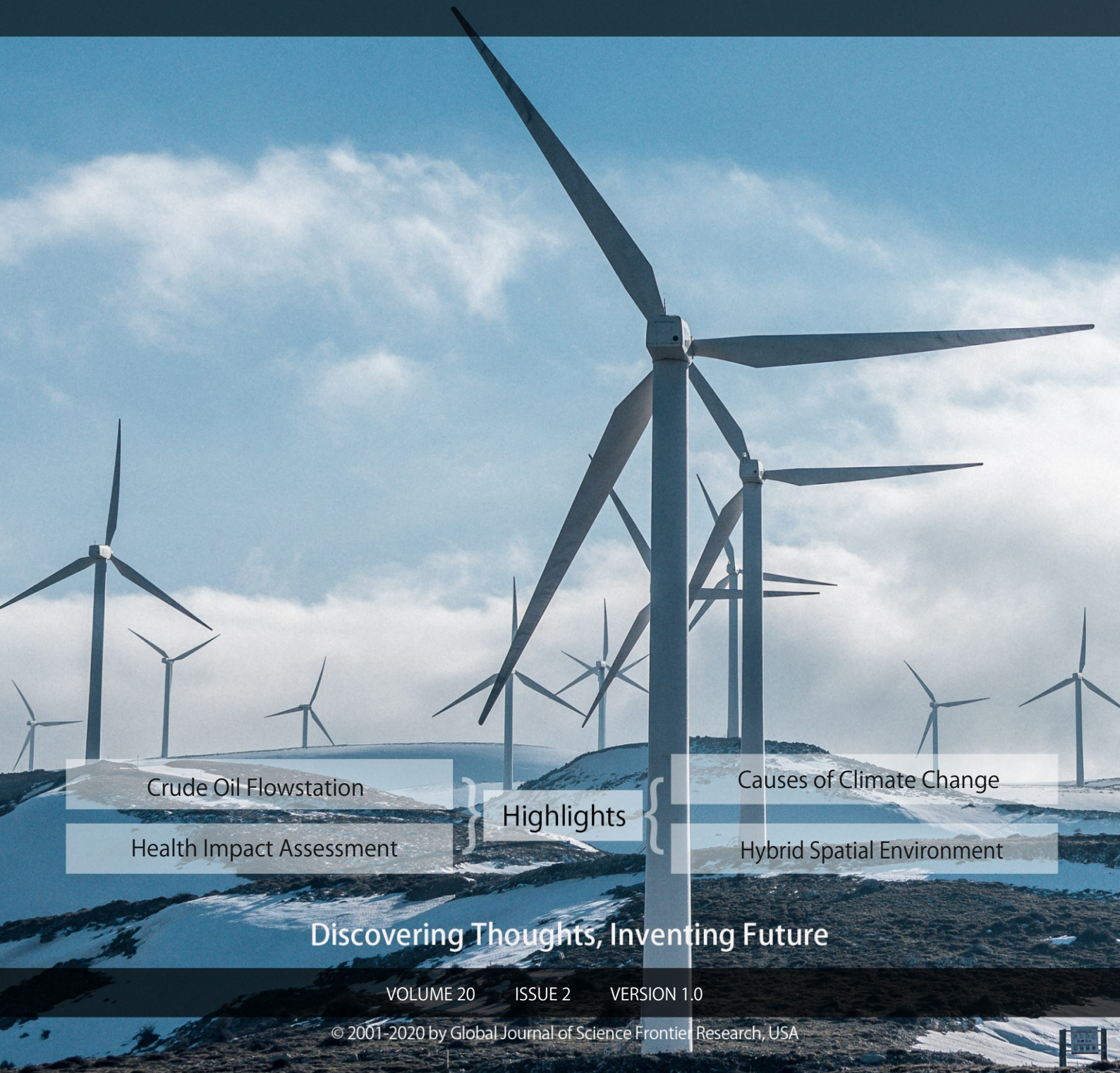


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Formation of Hybrid Spatial Environment as a Multi-Agent System: Innovative Concepts

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The Moscow Architectural Institute (State Academy)

Abstract- The article is devoted to the topical problem of forming a hybrid spatial environment as a multi-agent system. In the study have been identify the innovative concepts of the forming an architectural space as a multi-agent system that uses the technological innovations of the future. A forward-looking approach to the organization of spatial habitat as a multi-component system is propos. The leading approach to the study of this problem is based on analytical research methods: comprehensive design of the object as a system, the method of structural analysis, and the information technique. As a result, concepts of creating an artificial habitat using hybridization properties have been identify. Trends in modeling new types of spaces based on the idea of self-organization of the evolving system have been identifying.

Keywords: *hybridity; multi-agent systems, integrated hybrid space, information technology, automated control; self-government, adaptively.*

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Formation of Hybrid Spatial Environment as a Multi-Agent System: Innovative Concepts

Natalia Saprykina

Abstract- The article is devoted to the topical problem of forming a hybrid spatial environment as a multi-agent system. In the study have been identify the innovative concepts of the forming an architectural space as a multi-agent system that uses the technological innovations of the future. A forward-looking approach to the organization of spatial habitat as a multi-component system is propos. The leading approach to the study of this problem is based on analytical research methods: comprehensive design of the object as a system, the method of structural analysis, and the information technique. As a result, concepts of creating an artificial habitat using hybridization properties have been identify. Trends in modeling new types of spaces based on the idea of self-organization of the evolving system have been identifying.

