{dQ}{dX} = By$$
$$Q = \frac{dm}{dx}$$
$$\frac{dQ}{dX} = d2\ M\sqrt{dx} = By$$

Let E = Elastic modulus
I = Moment of inertia
$EI = d2\ y/dx2$ =M
EI d^2y/dx^2 =dm/dx

$$since\ Q = \frac{dm}{dx} from\ equation$$
$$EI\frac{d2y}{dx2} = \frac{dQ}{dx}$$

Putting equation together

$$EI\ d2\frac{y}{dx2} = -By$$
$$d2\frac{y}{dx2} + \frac{B}{EI}y = 0$$

Let EI = o
Substituting

$$d2\frac{y}{d}x4 + \frac{By}{D} = 0$$

Let x be constant from that

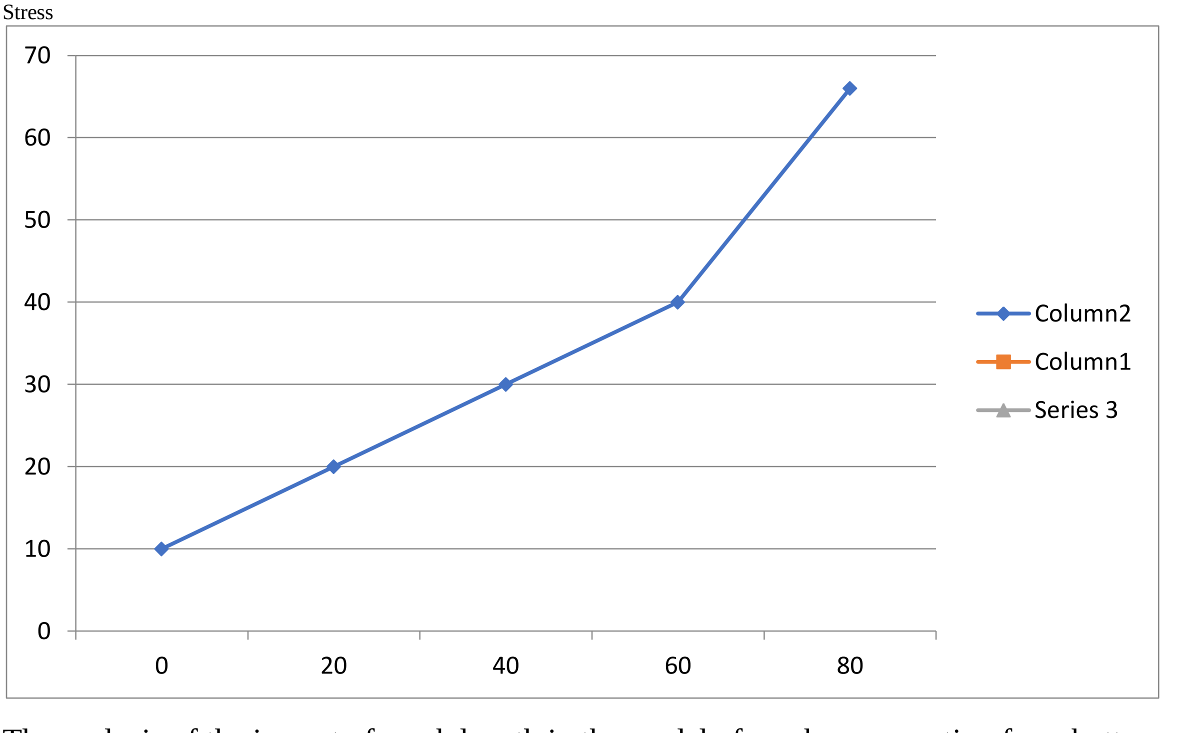
$$x2 = \frac{B}{4D}$$
$$X = \frac{\sqrt{B}}{4D}$$

Therefore equation $d4\frac{y}{d}x\ 4 + 4x4y4 = 0$

When wheel load passes on a transverse crack, it develops shear stress and deflection on the pavement surface. The repetition of wheel load produces shear stress and deflection on each application of wheel load. The edge of the cracks starts breaking up to form a layer new crack area. The widening of cracks area loads to the formation of potholes. Deflection of asphalt concrete layer, depends upon its thickness. The layer the thickness the lesser the deflection in the pavement. The strength of an asphalt pavement is directly proportional to the thickness. Strong pavement material produces less deflection as compared to weak material.

Fatigue Cracking in Pavement

Mackiewicz (2014) asserts fatique cracking in road pavement. It provides with the details on thickness of the pavement, its upper layers undergo varying degrees of fatique and bending. It requires vital information to understand the changes occurring under the influence of the load in different places of the pavement layer. Attention is paid to various values of longitudinal and transverse strains generated at the moment of passing the wheel on the pavement. It was found that the key element in the crack propagation analysis is the method of transferring the load of the pavement by the tire and the strain distribution in the pavement. During the passage of the wheel in the lower layers of the pavement, a complex stress state arises. Then vertical, horizontal and tangent stresses with various values appear. The numerical analysis carried out with the use of finite element method allowed to assess the strain and stress changes occurring in the process of cracking road pavement.



The analysis of the impact of crack length in the model of cracks propagating from bottom – up in the binding layer and top-down in the wear layer was carried out. For pavement the results of tensile stress calculation at the apex of the propagating crack from bottom to top is shown in fig 1.0 for a thicker pavement, there are almost ten times less stresses than for a thinner one. In the case of the thinner pavement above the crack with the length of 20mm, a significant increase in stress is observed. A similar analysis was carried out on the crack located on the edge of the wheel track, propagating from top to bottom. The value of stresses was analyzed at the tip of the crack.

2.3.1 Summary and Gap in Literature

S/n	Author(s)	Title of a Paper	Findings	Limitation
1	El-Maaty (2017)	Temperature Changes Implications for Flexible Pavement Performance Life	Temperature up to 50^{o}C, the fatigue life of pavement increases with increasing layer stiffness comparing at 23^{o}C a decrease with fatigue cracks	i). Differences in stress type and temperature ii). Type and time of available raw data iii). The result lack clearly detail expression on stress values, severity effects and pavement life iv). Weather and raveling of pavement
2.	Jaseal (2003)	Development of Potholes from cracks in Flexible Pavement	The research work deals with the formation of potholes stating from different types of cracks in flexible pavement	i). In Urban roads limited to atmospheric conditions and material disintegration ii). Differences in analytical expression of pavement iii). Time and type of data
3.	Mackiewicz (2014)	Fatigue Cracking in road pavement	Mechanism and size of cracking in thin and thicker asphalt layers allows to determine future methods of repairs and reinforcement of the pavement	i) Differences in stress density and vehicular types and volumes ii) Differences in methodology and analytical expression of data iii) The proposed critical values need to be verify
4	Viitanen (2011)	Moisture & Bio-deterioration risk of Materials and Structure	Experiment is been carried out on high material, sensitivities, surface treatment and different mould species	i). Affected by vehicular types weight and in-flows ii). Road density & Intensity iii). Different types of material and structure on flexible pavement

3.0 Research Methodologies

The research was done only based on measurement of ruttings, ravellings, potholes and alligator cracks on affected urban pave roads in Aba and Umuahia. The secondary data helped establish the theoretical background and research problems, aim and objectives and significance of the study. The secondary data sources used included journals articles and newspapers conference/workshop papers and proceedings

4.1 Presentation of data

i). Surface defects in Aba and Umuahia rehabilitations

To analyze the impact of thermal stress on the state road the research was carried out through measurement of surface defects. Below are the answers as deduced from the data.

Analysis of the Impact of Thermal Stress on the State Rehabilitation Roads

Table 4.1 identifies the surface defects on the state rehabilitation rating scale of stress values and severity effect on urban roads as ranges from **0 -3 low, 3 -6 medium and 6-9 high** in ravellings, ruttings, potholes and alligator cracks

S/n	Stress Names	Percentage (%)	Severity	Remark
1	Ravellings	3.36	High	
2	Ruttings	2.90	Medium	
3	Potholes	1.90	Low	
4	Alligator cracks	0.90	Low	

Field work of the researcher (2022)

Fig. 4.1

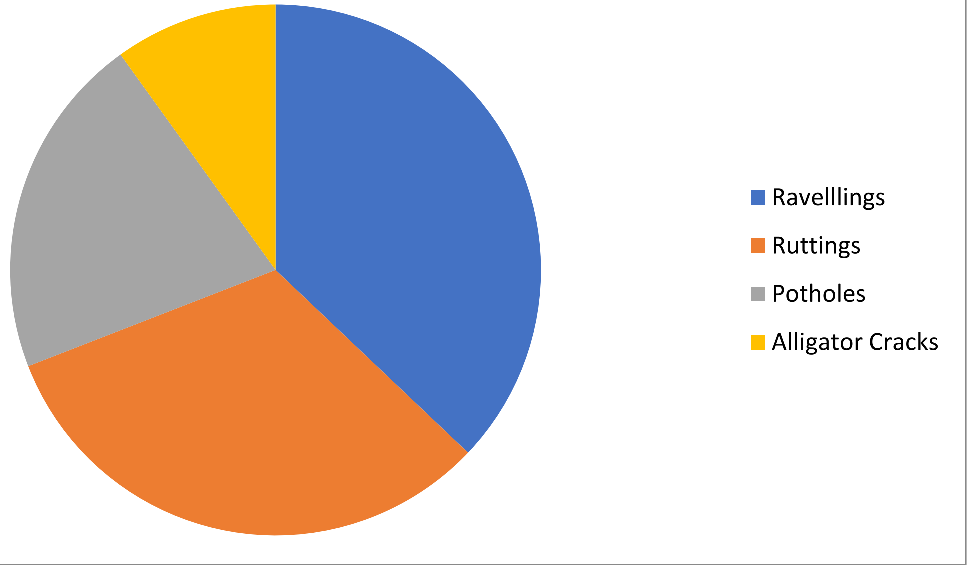


Figure 4.1 in the pie chart above discovered that alligator cracks and potholes with 0.90% and 1.90% low stress values and severity effects occupying the last in the stress value of the road pavement while ravellings and ruttings with 3.36% and 2.90% high and medium stress values and severity effects emerges as the highest rate of oxidation or chemical disintegration of non crystalline viscous aggregated material due to temperature variation

ii). Surface defects of Aba and Umuahia re-constructions

To analysis the impact of thermal stress on the state road the research was carried out through measurement of surface defects. Below are the answers as deduced from the data collected.

Analysis of the Impact of Thermal Stress on the State Re-constructions Roads

Table 4.2 identifies the surface defects on the state **re-construction** rating scale of stress values and severity effect on urban roads as ranges from **0 -4 low, 4 -8 medium and 8-13 high** in ravellings, ruttings, potholes and alligator cracks

S/n	Stress Names	Percentage (%)	Severity	Remark
1	Ravellings	12.39	High	
2	Ruttings	10.71	Medium	
3	Potholes	7.03	Low	
4	Alligator cracks	3.34	Low	

Field work of the researcher (2022)

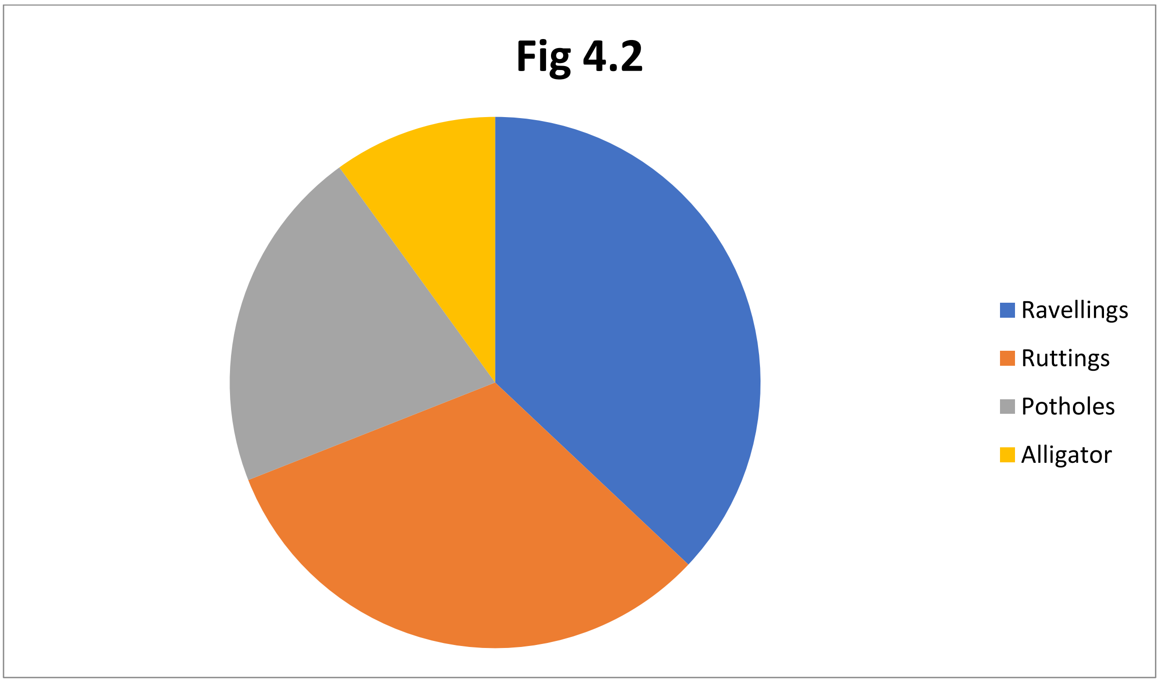


Figure 4.2 in the pie chart above discovered that alligator cracks with 3.34% and low stress value and severity effects occupying the last in the stress value of the road pavement while raveling, ruttings and potholes with 12.39%, 10.71% and 7.03% high and medium stress values and severity effects emerges as the highest rate of oxidation or chemical disintegration of non crystalline viscous aggregated material due to temperature variation

4.2 Presentation of Results

In the table below, illustrate the data obtained from rehabilitation and reconstruction of Aba and Umuahia pavement in roads that affected with stress varying occurrence in kilometer. From the below table 4.30 and 4.4 when the data are plotted such that all the points fall into a straight line, then there is ***a perfect relationship*** between the two variables under consideration. See fig 4.3 and 4.4 respectively. When there is perfect relationship, the correction coefficient is minus/plus one $-^{+}$ (1).

When the relationship is positive, the variable Y increases (decreases) as X increases (decreases). When it is negative, Y increases as X decreases and vice verse. When there is no relationship, the correlation coefficient is zero. From the above explanation, the value of the correlation coefficient ranges from -1 to 1 i.e (-1 <Y<1)

The nearer the value of P is to $-^{+}$ 1, the higher (or stronger) the degree of association and predictions could be made with confidence. But the lower the value of P, the weaker the degree or extent of association and prediction is practically worthless.

i). Rehabilitation and Reconstruction of Aba and Umuahia urban roads

In fig. 4.3 and fig 4.4 below the scattered randomly and variations increased by time in Aba and Umuahia pave roads. Therefore, the relationship is a strong and positive relationship between the stress and pavement design life

Fig. 4.3

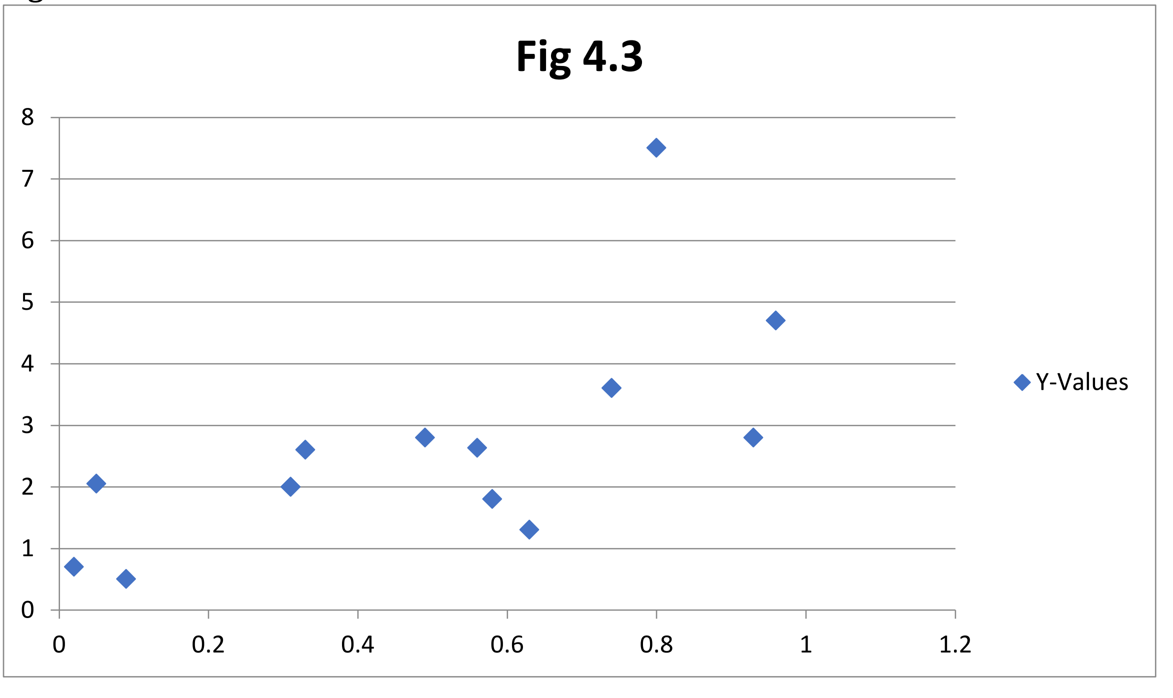
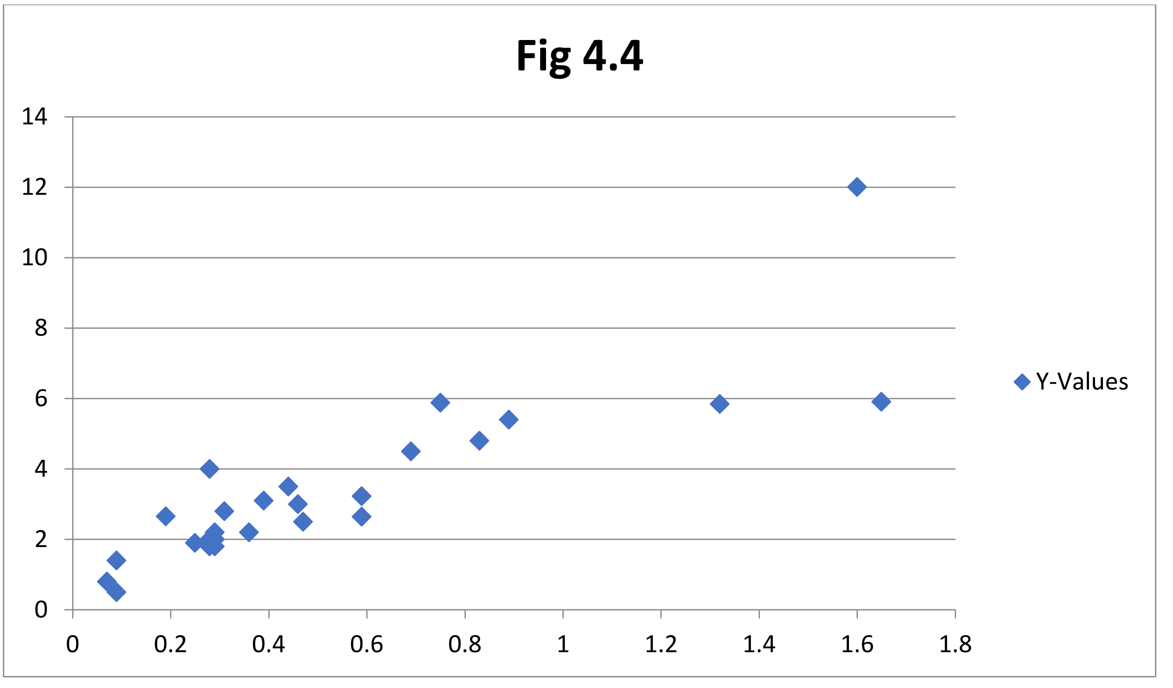


Fig. 4.2



The above illustration show from the fig. 4.3 and fig. 4.4 in a scatter plots represents ravelings, ruttings, potholes and alligator of pavement surface are such that they approximate to a straight line, which means the correlation is said to be linear. It was no doubt that surface defects resulted from temperature variations in road pavement was linear to functional failures in Umuahia and Aba pave urban roads. The value of $\beta = 1.04$ in rehabilitation and $\beta = 1.50$ in re-construction indicate that there is very strong and positive relationship. Therefore, the rate of failures by surface defects in road pavement life, the internal dimension of the non-crystalline solid viscous aggregate were dislodge or disintegrate at 1.04 and 1.5 in loosening of total mass

Table 4.3 and 4.4 illustrate the stress and strain respectively on the pavement surface of Aba and Umuahia urban roads under thermal stress as a result of temperature **33^{o} C** cause dimensional changes in non-crystalline solid viscous material of pavement surface. It is clearly noted that the surface deflection under stress gradually disintegrate on the binding aggregate particles by 1.04 and 1.5 increase respectively. Which means the rate of disintegration (thinner potholes, rutting failures, ravellings and alligator cracks) varies with resistance of some high elasticity or adhesiveness of bitumen materials in pavement section. The effects of deterioration can be minimized or slowed down by taking the corrective actions at appropriate time and adequate allocation of financial resources that hamper maintenance.

The analysis of urban road in table 4.3 and 4.4 from Aba and Umuahia shows the exposed in non-crystalline solid viscous material to weathering cause by removal of binding aggregate particle materials by leaving the aggregate in loose state. Loss in aggregate is the cause of forming pot holes while higher binding viscosity aggregates resist in compactive effort. Removal of material is called raveling. Many materials deteriorate and oxidized due to their exposure to continuous cycles of weather changes hence materials should be tested

The numerical summary reveal that pavement stress values under study shows variation in distribution. Because of the atmospheric condition in pavement surface caused dimensional change on non-crystalline solid viscous materials in pavement surface. The surfacing aggregate becomes inadequate to performed desirable function. Binding materials was chemically decomposed by action of weather not be able to be adhesion and durable to withstand the adverse action. The fig 4.3 and 4.4 show the relationship of stress for maximum over strain in the representative time frame of era was represented.

Insufficient thickness of pavement or base or improper construction results in serious damages very soon, which entails expensive repair and maintenance. Aba and Umuahia where narrow lanes or small roadway width force with heavy traffic on acceleration lane, increase in the intensity of traffic and inadequate thickness of pavement will results to lose of total mass. The acceleration lanes maintenance becomes a serious problem

4.3 Pavement life and damage under thermal stress

To evaluate the fatique live of pavement which was tensile damage under by surface defects caused by dimensional changes on non-crystalline solid viscous material which have exceed the strength of some material results in rupture and failures. This has solved the problem of inaccurate estimation of potholes, ravellings, alligator cracks and rutting failures by adopting a single fixed maintenance, methodology and innovations to avert the situation. It can be concluded that thermal stress is as a result of high temperature variation which provides higher tensile stress to desist fatique life of pavement; therefore increase in layers is more influential characteristics.

Pavement design life period has been estimated based on mechanistic-empirical method. After that the life period of design pavement life decreases dramatically with thermal stress generated from rut failures, ravellings, alligator cracks and potholes in urban roads. As a matter of fact design pavement life in urban roads at Aba and Umuahia is slightly decrease by 1.04 and 1.50 daily

Pavement design lives decreases as result of number of load repetitions required to cause potholes, rutting failures, alligator cracks with temperature variation. Unless adequate and timely maintenance will be adopt to increase the pavement fatigue life. This result establish the importance of pavement timely maintenance

Sub-grade which formed the integral part of a road pavement structure as it provides the support to the pavement from beneath. Therefore this soil should possess sufficient strength and stability under adverse weathering and loading condition.

5.1 Conclusion and Recommendation

The analysis presented in this study indicates potential impacts of surface defects on urban road pavement. The results indicate the need for proactive policy planning to avoid costly impacts later in the state. The outcomes are projected under dimensional increase in non-crystalline solid viscous materials as resulted from potential climate changes scenario. The following conclusion is drawn

Pavement performance was significantly affected by the stress, which dimensionally changed or deflected or disintegrated the non-crystalline solid viscous materials surface. As expected, the predicted deflection on pavement surface keep increasing by 1.04 and 1.5 on daily bases

Increasing of ruttings, alligator cracks, ravellings and potholes was more effective characteristics on layers thickness by reducing the surface of pavement under stress

Pavement design life is most significant in the predicting pavement deterioration because it is common factors in the estimation of stress over the lifecycle period

The pavement design life was governed by stress. The damage effect increased gradually by 1.04 and 1.50 on daily bases. Therefore the damage effect decreased with increasing layers thickness.

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APPENDIX

Table 4.0 Rehabilitation

S/n	**Rehabilitation**	**Y=responsive (length in Km)**	**X=predictor (Surface defects)**	**XY**	**Y^2**	**X^2**
1	Aba	0.5	0.09	0.05	0.25	0.008
2	Umuahia	2.8	0.49	1.38	7.84	0.24
3	Umuahia	2.8	0.93	2.60	7.84	0.86
4	Umuahia	2.63	0.56	1.48	6.91	0.31
5	Aba	1.8	0.56	1.48	6.91	0.31
6	Umuahia	2.60	0.33	0.86	6.91	0.33
7	Umuahia	2.05	0.05	0.11	4.20	0.0025
8	Umuahia	7.5	0.80	6.00	56.25	0.64
9	Umuahia	2	0.31	0.62	4	0.096
10	Umuahia	2	0.30	0.60	4	0.09
11	Umuahia	19.9	2.29	45.58	396	5.24
12	Umuahia	1.3	0.64	0.84	1.69	0.40
13	Umuahia	0.7	0.02	0.02	0.49	0.0004
14	Umuahia	3.6	0.74	2.67	12.96	0.54
15	Umuahia	4.7	0.96	4.52	22.09	0.92
	TOTAL	$\sum Y$ =56.88	$\sum X$=9.09	$\sum XY$=68.38	$\sum Y^2$=534.52	$\sum X^2$=9.74

Source: Field Survey (2022)

$\beta = n\sum xy - \sum x \sum y \div \sqrt{(n\sum x2 - \sum(x)2(n\sum y2 - (\sum y)2}$ ………………...eq 1

Substitute the variables

$$15(68) - (9)(57) \div \sqrt{15(10)} - (10)2\,\{15(534) - (57)2$$

1020 – 513 ÷ √(150 -100) (8010 – 3249)

507 ÷ √(50) (4761)

507 ÷ √238,050

507 ÷ 488 = 1.04

Table 4.1 Re-construction

S/n	Re-Construction	Y=responsive(length in KM)	X=predictor(Surface defects)	XY	Y^2	X^2
1	Umuahia	5.88	0.75	4.41	34.6	0.56
2	Aba	1.80	0.28	0.51	3.24	0.07
3	Aba	36	1.80	64.80	1296	3.24
4	Umuahia	1.4	0.09	0.13	1.96	0.01
5	Umuahia	36	4.16	149.76	1296	17.3
6	Umuahia	3.5	0.44	1.44	12.25	0.20
7	Umuahia	3.22	0.59	1.90	10.37	0.35
8	Umuahia	4	0.28	1.12	16.00	0.09
9	Umuahia	1.8	0.29	0.53	3.24	0.09
10	Umuahia	3	0.46	1.38	9.00	0.22
11	Umuahia	3.1	0.39	1.20	9.61	0.16
12	Umuahia	0.8	0.07	0.056	0.64	0.01
13	Umuahia	2.8	0.31	0.86	7.84	0.10
14	Umuahia	2.65	0.19	0.50	7.03	0.04
15	Aba	4.8	0.83	3.98	23.04	0.69
16	Aba	5.40	0.89	4.80	29.16	0.80
17	Aba	2	0.28	0.56	4.00	0.08
18	Aba	2	0.29	0.58	4.00	0.09
19	Aba	10.9	1.78	19.40	118.8	3.17
20	Aba	9.8	1.88	18.42	96.04	3.54
21	Aba	2	0.28	0.56	4.00	0.08
22	Aba	2	0.29	0.58	4.00	0.09
23	Umuahia	1.9	0.25	0.47	3.60	0.07
24	Aba	5.84	1.32	7.70	34.11	1.75
25	Aba	65	6.5	422.5	4225	42.2
26	Aba	2.50	0.47	1.17	6.25	0.22
27	Ukwa west	5.9	1.65	9.73	34.81	2.73
28	Umuahia	12	1.6	19.2	144	2.56
29	Aba	4.5	0.69	3.10	20.25	0.48
30	Aba	2.64	0.59	1.55	6.97	0.35
31	Aba	2.2	0.36	0.79	4.84	0.13
32	Aba	2.2	0.29	0.63	4.84	0.09
33	Aba	0.5	0.09	0.04	0.25	0.01
34	Aba	36	5.6	201.6	1296	31.36
	TOTAL	$\sum Y$ =286.03	$\sum X$=33.49	$\sum XY$=945.9	$\sum Y^2$=4969.2	$\sum X^2$=110.36

Source: Field Survey (2022)

$\beta = n\sum xy - \sum x \sum y \div \sqrt{(n}\sum x2 - \sum(x)2(n\sum y2 - (\sum y)2$ ………………...eq 2

34(946) – (33) (286) ÷√34(110) – (33)2 {34(4969 – (286)2

32164 – 9438 ÷ √(3740 – 1089) (168,946 – 81,796)

$22,726 \div \sqrt{(2651)\ (87150)}$

$22,726 \div \sqrt{231,034,650}$

$22,726 \div 15,200 = 1.50$

ASSESSMENT OF SAFETY TRAINING PRACTICES ON CONSTRUCTION WORKERS PERFORMANCE IN SELECTED BUILDING CONSTRUCTION SITES IN ENUGU STATE UNIVERSITY OF SCIENCE AND TECHNOLOGY

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Abstract

The seminar paper focused on the effect of safety training practices and workers performance on building construction project at Enugu State University of Science and Technology. The specific objectives achieved were; to ascertain how safety training affects workers performance on construction sites. The research work adopted a descriptive research design. The data for the study consist of primary data which was sourced directly from the respondent via structured questionnaire. The study adopted correlational design, the sample size of 223 which includes the senior level manager, (Consultants Architect, Structural Engineer, Quantity surveyor, Mechanical Engineer and the Electrical Engineer. middle level manager, (Site Engineer, Project Engineer, Safety Engineer and the foreman). Junior level manager,(all mechanical operators and trade foreman were used),Data obtained based on snowball and random sampling techniques were analyzed through Statistical Package for Social Sciences (SPSS) version 21. The findings of the study concluded that. The firm should on a consistent basis train their workers. This will aid them to take abreast of the changes coming from the environs with respect to the provision of safety wears and alike to protect individual workers against environmental health hazards that may arise in the course of construction activities in the site.

KEYWORDS: Safety training practices, construction workers performance, building construction sites, ESUT

INTRODUCTION

Background of the Study

The construction industry world over, is however considered as one of the most hazardous industry. The international Training Centre of the International Labour Organization (2011) claims that one in six fatal accidents at work occur on a construction site. It further stated that no less than 60,000 fatal accidents occur on construction sites around the world in every year.

Similar conclusions were made by Keller and Keller (2009) and Injuries Board (2009). The construction industry is where craftsmen and other workers can easily get hurt in the process of carrying out their duties. For that matter, it is important to have control on risk and safety of projects to ensure the construction cost and efficiency is within the budget. Risks arise from uncertainty and are generally interpreted as factors which have an adverse effect on the achievement of the project objectives (Smith, 2002). Cook and William (2004) noted that construction is undeniably a risk business for many reasons; one of which include poor record of cost and time certainty.

Nigeria, being the most populous country in Africa and also the largest economy in Africa (World Bank, 2016), its construction industry plays an important role in the nation's economy. In 2012 the sector's contribution to national gross domestic product stood at 3.05% and in that same year the sector employed circa 6.9 million workers (National Bureau of Statistics, 2015). In spite of the socio-economic significance of the construction sector, it has an enviable reputation in terms of occupational health and safety. Accident and injury rates in developing countries like Nigeria are generally considered to be higher than in the developed countries (see Hämäläinen et al., 2009). This has been attributed to a lack of appropriate consideration of H&S management measures or practices in construction project delivery process (Belel and Mahmud, 2012). Despite being a party to the Geneva Occupational Safety and Health Convention 1981, Nigeria continues to lag behind in the implementation occupational H&S practices (Adeogun and Okafor, 2013). According to Idoro (2011) contractors with the best safety records in Nigeria still record substantially high numbers of injuries on their sites. A survey of 42 Nigerian contractors revealed such poor performance with rates such as 5 injuries per worker and 2 accidents per 100 workers even among some of the best performing firms (Idoro, 2011). According to Ezenwa (2001) these figures are often even worse in practice as a result of a culture of under-reporting and concealment. Other studies have further highlighted a high prevalence of non-compliance with safety regulations that require organizations to report accidents (Diugwu et al. 2012).

Statement of the Problem

Studies that have investigated the direct association between workers training and accident rate (Bell & Grushecky, 2006; Dong et al., 2004; Johnson & Ruppe, 2001; Kinn et al., 2000; Spangenberg et al., 2003) showed a real reduction in the latter as a result of the attendance. Only Bell and Grushecky (2006) found no difference in the number of injuries (calculated based n the number of compensation requests made to employers following an injury) before and after a training program due to the high turnover among workers, which may have annulled the beneficial effects of the training.

Unsafe practices have been pronounced among the workers performance on construction sites. Clark (2006) reported that failure to adhere with the required safety procedures and as well take precautions against hazards such as wearing safety wears are common on project sites. Awwad, et al., (2016) added that safety practices lack necessary implementation due to absence of proper monitoring system, low level of safety awareness and inadequate support from safety managers,. Che Hassan, Basha, Wan Hanafi (2007) and Shamsuddin et al., (2015) argue that workers' knowledge and understanding of safety at work setting remained vita in promoting safety among themselves on construction site.

Objectives of the Study

The broad objective is to examine the relationship between safety management practices and worker's operation performance in the selected building construction sites in Enugu State University of Science and Technology (ESUT). The specific objective is to ascertain the extent to how safety training affects workers performance on construction sites in ESUT

Research Questions

The research question is designed to address the objective of this study

How safety training does affect workers performance on construction sites in ESUT?

Statement of the Hypotheses

The hypotheses are designed in null format to guide the study effectively.

H_{02}: There is no significant relationship between safety training and workers performance on construction sites in ESUT.

Implications of the study

In bid to determine the outcome of the various projects executed, construction operatives play very significant roles. The significance of this paper is to examine the role of safety training as a mediator in the relationship to construction workers performance (i.e. safety training, ,) and safety compliance.

Therefore, this study when concluded will be addition to past researchers' effort in addressing safety training practices during the execution of construction projects in Enugu State and as well will provide lasting solutions to the challenges confronting compliance with safety training practices in building production process to furtherance get the best out of workers. It will also provide further suggestion and solutions to construction stakeholders on measures to upgrade safety training practices on construction projects.

Scope of the Study

There are several large scales to medium scale construction companies in Enugu State, engaged in infrastructural works in the State, especially in university environment, whence six (6) construction firms were selected for this study, LIVE ENTERPRISE NIG. LTD., UGOLANSON NIG. LTD., BONEZ CONSTRUCT LTD., GIANT COVENANT LTD., HALCON ENGINEERING LTD., U.Y.K NIG. LTD. This study shall focus on these firms' safety management practice (safety application, safety measures and safety wears) as it relates to employee work performance.

Limitation of the Study

Because of time constant this work is limited to (6) construction firms were selected for this study, Live Enterpise Nig. Ltd., Ugolanson Nig. Ltd., Bonez Construct Ltd., Giant Covenant Ltd., Halcon Engineering Ltd., u.y.k Nig. Ltd. This study shall focus on these firms.

REVIEW OF RELATED LITERATURE

Concept of Safety Training

Workplace safety training is as vital as workplace safety itself. It enables the management to ensure a safety hazards and healthy work environment. It also helps the employees to recognize safety hazards and correct them. It enables them to understand best safety practices and expectations.

Neale (2013) opined that adequate training of students on occupational safety and health via cognitive education will go a long way in helping stakeholders improve the level safety awareness. In a bid to improve occupational safety and health, Kolawole (2014) assessed safety measures on building sites: a case study of Minna, north central Nigeria. The study found out that site workers embraced safety training as this enhances their performance and reduces accidents on site. In agreement, Okolie and Okoye (2012) studied building construction workers' health and safety knowledge and compliance on site in Anambra State, Nigeria. Hughes 2010; and Abdullah and Wern (2011) opined that the role of academia in creating necessary awareness, knowledge, skills and values in construction students during their training is vital in developing safety culture. Hughes (2010) stressed that a paradigm shift in thinking, values addition and change of believes will boost healthy and environmentally sustainable society. According to Stephens, Hernanadez, Roman, Graham and Scholz (2008) assertion about the construction programs being a core of any nation's economy development. However, improper handling of safety education as part of the students training will forfeit the objectives of building a safe construction industry.

Workers Involvement in Safety

In understanding and defining operational health and safety competency on construction sites involving workers, Dingsdag, Biggs and Sheahan (2007) assessed the feelings, skills, behaviors and knowledge of construction participants that contribute to safety culture. The study adopted structured questionnaire via e-mail and self-addressed pre-paid envelopes to obtained needed data. However, results of the study revealed that workers have four most "influential safety critical positions to be at construction sites and not at head office, workers opinion on safety culture promotion via training and education, a strong knowledge of rules and regulations, good communication and interpersonal skills, behavior and actions that could enforce and monitor safety. The studies called for an improvement on workers training and as well maximize safety practices.

Che Hassan, Basha, Wan Hanafi (2007) and Shamsuddin, Ani, Ismail, Ibrahim (2015) argued that workers knowledge and understanding of safety practices at work setting remain vital in promoting safety among themselves on construction site. Abdelhamid (2000) and Shamsuddin, *el al*., (2015) added that worker omission is the cause of construction injuries and can be view under behavior and human factor approach.

Safety Improvement Measures in Construction Industry

Improving safety in construction remains a priority in almost every country around the world, because the construction industry stands out among all other industries as the main contributor to severe and fatal accidents (Ahmed et al. 2000). The major approaches implemented in the construction industry to improve safety have been summarized in this paper along with their individual benefits and limitations. Upon review of the prevailing safety improvement approaches in terms of techniques and effectiveness, it was found that traditionally the burden of ensuring safety of construction work site has been placed solely on the contractor. While the contractor will always bear the responsibility for construction site safety, the novel concept of Prevention through design also allows architects and engineers to contribute in enhancing site safety. According to Prevention through design which was initiated in 1985 by International Labor Office (ILO 1985), hazards should be “designed out” such that they are eliminated or reduced before the workers are exposed to them. After reviewing the major approaches that have been taken to improve occupational safety in the construction industry, this paper concludes that Prevention through Design is a promising approach and can provide a positive impetus towards improving safety in the construction industry.

Workers Operation Performance

Workers Operation Performance, according to Siebeth (2015) refers to work related behavior that seemingly expressed the relative strength of an individual involvement expected of a worker towards attainment of tasks. Worker’s performance could be justified especially when the person is able to perform his/her tasks effectively. Siebeth (2015) contends that workers performance is evaluated to ensure conformity with standards. The workers performance could be assessed in annual or quarterly basis to explore strength and weakness of employees for on-ward decision of the organization (Waith, 2014). Worker’s operation performance is measured with workers commitment to work, workers effectiveness and quantity of output, respectively.

Significant Relationship between Safety Measures and Workers Performance

Safety can be viewed as a point at which all associated risks with a particular job are well managed in a reasonable manner (Brueggman, 2001). The anomalies as seen in the construction firm’s failure to comply with minimum requirement of health and safety practices might cause the victim waste of time and loss of money to the firms. Although construction firms may be covered with life assurance for their staffers from certain direct costs resulting from injury suffered, however some tectonic cost may be involved which cannot be insured against, such as loss of trained personnel, loss of production hours due to other operatives stopping the progress of the work out of concern or assisting the injured persons (Aniekwu, 2007). Thus, the lack of adherence to safety practices will delay the production process of construction activities.

In the same vein, Ahmad, Iqbal, Rashid, Iqbal and Roomi (2016) defined safety as unique event that is paramount to continuous attainment of productivity. In the same vein, Ahmad, Iqbal, Rashid, Iqbal and Roomi (2016) opined that safety focus on curbing accidents at work setting and its negative effect on the workers in all manner. Assessment of various researchers such as: Aniekwu (2007); Idoro 2011; Okolie and Okoye (2012); Idubor and Oisamoje (2013); Dodo (2014); and Umeokafor *et al.*, (2014); on provisions and management of safety in construction project reveals that adoption and compliance with health and safety provision served as catalyst in optimizing construction production process. On the other hand, without compliance to health and safety practices, more accident will result in pains, accidents and legal actions thereby escalating production cost.

Empirical Review

Umoh, G.I. (2013) carried out a research on Safety Practices and The productivity of employees in manufacturing firms: evidence from Nigeria. The following objectives were obtained; i.) To identify what extent the provision of adequate safety equipment impact on the work output of employees.) The Examine the improvement in legal institutional safety policies affect the increase in the production output of employees. iii.) To proffer solution to the compliance of safety rules important in influencing the man hour put in by employees in the production process. Methodology adopted in this study was the cross-sectional survey. The target population constituted manufacturing firms in Port Harcourt and ten of these manufacturing firms were randomly selected by the researcher for the purpose of this study Conclusion and Recommendations, Consequent upon the outcome of the findings, the following conclusions emerged; 1) There is a significant relationship between the provision of adequate safety equipments and the work input of employees. 2) There is a significant relationship between legal institutional safety policies and the production outputs of employees. 3) There is a significant relationship between employer's compliance to safety rules and man hour put in by employees in the production process. Based on the outcome of this research study, and its implication on organizational effectiveness, the following recommendations have been suggested by the researcher. 1) Employers' and management of organizations should ensure that safety precautions are taken in the work environment at all instances so as to spur employees to higher productivity. 2) Qualified safety officers should be employed to manage the safety challenges facing the organizations in their business operations. 3) Employees should be sent on regular and seasoned training courses on safety management so that they can appreciate the need for safety precautions. 4) The safety policies of business organizations must not be taken for granted, such must be effectively implemented to the later and adherence monitored at every instance. 5) Government should establish a monitoring team that will visit these operational business organizations unannounced to evaluate their safety policies and measure their levels of compliance.

Okoye, Ezeokonkwo, and Ezeokoli (2016) studied building construction workers' health and safety knowledge and compliance on sites in Anambra State, Nigeria. The research employed Mean Score Index and Pearson's Product-moment Correlation Coefficient (**r**) to analyze the data randomly sampled from the fifteen (15) selected construction sites in the study area. However, the outcome of the research showed that, low safety awareness and compliance among the sites operatives, this resort into low project performance. The study recommended that, knowledge and compliance with health and safety practices alone cannot achieve optimum project performance, it would require safety culture which encompassed other factors are as follows: management commitment, workers involvement and strict enforcement of safety regulation should be adopted.

Theoretical Framework

This study focuses on Domino's safety theory propounded by Bird and Loftus (1974) in Bwell (2014). The theory assumes that the growing incidence of work place hazards are orchestrated by unsafe act of the workers and the theory also believed that work-related-hazards could be personal or work-related-factors. The theory identified personal factors to include personal problems, mental problems, illness, bad attitude and lack of operational skills needed for the job while work-related-factors include inadequate work, work environment, and low-quality equipment. The theory believes that these hazards constitute a bottleneck on operations management because it hampers the free flow of job processes in organization.

METHODOLOGY

Research Design

This study adopted descriptive research design using approach. This is because the study seeks to identify and make inference about the relationship between variables. Thus, a survey was conducted on the sample units with the designed questionnaire. The questionnaire contained question items which individually addressed paired variables of importance with respect to employee performance (dependent variable) and safety management (independent variable). The two variables were decomposed into their respective operationally defined variables components and matched in pair-wise fashion.

Area of the Study

The study covered six (6) construction firms selected from the various construction companies contracting for the Enugu State University of Science and Technology in Enugu State, LIVE ENTERPRISE NIG. LTD., UGOLANSON NIG. LTD., BONEZ CONSTRUCT LTD., GIANT COVENANT LTD., HALCON ENGINEERING LTD., U.Y.K NIG. LTD.

Population of the Study

Population of the study consists of contractors' site-based staff which consist of the following; General foremen, site foremen, trade foremen, Ganger, Operatives, Site Engineers, Site Supervisors, Planners, safety officers, Surveyors, Managers, Temporal workers. From preliminary investigation, UGOLANSON NIG. LTD. has the staff strength of 86, GIANT COVENANT LTD has 112, LIVE ENTERPRISE NIG. LTD has 168, BONEZ CONSTRUCT LTD has 56, U.Y.K NIG. LTD has 45, and HALCON ENGINEERING LTD has 38. Therefore, the population of the study is five hundred and five (505). (Extracted from the personnel units of the six firms, 2019)

Table 1: Category of respondents on the class of safety training main responsible for performance in construction sites.

Senior Level Manager	Frequency	Percentage Frequency
Architects	7	3.29
Quantity Surveyors	7	3.29
Structural Engineers	8	3.56
M&E Engineers	10	4.69
Builders	24	11.28

Source: Field survey 2019 Professional (N= 56)

Table 2: Category of respondents on the class of workers mainly responsible for safety in construction sites

Junior and Middle Level Manager	Frequency	Percentage Frequency
Project Manager	6	2.82
Supervisors	12	5.63
Foremen	12	5.63
Sub-Contractors	10	4.69
Artisans	31	14.55
Skilled Laborers	71	33.33
Unskilled Laborers	15	7.24

Source: Field survey 2019 Professional (N= 56)

Table 1 and Table 2 shows the position of the respondents on the class of workers mainly responsible for Safety in construction sites. It can be seen that site operative constitute of 157 numbers while the professionals contributes about 56 numbers to construction Safety respectively. These groups of people are either engaged on a daily pay basis or finish and go method which creates an avenue for been hasty and impatiently carrying out their responsibility. These factors deliberately ignore the use of personal protective equipment and safe working practices which create grounds for accidents to occur.

Sample Size Determination

The sample size for this study was determined using Taro Yemeni as shown in Equation

$$n = \frac{N}{1 + N(e)^2}$$

Where: n= sample size, N = population of the study, e = level of significance (0.05). Substituting the values into Equation (1) gives,

$$n = \frac{505}{1 + 505\,(0.05)^2}$$

$$n = \frac{505}{1.8475}$$

Therefore, the sample size is 398.

$$n = 398.$$

However, due to the stratification of the population, the proportionate sampling technique will be employed in order to determine the proportion of the sample that should be drawn from each firm. The proportionate sampling formula is written as:

$$n^*_i = \frac{K.\,n}{T}$$

Where n* is sample size to be drawn for the category; K is the total population of the category while T is the total population of the study (all categories); and n is the sample size calculated using Equation (2) and total population of the six firms.

Research Instrument

The instrument for data collection was structured questionnaire, 5 question items for bio data, 6 items for safety policy and commitment, 6 items for safety measures and employee effectiveness and 6 items for safety helmet and quantity of employee output. This questionnaire was designed in structured response format, such that, the respondents were precise with their answers and also free to express their opinion. Thus, the question items were weighted based on 5-point like scale: Strongly Agree (SA) =5, Agree (A) = 4, Disagree (D) =3, Strongly Disagree (SD) = 2, and Undecided (U) =1.

Reliability of the study

Data for this study consisted of primary data which was sourced directly from the respondents via structured questionnaire.

Validity of the Instrument

The test re-test pilot approach was employed such that cronbach's apha coefficient was used to determine the reliability of the research instrument. The test re-test approach was conducted, such that, questionnaire items were administered on few respondents in four weeks intervals, after which, their responses therefore were correlated using cronbach'sapha test for internal reliability of the instrument.

Analytical technique

Statistical Package for the Social Science (SPSS) software was used to run the data analysis using 223 copies of questionnaire collected from the construction companies involving the general foremen, site foremen, trade foremen, Ganger, Operatives, Site Engineers, Site Supervisors, Planners, safety officers, Surveyors, Managers, Resident Architect, Structural Engineer, Electrical Engineer, Mechanical Engineer, Quantity Surveyor and Temporal workers.

RESULT

Table 1: Questionnaire Administration and Response Rate

Questionnaire	Number	Percentage %
Questionnaire administered	505	100
Questionnaire collected	398	91
Questionnaire not collected	107	18

Source: Field survey, 2019.

Table 1 above shows that 505 copies of questionnaire were administered on respondents, 381 copies were returned (response rate of 91%), while 107 copies of the questionnaire were not returned (non-response rate of 9%). Therefore, 398 copies were returned, hence used for the analysis.

H_{02}: There is no significant relationship between safety training and workers performance on construction sites in ESUT.

Table 3: Correlation between safety training and workers performance

		Safety Training	Workers Performance
safety control	Pearson Correlation	1	.783**
	Sig. (2-tailed)		.000
	N	398	398
Employee effectiveness	Pearson Correlation	.783	1
	Sig. (2-tailed)	.000	
	N	398	398

**. Correlation is significant at the 0.01 level (2-tailed).
Source: SPSS Data output.

Table 3 above shows the correlation result between safety training and employee performance (rho: 0.783, P-value: 0.000). The result shows that safety training significantly relates with employee performance of the selected construction firms in Enugu State. Therefore, since $P<0.01$, the study rejects the null hypothesis.

SUMMARY, CONCLUSION AND COMMENDATIONS

From the flood of literature, empirical reviews and the results, the study logically concludes that there is an important positive relationship between safety measures and workers performance. The implication of the substantial relationship is that any rise in the level at which these construction firms establish safety management ethics on their operations; such will bring about a major increase in performance and vice versa. More importantly, the results engender the imperativeness of maintaining a safety working environment that is capable of driving the efforts of the workers towards the realization of organizational goals. From ‘the conclusions, the study made the following recommendations:

(i) The firm should on a consistent basis train their workers. This will aid them to take abreast of the changes coming from the environs with respect to the provision of safety wears and alike to protect individual workers against environmental health hazards that may arise in the course of construction activities in the site.

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USE OF URBAN PARKS IN CITIES: THE RENEWAL OF EDWARD NNAJI PARK, NEW HAVEN, ENUGU, NIGERIA.

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ABSTRACT

Urban Park is a type of Urban Open Spaces (UOS) used formal and informal sports, recreation and preservation of natural environments. Urban Parks are divided into categories depending on the use and nieghbourhood needs. The aim of this study is to make an urban renewal plan for Edward Nnaji Park, New Haven, Enugu. This was because the Park has become disused and in the recent past, new developments around the park environs necessitates a renewal programme. The study is descriptive in nature, so makes use of reconignaise survey and extensive literature review. These were synthesized to make designs appropriate for the situation to enhance and revitalize the neighbourhood.

KEYWORDS: Cities, Parks, Public Participation, Urban Greens, Urban Open Spaces (UOS), Urban Renewal.

Introduction

Urban Park is a type of Urban Open Spaces (UOS), which is the reserved land for the purpose of formal and informal sports, recreation and preservation of natural environments. It is also used for provision of green spaces and or urban storm management. It provides cool environment by filtering pollution (air, noise, light), allows water percolation into the subsoil recharging the underground waters, Emenike, 2014. Urban parks vary in size, form and function. In a city, there should be a network of parks to properly cater for the needs of the populace and also connect the other land uses.

The Edward Nnaji Park is a prominent park in New Haven, Enugu, but of recent has not been in use, with all its facilities falling apart. Informal trading (car washing, food vendors, etc) is taking over the place, creating unwholesome atmosphere. Thus it has become a danger to those living around. With the recent development around the park area notable among them being ‘the Dome’ event centre a new centre where social activities take place daily, makes it imperative that the park needs to be upgraded and revitalized for better patronage and usage.

The study aims at renewal, revitalizing and upgrading of this park area for the enjoyment of the populace. To be able to do this well, the current status of the park was under taken, literature review of some key were done and then a renewal plan was formulated. In all these the angle of management cannot be overlooked, so the residents input inform of public participation in the management style is envisaged.

Literature Review

Parks are a form of open spaces used for recreation, formal and informal physical activities. Being an open space, it provides relief for the built environment by providing by using soft landscaping to counter the concrete jungle of the built up area. It also provides a relief for residents (adult and children) and other animals and birds of the air within the neighbourhood. Parks are seen as integral to city planning as they are set aside to preserve a sense of nature in the cities, (Caves, 2004).

There are types and sizes of Parks, which is tied to population and activities within the park space. The parks in the cities comprise national parks, state parks, provisional parks, district parks, neighbourhood parks and linear parks (greenways, waterfronts, etc.). All these parks work for the physical activities of families and communities in the cities and also benefit pollination, (Bliss, 2014), (Shepherd, Vaughan & Hoffman-Black, 2008). Neighbourhood parks are small areas in neighbourhoods, close and accessible to the local residents. It usually caters for children, provides identity and sense of place for the community. Linear parks often follow drainage and transport lines. They provide linkages between land uses and open spaces creating environmental corridors. District, Regional and National parks are bigger and the parks are for more organized active field games, conservation and reserved areas (wetlands, escarpments, etc).

Urban renewal is a programme of land redevelopment often used to address urban decay in cities. Its main purpose is to improve specific areas of a city, upgrade neighbourhoods that are in state of distress or decay and restore economic viability, (Caves, 2004). Urban renewal goes by different names like urban regeneration in United Kingdom and urban redevelopment in the United States but all aim at the same thing ‘improvement of decayed or distressed areas of the city’. Urban renewal grew as a result of cramped and unsanitary conditions of the urban poor in rapidly industrializing cities of the 19th century.

Urban renewal is an effective tool in promoting sustainability and enhancing macro-level quality of life in cities. It is a comprehensive scheme to redress a complex of urban problems (unsanitary, deficient and/or obsolete housing, inadequate transportation, traffic congestion, haphazard land use, etc).

The study area

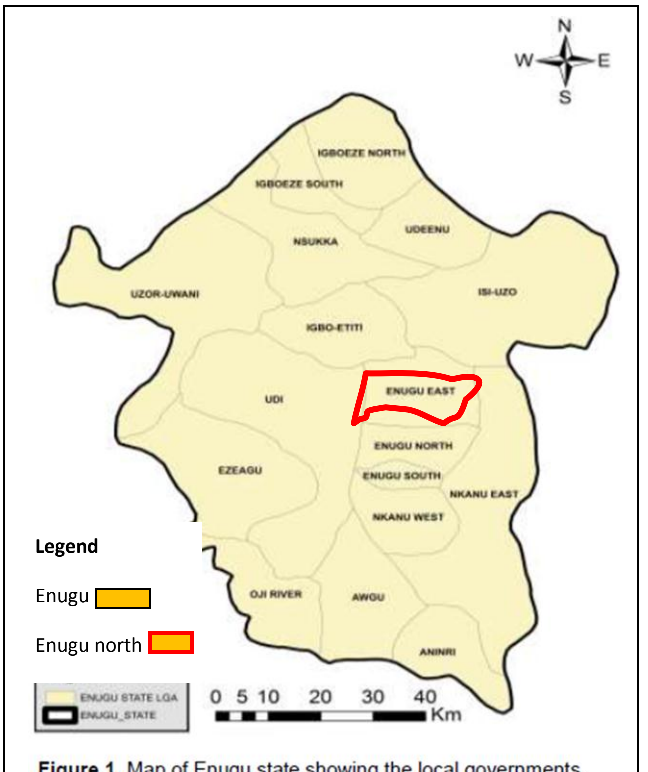

Figure 1. Map of Enugu state showing the local governments.

Renewal of parks is especially necessary because urban renewal improves specific areas of the city and parks play a great role in improving the cities and the futures of its residents, Nagel (). Parks being open spaces is the main arteries of the city so the renewal of urban parks is very important to the city regeneration. Marty Rubin says that 'parks and playgrounds are the soul of a city'.

The study area is Enugu Metropolis in general but Edward Nnaji Park, New Haven as a casestudy. Enugu metropolis is located on latitude 6' 27" north of the equator and longitude 7' 29" east of Greenwich Meriden. New Haven is a medium density layout to the north east side of Enugu. New Haven layout houses the park under study.

Plate 1 ji Park.

The study made use of survey research method whereby recognisance survey was used to ascertain the current status of the park. This park is situated along Nnaji street in New Haven and adjoins New Haven –Independence layout link road by bush bar. The park was fenced with dilapidating block walls. It has two abandoned structures formally housing ESWAMA offices, Emenike, 2014. The park vicinity is totally overgrown with tall trees. This park is within a triving residential neighbourhood, very close to the De Dome events centre. There is no visible management system for the park.

Plate 2. Street Views of the Edward Nnaji Park.

Discussion of finding

From the survey conducted, the following is evident; the park is dilapidated and abandoned. It is therefore in dire need of regeneration and so there is a design proposal for renewal of the park. The design combines vertical, horizontal and 45 degrees lines with arcs and circles resulting in a well organized and dynamic park space. The main aim of this design is raising the quality of living in the neighbourhood to a safe and serene environment.

Le

pergola stand, F- park benches, G- toilets/urinals, H- trees, I- trails/pathways, J- lighting, K- trash bins, L- sales kiosk, M-shrubs.

Plate 3: A model of the proposed park.

The proposed park design provided for the following:

- ✓ A beautiful park signage for effective information, direction and communication of park rules and regulations.
- ✓ A water fountain; a decorative reserviour and structure for providing drinking water. It can also be used for decoration and celebration.
- ✓ There is outdoor lounge that helps people to enjoy the outdoors in comfort.
- ✓ Children’s playground for the use of the very young ones, this playground is natural inclusive and adventurous.
- ✓ There is a pergola stand for outdoor activities which provides protection for visitors from the harsh weather elements.
- ✓ Park benches are also provided for comfort and relaxation of the park users. They can be made of concrete, timber, metal or plastics.
- ✓ Toilets and urinals are provided for the comfort of the park users.
- ✓ Trees, shrubs, hedges and grasses (ground covers) are generously used. They aid filtration, sound and wind barrier, generally improves human health.

- ✓ Trails and pathways are unpaved lane or road for walking, cycling, etc within the park.
- ✓ Lighting is deliberately used to achieve practical and aesthetic effects. Also for safety and surveillance of the park.
- ✓ Trash bins are positioned for the total cleanliness of the park. They could be made plastics, metals, or concrete.
- ✓ Sales kiosk is used for small businesses for supplies and similar items. They could also serve for information, internet, wayfinding, etc.

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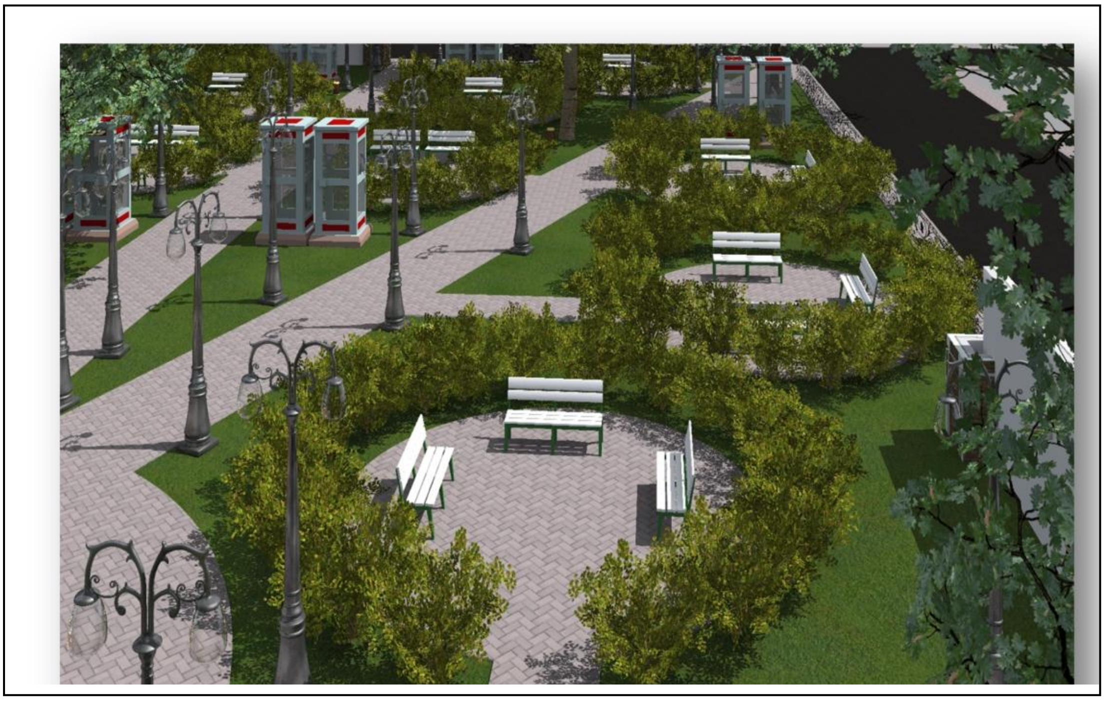

Plate 5: Perspective view of the proposed park from another angle.

Recommendation

The major problem of this park and similar open spaces in Enugu Meteropolis is the issue of management and taking care of the spaces on day to day. Therefore it is the opinion of these researchers that a lasting solution be found. They proposed for a body to be created in the development control unit of planning offices or similar ministries to oversee these open spaces.

In the edicts for one to cut a tree, you apply to forestry department and obtain a permit, but the space housing the tree is neglected. This is not good. In the Nigerian Urban and Regional Planning decree no 88 of 1992, part 5 section 80 subsection 2 on '**improvement areas: ….**' It says ' the rehabilitation, renovation and upgrading maybe brought about through the combined efforts of the residents of the area concerned, the Control Department and any other statutory bodies as may be relevant and complimentary to the ….. of the area.'

The researchers are of the opinion that open space management and control can fit into the following ministries 'Environment, Housing and Urban Development'. A body (unit) can be created in any of these ministries to work with the residents (public) to monitor, manage and over see these open spaces such that they do not fall into total neglect as is the case of this park.

The existence of working parks in neighbourhoods can boost tourism, enhance the health of the populace and improve the environment generally.

Conclusion

The study was able to expose the state of Nnaji park at New Haven and the need for immediate and speedy renewal of this urban space for the neighbourhood's enjoyment. The design is achievable with a good management team comprising community based organization and the supervising ministry. This park when renewed will aid the healthy development of the populace, enhance regeneration of the environment and even earn some economy for the government.

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ENVIRONMENTAL IMPACT ASSESSMENT ON A PROPOSED HYDROPOWER DAMS PROJECT AT AWGU, ENUGU IN EASTERN NIGERIA.

BY

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ABSTRACT

Hydropower Dam Projects and reservoirs are one of the most sensitive of all development projects, in terms of pervasiveness of their impact in altering the environmental conditions and resources. The Environmental impact Assessment of this Dam project at Awgu, Enugu in Eastern Nigeria, examines the effect of positive and negative impact the project would have in the proposed region of construction. Hydropower Dam projects brings about major changes in the immediate environment. It affects public health, settlements, farmlands, roads and historical sites. The impact on human population and wildlife are critical to location of the Dam project. Tropical diseases, involving fresh-water hosts or vectors in their transmission, are often common around new reservoirs. Large lakes create Limnological changes, excessive evaporation, seepage and disturbance in water table and increased tendencies of landslides and earthquakes. Microclimate changes are possible such as fog formation, increased cloudiness and modified rainfall patterns. Retention of sediment results in silting up reservoirs. Sediment deposition and growth of vegetation in reservoir affects the water extraction for navigation, power generation and fishing. The environmental assessment impact of this hydropower dam project were examined and possible mitigation measures, suggested for its successful construction and operations.

Keywords: Environmental impact assessment, Hydropower dam projects, Environmental factors.

1.0 Introduction

Environmental impact Assessment (E1A) on a proposed hydropower dam project at Awgu in Awgu Local Government Area of Enugu State in Eastern Nigeria is aimed at studying the effects of the proposed project, plan, or program on the environment.

Geographically, Awgu Local Government Area is located approximately between latitudes 06^0 00' and $06^0$19' North of the Equator and longitudes $07^0$23' and $07^0$35' East of the Greenwich meridian. It is bounded in the North by Udi and Nkanu west L.G.As, in the west by Oji River L.G.A, Aninri L.G.A, and Ivo L.G.A of Ebonyi State in the East and share border with umunneochi L.G.A. of Abia State in the south. Awgu L.G.A has a population of 390,681 (NPC, 2006) projected to be 494425 in 2021. The population distribution is uneven; a few areas are densely populated while many other areas are virtually uninhabitable. Majority of the population settle at the foot of the hills as a result of difficulty posed by the rugged terrain and because the lowland have richer soil which support better crop yield. Awgu is marked by extensive hills especially in the western flank and lowland in the eastern side. These hills have steep slopes and could attain an attitude of about 350-400 meters above sea level with mean slope angle of 15^0 and a modal class of 11^0. (Wikkipedia). The major river that cut across the major towns in the area where a proposed hydropower Dam project can be construction is Mmamu River. Dam construction is one of the important civil and developing projects that have positive and negative effects on environment. Dams have one of the most important roles in utilizing water resources and are useful in meeting the benefits like controlling or regulating stream regimes, floods prevention, domestic and irrigation water supply from stored water (reservoir) and hydropower (Energy) generation etc. Wherever the location of a dam is, its ecological results are the same. The Environmental Impact Assessment of dams can be categorized based on different criteria which include;

a) short and long-term impacts on surface and ecosystem of the region.
b) upstream and downstream side of dam.
c) social and economic impacts.
d) beneficial and harmful impact on the closed area and region.

Although, there are very important social and environmental benefits in dams project, it is important to minimize its negative effects on the environment regarding sustainable development. These effects may be ordered in an intensive and complicated manner like climatic, hydraulic, biologic, social, cultural, archaeological e.t.c. and their solutions will be taken into account in the environmental impact assessment concept.

2.0 Objectives of the Study

The main objective of this study consists in carrying out a comprehensive Environmental Impact Assessment for the proposed hydropower dam project at Awgu, South Eastern Nigeria on the environment during the site preparation and operation phase.

The specific objectives is

1. to ascertain the effects of the project on the neighbouring environment such as water bodies, the soil, the people the infrastructure, the fauna, the flora and the atmosphere;
2. to determine the effect of the neighboring environment on the projects, which includes the effects on the soil of the project and the surrounding activities;
3. to determine the effect of the project on the environment;
4. to propose alternative measures where it is noticed that adverse effect may occur.
5. to enable the proposed mitigation measures where adverse effects may have occurred;
6. to carry out of a diagnosis of the existing environment and activities in the area of the project;
7. to propose enforcement measure where beneficial effects from the project are detected;
8. to set up an environmental management plan that will govern all activities of the project for the better protection of the environment.

3.0 **Methodology;** This consists of

- Literature review of documentation on policies, laws, regulations, and guidelines related to environmental management, industry sector, hydropower management of water resources, land use EIA e.t.c. At the national and international levels.

- This is followed by interview of people in the area of the project as well as the ministries and other government institutions related to this dam project.
- Data collection through visit to the site to get the required qualitative and quantitative data,
- Stakeholders' consultation was done to analyze key partners and stakeholders which include all concerns private sectors, neighboring communities e.t.c. to find out their involvement, role and responsibilities in this project.
- Mapping and zoning of the site.
- Reporting: The compilation of the data and information collected in a report.

4.0 Environmental Impacts of Dam on the Environment:

1. Sediment feeding of downstream channel or shore beaches is prevented as a result of dam construction and holding of sediments in reservoirs. Corrosion may occur and the egg lying zone of the fishes living in the stream ecosystem is restricted.
2. There is disappearance of archaeological and historical places in company with geological and topographical places that are rare with their exceptional beauties after lying under the reservoir.
3. The egg gravel beds can be destructed during the excavation and coating work in the stream beds while reproduction of migrating fishes is hindered by the floods that harm the egg beds.
4. The water temperature, salt and oxygen distribution may change vertically as a consequence of reservoir formation which may cause the generation of new living species.
5. The upstream fish movement aiming ovulation and feeding is prevented which decreases the fish population significantly and normal passing ways of territorial animals are hindered since the dam works as a barrier.
6. The drainage of marshs and other water accumulations and the excavation works causing changes in the stream bed structures affect the creatures living there negatively, even result in their death. Also the fishes passing through the floodgates can be damaged.
7. If the dam was done based on irrigation project, there will be serious change in the water quality as a result of drainage water returning from irrigation. This means that over- transfer of flood and the increase in salt density can raise water lichens which may change water living species.
8. The species may change parallel to the erosion caused by human activities or the permanent increase in the water turbidity as an outcome of the dam construction.
9. When the stream becomes unable to recover itself, all living organism may expire and discharge of toxic matters (pesticides, toxic metals etc.) and their condensation in flood chain may affect sensitive animals immediately.
10. Unexpected floods, may occur which can damage vegetation and natural structures in the river bank and the water regime may change as a result of destruction of nature.
11. Filling of big dam reservoir may result to increase in earthquakes.
12. Increase in the water surface area may cause rise in evaporation losses.

13. The stagnant, big scaled mass of water may cause microclimate and some regional climate changes with changes in air moisture percentage, air temperature, air movements in big scale and the changes in the region topography.
14. There are compulsory changes in the agricultural habits of the people living in the area and also in the flora and fauna. The water soil nutrient relations, which come into existence downstream related to the floods occurring form time to time in a long period of time also change.
15. Increases in water sourced illnesses like typhoid fever, typhus, malaria and cholera may result because of the dam.
16. Dam project affect the social, cultural and economic structure of the region considerably by forcing people whose settlement areas and lands remain under water to migrate which affect their psychology negatively.

5.0 Benefits that will come into Existence after the Dam Project

a) Irrigation benefits – distinction between dry and irrigated positions.
b) Providing drinking water and domestic water benefit.
c) Electricity energy benefits are the energy benefit value of the more economical project out of two alternative projects.
d) Transportation benefits if there is waterway transportation in the project.
e) Flood control decreases and remove the flood effects.
f) Land improvement benefits are extra benefits that will occur after an increase in the soil productivity because of drainage and land improvement precautions.

5.1. Effect of the Dam on Hydraulic System

The discharge of the collection basin to a stationary reservoir instead of a stream is bed is the main hydraulic affect. Instant change starts at downstream which manifests by partial or total drying at downstream whenever the reservoir begins to accumulate water. This temporary or periodically repeating time interval can collapse the hydrological balance which causes irreversible death, disappearance and structural jumps are observed in the water dependent ecosystem. Decay of dead flora and fauna in the new coming water body speeds up, which pollutes upstream water flows, without oxygen in deeper parts, dark coloured for a long time and usually smells rotten because of sulphurous hydrogen disposal. The stream forms a new and healthy ecosystem in this part of it after this process but, neither this new aqua balance nor the terrestrial ecosystem and even the sea environment that the stream joins the sea have the chance to join their previous health.

5.2 Effect of the Dam on the Atmosphere System:

Moisture percentage, temperature and air body movements of air variations caused by the impoundment differentiate microclima related to region topography. It may not be harmful for human health but are notable for many plants and animals.

5.3 Geophysical Effects:

1. **Topography impact-** The topography is subject to significant changes due to rock and soil excavation, back filling, road construction, temporary and permanent camps, borrow area excavation etc. during construction period. Although it is a negative impact, it changes the region from its intact and natural condition and would be intense, permanent and unavoidable.

2. **Soil Erosion Impact-** It can be considered to have intense effect as a result of river diversion system, excavation, and backfilling, removal of vegetation at the construction area, borrow area extraction and disposition, road and structures construction and machinery travelling during construction. Availability of water supply in the upstream side of dam can lead to expansion of farmland by people but may result to increased soil erosion and sediment in dam reservoir project impact on the soil erosion during construction and operation periods is exposed in medium to high intensity.
3. **Reservoir Sedimentation Impact-** There is always small or large sediment and disposition in the dam reservoir which can be reviewed from different aspects.
   a) Accumulation and combination of sedimentary materials lead to rapid increase of reservoir dead volume and reduction of dam service life. This impact on economic of the project in form of losing national capital and social problems.
   b) The river flow transmits a lot of amount of nutrients e.g. nitrogen, phosphorus and other required substances of plants to downstream. This reduces the nutrients in the downstream side of dam. Dam construction and water controlling change the natural pattern of disposition in the downstream side of the dam and leads to reduction of suspended loads in the river.
4. **Earthquake Induced Impact-** This impact goes with any constructed dam because of the new imposed load on the dam and its associated foundation. This is precipitated by the impounding at the reservoir and their intensity is a function of the water depth of the dam reservoir.
5. **Reservoir Abutments Impact on Flood and Slope Stability-** Water penetration into the surrounded grounded layers of the dam is one of the natural processes after dam construction and it also helps in damaging impact of river flood to aid flood control.
   Instability of Abutments can cause potential dangers in dams and result in trivial issues like;
   a) Lots of human and financial damages caused by dam failure and destroying all facilities due to long waves on the reservoir surface making the risk of overtopping and high pressure to dam body.
   b) Water resources management and investment get ruined which will result in social, political and economic damages due to reduction of dam useful volume of soil and rock failure into dam.
   c) The breaking of intake systems, gates and trash racks will cause the operational system to be out of function.

5.4 River and Reservoir Water Related Factors Effects

1. **Dam reservoir thermal stratification-** The alteration of the quality of reservoir water is seasonal and depends on whether it is dry or rainy season. The thermal process of stratification is a function of different factors like reservoir volume, morphology and depth, geographic conditions of the environment, the ratio of inflow to reservoir and the ratio of reservoir depth to length, layering phenomena in lakes and reservoirs make the most important impact on the hydraulic and thermal features of the dam.

2. **Reservoir Eutrophication probability-**The accumulation of organic matters and sediments in the reservoir is the base of eutrophication phenomena in dam reservoir. The phenomena mean enrichment of water with nutrients e.g. Nitrogen, phosphorus, algae and other aquatic plants will grow more in the reservoir. Some treatments should be done during the dam and related structures operation period for reducing the eutrophication.
3. **Evaporation Impact-** Evaporation depends on the dam surface area, its depth, region's climate and wind. It increases in dry and semidry climate and decreases in humid climate. Other important impact to be considered in environmental impact assessment will include, impact on surface water quality (river), the river self-refining and the impact on quantity and quality of underground water.

5.5 The Vegetation and Animal Effects

These are considered with respect to the impact on plants species that are near to extinction and on vegetation inside dam reservoir. Also, impact on animal species (ie aquatic and terrestrial animals) with access to dam water during dry weather could lead to their population growth.

5.6 The Social, Economic and Cultural Effects

Knowledge, employment and income, houses and resettlement, hygiene and diseases, and tourism consist of the social, economic, and cultural effect of dam construction. These are long term positive effects.

5.7 Dam Effects on Human Life

1. **Water quality**

   The presence of organic matter is an important factors in water quality which differ in usage (farming, drinking etc.), the sources of organic matters in dam reservoir are: jungles and grasslands, manure, waste, water of factory, animal trapping production, organic fertilizers etc. It will make the soil fertile for agricultural purpose but becomes out of function when the water is for drinking and industrial usage.

2. **Soil pollution**

   The effect on soil pollution is a negative factors on the project impact which is considerable with average intensity. Tourism and other industries in the region that can make more trashes is a secondary and indirect impact of the project.

3. **Air and Noise Pollution**

   Air and noise pollution can be generated during different preparation and construction works eg. Rock and soil excavation, road construction, blasting, evaporation drill holes, upstream and downstream cofferdams, temporary and permanent camps, equipment transportation, borrow area excavation and machineries. These activities make dust, particulates, smokes from heavy machineries leads to air and noise population. The impact is unavoidable negative impact in construction site and around but is temporal. During operation and after construction of the dam, no air and noise pollution is expected.

6.0 Conclusion

The general conclusions about Environmental Impact Assessment are the following.

1. Environmental Impact Assessment (EJA) prior to dam construction is necessary to prevent the environmental hazardous consequences.
2. The study shows that the positive impact of dam construction projects for outweigh the negative impact considering social, economic and cultural parameters. For long term negative impacts suitable environmental treatments should be planned and make it minimum with environmental management planning.
3. The civil projects nature of dams has unavoidable hazardous positive impacts. The negative impact of construction period due to improper geophysical, biological and hygienic changes are much more than operational period.
4. The Environmental management program is necessary for dam study and construction to obviate the undesirable consequences of dam construction such as; reducing biodiversity in downstream, destroying the farmlands, gardens, grass lands near river after impounding, destroying the houses and residential areas near the river, resettlement of people in the neighbourhood and etc.
5. There should be environmental management program (EMP) which will include solutions for reducing important negative environmental impacts; make positive effects of the project more, develop a stable development goal; considers solution for controlling the negative impact of environment; make plans to reduce hazardous environmental impacts; supervise the treatments and reduce the negative impacts by survey and test the environment.
6. The construction of hydropower dam project in Awgu area is feasible when all the necessary precaution as articulated in this paper are strictly adhered to during the planning and execution on the Environmental Impact Assessment.

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CONVERTING URBAN SOLID WASTE TO ENERGY IN ENUGU URBAN AREA, SOUTHEAST, NIGERIA

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ABSTRACT

The increase in population, rapid rate of urbanization and the upsurge in economic activities in Enugu urban area have produced severe problems in many aspects, among which are solid waste management and energy insufficiency. Notwithstanding the emergence of distinct waste and energy linkage, the concept of “waste to energy” yet is viewed as substandard method in Nigeria. The Nigerian government and also other interested stakeholders concentrate their attention more on hydropower, the chief source of electricity generation in Nigeria. Linking solid waste management and insufficient energy supply is the aim of this study. It makes use of journal articles, data from National population commission and Enugu Electricity Distribution Company. Descriptive statistics is used to present the findings of the study. Enugu urban generates about 420 tons/day solid waste from its six waste management zones. The study has shown some opportunities for Enugu urban area to convert its solid waste into energy. Even if only organic waste is treated, it generates energy sufficient to light more than 900 houses in Enugu urban area. The quantity of waste, its heat content, the need of additional energy supply, the support from government and service users are some openings that hopefully can contribute to resolving the problems of solid waste and energy supply in Enugu urban area.

Key words: composition, conversion, electricity, urban solid waste, energy value.

INTRODUCTION

The problems of waste management in all districts in Enugu urban area have continued to worry relevant government authorities. The constantly increasing geographical extension of the city together with its geometrical progression in population, rapid rate of urbanization, changing peoples’ life styles and rise of economic activities have impact adversely on sanitation and health, good source of water for consumption, management of waste, impromptu housing projects and energy source (Shrestha, sartohadi, Ridwan & Hizbaron, 2014). Solid waste is defined as the collection of garbage materials originating from activities of human and animal that are rejected as useless and unwanted. Solid waste is produced from residential, industrial and commercial activities in an area, and it has various ways of handling.

The Enugu municipality which consists empirically of about six waste management zones (New Haven, Abakpa, Agbani road, Coal Camp (Ogbete), Emene and Ogui) generates 420 metric tons of solid waste per day at the rate of 0.48kg per capita per day (Nwoke *et al.,* 2020). This massive amount of solid waste has been generating disposal and treatment problems. The life of Enugu urban people have been affected by severe environmental problems. Whereas people are facing the problems, the solid waste management remains a huge question mark. Enugu waste disposal authorities have been doing their best but then a lot more has to be done. The accumulations of solid waste can be seen all over the places, along road sides, beside water channels, near markets and many other city corners.

Further on, as point out earlier, the rise in population also has affected the energy supply (electricity) in Enugu urban area. This paper aims at drawing a connection between two main problems standing out in Enugu urban area: the solid waste management and insufficient energy supply to the urban occupants.

Research Problems:

Recently, there have been massive increase in the population of Enugu urban dwellers, and this increment necessitates an expansion of residential layout to accommodate such population. Consequent upon such massive population increase are continuous generation of solid waste which pose environmental issues, and inefficient power supply. As waste generated is toxic to the environments which negatively affect man, it can also through adequate process be converted to energy. This will assist in mitigating the effects of both solid waste generation and inefficient power supply to Enugu urban dwellers.

Aims and Objectives:

The main aim of the study is to carry out investigation on the connection between two main problems standing out in Enugu urban area: the municipal solid waste management and insufficient energy supply to the urban occupants.

Specifically, the study seeks to:

i. To determine the physical composition of Enugu urban solid waste (EUSW).
ii. To determine the energy content of Enugu urban solid waste (EUSW).

LITERATURE REVIEW

This study makes use primarily of literature survey and secondary data for discussion and analysis. National population reports, National Bureau of Statistics, Enugu Electricity Distribution Authority are some of the sources for obtaining the data to be used in this study.

Urban Areas Solid Waste Management (SWM) System

In several developing countries of the world solid waste management has always been a main issue. For instance, Greece, was using landfill and open dump solid waste management techniques which lasted till late 1980s (Shrestha *et al.*, 2014). The lack of systematic facilities, coordination and governance of the concerned institutions has created serious problems in the solid waste disposal (Boemi, Papadopoulos, Karagiannidis, and Kontogianni, 2010). However, later, the legislation and environmental planning of Greece has set the target to implement internal SWM, followed by the ongoing reduction of biodegradable solid waste which is presently steering to landfilling, increasing recycle activities and also the closure of open dumping sites (Boemi, Papadopoulos, Karagiannidis, and Kontogianni, 2010). One of the recently proposed ways of waste management is to recover the energy from the waste through high temperature thermal treatment, as waste contains significant amount of biodegradable matters, that is expected be used as renewable energy source (Rentizelas, Tolis, and Tatsiopoulos, 2014).

India is an example of a fast growing country. Rapid growth of industrialization, population and urbanization has caused huge amount of municipal solid waste that lead to environmental degradation (Singh, Tyagi, Allen, Ibrahim, and Kothari, 2011). Unfortunately, most of the cities there are not able to cope up with environmental pressure due to lack of facilities. With waste generation per capita of 0.5 kg/day, India is facing a major challenge in municipality solid waste management (Kalyani, and Pandey, 2014). Sharholy *et al*. (2008) has conducted rigorous review on solid waste management in Indian context. Mindsets are changing with the progress of development and education. The price hike in petroleum products and other power have enforced the concerned institutions and investors to make energy recovery projects from waste become more practical (Sharholy cited in (Kumar, and Goel, (2009)). In response to Kyoto Protocol and agreement in Marrakech, Korea has been giving serious attention on CO_2 emission reduction. The development of renewable energy is considered as one way to reduce CO_2 emission and socio-economic cost due to environmental pressure. As one of the possible sources of energy alternative, the government has been promoting the expansion of landfill gas for electricity generation. Shin, Park, Kim, and Shin, 2005) had conducted economic and environmental analysis to see the prospect of landfill gas to generate electricity, under various scenarios of technology. The result showed that electricity generation from waste using steam turbine was the most economical way. However, there are still uncertainties in utilizing landfill gas and the introduction of it to energy market. The technology, economy and regulations are few to take into account in promoting waste to energy concept in Korea (Shin *et al*., 2005).

Indonesia is the countries in fourth position in the world in its population (UNFPA World Population 2012). Gunnamatta has perceived that solid waste management solution is not a straight forward problem. The collection and disposal are not the final answer. Different types of methods are available, but the characteristic of waste which is not homogeneous, has created other hindrances. The life cycle assessment on various ways to recover the energy from solid waste in Yogyakarta province has been conducted to encounter questions such as: anaerobic digestion or landfill, thermal conversion or landfill, loss or benefit to the environment (Gunamantha, 2012). The study showed that direct gasification was supposed to be the safest method in energy recovery from solid waste. Life cycle assessment was considered the appropriate technique to evaluate diverse waste treatment methods in relation to their environmental impact.

In Nigeria, most dumpsites are not managed and engineered properly (Ogwueleka, 2009), and eventually pollutants discharged from the dumpsites have serious impact on human lives either indirectly or directly (Zahari et al, 2010; Nwoke et al., 2020). According to Onyia, et al (2019) solid wastes, constantly collected from urban areas, have in recent times thought as an important renewable source of energy. Generating energy from urban solid waste is achievable by applying energy generation technologies as incineration, Liquefaction, combustion, gasification and pyrolysis (Onyia et al., 2020)

The operational design of the aforementioned energy generation technologies centered on urban solid waste are greatly connected to energy value of the used urban solid waste materials. Therefore, determining energy value of urban solid waste is a vital operation to performing the effective operational design of the waste to energy conversion (WTE) technologies (Kalantarifard and Yang, 2011; Nwoke et al, 2020 C).

Many people have conducted many research in urban waste management in Enugu urban but have not considered more about method of sustainable waste management. As a result much ecological damage continues to rise. Therefore, this study aims at presenting an investigation on converting the Enugu urban waste to energy. This will assist in reducing the waste management issues and sustainably protect our eco-system.

Waste to Energy Concept

The process of converting waste into electricity or gas is known as Waste to energy (WTE). The wastes are mainly generated from residence areas, industrial activities, commercial activities and institutional activities (offices). The word “waste” denotes an unwanted by-product of a manufacturing process, chemical laboratory, or nuclear reactor. Historically, the first incineration plant was built in Denmark in 1903 (Habib, Schmidt, and Christensen, 2013). As the consumption of energy continues to rise, the idea of converting solid waste to energy becomes an important issues in encouraging an alternate energy source. The need for environmental pressure reduction and efficient energy source for quality life have generated a firm connection between energy and waste (Habib, Schmidt, and Christensen, 2013). In most waste management programs, reusing and recycling are the utmost preferred techniques. However, waste conversion to energy is seen as a significant aspect in the management of solid waste.

Burning of solid waste was previously a process of both shrinking solid waste volume and reduction of its detrimental effect to human (Shrestha et al., 2014). Today, there is an integration of waste incineration and energy extraction (Bosmans, Vanderreydt, Geysen and Helsen, 2013).

There are various technological processes of converting solid waste into energy. The most common technology as identified by (Kalyani, and Pandey, 2014) are thermal conversion, landfilling and biochemical conversion (Shrestha et al., 2014). Techniques for thermal conversion comprise pyrolysis, incineration (combustion), gasification and refuse derived fuel (RDF). The incineration otherwise known as combustion entails burning plastics, textile and organic waste. The heat generated from this technique is transformed into electricity. The release of poisonous gases as the negative effect of this process is the chief disadvantage of thermal conversion.

Biochemical process is a better alternative because is more eco-friendly. It is made up of composting, anaerobic digestion and vermicomposting. The technique of thermal conversion process encompasses trans-esterification as well as other processes that convert bio- oil and plants into biodiesel (Annepu cited in (Kalyani, and Pandey, 2014)); (Singh et al., 2011).

Landfilling, which is the commonest method of waste disposal in developing and least developed countries, has a simple technique of solid waste disposal in an open field. This process is easy but not eco-friendly and as a result cannot be taken as a suitable option.

The Energy Situation and the position of waste to Energy concept in Nigeria

Nigeria’s electricity distribution network comprised of high voltage (19,226 Km of 11KV and 23,753 km of 33KV) networks from primary and sub-primary substations.

The substations fed with their respective ratings are shown in table 1.

Table 1. Nigeria Electricity substations fed with the ratings.

Substations	
679	20,543

	Ratings		
33/11 Kv		33/0.415KV ;	11/0.415KV

Source: (Nwoke *et al*., 2020)

Additional, injection and distribution transformers are 680 and 1,790 respectively. The transmission system has a wheeling capacity which is less than 4,000MW, and is overloaded. Some of the networks especially in the northern part experience poor voltage pattern. This is because of high prevalent rate of insufficient dispatch and control structure, radial and delicate grid network, recurrent collapse in the system and exceptionally high losses in the transmission. Electricity access is very poor in Nigeria. Estimate of 60 -70% Nigeria population live without access to electricity (Nwoke *et al*., 2020). Per capita electricity consumption is roughly 145 kWh in contrast to 4,198 kWh, 3,927kWh, 2,620kWh, and 351 kWh in South Africa, China,

There are a lot of many renewable energy sources in Nigeria that need to be explored further but most stakeholders are particular about hydropower development which its capacity does not measure up with the electricity demand of the teeming population. Renewable energy will be considered as instant solution to energy crisis that has been a lasting feature in peoples' lives, particularly in urban areas.

Research Gap.

Unfortunately, many people have conducted many research in urban waste management in Enugu urban but have not considered more about method of sustainable waste management. As a result much ecological damage continues to rise. Thus this study is undertaken to close the gap.

METHOD OF RESEARCH

Area of study

Enugu urban area is roughly located between Latitudes 06˚30'N and 06˚40'N and Longitudes 07˚20'E and 07˚35'E. The urban area covers three local government areas and nine principal districts, some of them are Trans-Ekulu, Uwani, Coal Camp (Ogbete), Achala layout, New heaven, Ogui, Figure 1. According to (National Population Commission 2006) the population of the town was 772,664 in 2006 while its 2014 population was projected to 910,003 using the authorized 3% growth rate for urban areas in Nigeria. It has a city area of 44 sq mi (113 km2) and the metropolitan area of 80 sq mi (200 km2).

In terms of geology, the town lies in the eastern Nigeria sedimentary basin, underlain by Enugu shales, lower coal measure (Mamu formation) and false bedded sandstone (Ajalli formation). Its topographical features are classified into two; the escarpment zone, the plains and lowlands of Cross River Basin. Average maximum temperature is usually a little above 27˚C all over the year although it sometimes exhibits peak of up to 36˚C in March, which is usually the hottest month of any year. Average annual rainfall is about 1800 mm but over 70% of the amounts fall in four months, between June and September. According to (Nwoke et al., 2020), empirically the urban area is zoned into six for managing the solid waste. The zones are: Agbani boulevard, Emene, Abakpa Nike, Coal camp, Ogui and New Heaven zone (Figure 1). The onus is on each zone to collect and transport the waste to Ugwuaji landfill. Great quantity of the generated waste in Enugu urban municipality is dumped of at Ugwuaji open dumpsite, in Enugu. This method of waste management has some disadvantages which among others are methane emission and production of leachate (Nwoke et al., 2020). For that reason, this study is done to present some approaches for recovery of energy by the treatment of waste towards lessening the environmental burden.

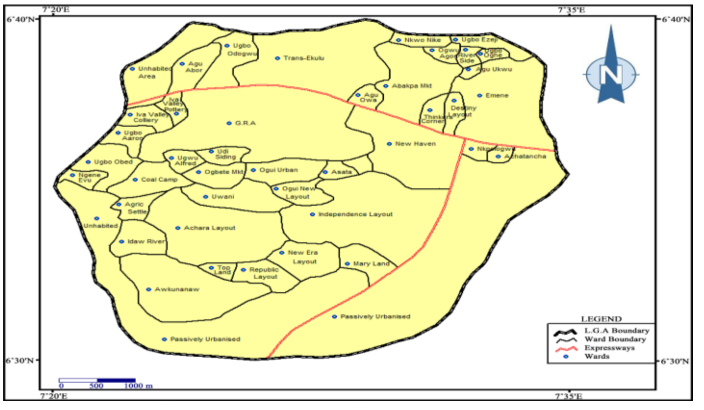

Figure 1. Map of Enugu Urban Area (Ezenwaji et al, 2016)

METHODS OF DATA COLLECTION

This study makes use mostly of literature survey and secondary data, which came from Books, Records, Published censuses (National population reports) and other statistical data (National Bureau of Statistics), Data archives (Enugu Electricity Distribution Authority), Internet articles, Research articles by other researchers (journals), and Databases for discussion and analysis.

DATA ANALYSIS AND PRESENTATION

The data for this study was analyzed using statistical method of data analysis. The presentation makes use of tabular and diagrammatic presentation types. It actually employs geometric diagram (bar charts, pie charts and frequency diagrams) to present the data.

RESULTS AND DISCUSSIONS

At the landfill at Ugwuaji based on the generation zone as shown in figure 2, according to (Nwoke et al., 2020), the municipal solid waste (MSW) composed physically on average 39% organic matter, which has high fraction vegetables and food waste. Others are as shown in the Table 2.

Table 2 Average composition of Enugu urban solid waste

Waste constituents	% Composition
Organic matter	39
Plastics	21
Paper	16
Textile	5
Metal	2
Glass	3
Others	19

Source: Nwoke et al., 2020

The result showed that organic matter is the major constituent of MSW in municipality followed by plastics. The plastic constituent is majorly the lower dense polyethylene such as packs sachet water, biscuits, bread and other packaging materials. Others such as soil, ceramics, bones, are the third prominent constitute of MSW with 19%. These materials occupy small volume but have high weight content. Paper is the fourth with 11% followed by textile (5%), glass (3%) and lastly metal with 2%. Scavengers pick metal products from their primary disposal point before they get to the land fill site and this is makes it to have low percentage.

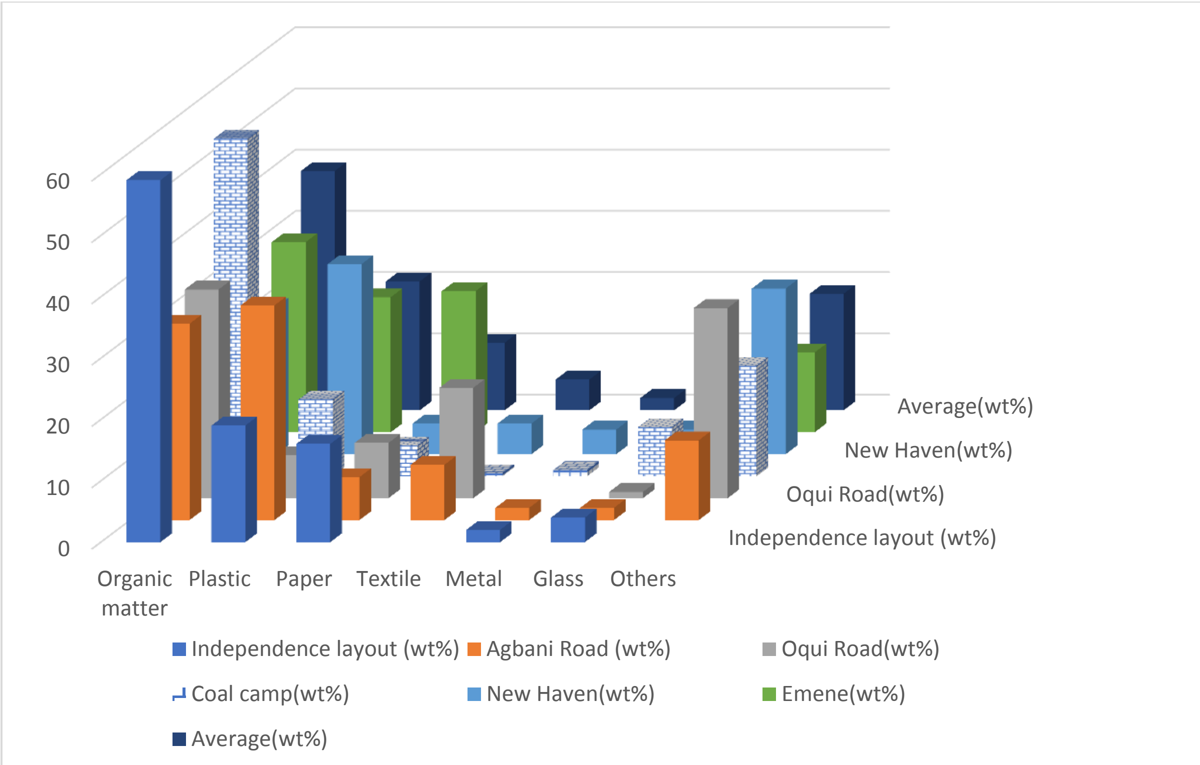

Figure 2. **Physical composition of urban solid waste from various sectors**

Source: (Nwoke *et al.*, 2020)

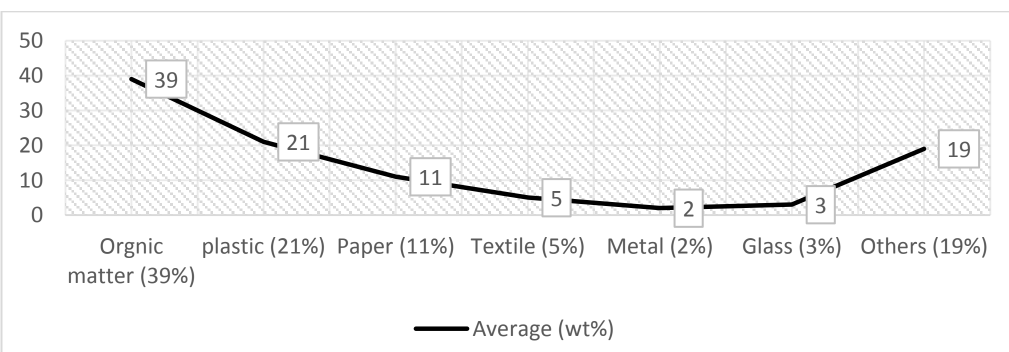

Figure 3: *Enugu urban solid waste composition*

Source : (Nwoke *et al.*, 2020)

The comparison of the result of physical composition of Enugu municipality waste stream between the previously done research by other researchers with the current study for other major cities in Nigeria as presented by (Ogwueleka, 2009 ; Nwoke et al., 2020) shown in table 3 and figure 4.

Table 3 Characteristics of waste stream compositions in Nigeria

	Organic matter	**Plastics**	**Paper**	**Textile**	**Metal**	**Glass**	**Others**
Onitsha	30.7	9.2	23.1	6.2	6.2	9.2	15.4
Nsukka	56	8.4	13.8	3.1	6.8	2.5	9.4
Lagos	59	4	14.0	-	4.0	3.0	19.0
Kano	43.0	4.0	17.0	7.0	5.0	2.0	22.0
Ibadan	76	4.0	6.6	1.4	2.5	0.6	8.9
Maidugri	25.8	18.1	7.5	3.9	9.1	4.3	31.3
Markurdi	52.2	8.2	12.3	2.5	7.1	3.6	14.0
Enugu	39.0	21.0	11.0	5.0	2.0	3.0	19.0

CR

Note: Others = ash, rubber, soil, bones, dust
CR= current Research
Source : (Nwoke et al., 2020)

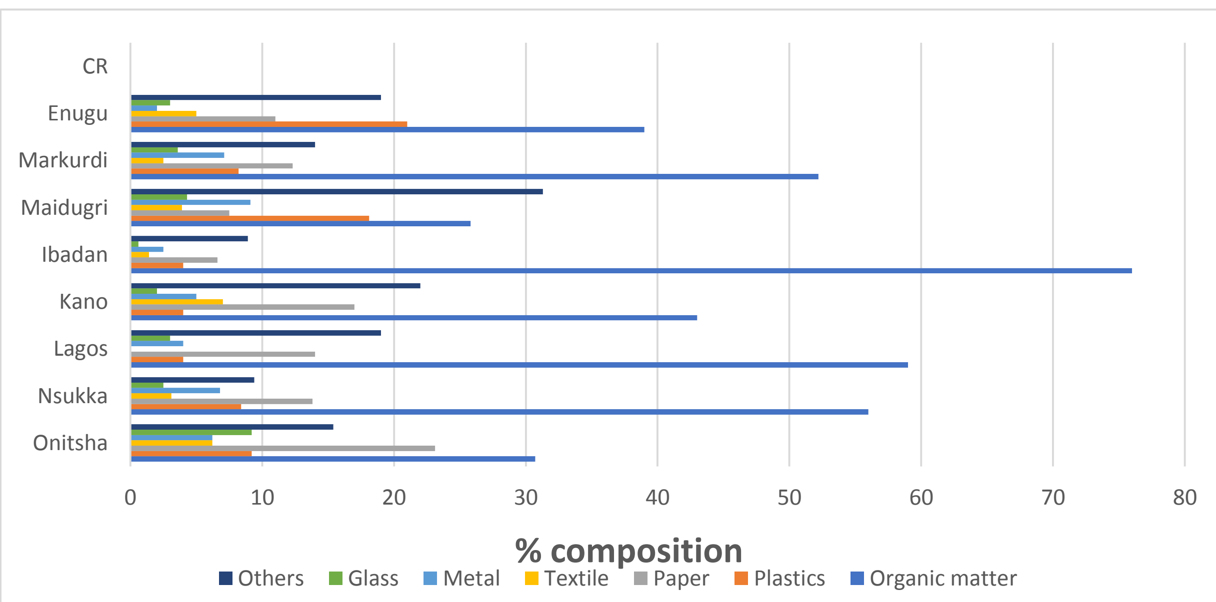

Figure 4: *Characteristics of waste stream compositions in others cities in Nigeria*

It can be seen from Figure 4 and Table 3 that the physical composition of the current work trails the same inclination with the research done previously by other researchers in Nigeria. (Diaz and Golueke, 1985; Ogwueleka, 2003; Ogwueleka, 2009; Agunwamba, 1998; Cointreau, 1982; Dauda; Osita, 2003 and Nwoke et al., 2020).

Opportunities in Enugu urban solid waste

Recollecting the influence of population expansion and increase in economic activities in Enugu urban, it is essential to look out for a possible means of addressing the situation. Managing waste and efficient supply of energy are obviously challenging issues in Enugu urban. Although, hydropower in Nigeria has enormous potential to generate electricity, however, it does not solve satisfactorily the problem. WTE concept, no matter the generated amount, can enhance energy supply Enugu urban dwellers. Presented in this section is the urban solid waste to energy conversions.

The Energy Content of Solid Waste in Enugu urban area

As solid waste contains different components so also there are differences in the calorific values of the individual components. In order to determine the heat content of solid waste, it is vital to not only know its composition but also its moisture content. Various sectors composition of solid waste in Enugu urban area are shown in figure 2 likewise collective Enugu urban solid waste composition figure 3. To determine the heat content of solid waste, the heat values of individual solid waste component is used. Table 4 shows the heat values of on dry basis, of various materials. The below formula is used to calculate the heat content of solid waste.

Heat content (HC) = Xi * HVi

where Xi = the fraction of component *i*

HVi = Heat Value of component *i*

Thus, the heat content of Enugu urban area solid waste is simply calculated as:

HC = 0.39 * 7.6 + 0.21 * 22.6 +0.11 * 6.7 + 0.05 * 13.8 + 0.02 * 0.7 + 0.03 * 0.1 + 0.19 * 41.3

= 17.001 million Btu

From the analysis it is obvious that each ton of Enugu urban solid waste has the potential to generate 17.001 million Btu.

It means that every day, a total of 5.0 MW energy theoretically can be generated from solid waste in Enugu urban area. If organic waste is the only one incinerated (as other components can be recycled or reused), it will generate about 2.96 million Btu (1.1MW), which is adequate to light just about 900 households. The amount produced is not that much, however, it is not that small to be ignored.

Table 4. Average heat value of possible components in Solid waste

Waste Component	**Heat Value (Btu/ton x 10^6)**
Plastic	22.6
Rubber	26.9
Leather	14.4
Textiles	13.8
Glass	0.1
Organic waste	7.6
Paper	6.7
Metal	0.7

(Source: Shrestha *et al.,* 2014**)**

Government Plan and Support

The execution of waste to energy concept involves reasonably great start -up investment. Full government support is needed. With the emergence of solid waste management innovative technologies, Enugu State Government, in order, to assist the Enugu State Waste Management Authority (ESWAMA) get rid of waste that is beginning to grow on dump locations in the city has constituted a 12-man committee charged with the responsibility of providing unprecedented efficient waste management services to all its domestic, industrial and commercial clients, government inclusive. The committee has already brought relief to the residents, with its partnership with private refuse collectors, who are assigned each of the 29 zones created to ensure better management of the wastes. The state government has also kick-off its programme on waste to wealth aiming at harnessing a novel line of economic activities and engaging interested investors through providing enabling environment for resources management, environmental protection by means of re-using and re-distribution of unwanted materials.

The Enugu state government is considering a partnership with Serene Green Field and Portland Waste to Energy in the waste management and disposal and to eventually grow the waste to an extent of generating energy and fertilizer (https://guardian.ng/property/enugu-begins-solid-waste-reform-partners-private-sector/) . Besides, transforming waste into energy will mitigate the level of air and water pollution, thus offering improved environment and significant energy production for the people. These impalpable benefits are frequently overlooked.

CONCLUSION AND RECOMMENDATION

Conclusion

The management of solid waste is a multi-variable problem. Basically in Enugu municipality, the problem is still at the rudimentary level. Numerous challenges are bound to be faced by the government, populace, private sectors and any other stakeholders. The technology, technique, public awareness, financial and management problems are some of the issues to be faced. Conversely, there are various substantial opportunities to be noted. The potential of solid waste to energy, the sponsorship from government and private sector participation would be the premeditation for progress.

Recommendation

- Government should set up strong policy on solid waste management and also offer with clear standard on the waste collection and transportation technique.
- It can make the landfill site so hygienic.
- Replacement of open dump with sanitary landfill.
- Anaerobic digestion is thought of to be the most economical solid waste to energy conversion technology. Ultimately, private sectors support will be needed by the government in procuring technology to convert solid waste into gas or electricity to have energy demand fulfilled.

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APPRAISING THE UNCONVENTIONAL EXPLOITATION OF COUNSTRUCTION MATERIALS AND SOLID MINERALS IN ENUGU NORTH LOCAL GOVERNMENT AREA, ENUGU STATE, NIGERIA

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ABSTRACT

In the exploitation of solid minerals, people harness them with the intention of boosting their socio – economic activities. The solid minerals like coal, sand, gravel, talc, gypsum, iron ore, lead, zinc, bentonite, barite, gold, and bitumen are exploited unlawfully and cause environmental degradation in the country. In the study area, Enugu North Local Government Area of Enugu State where active exploitation of solid minerals take place along Ekulu River. From the above mentioned problems, this study on appraising the unconventional exploitation of construction and solid minerals in Enugu North Local Government, was carried out with the following objectives; to identify the solid minerals in study area and to identify the unconventional exploitation practices in the study area. The descriptive empirical research was adopted in this study. The main reason for the adoption of this method was to obtain detailed and factual information about the various phenomena being studied, permitting their description and comparison as they really are.The entire three hundred and ninety seven (397) questionnaires administered to respondents in the study area were retrieved by the researcher. Data collected from the field work was presented and analysed in this section. A majority of the respondents said it causes erosion with 33.3% (132) while 15.1% (60) confirmed it increases health problems. Solid mineral exploitation practices in Enugu North Local Government Area have contaminated the Ekulu River through exposing unwanted ecological effects due to the uncontrolled disposal or poor management of mine wastes.

1.0 INTRODUCTION

Nigeria is one of the countries blessed in the world with abundant solid minerals (Adekoya, 2003). In the exploitation of solid minerals, people harness them with the intention of boosting their socio – economic activities. The solid mineral like coal, sand, gravel, talc, gypsum, iron ore, lead, zinc, bentonite, barite, gold, and bitumen are exploited unlawfully and causes environmental degradation in the country. In other words, the Federal Government owns, controls, monitors the exploitation of our natural solid mineral resources. Solid mineral deposits are scattered all over Nigeria, with more deposits in certain areas than other (Vanguard 13th June, 2014).

To that end, to ameliorate the problem mentioned above, the Nigerian Minerals and Mining Act (2007) passed into law on March 16, 2007 to repeal the Minerals and Mining Act, No 34 of 1999 (Vanguard 13th June, 2014). The Act vests control of all properties and minerals in Nigeria in the states and prohibits unauthorized exploitation of minerals.

All lands in which solid minerals have been found in commercial quantities shall from the commencement of the Act be acquired by the federal government in accordance with the Landuse Act of 1978. Property in mineral resources shall pass from the government to the person by whom the mineral resources are lawfully won upon their recovery in accordance with provisions of the Act.

The minister, amongst other things, is charged with the responsibility of ensuring the orderly and sustainable development of Nigeria's mineral resources, creating an enabling environment for private investors, both foreign and domestic, by providing adequate infrastructure for mining activities and also identifying areas where government intervention is desirable in achieving policy goals in mineral resources development.

The Act also provides for the establishment of the Mining Cadastre Office, MCO, which shall be responsible for the administration of mineral titles and the maintenance of the cadastral registers, and empowers the Minister, by regulation, to determine areas eligible for the grant of an exploration or mining lease based on a competitive bidding process. The MCO shall collect a fee for processing of applications for mineral titles and an annual service fee established at a fixed rate per square cadastral unit for administrative and management services.

All the local governments in Nigeria are endowed with abundant solid minerals including Enugu North L.G.A. is endowed with bountiful solid mineral resources some of which are in commercial quantities that can be exploited and utilized for earning foreign exchange. The Ekulu river of Enugu North L.G.A. has large deposits of sand and gravel.

Therefore, the study is carried out in order to assess the physical planning implications of unconventional exploitation of these solid minerals in Enugu North L.G.A. of Enugu State.

1.1 STATEMENT OF THE RESEARCH PROBLEM

In the study area, Enugu North Local Government Area of Enugu State where active exploitation of solid minerals take place along Ekulu river. The water is becoming exposed to unwanted ecological effects of mining activities due to the uncontrolled disposal or poor management of mine wastes. These drainage systems are connected to the city and the water percolates into the ground without being subjected to pre-treatment.

During and after the exploitation of solid minerals, the environment is exposed to erosion and the expansion of the river bank is experienced which endangers the live of people living within the area.

Heavy metals are generated by which the wastes are discharged in the environment due to lack of awareness concerning the health implications associated with it. It increases the health problems such as typhoid, cholera, dysentery and hepatitis. Again, the exploitation of solid minerals contributes in cracking of the buildings.From the above mentioned problems in Enugu North, this study on appraising the unconventional exploitation of construction and solid minerals in Enugu State, Nigeria was carried out.

1.2 AIM AND OBJECTIVES OF THE STUDY

The aim of this study is to appraise the unconventional exploitation of construction materials and solid minerals in Enugu North. To achieve this aim the following objectives are pursued:

1. To identify the solid minerals in Enugu North Local Government Area.
2. To identify the unconventional exploitation practices in solid minerals in Enugu North.

2.0 LITERATURE REVIEW

2.1 THE CLASSIFICATION OF SOLID MINERALS

Solid minerals are materials that originate from the earth and in its raw and natural form which are of value for one reason or the other (Adekoya, 2003). Solid minerals are not man-made (artificial) and are already on the earth, examples of solid minerals include limestone, iron ore, salt, zinc, aluminium, gold, lead, coal, sand and gravel. Solid minerals may also be defined as naturally occurring substances derived from the earth's crust and upper mantle which are of value to man. They include such broad groups as ferrous, non-ferrous and non-metallic substances. By simple elimination, therefore, solid minerals cover all such substances excluding crude oil, gas and water (Committee on National Policy on Solid Minerals (CNPSM) 1995: 4).

There are very many alternative ways of categorizing solid minerals. The approach to classification depends on the purpose on hand. They could be classified by reference to commodities, sector of activity, industrial use, mode of occurrence, size and spread of deposits. Whatever mode of classification adopted, it depends on the scope of analysis to be undertaken, that is, on whether analysis is from the point of view of the user or of the suppliers or of the controller and regulator.

The classification of the Department of Geological survey is adopted which groups solid minerals by reference to use. The following are the classes of solid minerals:

(i) **Mineral Fuels:** These are the solid minerals which are seen as fuel such as coal, lignite, bitumen, uranium and thorium.

(ii) **Structural and Building Materials:** They include limestone, stone, gypsum, asbestos, sand, gravel, marble and ceramic materials such as clay, feldspar, dolomite, and fluorspar asbestos.

(iii) **Industrial Materials:** These include the following four types of solid minerals:

- (a) Chemical materials such as salt, sodium carbonate and sulphate, potash, phosphate, nitrates and sulphur.
- (b) Metallurgical and refractory materials which include metallic ores, fluorspar, graphite, limetstome, dolomite, refractory clays, kynmite.
- (c) Abrasives within which are corundum, quartz, sand, diatomite and monazite.
- (d) Other industrial and manufacturing materials that include asbestos, mica, talc and monazite.
- (e) Gemstones include aquamanine, marine emerald, diamond, rubby, almandine, garnet, sapphire, amethyst, tourmaline, zircon and topaz.

The government as a controller and regulator may wish to separate some minerals from the general classifications for special reasons such as protection of:

(i) National Interest: Within this category are fuels like coal, lignite and thorium.

(ii) Security Interest: Such minerals include uranium and fissionable materials.

(iii) Strategic Industrial Interest: This group includes iron ore, gypsum (Committee on National Policy on Solid Minerals (CNPSM) 1995:4)

Table 1 Geographical Dispersion of Solid Minerals in Nigeria

Minerals	**Location**

Iron Ore	Itakpe, Chakochoko, Ajabonoko, Obajana, Ebija and Okudu in Kogi State; Muro in Plateau State; Bingi and Mararaba in Maru District of Northern Nigeria; Ajase in Osun State, Birni Kebbi, and Gusaka in Sokoto State.
Iron stone	Dakingari in Sokoto State; Tajimi in Kaduna State; Rishi in Bauchi State; Karfa in Borno State; Ejieja in Benue State; Nsude in Enugu State; Lokaja and Akpanya in Kogi State; Batati and Sakpe in Niger State.
Cassiterite	Jos in Plateau State, Bauchi
Columbite	Plateau, Kaduna, Kano, Bauchi, Ondo, Abuja and Kwara
Tantalite	Plateau, Kaduna, Bauchi and Ondo
Manganese	Mallam Ayuba in Kaduna State, Zaria
Vanadium	Abuja
Nickel	Ife – Ilesha in Osun State
Chromite	Sokoto and Katsina
Molybdenum	Plateau
Wolfram	Bauchi, Kano and Kaduna
Limenite	Plateau, Kaduna, Niger, Osun and Kwara
Tourmaline	Plateau, Kaduna and Kwara
Zircon	Kaduna
Limestone	Nkalagu and Odumoke in Ebonyi State, Mfamoshi and Odukpau in Cross River State; Ewekoro in Ogun State; Igumale, Ogbolokuta and Yandeu in Benue State, Ashaka, Bauchi, Kanawa, Kambiena in Sokoto State, Umu-Obom and Ohafia in Abia State.
Marbel	Jakura, Ubo and Ajaokuta in Kogi State, Ukpilla in Edo State, Itobe in Benue State and Kankara in Katsina State.
Dolomite	Osara and Elebu in Kogi State; Burum and Taka Lafia in the Federal Capital Territory, and Igbetti in Oyo State.
Clay	Ozubulu, Ihiala and Nnewi in Anambra State, Enugu, Kankara in Katsina State, Maraba Rido in Kaduna State, Onibode, Lisabi and Miroko in Ogun State, Jos and Ropp in Plateau State, Bin and Maiduguri in Borno State; Ukwuazuin Delta State, Bende, Umuahia and Ohaozara in Abia State, Nsu in Imo State, Garkidda and Taraba/Adamawa, Dawakin Minjibar and Tsanyawa in Kano State, Illo and Kaoje in Sokoto State, Ifon and Igbotako in Ondo State.
Emerald	Keffi in Plateau State
Aquamarine	Keffi in Plateau and Jamaa in Kaduna State
Ruby	Kaduna
Sapphire	Kaduna
Amethyst	Zaria Dala and Panama Ilemga Hill in Kaduna State, and Tafawa Balewa in Bauchi State
Rock Crystal	Jos Plateau
Garnet	Various location
Topaz	Jose Plateau
Fluorspar	Jos Plateau
Tourmaline	Jos Plateau
Coal	Enugu, Benue, Kogi, Obi-Lafia in Nassarawa State
Lignite	Enugu and Anambra States
Lead and Zinc	Abakaliki, Amaka, Amari, Enuigba, Ekwetekwe, Ika Inyere, Uburu and Ishiagu in Ebonyi State, Awe and Arufu in Nassarawa State and Tunga and Zunak in Amadawa/ Taraba States, Gwona in Bauchi State.

Source: Aliyu, 1996.Aigbedion and Iyayi (2007) identified the seven (7) strategic solid minerals, namely; coal, Bitumen, limestone, Iron Ore, Barites, Gold and Lead/Zinc.

2.2 SOLID MINERAL EXPLOITATION IN ENUGU STATE

The major solid mineral in Enugu State is coal which was discovered in 1909 and the Ogbete Mine had opened and begun regularly extracting coal by 1916. By 1920, coal production had reached 180,122 long tons (183,012t). At the same time, there were Okpara underground mine and Onyeama coal mine existing in Enugu State.

The Nigeria Coal Corporation (NCC) is a parastatal corporation that was formed in 1950 and held a monopoly on the mining, processing, and sales of coal, lignite, and coke products until 1999. Nigeria's peak coal production was in the late 1950's and by 1960 production was at 565,681 long tons (574,758t). the Nigerian civil war caused many mines to be abandoned. After the war ended in the early 1970s, coal production was never able to recover. Attempts to mechanize the industry in the 1970s and 1980s were ultimately unsuccessful and actually hindered production due to problems with implementation and maintenance (Ugwu, 1996). All the coal mines in Enugu State, none of them is functioning which made the Nigerian government to make effort to privatize the Nigerian Coal Corporation and sell off its assets to capable hands.

3.0 METHODOLOGY

3.1 RESEARCH DESIGN

The descriptive empirical research was adopted in this study. The main reason for the adoption of this method was to obtain detailed and factual information about the various phenomena being studied, permitting their description and comparison as they really are.

3.2 SOURCES OF DATA

The sources of data used in this research include primary and secondary data.

3.3 DETERMINATION OF SAMPLE SIZE

To interview the entire projected 2014 population of 197,850 inhabitants will be too large for the scope of the study. The researcher selected four communities which are Iva Valley, Government Reserved Area (GRA), Ogbete and Independence Layout. Therefore, the population was reduced to a manageable size. Thus, the Yamani (1964) formular for sample size was used.

The formular is:

$$n = 1 + \frac{N}{(Ne^2)}$$

Where n = Sample Size

N = Population Size

e = Error Limit

Thus, we have N = 64,521

e = 0.05

$$\therefore \quad n = \frac{64{,}521}{1 + (64{,}521\, x\, 0.05^2)}$$

$$= \frac{64{,}521}{1 + 161.302}$$

$$= \frac{64{,}521}{162.302}$$

= 397

In other words, 397 inhabitants were selected in the study area. Given this sample size to be 397 inhabitants, it is then possible to determine the fractional representation of the inhabitants to be surveyed in the selected communities.

Table 3: Number of Sampled Respondents from the Communities

S/N	Names of Community	Population Size	No of Sampled Respondents	Percentage (%)
1	Iva Valley	8,891	55	13.78
2	Government Reserved Area (GRA)	19,600	121	30.38
3	Ogbete	25,994	159	40.29
4	Independence Layout	10,036	62	15.55
	Total	**64,521**	**397**	**100**

Source: Researcher's Fieldwork, 2014

Table 4.1 above shows that out of the total number of the total number of respondents sampled Iva Valley, Government Reserved Area (GRA), Ogbete and Independence Layout have 55 (13.78%), 121 (30.38%), 159 (40.29%), and 62 (15.55%) respectively.

3.4 METHOD OF DATA ANALYSIS

After collating the raw data, all information generated were analyzed and presented in tables and charts. The researcher at the same time used simple percentages and frequency of occurrence of variables to analysis data. Data were presented in visual, numerical and literal manner.

3.5 CONSTRAINTS OF DATA ANALYSIS

In the process of data analysis, the researcher encountered many problems. Firstly, relevant data on solid minerals in the study area were not easily obtained. Some of the key officers in the local government headquarters interviewed like the Chief Executive Officer of the Town Planning Authority could not present most of the information required from him. Moreover, the office could not locate them because the files were not well arranged. Secondly, the researcher could not easily obtain the amount generated every day because the accountant responded that the file bearing the information was confidential.Finally, one would expect that valuable information was formally reported in brochures or quarterly magazines. Such was not always the case. Consequently, relevant information were not readily available, while those that were available, were not organized in a format that the researcher could use them easily.