Keywords: hybridity; multi-agent systems, integrated hybrid space, information technology, automated control; self-government, adaptively.

I. INTRODUCTION

Due to the complexity in the current conditions of the processes taking place in society, the concept of "hybridization" arises in various areas of activity. It's a phenomenon is especially evident in the formation of urban habitats, which are characterized by the multi-aspects problems facing. Here, hybridization goes beyond the usual multi-functionality. In predicting the existing planning structure of the city, there is uncertainty and inconsistency of parts of the spatial system. This situation does not allow prevents architects to leveling the negative impact of urbanization processes on creating a sustainable and comfortable urban environment [1].

In such cases, it is propos to use a multi-agent approach in which a hybrid spatial system is form based on routines or agents.

Moreover, they can interact with each other, using information about the state of the environment received from other agents. Extreme flexibility and adaptability to environments are the main benefits of using multi-agent systems [2].

a) The Relevance

The use of information technology in the formation of architectural objects leads to the development of new approaches to their design,

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containing related themselves elements of a multi-component system. This setting of the problem attracts many specialists involved in the formation of hybrid spatial habitat [1-3], [7-9], [12], [14-16]. Also, experts are offer specific design solutions and numerous developments implemented within the framework of this concept [4-6], [10-11], [13], [17-20].

At the same time, the issues of identifying innovative concepts of spatial environment formation as a multi-agent ecosystem remain little highlighted in scientific papers and design developments. They are developing approaches to this problem requires in-depth research because of its exceptional complexity and relevance.

b) Problem Statement

To identify innovative concepts of hybrid space formation as an adaptive system that uses the technological innovations of the future, several research challenges must be solved:

- To identify an alternative strategy for innovative techniques for mastering hybrid space.
- To reveal the properties of integral hybrid space in the context of its automated control and self-government.
- To determine the peculiarities of the formation of a hybrid architectural environment in the context of space-time pulsations of its multi-agents.
- To reveal methods of reverse migration of functional agents in the hybrid space of the city.

Solving these problems necessitates identifying ways and tricks to create an artificial habitat that are practically not used in modern architecture and construction practices.

II. HYBRID SPATIAL ENVIRONMENT AS A MULTI-AGENT SYSTEM

Considering ways and techniques to create a hybrid spatial environment as a multi-agent system that uses the technological innovations of the future is relevant. Innovative concepts are presented in the article on four directions in accordance with the manifestation of their hybrid properties.

- a) *Alternative strategies of vertical communication with using innovative techniques of mastering of hybrid space*
- i. *Mobility as a lack of containment the evolution of hybrid spatial*

The concept of concentration of vertical communication in architectural objects is known in the middle of the last century in utopian developments (I. Friedman, A. Isozaki, M. Safdie, etc.) as the most radical and original alternatives [3]. Vertical communication in the form of ladders or mechanical devices usually has a range of motion completely limited by the shell of the object. It not only retains the structure of communication but also limits the possibilities of the evolution of the function of the building. The challenge is that a mechanical device to move people inside a building can free it from the constraints imposed by vertical circulation.

The Proposal by author Eduardo McIntosh's 2007 "*Mobility as zero deterrence*" (UK) is to separate vertical circulation from the main structure of the building. To do this offers the idea of the autonomous free-moving device that can move on the outside of the building have propos. It attaches to the mechanisms on the surface of the building and transports users or objects inside their capsules. These agents can work as a system that will be controlled by a minimum route algorithm to reduce each user's travel time. The advantage of this type of movement is also to ensure the rapid evacuation of residents of any part of the building [4].

The considered example allows identifying the techniques of the innovative concept of the formation of hybrid space as a multi-agent system, where the mobility of multi-component agents allows the evolutionary development of the object.

- ii. *Multi-agent systems as a feeling of movement continuity in the hybrid space*

This trend is particularly evident in the development of space, which arises as a result of the large concentration of its inhabitants. In this sense, we can say that each vertical structure has its monumentality, given its height, multi-component functions, and achievements of technology. There are design proposals where the skyscraper denies the simple idea of vertical emptiness. It becomes an attractive feature for the hybrid space of the city as if imitating a *historical monument*.

An example is the 2008 project *Mist in the Shell* by Hajung Lee (USA). The proposal has aim at the true monumentality of the vertical object located on the river. The environment creates a mirror image of the tower on the surface of the water, forming a sense of buoyancy. Vertical circulation and elevator work like his skeleton. Here, with the maximum possible use in operation, the tower becomes a vertical connection between the

ground and the sky, creating a sense of continuity from ground level to the top of the tower [5]. The example of the formation of a hybrid urban environment demonstrates the new relationship between the structure and shape of the facility, its self-government program and the use of innovative maintenance technologies. This approach has meets the object's adaptation to the changing needs of society, and allows for the resolution of some environmental and social problems.