The above delay notwithstanding, efforts were made to ensure that the limitations have little or no effect on the quality of this work.

3.6 DATA ANALYSIS

The entire three hundred and ninety seven (397) questionnaires administered to respondents in the study area were retrieved by the researcher. Data collected from the field work was presented and analysed in this section. Response from respondents in the four (4) communities were collated and collectively analysed. Effort was made by the researcher to relate data analysis to the stated objectives.

3.7 CHARACTERISTICS OF RESPONDENTS

This chapter helps in discussing the attitudes or behaviours of respondents towards the questions given to them and the answer provided by them on the physical planning implications of unconventional exploitation of solid minerals which the researcher will use in analysing and determining the final result on the course of the study.

Table 4: Sex of Respondents

Sex	No	Percentage (%)
Male	219	55.2
Female	178	44.8
Total	**397**	**100.00**

Source: Field Survey, 2014.

Of the 397 respondents, 55.2% of them were males while 44.8% were females. This means that more than half of the total respondents sampled were males. (Table 4)

Data analysis of the marital status of the respondents is shown in table 5

Table 5: Marital Status of Respondents

Marital Status	No	Percentage (%)
Single	185	46.6
Married	133	33.5
Divorced	22	5.6
Widowed	39	9.8
Separated	18	4.5
Total	**397**	**100.00**

Source: Researcher's Fieldwork, 2014.

Table 5 above shows that 46.6% (185) of the respondents interviewed were single, 33.5% (133) were married, 5.6% (22) were divorced, 9.8% (39) were widowed and 4.5% (18) were separated respectively.

Table 6: Educational Qualification of Respondents

Educational Qualification	No	Percentage (%)
No Formal Education	9	2.3

Primary Education	86	21.6
WASCE	72	18.1
OND/NCE	90	22.7
BSC	77	19.4
MSC	35	8.8
PhD	28	7.1
Total	**397**	**100.00**

Source: Researcher's Fieldwork, 2014.

Table 6 shows that 2.3% (9) of the respondents had no formal education, 21.6% (86) had primary education, 18.1% (72) had West African School Certificate Examination while 19.4% (77) and 8.8% (35) of the respondents had Bachelor of Science and Master of Science degree respectively.

Table 7: Occupation of Respondents

Occupation	No	Percentage (%)
Miner	52	13.1
Trader	82	20.6
Student	109	27.5
Civil servant	100	25.2
Unemployed	54	13.6
Total	**397**	**100.00**

Source: Researcher's Fieldwork, 2014.

Table 7 indicates that 13.1% (52) were miners while 20.6% (82) were traders. 27.5% (109) of the respondents were students, 25.2% (100) were civil servants and 13.6% (54) were unemployed respectively.

Table 8: Monthly Income Level of Respondents

Income Level	No	Percentage (%)
N1000 – N7500	202	50.9
N7501 – N15000	76	19.1
N15001 – N25000	65	16.4
N25001 and above	54	13.6
Total	**397**	**100.00**

Source: Researcher's Fieldwork, 2014.

The monthly income of the respondents as shown in table 8 reveals that 50.9% (202) fall within the income range of N1000 – N7500 per month while 19.1% (76) of the respondents were under N7501 – N15000 per month. 16.4% (65) of the respondents were under the range of N15001 – N25000 and 13.6% (54) were under the range of N25001 and above.

3.7.1 THE SOLID MINERALS HARNESSED IN ENUGU NORTH

In this section, it is understood that the solid minerals harnessed in the study area are coal, sand, gravel and clay. Some of the solid minerals are harnessed both in small and large quantities depending on the equipments used and the number of people that are in most need of them.

3.7.2 THE METHODS USED IN THE EXPLOITATION OF SOLID MINERALS

It helps in explaining the methods used in exploiting solid minerals in Enugu North Local Government Area of Enugu State.

Table 5.6: The Method Used in the Exploitation of Solid Minerals

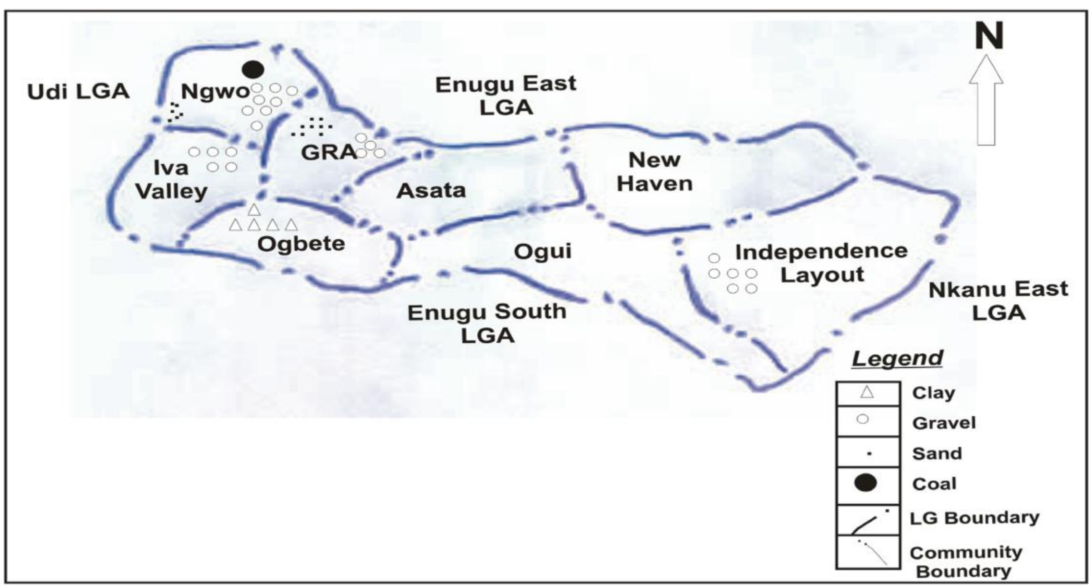
S/N	Solid Minerals	Method used			
		Manual	%	Mechanical	(%)
1	Coal	74	19	30	7
2	Sand	67	17	20	5
3	Gravel	50	13	40	10
4	Clay	78	20	38	9
	Total	**269**		128	

Source: Researcher's Fieldwork, 2014.

Table 5.6 shows that at Ngwo 19% of the respondents used manual method in exploiting coal while 7% used mechanical. At GRA 17% exploited sand manually, 5% mechanically. Iva Valley exploited gravel 13% manually, 10% mechanically and 20% exploited clay manually at Ogbete while 9% mechanically.

3.7.3 THE UNCONVENTIONAL EXPLOITATION PRACTICES IN SOLID MINERALS IN ENUGU NORTH

In this section, it explains the solid minerals exploitation practices done unconventionally in the study area such as coal, sand, gravel and clay.



Map 1: Solid Minerals in Selected Communities of Enugu North

Source: Ministry of Lands, Enugu State and Researcher's Fieldwork, 2014

Figure 1 above explains areas where solid minerals are exploited unconventionally in the study area. Some of the solid minerals are coal, sand, gravel and clay.

Onyeama Coal Mine is situated at Ngwo, where the category of mining practice used was the underground mining system (see Plate 5.3). In the underground mining practice picks and shovels were used in the exploitation of coal. The coal at Onyeama mine in Enugu North in known to be sub bituminous at the depth of 180m. The illegal miners exploit very small amount of coal due to they use manual method of exploitation. It is used in the generation of electricity, steel production, cement manufacturing and as a solid fuel. From the researcher's observation and enquiry, the exploitation of coal in Enugu North is a thing of the past because of the disturbances gotten from the government security personnels. It was observed that people contaminated diseases such as typhoid, cholera, dysentery and hepatitis when they drink water fetched from the river (see plate 5.5)

In the exploitation of sand and gravel at Malachy, Charley and Alabama sites, the miners exploit the minerals from the water whereby articulated vehicles will convey the products to the users at different locations within the state (see Plate 5.1). Sand and gravel are used in the building of roads and house making concretes and blocks, mortar and plaster. The researcher was made to understand that the quality of sand and gravel exploited is determined by the rainfall. The miner make use of shovel and iron sieve in the exploitation of the minerals.

Moreover, Baba (Omemgboji), Peter and Canal sites also exist at the Gulf Estate where the exploitation of solid minerals written above still reoccurs itself. (see Plate 1.2)

The exploitation of clay was noticed at bunker the former Coal Preparatory Plant (CPP) where coal was assembled, washed and distributed within and outside the country as the case may be (see Plate 5.4). The miners at the same time make use of picks and shovels in the exploitation of the mineral. In this context, clay is used to manufacture ceramics, plastic, paper, rubber, building of houses in the form of bricks, manufacturing of tiles and making of fillers. Recently, clay is exploited by few people in the study area.

To that end, the effects of unconventional exploitation practices in the area; the reduction of farm and grazing land, destruction of landscape, collapse of river bank, deforestation, water and air pollutions.

In Enugu North, the miners prefer the manual method of solid minerals exploitation because if they are provided with the mechanized method that the finance generated will be for the government. It has also been observed the factors responsible for unconventional exploitation of solid minerals are lack of experience, poverty, lack of mechanized equipment, low level of education and lack of job opportunity.

Plate 4: Exploitation of Clay at Bunker, Ogbete, Enugu.

Plate 5: People Fetching Water at Ekulu River, GRA, Enugu.

Source: Researcher's Fieldwork, 2014.

4.0 FINDINGS

In this section, the data analysis in the proceeding section the findings are indicated as follows:

i. The male respondents are more than the female ones with 55.2% (219) to 44.8% (178) in the four selected communities.

ii. 46.6% (185) of the respondents were single and 33.5% (133) were married.

iii. A large number of the respondents had OND/NCE with 22.7% (90) while 2.3% (9) of the respondents had no formal education.

iv. About 50.9% (202) of the respondents earned N1000 – N7500 per month while 13.6% (54) earned N2500 and above.

v. A huge number of the respondents harnessed sand with 56.2% (223) while 7.5% (30) was on clay.

vi. A large number of the respondents exploited the minerals manually with 67.8% (269) while 32.2% (128) was done mechanically.

vii. A large proportion of the respondents said the factor influencing practices in harnessing solid minerals is poverty with 34.3% (136) while 8.1% (32) was lack of job opportunity.

viii. A majority of the respondents said it causes erosion with 33.3% (132) while 15.1% (60) confirmed it increases health problems.

5.0 CONCLUSION

Solid mineral exploitation practices in Enugu North Local Government Area have contaminated the Ekulu river through exposing unwanted ecological effects due to the uncontrolled disposal or poor management of mine wastes. The drainages are connected to the mine wastes. The drainages ware connected to the city and the water percolates into the ground without being subjected to pre-treatment. The exploitation of solid minerals in the environment is exposed to erosion environmental pollution and the expansion of the river bank is experienced which endangers the live of people living in the study area. Heavy metals are generated by which the wastes are discharged in the environment due to lack of awareness concerning the health implications associated with it. It increases the health problems in the area such as typhoid, cholera, dysentery and hepatitis. It was observed that the exploitation practices contribute in cracking the buildings.

The result of this research give relevant information on the solid minerals in the four selected communities from Enugu North Local Government Area of Enugu State. The research shows that the miners made use of manual method of exploitation which contributed in extracting small amount of the solid minerals at Iva Valley, Government Reserved Area (GRA), Ogbete and Independence Layout respectively.

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DURABILITY PERFORMANCE OF GEOPOLYMER MORTAR SYNTHESIZED FROM TERNARY BLEND OF CASSAVA PEEL ASH, RICE HUSK ASH, AND METAKAOLIN

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Geopolymer technology involves production of cementless, environmental-friendly concrete which is synthesized from agriculture by-products such as Rice Husk Ash (RHA), Cassava Peel Ash (CPA) and earth explore product like Metakaolin (MK) with merits to decrease the enormous amount of agricultural waste and earth explore materials as well as the contribution in carbon footprint annually. The study therefore explored the development of alkali-activated CPA-SHA-MK ternary blended geopolymer mortar (GPM) using sodium silicate (Na_2Si_3) and sodium hydroxide (NAOH) solution with 9M constant concentration as alkaline activators under both the aggressive and ambient-temperature curing media. The mass ratio of sodium silicate to sodium hydroxide (NS:NH) and as well as the binder to fine aggregate were fixed to 2.5 and 0.8 respectively It also analyse the extent to which the Supplementary Cementitious Materials (SCMs) improves the durability performance of the product. The durability of the ternary blended geopolymer mortar was examined through water absorption test, acid resistance test and sulphate resistance test using 50 mm cubes after 28, 56 and 90 days of curing. The results revealed that the setting time prolonged as the replacement levels of RHA-MK increased at a decrease in replacement levels of CPA. The results also showed that the mortar cured in sulphate solution as well as the sulphuric acid showed white precipitate on the reference specimen (PCM) with rounded edges and the GPM incorporated SCMs and activators (C90M7R3, C70M20R10, C50M33R17, C30M47R23 and C10M60R30) showed a little dark colour at all ages. The GPM discovered to be more resistance to water absorption as compared to PCM while it was observed that the absorption increases as the hydration periods increases. Furthermore, both the PCM and GPM samples studied suffered mass and strength losses in both the acid and sulphate solution and the loss increases at an increase in the hydration periods while the loss as caused by sulphuric acid is more pronounced. The losses were observed to be higher in PCM as compared to the GPMs while the mix incorporated 50% CPA, 33% MK and 17% RHA (C50M33R17) was observed to be better compared to other mixes in durability behaviour and the study therefore recommends C50M33R17 for good durability performance.

Keywords: Durability, Geopolymer, Rice Husk Ash (RHA), Cassava Peel Ash (CPA) and Metakaolin (MK).

GREEN BUILDING STRATEGIES: THE WAY FORWARD FOR EBONYI STATE, NIGERIA

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Abstract

Green Building Strategies: The Way Forward for Ebonyi State, Nigeria" was a study carried out to determine the feasibility for the adoption of green building strategies in Ebonyi State. It has two specific objectives as follows: to identify the benefits of green buildings over conventional buildings; and to evaluate the challenges of green buildings over conventional buildings. Two research questions and two null hypotheses guided the study. The study used descriptive survey design. The area of study was Ebonyi State in Southeast Region, Nigeria. The population of the study was 56 architects who were members of the Nigerian Institute of Architects, Abakaliki Branch. There was no sample size as the whole population was used for the study. The two research questions were analysed using mean and standard deviation while the two null hypotheses were tested using Chi-square statistic at 0.05 level of significance. The results of the study showed that: there are significant benefits of green building over conventional buildings for its adoption in Ebonyi State (χ^2 =46.08 at $P<0.05$); and there are significant challenges or problems of green buildings over conventional buildings for their adoption in Ebonyi State (χ^2 =32 at $P<0.05$). The conclusion of the study was that green buildings have significant benefits as well as significant problems or challenges. The study recommended that the Ebonyi State should not adopt green building strategies until the identified challenges have been fully mitigated.

Key Words: Green Building, Strategies

INTRODUCTION

Background of the Study

The green building concept has gained momentum recently in developed and developing nations because of the negative impact of carbon dioxide and other dangerous gases' emissions into the atmosphere from conventional buildings which have resulted in global warming and their negative impacts worldwide especially changes in weather and climate on Earth. Green Building (GB) was defined by the Organisation for Economic Co-operation and Development (OECD, 2003) as those buildings that have minimum adverse effects on the built and natural environment, in terms of the buildings themselves, their immediate surroundings and the broader regional and global setting. According to OECD, a green building is designed to minimize the total environmental impact of its materials, construction, operation and deconstruction while maximizing opportunities for indoor environmental quality and performance. Green buildings are constructed and operated in ways that enhance their impact on the building occupants while reducing impacts on the environment.

Jain (2009) defined green building as one which adopts the best practices of environmental technology for optimizing the use of natural resources for providing clean and cost effective working ambience. Green buildings minimize the consumption of materials and maximize their reuse; create quality buildings that are commercially viable; minimize energy consumption and greenhouse gas emissions; adopt environmentally sound and healthy work practices during and after construction. Green building is also known as sustainable building. It is both structure and the application of processes that are environmentally responsible and resource-efficient throughout a buildings life-cycle: from planning to design, construction, operation, maintenance, renovation and demolition (Wiki, 2021). A sustainable building is a structure that is designed, built, renovated, operated or reused in an ecological and resource efficient manner. Consequently, a green building has these attributes: it has eco-friendly structure and environment; it utilizes minimum natural resources; it is sustainable-has internal means of generating resources; it conserves energy by means of smart devices and uses recyclable materials. It is designed to use the standard elements of building-walls, windows and floors to collect, store and release energy from the sun for heating, lighting and cooling (Jain, 2009).

The need to evaluate the usefulness of green building concept with a view to adopting it in Ebonyi State at this time of her socio-economic development cannot be overemphasized. The study therefore, sought to determine the way forward for green buildings over conventional buildings in Ebonyi State, using the benefits and challenges. In this study, strategy is defined as a plan intended to be used to achieve a given task or goal (Hornby,2015).

Statement of the Problem

Conventional buildings consume too much energy in terms of electricity and this affects the finances of occupants negatively. The problem of rising energy charge in Nigeria is affecting both the rich and poor in urban centres especially residents of Ebonyi State. Monthly electricity bills from Enugu Electricity Distribution Company (EEDC) for a three bedroom flat in Abakaliki hovers between N15000 and N18000 and that is impacting negatively on people's meager incomes. Aside high energy costs, maintenance and operational costs increase as the buildings get old. Residents of major towns in Ebonyi State are in dire need of environmentally friendly houses that can lower energy and maintenance costs. Before green building strategies can be considered for adoption in Ebonyi State, there is need to provide answers to the following nagging questions: What are the benefits of green buildings? What are the problems or challenges of green buildings? Given the above situation, and the need to properly evaluate the new concept of green building before its adoption in the state, it became imperative to undertake the study on “Green Building Strategies: The Way Forward for Ebonyi State, Nigeria.”

Aims and Objectives of the Study

The main aim of the study was to determine green building strategies-the way forward for Ebonyi State, Nigeria. The specific objectives of the study were:

- To identify the benefits of green building over conventional building for its adoption in Ebonyi State; and
- To appraise the challenges of green building over conventional building for its adoption in Ebonyi State.

Scope of the Study

This study covers the following:

- Academic scope- benefits and challenges of green buildings.
- Geographical scope- Ebonyi State, Southeast Region,Nigeria.

Research Questions

The following research questions guided the study:

- What are the benefits of green building over conventional building for its adoption in Ebonyi State?
- What are the challenges of green building over conventional building for its in Ebonyi State?

Research Hypothesis

The study tested the following null hypotheses at 0.05 level of significance:

Ho_1: There are no significant benefits of green buildings over conventional buildings for adoption in Ebonyi State, Nigeria.

HO_2: There are no significant challenges of green buildings over conventional buildings for adoption in Ebonyi State, Nigeria.

2.0 LITERATURE REVIEW

2.1 Conceptual Review

Benefits of Green Buildings

On the other hand, studies by Davies (2006), Sarma (2014) and Dahiru, Dania and Adejoh (2014), showed that green buildings have these benefits: reduce energy consumption, reduce water consumption. They are cost efficient to run, reduce operational costs, preserve natural resources, reduce greenhouse emissions and improve the quality of life and health of occupants. Other benefits of green buildings according to experts (Jain, 2009; Giduthuri and Vanakuru, 2017 and Ismaila, et al, 2021) are as follows:

- Green buildings have lower running costs by using natural ventilation, energy saving lighting, heating and cooling systems resulting in savings.
- They have lower maintenance costs by using intelligent and sophisticated technology for monitoring all devices installed in the building and so can alert the occupants of imminent faults thus, saving more costly maintenance at a later date.
- Increased productivity-by providing an environment that is capable of adapting to individual or collective requirements thereby producing a comfortable work environment that help people to raise their productivity at work.
- It adapts to changes in the environment because of its robust design and so can respond to personal or group changing requirements, mood and taste.
- Economically, a green building may cost more up front but saves costs through lower operating costs over the life of the building.
- Other benefits are that they improve the health of the occupants, comfort, reduce pollution and landfill wastes.
- They minimize the consumption of materials and maximizes their reuse; creates a quality building that is commercially viable; minimizes energy consumption and greenhouse gas emissions; adopts environmentally sound and healthy work practices, during both construction and occupancy.
- They have higher occupancy rate and lower tenant turnover; they protect and conserve the environment; average increase in building value is about 7.5% (McGraw Hill, 2006). According to Green Building Council of Australia (2006), green buildings have higher relative return on investment (minimum of 14%).

Given the financial and economic benefits of green building in other parts of the world especially in developed nations as revealed by literature, there is a need to examine the challenges that may militate against its adoption in Ebonyi State. Studies in the United States of America have found that every conventional building is producing 40% of carbon dioxide in the environment. Carbon dioxide produces green house effects by depleting the ozone layer (Shabrin and Kashem, 2017).

Challenges of Green Buildings

Production of green buildings has many challenges or problems despite the benefits. The major challenges are: design difficulties; scarcity of materials; how to minimize energy usage; how to minimize external pollution; how to reduce embodied energy and resource depletion; how to reduce internal pollution and damage to human health (Jain, 2009). Other researchers and experts such as Onyia, Chime, Nnam, Ifeanyi and Agbatah (2019); Giduthuri and Vanakuru, 2017; Ismaila,Egbo, Kigun and Ayoola (2021); Dahiru, Dania and Adejoh (2014) identified other challenges facing the adoption of green building strategies in developing countries including Nigeria as follows: lack of enabling environment; lack of technology to produce green building materials; lack of interest in the issue of sustainability; uncertainty in economic environment; lack of awareness of the existence of green building concepts and lack of green building materials. On the other hand, conventional buildings do not face those problems that green buildings are associated with and besides technologies and materials abound everywhere.

2.2 Empirical Review

Ismaila, Egbo, Kigun and Ayoola (2021), conducted a study on "The Challenges and Prospects of Green Building Construction for Sustainable Urbanisation in Jos Metropolis, Nigeria." They found that green building was not being adopted and constructed in Jos Metropolis despite the need because there was no awareness on green building concept and developers preferred conventional buildings to green buildings. The study also identified the benefits of green buildings as preservation of natural resources and increase in health and productivity of occupants.

Zhao, Wang, Qiu, Qu and Zhang (2018), carried out a study titled, "Research on the Application of Green Building Materials in China." The study found that companies and individuals that wanted to apply green building materials faced challenges of lack of enough green building materials; high cost of technological inputs and raw materials for the production of green building materials; and lack of government support to those that want to construct green buildings.

Ogbonna, Obinka and Aguguo (2017), carried out a study on "Property Development and Land Use Planning Regulations in Nigeria." The area of study was Abia State in Nigeria. The study found that the level of compliance to building regulations was insignificant and that the level of compliance to building regulations between buildings constructed in urban areas and those constructed in sub-urban areas was significant. They recommended that Abia State Government should prepare up-to-date land use plans for various categories of towns in urban and rural areas of the state.

Dahiru, Dania and Adejoh (2014), conducted a study on "An Investigation into the Prospects of Green Building Practice in Nigeria," and found that green building was not practiced in Nigeria due to lack of awareness; harsh economic conditions and lack of enabling environment in form of government policy or legislation. It identified health and increase in productivity as benefits of green building.

The study by Sarma (2014) on "Problem, Progress and Prospect of Green Building as a means of Sustainable Urbanization with special reference to Guwahati City of Assam, India," found that green building construction would benefit Guwahati City by reducing energy consumption, bring economic and financial growth and gains; reduce wastes and would make buildings cost efficient to run.

3.0 METHODS

The study used survey design. The area of study was Abakaliki Metropolis of Ebonyi State, Southeast Region in Nigeria. The population of study was 56 architects who were members of Nigerian Institute of Architects, Abakaliki Branch. There was no sample size as the whole population was used. The instrument for data collection was a questionnaire containing two sections with 8 items per section making it 16 items. It was structured on a five point Likert Type scale of Strongly Agree (SA), Agree (A), Undecided (UD), Strongly Disagree (SD) and Disagree (D).They were assigned weights of 5,4,3,2 and 1 respectively. The research questions were analysed using mean and standard deviation while the null hypotheses were tested using Chi-square statistic. 56 copies of the questionnaire were distributed to the respondents but only 50copies were returned. The return rate was 89.29%. Analysis of the research questions were based on 50 copies. Criteria for accepting that respondents agreed on an item was that the calculated mean value should be equal to or greater than 3.00 while standard deviation score should be less than 1.0. In the test of hypothesis, null hypothesis or Ho, was accepted if the Chi-square table value was greater than Chi-square calculated value at 0.05 significant level and at appropriate degree of freedom.

4.0 RESULTS

Presentation of Data Relating to Research Questions

Research Questions 1: What are the benefits of green buildings over conventional buildings for adoption in Ebonyi State, Nigeria?

Table 4.1: Summary of respondents' views and mean scores of significant benefits of green building showed that there were eight benefits of green building, namely: lowers running and maintenance costs; improves health of occupants; reduces environmental pollution and landfills; minimizes consumption of materials and maximizes their reuse; increases productivity of occupants; minimizes energy consumption and green house emissions; have higher occupancy rate and lower turnover; have higher relative return on investment. Mean score for each benefit was greater than 3.0 and were 4.52, 4.46, 4.38, 4.36, 4.24, 4.60, 4.52 and 4.36 respectively. Grand mean value was 4.88. Standard deviation value for each benefit was less than 1.0. It

ranged from 0.60 to 0.68. Grand standard deviation value was 0.64. The standard deviation values clustered about the mean, showing homogeneity in agreement by the respondents. They agreed that green building had the eight (8) benefits.

Table 4.1: Summary of respondents' views and mean scores on significant benefits of green buildings over conventional buildings for adoption in Ebonyi State, Nigeria

S/N	Benefits of Green Building	SA	A	UD	SD	D	Total	X	SD	Rmk
1	Lowers running and maintenance costs	26	24	0	0	0	50	4.52	0.66	Agree
2	Improves health of occupants	25	23	2	0	0	50	4.46	0.64	Agree
3	Reduces environmental pollution and landfill wastes	25	24	1	0	0	50	4.80	0.65	Agree
4	Minimizes consumption and maximizes reuse of materials	20	28	2	0	0	50	4.36	0.62	Agree
5	Increases productivity of occupants	18	26	6	0	0	50	4.24	0.50	Agree
6	Minimizes energy consumption and green gas emissions	30	20	0	0	0	50	4.60	0.68	Agree
7	Have higher occupancy rate and lower turnover	26	24	0	0	0	50	4.52	0.66	Agree
8	Have higher relative return on investment	20	28	2	0	0	50	4.36	0.62	Agree

	Grand Total							**35.54**	**5.13**	
	Grand Mean							**4.88**	**0.64**	**Agree**

Source: Field Survey, 2021

Research Questions 2: What are the challenges of green buildings over conventional buildings for adoption in Ebonyi State, Nigeria?

Table 4.2: Summary of respondents' views and mean scores of challenges of green buildings over conventional ones showed that there were seven of such challenges, namely: lack of government policy legislation at federal and state levels for its adoption; lack of technology for the production of green building materials in Nigeria; lack of interest on issue of sustainability by most Nigerians; lack of awareness of the existence of green building concept by the public; . lack of experience on design of green buildings by Nigerian architects; uncertainty in Nigerian economic environment; and lack of green building materials. Mean score for each challenge of green building was greater than 3.0 and were 4.56, 4.60, 4.46, 4.53, 4.56, 4.40 and 4.56 respectively. Grand mean value was 4.52. Standard deviation value for each challenge was less than 1.0. It ranged from 0.63 to 0.68. Grand standard deviation value was 0.66. The standard deviation values clustered about the mean, showing homogeneity in agreement by the respondents. They agreed that there were eight challenges of green building strategies over conventional buildings.

Table 4.2: Summary of respondents' views and mean scores on challenges of green buildings over conventional buildings for adoption in Ebonyi State, Nigeria

S/N	Challenges of green buildings	SA	A	UD	SD	D	Total	X	SD	Rmk
1	Lack of government policy legislation at federal and state levels for its adoption	30	18	2	0	0	50	4.56	0.67	Agree
2	Lack of technology for the production of green building materials in Nigeria	32	16	2	0	0	50	4.60	0.68	Agree
3	Lack of interest on issue of sustainability by most	25	23	2	0	0	50	4.46	0.64	Agree

	Nigerians									
4	Lack of awareness of the existence of green building concept by the public	26	24	0	0	0	50	4.53	0.66	Agree
5	Lack of experience on design of green buildings by Nigerian architects	28	22	0	0	0	50	4.56	0.67	Agree
6	Uncertainty in Nigerian economic environment	22	26	2	0	0	50	4.40	0.63	Agree
7	Lack of green building materials	28	22	0	0	0	50	4.56	0.67	Agree
	Grand Total							**31.66**	**4.62**	
	Grand Mean							**4.52**	**0.66**	Agree

Source: Field Survey, 2021

Testing Hypotheses

Hypothesis 1

HO_1: There are no significant benefits of green buildings over conventional buildings for adoption in Ebonyi State, Nigeria.

Hypothesis 1 was tested using data from Table 4.1 above and table 4.3 below. Table 4.1 showed that the grand mean score for respondents was 4.88 with standard deviation score of 0.64 while Chi-square calculated value was 46.08 (see table 4.3 below). With 15 degrees of freedom at 0.05 level of significance, Chi-square critical value is 24.996. Since Chi-square calculated value of 46.08 was greater than Chi-square critical value of 24.996, HO was rejected while Hi was accepted, showing that there were significant benefits of green buildings over conventional buildings for adoption in Ebonyi State. The result is statistically significant. The evidence was that “there are significant benefits of green buildings over conventional buildings for adoption in

Ebonyi State.” In other words, adoption of green building strategies in Ebonyi State will bring significant benefits to the adopters, occupants and users compared with conventional buildings.

Table 4.3: Observed and Expected Frequency for Testing Hypothesis 1

Response	Observed O	Expected E	O – E	$(O - E)^2$	$\sum(O-E)^2$
Yes	49	25	24	576	23.04
No	1	25	-24	576	23.04
Total	50	50	-	χ^2	46.08

Source: Field Survey, 2021

Hypothesis 2

HO_2: There are no significant challenges of green buildings over conventional buildings for adoption in Ebonyi State, Nigeria.

Hypothesis 2 was tested using data from Table 4.2 above and table 4.4 below. Table 4.2 showed that the grand mean score for respondents was 4.52 with standard deviation score of 0.66 while Chi-square calculated value was 32 (see table 4.4 below). With 15 degrees of freedom at 0.05 level of significance, Chi-square critical value was 24.996. Since Chi-square calculated value of 32 was greater than Chi-square critical value of 24.996, HO was rejected while Hi was accepted, showing that there were significant challenges of green buildings over conventional buildings for adoption in Ebonyi State, Nigeria. The result is statistically significant. The evidence was that “There are significant challenges on green buildings for adoption in Ebonyi State, Nigeria.” In other words, there are challenges or problems which green buildings have that militate against adoption in Ebonyi State.

Table 4.4: Observed and Expected Frequency for Testing Hypothesis 2

Response	Observed O	Expected E	O – E	$(O - E)^2$	$\sum(O-E)^2$
Yes	45	25	20	400	16
No	5	25	-20	400	16

Total	50	50	-	χ^2	32

Source: Field Survey, 2021

Discussion of Findings

Test of Hypothesis I

Test of hypothesis 1 found that "there are significant benefits of green building over conventional buildings for adoption in Ebonyi State, Nigeria." Eight (8) benefits were identified in analysis of Research Question 1 as follows: lowers running and maintenance costs, improves health of occupants, reduces environmental pollution and landfills, minimizes consumption of materials and maximizes their reuse, increases productivity of occupants, minimizes energy consumption and green house emissions; have higher occupancy rate and lower turnover; and have higher relative return on investment. The finding was in line with the findings of Ismaila, Egbo, Kigun and Ayoola (2021), in their study on "The Challenges and Prospects of Green Building Construction for Sustainable Urbanisation in Jos Metropolis, Nigeria." The study identified the benefits of green buildings as preservation of natural resources and increase in health and productivity of occupants. The study by Dahiru, Dania and Adejoh (2014), on "An Investigation into the Prospects of Green Building Practice in Nigeria," found that green building improved health and increase in productivity of occupants. The study by Sarma (2014) on "Problem, Progress and Prospect of Green Building as a means of Sustainable Urbanization with special reference to Guwahati City of Assam, India," found that green building construction would benefit Guwahati City by reducing energy consumption, bring economic and financial growth and gains; reduce wastes and would make buildings cost efficient to run.

Test of Hypothesis 2

Test of hypothesis 2 found that "There were significant challenges of green buildings over conventional buildings for adoption in Ebonyi State, Nigeria. The challenges were seven, namely: lack of government policy legislation at federal and state levels for its adoption; lack of technology for the production of green building materials in Nigeria; lack of interest on issue of sustainability by most Nigerians; lack of awareness of the existence of green building concept by the public; . lack of experience on design of green buildings by Nigerian architects; uncertainty in Nigerian economic environment; and lack of green building materials. This finding is consistent with the findings of Zhao, Wang, Qiu, Qu and Zhang (2018) in their study titled "Research on the Application of Green Building Materials in China."They found that companies and individuals that wanted to apply green building materials faced challenges of lack of enough green building materials; high cost of technological inputs and lack of raw materials for the production of green building materials; and lack of government support to those that wanted to construct green buildings. The study by Dahiru, Dania and Adejoh (2014) titled "An Investigation into the Prospects of Green Building Practice in Nigeria," found that green building was not practiced in Nigeria due to lack of awareness; harsh economic conditions and lack of enabling environment in form of government policy or legislation. Also the study by Ismaila, Egbo, Kigun and Ayoola (2021) titled "The Challenges and Prospects of Green Building Construction for Sustainable Urbanisation in Jos Metropolis, Nigeria" found that green building was not being practiced in Jos Metropolis despite the need because there was no awareness on green building concept and developers preferred conventional buildings to green buildings.

Conclusion

Two conclusions can be drawn from the study. Firstly, there are eight significant benefits of green buildings, namely: it lowers running and maintenance costs; improves health of occupants; reduces environmental pollution and landfills; minimizes consumption of materials and maximizes their reuse; increases productivity of occupants; minimizes energy consumption and green house emissions; have higher occupancy rate and lower turnover; and have higher relative return on investment. Secondly, there are also seven significant challenges or problems that face green building concepts, namely: lack of government policy legislation at federal and state levels for its adoption; lack of technology for the production of green building materials in Nigeria; lack of interest on issue of sustainability by most Nigerians; lack of awareness of the existence of green building concept by the public; lack of experience on design of green buildings by Nigerian architects; uncertainty in Nigerian economic environment; and lack of green building materials.

Recommendations

The study recommended that Ebonyi State should not rush to adopt green building strategies until all the identified seven problems or challenges have been mitigated fully. Secondly, the

Federal Government of Nigeria should organize seminars in all the states in Nigeria to create awareness of the existence of the concept and benefits of green building. Thirdly, Nigerian architects and builders should be trained on design and production of green buildings. Fourthly. the Federal Government of Nigeria should fund research on green building materials and the technology for their production in cooperation with private businesses.

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AN ANALYTIC REVIEW OF THE IMPACT OF POPULATION GROWTH ON LANDUSE LANDCOVER CHANGE IN SOUTHEASTERN NIGERIA

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Abstract:

This paper examined the impact of population growth and the resulting challenges in landuse/landcover change in southeastern Nigeria. This was done through descriptive research. It is understood that growth in human population affect landuse/landcover pattern available for agriculture, forest land cover and area of different type of water bodies. The expression of growth in population and its impact on landuse/landcover change in the region are found among others to be intensification of agricultural activities, land degradation, soil erosion, deforestation, biodiversity loss, urban sprawl and waste generation. Some measures enunciated to curtail these negative environmental challenges and enthrone sustainable environment include: agro-forestry, erosion control, aforestation, conservation of wild life, urban planning and control, and institutional measures. It is hoped that the employment of these measures will bring about sustainable environment in south-eastern Nigeria.

Key words: Population growth, land use/ land cover change, southeastern Nigeria.

INTRODUCTION

The view point on the relationships between population growth, Land use/ Land cover change (LULCC) and development is longstanding. A chronological review of the relationships by the national science. Academy as cited by Madu (2007) shows that throughout history and especially during the 20th century LULCC has primarily been a product of human efforts to secure improved living standard in the area of food, clothing, shelter, comfort and recreation for the teeming population. In most parts of Nigeria, population growth has been unstable and urban areas are facing unplanned and uncontrolled settlements (slum/ghetto), threat to biodiversity, strain on forest, massive generation of waste and other forms of land degradation. Human beings have natural instinct for increase in birth (reproduction) on earth although it is suppressed by high death rate due to illnesses, infections, famines, accidents and war but comparatively fertility rate remain high. Many factors affect the rate of change of population. The main factors are:

natality, mortality, immigration and emigration (weeks, 2012). However, the main driving force of population growth is increase in birth rates and decrease in death rates due to progress in the field of medicine. According to Eze (2014), growth in population is a general feature of southeastern Nigeria where some locations are especially noted for their high population density. In some areas in the region, population density is over 1000 persons per sq.km resulting to pressure on natural resources, (Attah & Adinna, 2001). Among all the natural resources, the demand for land is outstanding because all agricultural, animal, industrial and forestry productions depend on land resource which is used in turn to fulfill the community demand for food, energy and water requirement. The use of land for several purposes is the main reason for LULCC and the inappropriate use of it is the major cause of land degradation which is abundantly expressed in southeastern Nigeria (Effiong, 2012).

For example, in Anambra state places like (otu, mammy market, okpoko etc), in Enugu state (ugbo-odogwu, ngenevu, coal camp, onu asata, abakpa etc), in Abia State (Aba, Ariaria etc), in Imo State (Owerri, Orlu etc) are noted for the presence of slum/ghetto, pollution and incontrollable eutrophication due to inappropriate waste dumping. It is also worthy to note that the cumulative growth of new residential layouts and estates in these urban areas is an evidence of the persistent population growth and pressure on urban and peri-urban lands which have been converted to high density residential, commercial and industrial uses at the detriment of agricultural (arable) land, forestry, Game reserve, parks and cemetery. Southeastern Nigeria is one of the six geo-political zones in Nigeria and it comprises of five igbo speaking states of Anambra, Abia, Enugu, Imo and Ebonyi. It is a densely forested region with segments of rolling hilly terrain and widely noted as an aggragrian sub-region. It is located between latitude $6^0$67" and $7^0$13" east of the Greenwich Meridian. To the north, the study area is bounded by Benue and Kogi states, to the east it is bounded by Cross River state and to the west, it is bounded by Delta state. In terms of landmass, it covers 41,440 square kilometers (Jansen, 2014).

According to Atu, Offiong, Eni, Eja and Essien (2012), the manifestation of LULCC is greatest in southeastern Nigeria when compared to other regions. The incidence of population growth and LULCC in southeastern Nigeria has became so visible that it is undeniable. Examining this scenario and necessary combative measures is of outstanding urgency at such a time as this. For efficacy, this discourse is split out into the following sections, namely:

- Conceptual issues
- Theoretical reflections
- Manifestation of population growth and LULCC.
- Impacts of growth in population on LULCC
- Tackling environmental challenges of LULCC

CONCEPTUAL ISSUES

United Nations (2007) defined population as a group of individuals of the same species living and interbreeding within a given area. Thus, members of a population often rely on the same resources, are subject to similar environmental constraints, and depend on the availability of other members to persist over time. Population in a more simple term, is the number of people living within a geographical area at a particular time (UN, 2007). This implies that all members in a population belong to the same species and that population is dynamic, thus, it is subject to growth or decline.

Growth in population is a fundamental ecological process, according to Theodore (2014), it refers to change in the size of a population which can be either positive or negative overtime, depending on the balance of births and deaths. It is determined by the net recruitment rate of individuals to the population. Population growth in a given generation is a linear combination to its initial size, birth, death, immigration and emigration rates. All these parameters are influenced by the ratio between the sexes in the population (Weeks, 2012). Growth in population in most cases is intertwined and measured *pari passu* with fundamental concepts like: over population, under population and optimum population. Equally associated with these concepts and more importantly to optimum population is the critical density of population (CDP) concept. This concept is defined as the human carrying capacity of an area in relation to a given landuse/landcover system usually expressed by population per km^2 or miles (Eze, 2014). It is the maximum population density which a system is capable of supporting permanently without damage to the land. This follows that the CDP is a function of several factors which are but not limited to the following

- Population in terms of number, quality, distribution and rate of change.
- Method and system of LULC
- Technology employed
- Physical conditions of the area

Very often, people think of population growth in terms of absolute numbers or available densities only and so from such a view, Nigeria with an average density of 226 pers/km^2 (586 pers/ml^2), is underpopulated and so much more capable of supporting larger population. However, there are factors which reduce habitable and available land as deserts and desertification, topography such as mountains, rugged valleys, steep slopes, poor soils and even livestock that compete with man for food in Nigeria (Eze, 2014). From the foregoing, it is obvious that Nigeria experiences high pressure on its natural resources in many areas especially in southeastern region.

The terms landuse and landcover are not synonymous and the literature draws attention to their use and cover change. One common element in the myriad of definitions is the criteria of use and change. Landuse/landcover change is generally considered as the conversion of different landuse types for example residential, agricultural, commercial, forestry, recreation to another (Effiong, 2011). This implies that there is a preference of a land use type over the other at a given period which is brought about by a complex interaction between humans and the physical environment. In other words, landuse documents how people are using the land. Landcover on the other hand, indicates the physical land types such as forest, grassland, mangrove swamp or surface water. Landcover change therefore, denotes a change in certain continuous characteristics of land such as vegetation type, soil properties and water bodies (Praskasam, 2010).

THEORETICAL REFLECTIONS

For a long time, observers of population change have made prepositions which are designed to express their perceptions about the inevitable relationship between population growth and available resources. Most of the early writers on populations' growth were concerned with the need to balance population with resources (Turne and Marina, 2010).

T.R. Malthus's theory is undoubtedly the most influential work relating to population growth and its consequences. According to Lutz, O'Neill & Scherbov (2013), the basic preposition of

Malthusian theory is exponential population and arithmetic food supply growth. Malthus specifically stated that the human population increases geometrically, while food production increases arithmetically. Under this paradigm, humans would eventually be unable to produce enough food to sustain them.

The Malthusian Concept of population growth is relevant especially in developing countries like Nigeria where rapid growth in population according to Dodoo and Frost (2008), reduces income per capita, more so, where large rural population are dependent on agriculture, as well as heavy reliant on environmental resources. Furthermore, Chertow (2012), suggested that the concept is relevant to third world countries which are least able to use trade as a means of avoiding resources Constraints. However, this theory was criticized by some scholars. One of such scholars is Ester Boserup who argues that population growth is independent of food supply and that population increases is a cause of changes in agriculture via intensification. Boserup maintains that population growth is the cause rather than the result of agricultural change and that the principal change is the intensification of landuse. According to Boserup, population pressure is the major cause of change in landuse, agricultural technology, land tenure systems, and settlement form. A major point in Boserup argument is that necessity is the mother of invention, which was quoted in saying “The power of Ingenuity would always outmatch that of demand” (Stone, 2001).

In summary, the basic difference between the Malthus and Boserup views is that first, the input of more labour increases productivity (Malthus, 1798), subject to the constraints of finite resources and diminishing returns. However, whereas Malthus focuses on extensive productivity increases, Boserup (1965) highlights the intensification Component of productivity increases.

On the contrary so far, the Marxist theory on population growth is based on Socio-economic model of population control. Though Marxist theory appears to agree with Malthus that population grows rapidly because human beings have the urge to reproduce. However, Marx and Engels believed that the consequences of population growth will be quite different in a capitalist society when compared with those in a socialist society. According to the Marxist theory, the consequences of population growth in a capitalist society would be over-population and poverty while in a socialist society population growth is readily absorbed by the economy with no side effects. In Conclusion, all the theories reviewed pictured growth in population over-time in any society and that there are impacts therein whether through human activities or natural processes which necessitates awareness and strategies for environmental sustainability.

MANIFESTATIONS OF POPULATION GROWTH AND LANDUSE/LANDCOVER CHANGE

Landuse/landcover has significantly changed during the past decades in Southeastern Nigeria. Historically, the driving force for most LULCC is growth in population (Falcucci, Luigi & Luigi, 2007) and the increasing demand for food, shelter and comfort as a result of population growth has created pressure on land resources (Atu et al, 2012).

According to Madu (2001), the Southeastern region of Nigeria has been affected by anthropic disturbance for many decades and is nowadays, one of the most significantly altered hotspot in Nigeria. With a population of 21,000,000 and a landmass of 41,440Km^2, Southeastern region has an average population density of 506.8 pers/km^2 (Effiong, 2011) and over 1000 pers/Km^2 in some areas like Onitsha, Nnewi, Awka in Anambra State; Owerri, Orlu, Akokwa in Imo state; Aba, Bende, Isuikwuato in Abia State; Abakpa, 9th mile corner, Okpara Avenue, Onuasata in Enugu State and Izzi, Afikpo, Abakaliki in Ebonyi State all as a result of growth in population. Table I below shows population, land area and population density in each of the five states in southeastern Nigeria.

Table I Population size, Land area and population densities of the five states in southeastern Nigeria.

S/N	**State**	**Population**	**Land area (Km^2)**	**Population Density (pers/KM^2)**
1.	Anambra	6,355,642	4,844	1,174
2.	Imo	8,408,756	5,530	1,520
3.	Abia	4,112,230	6,320	650
4.	Enugu	4,211,100	7,161	615
5.	Ebonyi	2,490,383	5,533	450

Sources: 1. National population commission (2006 Census)

2. Personal calculations.

Aside from Lagos, Nigeria's highest population growth and densities are in Imo state and Anambra (Pubmed.ncbi.nin.nih.gov). The absence of drought and high soil fertility contribute to population growth and density in the region although over farming has now occurred in some areas (Iwejingi, 2011), however, trade has also contributed significantly to the growth in population. Evidence suggests that some areas with growth in population (densities) have very little cultivable land which is abundantly expressed in the study area. Some general observations on pattern of population growth and distribution include: 1) Igbo community migration tendencies, (2) Landuse potentials, (3) encroachment by growing communities on farmlands and the need for nonfarm earning sources, and (4) decreasing land fallow periods (Atu et al, 2012). Population growth in this region strains land resources and alter the landuse/landcover pattern but some scholars argue that growth in population could stimulate socio-economic development, and generate interest in new food production methods. This theory however, supposes that agricultural production methods can easily be changed and that virgin lands are still available. Instead, in response to population growth pressure, young people in the region move from rural areas to towns and cities thereby, increasing urban unemployment, traffic jams, overcrowding and slum dwelling to mention but a few which in turn exacerbate the issue of LULCC. Unfortunately, the older people, women and children left behind in rural villages cannot produce enough food on the available impoverished land (Eze, 2014). This scenario is a running cycle in Southeastern Nigeria which further accelerates pressure on land especially in the urban areas. All these have given rise to diverse adverse LULCC and environmental consequences.

IMPACTS OF GROWTH IN POPULATION ON LANDUSE/LANDCOVER CHANGE

Population growth has negative impact on the quality and pattern of LULCC. As more land is used for agriculture and other purposes, the landuse/landcover changes drastically. Botkin and Keller (2009) categorized the effect of growth in population on LULCC into three: local, regional and global. Local effects are those that are at or near settlements, regional effects occur over large areas while global effects include climatic changes, hydrolozical changes as well as potentially extensive changes in chemical cycles.

Land is required for various uses in both urban and rural areas. It is a major factor of production and a vital element in socio economic development of any society (Stone, 2006). Response to population growth and LULCC has taken many dimensions in southeastern region. For example agricultural systems have been intensified to enable production of needed commodities from increasingly limited land space. The land tenure system has also changed from general use right without permanent interest to increasing tenacity of tenure and persistent rights to cultivate land and other land use rights. Generally, land degradation becomes the end point. Land degradation initiated by growth in population vis a vis LULCC is discussed in its diverse forms as: intensification of agricultural activities, land impoverishment, soil erosion, deforestation, biodiversity loss, strain on forest, urbanization and generation of waste.

The major impact of population growth on LULCC is its effect on arable land which is expressed through intensification of agricultural activities. For example, over-cultivation, drastic reduction or total elimination of fallow period and fragmentation of farm holdings are conspicuous in southeastern Nigeria (Eze, 2014). These agricultural practices culminate to intensification, extensification and cumulatively causes adverse LULCC.

Often land impoverishment is the consequences of over-use of land resource through continuous cultivation with non/or inadequate application of manure and chemical fertilizers. Furthermore, the incompatible use of land which according to Adinna (2001) has resulted in most lands in the region to be impoverished with poor yield agriculturally.

Soil erosion is also a serious form of land degradation which has led to severe LULCC in southeastern Nigeria. The rate of erosion is determined by climate change, soil type, vegetation cover, alteration and alternation of land use pattern, but accelerated by poor farming practices (Okigbo, 2014). Over 60% of the total area of 41,440 Km^2 of southeastern region is affected by one form of soil erosion or another. Obi (2010) affirms that the damage caused by gully erosion and landslides is quite extensive and conspicuous in Anambra, Enugu, Imo and Abia states. For example, the Agulu Nanka, Abagana, Enugwu Ukwu in Anambra; Enugu Ngwo, Agbaja Ngwo, Obollo-afor, Obollo-Eke in Enugu; Amakohia-udi, Ezinihitte-mbaise in Abia and Ogberuru, Orlu in Imo are widely acknowledged for erosion menace. Among all the factors of soil erosion, anthropogenic factors connected to LULCC are deemed salient. Madu, (2003) identifies consequences of soil erosion in southeastern region in terms of productivity and sustainability as two folds; namely: general decrease in soil fertility and diminution of arable land. In addition, gully erosion and landslides are responsible for widespread destruction of transportation and communication systems in southeastern Nigeria.

Another impact of population growth on LULCC is deforestation. As population increases, the need for food and other resources becomes intense so that natural habitats are destroyed and transform into non-forest uses like agriculture, human settlement and road construction thereby changing the landcover (Eze, 2014). Deforestation leads to desertification, atmospheric imbalance (urban heat island) because forests and vegetative cover acts as carbon sink (Enete, 2016). Other impacts of deforestation are: localized changes in weather pattern, regional climatic changes, siltation of rivers, emission of green house gases and pollution.

Another manifestation of environmental degradation in the region is loss of biodiversity. Many Scholars affirms that southeast region is endowed with highest member of endemic species which regrettably are under threat. For example Gbile et al (2000) compiled list of 484 species in Nigeria from 112 families threatened with extinction. They queried that wildlife was disappearing and warned that poaching and deforestation should be discouraged. According to Phil-Eze (2001), animals and native plants used by herbalists for medicinal purposes are also threatened with extinctions. Apart from medicinal value of plants and animal parts, Phil Eze (2001) asserted that vegetation moderates climate by influencing precipitation, breaking wind speed and acts as carbon sink. In addition, biodiversity loss brings in its wake adverse environmental consequences like: coastal erosion, Soil erosion, desertification, disease outbreak, climate change and environmental refugee (Phil- Eze, 2001).

The negative impact of urbanization on LULCC cannot be overemphasized. In most of southeastern Nigeria, new areas hitherto neglected have been settled and out migration has occurred to marginal lands. Urban sprawls generate wastes and inappropriate waste disposal methods, development of slum/ghetto, pollution and it’s a major driving force of deforestation. No doubt, urbanization reduces the manpower need for agricultural activities in the rural areas and create unemployment, Social vices, pressure on social and infrastructural amenities and pollution on natural surface water resources in the cities and urban centres (Onyia, 2012).

TACKLING ENVIRONMENTAL CHALLENGES OF LANDUSE/ LANDCOVER CHANGE

It is now obvious that in an attempt by man to better his lot, he has engaged in several activities that are harmful to his environment. These activities include: Intensification of agriculture, deforestation, urban sprawl, generation of waste, indiscriminate gravel and sand mining, and poaching which results to: land impoverishment, soil erosion, biodiversity loss, eutrophication and climate change. The welfare of the future generation demands that the present generation should adopt a more rational and sustainable approaches with respect to the use of land resources in southeastern Nigeria. This section highlights the various strategies of curtailing the negative environmental challenges associated with LULC and population growth in order to enthrone sustainable environmental development in the region. Some of these measures include: agro-forestry, soil erosion control, aforestation, conservation of wildlife, urban planning /control and institutional measures.

Agro - forestry: According to Adinna (2001), it is a combination of cropping, forests and animals in the farm as against farming specialization in one of the above. Hence, it is a landuse management system in which economic trees or shrubs are grown among crops or pastureland. Among the justification for agro-forestry according to Madu (2003), is that agricultural production system in southeastern Nigeria is traditionally subsistence oriented in which food crops are grown alongside commercial woody, perennials such as mango, oranges and oil palm. This is primarily born out of a need to fulfill immediate basic human needs of food, fuel, fodder, shelter and protection. Agro-forestry practices support agricultural production, improves water and air quality, soil health and wildlife habitat. The working trees can also grow fiber, food, energy and shelter belts or hedges.

Erosion control and soil Conservation: Erosion control measures are designed to reduce runoff amount and its velocity by using engineering structures that lead to safe disposal of excess runoff. According to Eze (2014), agronomic methods of contour ploughing, strip cropping and strip reclamation, limitation of tillage, terraces, mulching, organic fertilizing and multiple cropping are the basic techniques in sustaining the soil and soil field in southeastern Nigeria.

Urban planning and control: Urban sprawl has many negative consequences on the environment and human health. These include pollution, traffic fatalities, loss of arable land and biodiversity. Some of the measures of controlling urban sprawl include: creating urban boundaries in edges of cities, revitalization of existing urban centres and towns helps to preserve the existing natural environment thereby cleaning up polluted and dilapidated areas as well as reducing urban sprawl. Furthermore, reduction in air pollution by upgrading energy use and alternative transport systems. Create private-public partnerships to provide services such as waste disposal and housing. Plant trees and incorporate the care of city green space as key element in urban planning (Umeuduji, 2010).

Conservation of biodiversity: The threats to biodiversity are seemingly irreversible and demand the setting of tight priorities for successful conservation action in southeastern region. According to Phil-Eze (2001), awareness and knowledge would engender motivation to enable people acquire the necessary skills and capacity. Capacity building transcends from local community members, policy makers, non-governmental organizations (NGOs) community-based organization (CBOs) and government agencies.

Institutional Setups: The various governments and her agencies in southeastern Nigeria should step up in the making and enforcement of laws on agro and forest landuse. They should equally generate policies on sustainable land tenure, land rights and landuse/landcover approaches as well as forest, gravel and water harvesting strategies. Institutional setups should equally generate policies to control prices of land resources such as crops, and rents (Adinna 2001). Such laws and policies should not remain as toothless bull dogs and their implementation must not be trivialized.

Conclusion:

This paper has discussed major concepts in population growth and LULCC and consequential environmental problems in southeastern Nigeria. These challenges / impacts are fundamentally Land degradation which manifest in its diverse forms as: intensification of agriculture, Land impoverishment, soil erosion, deforestation, biodiversity loss and urban sprawl. The struggle to survive negates environmental consciousness which is why the adverse environmental conditions in the region appear insolvent. However, it is hoped that the measures enunciated in this paper will guarantee sustainable environmental development in the region.

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COMPARATIVE ANALYSIS OF COMFORT TEMPERATURE OF CHILDREN AND THEIR TEACHERS.

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ABSTRACT

Thermal comfort in learning environments influences the student's focus and learning productivity. This study aims to evaluate and compare the adaptive thermal comfort of schoolchildren and their teachers in naturally ventilated primary schools in some selected cities in Imo State Nigeria. To achieve these objectives, the study analyzed the data collected from 330 pupils and 44 teachers in six surveyed classrooms in two types of classroom buildings. The recorded data in the surveyed classrooms consisted of four environmental factors and two personal factors. At the same time, the subjects filled out the questionnaires asking them about thermal sensation and thermal preferences against the classrooms' thermal requirements. The results of the measurements showed that the indoor mean air temperature, relative humidity, and air velocity were 29.1^{o}C, 71.2%, and 0.19m/s, respectively. The mean thermal sensation votes of the children were +0.16 while that of their teachers was +0.58. The preferred temperatures were 27.4^{o}C and 29.4^{o}C for the schoolchildren and the teachers, respectively. Furthermore, the comfort range of the students was between 25.8^{o}C - 31.6^{o}C, and that of the teachers was between 28.0^{o}C - 29.9^{o}C. Based on the results of this study conducted in primary school buildings located in warm and humid climates, the thermal comfort perception of children and adults differ.

Keywords: Classrooms, Schoolchildren, Teachers, Temperature, Thermal comfort

1. Introduction

The continuous increase in the global surface temperature, caused by climate change, is of great concern as it impacts the health and the academic performance of children during class lessons. Young children coming out fresh from their various homes in quest of education are exposed to different indoor classroom environments. The indoor environments in classrooms are vital for pupils' perception, health, and performance, especially thermal comfort (Jiang et al, 2018), considering that these children spend many hours inside classrooms having class lessons. At the level of primary education, children are exposed to becoming an integral part of society and adapting to situations outside of the home. Children are shaped by their physical, social, and emotional changes throughout their childhood. Because they are vulnerable, they could be negatively impacted by climate change-induced problems such as heat stress and other environmental problems. In primary schools, teachers, rather than students, are believed to control the internal environment by opening the windows, and doors and by putting on and offing the fans (where electricity is available) when they wish to do so. They do these considering their comfort first, believing that schoolchildren will perceive the comfort perception the way they perceive it. According to Humphreys, Nicole & Raja, (2007), the opportunity to control an environment affects the thermal perception of the occupants making those who do not have control over the environment bear to the uncomfortable indoor conditions. But children likely have a different comfort temperature than adults (Korsavi & Montazami, 2020).

Various research works have been probing if there is any difference between the thermal perception of adults and children. This argument has been going on with empirical data backing the various arguments. According to Zomorodian et al, (2016), and Jiang et al (2018) because the metabolic rate and activity levels between these two groups of people (children and teachers) vary, their thermal perception may differ. The metabolic heat generated by an elderly person is lower than that generated by a young person because of age and lower inactivity of the elderly. Compared with adults, children have a lower sweat rate in all environmental conditions (Falk & Dotan, 2008). Furthermore, the difference in physical and physiology between children and adults, including differences in surface-area-to-mass ratio, and blood volume may affect their different perceptions of thermal comfort. Shamila Hsddad et al (2017) attributed the lower thermal neutrality of children (compared with adults) to their higher metabolic rates because of their smaller surface (body) area. Because of these perceived differences between children and adults, the thermal perception between these two groups of people may differ and the class teachers may be oblivious of this fact when the indoor environments are under their control. The current comfort standards produced from fieldwork and climate chamber experiments are based on the study conducted with only adults as subjects (Nicole et al, 2012). The comfort guidelines are contained in ISO 7730, EN 15251, and ASHRAE 55 (Trebilcock et al, 2017).

The above reasons prompted various research studies across the globe to determine the thermal comfort temperature of children and to compare the findings with that of adults. Meanwhile, some pieces of empirical data about the thermal comfort perception of schoolchildren are available from studies done in Europe, America, and Asia, (Nicol, 2004; Montazami & Nicol, 2013), but in Africa this information is limited. The results from fieldwork in these continents may not apply to African countries. This is because, as social background, traditional way of life, culture, buildings, and climates are distinct from one geographical place to another, comfort study done in a geographical area may not be generalized to apply to a different geographical area (Yao, Li, & Liu, 2009; Indraganti, 2010; Nicol et al., 2012; Mishra & Ramgopal, 2015). Trebilcock et al. (2017) confirmed this argument when they obtained from fieldwork a correlation between thermal comfort temperature and the socioeconomic backgrounds of the participants. The comfort models specific to an area should be developed based on the indoor and outdoor temperature, relative humidity, and clothing pattern of people of the region.

Because of these issues raised in this paper, this study aims to determine the perception of the thermal environment by the primary school children and that of their teachers and to compare the thermal perception between these two groups of people. To achieve these objectives, fieldwork was carried out to determine the thermal sensation, thermal preference, comfort range, and sensitivity of school children aged (7-11years) and their school teachers.

2.0 Assessing Comfort Temperature.

Thermal comfort is defined by the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) as the ‘condition of mind that expresses satisfaction with the thermal environment’ (ASHRAE Standard 2017). For one to be thermally comfortable, the excess heat in the body produced by metabolism must be transferred into the surroundings for the body's core temperature to be kept constant. The human body strives to maintain its core body temperature at 37^{o}C to be thermally comfortable. In order words, someone is thermally comfortable when the person feels neither ‘too hot nor too cold’ or thermally neutral when in an environment. The person has to be healthy and wears a normal amount of clothing at the time of assessment. However, because the heat transferred to the environment differs from one individual to another, the temperature acceptable varies among individuals, even when they are exposed to the same indoor environment. This is attributed to the differences in age, health, status, type of clothing worn, and rate of activity. Thus, it will be difficult to establish a condition or standard that will satisfy everyone because of these differences. Because of this unlikeliness to satisfy 100% of the people at the same time in the same indoor space. ASHRAE Standard 55 suggested that when 80% or more of building occupants accept the indoor thermal conditions such an indoor space is deemed to be accepted by the occupants (ASHRAE, 2017).

To assess the thermal comfort of a group of people, two models are popularly adopted. The first model is the Heat Balance Model (HBM) which uses the Predicted Mean Votes (PMV) as an index to define acceptable indoor environments. The HBM is also called a steady-state or a rationale model, and it is a laboratory experiment where the subjects do not have control over six factors (four environmental factors and two personal factors). The environmental factors are; Air temperature, mean radiant temperature, Air velocity, and Relative humidity while the personal factors are; Activity rate and Clothing insulation. The Adaptive Comfort Model, developed by Professor Ole Fanger was based on data collected from North American and Danish subjects and was developed specifically for air-conditioned spaces predominantly found in Western countries. Thus, the model is not popular in tropical countries where many buildings are naturally ventilated. The second model is the Adaptive Comfort Model (ACM) which is based on adaptation to environmental parameters. According to the adaptive principle, people often resort to behavioral adaptations, such as clothing change, posture adjustment, etc, to fit into the local conditions they find themselves in and so are capable of regulating the environmental parameters to be comfortable. Fig 1 shows the adaptive comfort chart with zones where 80% and 90% of building occupants may be thermally comfortable.

This model was considered as an assessment approach because of oil shock in the 1970s. There was energy crisis during the oil shock causing high cost of heating indoor spaces in the cold regions. The ACM considers the relationship between the indoor temperature and the outdoor temperature in determining the thermal performance of building. People who are indoors, in free running buildings, do adapt to the external temperature around the building mediated through its walls and operable windows, and roofs and floors (Nicol et al, 2012). ASHRAE Standard 55 adaptive comfort model is the preferred choice adopted by researchers to check the thermal comfort in NV buildings in the tropics, especially in Sub- Sahara African countries. This is because ASHRAE RP-884 data was obtained from climate zones that covered all the four continents including Africa. Adaptive chart, represented graphically in Figure 1, shows the zone where 80% and 90% of building occupants may be thermally comfortable.

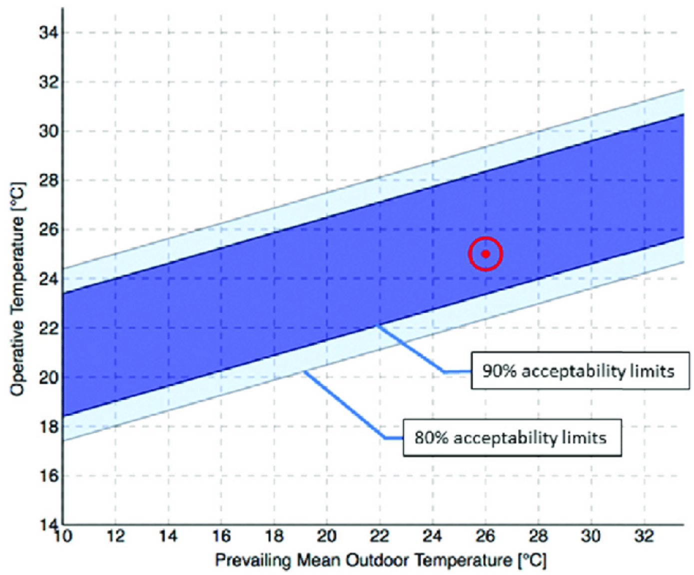

Figure 1: Adaptive thermal comfort chart according to ASHRAE Standard 55-2017
(Adapted from ASHRAE, 2017).

. Thermal comfort can be assessed by adopting both objective and subjective procedures. The objective procedure involves the use of measuring instruments to record the environmental parameters while the subjective procedure involves using a questionnaire to collect data about how the subjects feel about the internal environment. Teachers are capable of responding to the questionnaire by filling them appropriately. But for the students, it will not be easy for them to understand the wording of the questionnaire. For this reason, researchers are allowed to make minor modifications to the ASHRAE-approved standardized questionnaire and scale to suit the cultural background, language, and age of the subjects. In thermal comfort research works done on children aged 6-11 years, the same standardized thermal comfort questionnaires used for adults were adopted but some of the studies reduced the number of questions and modified the wording so that the children could understand them better. For example, the original word 'neutral' used by Professor Fanger P.O to determine the central category of the 7-point ASHRAE scale was changed to the word 'good' by Martinez (2007). In the survey conducted by Karyono & Delyuzir (2016) the word 'comfort' was adopted in place of 'neutral', while Teli et al., (2012), Trebilcock et al., (2017), Montazami et al., (2017) and Korsavi & Montazami (2019) used the word 'ok', instead of 'neutral'. H. Zhang et al., (2007) used the word 'keep constant' instead of 'no change' in the thermal preference question and 'temperature' instead of 'thermal comfort' in the thermal sensation question.

Furthermore, Karyono & Delyuzir (2016) used the Indonesian language to investigate the thermal comfort conditions of primary school students in Tangerang, Indonesia. In adopting a different language, what is important is ensuring that the language is translated correctly to comply with the ASHRAE standard. While investigating the thermal comfort perception of primary school children Wong & Khoo (2003) left out numbers in the questionnaire arguing that the numbers will confuse the children and Trebilock & Figueroa (2014) adopted this method.

3.0 Method

3.1 Study Area

This study is based on a large experimental campaign survey carried out during the rainy season and dry season from 2017 to 2019 in Imo State, Nigeria. Imo State, is located in the South East of Nigeria and categorized according to the climatic classification of Koppen- Geinger in the group of tropical (Azadeh, M., Fergus, N. Mark, L. Chryssa, T. 2017). The State, is located between latitude 4 ° 45′N, 7° 15′N, longitude 6 ° 50′E, and 7° 25′E, and represents one of the five South Eastern states in Nigeria. The state lies in the rain forest zone of the warm humid tropics. It is characterized by high temperatures and high relative humidity for most periods of the year. Mean annual rainfall ranges from 2500 to over 4000 mm, with mean maximum temperature of about 30^{o}C.

3.2 Data collection and Analysis

This study was carried out in two case study classroom types; open-space classroom type and enclosed plan classroom type. In total, six naturally ventilated classrooms were investigated during the survey. A total of 330 pupils and 44 teachers participated in the survey. The period of the survey was from 7.30 am to 2. 45 pm. Both subjective and objective evaluations of the subjects were adopted in this study. The questionnaire, shown in table 1, adopted the ASHRAE 7- point thermal sensation scale (-3=colder, -2=cooler, -1= a bit cold, 0=okay, +1= a bit warm, +2=warmer, +3= hotter), to assess the occupant's degree of satisfaction with their thermal environment. Following Fanger's approach, the central three categories of the scale which represent the range of 'a bit cold' (-1) to 'a bit warm' (+1), are taken to indicate the sensations at which an occupant will be 'satisfied' with the thermal environment. This approach was adopted to determine the thermal sensation of the subjects. Voting on these 4 categories (-3, -2, +2, +3) is assumed to indicate 'dissatisfaction', with the most extreme ratings of 'colder' (-3) and 'hotter' (+3) suggesting the highest level of dissatisfaction. The thermal preference is based on 3-point McIntyre thermal preference scale which asks the subjects whether they prefer to be 'cooler'' or 'okay' or 'warmer' to the temperature in the classrooms

Table 1: Rating scales used in thermal comfort

ASHRAE Thermal Sensation	-3 (cold)	-2 (cool)	-1 (a bit cold)	0 (okay)	+1 (a bit warm)	+2 (warm)	+3 (hot)
McIntyre Thermal Preference	Cooler			okay		Warmer	

Source: (ASHRAE 55 - 2017)

Before the students were asked to respond to the questions (by way of filling out the questionnaire) they were to be seated and be writing or reading or listening to their teachers for about 30 minutes. In any of these states, their activity was estimated at 1.2 MET, representing sedentary activity as recommended by ASHRAE Standard 55. It is at this stage that the questionnaire can be administered to the students to fill.

The teachers will equally fill out their questionnaires when they were seated and were also engaged in sedentary activity.

The objective survey involved the collection of environmental parameters. In each of the surveyed classrooms, TinyTag Ultra 2 Gemini Logger was placed at the center of the classroom at a height of approximately 0.9 meters above the floor level. The logger measured the indoor air temperature and indoor relative humidity. The WetBulb Globe Temperature (WBGT) Heat Stress Meter measured the globe temperature. Kestral 3000 pocket wind meter measured the .airspeed at various spots in the surveyed classrooms. Tiny Plus 2 Gemini Loggers measured the outdoor temperature. Table 2 shows the technical details of these instruments

Table 2: Technical characteristics of the measuring instruments

Instrument and Make	Measured parameter	Range	Resolution	Accuracy
Tinytag ultra 2 (TGU-4500) logger	Indoor air temperature	-25 to +85°C	±0.01°C	±0.3%
	Indoor relative humidity	0% to 100%	±0.3%.	±1.8% RH
Tinytag Plus 2 (TGP-4017) loggers	Outdoor Temperature	25 to +85 °C	±0.01°C	-
Kestrel 3000 Pocket wind meter	Air velocity	0.30 to 40.0m/s	-	±1.66%

Source: (Data Logger technical details, 2016)

After the subjective and objective data have been collected they were analysed with SPSS program and the results are presented in tabular and in graphical forms.

Figure 2: Dress Code in School (left) and Children filling in Questionnaire in their classroom (right)

4.0 Results and Discussions

4.1 Measured Thermal Variables in the classrooms

Table 3 presents a detailed statistical summary of the minimum, maximum, mean, standard deviation and coefficient variation of the measured indoor and outdoor thermal variables in the surveyed classrooms at occupied school hour time that spanned from 7.30 am to 2.45 pm. While Figure 3 shows a sampled graphical presentation of temperature from the data logger. The indoor operative temperature extracted from the data loggers for all the combined classrooms in both seasons was within the range 22.5-35.6°C The studied pupils and the teachers experienced a mean indoor temperature of 29.1°C (SD1.7), with 5.8% as the coefficient of variation.

The outdoor temperature for all 6 classrooms averaged 29.6 °C during the same survey period falling within the range 23.0-37.4°C with (SD =1.7). The relative humidity varied from 24.0 to 94.2% with a mean value of 71.8% (SD=12.4). Spots checks of the airflow in the classrooms show that the maximum air velocity in the combined classrooms all season was 0.30m/s, with a mean value of 0.19m/s.

Table 3: Mean, standard deviation, min and max values of the main environmental parameters and0 mean thermal sensation votes.

Classroom	All Open	All Enclosed	Combined Open and Enclosed
Air Temperature (^{0}C)			
Mean	28.8	29.3	29.1
S.D.	1.6	1.5	1.7
Min	22.5	22.9	22.5
Max	35.6	35.1	35.6
Operative Temperature (^{0}C)			
Mean	28.9	29.3	29.1
S.D.	1.6	1.5	1.7
Min	22.5	22.9	22.5
Max	35.6	35.1	35.6

Outdoor Temperature (^{0}C	29.6	29.6	29.6
Mean	1.7	1.7	1.7
S.D.	23.0	23.0	23.0
Min	37.4	37.4	37.4
Max			
Relative Humidity (%)			
Mean	71.8	70.8	71.2
S.D.	13.1	11.8	12.4
Min	24.0	27.4	24.0
Max	94.2	93.5	94.2
Air velocity (m/s)			
Mean	0.19	0.14	0.19
S.D.	-	-	-
Min	-	-	-
Max	0.30	0.28	0.30

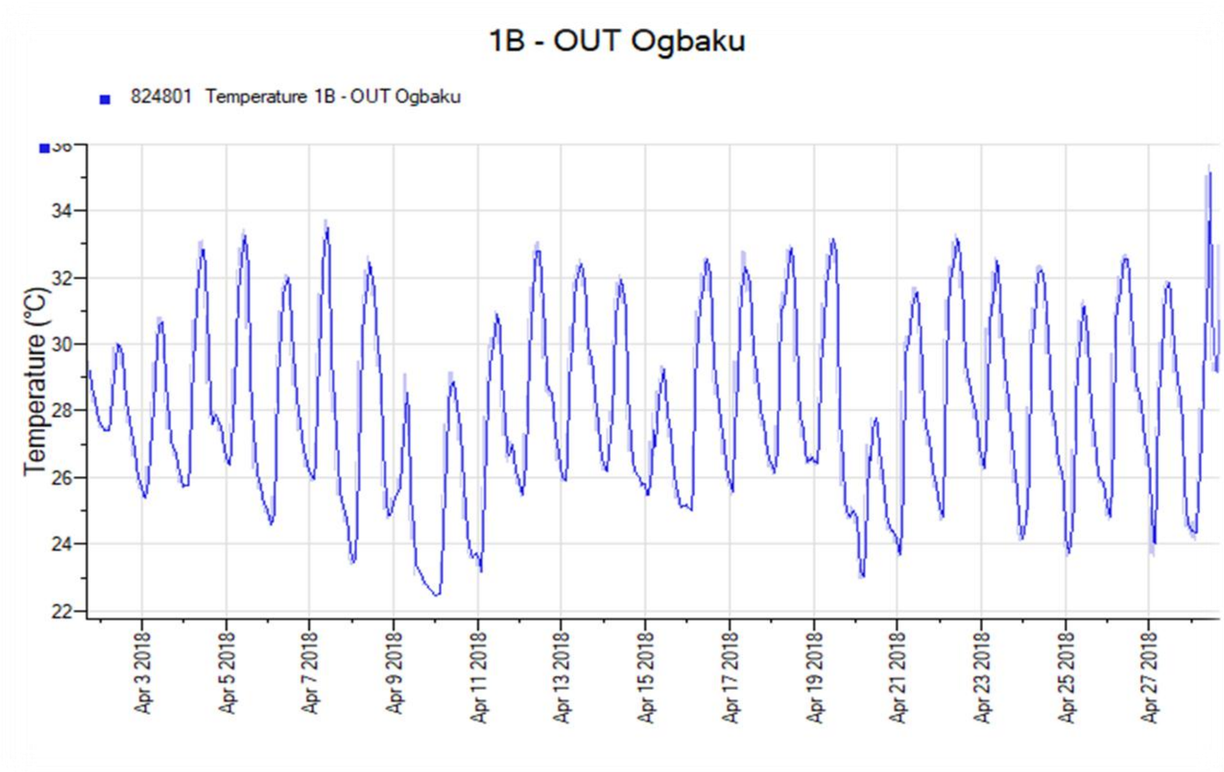

Figure 3: Sample of graphical presentation of temperature from data logger

4.2 Children's Comfort Temperature

4.2.1 General Characteristics of the Sampled Pupils

There were 7050 valid returned questionnaires drawn from 330 primary school children aged 7-12 years in the rainy season and dry season. A total of 164 visits were made to the surveyed schools; rainy season 64 visits and dry season 100 visits. Each day two surveys were conducted; morning and afternoon. All the classrooms in the study area were naturally ventilated and none had any active ventilator such as an air conditioning system or fan.

The number of children in each classroom ranged from 25 to 30. A set of 158, representing 47.9% of the children participated during the dry season survey, while 172 children, representing 52.1%, participated during the rainy season survey. Further details show that the number of female participants was more (58%) compared to the number of male (42%) during both seasons. According to the season, females constituted; 55.1% and 61.0% for the rainy season and the dry season, respectively, against 44.9% and 59.0% for the rainy season and dry season respectively for men. Most of the participating children (56.0%) were within the age range of 9-10 years, with 9 years as the mean age. Of all the participants that were surveyed, none was less than 7 years or more than 12 years.

4.2.2 Thermal sensation of the children

Table 4 summarizes the thermal sensation votes of the children in the six surveyed classrooms. With the mean thermal sensation vote of +0.16 all season in combined classrooms, the mean sensation lay between 'okay' and 'a bit warm' on the ASHRAE 7-point thermal sensation scale. Generally, the thermal sensation spread during the survey was from -2 to +1.8 (SD=0.66).
A further breakdown of the thermal sensation votes according to season indicates that the subjects felt cold in the rainy season at the mean thermal sensation with the value of -0.01. The vote was slightly above neutral (0), an indication that the subjects found the indoor thermal conditions comfortable in the rainy season. During the dry season, the thermal sensation votes were between 'okay' and 'a bit warm', with a mean value of +0.31, and ranged from -1.4 to 1.8, SD (.56). This suggests that the subjects felt warmer in the dry season compared to the rainy season. However, the mean value of the vote suggested that they were comfortable with the indoor thermal conditions

Table 4: Children's mean thermal sensation votes

Thermal Sensation	All open	All enclosed	All classrooms
Mean	0.09	0.29	0.16
S.D.	.60	.70	.66
Min	-1.7	-1.5	-1.7
Max	1.7	1.8	1.8

The results of the thermal sensation votes are further illustrated in relative frequency in Figure 4. The percentage of children's votes that fell on neutrality (okay) was 51% for the combined classrooms all season. The percentage of children who voted on ASHRAE three central categories (-1, 0, 1) of the thermal sensation scale was 82%. The percentage of votes on the two extreme ends of the ASHRAE scale that indicates discomfort (-2, -3, +2, +3) totaled 18%. However, the discomfort was more on the warmer side (15%) than on the colder side (3%).

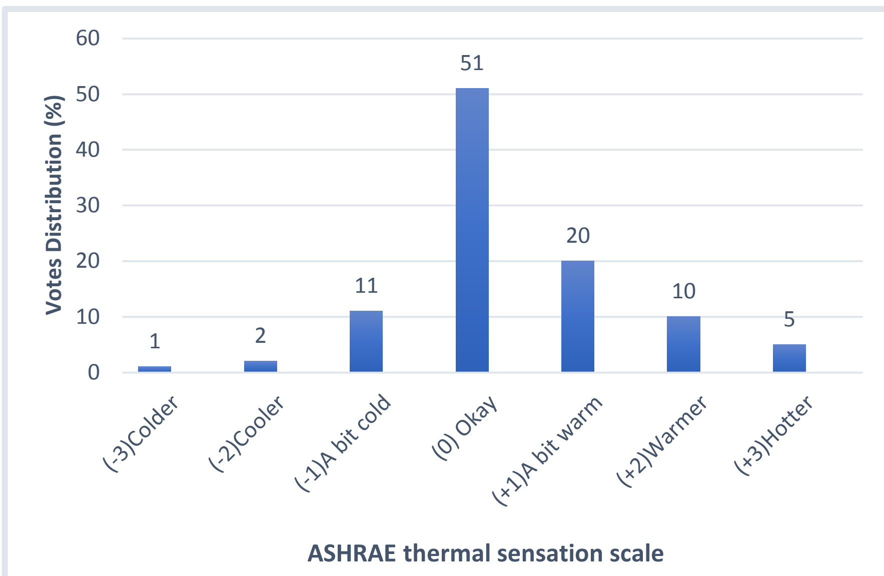

Figure 4: Distribution of the children's votes on ASHRAE scale in combined classrooms

4.2.3 Thermal Preference of the Children

The thermal preference of the studied children illustrated in the histogram in Figure 5 shows that in the combined classrooms all seasons, 50% (half of the entire children) preferred to be cooler than what the existing indoor thermal condition presented. 37% of the entire class preferred the thermal condition to remain in the condition they found it, while 13% preferred a warmer condition.

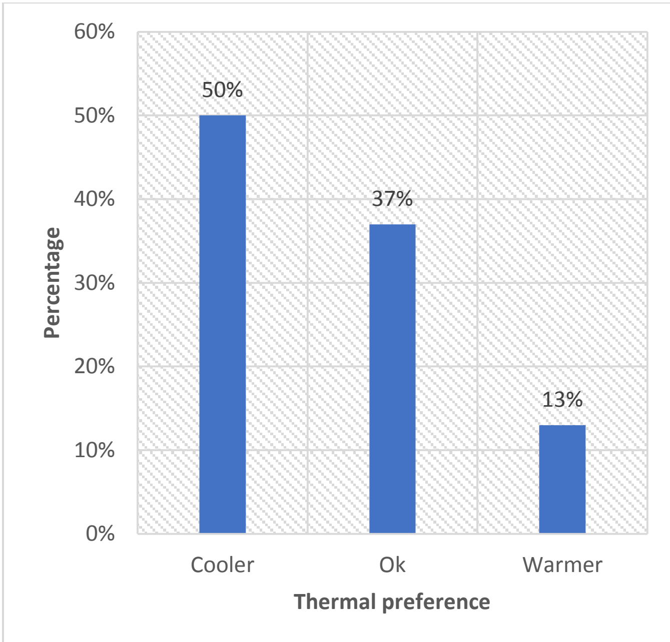

Figure 5: Distribution of subjects' thermal preference votes

Near to half the entire class (45%) were satisfied with their thermal conditions in the rainy season and would rather prefer the thermal state to remain as they found it. A significant percentage (69%) was not satisfied with the thermal state during the dry season and would prefer the thermal condition to be either warmer or cooler. The preference for a cooler indoor thermal condition was higher during the dry season compared to the rainy season. For instance, during the dry season, 63% of the children in the combined enclosed classrooms preferred cooler thermal conditions, while the preference for the cooler environment during the rainy season, for the same subjects, was 36%. The trend was the same in the combined open classrooms where 56% of the children preferred a cooler environment in the dry season, compared to the 27% vote in the rainy season.

A higher percentage of the subject's votes were on 'okay' during the rainy season, while a lower percentage of the subject's votes on 'okay' was lower during the dry season. Of the 19% of the children who preferred warmer conditions during the rainy season, only 8% of them preferred that during the dry season. Also, of the 20% of the children in the combined enclosed classrooms who preferred to be warmer during the rainy season, only 11% of them preferred that thermal state in the dry season survey.

4.2.4 Preferred temperature

The preferred temperature of the students' was obtained through linear regression analysis of the votes of the children who wanted to be cooler and those who wanted to be warmer against the operative temperature. The result of the regression produced a preferred temperature. This temperature is where the intersection of the percentage of children who wanted to be warmer and those who wanted to be cooler meet. As illustrated in Figure 6, the two fitted lines intersected at a preferred operative temperature of 27.4^{o}C.

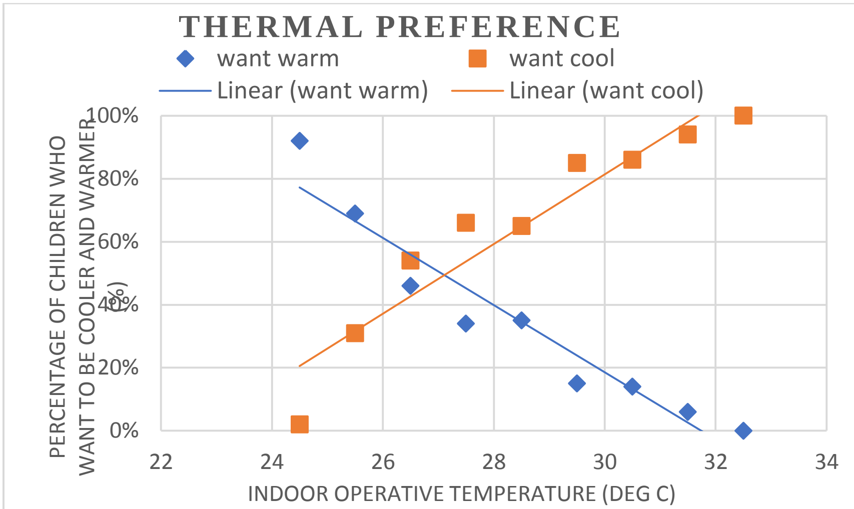

Figure 6: Linear regression models for preferred temperature

4.2.5 Comfort Range of the Students

The mean thermal sensation votes were regressed against the indoor operative temperatures to establish a comfortable range of temperatures for the schoolchildren. This comfortable range of temperatures falls within the 0.85≤TSV≤+0.85 set by the Adaptive Comfort Model based on 80% acceptability. The regression equation is TSV=0.29Top-8.33, which defines a comfort range of 25.8-31.6oC. The comfort range (acceptable indoor temperature) in the rainy season was from 25.1-31.4°C, while during the dry season the comfort range was from 25.4-30.2°C, for the 80% acceptability criterion.

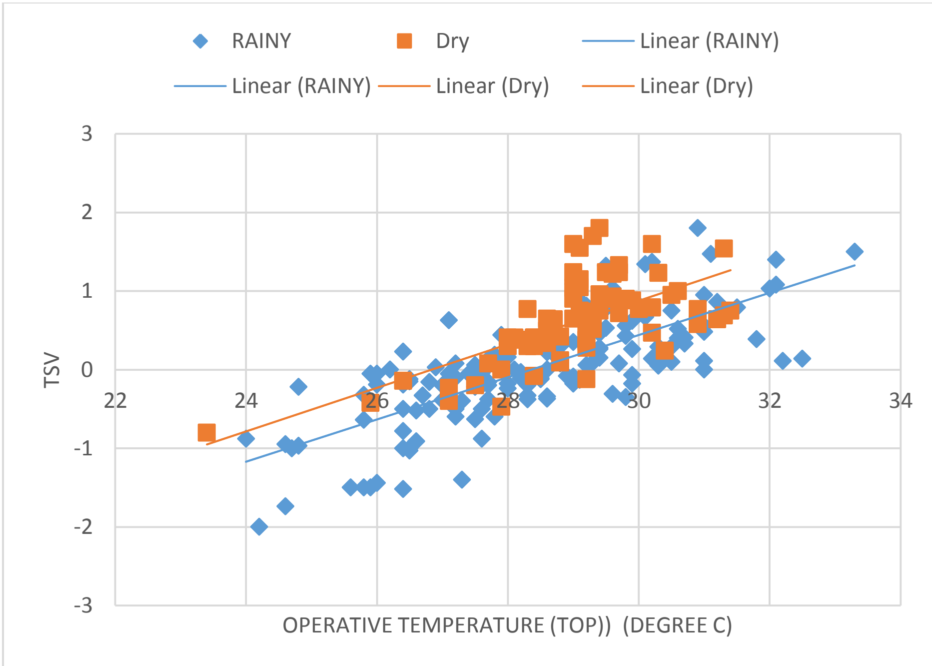

Figure 7: Regression analysis of thermal sensation upon Top according to season

4.3 Comfort Temperature for Teachers

4.3.1 General Characteristics and Samples

As presented in table 5, a sample size of 21, representing 47.7% of the teachers participated during the dry season, while 52.3% representing 23 teachers participated during the rainy season. There were by far a greater number of female teachers (88.6%) than their male counterparts (11.4%). The age of the teachers ranged from 19 to 59 with 37 years as the mean age. Majority of the teachers who participated (56.8%) were below 40 years in both seasons the survey were conducted.

Table 5: Summary of teacher’s background

		Total (n=44)		**Dry season (n=21)**		**Rainy season (n=23)**	
		Sample size	Percentage	Sample size	Percentage	Sample size	Percentage
Gender	Male	5	11.4%	2	9.6%	3	3.1%
	Female	39	88.6%	19	90.4%	20	86.9%
Age (years)	19-29	11	25.0%	4	19.1%	7	30.4%
	30-39	14	31.8%	7	33.3%	7	30.4%
	40-49	10	22.7%	6	28.6%	4	17.4%
	50-59	9	20.5%	4	19.0%	5	21.8%
Living in Imo State(years)	<1	3	6.8%	-	-	-	-
	1-5	12	27.3%	-	-	-	

	>5	29	65.9%	-	-		

4.3.2 Thermal sensation of the teachers

A mean thermal sensation vote of +0.58 was obtained, for the combined classrooms all season. The teachers evaluated their indoor thermal condition to lie in-between ‘okay’ and ‘a bit warm’, however tending more to ‘a bit warm’. The range of the thermal sensation was from -0.7 to +1.9, SD (.79). The results of the thermal sensation votes of the teachers were further illustrated in the relative frequency distribution shown in Figure 8. The highest percentage of thermal sensation votes (35%) was on ‘a bit warm’ section of the ASHRAE scale, while 10% of the votes were on the ‘cold’ (-1) side of the ASHRAE 7-point thermal sensation scale. Only 28% of the teachers cast their votes on okay (0). The percentage of the teachers who voted on ASHRAE’s three central categories (-1, 0, 1), was 76%. The percentage of votes on the two extreme ends of the ASHRAE scale (-3, -2, +3, +2) totaled 37%. However, the discomfort was more on the warmer side of the scale (20%), than on the cooler side of the scale (17%).

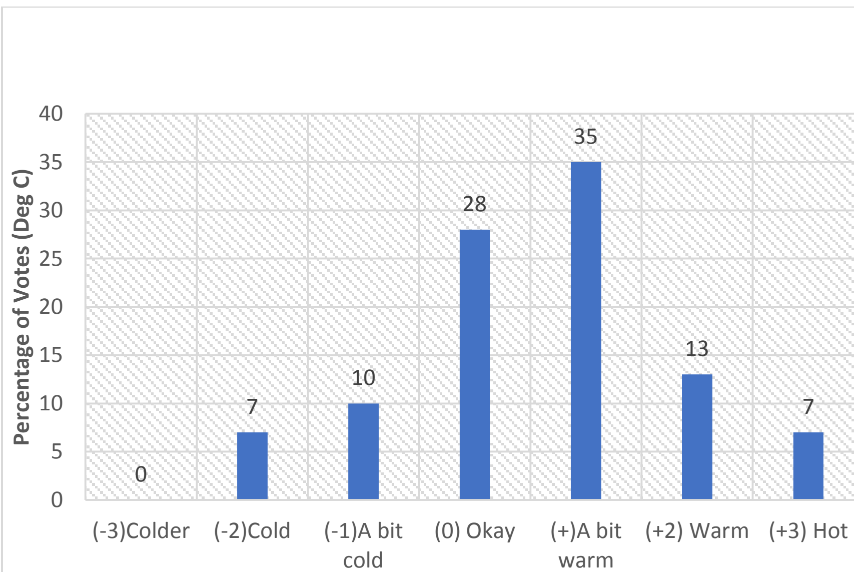

Figure 8: Histogram of thermal sensation of the teachers

4.3.3 Thermal preference of teachers

The subjects were asked whether they would prefer ‘warmer, ‘cooler; or ‘okay’ (no change) to their indoor thermal conditions. Almost half (49%) of the teachers preferred the thermal conditions in the classrooms to remain the way they found them during the survey period (Figure 9). 29% of the teachers preferred the classrooms to be cooler while 22% preferred it to be warmer. In order words, more teachers would prefer a cooler environment to a warmer environment during the survey.

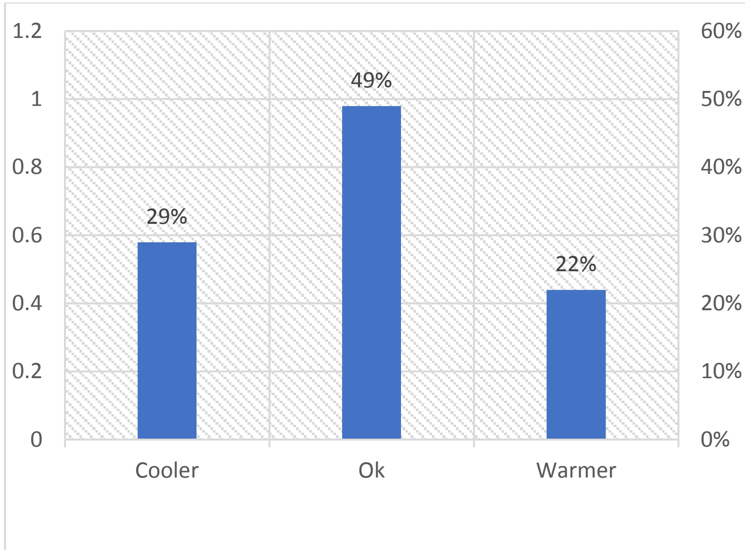

Figure 9: Histogram of thermal preference of the teachers

4.3.4 Comfort Range of Teachers

ASHRAE adaptive comfort standard defines the 80% operative comfort range as $-0.85 \leq TSV \leq +0.85$. This corresponds to approximately 80% thermal satisfaction, where the Predicted Percentage of Dissatisfied (PPD) is less than 20%.

The acceptable range of temperature was determined from the linear equation based on thermal sensation in the range of ($-0.85 \leq TSV \leq +0.85$) for 80% acceptable indoor thermal conditions. Based on the regression equation ($TSV=0.87T_{op}-25.2$) shown in Figure 10, a comfort range of 28.0-29.9^{o}C was produced.

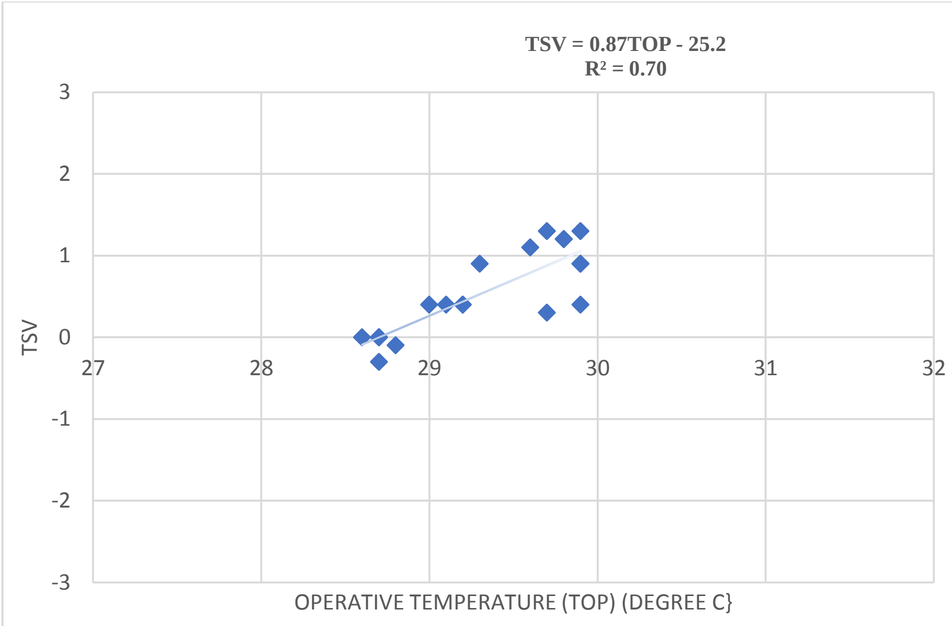

Figure 10: Mean thermal sensation votes of the teacher's vs TOP

4.3.5 Thermal Acceptability of Teachers

The thermal acceptability question of the teachers in the surveyed classrooms was judged adopting the same questions used on children's survey. As shown in Figure 11, only 35% of the teachers accepted the indoor thermal conditions while a good majority (65%) did not accept.

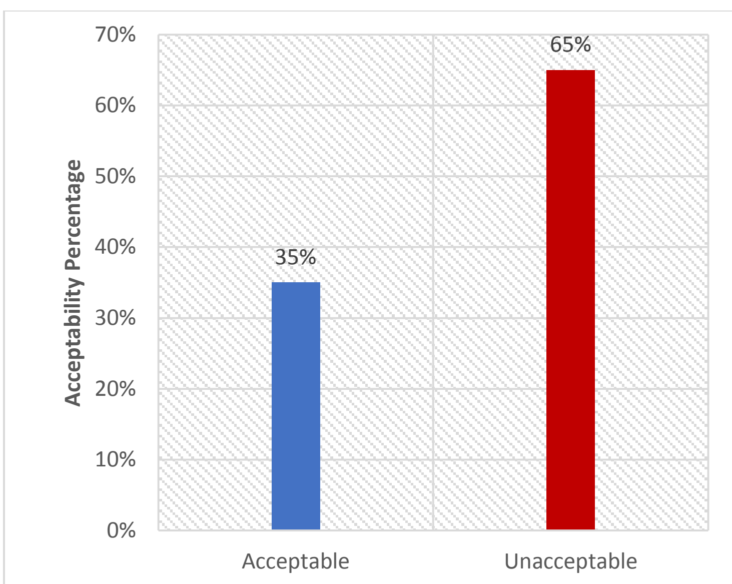

Figure 11: Thermal acceptability of the teachers

4.4 Comparing Thermal Perception of the Children with that of their Teachers

4.4.1 Thermal sensation

A poor correlation was found between the thermal sensation of the schoolchildren and their teachers. While the mean thermal sensation of the teachers is +0.58 that of the children is +0.16. This suggested that the teachers perceived their indoor environment as warmer than the children felt by 0.42 scale units. The implication is that when the teachers are feeling warm, the pupils may not necessarily be feeling warm.

Another way of comparing the thermal sensation votes of these two age groups is to check the results of the voting on the 7-point ASHRAE rating scale. As shown in Figure 12, 82% of the children voted on the three central categories of the ASHRAE scale (-1, 0, +1), while 73% of the teachers cast their votes on the same central category. Because voting on the 3-central categories of the ASHRAE scale is taken as 'comfortable', the result suggested that the teachers perceived the indoor environment as less comfortable when compared to the young children. The histogram further highlights other differences in the voting of the children and their teachers. While half of the schoolchildren voted 'okay', only about a quarter of the teachers voted 'okay'. Furthermore, while 20% of the teachers voted on the warmer side of the scale (+3, +2), 15% of the children voted on the same side of the scale.

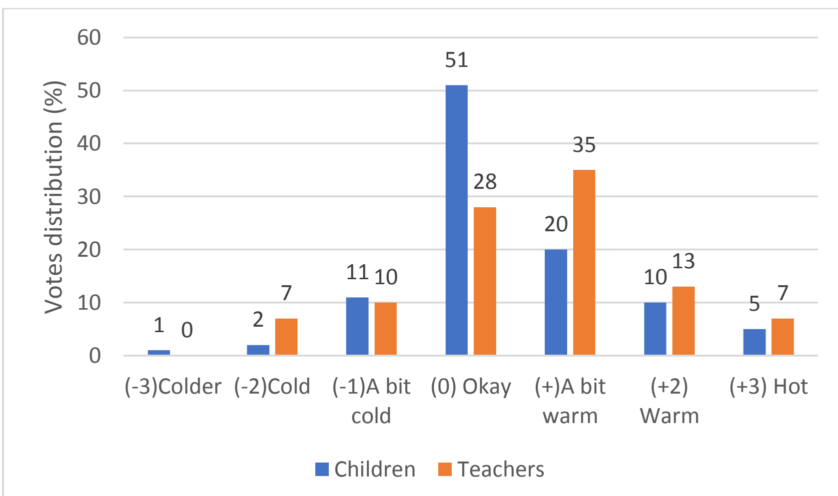

Figure 12: Comparing thermal sensation votes of teachers and schoolchildren

The results further suggested that the thermal sensation votes of the children were more spread compared to that of their teachers in the same indoor environment. The diverse activity of the children that produced different metabolic rates and the inability of some of them to adapt as they wished because of some restricted adaptive opportunities likely influenced the diverse result in their thermal sensation. The teachers' activities were similar to one another and resulted in a similar metabolic rate. Equally, all the teachers had the freedom to use adaptive opportunities available in the classrooms. These influenced the clustering of the result of their thermal sensation.

4.4.2 Thermal Preference

A poor correlation was also observed in the thermal preference of the students and the teachers, especially on the wanting to be warmer side of the 3-point McIntyre preference scale. While 13% of the students would prefer to be warmer, 28% of the teachers would prefer warmer conditions, indicating a significant difference in preferring to be warmer by 15%. 37% of the school children would prefer to remain in the thermal state they found themselves, while 32% of the teachers would rather prefer to remain in the thermal state, they found it. Using the thermal sensation scale, alongside the thermal preference scale, reveals further differences between these two age groups. Relating the votes in Figures 12 and 13, 14% of the children who voted neutral on the thermal sensation scale would rather prefer to be cooler or warmer. While 4% of the teachers who voted neutral on the thermal sensation scale would rather prefer to be ‘okay’ on the preference scale. The reason for this higher shift in these two scales by the children may be linked to their higher metabolism when compared to that of their teachers. The higher activity of the children, when compared to that of their teachers, results in high fluctuations (unsteady) in their body temperature.

However, both groups of people shared a commonality by casting more votes on preference to be ‘cooler’ than on preference for ‘no change’ and on preference to be ‘warmer’; 40% for the teachers and 50% for the schoolchildren.

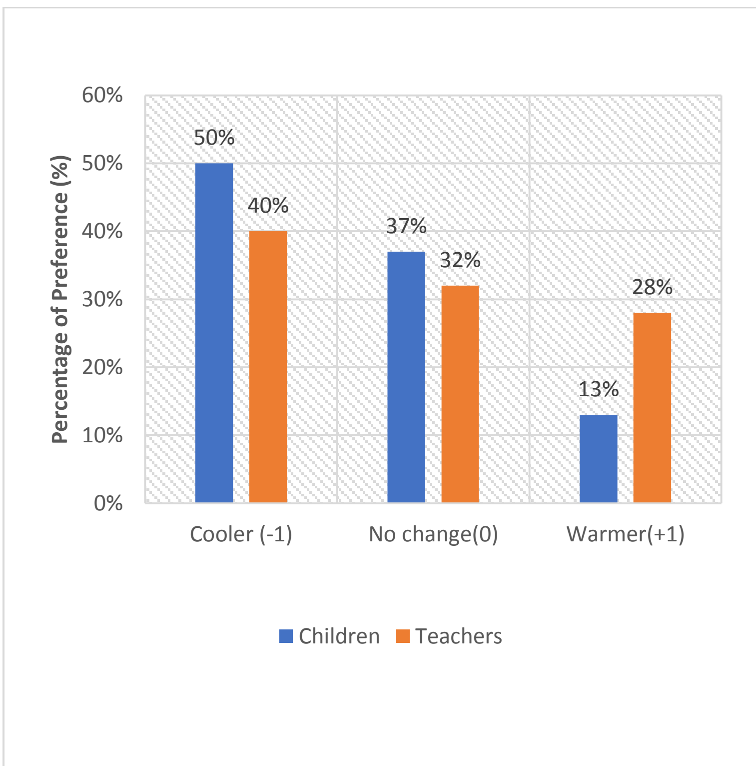

Figure 13: Comparing thermal preferences of teachers and schoolchildren

4.4.3 Comparing Comfort Range

According to table 6, the 80% acceptability (±0.85), the comfort bandwidths were 5.8K and 1.9K for the children and the teachers, respectively which indicated a significant comfort band difference of 3.9K.

This suggests that the comfort range of children is wider than that of the adults as observed in the previous work by (Al-Khatri et al., 2020). In order words, the students were adaptable to the indoor thermal conditions compared to their teachers.

The observation in this work about the difference in comfort perception of children and adults was also highlighted in the previous works of some thermal comfort researchers. For example, Humphreys (1977) found out that the levels of responses between children also have a lot of variance and classroom activities are more diverse than adult activities over a typical day. (Mishra & Ramgopal (2013), also observed in a review paper on field studies on thermal comfort that children have different levels of thermal sensation, different metabolic rates, different clothing restrictions, and different sensitivities to temperature changes.

Furthermore, a check on the summary Table 6 shows that differences also existed in thermal perception between these two age groups, considering the upper limits and the lower limits of the comfort temperature. For instance, while the upper limit of the children was 31.6^{o}C that of their teachers was 29.9^{o}C, a difference in comfort temperature of 1.7K considering the 80% acceptability (±0.85). This suggested that the children accepted higher indoor temperature in the classrooms by up to 1.7K more (higher temperature) compared with the teachers who shared the same classroom environment with them. Also, the children were able to accept lower indoor temperature by 2.2K more (lower temperature) compared to their teachers, considering the 80% acceptability (±0.85). The result is in agreement with the findings from previous works that children likely prefer a cooler temperature than adults (Yun *et al.*, 2009; Hwang *et al.*, 2009; Shamila Haddad et al., 2017; Al-Khatri et al., 2020).

Table 6; Comparing thermal perception of students and teachers

Group	**Neutral Temp (^{o}C)**	**TSV mean**	**Comfort Bandwidth**		**Comfort limits**				**Sensitivity**	**Correlation Coefficient (R^2)**
			±0.85 (80%)	±0.5 (90%)	Upper ±0.85 (80%)	Lower ±0.85 (80%)	Upper ±0.5 (90%)	Lower ±0.5 (90%)		
Children	28.8	+.16	5.8	1.7	31.6	25.8	30.4	28.7	0.29	0.51
Teachers	28.9	+.55	1.9	1.1	29.9	28.0	29.5	28.4	0.87	0.70

4.4.4 Comparing coefficient of Determination (r^2)

The coefficient of determination (r^2) is another way of checking how sensitive building occupants are to variations in indoor temperatures. As shown in table 7, the regression results from the regression of mean thermal sensation votes and the indoor operative temperatures produced r^2 with a value of 0.51 for the children and 0.70 for the teachers. The value from the children is low, while that from the teachers is high. However, for surveys involving human behaviors, an r^2 value as low as 0.40 is often considered a strong correlation (Mishra & Ramgopal, 2015). Lower r^2 indicates better adaptation to indoor thermal conditions. The lower value reported by the children suggested that the studied children were more tolerant of the changes in the indoor thermal conditions compared to their teachers. This means that a change of 1.9K in the room temperature changed the children's thermal sensation by 1 scale unit, while a change of 1.4K in the room temperature changed the teacher's thermal sensation by 1 scaler unit. The same finding was also reported in the works of Teli et al., (2012)\, Trebilock & Figueroa, (2014) , Karyono & Delyuzir (2016), and Rijal et al., (2015).

4.5 Conclusion

.As observed in the literature review, the research on thermal comfort of building occupants championed by Professor Fanger did not include children in the sample of occupants for the investigation of thermal comfort. Is of recent that research is being focused on young children to assess indoor thermal comfort. The results from this fieldwork showed some differences between children and teachers in terms of satisfaction with the thermal environment, demonstrating that the children perceived thermal comfort differently from the adults considering the adaptive model. This was also observed by thermal comfort researchers (such as de Dear et al., 2015; Zomorodian et al., 2016; Jiang et al., 2018) in their separate thermal comfort research. The reasons for the differences in the perception of thermal environments between the school children and their teachers are linked to the wide difference in age between these two groups. While the mean age of the children is, in this study, is 9 years that of their teachers is 37 years. Children are known to have different metabolic rates and activity rates when compared to adults, as summarized by Nicol et al., (2012) who posited that the metabolic heat generated for the elderly would have been rather low, because of the age and because of relative inactivity that comes with age.

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PETROLEUM FILLING STATIONS AND THEIR IMPACT ON THE ENVIRONMENT IN NIGERIA (A REVIEW)

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ABSTRACT

The poor state of the environment, especially in urban areas, has become a major global issue, with developing countries such as Nigeria voicing growing concern. There is a scarcity of knowledge on the environmental impact of PFSs as a result of the loss of life and property, as well as other serious socio-economic implications of non-compliance with PFSs siting criteria. The historical literature on the impact of residential buildings, the environment, and human health on PFSs in Nigeria, as well as the study's gap, is examined in this research. It also outlines DPR compliance with PFSs location as well as established criteria for prohibiting PFS siting in Nigeria's states. Relevant publications on PFSs-related topics were downloaded from Google Scholar. The goal of this study is to look back on a previous essay about PFSs in Nigeria and its impacts on the environment and human health. This study's main purpose is to give a complete overview of Nigerian PFSs. According to the article analyzed, the majority of PFSs were located close to residents, with setbacks from the road and residential areas of less than 30 m in 90% of the filling stations. As a result, the landowners can band together to argue that a facility that is improperly sited cannot be built. A great deal of public participation is required. A campaign should be launched to raise awareness among filling station owners and other developers of the dangers of non-compliance with established norms. All violators of the established norms, as well as corrupt officials of enforcement agencies/bodies, should face open punishment so that others might learn their lessons. Finally, appropriate planning is required to allow future road expansion.

Keywords: Petroleum filling stations (PFSs) Environment Health Impact, Department of Petroleum Resource (DPR)

1. Introduction

Volatile organic compounds (VOCs) are a diverse collection of substances distinguished by their relatively high vapor pressures. Exposure to these substances can cause asthma, headaches, mucosal symptoms (Steinemann, 2008) and, in some situations (e.g., benzene), an elevated risk of cancer (Ott *et al.,* 1978; Lynge *et al.,* 1997). In Europe, benzene is the only VOC that is officially regulated in terms of air quality (Directives 2000/69/EC and 2008/50/EC). VOCs have indirect health consequences due to their role as ozone and other photochemical pollution precursors. PFSs are frequently the largest source of VOCs in metropolitan settings. Additional sources include traffic and small-scale companies that employ organic chemicals as solvents (paint, glue, etc.). Petrol stations as VOC emission sources have been the topic of much research in recent years, with a special focus on the design and evaluation of control systems in an effort to reduce environmental concerns and emissions (Uren, 1997; Ohlrogge *et al.,* 2000). Mostly those concerning their effects on employees and environmental issues (Brugnone *et al.,* 1997; Palmgren et al., 2001; GPatroescu et al., 2009_onzalez-Flesca *et al.,* 2003; Periago and Prado, 2005; Srivasteva *et al.,* 2005; Fernandez-Villarrenaga *et al.,* 2005).

Several studies in the worldwide literature have looked at local projections of petroleum vapours on petrol station workers' health and the impact of petrol stations on their immediate surroundings, and gas stations as a major source of VOCs (Periago and Prado, 2005; Terres *et al.,* 2010). The inclusion of petrol stations within residential zones in human settlements was determined by the uncontrolled and rapid sprawl of built-up houses unique to Romanian urban ecosystems (Patroescu *et al.*, 2009).

Spanish petrol stations were traditionally located in relatively empty areas, the country's continual urbanization has resulted in numerous petrol stations being established within metropolitan areas surrounded by structures in recent years. This issue has sparked a debate between residents whose homes are close to gas stations and the authorities in charge of land management. With oil products, the residential areas-gas stations relationship can cause fires, increased traffic, noise, pollutants, waste, and wastewater (Ioja *et al.,* 2010). The climate zone, road network features, and urban agglomeration all amplify these effects (De Ross *et al.,* 2010). The haphazard expansion of built surfaces in Romania, particularly residential areas, has resulted in the replacement of the terrain profile, from one productive to one consumer, as well as the residential areas' closeness to opposing functions (Ioja, 2008). In general, gas stations are positioned only for economic reasons, with little consistency in issuing building certificates and no proper oversight of conformity with territorial planning requirements. Environmental endowments are modest, and environmental components are only superficially monitored at these gas stations. All of them are linked to excessive VOC emissions (particularly benzene), which cause structural disequilibrium in environmental components.

Oil is an important petrochemical feedstock, it is also a source of energy for the global economy (Joseph and Riva, 2010). As can be seen from the above data, oil has played a significant role in the growth of technology in our day. However, oil finding, like any other technique, has its drawbacks. One of these disadvantages is its harmful impact on the earth's biosphere, which includes the release of pollutants and greenhouse gases into the environment, as well as ecosystem damage from occurrences like oil spillage (Timothy, 2006). As a result of this predicament, developed countries are beginning to place a greater emphasis on a cleaner, more environmentally friendly energy source.

Nigeria's energy needs are provided by petroleum and natural gas reserves, which are plentiful. The Nigerian economy is heavily reliant on crude oil exports. The recent population growth in Nigeria has prompted a rise in demand for petroleum goods, and many marketers have taken advantage of this need by arbitrarily constructing service stations without considering the potential impact of their locations (Isabel *et al.,* 2020). The rapid growth of built-up gas filling stations in primarily residential neighborhoods in developing nations, including Nigeria, is concerning and poses issues for a sustainable environment as well as violations of land use arrangements and environmental aesthetics (Amakiri-Whyte *et al.,* 2021). Opinions show the accumulating and obstinate glassiness of these phenomena in Nigerian residential zones, exacerbated by quick approval, poor evaluation, and control of such developmental projects in residential areas by the relevant agencies, which are safekeeping physical planning and urban development without regard for the attendant environmental and health implications.

The emissions come from a variety of sources, including gasoline delivery to stations, tank breathing caused by temperature and pressure fluctuations during vehicle refueling, emissions from loosely closed tanks, and leakage caused by mishandling of petroleum (Isabel *et al.,* 2010). There is also the emission of combustion products from the station's vehicle engines (Ulakpa and Ulakpa, 2021). PFSs, as retail outlets for highly flammable petroleum resources such as gas, gasoline, and kerosene, must be strategically situated in relation to other operations to minimize the damage on the nearby environment. Petrol stations along the route were found to be too close together; some were even built side by side, resulting in a greater likelihood of massive and wide-ranging consequences on the nearby environment. The positions of gas stations in relation to road crossings and U-Turns, as well as their setbacks from the expressway, a high-tension power line, and adjacent land uses, have generated concerns about the area's safety.

Description of the Study Area

Nigeria is located in the West African sub-region between longitudes 30 and 14^0E and latitudes 40 and 14^0N as shown in Figure 1. It has a total area of 923,768 square kilometers. It is bordered to the North by the Republics of Niger and Chad, and to the West by the Republic of Benin. It shares Eastern borders with Cameroon all the way down to the Atlantic Ocean's coasts, establishing the Nigerian Territory's Southern boundaries.

Despite being totally inside the tropics, Nigeria's climate ranges from tropical on the coast to sub-tropical in the interior. The wet season runs from April to October, with the dry season being from November to March. The extreme maximum temperature in Southern coastal locations can reach 370 °C, while the extreme low is 100 °C. Temperature extremes can vary from 400 to 5000 degrees Celsius further north, and the climate is drier (Nuhu, 2019).

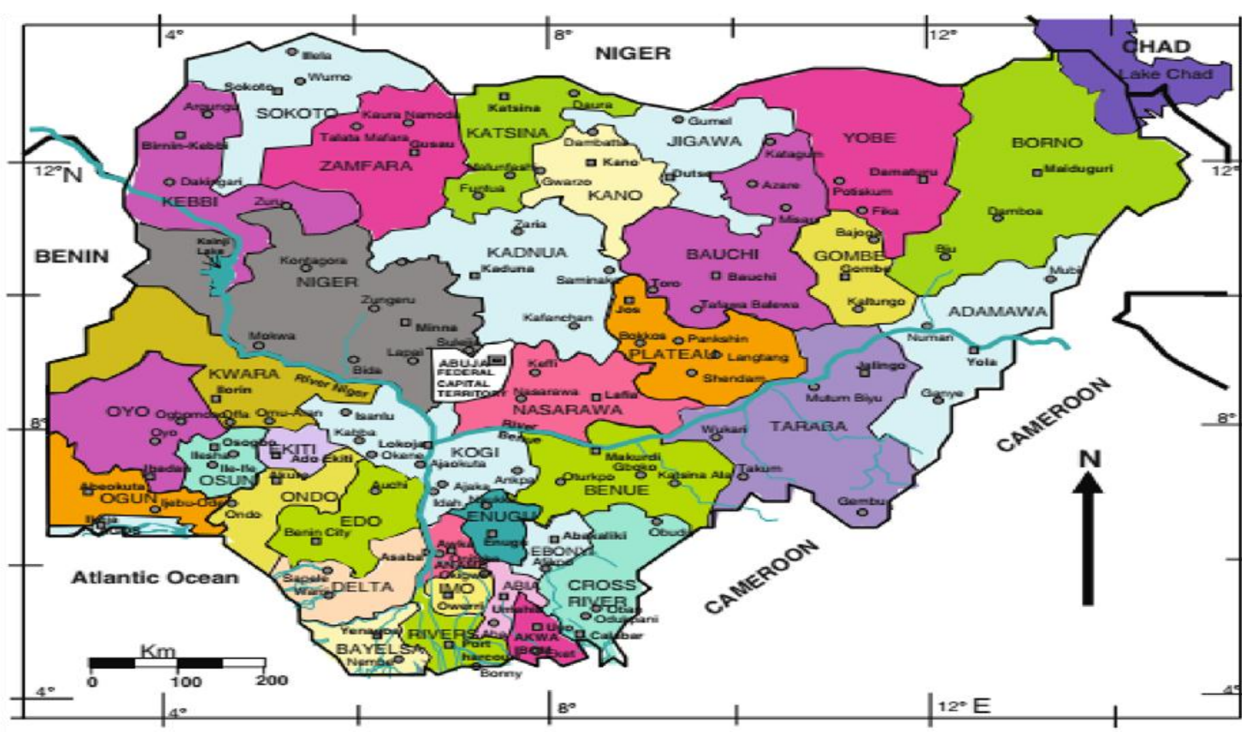

Figure 1. Nigerian map depicting the federating states (Nuhu, 2019).

2. Methods

In Nigeria, a similar technique was used to review PFSs, and the same was used in order to assess the environmental impact of petrol pumping stations near residential areas in Nigeria, as well as to suggest mitigating techniques, articles from the last 5-10 years were examined (Eyankware *et al.*, 2020). Articles relevant to this study were found using Google search engines and open access journal sites. These articles and papers were reviewed in their entirety, and the data was entered into a database containing the authors' names, publication details, study site, time period, strategy, and technique for studying the impact of filling stations on man and the environment, as well as the major conclusion.

Furthermore, multiple methods were employed for this study with some modifications to satisfy the goal and objectives of this paper, which was to interpret the status and quality of work done within and outside Nigeria. The following approaches were used to evaluate the quality of the articles; the environmental and human health consequences of the proliferation of PFSs in previously uncharted territory; to research EIA standards for PFS site selection suitability, and to assess the impact of their sites in order to provide a long-term solution to the difficulties.

3. Results and Discussion

3.1 Impacts of the Proliferation of PFSs with Their Unprecedented Locations It Has on the Environment

Several researches have demonstrated the problems associated with the environmental impact of PFSs in Nigeria. The manner in which petrol fuel outlets are sandwiched in residential zones of Nigerian urban centers without regard for the health and environmental consequences is not encouraging. An empirical study was conducted on contaminants released from PFSs and their impact on air quality (Okonkwo *et al.*, 2014). Their findings revealed that the main contaminants identified in the environment air were volatile organic compounds, methane, and carbon monoxide, with impurity levels exceeding the FEPA air quality limit. Over 98 percent of PFSs met the minimum reserve of 100 meters from health care centers and various gas stations in order to achieve the 400-meter basic station distance guideline (Mohammed *et al.*, 2014). PFSs have been found to be abundant near roadways and residential buildings in previous research. Similar research has demonstrated that the locational pattern of nearby petrol filling stations has a propensity to cluster in a specific zone. The study recommends that petrol stations be closed or restricted in and around the town's-built road flight path and strictly designated residential zones (Olapeju, 2017).

The buffer analysis and descriptive statistics to evaluate the proximity of PFSs to residential buildings in the Bucharest suburbs discovered that the presence of PFSs has resulted in malfunctions, highlighting a disadvantage area due to environmental issues, unplanned development, overburdened infrastructure, and pollution of each environment component (Cristain and Constantina, 2020). They evaluated the survival of filling stations and urban infrastructure to qualify check maintenance on compliance. In their research, they discovered that while 50% of gas stations followed the rules, the remaining 50% did not. According to the researchers, preparedness should be based on the adequacy, functionality, and sophistication of available extinguishing facilities. Setback standards and safety preparedness policies should be improved for long-term urban development (Ulakpa *et al.,* 2016). The study on the locational distribution of petrol stations and the underlying ramifications in Osun City, Nigeria's commercial density shows that about 56% of PFSs followed the area coverage standards, implying that the petrol stations' clustering was endangering the area's safety (Olusegun *et al.,* 2011).