- iii. *The entropy trends in modern urban scenarios like utopias*

The modern urban landscape with extensive freeway systems and infrastructure you can be seen as a space of educated form and its spatial environment. Instead of "correcting" these entropy trends that occur horizontally, the authors in the design proposals seek to translate them into a vertical architectural scenario. Thus, the project "*Compressed Complexity*" by the authors Hip E., Orthacker G., Schafelner D., Przybilla E. (Austria) 2007, as an urban model of multifunctional high-altitude level, combines commercial, office and residential programs. It can dynamically participate in the spatial complexities that characterize the modern urban network, based on the concept of a stationary skyscraper as a functionally structure that divides the program into predictable discrete zones [6].

The unifying structure of the generative object consists of three tubes, each of which has a central core that runs from the ground to the top. Where circulation has distributed across several sections, the tubes connect to the respective programs. In these areas of software, there are voids with different levels of interconnection, which depends on their software, combination. In the tower, each tube connects to the other two at one or more points, supporting each other.

This study focuses on hybrid objects, which are structures that combine different types of functional spaces and enable their interaction. Here, hybridity goes beyond the usual versatility of public and private spaces. At the same time, the architectural environment has explored through a utopia about freedom and movement [7].

The development of new software typologies based on centralized or distributed access establishes a single principle that applies equally to all programs. Through its rational organization and focus on specific tasks, chart indicators of different typologies can be re-combined, allowing for the evolutionary development of vertical interconnection life [8].

- b) *Integral hybrid space with automated control and self-government*

- i. *Information processing and storage systems in a hybrid environment*

The formation of information and operational environment of interaction, in connection with the

development of global telecommunications systems, is of particular importance in the use of the communication potential of the space information system [9]. The project proposal «*Information Skyscraper*» by the author's Mercury V., Merletty M. (Italy) 2016 is an example of the implementation of this approach. The Sustainable Data Center is located in Iceland and is used to host various servers of many companies to store and process daily information. The location of the facility in cold climates gives the opportunity you to avoid overheating equipment, as well as use clean energy from renewable sources. The use of the cylindrical hollow tower allows you to attach all the hardware components on the outer facade, and inside to form the space to accommodate the equipment to maintain and update information systems, as well as the organization of the duct cooling system [10].

ii. *The system of sharing energy and information controlled by its inhabitants*

Innovative techniques for organizing controlled space with the help of information technology are used in innovative developments when the creation of architectural objects. The project of the architect Kuangi Tao «*A House of the Future, Similar to the Matrix*» 2011 (University of Texas A-M) proposes the use of an information system that allows the exchange of energy and information when it has controlled by the inhabitants of the house. The ongoing processes in the house has carried out by using the principles of living cell functioning. Also, an electro-sensitive material has offered that can respond to electrical impulses by expanding and contracting like a heart muscle [11].

Built-in enclosure seaweed allows you to respond to changes in the building's lighting program, making it transparent and translucent. Also, algae generate oxygen to clean the air and are composted when they have disposed of in biofuels, the excess of which has returned to the city. This spatial concept of a house capable of self-organization and function, depending on the changing needs of its inhabitants, is similar to a living organism. These properties of architectural objects allow have responding to problems that arise in our time, such as overpopulation, lack of resources, and energy [12].

iii. *The structure of the rehabilitation of sensory information and emotions of the inhabitants*

Living in a hybrid environment of large "modern" cities, focused only on work, is a complex process. Despite all the conveniences that modernization brings, it absorbs such important components of life as people's feelings, sensory information, and emotions.

The Touch Skyscraper project is a multifunctional laboratory for scientific research of human feelings, perception, sensory information, analysis of the effects of experience and rehabilitation of motivations and expectations, etc. This laboratory is a

cube that consists of 6 pyramids with a side length of 100 m. inside the each pyramid, there are certain functional sectors. Each sector is an open space for different types of perceptions and feelings. Five flexible magnetic pillars support cubes that are visually floating in the air. The corridor system inside the pyramid connects all the nodes vertically and horizontally. Thus, the multifunctional cube project can be fully used autonomously [13].

c) *Information technology in the context of space-time pulsations of multi-agents of the hybrid architectural environment*

Space-time pulsations, which occur under the influence of natural or human-made factors, affect functionally-targeted habitat modifications and form a mobile and dynamic spatial environment [14].

i. *Foresight different states of the time-changing multi-agent hybrid environment*

In the situation of the formation of a pulsating architectural object, the viewer, in principle, can remain at rest, as the object itself changes. The architect's task is to anticipate the various states of the time-changing object, based on alternating phases of existence and functioning of the dynamic system. Information technology and electronic communication systems are becoming a means of transforming the functions of everyday. Their use has reduces the spatial dependence between them [15].

For example, the «*Feedback space*» project, by architect Ruairi Glynn (2005), proposes to equip the living space with built-in computer sensors that respond to the processes taking place inside it. Special sensory manipulators, made of flexible and durable material, have built into the walls of the room to the space has interact with its inhabitants. These devices have allowed you to change the shape of an architectural object depending on the desire of its inhabitants [16].