The location of filling stations and their impact on the environment in different parts of Nigeria was investigated (Ayodele, 2011; Mshelia *et al.*, 2015; Samuel *et al.*, 2015). In Kaduna North the spatial distribution of filling stations was analyzed, from the result it was discovered that the 22 PFSs in the area are irregularly dispersed and largely clustered along key highways (Ayodele, 2011). The analysis did not consider the impact of the spatial distribution of these filling stations on traffic flow along the highway which contradicts (Mshelia *et al.,* 2015). According to research conducted in Spain, gas stations contribute significantly to ambient benzene concentrations in their vicinity as a result of the non-conformity of filling station locations to statutory criteria on traffic flow (Karakitsios *et al.,* 2007). Table 1 shows the results.

The study's findings revealed that factors such as promotion, brand, pump pricing, service quality, opening hours, local authority assessment, and location size influenced siting. As a consequence of the study's findings, a fuel station placed in a high-traffic region, a struggle along the road, the area's land use activities, and the road's condition, including environmental and regulatory requirements, are all desirable. In the Nigerian city of Port Harcourt, there is an agreement that the spatial attribute for locational analysis of petroleum stations is that filling stations have been converted to residential houses, and 14 filling/ petrol dispensable engines are located near the road, and one is located near a high-tension line (DeRoss *et al.*, 2010; Boison *et al.*, 2018).

Researches on the impact of PFSs on petrol stations in Kampala, Uganda were compared to studies on the level of compliance of PFSs with development control requirements in Anambra, Nigeria (Joan and Isamil, 2020; Ulasi *et al.*, 2020). As the distances between the filling stations sampled from the road and the setback standards are significantly different, the results of their study suggested that the aforementioned explain why houses located 100 meters from stations were prone to sensible height and those 50 meters' analyses were rated the peak of the risk, as the distances between the filling stations sampled from the road and the setback standards are

Table 1. Brief Information on the Comparison on the Distance on PFSs in Nigeria.

From	To	Location	Kilometer	Meter	References
NNPC Mega Conoil	Federal road	Abuja- Keffi road	0.05	50	Blamah *et al.* 2012
Oando	Residential Buildings	Isoko road Ughelli	0.05	50	Field Study, 2021
Conoil	Businesses centers	Kubuwa Abuja	0.1	100	Field Study, 2021
Century	New path	Okpanam road Asaba	0.3	300	Field Study, 2021
Texaco	Total	Abuja-Keffi road	0.1	100	Blamah et al. 2012
Total	Mobil	Isoko road Ughelli	0.2	200	Field Study, 2021
Rain oil	Federal road	Asaba-Agbor road	0.1	100	Field Study, 2021
Conoil	Residential Buildings	Rumuokuta – Mgbuoba road	0.2	200	Field Study, 2021
SC Interconstruct '93 SRL,	National Road (NR)	Bucharest suburban area,	0.12	120	Cristian and , Constantina

Dobroesti		Romania			2012
SC Motanul Galantron SRL, Snagov	National Road (NR) or European Road (ER)	Bucharest suburban area, Romania	1	1000	Cristian and , Constantina 2012
SC Rompetrol Downstream SRL, Glina	National Road (NR) or European Road (ER)	Bucharest suburban area, Romania	0.25	250	Cristian and , Constantina 2012
Total	State road	Agbani-Enugu road	0.3	300	Field Study
NNPC mega stations	State road	Douglas road Owerri	0.05	50	Field Study
AA Rano Nig. Ltd.	Federal road	Mararaba	0.1	100	Field Study
Mobil	State road	Kurunduma	0.5	500	Field Study
Oando	State road	Kuchikau	0.14	140	Field Study
Total	State road	Masaka	0.14	140	Field Study
NNPC	Federal road	Ado	0.75	750	Field Study

significantly different, the results of their study suggested that the aforementioned explain why houses located 100 meters from stations were prone to sensible height and those 50 meters' analyses were rated the peak of the risk, as the distances between the filling stations sampled from the road and the setback standards are significantly different. Further studies revealed that the environmental problems of developed fuel filling stations in the residential domain are also numerous, including volatile organic compounds, methane, and carbon monoxide, to name a few in Port Harcourt Rivers State (Amakiri-whyte *et al.*, 2021).

The increase in the global population has outpaced, and automobiles, including Premium Motor Spirit (PMS), have posed a serious threat to human health in terms of providing the Liquified Natural Oil, Kerosene, Dual Purpose Kerosene masses with the necessary infrastructure, enact, and (DPK), Aviation Turbine Kerosene are sold (WHO, 2010). As the population of completed white petroleum products grows, so does the number of automobiles that run on flammable vapour at very low temperatures.

It is believed that PFSs hydrocarbons activated metabolites, when reacted with some cellular components, such as membrane lipids, to form lipid peroxidation products, could contribute to membrane alteration (Onwurah, 1999). They went on to say that this could react with enzymes and cause

Table 2 – Benzene concentrations (µg.m-3) measured by personal (R) or by fixed site monitors (S) placed in or around of petrol station.

Local	**Period**	**Observations (n)**	**Study Type (Sx)**	**References**
United States	1981-83	72	Rnc	(Wallace, 1987)
Europe	1986-1992		Rnc	CONCAWE, 1994
United Kingdom	1995	-	Rnc Rc	Duarte Davidson *et al.*, 2001
Valencia (Spain)	-	7	R	Esteves et al., 2007
Kolkata (India)	2005-2006	35	R	Majumdar *et al.*, 2008
Ioannina (Greece): - urban - rural	2006	30 30	Rc	Karakitisios *et al.*, 2007
Ioannina (Greece) - urban - rural	2006	32 32	Rc R	Karakitisios *et al.*, 2007
Owerri (Nigeria)	2005-2007	40	Rnc	Terres *et al.*, 2010
Italy	-	28	R	Fracasso *et al.*, 2010
Kano (Nigeria)	2008	214	Rnc	Afolabi *et al.*, 2011
Ilorin (Nigeria)	2018	297	Rc	Odipo *et al.*, 2018
Anambra (Nigeria)	2019-2020	270	Rnc	Ulasi *et al.*, 2020
Ife- central (Nigeria)	2021	52	Rnc	Oladele and Micheal, 2007
Ede Osun state (Nigeria)	2021	14	Rnc	Olanrewaju *et al.*, 2020

-: the requested information was not found; Rnc: refueling without an installed emission control system; Rc: refueling with an installed emission control system; R: refueling without knowing whether or not an emission control system is in place; Sx: a study conducted at a maximum distance of x meters around a petrol station.

inactivation by oxidizing proteins and/or breaking DNA strands. Because their metabolites can attach to proteins and nucleic acids, they can trigger these latter effects. Studies also shown that

PFS exposure has resulted in significant alterations in the activity of numerous enzymes in China particularly in the tissues of the liver, kidneys, and lungs (Khan *et al.,* 2002; WHO, 2012). The potential health risks of Owerri's petrol station personnel were assessed (Nwanjo and Ojiako, 2007). The results show a significant increase in alkaline phosphatase, analine, and aspartate amino transfer activities in people exposed to petrol vapour for 6-10 years. Individuals exposed to petrol vapour had significant amounts of serum urea, creatinine, and urine protein, according to the findings.

Qualitative interviews were conducted to confirm the discovered parameters of PFSs in Ife-Central using an inductive manner. The findings show that all of the PFSs violate the principles and criteria because the distribution was clumped, negatively impacting the residents' well-being, the environment, and their socioeconomic situation (Oladele and Michael, 2007). PFSs siting has resulted in the release of volatile organic compounds such as benzene and toluene, as well as toxic gases such as carbon monoxide and traces of soot, all of which have been shown to have a negative impact on general health and environmental hazards (Alam *et al.,* 2014). Table 1 shows the results.

3.2 EIA Requirements for Suitability of Site Selection of PFSs

Construction activities are anticipated to cause severe environmental harm, which is a major worry. Rail projects, fuel pumping stations, and infrastructural facilities all have the potential to impact the environment, including soil degradation, air pollution, and water contamination (Oladele and Michael, 2007; Aguib *et al.,* 2013; Ali *et al.,* 2012; Appiqh *et al.,* 2015; Carrion *et al.,* 2018). The main challenge for developers today is to establish and implement a strategy for sustainable building operations that is both environmentally friendly and long term (Matori and Aulia, 2010; Choudhury and Das, 2012; Arumaningrum, 2021). Continuous urbanization creates a fair demand for automobiles, resulting in increased fuel consumption and filling station demand (Darko, 2015).

Several incidences involving fires at gas stations and filling stations have already been reported in the news, with fatalities. It has a variety of effects on the industry as well as the mental health of users. Take a look at Figure 2.

Researchers continue to be interested in developing a sustainable way to maintain the natural environment. Construction field activities that can harm the environment have long been a source of worry. The structure of such places has the potential to cause significant environmental damage. A PFSs improves transporter and traveler convenience, but these stations are frequently dangerous

Perceptions of Residents on Danger Associated with Petrol Stations in Nigeria

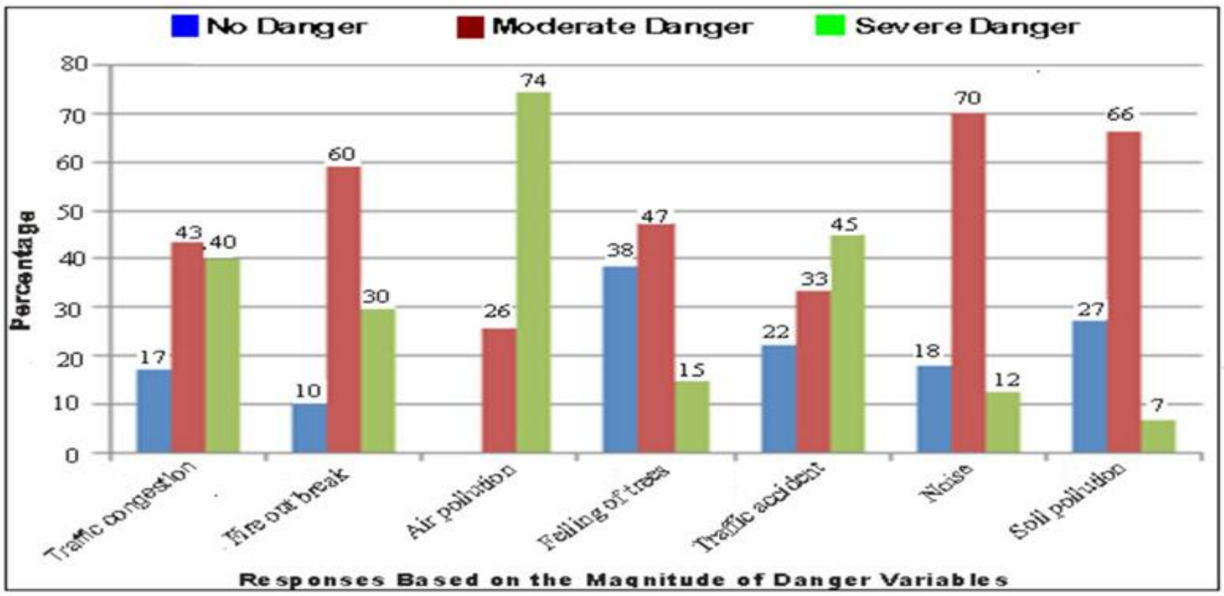

Figure 2. Perceptions of Residents on Danger of the Presence PFSs (Mshelia *et al.*, 2015)

(Kirby, 2003; Ekanayake and Ofori, 2015). Site selection is frequently cited as an important factor in the success of any business venture. This industry has become increasingly concerned about major environmental issues and negative consequences around the world. Petroleum retail companies are attempting to implement sound and effective environmental policies for PFSs. The EIA was created as an effective instrument for better management of such assets for this aim. Using regression and GIS, the PFS's position is determined by traffic volume counts (Malczewski, 2007).

The amount of clients who visit per day determines the site's potentiality, which is critical for business growth. A study was carried out in the Kano Metropolitan Area in Northern Nigeria to ascertain the concern of businesses in the sector of petrol retailing for taking physical planning requirements into consideration (Hangula and Shagama, 2020). The requirements stated for planned construction were found to be ignored by eight (8) stations (4%) out of 192 stations [78]. As illustrated in figure 3a and 3b. It is said that building crews for petrol-filling stations prefer to choose a site based on personal preferences; however, for environmental protection and other preventive measures, a uniform method is required. Furthermore, it is noted that an EIA study is required prior to obtaining approval for the fuel site (Pedersen *et al.*, 2003; Mulroy, 2012; Mohammed *et al.*, 2014; Mundjulu, 2020).

EIA entails the necessary examinations and analyses of a project's environmental viability. The methods and procedures involved in completing EIA reports take a significant amount of time, effort, and money (Mwania and Kitengela, 2003). The older approaches of site selection incorporate both qualitative and quantitative elements when deciding on a place. Because various factors are still involved in the EIA analysis of any facility, such as an FS, these studies lack factors considered in EIA assessment. And FS is a significant environmental liability since it poses a risk to the environment's well-being. As a result, a site study and general risk assessment are required before such facilities may be built (O' Faircheallaigh, 2010).

When opposed to those run by individual marketers, conglomerate-owned stations, such as the Nigeria National Petroleum Cooperation (NNPC) Retail Outlets- (State throughout the metropolis, resulting in cluster patterns that pose a major hazard to the town's heavily populated districts and are not constructed in compliance with existing norms.

Figure 3a and 3b. Displaying PFSs with no setback to residential buildings in Delta and Imo State.
Source: Researchers' Fieldwork, 2021.

In Malaysia, a similar study was carried out to determine suitable land parcels for the installation of new PFSs (Gonzalez -Flesca, 2002). According to them, the Ipoh Mapping and Surveying Department provided the geographic data, while the Ipoh City Planning Department provided the norms used in practice for site selection for PFSs. They prepared a questionnaire to get feedback on the PFSs location choices from stakeholders. During their investigation, they revealed that the vast majority of PFSs failed to meet the specified guidelines for position and distance from residential residences, which served as the foundation for future PFSs construction as shown in Figure 4a and 4b.

Figure 4a and 4b. Showing PFSs close to Residential Buildings in FCT and Rivers State
Source: Researchers' Fieldwork, 2021

4.Conclusion

As a result of the foregoing, it is clear that PFSs are forming in Nigeria without consideration for existing physical planning norms, putting the environment, as well as human and public health, in jeopardy. The majority of inhabitants, unfortunately, were unaware of the health risks associated with the petrol stations' infractions of planning requirements. As a result, the DPR must ensure that planning standards are properly enforced in Nigeria in order owned), have stronger safety procedures and orientations.

GIS was used to conduct a location analysis of PFSs in Ilorin, Kwara State, Nigeria. The coordinates of the stations were recorded using a handheld Global Positioning System (GPS) device, and other data were gathered by presenting questionnaires to the owners and workers in each PFSs. During their investigation, they determined that the majority of the stations were near buildings, with 10 (3%) being near a school, 226 (76%) near retailers, 192 (65%) near residential houses, and 11 (4%) being near hospitals [61]. The study reveals that PFSs are overly packed to protect public health and encourage healthy urban expansion. The relevant authorities also demand that fuel stations, as well as any other physical developments, be installed throughout the country, as well as public awareness campaigns about the environmental and health risks involved with such developments. These kinds of campaigns can be carried out with the help of the media and collaboration with traditional rulers and local groups.

Recommendation

In light of the study's findings, the following recommendation was made:

i. The law should empower the planning officer (s) to investigate all instances of illegal development, as well as plans submitted by non-planners without the planner's permission.

ii. Public participation is important because landowners can band together and say that a facility that is poorly located cannot be built.

iii. A campaign should be initiated to increase awareness among filling station owners and other developers of the dangers of non-compliance with set requirements.

iv. All violators of the established criteria should face open punishment in order for others to learn from their mistakes.

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EVALUATION OF AIR POLLUTION LEVEL DUE TO DOMESTIC GENERATORS USE IN ABAKPA NIKE, ENUGU EAST LGA., ENUGU STATE.

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ABSTRACT
The study investigated the environmental effects of air pollution (carbon monoxide emission) arising from the domestic use of electricity generators in Abakpa Nike, Enugu State, Nigeria, owing to the erratic supply of power by Enugu Electricity Distribution Company (EEDC). The key objectives of the study were to determine the concentrations of carbon monoxide CO (ppm) level of the area and compare it with NESREA and W.H.O. standards for CO (ppm) and to determine the effects of the carbon monoxide concentration on the air quality of the area. The study made use of NOK LCD Carbon Monoxide Meter for data collection. Two (2) streets were chosen from each of the stratified nine (9) zones of Abakpa, and ten (10 houses) selected per street. Two complete sets of air quality measurements were taken in the Mornings (6 – 8am) and Evenings (7 - 9pm). Empirical measurement showed that the CO (ppm) level in each of the sixteen (18) study sites were higher than NESREA and WHO CO (ppm) limits, respectively. The study made use of Paired samples T-Test. It was found that the CO (ppm) was significantly different from the set standard. Using U.S. Environmental Protection Agency Air Quality Index, air quality of the study area was very poor owing to the carbon monoxide emission. The study thus, recommended the expansion of the grid by the Federal Government of Niger. City managers should also provide guidance to residents on placement criteria for private power plants so that they do not endanger the lives of their household members. The neighbors also need to operate the generators in open spaces in order to prevent health hazard and improve air quality of the area.

Keywords: Pollution, Electricity, Air quality, Carbon monoxide, Concentration

1.0 INTRODUCTION

1.1 Background of the Study

Almost all that provides humans with the luxuries of everyday life requires generation and supply of electric energy; industrial products, agriculture and domestic valuables (Omokaro, 2008). Unstable electric power supply in Nigeria has remained a major challenge of government of the past and present. Less than 10% of the national electricity demand could only be met through the national grid (Hall, 2006). Over 50% of Nigeria's 160 million people have no access to electricity. For Nigeria to meet up with its electricity need, it requires power generating/transmitting capacity of 140,000MW as against the current capacity of 3,920MW

(Omoruiyi and Idiata, 2015). Current estimates indicate that over 90% of businesses and 30% of homes have diesel-powered generators, this implies that there are currently about 15 million generators in use in Africa's most populous nation. Energy Commission of Nigeria (ECN) (2009) reported that 60 million Nigerians now own generators.

Nigeria has a high rate of electric generators usage, and this is attributable to the shortfall of power generation, transmission and distribution by the power industries (Adinife and Babatope, 2013). Availability and reliability of electricity supplies have always been a vexed issue in Nigeria (Ibitoye and Adenikinju, 2007). 40% of the production cost of manufacturers in Nigeria is for the provision of alternative electricity supply, compared to 5-10% in other similar economies, thus crippling Nigerian businesses (Idiata *et al.,* 2008).

The primary pollutant of generator usage is carbon monoxide. Biologically, carbon monoxide poisoning is the most common type of fatal air poisoning in many countries. Since it is highly toxic, it combines with hemoglobin to produce carboxyhemoglobin (COHb) which is ineffective for delivering oxygen to bodily tissues. This condition is known as anoxemia. Concentrations, as low as 667ppm, may cause up to 50% of the body's hemoglobin to convert to carboxyhemoglobin (Akinyemi and Usikalu, 2013).

Electric energy occupies the top grade in energy hierarchy as it finds innumerable uses in homes. As a result there is an upsurge in the use of electricity generators with its attendant noise and air pollution on the environment and human health (Mbamali et al, 2012). Air pollution also has been shown to cause health situations like bronchitis; lung inflammation and others (Mishra, 2003, Yesufu *et al,* 2012).

Abakpa Nike, is a big metropolitan area, with industrial, commercial and financial interests (Okafor, 2013). Owing to diverse economic outlets, the population of the town has increased tremendously, attracting settlers who reside, engage in trading or are employed in these numerous businesses. Hence, Abakpa Nike have suffered for decades from the inadequate electricity service from the government owned monopoly Power Holding Company of Nigeria and its newly privatized subsidiary, Enugu Electricity Distribution Company (EEDC), which is in charge of electricity supply to the southeastern region of Nigeria. Thus, Abakpa Nike residents resort to alternative supply of energy, mainly diesel and petrol fueled generators, as evidenced by preliminary field visit. With the recent increased pump price of fuel from ₦85 to ₦165/180 per litre (over 100% increment), the fueling of these generators definitely affects the household standard of living and businesses negatively. During the preliminary field visits, many of the small-scale business operators reported that the use of electric generators is affecting their business and profit margins negatively. In most cases, they have to either shut their business, or lose important customers or hike the price of their services due to the extra cost of fueling and maintaining the electric generators, and erratic power supply.

1.10 The Study Area

1.10.1 Location

The study area is Abakpa Nike, Enugu East LGA. It lies within latitudes $6^{o}30'4''$N and $6^{o}31'4''$N; longitudes $7^{o}30'21''$E and $7^{o}31'23''$E, as shown by **Figure 1.2** below. **Figure 1.2** also presents the 21 LGAs of Enugu State, showing Enugu East LGA, where Abakpa Nike, the study area is located at while **Figure 1.3** shows map of Abakpa Nike which is located in Enugu East LGA and is bordered to the North by Trans-Ekulu, to the west by New Haven and to the East by Emene (Enugu State Government, 2018).

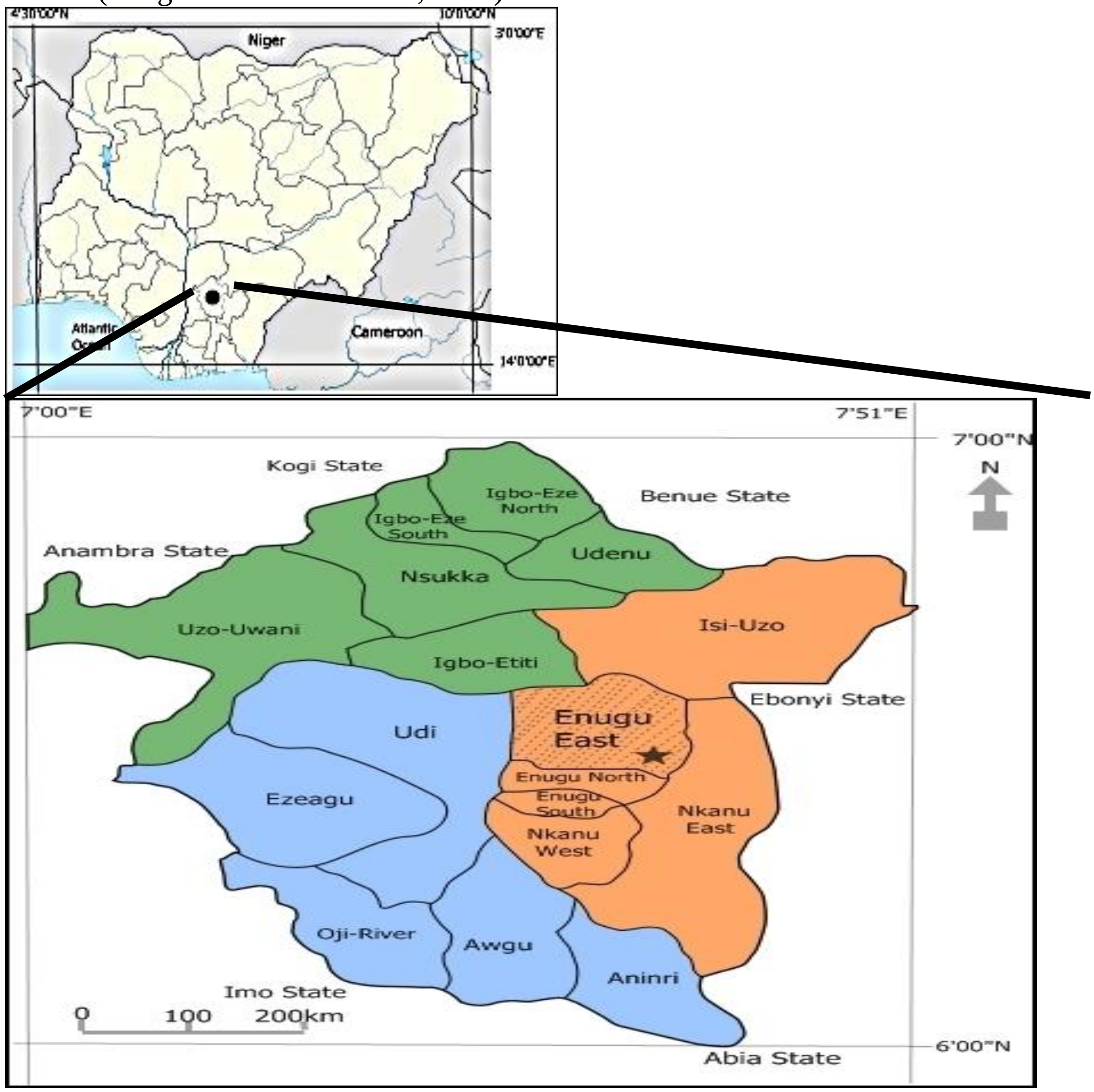

Fig. 1.2: Map of Enugu State Showing Enugu East LGA. Inset: Map of Nigeria showing Enugu State. Source: Enugu State Ministry of Lands (2018).

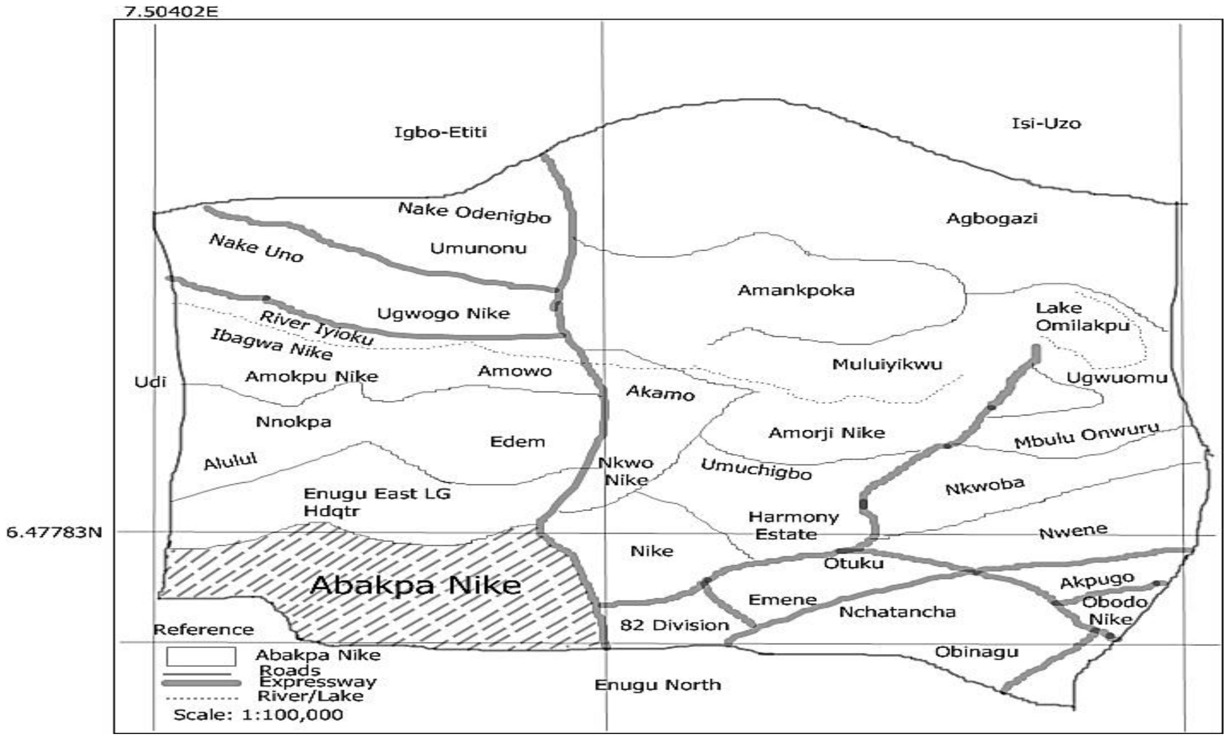

Fig 1.3: Map of Enugu East LGA showing Abakpa Nike, Enugu
Source: Enugu State Ministry of Lands (2018)

Fig. 1.3 above shows map of Enugu East LGA, located in Enugu State of Nigeria. Abakpa Nike is found in southwest of Enugu East LGA. It shows that Abakpa Nike is bordered to the East by 82 Division Cantonment Barracks and Nike town.

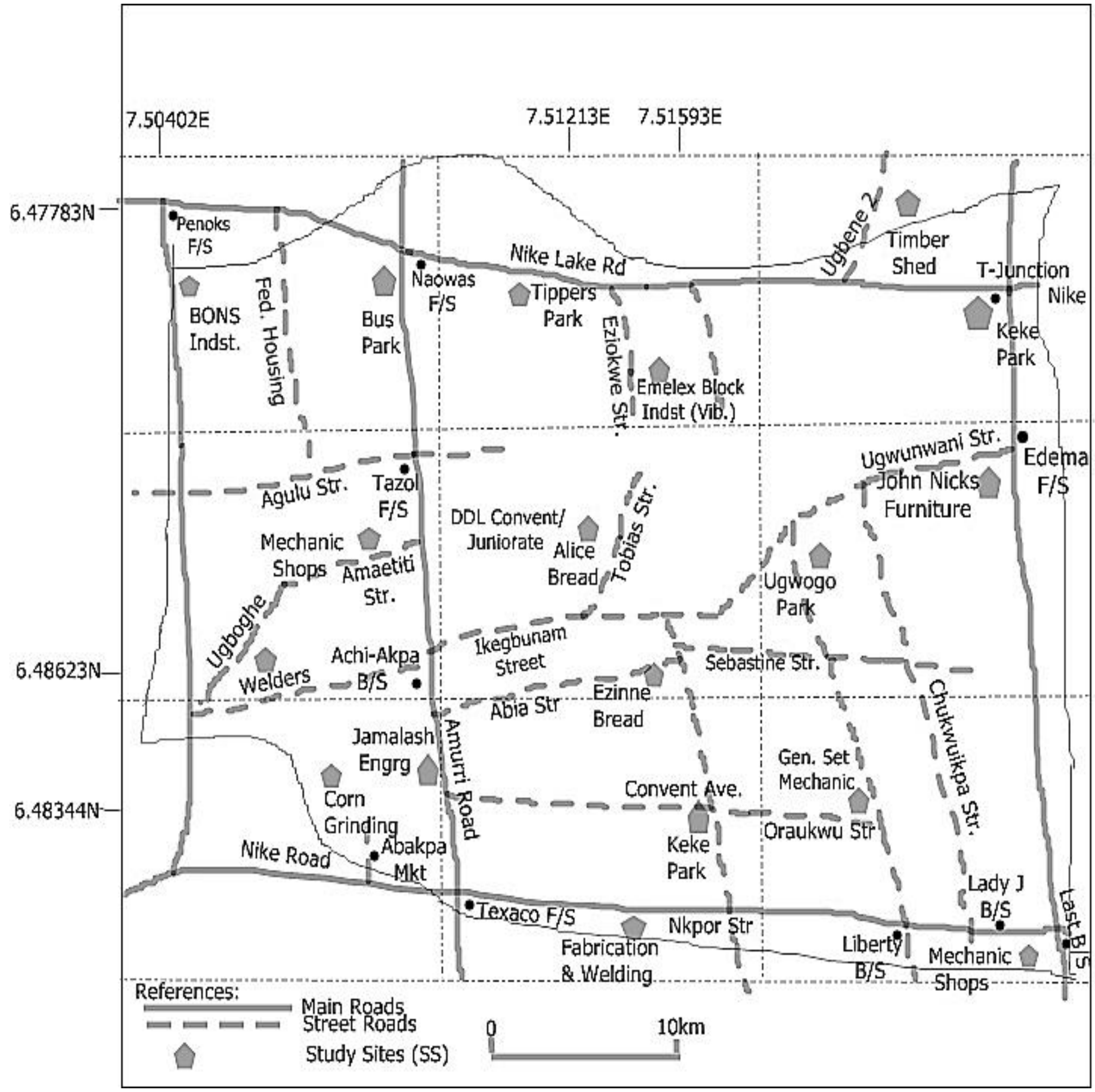

Fig. 1.4: Map of Abakpa Nike showing the Study Sites
Source: Researcher's Cartography, Enugu State Ministry of Lands Map (2018).

1.10.2 Historical Background

Abakpa Nike is the most populated settlement in Enugu City (Enugu State Government Online, 2015). The National Population Commission (NPC) in its 2006 Census gave the population of the town as 279,089. Abakpa Nike, as a commercial, industrial and residential area, is a highly populated area with a large percentage of migrant settlers and businessmen. The physical size, structure, population and manpower available make it suitable to play several roles and serve several functions in the socio-economic development of Enugu State. It is a highly residential area interspersed with small-scale industries and businesses. This is related to its technical functions of automobile repairs and related activities, including production/fabrication of manufactured goods, printing, timber production and sawing, furniture making and interior decoration, bakeries, educational institutions ranging from nursery to tertiary, exacerbated automobiles and keke (tricycle) traffic to convey goods and passengers to and fro their terminal parks. The area of the town built up and undeveloped is $383km^2$ according to Enugu State Town Planning Authority ETPA (1999). Abakpa Market (Ahia Abakpa) is one of the renowned markets in Enugu State.

2.0 Empirical Review of the Generator Usage

2.1 Environmental Effects of Power Generator Use

Several studies have been done on environmental effects of generator use. Omoruyi and Idiata (2008) studied the environmental and cost implication of fossil fuel generators: New Benin Market, Benin City, Nigeria. The research work was carried out in Balogun shopping mall in New Benin market and made use of structured questionnaire. The study was prompted by lack of a reliable supply and the constant blackouts which causes severe economic damage. The cost of alternatives, mainly diesel generation, is at least four times the cost of a reliable. The study showed that 66.7% uses generators daily, twice a week (7.3%) and thrice a week (26%). 73.3% of the generators are gasoline (fuel) powered, while diesel is 26.3%. The environmental effects are impaired hearing (96%), impairing visibility (49%), deafness (92.7%), sleeplessness (90.7%), choking sensation (94%) and dizziness (84.7%). The study recommended that government increase power plant generation and transmission capacity for reliable provision of affordable electricity, which has the potential to tackle both the symptoms and the causes of poverty. Adefeso, Sonibare, Akeredolu and Rabiu (2012), studied environmental impact of portable power Generator on Indoor air quality in Lagos, Nigeria. The study reveals that increased demand for power and the low generation capacity of the country has led to increased use of alternate sources for electricity in homes and offices in Nigeria. The study determined the emission factors of CO from gasoline-powered portable power generators (PPG). It evaluated the effects of the CO influx on the indoor air quality. Outdoor-indoor exchange of CO concentration was determined by modeling a number of scenarios of PPG operated outdoor using simulation tool kit for Indoor Air Quality and Inhalation Exposure (IAQX) model. The source CO concentration from PPG was found to be very high at 24.289 x 103 mg/m^3. The CO emission factors were obtained as 2.2366 x103 kg/m^3 of fuel consumed and 9.5411 x 106 kg/hr of activity. It was found that a PPG should not be placed at least 10 meters from the building.

3.0 Research Methodology

3.1 Research Design

The research deployed the collections of data from field and resource materials. The measurements were carried out to determine the CO[ppm] concentrations in Abakpa Nike as a result of electric generators usage.

3.2 Data Needs

The data needed for the research are as follows:

1. Map of the study area.
2. Geographic coordinates (latitudes and longitudes) of the study sites.
3. Carbon monoxide [COppm] pollutants concentrations
4. NESREA National Air Quality Standards
5. Public survey.

3.3 Sources of Data

Both primary and secondary data were used in this study. Primary data for the study were collected from field measurement of carbon monoxide concentrations (ppm) of the immediate environment around the running generators.

The secondary data was sourced through library research, a review of related literature, textbooks, theses, journals and works on the internet on the subject of the study done, NESREA permissible CO [ppm] limits for residential areas. The population statistics were obtained from the National Population Commission.

3.4 Sampling Size and Techniques

The study adopted areal sampling and systematic sampling technique in choosing the apartments and industrial / commercial activities that makes use of domestic electric generators in the study area (Abakpa Nike). Areal sampling is a probability sampling technique wherein the researcher divides the entire population into different groups or zones, (using a map in this Case) then selects the final subjects proportionally from the different zones (Enarson *et al.*, 2004).

In sampling of the residential neighborhoods for measurement, random table numbers were used in selecting randomly the first house in the selected street, after which every 2nd house were chosen systematically (if No. 4 was chosen randomly first from the number table, the order of the selection was 7th, 10th, 13th etc until the street is exhausted or returned to the starting point). The essence is to ensure even distribution of the houses / buildings which are also recipients of CO emanating from it. Abakpa Nike layout is based on parallel street system and the streets numbering are serial. This implies that if No.4 is on the left side of the road, No. 7 was on the right side, hence equal distribution. Table 3.1 below shows the table for selecting house numbers from streets.

Table 3.1: Selection of House Numbers from streets

1	2	3	4*	5	6
7*	8	9	10*	11	12
13*	14	15	16*	17	18
19*	20	21	22*	23	24
25*	26	27	28*	29	30

Source: Researchers' field work (2018)

Systematic sampling was also adopted in the selection of apartments in the selected houses. In the houses selected, the first flat/apartment/tenement (room) was selected randomly after which the 3rd flat/apartment (n^3) was selected until the houses were exhausted. Each flat/apartment/tenement (room) selected yields one respondent. The measurement took place only on apartments that makes use of electric generators. Purposively, ten (10) apartments and industrial / commercial outlets (generators users) were chosen from each selected streets in the study area. Thus, the sampled stations were ten (10) per street multiplied by eighteen (18) study locations, to yield one hundred and eighty (180) sample stations. See Table 3.2.

Table 3.2: Locations and Number of Samples

S/N	Locations	Sample Points
1	Fed. Housing	10
2	Naowas Road	10
3	Nike Lake Rd	10
4	Eziokwe Str	10
5	Ugbene 2	10

6	T- Junction	10
7	Amaetiti Str.	10
8	Ugboghe	10
9	Tobias Street	10
10	Abba Street	10
11	Ugwogo Park	10
12	Ibagwa	10
13	Abakpa Mkt	10
14	Amurri Road	10
15	Nkpor Street	10
16	Convent Ave	10
17	Oraukwu Str.	10
18	Lady J	10
		180

Source: Researcher's Fieldwork, 2018

3.5 Research Instruments

NOK LCD Digital Carbon Monoxide Metre and public survey (questionnaire), were used to collect data for this study. The features of NOK LCD Digital Carbon Monoxide Meter / High Precision Gas Tester (EN 8805 Model) includes measuring range of 0 – 1000ppm, resolution of 1ppm, Basic error ± 5%, Response time of 60 Seconds, MAX/AVG values, data hold function, buzzer alarm functions, electrochemical CO sensor, digital display of 4 digits.

3.6 Method of Data Collection

Data collection involved in-situ measurement of sound level [dBA] and concentrations of CO[ppm] at the study area. Samples were taken at different distances at the location. Considerations such as prevalence of diesel generators were made in the choice of sampling locations and points. Sampling period and time were considered to coincide with period of low wind speed, dispersion and without rain. Due to the quantum of data that was generated, values of the measurements CO(ppm) were be collapsed into temporal averages, meaning that for Location A for instance, the average temporal values of respective readings [ppm]from all the apartments (sample points) were utilized. Carbon monoxide (CO) measurements were taken in each sampled locations daily in the morning (6am- 8am) and in the evening (7-9pm). During each measurement, readings were taken from each site for 2 consecutive days. The data were collected in the Month of August to October, 2018.

3.6.1 Carbon Monoxide Measurement

NOK LCD Digital Carbon Monoxide Meter / High Precision Gas Tester (GM 8805 Model) makes use of electrochemical cell. The electrochemical consist of fuel cell that produces signal current that is precisely related to the amount of target gas (CO) in the atmosphere. Measurement of the current gives a measure of the concentration of CO in the atmosphere. The Metre comprises of Air hole, LCD Display, Inspection (SCAN) button, Power Switch and Setting.

To measure the CO[ppm] being emitted from the generators, press the power switch to start up. After Start-Up, the LCD panel displays in the full screen, and display carbon monoxide concentration value and temperature value under current environment after counting backwards for 10 seconds. Whenever the CO concentration is between 50ppm and 100ppm, buzzing will be on discontinuously.

The CO meter was placed at a distance of at least 1m from the generators and 1.5m above the floor. During measurement, the "air hole" was oriented towards the points or area to be measured. All intruding objects such as the body of the CO meter or the operator itself which will degrade the frequency response of the air hole being measured is carefully removed.

The sampling probe of the gas meter was held at a height of one meter for two minutes after the 180 seconds calibration and the maximum and maximum readings of the pollutants were recorded.

3.7 Method of Data Analysis and Presentation

Statistical analysis and data transformation were conducted using SPSS (version 17.0) and Microsoft Excel (2007 Version). Paired Sample T-Test was used to test the hypothesis which stated that there is no significant difference between the concentrations of the CO from that of NESREA standard for quality air index. T-Test helps to check whether or not there is a difference between two samples or, equivalently, whether or not the samples come from the same population. It is a parametric statistical tool.

The Student T-Test formula is given as

$$T = \frac{X - U_o}{SD\sqrt{n}}$$

Where T = the t-distribution

X = the mean of the samples population

Uo = the standard mean (WHO standard)

SD = the standard deviation

n = the sample size

With a degree of freedom n -1

In a T-distribution, if $T_{cal} > T_{tab}$ reject H_o, otherwise accept.

4.0 Result and Discussion of findings

This section shows the tables of the results and their findings.

Table 4.1:Carbon Monoxide Levels (COppm) of the Study Area

S/N	Locations	Morning (6-8am) [COppm]	Night (7-9pm) [COppm]	NESREA Std [COppm]	WHO Std [COppm]
1	Fed. Housing	9.034	17.345	10	8.73
2	Nowas Road	10.455	16.181	10	8.73
3	Nike Lake Rd	7.807	18.674	10	8.73
4	Eziokwe Str	8.07	19.769	10	8.73
5	Ugbene 2	9.046	20.17	10	8.73
6	T- Junction	10.044	17.956	10	8.73

7	Amaetiti Str.	9.62	18.583	10	8.73
8	Ugboghe	8.698	18.784	10	8.73
9	Tobias Street	9.756	21.251	10	8.73
10	Abba Street	9.214	19.511	10	8.73
11	Ugwogo Park	9.722	20.46	10	8.73
12	Ibagwa	8.934	21.035	10	8.73
13	Abakpa Mkt	10.727	19.597	10	8.73
14	Amurri Road	8.582	19.816	10	8.73
15	Nkpor Street	9.487	19.534	10	8.73
16	Convent Ave	8.316	19.038	10	8.73
17	Oraukwu Str.	8.832	19.777	10	8.73
18	Lady J	8.295	19.197	10	8.73
		9.147	**19.259**	**10**	**8.73**

Source: Researcher's Field Work (2018)

From Table 4.2, it is seen that only the SS2, SS6 and SS13 exceeded NESREA Standard for CO (10ppm) for morning hours. However, all the SS points exceeded both standards for evening hours.

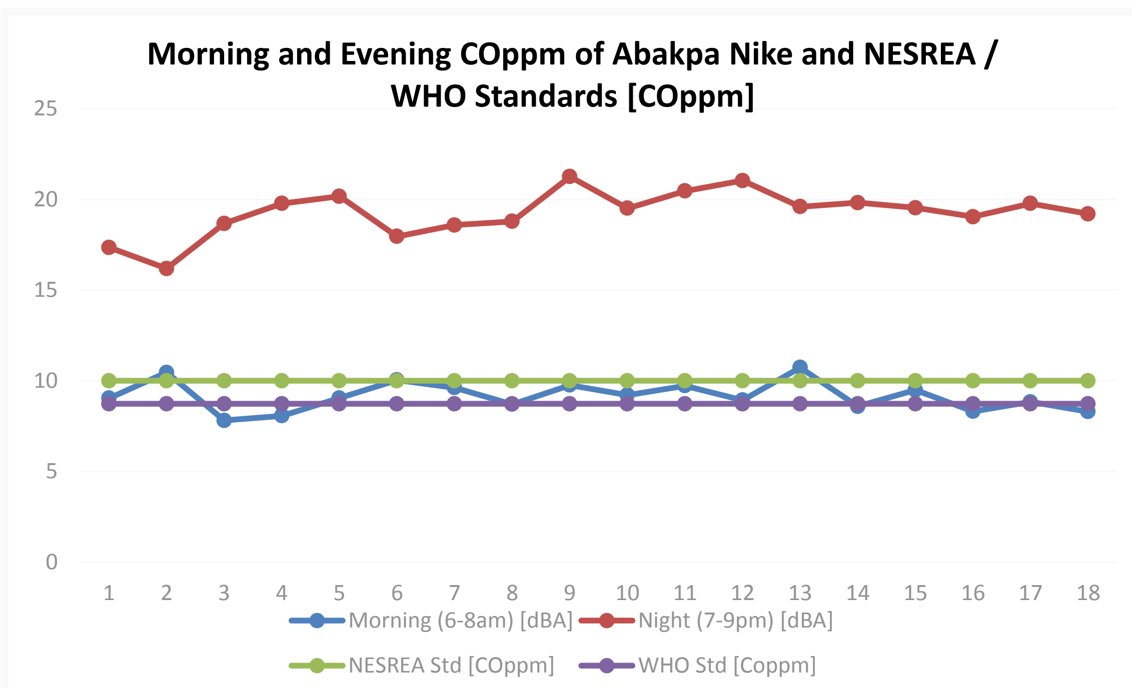

Figure 4.5: Comparative Explanation of the Carbon Monoxide [ppm] of Abakpa Nike and NESREA and W.H.O. Standards [COppm] Source: Researchers' analysis (2018)

From Figure 4.5 above, it is seen that all the Evening Period CO(ppm) in all the study locations are empirically higher than NESREA and W.H.O. standards; and some the morning CO (ppm) levels.

Decision: From Fig. 4.4 And 4.5, respectively above, it is clearly seen that the use of generators by the Abakpa Nike residents, mostly during the evening period are responsible for the high noise levels (dBA) and CO[ppm] concentrations in the area. This shows that Abakpa Nike noise level (dBA) and CO[ppm] during the evening period exceeds NESREA and W.H.O. permissible standards for both pollutants. Against this background, the study proceeded to ascertain the significant variations of such high noise levels (noise pollution) and CO emission as a result of generators use from the stated standards.

4.1 Test of Hypothesis

Hypothesis ($H_0$1)

There is no significant difference between the Carbon monoxide (CO) (ppm) of Abakpa Nike and that of National Environmental Standards and Regulatory Agency (NESREA) and W.H.O. limit for CO (ppm). **Table 4.5a shows Paired Samples Statistics for Carbon Monoxide [ppm] Level. Table 4.5b shows Paired Samples Correlations for COppm Level.**

Decision Rule: Reject the null hypothesis if p – value is less than or equal to 0.05, otherwise accept it.

Table 4.5a: Paired Samples Statistics for Carbon Monoxide [ppm] Level

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	NESREA	10.0000	18	.00000	.00000
	Morning	9.1466	18	.80869	.19061
Pair 2	NESREA	10.0000	18	.00000	.00000
	Evening	19.2599	18	1.24616	.29372
Pair 3	NESREA	10.0000	18	.00000	.00000
	Average	14.2035	18	.67913	.16007

Note: In the table above, the row labelled Average is comprised of the average values between readings from noon and evening.

Table 4.5b: Paired Samples Correlations for COppm Level

	N	Correlation	Sig.
Pair 1 NESREA & Morning	18	.	.
Pair 2 NESREA & Evening	18	.	.
Pair 3 NESREA & Average	18	.	.

Note: The columns labelled** Correlation **and** Sig**. are blank because the values for NESREA standards are uniform (all 10.00).

4.2 Discussion of Findings on the Carbon Monoxide (ppm) Level of Abakpa Nike, Enugu

From Table 4.2 and Figure 4.5, it was shown that the levels of CO(ppm) in all the Evening Periods and some of the mornings in the eighteen (18) study locations are empirically higher than NESREA and W.H.O. standards. The figure also shows that for W.H.O. standard for CO(ppm), only SS3 (Nike Lake Road), SS4 (Eziokwe Street), SS16 (Covent Avenue), SS18 (Lady J.) were below W.H.O. standards; the others exceeded W.H.O. limits. However, the figure shows that in the Morning CO(ppm), SS13 [Amurri by Abakpa Market] (10.727), SS2 [Nowas] (10.455ppm) and SS6 [T-Junction] (10.044ppm) were above NESREA Standard. The findings of this work of air pollution by generators of Abakpa Nike is consistent with the findings of Ibidapo-Obe and Ajibola (2011) which reveals that Nigeria has one of the lowest net electricity generation per capita rates in the world. South Africa produces 55 times more energy, and USA, 100 times more than Nigeria. Over 50% of Nigeria's 160 million people have no access to electricity. For Nigeria to meet up its energy need, it requires power generating/transmitting capacity of 140,000MW as against the current capacity of 3,920MW (National Electricity Regulatory Commission (NERC) (2015)). This clearly shows that on a fundamental level, there is simply not enough electricity generated to support the entire population of Nigeria (including Abakpa Nike, Enugu).

5.1 Summary

The research clearly reveals that the use of electric power generators in the study area (Abakpa Nike), pollutes the environment with carbon monoxide and noise; and this has adverse effect on the air quality index of the area. Similarly, test of hypothesis shows that there is no significant difference between CO(ppm) and NESREA standard at morning, whereas there is a significant difference between CO(ppm) and NESREA standard at evening time. The significant difference in the evening period is because that is when generators use is at its maximum with its attendant emission.

5.2 Conclusion

It is clear from the study that the all the sixteen (18) sampled streets from which ten (10) households were each selected are highly polluted by noise and carbon monoxide, due to the use of electric generators. Statistical analysis of hypothesis shows that the CO(ppm) for Evening period exceeded that of NESREA and W.H.O. standard whereas that of the Morning did not.

5.3 Recommendations

From this study, the following recommendations have been put forward:

1. The Federal Government of Nigeria should expand and improve electricity supply from the national grid and distribution companies.
2. City managers should also provide guidance to residents on placement criteria for private power plants so that they do not endanger the lives of their household members and that of their neighbors.
3. The Nigerian government should embark on renewable energy sources to minimize drastically, the rate of emission of carbon monoxide.
4. There is the need to operate the generators in open spaces that are removed from residential buildings in order to prevent health hazard.

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QUANTITATIVE TECHNIQUES FOR DECISION MAKING IN CONSTRUCTION PROJECT USING TCFMEA AND MONTE CARLO SIMULATION (MCS): CASE STUDY OF COMPUTERIZED WAREHOUSE IN PORTHARCOURT, NIGERIA.

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ABSTRACT

In this hostile atmosphere construction project managers must take crucial decisions to carry out the basic administrative tasks of planning, coordinating, leading, and managing to accomplish the predetermined project goals quickly and effectively. This study aims to fill a gap in the body of knowledge by evaluating the effectiveness of using time- and cost-oriented Failure Mode and Effect Analysis (tcFMEA) and Monte Carlo Simulation (MCS) to replace the deterministic conception of decision making in the construction industry with the stochastic conception. To achieve this, following objectives considered; to identify risks within a construction project phase by using tcFMEA, to model the construction project phase and its associated risks by using computer software, to simulate the construction project phase and its associated risks by using MCS and to compare the stochastic model with the deterministic model. Construction project of computerized warehouse in Port Harcourt Nigeria was analyzed. The project started in 02.02.2017 and finished in 01.04.2019. It consists of more than 150 main activities, including architectural, civil, mechanical, and electrical works. The findings of the tcFMEA and MCS showed that based on the deterministic finish period of Monday, April 9, 2018, with a span of 281 days, the likelihood of completing the construction project process was 20%. Furthermore, based on a deterministic fixed cost rise of ₦0, the likelihood of completing the construction project process is 0%. This means that due to the complexity and individual uncertainties involved with construction project operations, the time and expense of the construction project process are likely to rise by 80% and 100%, respectively.

1.0 INTRODUCTION

The building sector is a diverse and competitive world and strongly concerned with uncertainty and threats (Smith, Merna, Jobling, 2014; Cretu, Stewart and Berends, 2011). In this hostile atmosphere, managers must take crucial decisions to carry out the basic administrative tasks of planning, coordinating, leading, and managing to accomplish the predetermined project goals quickly and effectively. Unfortunately, traditional management has treated decision-making as if it were an art or a talent that can be developed over time through practice. To make decisions, managers used to rely on trial and error, a rule of thumb, common sense, intuition, or a snap judgment. These methods are misleading and may have severe implications. One single wrong move may not only be damaging but may also have consequences in the national economy. Therefore, the art of decision making must be supplemented by a scientific approach to increase the probability of coming up with good decisions. Decisions must be focused on a systematic review of evidence that exposes associations, highlights patterns, and displays rates of change in the related variables in this strategy.

2.0 STATEMENT OF THE PROBLEM

Since the early nineteenth century, analytical management has advanced to include multiple quantitative methods capable of solving complicated managerial problems (Dubey, Kothari, Awari, 2016; Sharma, 2017; Vohra, 2017). Despite the enormous advancements in analytical management and the widespread use of many quantitative decision-making methods, the deterministic approach continues to dominate decision-making in many building firms, rather than the stochastic approach. This could have serious consequences in terms of meeting the project's time, expense, and efficiency goals, and it could also lead to bankruptcy. This study aims to fill a gap in the body of knowledge by evaluating the effectiveness of using time- and cost-oriented Failure Mode and Effect Analysis (tcFMEA) and Monte Carlo Simulation (MCS) to replace the deterministic conception of decision making in the construction industry with the stochastic conception.

3.0 AIM AND OBJECTIVES OF THE STUDY

This aim can be achieved through the following objectives:

1. To identify risks within a construction project phase by using tcFMEA;
2. To model the construction project phase and its associated risks by using computer software;
3. To simulate the construction project phase and its associated risks by using MCS;
4. To compare the stochastic model with the deterministic model.

4.0 LITERATURE REVIEW

Project scheduling control refers to the procedures that must be followed to ensure that tasks are completed on time. It aims to provide a comprehensive schedule that shows how and where a project will implement the goods, resources, and outcomes defined in the project scope. It also acts as a tool for communicating with partners, setting priorities, and reporting on success (PMI, 2017; Schwalbe, 2017; Horine, 2017; Kerzner, 2017).

On a project, risk assessment preparation, recognition, review, solution planning, response execution, and risk monitoring are all procedures that must be implemented. To maximize the likelihood of project completion, it aims to increase the possibility and impact of beneficial risks while lowering the probability and impact of unfavorable risks (PMI, 2017; Schwalbe, 2017; Horine, 2017; Kerzner, 2017).

Scientific management emerged as a result of enormous advancements in mathematics, statistics, and information technology. This modern management paradigm paved the way for researchers to investigate managerial issues by designing computational methods that managers would use to make empirical decisions. A scientific approach to managerial decision-making is known as a quantitative methodology. Quantitative techniques are mathematical, computational, and programming techniques that assist decision makers in solving managerial challenges by gathering, evaluating, interpreting, and visually displaying evidence (Dubey, Kothari, Awari, 2016; Sharma, 2017; Vohra, 2017).

The FMEA is used to define and remove or minimize defects, consequences, and risks in a process or device. Three variables assess the corresponding probability of a loss and its influences: frequency, severity, and identification. Based on the available evidence and experience of the process or product, all potential failure modes and consequences are ordered on a scale ranging from 1 to 10, low to high, in each of these three variables. For each possible failure mode and result, the Risk Priority Number (RPN) is calculated by multiplying the rankings for the three factors (occurrence, magnitude, and detection). The FMEA worksheet is used to record the FMEA procedure for identifying, prioritizing, and then eliminating or reducing risks (McDermott, Mikulak, Beauregard, 2009; Carlson, 2012).

The MCS is a computer-assisted research tool that employs systematic sampling techniques to arrive at a probabilistic solution to a mathematical equation or model. In the natural sciences, social sciences, and engineering disciplines, scientists use mathematical models to explain the relationships in a system using mathematical expressions. These models usually depend on a number of input parameters, which are then interpreted by the model's mathematical formulas to produce one or more outputs. Several external variables influence the model's input parameters. As a result, the practical models are exposed to the possibility of systemic input parameter heterogeneity. Since the values of these input parameters are the most possible values, a deterministic model that does not explore these deviations is referred to as a base case. The risks associated with different input parameters should be considered in a realistic model. The MCS will assist an experimenter in investigating the full spectrum of risk associated with each dangerous input variable in a systematic manner. In MCS, researchers find a statistical distribution to use as the basis for each of the input parameters. Then they take random samples from each distribution to represent the input variables' values. They get a set of output parameters for and set of input parameters. Each performance parameter's magnitude represents a single simulation run's outcome scenario. They compile the results of several simulation loops. Finally, they use mathematical tests to make conclusions based on the values of the performance parameters. To characterize the output variance, they may use the sampling statistics of the output parameters. Static model development, input distribution recognition, random variable generation, and interpretation and decision making are the four key stages in the MCS process (Law and Kelton, 2000; Vose, 2008; Rubinstein and Kroese, 2008).

5.0 METHODOLOGY

The project was a construction project of computerized warehouse in Port Harcourt Nigeria. It started in 02.02.2017 and finished in 01.04.2019. It consists of more than 150 main activities, including architectural, civil, mechanical, and electrical works. The focus of this study is restricted to the project plan and risk control of a 16-activity development project process (see Table I). Based on past project interactions, the values of the tasks and possible errors were determined.

TABLE 1 ACTIVITIES

No.	Activity name	No.	Activity name
A	Precast RC structure planning	I	RC slab concrete
B	Precast RC structure production	J	Masonry
C	Precast RC columns	K	1st roof reinforcement
D	Precast RC beams	L	2nd roof reinforcement
E	RC skirting	M	Steel trapezoidal plates

F	PC fire resistance wall	N	Skylight
G	RC slab formwork	O	Insulation
H	RC slab reinforcement	P	Tinning

5.1 TIME- AND COST-ORIENTED FAILURE MODE AND EFFECT ANALYSIS

The FMEA is commonly used in a variety of industrial settings, including development planning, operations, and repair (Ekpiwhre and Tee, 2018). It is also commonly used in the area of risk management for the environment (Singovszka and Balintova, 2009). The standard FMEA, on the other hand, has certain drawbacks. To begin with, the detection principle is perplexing and can be interpreted in a variety of ways. Second, ordinal values preserve order in a collection of objects, but since there is no length function, the width between the values cannot be determined. As a result, since and parameter has a different size, the product or sum of ordinal variables wastes its rating. The RPN suggests that certain failure forms are more severe than others, although it does not quantify their relative consequences. Third, conventional FMEA ignores the ambiguity in a process' configuration (dependency between activities) as well as the uncertainty in the activities themselves. To solve these flaws, the FMEA during MCS was based on the risk of failures occurring, as well as the time and expense raised as a result of failures occurring. The tcFMEA (Kocsi, Pusztai, Budai, and Szcs, 2017) was created to classify defects, consequences, and risks during the construction project process. All other parameters can be easily expressed in terms of time and expense, which are universal parameters. Table II shows the probabilities, relative delays, fixed cost changes, and Expected Monetary Values for the operations and failures associated with them (EMV). Failure and correction charges are included in the fixed cost improvement. When the future involves situations that may or may not occur, the EMV is a mathematical tool used in project risk assessment to measure risks by measuring average outcomes (PMI, 2017). The failure H1 has the greatest relative delay of 80%, while the errors A1, C2, D2, G1, K2, and L2 have the smallest relative delays of 0%. The most expensive loss is E1, which costs $5935, while failures K2 and L2 just cost $173. EMV for failure E1 is $1780.5, while EMV for failure P1 is $50.1. The Pareto analysis, a predictive decision-making tool that identifies the 20% of factors that decide the 80% of outcomes, can be used to classify the top events that dramatically lead to the overall construction project phase's length and fixed cost rise (Montgomery, 2012). Nonetheless, the Pareto analysis, like the tcFMEA, ignores the ambiguity in the process structure (dependency between activities) as well as the uncertainty in the activities themselves. As a result, by performing a sensitivity analysis that measures the correlation coefficients between these variables during MCS, the contribution of activities to the length and fixed cost growth of the whole building project process can be precisely calculated.