The offer «*Pulsating LED Heart*» Bjarke Ingels Group's in Times Square in New York City is a 3-meter tall cube with 400 acrylic rods inside. Thanks to these rods inside the cube, there is a soaring and throbbing heart of pink color. The saturation of the heart color can has activated by the warmth of the hands of visitors. It becomes brighter the more people put their hands to a remote. In this case, architecture comes to life, turning into a dynamic sculptural object [16].

ii. *A hybrid space that responds to the presence and nature of people's movement*

In the operating field of architecture, there are a large number of precedents, where space reacts to the presence and nature of the movement of people (color-dynamic and sound pulses). The objects that transform mechanical movements into electricity are including «*Innovation Landscape*» 2013 by Fresh Kills (Barker Freeman Design Office). Wind energy, sound vibrations, and collective human movement can have

collected by using natural piezoelectric materials built into the pedestrian surface and flexible structures. Here, the combined dynamic components of the system allow the park to create a series of spaces of a wide range of uses - from the organization of social events to individual recreational activities [17].

The context in question is of interest to the installation «*Muscle Non-Standard Architecture*» by architect Casa Osterhuz and the research group Hyperbody. The experimental pavilion consists of a pneumatic membrane resting on a mesh. As a result, triangular cells - "muscles" are formed, which independently shrink and relax in real-time. Experiments with "muscle" architecture, the elements of which are controlled by a computer program, allow deforming the entire volume of the pavilion depending on the nature of the movement of visitors in the Centre Pompidou in Paris [18].

d) *Reverse migration of functional elements in the city space as a balanced interaction between natural and artificial habitat*

i. *Transforming the traditional relationship between landscape and architecture in the hybrid environment*

An example is the 2016 "New York Horizon" (USA) proposal for Manhattan, which was formed mainly by skyscrapers. Instead of building another tower, the «New York Horizon» project provides for a new concept of burying the foundations of Central Park in the ground. This allowed to open up the park's natural landscape and also creates a solid wall of skyscrapers around its periphery to accommodate residential formations with unobstructed views of the new underground park [19].

The project has designed to contrast the densely constructed buildings and tall skyscrapers of the city, as well as provide New Yorkers with a natural environment that they could enjoy and use as a way out of their vibrant city life. A new urban hybrid space will be created here, where the newly built landscape will become a cohesive part of the city. In this case, according to the authors of the concept, the dynamic landscape is surrounded by uncharacteristic architecture, which can be nothing more than a "mirror" reflecting nature. The glass facade of the skyscrapers will reflect the natural landscape of the park and create the illusion of an infinite natural world.

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glass facade of the skyscrapers will reflect the natural landscape of the park and create the illusion of an infinite natural world [19].

ii. *Conversion of a hybrid spatial environment for new functions and habitat restoration*

One of how this concept has developed is related to the return of production objects to the city space. According to its authors, in the near future, two-thirds of the world's population will live in megacities. Factories at one time moved to areas outside cities because they were noisy and polluting. However, many clean factories can now take place in urban environments. Moving them back to the city will provide a better quality of life, allowing employees to walk to work rather than drive.

The city's factories will be closer to the population and filled with skilled workers, as well as employees of technical and research centers. It will also ensure sustainable waste management and the return of nature to the city. The Vertical Factories in Megacities project proposes the vision of the authors of Titan Sun and Jianshi Wu (USA) 2017 for the cities of tomorrow, when factories in megacities will have divided into small elements, and then will be combined in high-rise vertical plants. Multi-agents of such hybrid objects combine to create a series of spaces that provide a wide range of human activities, both for public events and for individual recreation [20].

III. PRACTICAL SIGNIFICANCE

The use of the concept of a hybrid spatial environment as a multi-agent system in the architecture opens up a wide range of its capabilities for design and creation of habitable space. These are relevant areas of research, which use the properties of spatial environment hybridization as a tool available for use in research practice, offer advantages and opportunities for the formation of new types of habitats. Scientific results of the study reveal innovative approaches to research, as well as to give direction to searches for their creation and open the prospect of using new tools in the architectural formation of the new generation.

IV. CONCLUSION

The study of the hybrid spatial environment as a multi-agent system identifies the latest trends in modeling new types of spaces based on the idea of self-organizing of the evolving system in connection with the changes taking place in society outlined in the following positions:

- Alternative strategies of vertical communication with using innovative techniques of mastering of hybrid space in the article are considered in the context of the mobility as a lack of containment the evolution of hybrid spatial, of the multi-agent systems as a feeling of movement continuity in the hybrid space

and as well as of the trends of entropies in modern urban scenarios like utopias.

Integral hybrid space with automated control and self-government in the article has analyzed from the standpoint of the information processing and storage in a hybrid environment, of the system of sharing energy and information controlled by its inhabitants, of the structure of the rehabilitation of sensory reaction and emotions of the inhabitants.

- Information technology in the context of space-time pulsations of multi-agents of the hybrid architectural environment in the article is identified in of the foresight different states of the time-changing multi-agent hybrid environment and of a hybrid space that responds to the presence and nature of people's movement.
- Reverse migration of functional elements in the city space as a balanced interaction between natural and artificial habitat in the article is discovered in of the transforming of the traditional relationship between landscape and architecture in the hybrid environment and of the conversion of a hybrid spatial environment for new functions and habitat restoration.

The solution to the problem of the development of the objects of architecture and urban planning of multi-agent systems as a hybrid spatial environment in the future lies in the plane of parametric design - the direction of the architecture appeared relatively recently, but rapidly gaining momentum. In this regard, the development of hybrid space is the possibility of digital modeling and the use of virtual technologies, which in architecture expand the boundaries of the meaning of the habitat. The combination of all necessary aspects entails a resolution of the contradictions of the modern city and the improvement of its environment.

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Causes of Climate Change: Review Article

By Selemon Thomas Fakana

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Abstract- Climate change refers to a significant change in the measures of climate, such as in temperature, rainfall, snow, or wind patterns lasting for decades or longer. The Earth's climate has changed many times during the planet's history. It is a real and urgent challenge that is already affecting people and the environment worldwide. This review article focuses on identify different causes of the climate change. Understanding the causes of climate change helps to raise public awareness, theoretical studies, feedback processes and model simulations. It helps to share the information for experts and policy makers about applicable and beneficial adaptation and mitigation strategies. Hence, this article is produced through referring various secondary data sources and desktop data analysis. Accordingly, many factor both natural and anthropogenic activities are drivers of climate change. But, various studies indicated that most of the causes of climate change in the current era is the result of human activities.

Keywords: *climate change, causes, anthropogenic causes, natural causes.*

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Causes of Climate Change: Review Article

Selemon Thomas Fakana

Abstract- Climate change refers to a significant change in the measures of climate, such as in temperature, rainfall, snow, or wind patterns lasting for decades or longer. The Earth's climate has changed many times during the planet's history. It is a real and urgent challenge that is already affecting people and the environment worldwide. This review article focuses on identify different causes of the climate change. Understanding the causes of climate change helps to raise public awareness, theoretical studies, feedback processes and model simulations. It helps to share the information for experts and policy makers about applicable and beneficial adaptation and mitigation strategies. Hence, this article is produced through referring various secondary data sources and desktop data analysis. Accordingly, many factor both natural and anthropogenic activities are drivers of climate change. But, various studies indicated that most of the causes of climate change in the current era is the result of human activities.

Keywords: climate change, causes, anthropogenic causes, natural causes.

I. INTRODUCTION

Climate change is a term that refers to major changes in temperature, rainfall, snow, or wind patterns lasting for decades or longer (IPCC, 2007a). The United Nations Framework Convention on Climate Change (UNFCCC) uses the term "climate change" to refer exclusively to change brought about by human activities. In particular scientists refer to past climate change and address the complex issue of separating natural and human causes in currently observed changes (Houghton, 1990). Climate change is a real and urgent challenge that is already affecting people and the environment worldwide (Braman *et al.*, 2010). Significant changes are occurring on Earth, including increasing air and ocean temperatures, widespread melting of snow and ice, and rising sea levels (EPA, 2010; NRC, 2011). Climate change is a key concern in our time and need to be tackled. It has brought an escalating burden to already existing environmental concerns including deforestation, serious soil erosion and loss of top soil and land degradation which in turn have adversely impacted agricultural productivity (EPA, 2010; MoA, 2011).

Any factor which alters the radiation received from the Sun or lost to space, or which alters the redistribution of energy within the atmosphere, and between the atmosphere, land and ocean, can cause climate change (Houghton, 1990; EPA, 2010). To

distinguish anthropogenic climate changes from natural variations, it is necessary to identify the anthropogenic "signal" against the background "noise" of natural climate variability (Houghton, 1996). Most of the climate change in the current era is the result of anthropogenic activities. Anthropogenic greenhouse gas emissions have increased since the pre-industrial era, driven largely by economic and population growth, and are now higher than ever (IPCC, 2014). This has led to greenhouse gases (CO₂, CH₄, N₂O, etc.), concentrations that trap heat and cause the Earth to warm as well as reduce the efficiency with which the Earth cools to space (IPCC, 2020). Total anthropogenic GHG emissions have continued to increase over 1970 to 2010 with larger absolute increases between 2000 and 2010, despite a growing number of climate change mitigation policies (IPCC, 2014). On the other hand, any human-induced changes in climate will be superimposed on a background of natural climatic variations which occur on a whole range of space and time scales (IPCC, 2014a). Natural climate variability can occur as a result of changes in the forcing of the climate system, for example due to aerosol derived from volcanic eruptions. The changes in temperature, precipitation and soil moisture were not uniform over the globe (Houghton, 1990; USGCRP, 2009). However, our ability to quantify the human influence on global climate is currently limited because the expected signal is still emerging from the noise of natural variability, and because there are uncertainties in key factors (Houghton, 1996; Braman, L. *et al.*, 2010). These include the magnitude and patterns of long term natural variability and the time-evolving pattern of forcing by, and response to, changes in concentrations of greenhouse gases and aerosols, and land surface changes (Houghton, 1996; NRC, 2011).

a) Significance of the Review

Climate change is expected to exacerbate the occurrence and intensity in future which results in negative impacts on social, economic and environmental aspects. Hence, this review is focuses on identify different causes of the climate change. Understanding the causes of climate change helps to raise public awareness, theoretical studies, feedback processes and model simulations. Furthermore, it helps to share the information for experts and policy makers about applicable and beneficial adaptation and mitigation strategies.