TABLE 2 FAILURE MODE AND EFFECT

No.	Failure name	Probability (%)	Relative delay (%)	Fixed cost increase ($)	EMV ($)
A1	Lack of skilled workers	20	0	826	165.2
A2	Inappropriate regulations	80	45	806	644.8

B1	Unavailability of materials	20	50	2348	469.6
C1	Lack of infrastructure	40	20	851	340.4
C2	Equipment breakdown	30	0	980	294
D1	Lack of infrastructure	40	20	851	340.4
D2	Equipment breakdown	30	0	980	294
E1	Unavailability of materials	30	40	5935	1780.5
F1	Lack of skilled workers	10	30	930	93
G1	Lack of infrastructure	30	0	851	255.3
H1	Physical or chemical failure of materials	25	80	1755	438.75
I1	Unavailability of materials	10	15	930	93
J1	Unavailability of materials	30	25	2736	820.8
K1	Physical or chemical failure of materials	15	45	2186	327.9
K2	Unavailability of materials	5	0	173	8.65
L1	Physical or chemical failure of materials	15	45	2186	327.9
L2	Unavailability of materials	5	0	173	8.65
O1	Equipment breakdown	60	30	893	535.8
P1	Unavailability of materials	15	10	334	50.1

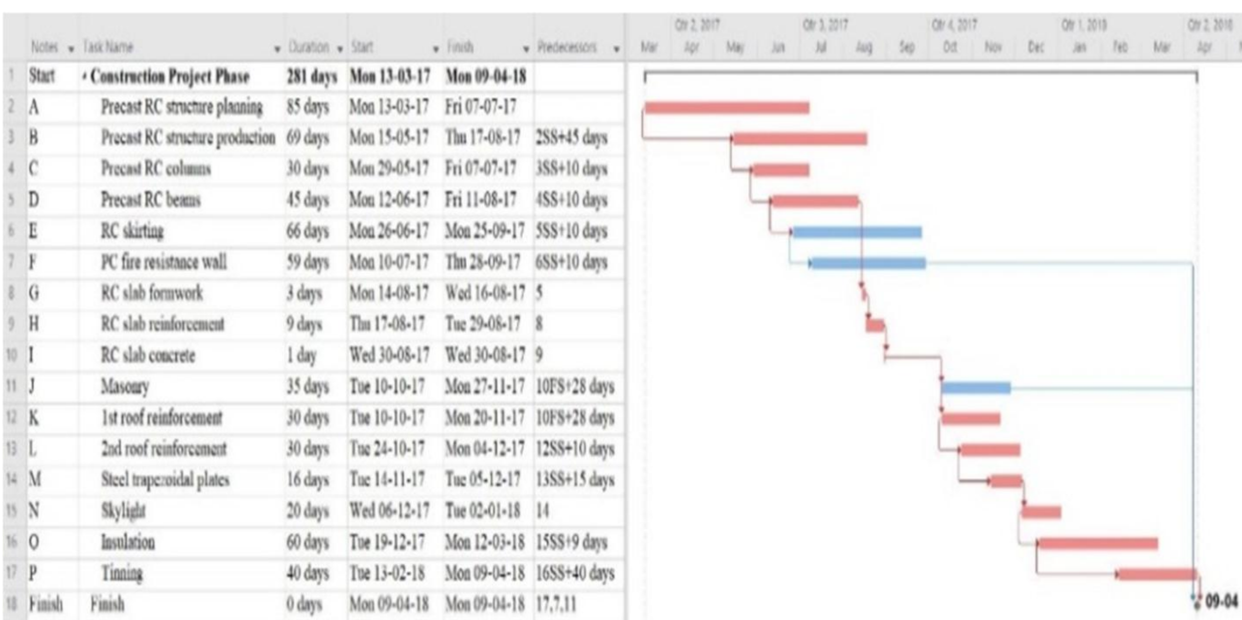
5.2 MONTE CARLO SIMULATION

The MCS was used to model the combined consequences of individual project uncertainties and other causes of uncertainty in order to determine their impact on meeting project goals. The key steps in the MCS process are as follows:

5.3 STATIC MODEL GENERATION

The MCS began with the creation of a deterministic model that represents the stakeholders' perception of how the job is performed in the construction business (Vose, 2008). To diagrammatically model operations, a variety of languages may be used (Dumas and La Rosa, 2013; Weske, 2012). The schedule network diagram and Gantt chart are the most commonly used modeling languages in the construction industry since they are the only languages that can graphically represent the functional relationships (dependency) within the construction project schedule activities.

The Gantt chart is a schedule bar chart of events on the vertical axis, dates on the horizontal axis, and task durations shown by horizontal bars depending on start and end dates (PMI, 2017). To prepare, modify, and coordinate the order of the activities; apply logical relationships, latency and lead values; and discern the various natures of dependencies, the schedule network diagram and Gantt map were created using two software programs, namely Microsoft Visio and Project 2016. (see Fig. 1 and Fig. 2). The deterministic model was built using the base (most likely) value of length (see Table III). The durations of tasks A and J is rounded down to the smallest amount possible. Activity A has the longest durations (76, 85.5, and 95 days), while activity I has the shortest durations (1 day). Although having the longest durations, operation O has the longest range (max-min) of 34 days. Except for activities G and I, the activity's approximate period is unknown. This assumes that all activities have a range of approximate durations greater than zero, while activities G and I have deterministic durations because their range is equal to zero. The Critical Path Method (CPM) was used to calculate the amount of schedule flexibility on the conceptual network paths within the schedule model and to define the operations that lie on the critical path that approximate the minimum construction project process length. This was accomplished by using a forward and backward route review via the schedule network to calculate the early start, early end, late start, and late finish dates for each task without regard for any resource constraints. The critical path is a set of events that represents the longest path through a project, defining the project's shortest possible length. The shortest path has the smallest cumulative float, which is always empty (PMI, 2017). A, B, C, D, G, H, I, K, L, M, N, O, and P are the crucial events on the critical path. Non-critical activities E, F, and J have a gross float of 137, 137, and 95 days, respectively. There are the maximum amounts of time that activities E, F, and J may be postponed or extended from their original start date without delaying the phase's completion date or breaching a scheduling limitation. As a result, the building project process will begin on Monday, March 13th, 2017 and end on Monday, April 9th, 2018, for a total of 281 days.



	Notes	Task Name	Duration	Start	Finish	Predecessors
1	Start	Construction Project Phase	281 days	Mon 13-03-17	Mon 09-04-18	
2	A	Precast RC structure planning	85 days	Mon 13-03-17	Fri 07-07-17	
3	B	Precast RC structure production	69 days	Mon 15-05-17	Thu 17-08-17	2SS+45 days
4	C	Precast RC columns	30 days	Mon 29-05-17	Fri 07-07-17	3SS+10 days
5	D	Precast RC beams	45 days	Mon 12-06-17	Fri 11-08-17	4SS+10 days
6	E	RC skirting	66 days	Mon 26-06-17	Mon 25-09-17	5SS+10 days
7	F	PC fire resistance wall	59 days	Mon 10-07-17	Thu 28-09-17	6SS+10 days
8	G	RC slab formwork	3 days	Mon 14-08-17	Wed 16-08-17	5
9	H	RC slab reinforcement	9 days	Thu 17-08-17	Tue 29-08-17	8
10	I	RC slab concrete	1 day	Wed 30-08-17	Wed 30-08-17	9
11	J	Masonry	35 days	Tue 10-10-17	Mon 27-11-17	10FS+28 days
12	K	1st roof reinforcement	30 days	Tue 10-10-17	Mon 20-11-17	10FS+28 days
13	L	2nd roof reinforcement	30 days	Tue 24-10-17	Mon 04-12-17	12SS+10 days
14	M	Steel trapezoidal plates	16 days	Tue 14-11-17	Tue 05-12-17	13SS+15 days
15	N	Skylight	20 days	Wed 06-12-17	Tue 02-01-18	14
16	O	Insulation	60 days	Tue 19-12-17	Mon 12-03-18	15SS+9 days
17	P	Tinning	40 days	Tue 13-02-18	Mon 09-04-18	16SS+40 days
18	Finish	Finish	0 days	Mon 09-04-18	Mon 09-04-18	17,7,11

Figure 1 **Schedule Network Diagram**

Figure 2 Gantt Chart

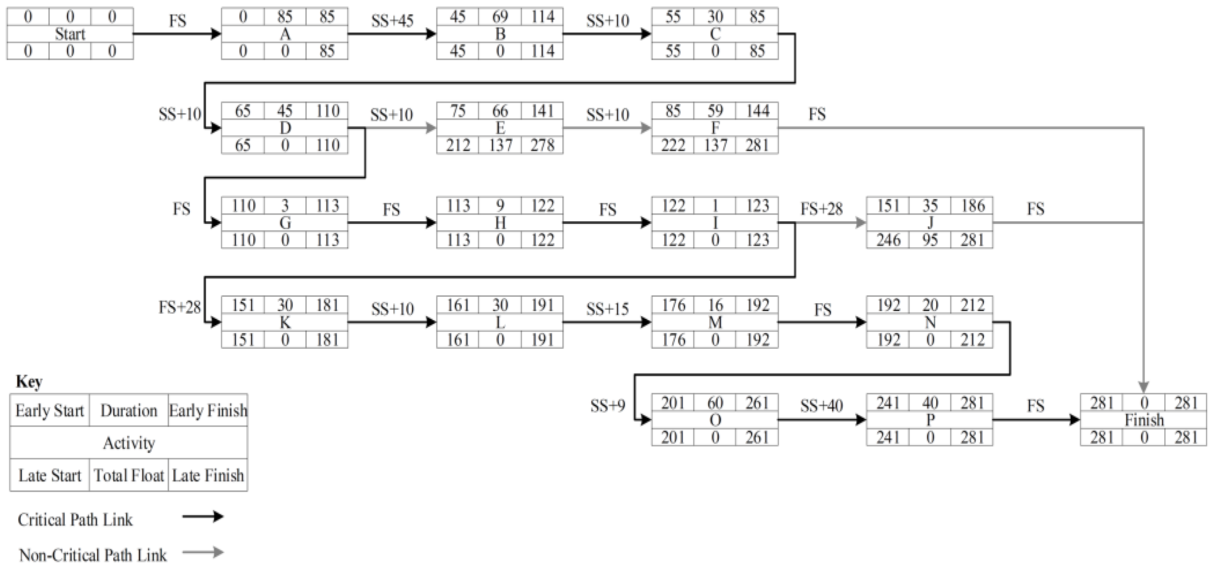


Table 3 Duration and Dependency of Activities

No.	Min (day)	Most likely (day)	Max (day)	Predecessor	Type	Lag (day)
A	76	85.5	95	-	-	-
B	62	69	76	A	SS	+45
C	27	30	33	B	SS	+10
D	39	45	51	C	SS	+10
E	59	66	73	D	SS	+10
F	49	59	69	E	SS	+10
G	3	3	3	D	FS	0
H	6	9	12	G	FS	0
I	1	1	1	H	FS	0
J	27	35.5	44	I	FS	+28
K	28	30	32	I	FS	+28
L	25	30	35	K	SS	+10
M	14	16	18	L	SS	+15
N	14	20	26	M	FS	0
O	43	60	77	N	SS	+9

P	37	40	43	O	SS	+40

5.4 INPUT DISTRIBUTION IDENTIFICATION

The appropriate use of probability distributions to precisely articulate the issue's complexity, randomness, and heterogeneity is critical to the precision of a risk analysis. Triangle, Beta, Program Evaluation and Review Technique (PERT), and Four Parameters Beta (Beta4) distributions are the most suitable for representing the time and expense of development project operations. As contrast to other, more normal distributions, the Triangle distribution normally overemphasizes the tails and underemphasizes the shoulders. The Beta distribution is a continuous probability distribution with two positive form parameters, usually denoted by and, that appear as exponents of the random variable and govern the shape of the distribution. The PERT (Beta-PERT) distribution is founded on the Beta distribution which is a continuous probability distribution. It uses the same three parameters as the Triangle distribution, with the exception that the predicted value (mean) is the weighted average of the variable's minimum, most likely, and maximum values, with the most likely value receiving four times the weight (Vose, 2008).

According to an analysis of many PERT networks, the most possible activity-time approximation (mode) is practically useless. In most project tasks, the mode was roughly one-third of the distance between the minimum and maximum value (Golenko-Ginzburg, 1988). This corresponds to = 2 and = 3 in the Beta4 (,, a, b) distribution. As a result, using the Beta4 (2, 3, min, max) instead of the PERT (min, mode, max) is appropriate, with the added advantage of only asking a subject matter expert for two values (Vose, 2008). The length of each operation has only minimum and maximum values based on the obtained data. As a result, the Beta4 distribution will be used to reflect activity length. Beta4 is positively polarized (2, 3, min, max) (the frequent scores are clustered at the lower end and the tail points towards the higher or more positive scores). This indicates that it is not symmetric, and yet favors the risk over the minimal value. As a result, the Beta4 (2, 2, min, max) can be used instead of the symmetrical Beta4 (2, 3, min, max), which brings equivalent weights to the risk at both the minimum and maximum values. The most suitable distribution to reflect the risks involved with construction project operations is the Bernoulli distribution, which is a special case of the binomial distribution. It's a discrete probability distribution of a random variable with only two outcomes: success or loss, yes or no. Instead of the terms Probability Density Function (PDF) and Cumulative Density Function (CDF), the terms Probability Mass Function (PMF) and Cumulative Mass Function (CMF) are often used to describe discrete distributions (Raychaudhuri, 2008).

5.5 RANDOM VARIABLE GENERATION

After determining the underlying distributions for the simulation model's input parameters, the task of producing random numbers starts. The inverse transformation method is the basic method for generating random numbers from any PDF or PMF given its CDF or CMF. This approach reverses the CDF or CMF and transforms a uniform distribution's random number between 0 and 1 into a random value for the input distribution. (Raychaudhuri, 2008; Vose, 2008).

5.6 ANALYSIS AND DECISION MAKING

Statistical analysis is usually performed on the MCS result of a model. The model formula is used to create a trial value for the output variable for each series of random numbers or trials created for each of the random variables. The obtained values are extracted after the trials are completed. The output variable's value is predicted by averaging trial output values. The estimated form of the PDF of the output variable is obtained by grouping the output variables by scale and displaying the values as a frequency histogram. The performance values will be used to create an objective distribution, allowing percentiles and other figures to be calculated. If not, the output values can be fitted to a probability distribution and the distribution's general statistics estimated. The confidence intervals can then be produced using these statistics. If the number of simulation trials increases, the accuracy of the predicted value of the component and the distribution form approximations improve (Vose, 2008; Raychaudhuri, 2008). MCS uses a total of 50000 samples, iterations, or evaluations. The following are the final findings of the mathematical research performed on MCS. The PDF, CDF, and table of length, finish time, and fixed cost rise of the building project process are among the findings. They also have a sensitivity analysis, which is illustrated by a tornado diagram, to assess which action has the greatest possible effects on project time and expense outcomes. This can be accomplished by calculating the correlation coefficients between the building project's inputs and outputs.

Table IV, Fig. 3, and Fig. 4 reveal that the building project phase's minimum finish period is Friday, March 23, 2018, with a duration of 270 days, and the median finish time is Monday, June 11, 2018, with a duration of 326 days and a range of 56 days. With a duration of 289 days and a standard deviation of 32 days, the mean finish time is Friday, April 20th, 2018. Activity D, with a high correlation coefficient of 0.695, has the greatest effect on the building project process period, as seen in Fig. 5. Based on the construction company's estimated deterministic finish time of Monday, April 9, 2018, with a period of 281 days, the chance of finishing the construction project process is 20%. This means that there's an 80% risk that the building job won't be completed on schedule. According to Table IV and Fig. 6, the minimum fixed cost increase due to risks associated with construction project activities is $0, while the maximum fixed cost increase is $22102, with a range of $22102. For a standard deviation of $3641, the mean fixed cost gain is $7302.

Table 4 Statistics of Duration, Finish Time, and Fixed Cost Increase

Parameter	Duration (day)	Finish time	Fixed cost increase ($)
Deterministic	281	Mon 09/04/2018	0
Minimum	269.81	Fri 23/03/2018	0
Maximum	325.65	Mon 11/06/2018	22102
Range	55.85	55.85 day	22102
Mean	288.82	Fri 20/04/2018	7302.33
Standard deviation	7.69	32.31	3640.60

Coefficient of variability (%)	2.66	-	49.86
Standard error of mean	0.03	0.14	16.28
Skewness	-0.70	-0.70	-0.68

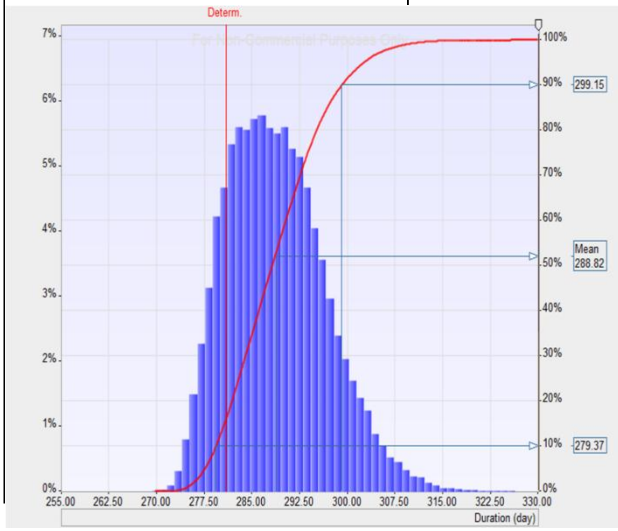


Figure 3. PDF and CDF of duration

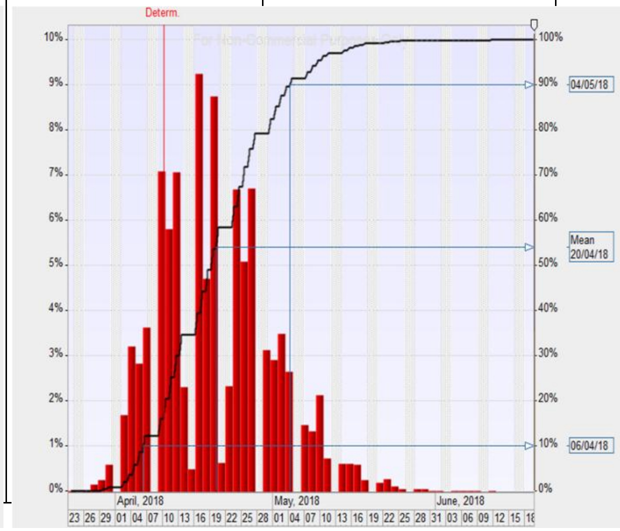


Figure 4. PDF and CDF of finish time

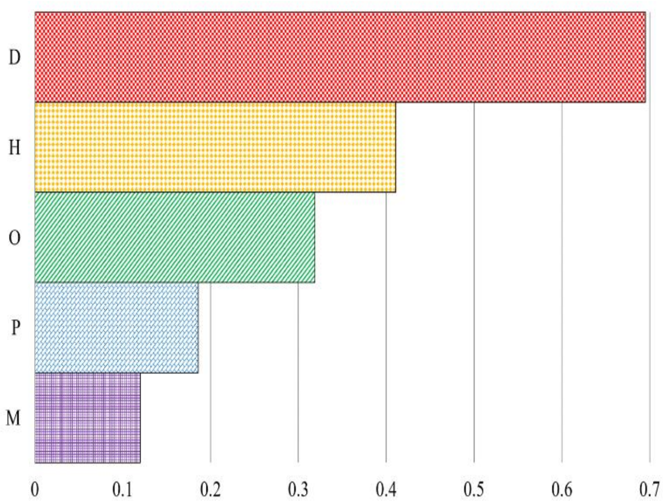


Figure 5. Sensitivity analysis of duration increase

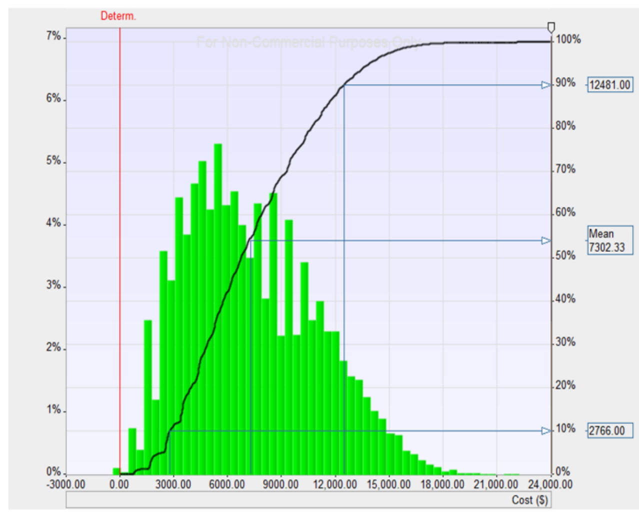


Figure 6. PDF and CDF of fixed cost

Based on the construction company's estimated deterministic fixed cost rise of $0, the chance of completing the construction project process is 0%. This means that there is a 100 percent risk that the building project's expense will rise. With a high correlation coefficient of 0.732, operation E has the greatest effect on the building project process fixed cost growth, as seen in Fig. 7. If 10% risk is appropriate, then there is a 90% probability that the building project process will be completed on Friday, May 4, 2018, with a total of 299 days and a fixed cost rise of $12481. This action can be addressed during the plan risk response.

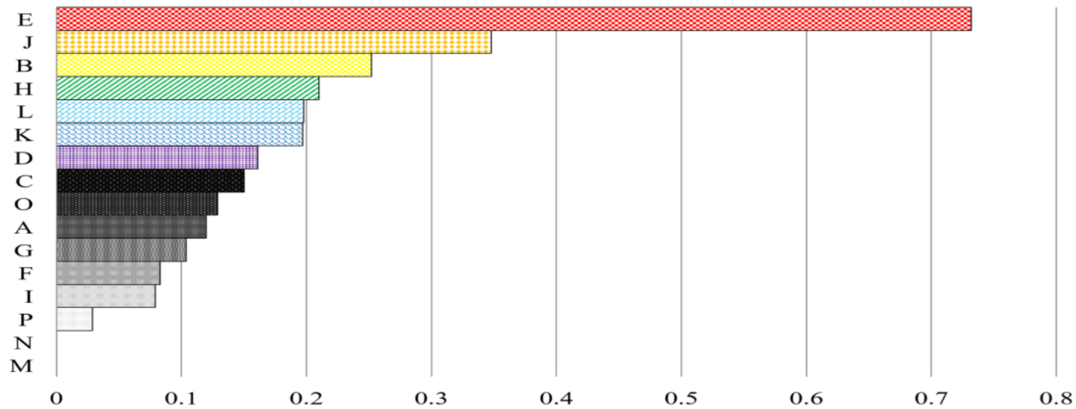


Figure 7. Sensitivity analysis of fixed cost increase

6.0 CONCLUSION

The findings of the tcFMEA and MCS showed that based on the deterministic finish period of Monday, April 9, 2018, with a span of 281 days, the likelihood of completing the construction project process was 20%. Furthermore, based on a deterministic fixed cost rise of ₦0, the likelihood of completing the construction project process is 0%. This means that due to the complexity and individual uncertainties involved with construction project operations, the time and expense of the construction project process are likely to rise by 80% and 100%, respectively. In the worst-case situation, there will be a two-month delay and a ₦22,000 expense boost. The sensitivity analysis shows that behaviors D and E should be given special attention because they have the greatest effect on the length of the building project process and the rise in fixed costs, with correlation coefficients of 0.695 and 0.732, respectively. As a result, the deterministic method is inefficient in delivering building projects since it describes structures without any probabilistic (random) components, where both statistical and logical interactions between elements (variables) are predetermined and not subject to variance. As a result, it should be replaced by a stochastic approach that considers the effect of project uncertainties and other causes of uncertainty on meeting project objectives. To resolve total project risk exposure as well as treat specific project risks, a strategy risk response should be developed for developing alternatives, choosing solutions, and deciding on measures. The construction project management team can use one or more of the following five risk management strategies: intensify, stop, pass, reduce, and agree. Decision making techniques that can be used to select a risk response strategy include but are not limited to multi-criteria decision analysis. Multi-criteria decision analysis uses a decision matrix to provide a systematic approach for establishing key decision criteria, evaluating and ranking alternatives, and selecting a preferred option. Finally, the construction project management team should monitor the implementation of agreed-upon risk response plans, track identified risks, identify and analyze new risks, and evaluate risk process effectiveness throughout the project.

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GULLY EROSION AND ITS IMPACT ON ENVIRONMENTAL SUSTAINABILITY IN NGWO AREA, ENUGU STATE, SOUTH EASTERN NIGERIA.

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ABSTRACT

Gully erosion has been a major economic and environmental issue for a relatively long time in Ngwo area, Enugu state. This research work explored the impacts of gully erosion on the environmental sustainability of people in Ngwo area, The study was carried out to determine the causes of gully erosion and its adverse impacts on the environmental sustainability of Ngwo people in Enugu State. Two hypotheses were postulated in this work and that is to identify the factors causing gully erosion and to determine the impacts of gully erosion on environmental sustainability in Ngwo Area. Survey research design was adopted in this study. A total of two hundred and twenty persons (220) whose economic activities has been adversely affected by gully erosion were sampled using the simple probability random sampling technique. This was done using questionnaires, oral interview and directs field observations. Data obtained were analyzed using Chi Square statistical technique test. Results of this work revealed that the factors causing gully erosion in Ngwo area include high rainfall, bad drainage systems, poor land use practices, nature of soil and deforestation. The two null hypothesis postulated were rejected since the calculated (49.2 & 45.0) at 0.05 level of significance and (9 & 12) degrees of freedom were greater than the table value (16.9 & 21.0) respectively. The Chi – Square test determined showed that there are significant factors and impacts of gully erosion in environmental sustainability in Ngwo Area. . From the findings of this research, it was recommended that studies be carried out by Research Institutes to identify ways of enhancing soil cementation and lithification which will in turn reduce erodibility and erosivity. It was also recommended that an Integrated Environmental Management Programme (IEMP) to combat ecological problems on a continuous basis and to enhance soil nutrient levels be carried out.

Keywords: Gully Erosion, Impacts, Environmental Sustainability and Ngwo Area.

INTRODUCTION

1.1 Background to the Study

Erosion is one of the surface processes that sculpture the earth's landscape and constitutes one of the global environmental problems. Gully erosion is a highly visible form of soil erosion that affects soil productivity, restricts land use and can threaten roads, fences, buildings and human life (Bettis, 2008). Gullies are defined as steep sided watercourses, marked by stepped longitudinal profile and commonly an abrupt channel head, subject to intermittent flow of water. In agricultural lands, it is frequently defined in terms of channels that are too deep to be easily ameliorated with ordinary farm tillage equipment, and typically ranging from 0.5m to as much as 25 to 30m (Nyssen and Soileau, 2007). This study was carried out to determine the causes of gully erosion and its adverse impacts on the environmental sustainability of Ngwo people in Enugu State. Environmental sustainability is the practice of interacting with the planet in a cordial manner targeted towards reducing the negative effects to natural elements. It is done to avoid depleting natural resources and compromising the future generations ability to meet their daily needs (Ekins, Dresner & Dahlstrom).

According to (Hudson, 2010) gully erosion results from breaking down of the optimum equilibrium between process and form in a water channel which may be caused by either an increment in the amount of runoff which a channel has to carry or a decrease in the ability of the channel to carry the flow. Egboka, (2010) noted that the greatest impact of gully erosion in Nigeria lies in the outright volumetric loss of soil and decrease in nutrient capacity, moisture retention capacity, organic matter content and the depth of soil. Gully erosion often indicates extreme land degradation and reduces economic productivity by destroying valuable land resources, increases sediment concentrations, reduces water quality, and fills up reservoirs. Rehabilitation techniques have proven to be challenging especially in the high-rainfall areas (Hilborn, 2008). Over the years gully erosion had occurred even without human influence or interference. Thus, the phenomenon of gully erosion is either naturally or artificially induced, or both. Like in other parts of the world, gully erosion is one of the major environmental challenges confronting Nigeria (Egboka, 2010). Also the perception of its causes, adverse impacts and control measures has varied across time and space. This prompted the researchers' to embark on this work of identify the causes of gullies, their impacts on economic activities in Ngwo, Enugu State with a view for possible measures of mitigation.

1.2 **Statement of the Problem**

Gully erosion is one of the most striking features on the land surface of south eastern Nigeria, especially in Ngwo, Enugu State. Several non-responsive human activities by both the government and the inhabitants have culminated in the devastating gully erosion in this area. The activities include, excavation of red sand in the process of mining, construction of roads without proper drainage channels, uncontrolled population growth and poor agricultural practices. According to Ekins (2000) it is our responsibility to conserve natural resources and protect global ecosystems to support health and wellbeing. The inhabitants of gully ravaged sites have suffered mishaps ranging from psychological trauma to loss of property and life. Observations showed that gullies in Ngwo are allowed to advance without adequate control efforts by government, hence, the affected people watch helplessly while their farmland and homes are destroyed. It is of utmost importance in this study that the social and economic impacts of gully erosion are adequately looked into and proper solution be provided for the improvement of environmental sustainability of the area.

1.3 Aim and Objectives of the Study

The aim of this research is to identify gully erosion and its impact on the environmental sustainability of Ngwo area, in Enugu state. To attain this aim, the following specific objectives were postulated;

To identify the factors causing gully erosion in Ngwo area of Enugu State.

To determine the impact of gully erosion on environmental sustainability in Ngwo, Enugu State.

Research Hypotheses

$H_{o;}$ There is no significant relationship among factors causing gully erosion on Environmental Sustainability in Ngwo Area, Enugu State,

$H_{o;}$ There is no significant relationship between the impacts of gully erosion on environmental sustainability in Ngwo Area.

REVIEW OF RELATED LITERATURE

2.1 Theoretical Framework

The Davison theory is the earliest cause and effect oriented theory on soil erosion. It holds that steep slopes are more easily eroded than gentle slopes and that runoff velocity are solely dependent on bed slopes, which got their derivation from this axiom. This law is tantamount to an obvious conclusion by Davis (2005) that the rate of change of land forms as well as other geometric impact magnitudes is functions of local relief. It therefore implies that the progressive changes on the terrain by the impacts of soil erosion are accepted to be universally associated with a progressive landscape evolution where the geometry of individual landforms and the rate of their erosion changes are both subject to sequential transformation through time. According to Ofomata (2006) soil erosion model for humid tropics incorporates both the biophysical and human components in soil erosion cause and impact. The major purpose that the model addressed are the clarification of the relative importance of the numerous factors (causes) of soil erosion in South Eastern Nigeria.

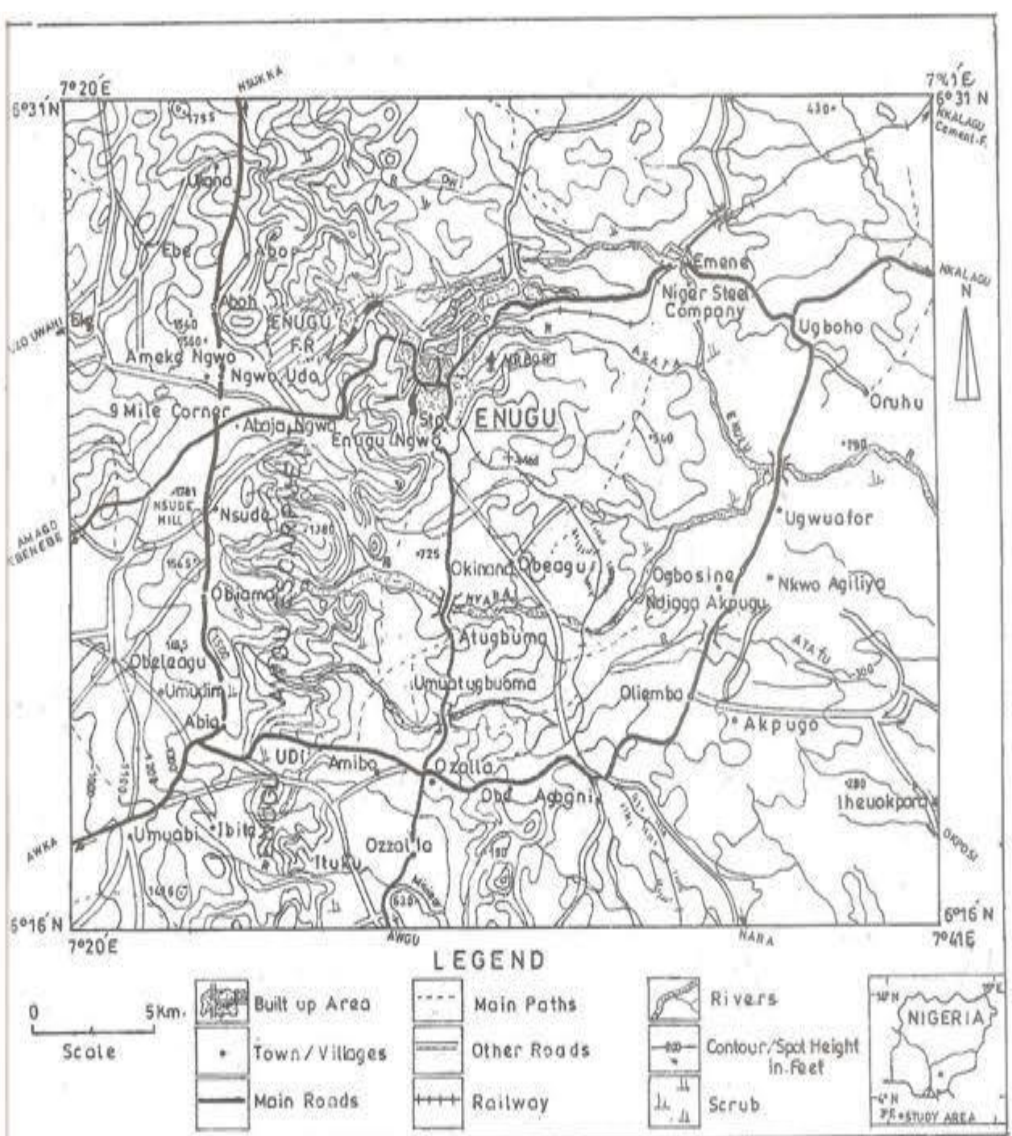
2.2 Gully Erosion

Gully erosion is currently an important environmental problem with frequent consequences facing the entire world. Gully erosion enthrones deprivation in its process and this affects soils in many parts of the world (LeRoux, 2010). It is a serious form of soil degradation often involving an initial incision into the subsurface, by concentrated runoff along lines of weakness such as tension and desiccation fractures (Kesstra, 2012). Akpokodje and Akaha (2010) reported that the initiation and development of gullies are facilitated by natural processes such as rainfall, topography, soil properties, and texture among others. Ogboi and Odeh (2012) in their study on erosion observed that erosion problems are more common in cultivated farmland, bared compounds, on poorly constructed road sites and in places of concentrated buildings. Sheet erosion is essentially a process that involves uniform removal of soil surfaces, which takes place when the soil surface is undergoing a uniform degradation. Rills are parallel grooves of little depth covering the land surface which can easily be filled through normal cultivation; formation of rills is one of the consequences of flow water. The rate of gully erosion depends primarily on the runoff producing characteristics of the water shed. Other factors that contribute to the occurrence of soil erosion in the tropics include soil types and its characteristics, topography, geology, cultural practice carried out in the region and conservative practice applied to the land (Davies, 2002). All these factors influence the sustainability of the area. Environmental sustainability is the practice of satisfying the needs of the present without adversely affecting the ability of future generations to satisfy their needs. (Ekins et al, 2008).

2.3 Location

The study is carried out in Ngwo area of Enugu state, south Eastern Nigeria. It lies within the latitudes 7^{0}23’N and 7^{0}30’N and Longitude 7^{0}23’E and 7^{0}30’E in the Eastern part of Nigeria (Encarta, 2012). Geographically, Ngwo is bounded to the north by Abor, to the south by Nsude, to the west by Eké, and to the east by Niké. Ngwo remains a historically important place in **Enugu** state. (Nwokwe, 2010)

Fig. 1: Ngwo, Enugu State



Source: Ngwo Town Planning (2019)

Ngwo area have hydromorphic soil which extends north ward where the underlying impervious clay shale cause water logging of the soil during rainy season. The soil is made up of fine loamy with lower layers faintly mottled and spotted containing stiff grey clay (Egboka,2010). Climate of the study area is characterized by two main seasons-the rainy (wet) season and dry season. The rainy season which lasts between the months of April and October is characterized by thunderstorms. The dry season (harvest season) extends from November to March annually. This is typically an equatorial tropical rain forest climate type. Rainy (wet) season is characterized by relatively high temperature (33^0C) and high relative humidity. Chilly and dry harmattan wind is experienced in dry season. The study area records average maximum and minimum temperatures of about 32^0C and 25^0C respectively and annual mean rainfall of about 2000mm.

3.0 RESEARCH METHODOLOGY

Survey research design involves obtaining information about a large population based on inferences from a representative fraction of the entire population known as sample (Mauz, 2013). .The population of this study centred on victims of gully erosion and its impact on environmental sustainability in Ngwo area precisely those whose economic activities have been adversely affected by gully erosion. The 220 persons that constituted the sample size were carefully selected from Ngwo area such as gullies at Enugu Ngwo, Eke Ngwo, and Agbaja Ngwo. The simple random sampling technique was adopted in conducting this research. This procedure demands that every person in the sampling frame is given equal chance of being selected as a sample (Ayandike, 2009). Both primary and secondary data were used for this study. Primary data collection entails personal observation, obtaining and recording of necessary data for the project. Such data were obtained through the following methods, oral interview, questionnaire and direct field observation method. Data collected were analyzed using inferential (chi – square) statistical tools.

.4.0 DATA PRESENTATION AND ANALYSIS

Research Question 1: what are the factors that cause gully erosion which influence Environmental Sustainability in Ngwo?

Hypothesis 1

Ho: There is no significant relationship between factors causing gully erosion on the environmental sustainability in Ngwo Area.

Table 1: Factors that Cause gully erosion in Environmental Sustainability issues in Ngwo Area.

Factors	**SA**	**A**	**D**	**SD**	**Row Total**
High rainfall	24(18.27)	18(15.82)	5(13.36)	13(12.55)	60
Inadequate drainage system & poor land use practices	21(14.61)	2(12.65)	19(10.69)	6(10.04)	48
Nature of soil	4(19.19)	22(16.61)	20(14.03)	17(13.17)	63
Deforestation	18(14.92)	16(12.92)	5(10.91)	10(10.25)	49
Column Total	67	58	49	46	220

Chi-square calculated = 49.2

Significance level = 0.05

Degree of freedom = (4-1) (4-1) = (3) (3) = 9

Table or critical value = 16.9

Decision

Given that Chi-square calculated (49.2) at 0.05 significance level and 9 degrees of freedom is greater than the table value (16.9), we reject the null hypothesis (Ho). Therefore, there are significant factors causing gully erosion on the environmental sustainability in Ngwo Area. This means that inadequate drainage system, poor land use and deforestation are among the factors that contributes to gully erosion problem in Ngwo Area.

Research Question 2: what are the impacts of gully erosion on environmental sustainability in Ngwo Area?.

Hypothesis 2

Ho: There is no significant relationship between the impacts of gully erosion on environmental sustainability in Ngwo Area.

Table 2: Impacts of gully erosion on the environmental sustainability in Ngwo Area.

Impacts	**4**	**3**	**2**	**1**	**Row Total**
Questionnaire items	**SA**	**A**	**D**	**SD**	
Loss of lives and properties	4(18.76)	19(11.56)	13(10.69)	11(6.98)	48
Destruction of route ways	20(17.98)	3(11.08)	15(10.25)	8(6.69)	46
Destruction of facilities	20(15.63)	11(9.63)	5(8.90)	4(5.81)	40
Loss of soil fertility	22(15.63)	13(9.63)	2(8.90)	3(5.81)	40
Destruction of economic trees	20(17.98)	7(11.08)	13(10.25)	6(6.69)	46
Column Total	86	53	49	32	220

Chi - Square calculated = 45.0

Significance level = 0.05

Degree of freedom = (R-1) (c-1)

= (5-1) (4-1) = (4) (3) = 12

Table or critical value = 21.0

Decision

Since Chi-square calculated (45.0) at 0.05significance level and 12 degrees of freedom is greater than the table (21.0) value, we reject the null hypothesis (Ho). Hence, there are significant impacts of gully erosion in environmental sustainability in Ngwo Area. The implication was that people always suffer the devastating impact of gully erosion when there is loss of lives and properties, loss of soil fertilities, destruction of economic trees and route ways which can be mitigated when the recommended strategies are adopted.

5.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

Summary

Gully erosion often indicates extreme land degradation. It reduces agricultural productivity by destroying valuable land resources, increases sediment concentrations, reduces water quality, and fills up reservoirs; its rehabilitation has proven to be challenging especially in the high rainfall areas (Ayele et al., 2015). The findings revealed that high rainfall, inadequate drainage system, indiscriminate land use of activities, nature of soil, deforestation are perceived factors causing gully erosion in Ngwo. These findings are in line with the research work of Egboka (1993) which stated that gully erosion can occur as a result of high rainfall, deforestation, inadequate drainage system and landslides. Soil erosion steadily removes thin layers of rich soils and sediments that can hardly be replaced thousands of years later, after few millimeters or centimeters of rainfall that must have occurred within some minutes.

This study looked at the economic impacts of erosion in these areas by collecting information with the aid of questionnaires. It showed that erosion in these areas has affected communication between the residents, led to migration of residents, loss of farm lands, low farm income, destruction of roads, psychological trauma, loss of properties, increase in the prices of goods and services, poor health conditions and increase in crime rates.

The two null hypotheses postulated were rejected after the Chi-square test statistics determined that both the factors causing gully erosion in Ngwo and the effects of gully erosion in Ngwo are significant.

Finally the findings of the study revealed that construction of erosion channels, planting of cover crops, afforestation, creation of awareness via education and making laws such as mounted sibling post with the inscription no sand mining were good measures to halt gully formation and expansion in Ngwo. The findings are in agreement with the work of Jeje and Agu (2007) which stated that measures like planting of vegetative cover, construction of erosion channels, agricultural method control and creation of awareness can be applied to control gully erosion.

Conclusion

Soil erosion in the form of gullies is very common in most places in south east Nigeria especially in Ngwo. The serious deforestation of the vegetation and poor revegetation or afforestation programmes have all contributed to the catastrophic erosion hazards. General strategies for soil conservation with respect to soil erosion should include a more comprehensive soil conservation method which will involve the application of certain hydrological or bioenvironmental processes so as to control the overhead flow and excessive runoff. The erosion menace in Ngwo has caused much destruction of the soil and thereby reducing the cultivatable land. Moreover destruction of route ways and roads, loss of lives and properties as well were established as serious effects of the gully erosion.

Recommendations

Based on the findings, the work recommended the following:

a. The research institutes need to have proper knowledge of the chemistry contents of the land in Ngwo area.

b. The study should be targeted towards finding the chemicals that are capable of reacting with the soil to enhance cementation and lithification and reduce erosivity of the soil.

c. The nutrient level of the soil should be enriched to help in the growth of trees whose roots will help in the improvement of the organic content of the soil and reduce detachability due to rain drops and the effects of the w

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THE IMPACT OF PROCUREMENT SYSTEM ON CONSTRUCTION PROJECT PERFORMANCE IN ENUGU STATE

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Abstract

Project procurement has been described as an organized methods or process and procedure for clients to obtain or acquire construction products. The broad objective of the study is to assess the impact of procurement system on the construction cost and delivery. The study adopted ex post facto research design and descriptive survey research design. The population of the study consists of one thousand and seventy one (1071) professionals, managers, directors, and consultants in construction project in Enugu state. The sample size of 291 was generated. A total of 291 questionnaires were distributed whereas 255 were returned while 36 were unreturned due to mutilations and empty responses. The result of the study indicates that the most widely used procurement system is traditional system with highest value (3.2), followed by design and build (3.1), management construction(3.13) and finally, construction management procurement system(2.9). The result further indicates that cost, time and quality have a positive and significant impact on the construction delivery in the selected construction firms in Enugu. The researcher recommends that it is very important at the very outset of the project to carefully consider all factors when selecting the most appropriate procurement approach for a construction project. This is because each system has its own feature and peculiarity that will have effect on the cost, time and quality of the project i.e. the project performance.

Keyword: Project procurement, performance, time, cost and quality

Introduction

The construction industry is an important part of the economical backbone in many countries (Ngai, 2002), often accounting for between 7-10 percent of the Gross Domestic Product (Winch, 2000). Furthermore, construction products and processes have a large impact on safety, health and environmental aspects (Bayliss, 2004). In many countries, however, the construction industry frequently receives criticism regarding poor quality and customer satisfaction, frequent conflicts and disputes among different actors, and cost and schedule overruns in projects (Eriksson & Westerberg, 2016). Anvuur & Kumaraswamy, (2007) avows that there increased complexity, uncertainty, and time pressure in construction projects have increased the need for cooperation among different project actors. These problems in construction projects are linked to inadequate procurement processes where the focus is on short-term individual sub-optimization rather than on long-term project team performance (Eriksson & Westerberg, 2016). Eriksson and Westerberg (2012) study in Sweden, postulates that different procurement factors at the design, bid invitation, bid evaluation and sub-contractor selections stages can have various influences on successful completion of projects. (Rosli , 2006) and (Ogunsanmi, 2013) in their studies on effect of different procurement process on successful completion of projects in Malaysia and Nigeria respectively, found out that procurement processes had positive impact on successful completion of project.

According to Barasa (2014) the choice of procurement process contributes significantly to the successful completion of construction projects. Jeptepkeny (2015) in her study on the effects of procurement procedures (specification definition, bid invitation, bid evaluation and contract negotiation) on project performance at Kenya Ports Authority, Mombasa, concluded that procurement processes have a strong and positive correlation with successful project completion. Stephen (2014) opines that procurement processes have moderately positive influence on successful completion of projects. This mixed results in these studies together with the recommendations by Jeptepkeny (2015) that further research be undertaken to investigate the effect of procurement processes on project performance purposely to ascertain how these other factors also contribute to project overall performance in public procurement entities, besides the low number of respondents used in that study compromises on its generalization to other public entities. This is the motivation behind the current study to fill in the existing gap in literature. The procurement processes affecting successful completion of construction projects are diverse but in the current study the specific variables which will be considered include procurement control regulations, procurement quality assurance and their effect on successful completion of construction projects in UasinGishu County. Practitioners, researchers and society at large have, therefore, called for a change in attitudes, behaviour and procedures in order to increase the chances for construction projects to be successful and result in improved end products (Love, 2000). Traditionally, relationships are, however, very competitive and adversarial in the construction industry (Cheung *et al.*, 2003), which to a large extent is due to the customary procurement procedures potentially causing many problems in all stages of the buying process (Eriksson and Laan, 2007).

Therefore, in order to take advantage of collaboration, procurement procedures is one key improvement area and can contribute substantially to project success (Cheung, 2003). A change of procurement procedures is, however, impeded by clients' habitual behaviour (Laedre, 2006). Although procurement procedures need to be tailored to enhance the fulfillment of different project objectives (Cox, 2006), clients tend to choose those procurement procedures they have a habit of using, regardless of any differences between projects (Laedre, 2006). In order to enhance change, an increased understanding of how different procurement procedures affect different aspects of project performance is vital. Earlier research efforts in this area have been limited to the investigation of how a single or a few specific procurement alternatives affect one or two project objectives. In order to achieve successful governance of construction projects a holistic and systemic approach to procurement procedures is crucial (Cox and Thompson, 1997). Since a systemic perspective on the effect of procurement procedures on different aspects of project performance is lacking in the construction management literature, this researsch effort aim to fill this theoretical gap that has potential to bring important practical implications. Different studies have confirmed the use of various types of procurement methods for project delivery in Nigeria. Studies of Ogunsanmi, Iyagba and Omirin (2003), and Dada (2012) all confirm the use of Traditional, Design and Build, Project Management, Construction Management, Labour only, Direct Labour and other types such as Alliancing, Partnering and Joint Ventures procurements in the Nigerian construction industry. The use of these procurement methods can significantly affect the performance of most projects.

Statement of the Problem

The Nigeria construction industry is modeled after the British system being our colonial master, although, since independence in 1960, it has incorporated the styles of other European countries, such as Italy, Germany and France (Mansfield, 1994). This industry is of paramount importance for employment and economic growth (Ogunsemi, 2004). The Nigerian construction industry forms nearly 70% of the nation's fixed capital formation; Federal Office of Statistics (FOS, 2004), yet its performance within the economy has been, and continues to be, very poor due to cost overruns resulting to abandonment of projects. For example, the Nigerian construction industry's contribution to employment has remained consistently at 1.0% over the last decade against the World Bank's average observation of about 3.2% in developing countries (Idrus, 2008). The traditional design-bid-build system of procurement is still dominant in the Nigerian construction sector and this may likely continue to be the trend. In addition, the Nigerian construction sector comprises the clients, contractors, subcontractors, suppliers, and key professional actors responsible for design and supervision of projects. The professionals includes architects, engineers (structural and services), and Quantity Surveyors.

There are professional bodies that regulate the activities of these professionals. Delay in project execution is a major problem in the Nigerian construction industry. This occurs both in small and large projects. Virtually, all the projects executed over the years in Nigeria were faced with problem of delay in delivery. Odeyinka and Yusuf (1997) observed that seven out of every ten projects suffer delay in Nigeria. Nigerian construction industry is faced with problem of cost overrun. Ogunsemi and Jagboro (2004) noted that one of the most serious problems the Nigerian construction industry is faced with is the project cost overrun, with attendant consequence of completing projects at sums higher than the initial sum. Therefore, working with realistic project estimate is necessary at the outset of a project work, which would eliminate uncertainty and as well provide a platform for project success. Idrus and Sodangi (2008) also observed that the last decade has however exposed the declining level of clients' satisfaction from the built facilities as a result of poor quality performance in addition to the perennial problems of time and cost overruns in the Nigerian construction industry. The Nigerian construction industry continues to occupy an important position in the nation's economy even though it contributes less than the manufacturing or other service industries. This industry plays an important role in the economy, and the products of its activities are so vital to the achievement of national socio-economic development goals of creating job opportunities and social amenities and infrastructures (Anaman, 2007).

Objectives of the Study

The main aim of the study is to assess the impact of procurement system on the construction cost and delivery. Specifically, this study seeks to:

1. Identify the various procurement system commonly used and their respective levels of usage and cost effectiveness
2. Examine the impact of the identified procurement system on the performance of construction industry in Nigeria.

Hypotheses of the Study

This study will be guided by the following null hypotheses

1. H_0: The identified procurement system has no significant impact on the performance of construction industry in Nigeria

Conceptual Literature

Procurement System

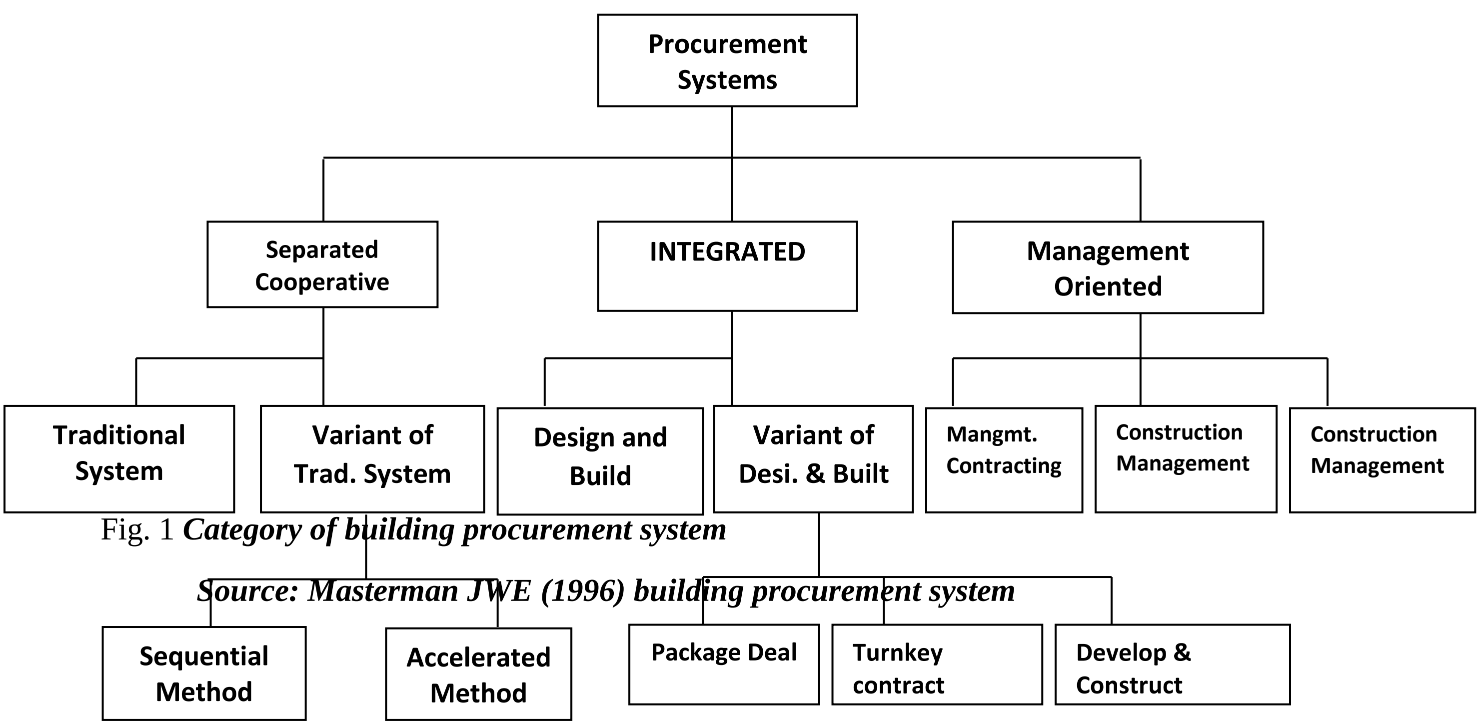

Fig. 1 ***Category of building procurement system***

Source: Masterman JWE (1996) building procurement system

Separated: separated are carried out by different independent organizations namely the designers and contractors. It is sometimes called linear or sequential contracting system or multiple responsibilities contracting approach. It is a system where the project development activities that start from feasibility study, preliminary design, documentation to construction and hand over, are carried out sequentially one after another. Traditionally, the complete working drawings or design has to be prepared by the designers before tender and construction activities can take place. It is sub-divided into 2 sub-categories – Traditional System and Variants of the Traditional Systems. The Variant System is further sub-divided into (i) Sequential Method, and (ii) Accelerated Method. Under the sequential method or a single stage tendering approach, the building owner will appoint a team of consultants to act on his behalf to produce construction drawings, specification and tender document and to administer the tendering processes to select a contractor. Once selected and awarded the contract, the contractor will carry out based on the drawings and specification prepared by the client's consultants. The accelerated method, can be considered as an innovative approach to speed up the selection of contractor and the commencement of construction (Barasa, 2014). The method can be divided into 2 sub-categories i.e. two-stage and negotiated tendering methods. Both methods involve preliminary discussion with selected few contractors, submission of fixed tender and/or cost negotiation.

Integrated Procurement Systems: This system, as the name implies, integrates or combines the responsibilities of design and construction of the project (Ashworth, 2001). Both responsibilities are contracted out to a single contracting organisation. It is also called a parallel or single responsibility procurement system whereby the client will only need to deal with a single organisation for both the designing and constructing the proposed project. In this case, the contractor will have to engage and be responsible for design and construction teams. Design and build system falls under this category of project procurement system. Under this system, the client together with is/her consultants will prepare a tender or bidding document that include the project brief and client's requirements and invite a number of contractors to bid. For the purpose of submitting tenders, the invited contractors will produce their own design, construction and cost proposal. Very often the successful contractor will into a contract based on lump sum price and a fixed duration (Ashworth, 2001)

The variation or innovation to this mode of project delivery systems includes (1) Package deal (2) Turnkey (3) Develop and construct. These systems that entail the contractor to be responsible for both the design and construction of the project, allow for the early start of construction through the reduction of the pre-tender activities as such they reduce process time.

Package deal: commonly called the "all in" contracting is a type of procurement method where a contractor is given the responsibility for everything that is required and necessary for the design, construction and delivery of the project. Under this system, the services of the contractor will include the preparation of project brief, sketch and final working drawings, getting all the approval from authorities, project financing, construction, furnishing and commissioning of all equipments and accessories and handing over the project to the client.

Turnkey contract is an American term for "all in" or package contract. Under this arrangement, a contractor is commissioned to undertake the responsibilities for everything necessary and required for the construction, completion, commissioning and hand over the project. The word "turnkey" means that, upon completion, the client is given the key and he can then enter the project by "turning the key". The contractor will have to do everything from preparing project brief, getting approval, designing, financing, construction, furnishing and decorating to commissioning and handing over completed, cleaned and ready for use project (Allen, 2001).

Develop and construct is another of the integrated procurement approach which is very much similar to design and build. In this case, the contractor is still given the responsibility for both the design and construction of the project. The difference is that, under this method the client's design consultants prepare the concept sketches or designs and passed them to the contractor who will develop them and produced the detailed working drawings. The contractor will then construct and complete the project based on what it has developed and produced.

Management Oriented Procurement Systems: It is a system that gives greater emphasis on the management and integration of the design and construction of projects. Under this system, the management of the design and construction a project is contracted out to a contractor who acts as a management consultant on behalf of the client. The construction itself is commissioned to many "specialist" or sub-contractors who enter into contract with either the management contractor or the client. This procurement approach that was introduced based on the conception that a builder or contractor has more expertise to manage the design and construction of a project. As management consultant, the appointed contractor does not itself, carry out the design or construction of the project. Its main responsibility is to manage the design and construction by the design consultants and the many specialist contractors, respectively (Dada, 2012).

The Impact of the Different Procurement Systems on Project Delivery

After having considered the concept and the working process and procedure of the different project procurement systems, let us now look into the general effect of the different system on project performance. As highlighted earlier, the focus of this paper in on three procurement systems (1) Traditional system (2) Design and Build and Turnkey Procurement Systems (3) Management contracting and Professional Construction Management Systems. The discussion is limited to the main project performance parameters – time, cost and quality.

Traditional Procurement System

Time: Due to its linear or sequential approach, the traditional procurement system has been identified as the slowest project delivery approach. However, this approach is more preferable because it provides clear accountability and better design and construction control by the client. Since the pre-contract stage of this system is longer, more time is available for the client and the project team to scrutinize and review the design before construction.

Cost: This system provides more price certainty to the client at the very early stage of the project. It also gives the client firmer and more competitive price because the design plus the complete working drawings have been fully developed and detailed out prior to tendering. It eliminates any design or construction ambiguity or uncertainty which often causes the contractors to unnecessarily inflate the price. In the case where bill of quantities is used, the bidding tend to be more fair as such the project cost is also lower. The system also better cost control as such cost increase due to variations is minimized, but works were often disrupted when there are too many variations (due to unforeseeable problems) and it tend to cause the cost to inflate. (Masterman, 1996)

Quality: The traditional procurement system also provides a high degree of quality certainty and functional standards. It is also a system that provides an opportunity for the building owner to combine the best design, management and construction expertise between consultants and contractor. It also provide more time for client and consultants to review and fully develop the design and specification thus allowing better documentation preparation. However, this system does not provide opportunities for contractor to contribute his construction technology and management expertise because they only come into the scene after the design has been fully developed and approved.