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II. METHODOLOGY

This article is produced through referring various secondary data sources (published and unpublished articles) and observation and desktop data analysis (deep explanation and discussion).

III. RESULTS AND DISCUSSIONS

EPA (2014) states that many factors, both natural and human, can cause changes in Earth's energy balance and climate change, including: variations in the sun's energy reaching Earth; changes in the reflectivity of Earth's atmosphere and surface; changes in the greenhouse effect, which affects the amount of heat retained by Earth's atmosphere.

a) *Anthropogenic Causes*

Human activities have changed and continue to change the Earth's surface and atmospheric composition (IPCC, 2007a). Human-induced activities which cause climate change include burning fossil fuels, cutting down forests, and developing land for farms, cities, and roads. These activities all release greenhouse gases into the atmosphere (EPA, 2010).

i. *Deforestation*

Forests play a critical role in the Earth's climate system, in a number of different ways. Most importantly for global climate change, they capture carbon dioxide from the atmosphere and convert it, through photosynthesis, into living biomass (FAO, 2010). Forests act as natural filters for carbon dioxide absorption in the atmosphere. They store more carbon than they release and are termed as CO₂ sinks in their natural state (Negar and Jean 2014). Forest cover regulates the air and surface temperature by absorbing carbon dioxide, with a decrease in the forest cover there would a significant increase in the temperature (Yuksel G., 2014). Where increases in forest cover in tropical regions, cooling results from enhanced evapotranspiration. Increased evapotranspiration can result in cooler days during the growing season (high confidence) and can reduce the amplitude of heat related events (MoA, 2011; FAO, 2011a). When forests are burned or cleared for uses such as cropland, pasture, infrastructure or urbanization, the net flow of carbon from the atmosphere into the forest ends, both in the present and for the entire projected future lifetime of the trees (FAO, 2010). Deforestation also causes the release of the stock of carbon that has accumulated, both in the trees themselves and in the forest soil (David E., 2018). Deforestation at the present rate has resulted in an unprecedented increase of CO₂ in the atmosphere for the past years (Adnan et al., 2011). Changes in forest cover directly affect Earth's surface temperature through exchanges of water and energy (IPCC, 2020). Removal of forest cover alters global and regional climate patterns and results in catastrophic rainfall spells

followed by prolonged dry periods (Strasser *et al.*, 2014).

ii. *Changes in Land-Use*

Land-use change, land-use intensification and climate change have contributed to desertification and land degradation (IPCC, 2020). Changes in the way people use land-for example for forests, farms, cities, etc.-can led to both warming and cooling effects locally by changing the reflectivity of Earth's surfaces (affecting how much sunlight is sent back into space) and by changing how wet a region is(Adnan et al., 2011; David, 2018). Unsustainable land management and land use has led to negative economic impacts which are exacerbated by the Climate change (IPCC, 2020). Land-use change – converting forests and peatlands to areas of agricultural production also releases carbon stored in the biomass and soil, which contributes a further 10 to 15 percent of total emissions as CO₂ (FAO, 2011a).

iii. *Emissions of Greenhouse Gases*

Since the pre-industrial period, the land surface air temperature has raised nearly twice as much as the global average temperature due to emission of greenhouse gases (IPCC, 2007a; IPCC, 2020). Global surface temperatures have risen by about 0.6°C since 1900. It is likely that this warming is larger than for any century since 200AD, and that the 1990s were the warmest decade in the last millennium. The warming differs in different parts of the world, but over the last 25 years, almost everywhere has warmed (Yuksel, 2014; IPCC, 2018). Continuous emission of greenhouse-gases from industrialized nations is resulting in hydro-meteorological events, sea-level rise, and seasonal unpredictability (Adnan et al., 2011; Yuksel, 2014). Globally, economic and population growth continued to be most important drivers of increases in CO₂ emissions from fossil fuel combustion. Emissions of CO₂ from fossil fuel combustion and industrial processes contributed about 78% of the total Greenhouse gases emissions increase from 1970 to 2010 (EPA, 2010; IPCC, 2014).

iv. *Burning Fossil Fuels*

The global agricultural food sector uses more than 30 percent of global end-use energy demand, which is mostly met by fossil fuel sources, and emits around 22% of total anthropogenic greenhouse gases (FAO, 2011a). According to NRC (2011) the Earth is getting warmer because humans are adding heat-trapping greenhouse gases like CO₂, N₂O, CH₄, and water vapor to the atmosphere, mainly by burning fossil fuels. As fossil fuel usage increases, the amount of these gases in the atmosphere rises. Combustion of fossil fuels (burning of coal, oil and natural gas), cement production, etc., increases the level of CO₂ which reduces the CO₂ taken up by trees. Increase in CO₂ concentration is the single largest contributor to global warming (IPCC, 2018).

v. Urbanization

Urbanization is believed to be a driving force of an economy which facilitates the transfer of surplus labor from the rural agricultural sector to the urban industrial sector and contributes to economic development (Muntasir M. and Syed Y.S., 2018). However, unplanned urbanization can result in negative impacts that adversely affect the economy, deforestation, environmental degradation as well as contribute to global warming and climate change (Zhang, N, Yu, K. and Chen, Z., 2017). Urban expansion can enhance warming in cities and their surroundings (heat island effect), especially during heat related events, including heat waves. Increased urbanization can also intensify extreme rainfall events over the city or downwind of urban areas. This can result in additional risks to the flood system (IPCC, 2020).

vi. Emissions of Pollutants

Some industrial and agricultural processes emit pollutants (other than Greenhouse Gases) that produce aerosols (small droplets or particles suspended in the atmosphere) (IPCC, 2020). Some aerosols also affect the formation of clouds, which can have a warming or cooling effect depending on their type and location. Black carbon particles or soot produced when fossil fuels or vegetation are burned, generally have a warming effect because they absorb incoming solar radiation (USGCRP, 2009). Chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF₆), together called F-gases, are often used in coolants, foaming agents, fire extinguishers, solvents, pesticides, and aerosol propellants (IPCC, 2013). Unlike water vapor and ozone, these F-gases have a long atmospheric lifetime, and some of these emissions will affect the climate for many decades or centuries (USGCRP, 2014). Black Carbon is a solid particle or aerosol, not a gas, but it also contributes to warming of the atmosphere. Unlike GHGs, Black Carbon can directly absorb incoming and reflected sunlight in addition to absorbing infrared radiation (IPCC, 2013; Sims, Gorsevski and Anenberg, 2017).

vii. Agricultural Expansion

Agricultural activities such as the use of nitrogen-based fertilizers increase the concentrations of Nitrous oxide (N₂O) in the air which causes climate change (MoA, 2011). In similar way human activities such as raising livestock, growing paddy rice, filling landfills, and using natural gas, etc. rise mostly Methane CH₄ which is significant contributor to the climate change. It is released by decomposition in swamps, from ruminants, especially cows, and leakage from fossil fuel extraction (Braman et al., 2010). Due to human activities, CH₄ concentrations increased in the 20th century and are now more than twice than pre-industrial level (EPA, 2010). In addition Halocarbons, including

chlorofluorocarbons (CFCs), are chemicals used as refrigerants and fire retardants are potential contributors to climate change which can damage the ozone layer. Greater cropland expansion results in larger declines in biodiversity (MoA, 2011; IPCC, 2020).

b) Natural Causes

Although anthropogenic activities are the root drivers of the climate change, there are some of major natural factors influencing climate system (EPA, 2010; IPCC, 2013).

i. Sun's Intensity

Climate is influenced by natural changes that affect how much solar energy reaches the Earth's surface (EPA, 2010; IPCC, 2018). Changes occurring in the sun itself can affect the intensity of the sunlight that reaches Earth's surface. The amount of heat energy received at any location on the globe is a direct effect of Sun angle on climate, as the angle at which sunlight strikes the Earth varies by location, time of day, and season due to the Earth's orbit around the Sun and the Earth's rotation around its tilted axis (Khavrus, V. and Shelevytsky, I., 2010). It has been suggested that changes in solar output might affect our climate—both directly, by changing the rate of solar heating of the Earth and atmosphere, and indirectly, by changing cloud forming processes. The intensity of the sunlight can cause either warming (during periods of stronger solar intensity) or cooling (during periods of weaker solar intensity) (USGCRP, 2014; IPCC, 2018).

ii. Changes in the Earth's Orbit

According to Rutgers University (2018) Earth's climate is affected by a number of factors dealing with the Earth as a whole, in relation to its position in the space relative to the sun. These factors include the angle of Earth's axial tilt (also known as Earth's obliquity), the eccentricity of Earth's orbit (how circular/elliptical Earth's orbit is), and Earth's position in time in the precession of the solstices and equinoxes (with different Earth-Sun distances during any given season) which contributes to the climate change (William F.R., 2007).

iii. Changes in Ocean Current Circulation

Since the 1950s, geologists and oceanographers have been gathering convincing evidence that alteration in ocean current circulation is a key determinant of climate change (Cunningham, 2005; Tierney et al., 2013). An ocean current is a continuous, directed movement of sea water generated by a number of forces acting upon the water, including wind, breaking waves, and temperature and salinity differences (England et al., 2014). Ocean current circulation plays a central role in regulating global climate and maintains primary productivity and marine ecosystems (Duteil et al., 2014). Ice-core records from Greenland suggest that abrupt shifts in circulation

strength triggered dramatic temperature fluctuations during the last glacial period (Jayne, S. R. and Marotzke, J., 2001; Fischer E. M. and Knutti R, 2015). According to Bryden, H. L. and Imawaki, S. (2001) the Atlantic Meridional overturning circulation carries warm upper waters into far-northern latitudes and returns cold deep waters southward across the Equator¹. Its heat transport makes a substantial contribution to the moderate climate of maritime and continental Europe, and any slowdown in the overturning circulation would have profound implications for climate change.

iv. Volcanic Eruptions

Volcanic eruption releases molten rock, or lava, from deep within the Earth, greenhouse gases etc. which causes impact the atmosphere (Robock, 2000). The gases, ashes and dust particles thrown into the atmosphere during volcanic eruptions have influences on climate. Most of the particles spewed from volcanoes cool the planet by shading incoming solar radiation (Hyde and Crowley, 2000). Volcanoes vent huge amounts of water vapor and carbon dioxide when they erupt (IPCC, 2012). Considering how small volcanoes are compared to the size of Earth, this activity doesn't have a very large impact on the climate, though that wasn't always the case (William F. Ruddiman, 2007). According to Rutgers University (2018), if we go back four billion years, when Earth was still young, hot, and devoid of life, there was significantly more tectonic activity (the movement of Earth's plates), resulting in constant earthquakes and volcanic actions.