Design and Build and Turnkey Procurement Systems

Time: Design and build and turnkey project procurement system are called "fast-tracking" or "build-it-fast" project delivery system where the design and construction are integrated. The design free pre-tender process allow for earlier construction date. It also allows the process of detail design and construction to run almost in parallel and concurrently to each other, thus reducing the overall project development period considerably. As a single entity responsible for both the design and construction, the contractor is able to control not only the construction time but also the time reserved for the design of the project, thus reducing the overall contract duration. In this type of procurement system, the contractor has always been selected based on its vast experience, knowledge and competency in construction, as such by giving it the design responsibility, the contractor very often able to reduce construction time. This is done by him rationalizing the design and construction process and site activities.

Cost: Although the cost is fixed at the tender stage and is subject to design changes, it is often higher than the traditional contracting system. Apart from the fact that very limited contractors are invited to submit tenders, the lack of design and specification detailing during tender, has made the contractors to jack up the price to allow for many uncertainties. This is because once accepted, the tender price will be the final contract sum. It is not subject to change, unless there are variations required or instructed by the client. Such additional cost cannot be avoided because under this procurement system the contractor will to take much of the financial risk. However, as many have claimed, the significant cost saving in this type of procurement system is made through the reduction of the overall development period. The cost of contractor's uncertainty can be set-off by the reduction in loan interest and early financial return or benefits. Cost saving may also be made when the contractor applies his construction knowledge and experience to simplify design and work. At the same further cost saving can be made when the client offer the contractor some form of incentive if he is able to save a significant amount of cost.

Quality: The integration of design and construction allows the contractor to utilize his knowledge and experience to develop much compacted and coherent work program and to develop more efficient design and project control programme. At the same time it allows the contractor to be innovative to further improve the construction process and techniques thus allowing for better work and process quality. However, it is more often found that the quality of work under this contracting system tend to be questionable. The assigning of the designing and construction to a contractor has caused the client to loose control of the design and supervision of the work. This is especially so when the client does have his own team of consultants. As far the contractor is concerned, they tend to cut corners in order to maximize their profit, especially when they feel that they have under price their quotation during when tendering for the work.

Management Contracting and Professional Construction Management Systems

Time: As mentioned earlier, the essence of these two methods of project procurement is that a contractor has the knowledge, experience and competency to better manage the design and construction of a project. It is a factor that allows for more efficient and effective coordination of works, materials, manpower and plants, thus making construction time shorter compared to other procurement systems. This is especially so, given the fact that the same management contractor is able to manage and contribute towards the development of the design. It allows the management contractor to improve buildability or constructability. At the same, the system also allow for early start of construction compared to the traditional approach. The preparation of simple or basic tender (bidding) document and the shift of the process of schematic and detail design to construction phase, allow for an early start of construction. As pointed earlier, under these two systems, the detail design (shop drawings) is carried out (either by the consultant or package contractors) during the construction stage. All these factors brought about a considerable reduction of the overall project time compared to the traditional or even design and build contracting systems.

Cost: The cost of the project procured using this system tends to be lower than those using other procurement approach. This is because the cost of the project is actually the sum of prices quoted by the package contractors. With the management contractor being the consultant, no extra cost is being added up for main contractor’s profit margin. The only additional cost is the consultant fee that the client has to pay to the management contractor or to the construction management consultant.

Quality: As an agent responsible for the construction, the management contractor or the professional construction manager tend to be more serious with the standard and quality of the work done by the package contractors. Their experience as contractor or construction manager made them more proficient and more effective in ensuring high quality works. Their knowledge and experience also made them more adept in selecting materials and components of the right type and quality. These factors have contributed to a better standard and quality of the completed construction products.

Research Design

The research design adopted for this study followed a pattern of both descriptive survey research and *ex post facto* research design. The research design refers to the overall strategy that you choose to integrate the different components of the study in coherent and logical way, thereby (Solomon, 2013). This study focuses on the assessment of causes and impacts of rework on public building construction project performance in Nigeria. Survey research design and *ex post facto* research design was deemed necessary by the researcher because of the nature of the research objectives.

Survey research provided the researcher with the accurate description of the respondents' opinion, and uses multi-variant statistics to analyze the data.

Model Specification

This study shall build a multiple regression model in order to examine the impact of the identified procurement system (traditional, management contracting, design and build) on construction delivery

Regression model on the impact of the identified procurement system (traditional, management contracting, design and build procurement system) on construction delivery

CD = F(C, T, Q)

Where

CD = Construction delivery
C = Cost
T = Time
Q = Quality

Types and Sources of Data:

Data for the research was sourced through primary and secondary data. The data was collected expressly to help solve the research problems.

Population of the Study

Preliminary survey of the study revealed that a total of one thousand and seventy one (1071) professionals, managers, directors and consultants in Enugu were used in the study area.

Determination of Sample Size

To get the sample size of the study, the researcher used Taro Yamane's principles of arriving at a sample size which is given as

$$n = \frac{N}{1 + N(e)^2}$$

Where: n= Desired sample size
N= the entire population
e= level of significance or limit of tolerable error assumed to be 5% or 0.05
I= unit, constant figure
Therefore

$$N = \frac{N}{1+N(e)^2}$$

$$n = \frac{1071}{1+1071\,(0.05)^2}$$

$$n = \frac{1071}{1+1071\,(0.0025)}$$

n= 291.23
n= 291

Data Analyses
Analyses of the first objectives
To identified the various procurement system commonly used and their respective levels of usage and cost effectiveness

4.2 Presentation of base Data
Data on questionnaire response as well as socio-economic characteristic of respondents were presented in this section.

Group	Population	Sample Size	Questionnaire distributed	Questionnaire Returned	Questionnaire not returned	Percentage of Questionnaire Returned
Enugu	**1071**	**291**	**291**	**255**	**36**	**87.6%**

The above table shows that a total of 291 copies of questionnaire were administered. A total of 255 were completely field and returned while 36 questionnaire were not returned by the respondents.

To identify the various procurement system commonly used and their respective levels of usage and cost effectiveness

S/N	Various procurement system used		SA-------------SD	∑FX	$\bar{X}$	Rank	DECISION

		W	4 3 2 1							
	Extent of usage of the identified procurement system									
1	Construction management procurement system	F WF	98 392	80 240	45 90	32 32	255 754	2.9	4th	ACCEPT
2	Traditional procurement system	F WF	107 428	99 297	42 84	7 7	255 816	3.2	1st	ACCEPT
3	Design and Build procurement system	F WF	110 440	96 288	32 64	17 17	255 809	3.17	2nd	ACCEPT
4	Management contracting procurement system	F WF	103 412	100 300	36 72	16 16	255 800	3.13	3rd	ACCEPT
	Cost effectiveness of the identified procurement system									
5	Traditional procurement system	F WF	87 348	99 297	40 80	29 29	255 754	2.95	1st	ACCEPT
6	Management contracting procurement system	F WF	94 376	101 303	12 24	48 48	255 751	2.9	2nd	ACCEPT
	Construction management procurement system	F WF	92 368	95 285	16 32	52 52	255 737	2.89	3rd	ACCEPT
	Design and build procurement system	F WF	90 360	90 270	17 34	58 58	255 722	2.83	4th	ACCEPT
7	Grand Total							3.04		ACCEPT

The table above shows the opinion of the respondents on the various procurement system commonly used and their respective levels of usage and cost effectiveness. The result indicates that the most widely used procurement system is traditional procurement system with a mean score of 3.2, strictly followed by design and build with a mean score of 3.17, management construction management procurement system with a mean score of 3.13, finally, construction management procurement system with a mean score of 2.9.

Under the section of cost effectiveness, traditional procurement system has the highest cost effectiveness, followed by management contracting procurement system, followed by construction management procurement system and finally, design and build procurement system.

Analyses of the Second Objective

Examine the impact of the identified procurement system on the performance of construction industry in Nigeria

Regression Techniques

Dependent Variable: PCD
Method: Least Squares
Date: 04/26/22 Time: 19:50
Sample (adjusted): 2015 2021
Included observations: 6 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.753414	1.404414	1.248183	0.2219
COST	9.452312	7.581012	2.247616	0.0222
TIME	2.257610	6.893709	3.270861	0.0028
QUALITY	4.230011	2.023312	2.209519	0.0355

R-squared	0.658946	Mean dependent var	4.51E+13
Adjusted R-squared	0.647003	S.D. dependent var	2.33E+14
S.E. of regression	1.88E+14	Akaike info criterion	68.74923
Sum squared resid	1.03E+30	Schwarz criterion	69.05713
Log likelihood	-1230.486	Hannan-Quinn criter.	68.85670
F-statistic	4.099840	Durbin-Watson stat	1.455343
Prob(F-statistic)	0.004245		

The signs of some of the variable coefficient from the estimated model are totally in line with a priori expectations. Cost has a positive relationship with construction delivery in Enugu state. Time has a positive relationship with construction delivery in Enugu state. Quality has positive relationship with the construction delivery in Enugu state. This implies that a unit increase in cost, time and quality will lead to increase in construction delivery in Enugu state.

The constant term is estimated at 1.753414 which means that the model passes through the point 1.753414 mechanically, if the independent variables are zero, construction delivery would be 1.753414 (Gujarati and Sangeetha, 2007).

The estimated coefficient for Cost is 9.452312; this implies that if we hold all other variables affecting construction delivery constant, a unit increase in cost will lead to a 9.452312 increase in construction delivery on the average. Likewise, the estimated coefficient of time is 2.257610 which imply that a unit increase in time will lead to a 2.257610 increase in construction delivery on the average. More so, from the result, the estimated coefficient for quality is 4.230011 which imply that unit increase in quality will lead to 4.230011 increases in construction delivery on the average.

The coefficient of determination R^2 from the regression result, the R^2 is given as 0.658946 this implies that 65.8946% of the variation in construction delivery is being explained by the variation in cost, time and quality on the average.

TEST OF HYPOTHESES

Hypotheses Two

Ho: *Sustainable costing does not have impact or effect on elemental cost profile in building.*

One-Sample Test

	Test Value = 0					
					95% Confidence Interval of the Difference	
Null Hypothesis	T	Df	Sig. (2-tailed)	Mean Difference	Lower	Upper
The identified procurement system has no significant impact on the performance of construction industry in Nigeria.	0.013	10	.041	0.00130	0.12	0.34

Source: SPSS Computation 2022

From the test of hypothesis above using one sample test t-statistics, based on the decision rule, accept null hypothesis if the value of the t-statistics is greater than 0.05, from the result; the value of the t-statistics (0.013) is less than 0.05 hence we reject the null hypothesis and conclude that the identified procurement system has significant impact on the performance of construction industry in Nigeria.

Discussions

In the result of the first objective, the result indicate that the most widely used procurement system is traditional procurement system with a mean score of 3.2, strictly followed by design and build with a mean score of 3.17, management construction management procurement system with a mean score of 3.13, finally, construction management procurement system with a mean score of 2.9. The result further indicates that traditional procurement system has the highest cost effectiveness, followed by management contracting procurement system, followed by construction management procurement system and finally, design and build procurement system.

The result of the second objective indicates that Cost has a positive relationship with construction delivery in Enugu state. Time has a positive relationship with construction delivery in Enugu state. Quality has positive relationship with the construction delivery in Enugu state. This implies that a unit increase in cost, time and quality will lead to increase in construction delivery in Enugu state.

Conclusion

From the findings of the study, the research concludes that the most widely used procurement system is used procurement system is the traditional procurement system and the least procurement is the construction management system. Also the researcher concludes that Cost has a positive relationship with construction delivery in Enugu state. Time has a positive relationship with construction delivery in Enugu state. Quality has positive relationship with the construction delivery in Enugu state. This implies that a unit increase in cost, time and quality will lead to increase in construction delivery in Enugu state.

Recommendations.

Based on the findings of the study the researcher recommends

1. It is very important at the very outset of the project to carefully consider all factors when selecting the most appropriate procurement approach for a construction project. This is because each system has its own feature and peculiarity that will have effect on the cost, time and quality of the project i.e. the project performance.

2. Each project procurement system has its own peculiarity in term of the pretender and post tender activities and processes, division of risks between client and contractors, and the effectiveness of project monitoring and control.

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SMART COMPACT CITY, AN ENVIRONMENTAL MANAGEMENT STRATEGY: UWANI LAYOUT, ENUGU.

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Abstract

Cities develop from rural to urban migration of people and goods. People move in search of greener pasture and better living conditions. The continuous movement of people impact on how smart and compact a city is. There are smart and compact cities in existence due to their design and their governance style. The aim of this study is to appraise what makes a city smart and compact and how Enugu can be made to fit the description of being smart and compact. The study is descriptive in nature and employed survey research method with extensive literature review. The study area is Uwani layout in Enugu Metropolis. The study shows that there are a lot of changes from the original. The researchers are of the view that the layout could be made smart and compact by introducing some changes both in design and governance.

Keywords: Compact City, Green Infrastructure, Layout, Open Spaces, Smart City, Urban Heat Island

Introduction

The movements of people from the rural areas to the urban areas create what we know as cities, (Caves, 2004). A city is associated with the good life, easy life, where there are improvements on the general living standard, mode of dressing, types of buildings, etc. Knox, (2005) says a city is a large human settlement where people predominantly work in areas other than agriculture. A city is the focal point of intense economic development. Cities most time refer to urban rather than rural territory, (Lynch, 2008). With rapid population and urbanization, more than half of the world populations now live in cities. As city keeps developing and expanding, there is move in making the city more smart and compact. All cities are connected in varying degrees globally beyond their regions thus influencing issues like global warming, sustainable development, global health, etc.

Enugu metropolis started as a rural area in the beginning of the 20th century before it was upgraded to township status and then unto where it is today. Enugu cannot be said to be a smart city or compact city but there are rooms for improvement. The aim of this study is to show the current state of Enugu using this layout and propose ways of upgrading it to a smart compact city. This could be done by making changes to some aspects of the city (transport system, flood water management, creating a data bank, creating and management of urban public spaces, etc), the governance type and then incorporating current technologies.

Literature review

Smart city (SC) is a city that incorporates information and communication technologies (ICT) to enhance the quality and performance of its urban services (energy, transport, utilities, etc), (Emenike, Obiefuna, & Offor, 2018). It follows that Smart city should be equipped with basic infrastructure such that it can support quality life within it. In this, Smart city should boost of good governance, up to date (current) laws guiding everything (planning, the built environment, etc) and then of course functioning internet and communication technology, internet of things.

Compact city (CC) contains people living and working within walking, cycling or riding distance of every one and thing else. Compact city minimizes the need and use of personal cars by employing more of rapid public transportation. In Compact city ecological footprint of developments on the environment are sort to be reduced. Compact city is seen as a crucial element in fighting climate change.

Smart and Compact city is a city that combines the benefits of being smart and compact at the same time. Here the city is car less that is promoting working and living in the same area within short walk-able distance (pedestrian environment). This is combined with smart technologies and good governance thereby promoting sustainable growth. Also citizens are engaged in the management of their city (citizen participation). All these tend towards sustainable growth.

The issue of sustainable growth means the city aim at addressing economic issues (stable business, good jobs, good wages, appropriate technologies, etc), environmental issues (not degrading the environment, nor using up finite resources, having healthy ecosystem and green spaces, etc) and fostering a sense of community, (Lachman, NA). All these point towards implementation of the sustainable development goals (SDG) as set out especially with the issues as concerned with reduction to footprint on the environment, using and having compact development all point to smart and compact cities, (UN).

Negative aspects of compact city are urban heat island, concentration of pollution and stressing water supplies and other resources. This calls for environmental management, whereby all land resources are placed on focus and managed equitably for the common good of all.

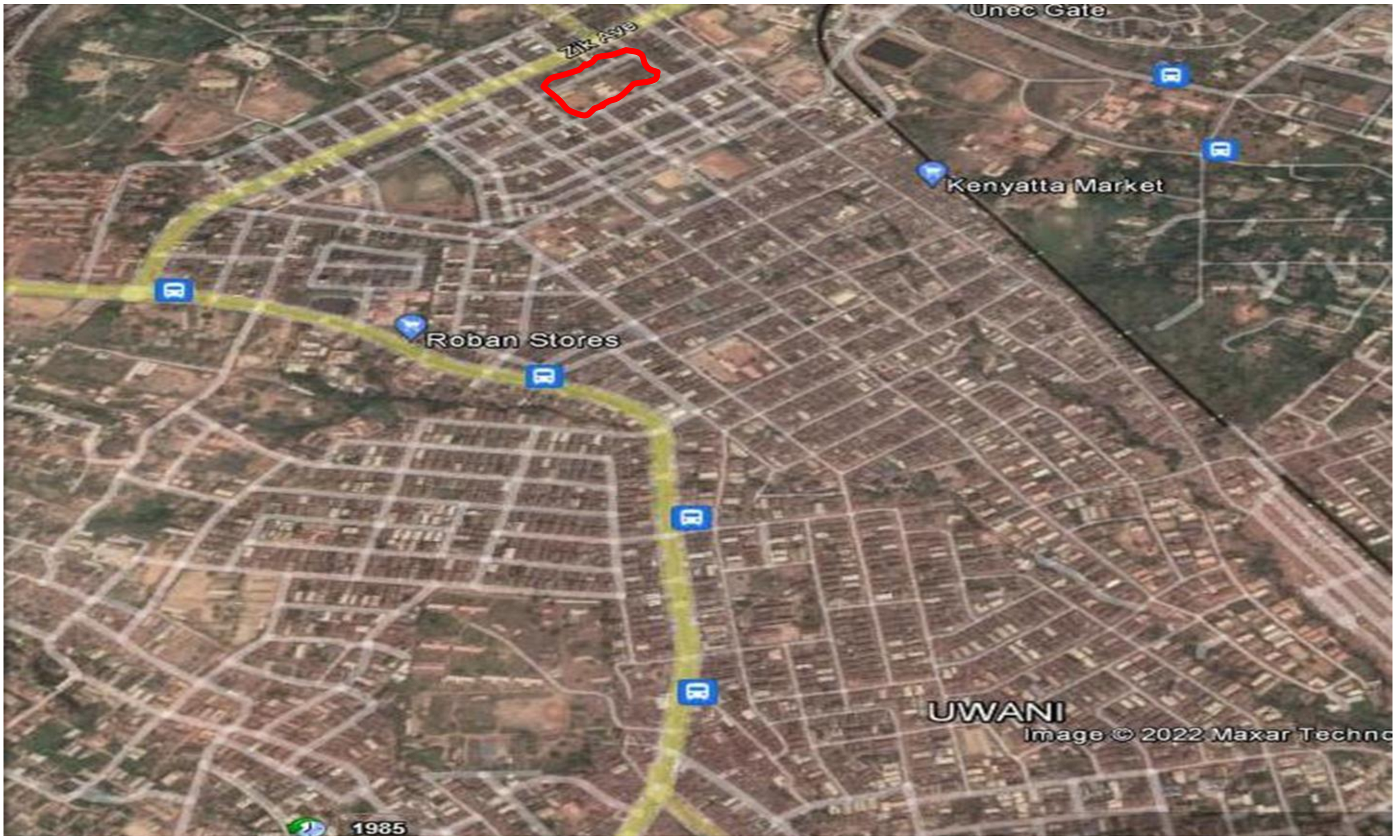
Environmental management is concerned with the description and monitoring of environmental changes, predicting future changes, maximising human benefits and minimising environmental degradation due to human activities, (Barrow, 2005). The main role of environmental management in this study is to protect the environment from the effect of human activities as such maintain environmental resources and enhance human health. In doing this, we need to employ equity and justice bearing in mind the principles of the environment: ‘nature knows best... everything is connected to everything else, everything changes .... ‘, (Kris, 2012). Environmental management involves all stakeholders and require multidisciplinary perspective, ranging from local to global action.

The Study

The study is on Enugu Metropolis, which lies on Latitude 6^0 27’’ north of the equator and Longitude $7^0$29’’ east of Greenwich. Enugu metropolis is the capital of Enugu State, with undulating topography, laterite soil and derived Savannah, (Emenike, 2014). The case for study is Uwani layout, which is the local government headquarter of Enugu South. The layout has approximately 62 residential plots, 13 commercial lots, 16 industrial lots, 3 public use lots, 3 open space lots and 2 filling station lots in the initial subdivision, (Emenike, 2014). This layout was designed for medium density and one of the oldest layouts in Enugu.

Figure 1. Map of Enugu state showing Enugu south

This layout was originally for residential purposes with bungalow type tenement buildings. Of recent this building type has been giving way to other types of building (blocks of flat, duplex). This might be due to population expansion which affected everything. The streets are narrow in most cases and losing their asphalt cover rapidly. The streets are patterned in grid iron crossings which is no longer in fashion. The open spaces where they exist are abandoned and occasionally youths are seen playing ball on them. There is conversion of every available space into some form of housing and commercial structures, especially the unbuilt open spaces and the change in use of many residential houses into commercial and industrial use. This made the layout to house one large building materials market (Kenyatta) and resulted into unbalanced human activity.



The layout as seen in fig 2 above is bound by Agbani road to the west, Zik avenue to the north and the Rail line to the east.

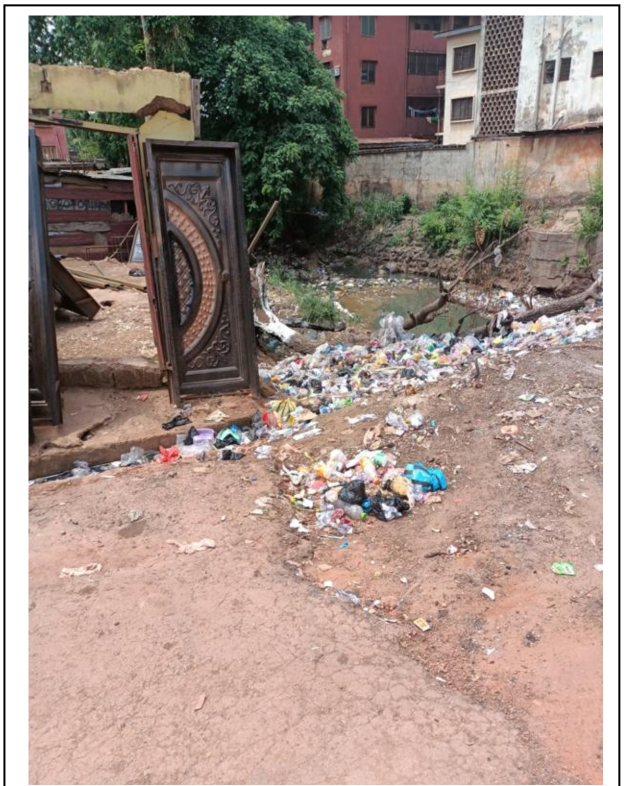


Figure 3:Snippets of existing conditions of some streets.

The issue of waste collection and disposal is very troublesome as waste is seen littered in every nook and cranny, the streets and gutters. Flood water just follows the path created by waste, inducing disaster everywhere. There was increase in urban heat island due to decreasing vegetation and increasing hard landscaping. The building materials market generated a lot of traffic congestion, wastes and security issues. Thankfully the building materials market has been relocated but the surrounding environment has not regained its former status.

Implications for Environmental Management

There is need to change some management options to a cleaner way of doing things. The issue of waste collection and disposal has to be revisited. The waste should be sorted at source for recycling, reuse and reduction. This will aid ‘waste to energy’ programme and therefore reduce environmental degradation and pollution.

Flood water needs to be channeled properly to enhance ground water recharge and water harvesting. This could be done by providing linear open spaces linked to each other running through the city, to serve as green verges, open parks, urban forest within the layout/city, infact green infrastructure should be employed to restructure the layout.

These open spaces will help filter the air around, reduce urban heat island, allow flood water to percolate into the underground water system and reduce pollution generally. They will help the layout to regenerate, help the citizenry to recreate and provide nature spaces into the urban city.

The system of governance has to change especially in this third tier of government (local government). Citizens must be brought in, to help in discussing and deciding on issues that concern them. The population needs to be educated on the use of information technology and how it can boost their lives, especially on information gathering and building up of data base on all aspect of life. Citizens participation is very useful at the moment, the citizens should be mobilized to help in taking care of their infrastructure. Bringing in the needs of the populace, nipping the general apathy of individuals to public property at the bud and thus increase sense of security. Also security issues can be designed into the fabric of the city through the use of information technology (IT).

Conclusion

Cities from the foregoing can be smart and compact by design or management. In the design of cities, the use of Open Spaces within the city framework can go a long way in making cities environmental friendly and enhance the life of the citizens.

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GEOGRAPHIC INFORMATION SYSTEM (GIS) TECHNOLOGY BASED ANALYSIS OF URBAN SPRAWL IN ENUGU URBAN.

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Abstracts:

In this study, a quantitative measurement of sprawling urban growth in Enugu Urban from year 2000 to 2020 was carried out with GIS technology. Enugu is a post-colonial urban settlement that emerged as a result of discovery of coal seams by British government sponsored mineral exploration along Udi hills in commercial quantity in 1905 and subsequent mining in 1909. The Geographic Information System (GIS) was used to identify and capture five categories of landuse land cover (LULC) changes for 30years in ten years' intervals of 2000, 2010 and 2020 covering an area of 242.874km^2 . The major landuse landcover were, water bodies/wetlands, forest, farmlands, built- up area, and bare soil. From year 2000 to 2020, there was a tremendous increase in physical growth in terms of infrastructures and decreasing land use for farmlands and forest. A comparative study of GIS maps in 2000, 2010, and 2020 manifested a significant change in land use land cover pattern in the study area. The built-up area covered 82.682 square kilometers representing increase from 15 percent in 2000 but changed to 110.559km^2 in 2020 showing over 100 percent increase in built up area while farmlands and forest declined from 80% to 32%. The cumulative Shannon entropy was calculated which gives 0.922 for year 2000, 0.913 for year 2010 and 0.938 for year 2020. Shannon entropy reading of over 0.9 indicated that Enugu Urban is under a chaotic urban development or sprawl which needed urgent attention in form of renewal and infrastructure upgrade while development of new town is recommended.

Keywords: Informal Settlement, Growth by accretion, Urban Sprawl, Physical Planning, Slum

1. Introduction.

Urban growth and landuse landcover (hereafter LULC) changes in fast- growing cities in the developing countries has drawn considerable attention from researchers in Urban and Regional Planning. Population growth through immigration and natural births demand for construction of new residential, commercial, utility, and transport infrastructures. They also require conversion of forests, farmlands, and bare soils, causing LULC changes and urban sprawl. Urban sprawl has its threshold limits. At the lowest end of the spectrum, a city remains uniform and vulnerable to change while rapid unplanned urban sprawl exceeding its maximum threshold limit creates chaos and deteriorates the quality of urban utility services.

Risbud (2017), in his study of urban sprawl in developing countries stated that in some cities, especially in countries located in southern part of Asia and sub-Saharan Africa, slums due to urban sprawling growths were not just few marginalized neighborhoods holding small concentration of population but are widespread, and are home to a large part of urban population.

These settlements and unique enclaves are sometimes called "slum cities", ghettoes, informal settlements and squatter settlements. Not only are the developing countries living in an urbanizing world, they are also experiencing an unprecedented urbanization of poverty and urban growth by sprawling, a growth devoid of proper physical planning (Ravallion, Chen and Sangraula, 2007). Several studies have been carried out on rural-urban migration, urbanization and urban sprawl especially in the poverty-stricken countries of the developing nations (Risbud, 2017; Aruna, 2008; Kuffer and Barros, 2017). There is still dearth of adequate literature on detailed analysis of the extent of sprawl and the consequent emerging patterns of incremental growth without any referral masterplan as a guide (Arouri, M; Ben-Youssef, M; Nguyen-Viet C and Soucat A 2014).

The UN-Habitat (2012) reported that about 43 percent of urban populations in these developing countries were slum dwellers while 78 percent of those living in the areas described as least developed countries were basically slum dwellers leaving only 22 percent living in planned urban areas. These situations have called for an innovative approach to urban studies and fast tracking of unplanned urban growth with GIS technology.

This research paper is therefore, to fill the knowledge gap by quantifying the level of sprawling, the extent poor physical planning and associated sprawling patterns of urban growth has affected the Enugu Urban through the use of modern GIS technology.

2. Literature Review.

The term "urban sprawl" was believed to have been first used in an article in 1955 as a negative comment on the state of urbanized London’s outskirts (London Times, 1955 as reported by Gregory L, 2020). According to Gregory (2020), *London Times* in1955 specifically defined sprawl as the “straggling expansion of an indeterminate urban or industrial environment into the adjoining countryside.” In their words, diffusion is too mild to use, but in bursting its bounds, the city actually sprawled and made the countryside ugly, uneconomic in terms of services with doubtful social value. There is perhaps no current topic more central to the study of urbanism than urban sprawl. Ever since then, definitions of sprawl continued to vary among urban researchers. Researchers in the field do acknowledge that the term lacks precision. For instance, Batty, Besussi, Elena and Chin (2013), defined sprawl as uncoordinated growth: the expansion of community without concern for its consequences, in short, unplanned, incremental urban growth.

However, Bhatta, Saraswati, and Bandyopadhyay (2010), wrote that despite the dispute over the precise definitions of sprawl, there is a general consensus that urban sprawl is characterized by unplanned and uneven pattern of growth, driven by multitude of processes and forces leading to inefficient resource utilization.

In the words of Arena (2008), the concept of urban sprawl dwells on emergence of a situation of unauthorized and unplanned development, normally at the fringe or peripheral areas of cities mostly haphazard and piecemeal construction of homesteads, commercial areas, local industrial areas and other non-conforming land uses, generally along the major lines of communications or roads adjacent to specified city limits.(Urban sprawl is the growth of a metropolitan area through the process of scattered development of miscellaneous types of land use in isolated locations on the fringe, followed by the gradual filling-in of the intervening spaces with similar land uses (Bosselman, 1998). Prodhan, Pravakar & Perera Rangith (2008) stated that such haphazard developments create slums, unauthorized colonies, piecemeal commercial development, intermixes of conforming and non-conforming uses of land coupled with inadequate services and facilities. The rising concern over the presumed consequences of urban sprawl – traffic congestion, the loss of open space, high public service costs and property taxes, and inflated vehicle-miles traveled and greenhouse gas emissions – has made urban sprawl a topic of widespread popular interest (Wahab, B. 2017; Streule M, Karaman O, Sawyer L and Schmid C, 2020;).

According to Jumin, Jayanthi, Juchul, Susan, Robert, Chandra and Kara Kockelman (2018), Urban Sprawl has been described as area expansion of urbanized area without organized physical planning while Urban Growth is general increase in the physical size of urbanized area, whether planned or unplanned. This conceptual definition by Jumin Song *et al* (2018) brought to rest the long controversy on the actual meaning of urban sprawl and will be adopted throughout this study as the basic conceptual framework. The concept clearly explained urban growth as distinct from urban sprawl.

Urban and metropolitan living were linked with higher levels of literacy and education, better health, lower fertility and a longer life expectancy, greater access to social services and enhanced opportunities for cultural and political participation (UNDESA, 2015).

While noting that urbanisation often evokes images of overcrowded cities, concentrations of poverty and environmental degradation, the World Bank (2009) cautions against seeing urban growth mainly from the negative point of view only. Instead, it is suggested that the debate and studies in urbanism should be about the efficiency and inclusiveness of the processes to transform rural economies to urban ones, and how policy can best mitigate the issues that arise at different stages of urbanisation which gap this study seeks to fill. This has become necessary as it has been more than established that the advantages of urbanisation far out weighted the disadvantages. Ruralization is an index of poverty and under development. Recent research has shown that the world's 40 largest mega-regions cover only a tiny fraction of the Earth's habitable surface and are home to fewer than 18 per cent of the world's population, yet they account for 66 per cent of global economic activities and about 85 per cent of technological and scientific innovations (UN-Habitat, 2010). The socioeconomic importance of urbanisation cannot be over emphasized. People of many classes and religions live and work together in cities, which create better understanding and harmony and help to break most of the stubborn traditional social and cultural barriers that created difficult to manage community problems leading to anti-growth in modernism culture.

The UN-Habitat (2020) warned in her report that the world will likely urbanize further in the next decade, from 56.2% in year 2020 to 60.4 % by 2030. That every region is expected to become more urbanized in the next 10 years. Surprisingly, the report went further to state that ninety-six per cent (96%) of the projected urban growth worldwide will occur in the less developed regions of East Asia, South Asia and Africa with three outstanding countries—India, China and **Nigeria**—accounting for over thirty-five per cent (35%) of the total increase in global urban population from 2018 to 2050.

The population of Nigerian urban dwellers living in unplanned areas and slums has risen to 80 percent while in Tanzania, 92.1percent of urban dwellers also live in slums. There is currently a growing case of shanty towns at the outskirts of most major urban centers in Nigeria where dwellers were coping with difficult environmental and socioeconomic situations partly explained by absence of physical planning (Agu and Eze, 2016; Stephen, Daniel, and Martina, 2017).

It is important to note that this challenge of urban growth by sprawling without properly guided physical planning, despite the preponderance of several planning laws some of which are duplicated, has become an important issue on sustainable human settlement development and management (Gyuse, 2020). Urbanization and rapid growth of cities in Developing Countries (DC) and Less Developed Countries (LDC) are most presently suffering from problems emanating from poor physical planning and management of city growth and urban development (Dumashie, 2011, UN-Habitat,2020). High population growth and human settlement development pressure undermined by insufficient supply mechanism of affordable land may have been partly causing the growth of unplanned areas coinciding often with deprived areas and outlying peri-urban areas in Enugu (Agu et al, 2016). In Enugu, there is rapid urban expansion and sprawling without proper physical planning to accommodate future expansion. The mosaic of human settlement growths overlaying the spurs and valleys of Enugu Urban quickly generate many puzzles and questions on the underlying factors of urban growth, sustainability and persistence of such planned intermixed with unplanned human settlements. Some of the unplanned settlements do not have standard access roads. The undeniable fact is that Enugu has been transforming from year to year, during which the urban landscapes were undergoing significant planned and unplanned shifts. Most of the urban settlements were dotted with slum areas and settlements that are not conducive for human habitation. The demand for urban land space for various land uses other than agriculture has been unprecedented leading to urban sprawl and unplanned urban invasion of the rural suburbs without physical planning. It was also discovered that in many instances the agricultural lands in the outskirts of cities were strongly customarily owned but weakly publicly managed. This may have given rise to easy short change of agricultural landscapes to urban sprawl. There is confusing ad mixture of traditional land ownership and what one may describe as weak and conflicting land and urban planning laws in Enugu.

There is poor economic investment in the rural areas and high level of unemployment in the urban centres leading to massive invasion of the originally planned urban space by informal enterprise migrants in search of livelihood. There is no effective master plan or comprehensive structural plan that serve as a framework for orderly implementation of aesthetic and sustainable physical planning. There have been massive urban growth dispossessing farmers’ agricultural lands especially at the urban peripheries. Enugu urban has been found to be growing through uncoordinated piecemeal acquisition of lands and preparation of layouts at the outskirts of the cities by individuals, estate firms, communities, land speculators and government agencies creating an unsustainable urban growth and uncoordinated layouts in a process called incremental planning (Kharaman,2022).

Most of the previous research studies on urbanisation, urban slums, housing conditions, informal and peri-urban settlements centered mostly on rate of rural–urban migration, housing and urban infrastructure challenges, slum growth, regeneration and renewal, with only very few attempting to measure in numerical terms the extent of urban sprawl so as to explain most of the emerging challenges facing the dwellers in Enugu Urban. Urban growth pattern seems to have adopted growth by sprawling and reactionary urban redevelopment and renewal instead of predicted planned physical growth devoid of slums and preponderant urban crisis.

The conclusion to be derived from this fresh reality is that the major trends and efforts in the world's cities are indispensable and has been transforming from year to year, during which the urban landscape were undergoing significant shifts. Whereas past decades may have needed to deal with rural poverty and neglect, which were the major challenges remaining in that time, the name of the current game is how to make cities more productive, more manageable, and more conducive to the aspirations of increasing urbanized populations through proper physical planning.

3.The Study Area.

Enugu Town, the administrative capital of Enugu State is located on latitude 6^0 25'30.63'' and 6^0 40'38.61" North and longitude $7^0$25'30.74'' and 7^0 36'0.71" East on the globe. It is arguably the most important town in South Eastern Nigeria having been the colonial administrative headquarters of Southern Nigeria in 1929, Regional Headquarters of Eastern Region, Headquarters of old East Central State and old Anambra State and presently the capital of Enugu State Eze (2012). The study area is Enugu urban made up of three local government areas, namely Enugu North, Enugu South and Enugu East council areas. Map of Enugu State showing the study areas shaded among the seventeen local government areas of Enugu State were shown in figure 1below.

Enugu is one of the urban centers that sprang up as a result of contact with colonial government of Great Britain in 1909. Enugu town is franked in the west by Udi hills, a long range of folded sedimentary escarpment which started from Basanga range in Benue state through the length of Enugu State to Okigwe plains. The ridge ranging from 600m to 800m above sea level stretches towards the north, east and south of Udi hills. The hillside is made up of clay and reddish-brown gravel silt mainly from the wasting slopes.

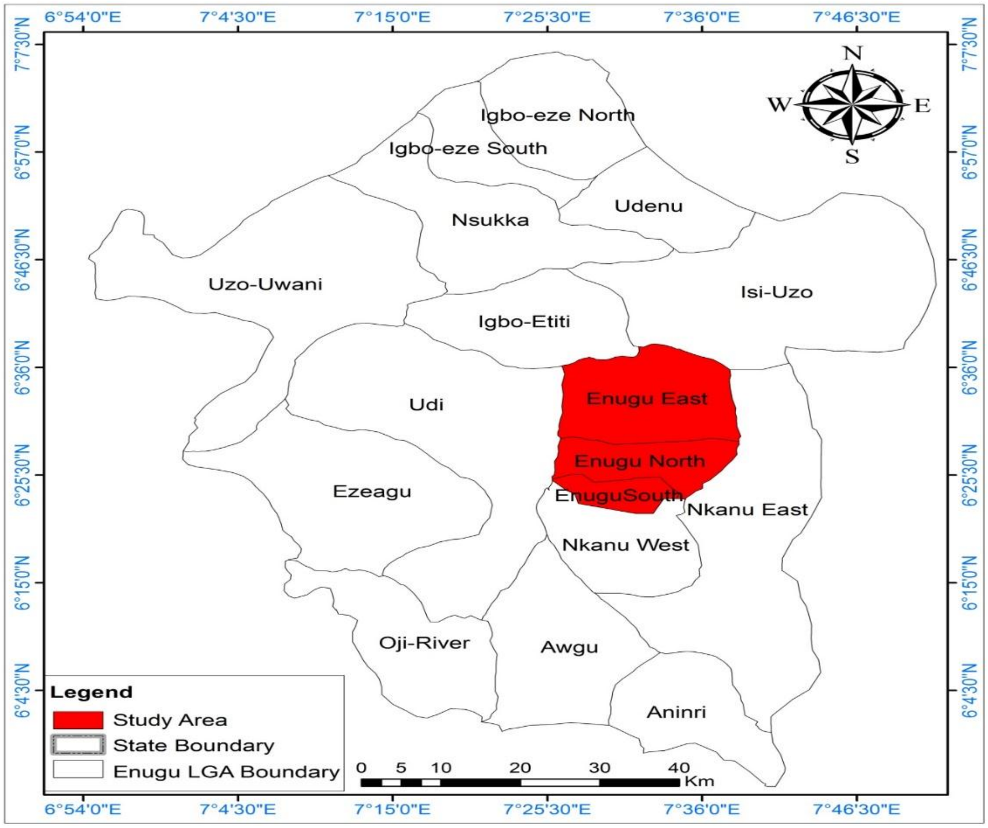

Figure 1: Map of Enugu State showing Enugu Metropolis.

Source: Survey Division, Enugu State Ministry of Lands Town Planning 2021.

The underlying bedrock is shale and coal seams that project from the dipping plain to the angle of east-west orientation. The discovery of these coal seams in commercial reserves by the British explorers in 1905 gave birth to the present Enugu town called Coal city Eze,(2012).

Enugu is located within the tropical climate zone with diminishing influence of the maritime. Enugu used to experience about 8 months of rainy season and 4 months of dry season which last from December to March. The rainy season has been increasing in the duration and intensity due to the present global warming.

Enugu Urban fondly known as Coal City has grown to be an important tourist centre in Nigeria. The town is endowed with a lot of tourist resources, facilities and potentials. These exist in natural features such as lakes, hills, falls, springs and cultural festivals as well as such man-made features like hotels, telecommunications and transportation outfits, galleries and monumental or archaeological collections. Some of these potentials are developed, others are yearning for development. Some of the existing tourist events in Enugu include the New Yam Festival and associated masquerade displays.

This study deployed extensively the use of Geographic Information System (GIS) to map the landuse and land cover (LULC) changes from year 2000 to 2020.

This study of LULC changes made an analysis of a large amount of spatio- temporal data that were traditionally collected through analogue ground- based field surveys. Due to rapid improvements in remote sensing technologies, spatial coverages, repetitive observations, and efficient data- processing capabilities, has encouraged urban researchers and city planners to use remote sensing data to examine the spatio- temporal LULC changes and urban sprawl. The identification of LULC changes using remote sensing data in the study area involved methods of pre- classification and post- classification of the changes. The pre- classification method processes a set of multi- temporal remote sensing images to create maps identifying areas of change or no- change in LULC without going further in classifying the nature of changes. The post- classification method then goes further to compare two classified temporal remotely sensed images to produce maps that showed the changes within and between LULC classes over the time frame. Considering the existence of complex, overlapping, and inaccessible LULC patterns in the study area, and lower accuracy level likely to be achieved, an unsupervised classification using the Iterative Self- Organizing Data Analysis Technique Algorithm (ISODATA) was used to achieve better accuracy in LULC classification. The resulting classes were combined and reclassified into five major urban land cover categories (Table 1). Finally, extent of urban sprawl was calculated by integrating Shannon's entropy and GIS tools. Shannon's entropy (*En*) was used to compute the density of urban development in order to measure its degree of concentration or dispersion among *n* zones. In this study eleven (11) zones were used at 500m intervals.

4. RESULT OF FINDINGS AND DATA ANALYSIS

(i) Urban Sprawl in Enugu from Year 2000 to Year 2020.

The Geographic Information System (GIS) was used to identify and capture five categories of landuse land cover (LULC) in ten years' intervals of 2000,2010 and 2020 covering an area of 242.874km^2 as follows: water bodies/wetlands, forest, farmlands, built- up area, and bare soil.

1. Built- Up Area; All types of manmade structures: residential, industrial, agricultural commercial and services; transportation and utilities; mixed urban or built- up.
2. Forest; Trees, natural vegetation, grassland and other vegetation land covers.
3. Farmlands; Agricultural lands, cultivated crop fields, gardens, ornamented parks and playgrounds.
4. Bare Soil; Areas with no vegetation cover, sand, open space, and bare lands.

5 Water Bodies/Wetlands; Reservoirs, swampy/marshlands, ponds, streams, and rivers.

4(ii). Urban Sprawl in Enugu as at Year 2000.

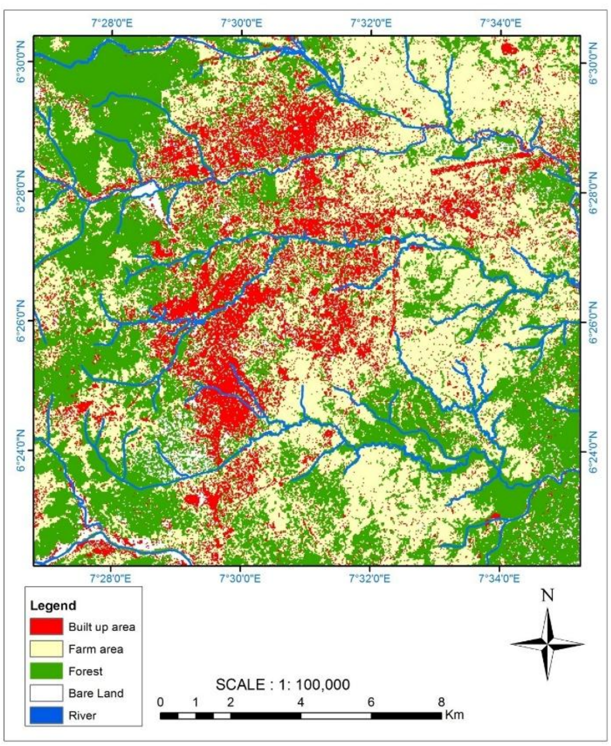

Figure 2: Landuse land cover Map of Enugu in 2000.
Source: GIS map of Enugu accessed on 2021,15/08:18.00.

ID_2000	Classes	Count	Area (Km2)	(%)

1	Built up Area	41570	37.413	15.4
2	Farm Land	111914	100.723	41.47
3	Forest	105578	95.02	39.12
4	Bare Land	10191	9.172	3.78
5	Water Body	607	0.546	0.22
Total		**269860**	**242.874**	**100**

Table1: Statistical table of land use land cover of Enugu, 2000
Source; Calculated from Figure

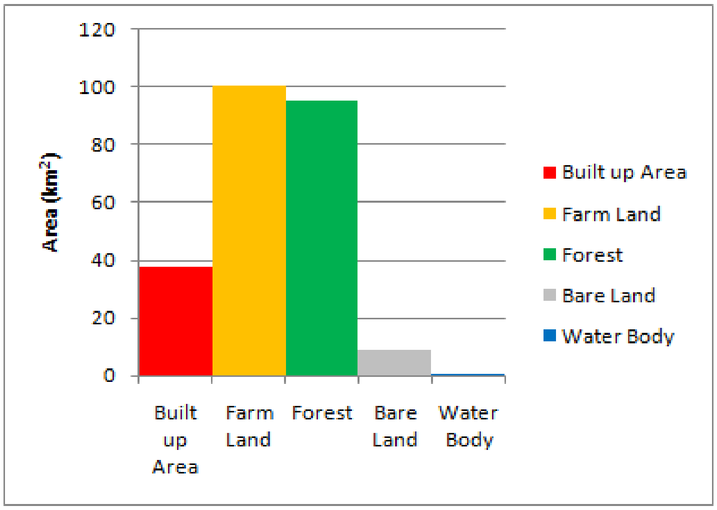

Figure 3: Histogram of landuse landcover of Enugu, 2000
Source: From Table 1.

From figure 2 showing the built-up areas in Enugu as at year 2000, out of 242.874 square kilometers of Enugu land area, only 37.413 square kilometers representing 15.4 percent of the present Enugu urban were built up and covered with physical structures. Up to 80 percent of the whole landmass was covered by farmlands and forests at equal proportion. Farming and other agricultural activities formed the major landuse activities. Most of the pre-existing native villages and migrant farm settlements located at distance were fully occupied by itinerant farmers who provided adequate food for sale in the township creating an excellent sustainable city.

4(iii). Urban Sprawl in Enugu as at Year 2010.

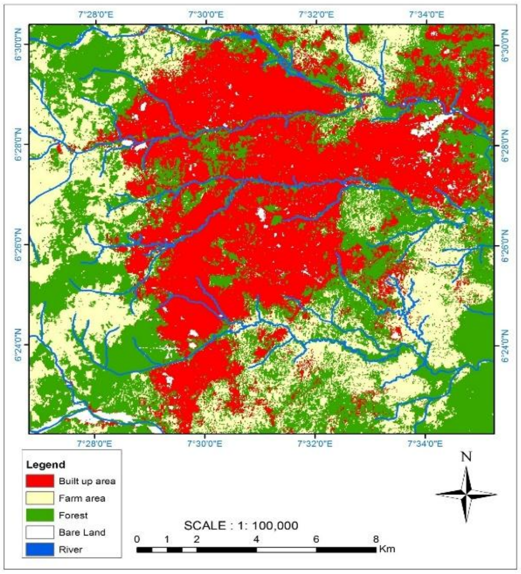

Figure 4: Landuse land cover Map of Enugu in 2000.
Source: GIS map of Enugu accessed on 2021,15/08:18.00.

Table 2: Statistical table of landuse landcover of Enugu, 2010

ID_2010	Classes	Count	Area (Km2)	(%)
1	Built up Area	91869	82.682	34.04
2	Farm Land	70706	63.635	26.2
3	Forest	57902	52.112	21.46
4	Bare Land	4677	4.209	1.73
5	Water Body	44706	40.235	16.57
Total		269860	242.874	100

Source: Calculated from Figure 4

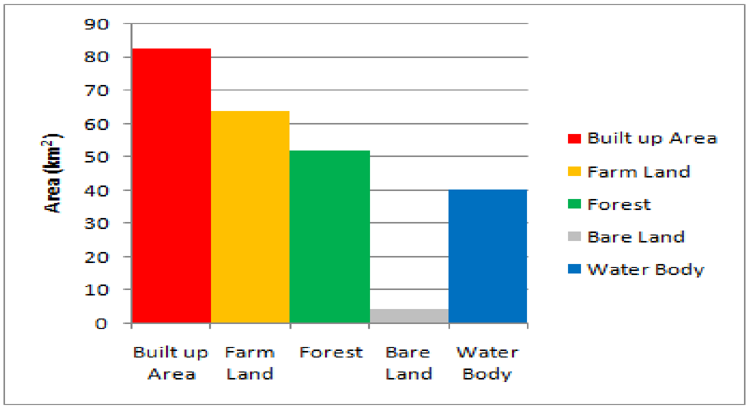

Figure 5: Histogram of landuse landcover of Enugu, 2000
Source: From Table 2.

From year 2001 to 2010 there was a tremendous increase in physical growth in terms of infrastructures as shown by rising trend in housing development. When the GIS apparatus was adjusted to capture the landuse as at year 2010, the result as shown in figure 4. indicated an outstanding change in the built up area of Enugu urban. A comparative study of figure 4 and 2 manifested a significant change in land use land cover pattern in the study area. The built-up area covered 82.682 square kilometers representing increase from 15 percent to over 34 percent. The rise is remarkable showing over 100 percent increase in built up area while farmlands and forest declined from 80% to 47%. The bar charts in figures 3 and 5 vividly showed a remarkable change in the LULC.

4(iv). Urban Sprawl in Enugu as at Year 2020.

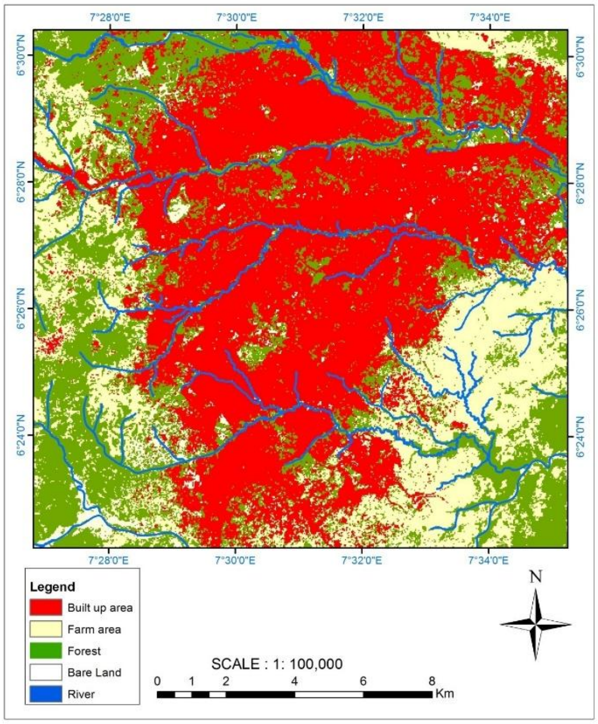

Figure 6: Enugu Landuse Landcover 2020.
Source: GIS map of Enugu accessed in 2021,15/08:18.00.

Table 3: Statistical table of landuse landcover of Enugu, 2020

2020	Classes	Count	Area (km2)	(%)
1	Built up Area	122843	110.559	45.52
2	Farm Land	52750	47.475	19.55
3	Forest	34804	31.324	12.90
4	Bare Land	8964	8.068	3.32
5	Water Body	50499	45.449	18.71
Total		269860	242.874	100.00

Source: From Figure 6.

There was a persistent increase in built up areas as noticed in the GIS map of 2020. The satellite imagery showed intensive coverage of land surface by more built up infrastructures (see figure 6 and 7). In fact, the built-up areas were in a hot chase on the farm lands. The urbanised area increased from 82.6km^2 to 110.6 km^2.

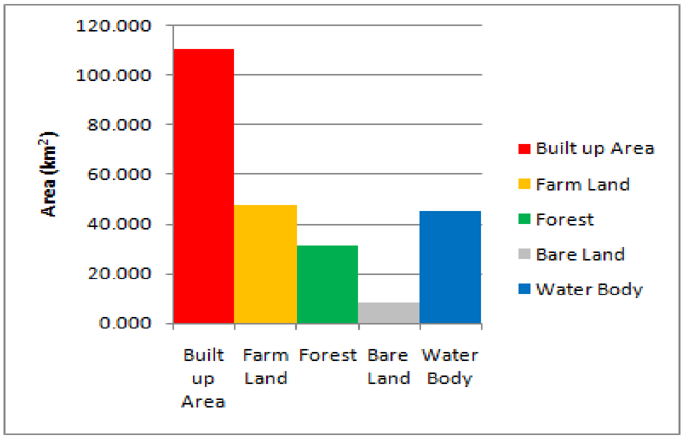

Figure 7: Histogram of landuse landcover of Enugu, 2000
Source: From Table 3.

The bar chart in figure 7 showed that the built-up area increased to cover up to 45.5% of Enugu land mass while farmlands and forest declined to less than33% of the land mass.

4(v). Extent of Urban Sprawl in Enugu from Year 2000 to Year 2020.

To perform the Shannon's entropy analysis, the three classified maps were first reclassified into two categories: built- up and non- built- up areas. Then *i*th numbers of concentric circles or buffers are drawn from the center of the city. A total of 11 concentric buffer rings, each at 500 m apart, were drawn around the city centre to cover the entire study area. The density of the built-up area was calculated for each ring or circle. Finally, the relative entropy values were calculated for each year by using the formula:

$$E_n = \sum_{i}^{n} pi \frac{log(\frac{1}{pi})}{log(n)}$$

Source;Muhammad T R (2016).

and xi is the density of land development, which equals the amount of built- up

land divided by the total amount of land in the *i*th zone in *n* total zones. Relative entropy values closer to 0 indicate uniformity and compact or high density urban development that makes the city vulnerable to change; whereas entropy values close to 1 indicate low density urban development and a high degree of urban sprawl causing chaos in providing urban infrastructure and utility services; entropy values in the middle between two extremities indicate an organized urban development. Entropy values for each buffer ring were plotted against the buffer distance, and mapped for each of three years to detect the spatial pattern of urban sprawl over time. To map and identify the zones of *uniform*, *organized* and *chaotic* urban sprawl in the study area, the entropy value of each buffer zone was added to obtain a cumulative entropy value which ranges between 0 at centermost buffer ring to the maximum at the 11th ring. The cumulative entropy value was then divided into three equal intervals: buffer zones with values ranging between 0.0–0.33 would be the zones of *uniformity*; those between 0.33–0.66 would be the zones of *organized* urban development; and those above 0.66 would indicate zones of *chaotic* urban development. Change of entropy between two time periods indicate the magnitude, direction, and nature of urban sprawl. Therefore, changes in entropy values were computed by subtracting the entropy value of the base year from that of the terminal years.

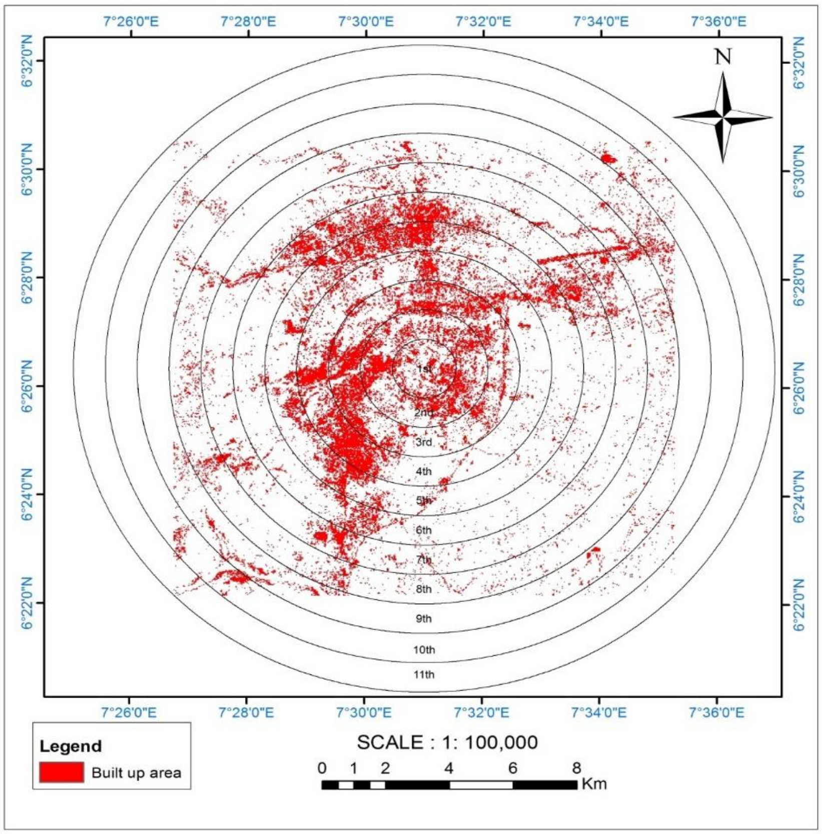

Figure 8: Enugu Built up Area, Year 2000Table 4: Calculation of Sprawl year 2000

ID Zone 2000	Area (built up area) in Skim 2000	Area (Zone)in sqkm	% of built-up	built up den	PDENi	1/PDENi	log(1/PDENi)	Log 11	Entropy
1st	1.103	3.141	35.127	0.351	0.181	5.531	0.743	1.041	0.140
2nd	3.802	9.424	40.338	0.403	0.208	4.817	0.683	1.041	0.148
3rd	5.619	15.708	35.77	0.35	0.184	5.432	0.735	1.04	0.141

			1	8				1	
4th	5.320	21.991	24.192	0.242	0.125	8.032	0.905	1.041	0.117
5th	6.192	28.274	21.900	0.219	0.113	8.872	0.948	1.041	0.111
6th	5.523	34.557	15.983	0.160	0.082	12.156	1.085	1.041	0.093
7th	3.596	40.840	8.806	0.088	0.045	22.064	1.344	1.041	0.063
8th	3.065	47.123	6.503	0.065	0.033	29.878	1.475	1.041	0.051
9th	1.967	53.406	3.682	0.037	0.019	52.768	1.722	1.041	0.034
10th	1.075	59.690	1.800	0.018	0.009	107.926	2.033	1.041	0.020
11th	0.152	65.973	0.231	0.002	0.001	842.768	2.926	1.041	0.004
Total	**37.41**	**380.13**	**194.33**	**1.943**	**1.000**	**1100.24**	**14.60**	**11.46**	**0.922**

Source: GIS from Figure 8.

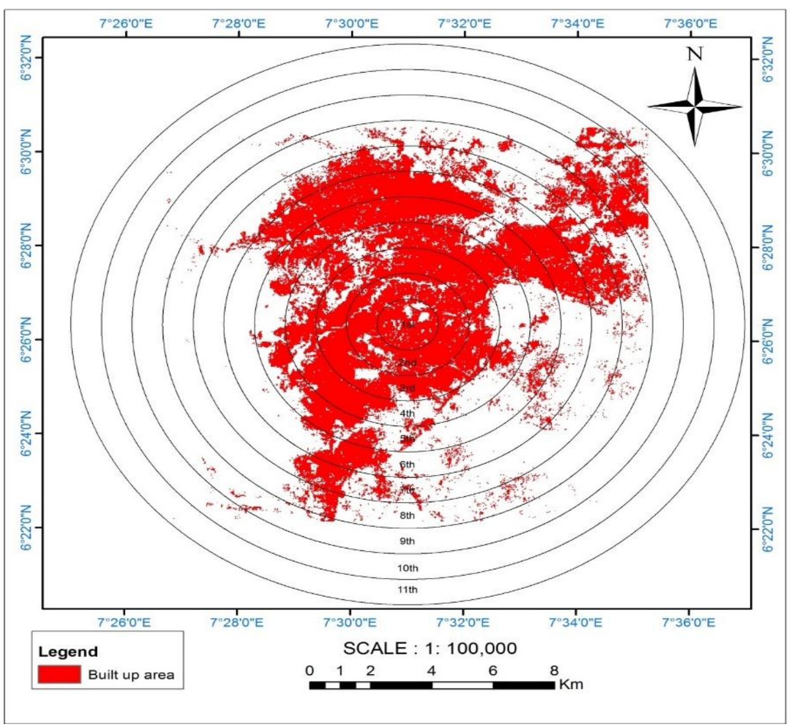

Figure 9: Enugu Built up Area, Year 2010.

Table 5: Calculation of Sprawl in Year 2010.

ID Zone 2010	**Area (built up area) in Sqkm 2010**	**Area (Zone)in sqkm**	**% of built-up**	**built up den**	**PDENi**	**1/PDENi**	**log(1/PDENi)**	**Log 11**	**Entropy**
1st	2.597	3.141	82.661	0.827	0.190	5.261	0.721	1.041	0.143
2nd	8.060	9.424	85.528	0.855	0.197	5.085	0.706	1.041	0.145
3rd	12.527	15.708	79.752	0.798	0.183	5.453	0.737	1.041	0.141
4th	11.885	21.991	54.043	0.540	0.124	8.047	0.906	1.041	0.117
5th	13.910	28.274	49.199	0.492	0.113	8.840	0.946	1.041	0.111
6th	13.583	34.557	39.306	0.393	0.090	11.065	1.044	1.041	0.098
7th	10.134	40.840	24.814	0.248	0.057	17.527	1.244	1.041	0.074
8th	5.179	47.123	10.990	0.110	0.025	39.574	1.597	1.041	0.042
9th	2.820	53.406	5.280	0.053	0.012	82.372	1.916	1.041	0.024
10th	1.773	59.690	2.970	0.030	0.007	146.413	2.166	1.041	0.015
11th	0.215	65.973	0.326	0.003	0.001	1333.870	3.125	1.041	0.002
Total	**82.68**	**380.13**	**434.87**	**4.349**	**2.238**	**1663.51**	**15.11**	**11.46**	**0.913**
	37.413								
	82.6821								

Source: GIS from Figure 9

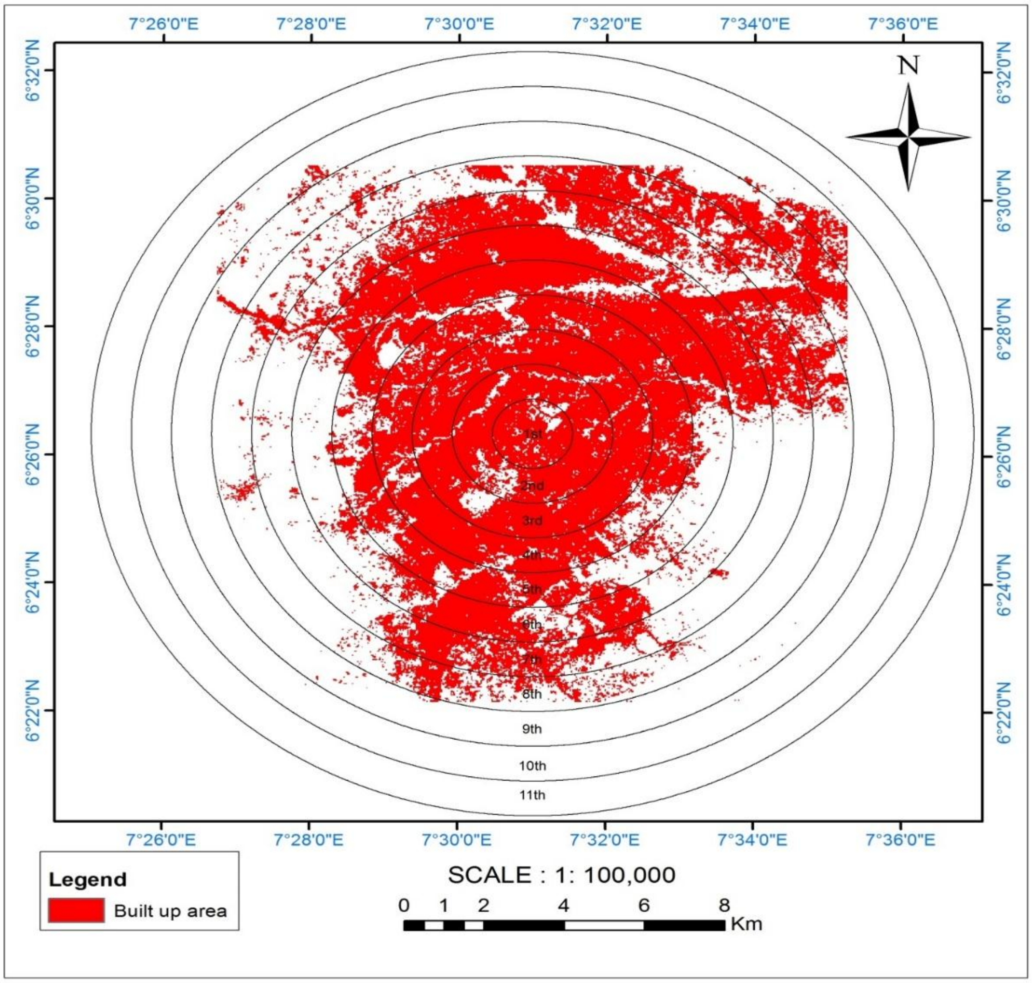

Figure 10: Enugu Built up Area, Year 2020.

Table 6: Calculation of Sprawl in Year 2020.

ID Zone 2020	Area (built up area) in Sqkm 2020	Area (Zone)in sqkm	% of built-up	built up den	PDENi	1/PDENi	log(1/PDENi)	Log 11	Entropy
1st	2.659	3.141	84.638	0.846	0.160	6.238	0.795	1.041	0.133
2nd	8.153	9.424	86.512	0.865	0.164	6.103	0.786	1.041	0.134
3rd	14.159	15.708	90.140	0.901	0.171	5.858	0.768	1.041	0.136
4th	17.854	21.991	81.190	0.812	0.154	6.503	0.813	1.041	0.130
5th	17.602	28.274	62.256	0.623	0.118	8.481	0.928	1.041	0.114
6th	17.458	34.557	50.520	0.505	0.096	10.451	1.019	1.041	0.102
7th	15.577	40.840	38.142	0.381	0.072	13.843	1.141	1.041	0.086
8th	11.491	47.123	24.386	0.244	0.046	21.652	1.336	1.041	0.064

9th	4.217	53.406	7.897	0.079	0.015	66.862	1.825	1.041	0.028
10th	1.369	59.690	2.293	0.023	0.004	230.229	2.362	1.041	0.011
11th	0.019	65.973	0.029	0.000	0.000	18430.483	4.266	1.041	0.000
Total	**110.56**	**380.13**	**528.00**	**5.280**	**2.717**	**18806.70**	**16.04**	**11.46**	**0.938**

Source: GIS from Figure 10

5. Discussion of results.

Figure 2 to 10 and tables 1 to 6 displayed a comprehensive maps and data extracted from Enugu satellite map using the GIS apparatus. These were done at ten years' intervals for years 2000, 2010 and 2020. The map captured an area of 242.874km^2 covering greater part of Enugu North, Enugu South and Enugu East Local Government Areas. In the maps, five classes of landuse land cover were identified namely (1) built-up area, (2) farmland, (3) forest, (4) bare land and (5) wetland/water body.

In Shannon entropy interpretation 0.1-0.33 are zone of concentrated urban development or minimal urban sprawl, 0.33-0.66 are zones of organised urban development or low urban sprawl while 0.66 and above belong to zone of chaotic urban sprawl or high level of urban sprawl. The cumulative Shannon entropy as calculated in table 4, 5 and 6 are 0.922 for year 2000. Then,0.913 and 0.938 for years 2010 and 2020 respectively. Right from year 2000, the study area Enugu has surpassed the normal level of Urban development but fall into the level of chaotic urban development or high-level urban sprawl. The increasing intensity of the colour shadings from figures 8 to 10 showed vividly that the study area experienced a drastic change and intensity in land use/land cover over the last 30 years. Areas under built up increased while areas under agricultural land, vegetation, and open land decreased rapidly. Built-up area increased from 37.413km^2 in year 2000 to 82.682km^2 in 2010 representing over 100% increase while farmlands and forest decreased from 192km^2 to 115km$^{2.}$ It indicated urban expansion at the cost of prime agricultural land. This is a serious factor for change in socio-economic status of Enugu urban. Open land has also been transformed into built up areas and this class of landuse has registered a decrease of 5km^2 during the ten-year period. Other classes of landuse/land cover witnessed minor changes.

In 2020, built-up area covered an area of 110.559km^2 out of total land area of 242.874km^2 representing 45.52%. To be precise, if we adjust for difficult terrains and water bodies/ wetlands/ flood prone areas, one can as well realise that percentage of built up areas has gone beyond 60% in general. Little wonder the residents have started experiencing increasing challenges of congestion in traffic, housing and high level of inadequacies in most other social amenities.

6. Conclusion.

Calculating from the current planning standard where it is professionally advised not to develop over 35% of a plot of land in low density and 45% in high density areas, Enugu urban can be said to have been over developed. The Shannon entropy figure of over 0.90 showed that sprawling pattern is **chaotic.** It is therefore recommended that Enugu should undergo further research to find out the major causes of this chaotic urban development and likely challenges associated with the level of urban sprawl. Instead of continued development of new buildings and layouts in the chaotic enclave, massive infrastructure upgrade and development of new towns at 9th mile, Ituku/Ozara/Agbogwugwu and Ogbeke/Ugwogo Areas should be encouraged.

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Durability Performance of Geopolymer Mortar Synthesized from Ternary Blend of Cassava Peel Ash, Rice Husk Ash, and Metakaolin

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Abstract

Geopolymer technology involves production of cementless, environmental-friendly concrete which is synthesized from agriculture by-products such as Rice Husk Ash (RHA), Cassava Peel Ash (CPA) and earth explore product like Metakaolin (MK) with merits to decrease the enormous amount of agricultural waste and earth explore materials as well as the contribution in carbon footprint annually. The study therefore explored the development of alkali-activated CPA-SHA-MK ternary blended geopolymer mortar (GPM) using sodium silicate (Na_2Si_3) and sodium hydroxide (NAOH) solution with 9M constant concentration as alkaline activators under both the aggressive and ambient-temperature curing media. The mass ratio of sodium silicate to sodium hydroxide (NS:NH) and as well as the binder to fine aggregate were fixed to 2.5 and 0.8 respectively It also analyse the extent to which the Supplementary Cementitious Materials (SCMs) improves the durability performance of the product. The durability of the ternary blended geopolymer mortar was examined through water absorption test, and acid resistance test using 50 mm cubes after 28, 56 and 90 days of curing. The results revealed that the setting time prolonged as the replacement levels of RHA-MK increased at a decrease in replacement levels of CPA. The results also showed that the water absorption rate of GPM is lesser, compared to PCM while it was observed that the water absorption increases as the hydration periods increases. Furthermore, both the PCM and GPM samples studied suffered mass and strength losses in the acid solution and the loss increases at an increase in the hydration periods. The losses were observed to be higher in PCM as compared to the GPMs while the mix incorporated 50% CPA, 33% MK and 17% RHA (C50M33R17) was observed to be better compared to other mixes in durability behavior. The study therefore recommends C50M33R17 for good durability performance.

Keywords: Durability, Geopolymer, Rice Husk Ash (RHA), Cassava Peel Ash (CPA) and Metakaolin (MK).

1.0 Introduction

Over the years, Ordinary Portland Cement (OPC) has been widely employed as mortar binder, concrete binder and various building substances worldwide. It is known that, large scale manufacturing of OPC causes serious pollution in the environment in terms of considerable amount of greenhouse gases emission (Duxson *et al.*, 2007; Rashad *et al*., 2013). The OPC production alone is accountable for nearly 6 to 7% of total CO_2 emissions as estimated by International Energy Agency (IEA) (Palomo *et al.*, 2011). In fact, among all the greenhouse gases approximately 65% of the global warming is ascribed to the CO_2 emission. The emitted greenhouse gases such as CO_2, SO_3 and NOx from the cement manufacturing industries can cause acid rain and damage the soil fertility (Zhang *et al.*, 2011). Generally, the industrial consumption of raw materials is around 1.5 tonnes per each tonne of OPC production (Rashad, 2013a). To surmount such problems, scientists, engineers and industrial personnel have been continuously dedicating many efforts to develop novel construction materials to achieve alternate binders (Rashad, 2013b).

The term ‘‘geopolymers’’ was coined by Joseph Davidovits in 1972 (Komnitsas & Zaharaki, 2007) to describe the zeolite like polymers. Geopolymers are the alumino-silicate polymers which consist of three dimensional amorphous structures formed due to the geopolymerization of alumino-silicate monomers in alkaline solution (Rowles & O'connor, 2003). In the past, intensive studies have been carried out on calcined clays (metakaolin) or industrial wastes such as FA, palm oil fuel ash and slag (Chang, 2003; Kong *et al*., 2007; Temuujin *et al*., 2010). Yet, the complex process so called geopolymerization is not fully understood (Yao *et al*., 2009). Davidovits proposed a reaction pathway involving the polycondensation of orthosialiate ions (hypothetical monomer) (Provis *et al*., 2005). The mechanism of geopolymerization process (Dimas *et al*., 2009) is based on three steps: (i) dissolution in alkaline solution, (ii) reorganization and diffusion of dissolved ions with the formation of small coagulated structures and (iii) polycondensation of soluble species to form hydrated products. Compared to OPC, alkali activated mortars are well-known for their excellent properties such as high compressive strength (Burciaga-Díaz *et al.*, 2013; Zhang *et al*., 2010), low shrinkage (Chi *et al*., 2012; Zhang *et al*., 2010), acid resistance (Palomo *et al*., 1999), fire resistance, devoid of toxic fumes emission (Duxson *et al*., 2007), low thermal conductivity (Zhang *et al.*, 2010), excellent heavy metal immobilization, high temperature stability (Yao *et al*., 2009), low manufacturing energy consumption for construction purposes and several engineering applications (Zhang *et al*., 2010).

Mortars and concretes made with Portland cement deteriorate in aggressive environment of sewers, mining, mineral processing, acid rain or acid ground-water (Harrison, 1987; Bakharev *et al*., 2003; Allahverdi & Skvara, 2005; Bakharev, 2005). Most of the commercial repair materials owing to their low durability and sustainability perform poorly under aggressive chemical and adverse weather environmental conditions. Geopolymer prepared from the waste materials with high content of aluminium-silicate and alkaline activator solution has emerged as a leading repair material. However, new binders are prerequisite for enhanced durability performance, better sustainability and environmental affability.

Consequently, the present study intends to develop an environmental friendly geopolymer mortar with broad arrays of applications in the construction industry and exhibiting durability characteristics by introducing three pozzolanic materials in enhancing the durability characteristics of the geopolymer mortar.

The aim of this study is to evaluate the durability properties of geopolymer mortar synthesized from ternary blend of RHA, CPA and MK with a view to producing a zero cement mortar with low carbon foot print and enhanced durability.

2.0 Materials and Methods

2.1 Materials

The materials used in the test programme includes cement (CEM 1), Rice Husk Ash (RHA), Metakaolin, Cassava Peel Ash (CPA), fine aggregate, Alkaline solution (Sodium Silicate (Na_2SiO_3) and Sodium Hydroxide (NaOH)), water and superplasticizer.

Portland Cement type CEM II/A-LL, 42.5 N from Dangote Cement Company conforming to BS EN 1971-1 (201) and NIS 444-1 (2003) was used as main binder (PC) throughout the investigation. The cement was obtained from local cement merchant in Minna and effort was made to ensure that the supply is gotten from the most recent stock and kept in dry position.

The RHA used in this research work was collected from a local grain mill in Garatu village along Minna-Bida Road, Bosso LGA, in Niger State. The collected Rice husk was then burnt in open air with a locally fabricated incinerator. The resulting RHA was dried and sieved to eliminate larger materials and to lessen the carbon content. A local milling device was used to ground the resulting burnt RHA particles to a size smaller than 150 µm. Finally, the grounded ash was sieved with a 75 µm sieve and particles passing through were used as the RHA for the experiment.

The RHA powder was white in colour, which was an indication of complete burning of all carbon and impurities within the husk. The powdered PC, MK, CPA and RHA were then tested for X-Ray Florescence (XRF) analysis to determine their oxide composition.

River sand with maximum size of 4.75 mm was used in this study. The sand was used at saturated surface dry conditions and its grading was measured according to ASTM C33/C33M (2019). Master Rheobuild plasticizer was used as a high range water reducer and was administered at constant concentration of 10% by weight of binder (bwob). Clean potable water as specified by BS EN 1008 (2015) available within the concrete laboratory of Department of Building, School of Environmental Technology, Federal University of Technology, Minna was used for mixing of the mortar and other laboratory use in accomplishing the work.

2.2 Methods

The methods adopted in conducting the material analysis (physical and chemical), fresh properties and durability properties is presented in this section. The durability performance test of the ternary-blend alkali activated mortars durability involved the evaluation of acid resistance and the permeability (water absorption) of the specimens tested.

2.2.1 Material characterization

The material characterizations involved the examination of both the chemical and physical properties of the constituent materials. The physical analysis carried out on the sand, RHA, CPA, MK were Particle size distribution analysis (PSD), specific gravity and moisture content. The chemical analysis conducted on RHA, CPA and MK samples was X-ray Fluorescent (XRF) analysis for determination of oxide composition in accordance to ASTM C618 (2015) using XRF analyzer. Also, setting time and flowability of the mortar mix was also evaluated.

2.2.2 Mix proportioning and specimen production

This research investigated the varying composition of solid binder as independent variable on the durability properties of ternary blend GPM. A trial mix was conducted prior to the casting of experimental specimens. The control variable of this research was the specimens incorporated portland cement only (PCM) and the other mixes were those with variation in binder composite, total five mortar samples were cast with increasing CPA content of 10 %, 30 %, 50 %, 70 % and 90 %. While the remaining contents was two-third of MK and one-third of RHA as shown in Table 1.

Table 1: Mix proportion of Alkali Activator Mortar for optimum CPA content

Mix ID	CPA (%)	MK (%)	SHA (%)	W/B Ratio	FA	Na_2SiO_3	NaOH
C90M07S03	90	7	3	0.35	2.5	0.25	0.1
C70M20S10	70	20	10	0.35	2.5	0.25	0.1
C50M33S17	50	33	17	0.35	2.5	0.25	0.1
C30M47S23	30	47	23	0.35	2.5	0.25	0.1
C10M60S30	10	60	30	0.35	2.5	0.25	0.1

2.2.3 Specimen testing and data collection
The various test specimens will be tested for the following durability test

2.2.3.1 Acid resistance test

The resistance of the geopolymer mortar to acid attack was studied by immersion of cube specimens (50 x 50 mm) in 5% solutions of sulfuric acid with pH of 0.8. The choice of acid solution and its concentrations was based on practical utilization of concrete as a construction material in sewage pipes, mining, and food processing industries. The testing media was replaced monthly with fresh solutions. The compressive strength of specimen (50 x 50 mm) was measured at 28, 56 and 90 days of exposure.

The assessment of the geopolymer specimens in acidic environment was carried out based on the performance from weight loss and strength loss.

2.2.3.2 Water Absorption Test (ASTM C642/C642M, 2013)

The test was conducted in conformity with ASTM C642/C642M (2013), which specifies a method for the determination of water absorption of mortar and concrete specimens. An average of three 50 mm cube specimens was prepared. The cubes were oven dried at temperature of 110 ± 5^{o}C for 24 hours. The oven dried specimens were allowed to cool in an airtight desiccator of temperature 24 ± 2^{o}C. At the end of drying and cooling, the specimens were weighed and immersed in water tank at approximately 21 ^{o}C for 48 hours. After removal from water, the specimens were wiped with a dried towel to remove the surface water and weighed. The measured absorption of each test specimen was then calculated as the increase in the weight resulting from the immersion expressed as a percentage of the mass of the dry specimen as shown in the following equation:

$$Wa = (Ms{-}Md/Md\ ) * 100\% \qquad (1)$$

Where: Wa = Water absorption (mass %)

Ms = Saturated surface dry mass of the specimen in air

Md = Oven-dry mass of the specimen in air

3.0 Results and Discussion

3.1 Materials Characterization

3.1.1 Physical properties of the constituent materials

The results revealed that the fine aggregate conformed to the medium sand classification according to Shetty (2004) with uniformity coefficient (C_u) of 2.39, coefficient of curvature (C_c) of 0.94, specific gravity value of 2.82 and fineness modulus (FM) of 2.65. Table 2 makes it crystal cleared that the fine aggregate is appropriate for the production of geopolymer mortar (GPMs).

Table 2: Summary of physical properties of the constituent materials

Item	Sand	RHA	CPA	MK	PC
D_{10}	360				
D_{30}	540				
D_{60}	860				
C_u	2.39				
C_c	0.94				

FM	2.65				
SG	2.82	2.8	1.8	2.59	3.15

3.1.2 XRF characterization of binders of RHA, CPA and MK

The chemical composition and loss on ignition of CEM II (Portland cement) as received and RHA, CPA and MK determined by XRF are shown in Table 3. The outcome of the test reveals that the RHA, CPA and MK contained majorly SiO_2. Furthermore, it can be seen that the SiO_2 present in them as revealed by the result are 95%, 80.83% and 72.39% with silica-sesquioxide (S-S) ratio (SR) of 166.67, 34.84 and 3.37 with aluminium-sesquioxide ratio (AR) of 3.75, 0.50 and 18.17 respectively which according to ASTM C618 (2015) is affirmed to be a very strong reactive Class F Pozzolan with the sum of silica (95%, 80.83% and 72.39%), alumina (0.45%, 0.77% and 20.35%) and ferric oxides (0.12%, 1.55% and 1.12%) respectively higher than the specified 70%. Also, the CEM II contained 60% CaO which makes it crystal cleared that the PC is majorly calcium oxide and is in conformance with the oxide composition reported in literature (Shetty, 2004) for CEM II.

Table 3: Oxide Composition of Binder Constituents (RHA, CPA and MK)

Oxides	RHA (%)	CPA (%)	MK (%)	CEM II (%)
SiO_2	95.0	80.83	72.39	25.64
Al_2O_3	0.45	0.77	20.35	5.24
Fe_2O_3	0.12	1.55	1.12	7.15
CaO	0.84	4.24	0.01	60.35
MgO	0.45	-	0.12	0.41
SO_3	0.10	0.83	-	0.11
K_2O	1.50	5.50	3.12	0.05

Na_2O	0.03	0.06	0.34	0.31
M_2O_5	0.05	-	-	0.04
P_2O_5	0.72	-	-	0.03
LOI	0.74	2.10	2.35	0.67
$SiO_2 + Al_2O_3 + Fe_2O_3$	95.57	83.15	93.86	12.68
SR	166.67	34.84	3.37	2.07
AR	3.75	0.50	18.17	0.73
Total	100	100	100	100

3.2 Fresh Properties Test

Before the production of the specimens, fresh GPMs mixtures were examined for workability using flow table test as described in BS EN 1015-3:1999 as a measure of workability of the GPMs mixtures presented in Table 4. Flow table test was used to observe the spreading of the fresh geopolymer mortar by repeatedly tapping for 25 times on a leveled surface. Throughout the experiment, the rapid setting of ternary-based GPM was noticed as shown in the Table 4. The fresh mortar began to set within five to twenty minutes (5-20 mins) right after thoroughly mixing process for the C90M07R03 mix followed by C70M20R10, C50M33R17, C30M47R23 and C10M60R30 with the initial and final setting times of twenty and sixty minutes (20-60 mins), twenty-five and sixty-five minutes (25-65 mins), thirty and hundred minutes (30-100 mins), forty-five and one-twenty minutes (45-120 mins) respectively.

It was later discovered that the GPM had a very flash setting in comparison with the reference mortar (CGPM) having it initial and final setting times to be one and half hours and three hours respectively. Hence, the results also revealed that at a decrease in the CPA content then the setting time increases.

Furthermore, the result also showed a descending trend in the spreading width as observed with a decrease in the replacement levels of CPA. Higher CPA content exhibits higher workability and faster settings of the GPM. Hence, it was discovered that the RHA incorporation contributed to the reduction in the spreading width as a result of its hygroscopic nature and thereby accelerate the geopolymerization of the specimens (Gao *et al*., 2016). Lower spreading width achieved by increasing the replacement level of MK-RHA attributed to the content of CaO and thus accelerate the geopolymerization as its rapid reaction with alkali activator (Khan *et al*., 2016).

Table 3: Fresh Properties of ternary blended GPMs

Variables	Spreading Width (mm)	Setting time (min)	
		Initial	Final
PCM	220	90	180
C90M7R3	210	5	20
C70M20R10	200	20	60
C50M33R17	190	25	65
C30M47R23	150	30	100
C10M60R30	140	45	120

3.2 Influence of sulphuric acid attack on the compressive strength of GPMs

The mass loss and the compressive strength were monitored in order to understand the primary degradation mechanism.

3.2.1 Mass loss

The mass change in mortar samples during the period of immersion in H2SO4 solutions is shown in Figure 4.5. The rate of mass loss in both the PCM and GPMs sample exposed to H_2SO_4 solutions was increasing from one cycle to the next during the hydration periods but the loss was highly pronounced in PCM with 31.25%, 33.30% and 34.10% at 28, 56 and 90 days respectively compare to the GPMs. The results also revealed that the sample C90M7R3 reached maximum mass loss of 29.50%, 32.55% and 32.95% at 28, 56 and 90 days respectively when exposed to H_2SO_4 solutions with 5% by weight of curing water concentrations. The same trend were followed in other GPM mixes with an increase in the mass loss as the hydration periods increases and with the GPM samples C70M20R10 having the values of 24.20%, 23.99% and 26.45% at 28, 56 and 90 days respectively followed by the GPM mix C50M30R20 having the lowest mass loss of 16.50%, 18.25% and 19.22% at 28, 56 and 90 days respectively. The GPM mix C30M47R23 had the values of 20.25%, 25.05% and 26.59% and as well as 29.50%, 30.69% and 33.45% for C10M60R30 GPM mix.

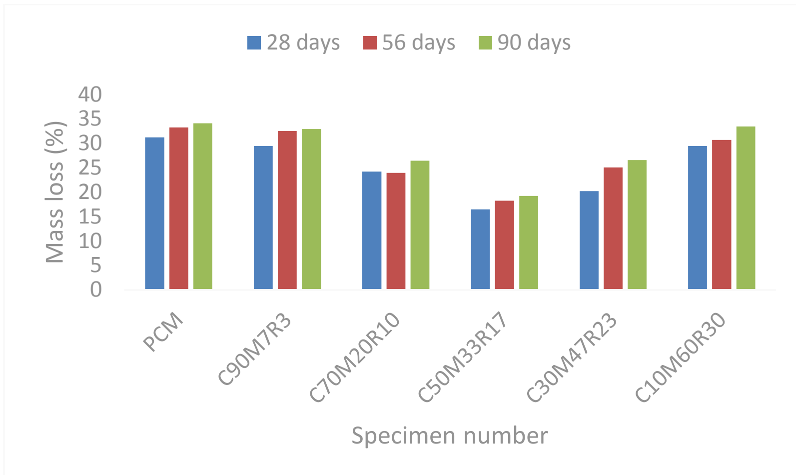

Figure 1: Mass loss of ternary blended GPMs subjected to H_2SO_4 attack

In contrast, the PCM mass loss was above the mass loss in all the GPM mixes. As evidenced by the colour change of the sample's surface, the difference was most probably related to the decalcification of hep and formation of a layer sulphate salts, gypsum and ettringite (Peyvandi *et al.*, 2015), on the surface of the sample. Most likely, these salts also formed in the pores of the outermost surface layer of the samples. At this stage, no degradation was observed and the mass loss was the result of high degree of hep decalcification and most importantly, the result of progressive degradation of the surface layer caused by pressure exerted by expansive crystals of the salt formed inside the pore structure. This suggest that the degraded layer of the material in GPM mixes acted as a buffer zone and slowed down further progression of the acid attack, thus providing better overall resistance against the acid attack than the PCM counterparts.

3.2.2 Strength loss

Comparisons between GPMs compressive strength cured in both ambient and sulphuric acid (H_2SO_4) media at various hydration periods (28, 56 and 90 days) are shown in Figure 2 At the end of 90 days curing age, the strength of mortar specimens immersed in H_2SO_4 solution is compared with those cured in normal ambient temperature. The difference between the GPMs compressive strength cured in ambient temperature and those immersed in H_2SO_4 solution is referred to as the strength loss. From the results showing in Figure 2, it is crystal cleared that the whole specimens suffered strength losses and the loss of some mixes were not drastically detrimental. The strength loss were observed to be more in reference mortar (PCM) as discussed under the sulphate attack when compared to GPMs (C90M7R3, C70M20R10, C50M33R17, C30M47R23 and C10M60R30). The C50M33R17 of the GPM mixes exhibited the lowest loss in strength with the highest residual strength of 94%, 90% and 85% at 28, 56 and 90 days respectively followed by C30M47R23 having residual strengths of 84%, 82% and 81%, C70M20R10 with residual strengths of 82%, 81% and 81% and as well as 80%, 77% and 74% for the GPM mix C10M60R30 and 70%, 61% and 58% for the GPM mix C90M7R3 at 28, 56 and 90 days respectively. The strength losses values of 8.40 N/mm^2, 11.31 N/mm^2 and 12.19 N/mm^2 were observed for PCM mix at 28, 56 and 90 days respectively. Whereas, the strength loss values of 8.51 N/mm^2, 9.30 N/mm^2 and 10.16 N/mm^2 were recorded in C90M7R3, 5.25 N/mm^2, 6.19 N/mm^2 and 7.16 N/mm^2 for C70M20R10, 4.94 N/mm^2, 6.16 N/mm^2 and 7.40 N/mm^2 for C30M47R23 , 6.05 N/mm^2, 7.08 N/mm^2 and 9.10 N/mm^2 for C10M60R30 and as well as the GPM mix C50M33R17 having the lowest strength loss values of 2.67 N/mm^2, 4.20 N/mm^2 and 6.67 N/mm^2 with the highest residual strength as said earlier at 28, 56 and 90 days respectively. However, the result also revealed that irrespective of the mix, the loss in strength for both the PCM and GPMs kept increasing at an increase in the hydration periods while the loss is more pronounced in PCM in comparison with the GPMs.

Figure 2: Strength losses as caused by H_2SO_4 attack on ternary blended GPMs

3.3 Water Absorption of ternary blended GPMs

Figure 3 illustrates the water absorption rate of geopolymer samples with different compositions of binders cured at 28, 56 and 90 days. The overall variance of 65.10% in water absorption rate within the range of between 10.23% to 16.89% was manipulated by the varying composition of geopolymer binder comprises of CPA, MK and RHA. A decreasing trend of water absorption rate was observed with a decrease in CPA contents up to the GPM mix incorporated 50% CPA, 33% MK and 17% RHA (C50M33R17) which happened to be the lowest absorption and later increased slightly for the GPM s incorporated C30M47R23 and C10M60R30. PCM has the highest absorption rate of 16.89% at 90 days followed by C90M7R3 having 16.35% also at 90 days, yet dropped to 15.95% when 20% of CPA replacement had been removed from the composition of the binders. The absorption was consecutively decreased to 10.25%, 14.07% and 16.14% with further decreasing in replacement of CPA at every 20% interval up to C10M60R30 and with the GPM mix C50M33R17 having the lowest absorption of 10.25% at 90 days. This can be explained by the degree of geopolymerization as well as the resultant product. RHA is relatively low reactivity at ambient temperature curing, yet inclusion of CPA and MK could accelerate the dissolution of the RHA particle (Yusuf *et al*., 2014). Large amount of unreacted RHA and MK particles were spotted in C10M60R30 as it contained lowest dosage of CPA as shown in Figure 3.

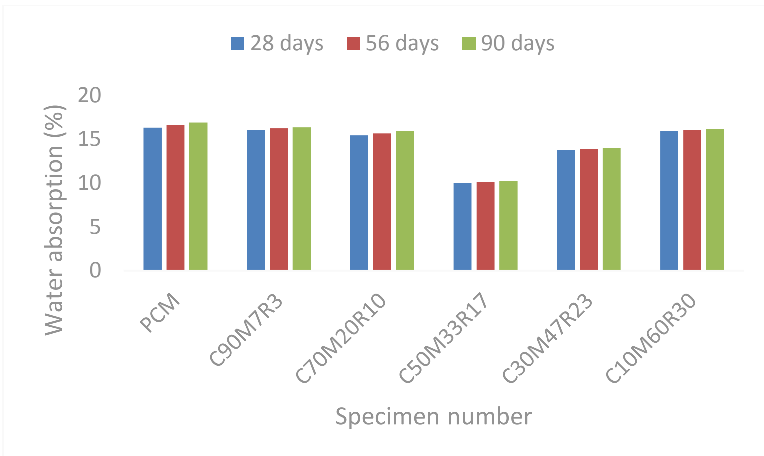

Figure 3: Water absorption of ternary blended GPMs

The unreacted particles very often are found in hollow cavities and it tends to create pores in the geopolymer paste (Raybar *et al*., 2014). However, about 60-70% reduction in water absorption for C50M33R17 attributed to 40% increment in CPA replacement. The result also revealed that the GPM is more resistance to moisture penetration in comparism with the reference mortar (PCM) and the absorption increased as the hydration periods increases.

4.0. Conclusion

All the GPM mixes in H_2SO_4 environment had an improved strength compared with the reference mortar (PCM). H_2SO_4 as a curing media resulted in to loss in the mass and compressive strength values of both the PCM and GPMs and the loss is more pronounced in PCM. The ternary GPMs absorption rate examined resulted to an increment as the hydration periods increases and the absorption is more pronounced with samples in H_2SO_4 curing media while the PCM yielded the highest for both when compared. Acid immersion studies indicated that geopolymer mortars have shown better acid-resistant properties. Ternary blended of CPA, MK and RHA with the composition of C50M33R17 should be adopted as the SCMs for 9M concentrations of alkali activators for good durability performance.

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BUILDING DEFECTS AS EFFECT OF POOR DESIGN: A POST OCCUPATIONAL EVALUATION OF RESIDENTIAL BUILDING IN ENUGU, NIGERIA.

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Abstract

Housing provision and quality housing are two issues, which remained the subject of research and interest to researchers' and designers'. Whenever a designer completes a project, they are not fully aware of the consequences of their design. Only through post occupational survey, the designer usually realizes the shortfall they have made during the design process. Unfortunately, such unforeseen conditions are the part of daily life for the end user of residential buildings in developing cities. The main purpose of this research is to understand and identify the causes of design tribulations and their effects on residential buildings at post occupational stage. This research circumscribes the issues and problems faced by the users of private housing at post occupational stage, which results in because of poor design. These problems affect the users through unplanned maintenance to major repairs leading to danger of collapse. In order to evaluate these effects on buildings, case studies were conducted in housing of metropolitan areas of Enugu State. The finding reveals that the housing is experiencing common building defects for housing such as dampness, facade deterioration and sanitation problem.

INTRODUCTION

Background

The concentrations of planning and design solution are cradled for maintenance issues related to design faults in built forms. Maintenance which emerges from design faults indicates that design has not been practiced in the perception of building maintenance, or that the construction phase has remained unchecked by the field experts. Reviewing the maintenance problems in various built forms reveals that the housing sector is the most effective of these activities.

House is an enclosure which presents the perception of peaceful and protecting environment. A house is supposed to be a place/enclosure which is capable enough to accommodate ideas of living and work. In prehistoric days, caves were used to fulfil that requirement of living space as well as protecting its user from extremes climatic conditions. With the passage of time and advent of technology, the perception of shelter has changed its form in modern day housing. Under developing countries which normally have an unplanned growth, development and law, transient in almost all spheres of life, particularly in urban centres. Alarming rate of population growth is another problem faced by these countries which ultimately creates the demand for increased number of housing facilities. In modern days, house is a basic icon of shelter where people can plan to live and work under a protected environment. House or its multiple form of housing has remained subject of research and discussion on number of reputable platforms. Around the globe the importance of housing has increased many folds and it is still growing with every day past. Its importance gains more momentum when the state of housing in developing nations is taken into account, A. H. Chohan, A. I. Che-Ani, M. M. Tahir, N. A. G. Abdullah, N. M. Tawil and S. N. Kamaruzzaman (2011).

The importance of housing design is pronounced by Chowdhury I. (1985), as design of the house is one of the most difficult tasks in the field of architecture. A proper understanding of the nature of human needs is of crucial importance in the formulation of houses and space standards. Chowdhury further stressed that, a shelter provides people with functional, social and spiritual needs. The life of an individual and family unfolds in the space within shelter. Conceivably it can be declared that any attempt at formulating housing and space standards should start by recognizing the quality of space and social aspects of society or individual to avoid the design deficiency at post occupational stage.

Towards the need to improve the housing quality and its design in under developed world is highlighted by renowned architect, Correa C. (1980) that the wonderful thing about third world is that there is no shortage of housing. What is in short supply, of course is the urban context. The real task and responsibility of the third world architect is to help generate this urban context. The study of Correa reveals that urban amenities are missing in the housing sector of underdeveloped regions. These amenities should be considered and properly planned at design stage to facilitate the user and to avoid nuisance of reworks or redesign at later stage.

A. H. Chohan et al (2011) states that the lack of maintenance often results in deterioration that leads the building to the point of collapse or to it having to be demolished. The question arises as to whether there is any way to avoid this waste of the built environment in developing countries.

The answer lies in better design as the lack of it would appear to be a major cause of the problem. Hence, it could be suggested that unplanned maintenance can be avoided if building design takes account of the need for careful and methodical planning, budgeting, monitoring and execution.

STATEMENT OF PROBLEMS

Most buildings in Nigeria are in abandon conditions of structural and aesthetic disrepair and if corrective measures are not properly carried out, it could result in a total breakdown of structural components. Despite the various strategies being adopted by the government for the maintenance of those facilities, the buildings remain a home for defects that should have been avoided if proper feasibility planning on maintenance has been given cognizance right from the design and construction stage of the project. This has led to unnecessary expenditure from the various authorities in carrying out remedial work to curb the effects. Brennan (2000: cited in Okuntade T. F. 2014) that the main purpose of maintenance of property is essentially to retain it values for investment, aesthetics, safety and durability with a view to ensuring that the property is continually used for habitation and to satisfaction of the owner. It was even observed that majority of the new construction were being built up with defects which later transpire into substantial expenses on maintenance.

These problems were identified as:

1. Lack of proper planning on maintenance right from design stages.
2. Imitation of building design without considering the condition that lead to such design.
3. Designs not being finished within the required standards and thus resulted in faults.
4. Unawareness amongst Nigerians about the significance of maintenance in both private and public buildings.

AIM AND OBJECTIVES

The aim of this study is to understand and identify the causes of design tribulations and their effects on residential building at post occupational stage.

Objectives are:

1. To identify the issues and problems faced by users of private housing at post occupational stage.
2. To identify whether or not the problems are caused by design faults.
3. To identify the cause of deterioration in private buildings at post occupational stage.
4. To ascertain the level of awareness on building maintenance manual.

SCOPE OF THE STUDY

The focus is to investigate the level of dilapidation caused by design defects on residential buildings in Enugu metropolis. The scope is limited to the various housing densities within Enugu North, Enugu East and Enugu South LGAs that made up Enugu state urban.

RESEARCH QUESTION

1. Do the owners and occupiers of buildings know the benefit of building maintenance manual?
2. Do the architect and other professionals in building industry carry out their jobs properly at the early stage?
3. Are the public building owners and occupiers aware of building maintenance?

LITERATURE REVIEW

a. REPERCUSSIONS OF POOR DESIGN

Faults in building design place a heavy burden on the building for rest of its life and there is no compensation for it. In such situations, the responsibility falls on the shoulders of the designer in that they must think carefully with full concentration and consideration towards completion of their design project.

Explaining the link between maintenance and building design, Ramly (2006) suggests that four sectors of building design should be considered and regarded as important if one is to avoid the need for unplanned maintenance at the post-occupation stage. These sectors are:

- the *main fabric* which includes walls, floors, roofs, doors and windows;
- *internal finishes* which includes ceiling and wall finishes as well as floors;
- *special design features* such as decorative elements for the doors, windows, glass, air vents and special brick and stone work;
- the fourth and the last sector is *cleaning and housekeeping* of all building components.

The study identified deterioration in these sectors that resulted from design faults, which subsequently imposed a heavy financial burden on the occupier or owner.

Based on the outline of causes derived from the work of Gibson (1979), the implication of design fault on maintenance in buildings has resulted from the following:

- the consequence of *thermal movement;*

- the consequence of *inefficient detailing;*
- the consequence of *improper material selection;* and
- the consequence of poor design for *access for maintenance* measures.

The designer must understand what consequences the use of materials in combination can impose on their designs. *Thermal movement* in materials can affect a building in a number of ways. It can cause cracking in walls or plaster and fractures in structural elements if consideration has not been given to thermal expansion. Thermal movement can also result in distortion of otherwise impervious joints with the result that penetration of water takes place or there is a loss of adhesion. *Inadequate detailing* can cause deterioration of the building façade. In the absence of proper architectural detailing of rainwater discharge from the building face, water may penetrate into the building or stagnate within or on the construction. Ponding water is a potential source of disease, as it can harbour insects that transmit malaria or dengue fever, for example. Incorrect *material selection* can add to the financial burden of maintenance, as well as be the cause of thermal movement, distortion, ponding, or early failure. Whereas *poor access* for maintenance will cause delay in the repair process that escalates the cost and increases the probability of substandard remedial actions.

Nicastro (1997) reported the case of a high rise luxury condominium in Austin, Texas, USA and built in 1980 in which the fine network of the cracks hinted at widespread cladding cracks. The identified defect was described by the author as like 'skin cancer' due to the uncontrollable situation of maintenance. The solution under such condition is usually total replacement of the building's cladding. This study also shows that even in the wealthy parts of the world, poor material selection and design control can still result in expensive defects in their buildings.

b. THE FACTORS OF DEFICIENT DESIGN AND MAINTENANCE: A REVIEW OF DEVELOPING REGIONS

Study by Okpala DCI (1992) regarding housing in developing country is précised; as the larger faction of population living in third world has a little access of quality housing. In the housing sector of developing world, it is worth mentioning that unlike other parts of the world, private sector is much more efficient than public sector in providing housing to residents (Okpala, 1992).

According to report on housing conditions in Pakistan published by Human Right Commission of Pakistan (HRCP) (2005), it is mentioned that the estimation suggest that more than half a million housing units are required in Pakistan. In other words, a small city is required annually to meet the severe housing shortage in the country and the increasingly dilapidated state of existing housing presented new threats. Reviewing the history of housing and its related issues in Pakistan, Syed AM (1996) describe it as; Pakistan has faced formidable housing problems from its very birth in August 1947, as an independent nation; in the wake of the mass influx of millions who migrated to the country from India.

The situation has not changed much almost 50 years and problems, for example, issue mentioned in paragraph 3 of the report. Since every problem of housing is coupled with some degree of defects or compromising design quality, therefore there are high chances for end user to experience the end results of these issues. By developing an understanding for issues mentioned by researchers, organizations and expertise of field in above paragraphs, it is revealed that lack of housing is not only mounting pressure on available housing but ever growing housing demand in these regions have paved the track for improper and faulty design and construction. Design deficiency and its implications on the house maintenance has remained a neglected part in field of research and modern society, especially in developed and developing nations. The theme of this study can be understood in terms of Architectural Eco System. Whenever designer completes the project, the designer was not fully aware of consequences of their design. It is only through post occupational survey that designers

usually realize that mistakes or bad decision they have taken during design process. Those decisions mostly emerged in form of certain types of defects in building.

Unfortunately, such unforeseen conditions are the part of daily life for end user of residential buildings in proposed areas of research. Therefore, the main purpose of this research is to understand and investigate the causes of faulty design and their implication on residential buildings. The proportion of the maintenance is highly controlled and governed by the quality of design. In fact, these two characters of building are inversely proportional to each other, that is, the higher the quality of the design, the lower the maintenance and the lower the quality of the design, the higher the maintenance. It is well phrased by CIOB (1982) as; it is at the design stage that the maintenance burden can be positively influenced for better or for worse. Hence it could be concluded that skillful design can reduce the amount of maintenance work.

In this perspective, Seeley (1987) added that design team frequently neglects the consideration of maintenance aspects and there is great need to reduce the gap between design and maintenance. Seeley identified the problem of design and maintenance as the gap between design and maintenance. Conceivably Seeley stress that maintenance is important issue to be considered right from the design stage to prevent its unplanned reappearance at post occupational stage of building. This could be more implicating and it has effect on the building. But how this gap would be reduced, the answer may be found in developing understanding for design and maintenance in the light of definition given by RICS (2000), according to which the building design should consider a design of the auto. The auto is usually provided with schedule of planned and emergency manual, thus it could be recommended that one way to reduce the gap between the maintenance and design is to provide the residents with manual of house/building design and product used in that design.

The caption of this research has gained certain momentum and attracts good number of researchers to address the similar problem in other parts of globe and they have highlighted the vitality of topic through their publications and also developed a reliable link between the design and maintenance issues. Research by Ramly (2006) shows that, the design plays a major role in determining the condition of the building after completion, mainly in aspects of defects and maintenance.

Ramly further stresses that indirectly, design influences the performance and physical characteristic of building and its durability to withstand environmental condition, social interfaces such as graffiti and vandalism. Therefore, the link between design and maintenance should not only be

seen from the point of increasing the repair work or cost involve, but it need to consider also the impact of design on structure and material installed as well as the life cycle of each component of building.

In summary, the discussion above reveals that mostly the researchers have agreed on the importance of emerging issue of faulty design and building maintenance. Through their work they highlighted the various issues and aspects of design tribulations and their effects on building maintenance. Identification of issues and their causes had remained major task for researches.

MATERIALS AND METHODS

Study area

Enugu Urban is the most developed urban area in Enugu state. It is one of the states in south eastern Nigeria, its capital is Enugu. The state was created in 1991 from the old Anambra State. Enugu state is located within latitude 06^0 00'N and 07^0 00'N and longitude 07^0 00'E and 07^0 45'E.

The State shares borders with Abia State and Imo State to the South, Ebonyi state to the east, Benue state to the Northeast, Kogi State to the northwest and Anambra State to the west. Enugu state is made up of 17 local government areas. There are 18 prominent residential areas in the urban. These are Abakpa, TransEkulu, Nike, GRA, Ogui, Asata, New Layout, Achara Layout, Ugwuaji, Maryland, Awkanaw, Uwani, Agbani, and Caol Camp.

Methodology

Survey research method was adopted for this study. Questionnaire was used which represent the survey research method.

Research population and sampling frame

The population of the study is 722, 664 respondents which is estimated population of the study. They are made up of population from the three local government area in the Enugu urban. (Enugu East, Enugu North, and Enugu South). It comprises the occupants and architects and house owners in the study area.

Population and sample size

The Cochran sample size formula for the 722,664 population was used to determine sample size for the study.

$$N=z^2pq/d^2$$

Where:

N = the desired sample size

Z = standard normal size at 95% confidence interval (1.96)

P = proportion attributes of a population (50%)

q=1-p (50%)

d= desired precision (0.05) n= $(1.96)^2 * (0.50) * (0.50) / (0.5)^2$ n=384.16

Rounding off to the nearest hundredth, n= 400. The 400 respondents were breakdown into three groups which represent the occupants (262), architects (128) and house owners (10)

Results and findings

To estimate the nature of building defects as a result of poor design in Enugu urban area, the following observation were obtained from the respondent and analyzed as follows.

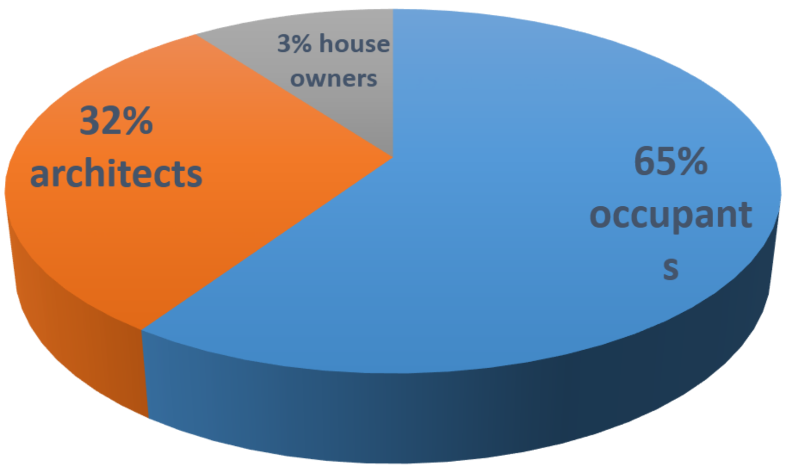


Figure 1: Population of the respondents

Source: field survey, 2021

From the above figure, it is observed that 100% of distributed questionnaires were completed and returned with 65% as occupants, 32% as architects and 3% as house owners. The level of respondents was highly satisfactory.

Table 1: Demographic characteristics of the Respondents

	Frequency	percentage

Age group		
20-29	217	53.3
30-39	124	31.0
40-49	34	8.5
50 and above	25	6.3
Total	400	100
Sex		
Male	275	68.8
Female	125	31.3
Total	400	100
Level of education		
No formal education	4	1.0
Primary	8	2.0
Secondary	102	25.5
Tertiary	286	71.5
Total	400	100
Marital status		
married	258	64.5
single	133	33.3

Separated	6	1.5
Widow/widower	3	0.8
Total	400	100
Occupation		
Civil servant	175	43.8
Farmer	14	3.5
Trader	75	18.8
Artisan	136	34.0
Total	400	100

Source: field survey, (2021)

Table 1 shows that majority of respondents are between the ages of 20-39 (85.3%), a number of male 68.8%, tertiary as the highest level of education 7.5%, single respondents 64.5%, and civil servants 43.8ft.

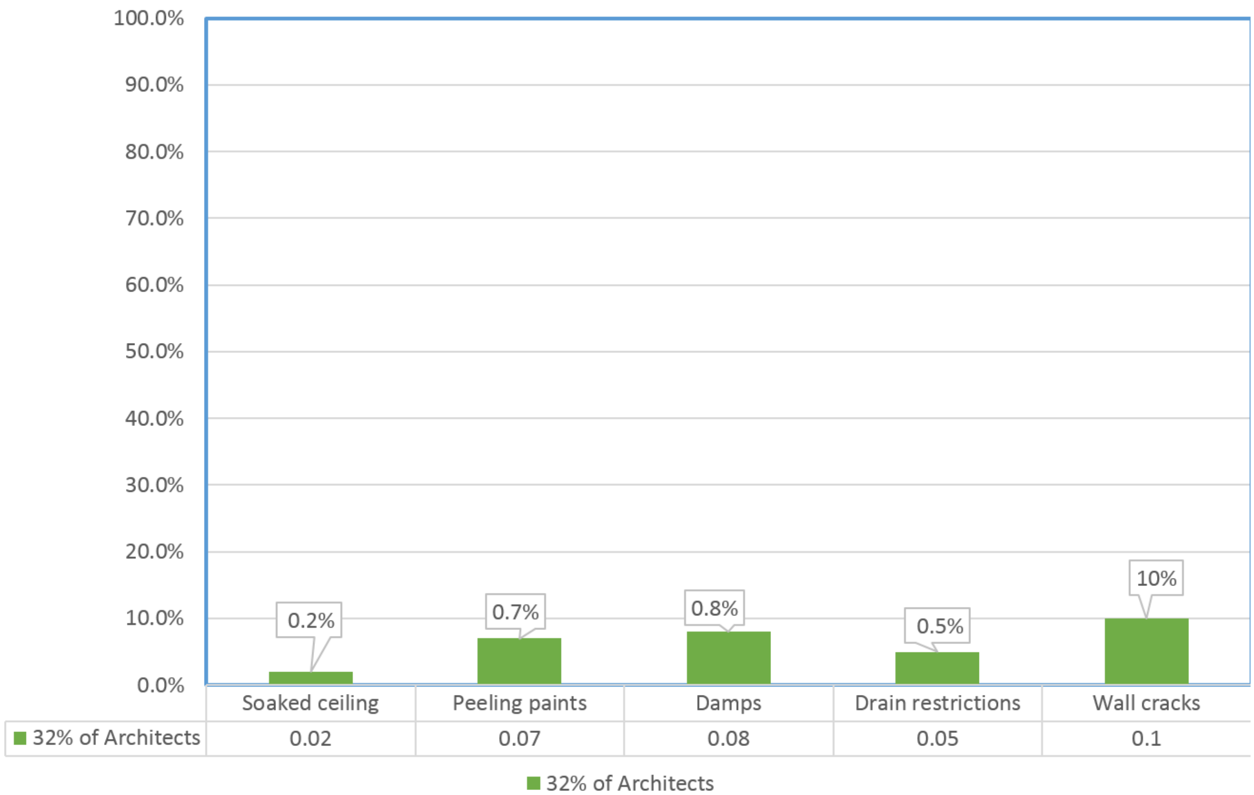
Table 2: Problems faced by users of private housing at post occupational stage.

Problems faced by users	Frequency	Percent
Soaked ceiling and roof leakage	125	31.3%
Peeling paints	77	19.3%
Soaked walls / damp	153	38.3%
Water drains restrictions	118	29.5%
Wall cracks	47	11.8%
Total	**520**	**130.2%**

Source: field survey, (2021)

From table 2 above, it can be seen that the data is above the respond's population and 100%. The reason is that the opinion gives the respondents room to answer as many opinions as possible. It shows that 31.3% of private housing are battled with soaked ceilings as a result of roof leakage, 19.3% are facing paint pelage, 38.3% have problem of soaked walls or damps usually caused by service pipe leakages, 29.5% are water drainage restrictions which does not allow the free flow of water, while 11.8% complained of sudden wall cracks.

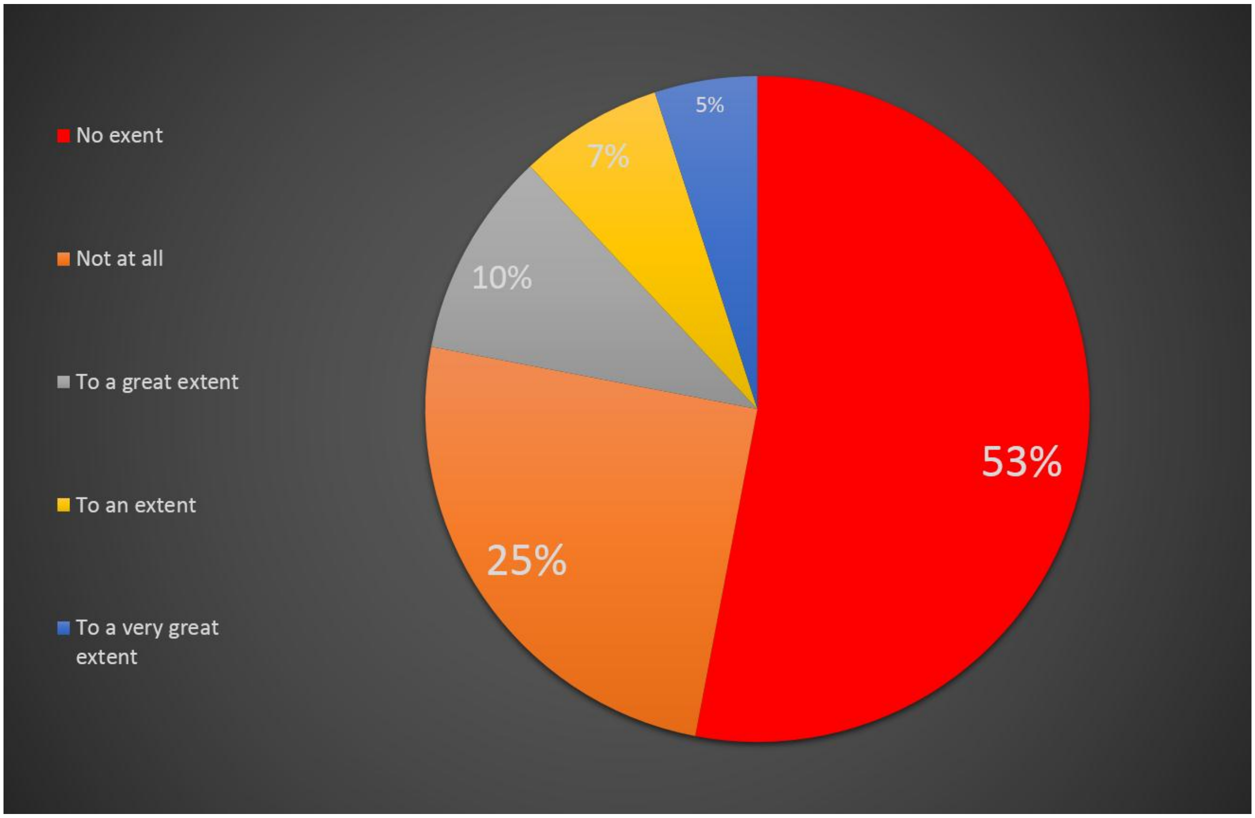
Figure 2: Building defects caused by design faults by 32% of the Architects.



Source: field survey, (2022)

From figure 2 above, 0.2% of the architects agreed that soaked ceilings are caused by design faults, 0.7% agreed with peeling paints, 0.8% agreed with soaking of walls and damps, 0.5% believes drain restrictions are as a result of design faults, while 10% agreed with wall cracks.

Figure 3: Awareness on building maintenance manual



Source: field survey, (2022)

Figure 3 above seeks to find out the extent which people are aware of building maintenance manual. 5% of the respondents responded ‘no extent’ on the awareness of building maintenance manual, 10% responded ‘to a great extent’, 7% responded ‘to an extent’, 25% responded ‘not at all’ heard of any maintenance manual, while 53% responded ‘no extent’ meaning that people are not aware of building maintenance manual.

CONCLUSION

While a journey of thousand miles begins with a single step, the most complex design of a building starts from the single stroke of designer. Errors in design can, however, result in unplanned maintenance where the designer fails to understand the buildability of that initial concept. The designer who is aware of the risk is more likely to create buildings that will require only planned maintenance. One way of evaluating the work of the designer is to go through the occupier’s experience of maintenance requirements, even if

the building may be regarded as a landmark of urban design.

Thus, it can be suggested that there must be a strong relationship between design and maintenance and only those design should be considered good which were proved as less demanding in terms of maintenance. This research has revealed several important factors at various design stages. The work has aided understanding of avoidable building / housing maintenance issues caused by design faults. The consequence of poor design has been considered from the minimum level of maintenance such as surface decay to the ultimate level of collapse. Design faults not only result in unplanned maintenance they also are expensive in terms of the lives of occupants and the cost of repairs. Faulty design and its consequences are a global problem that can be seen in both developed and underdeveloped countries. There is a need for more research to be conducted in this field to resolve the design deficiencies that result in a high maintenance and monetary burdens.

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