v. Melting of Glaciers

Anthropogenic influences have affected the global water cycle since 1960 and contributed to the retreat of glaciers since the 1960s and to the increased surface melting of the Greenland ice sheet since 1993 (Peterson *et al.*, 2013). It contributed to Arctic Sea-ice loss since 1979 and has made a substantial contribution to increases in global upper ocean heat content (0–700 m). Global mean sea level rise has observed since the 1970s (You and Ringler, 2010; IPCC, 2014). Over the period 1992 to 2011, the Greenland and Antarctic ice sheets have been losing mass. Glaciers have continued to shrink almost worldwide (You and Ringler, 2010). The atmosphere and ocean have warmed; the amounts of snow and ice have diminished (IPCC, 2012). Glaciers are expected to continue to decrease in size while the rate of melting is expected to continue to increase, which will contribute to Sea level rise (Savage *et al.*, 2015). It is retreating almost everywhere around the world including the Alps, Himalayas, Andes, Rockies, Alaska and Africa (NRC, 2011). According to Peterson *et al.*, (2013) Antarctica and Greenland has been losing about 134 and 287 Gigatonnes of ice per year since 2002 respectively.

vi. Sea-level rise

Average Sea level rise is expected to rise as a result of thermal expansion of the oceans and melting of glaciers and ice-sheets (Peterson *et al.*, 2013). The major causes of sea-level rise are: thermal expansion and the loss of land-based ice. Thermal expansion is caused by the warming of the oceans (since water expands as it warms); i.e. the warmer oceans occupy more space (You and Ringler, 2010; Hansen, 2016).

The loss of land-based ice (such as glaciers and ice sheets) due to increased melting Sea-levels have risen about 17 cm (global average) since 1900 because of thermal expansion of ocean water and melting of glacier ice (Peterson *et al.*, 2013; Hansen, 2016). Sea level rise has increased from 1mm/year 100 years ago to 3 mm/year today. The primary contributions to changes in the volume of water in the ocean are the expansion of the ocean water as it warms and the transfer to the ocean of water currently stored on land, particularly from glaciers and ice sheets (Fischer and Knutti, 2015; Savage *et al.*, 2015).

IV. CONCLUSION AND THE WAY FORWARD

Anthropogenic activities and natural processes that alter the Earth's energy budget are major drivers of climate change. Human activities have changed and continue to change the Earth's surface and atmospheric composition. Some of these changes have a direct or indirect impact on the energy balance of the Earth which causes climate change. Human activities resulted in changes in rainfall patterns across the globe with increasing floods, drought frequency and severity, heat stress, wind, sea-level rise and wave action (IPCC, 2020). Climate change creates additional stresses on land, exacerbating existing risks to livelihoods, biodiversity, human and ecosystem health, infrastructure, and food systems. Warmer temperatures will lead to a more vigorous hydrological cycle; this translates into prospects for more severe droughts and/or floods in some places.

Many factors currently limit our ability to project and detect current and future climate change. Sustainable land management, including sustainable forest management, can prevent and reduce land degradation, maintain land productivity, and sometimes reverse the adverse impacts of climate change on land degradation. Sustainable forest management can maintain or enhance forest carbon stocks, and can maintain forest carbon sinks. In particular, to reduce uncertainties of climate change further work is needed like (i) reducing anthropogenic activities those cause climate change (ii) estimation of future emissions and biogeochemical cycling (including sources and sinks) of greenhouse gases, aerosols and aerosol precursors and projections of future concentrations and radiative properties; (iii) representation of climate processes in

models, especially feedbacks associated with clouds, oceans, sea ice and vegetation, in order to improve projections of rates and regional patterns of climate change; (iv) systematic collection of long-term instrumental and proxy observations of climate system variables (e.g., solar output, atmospheric energy balance components, hydrological cycles, ocean characteristics and ecosystem changes) for the purposes of model testing, assessment of temporal and regional variability and for detection and attribution studies.

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Modeling Tree Diameter Distributions in Arboretum of Forestry and Wildlife University of Uyo: An Evaluation of 8 Statistical Models

By Ekpa, N. E., Daniel, K. S., Ukpong, E. E., Etigale, E. B. & Asuquo. O. E.

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I. INTRODUCTION

The diameter of a tree provides a measure of tree performance and is a useful starting point for estimating tree height and volume. Diameter distribution is an efficient indicator of forest growth and most powerful way to describe the properties of a stand. They have direct effect on the choices concerning silvicultural and harvesting stages activities.(Robson *et al.*, 2016, Ekpa *et al.*, 2014, Zira and Ghide, 2013, Robson and Hamann, 2011. There are different fitting methodologies that have been used to model diameter distributions. These include Lognormal, Weibull and Johnson SB, Generalized pareto, Weibull, Log-logistic, Generalized gamma, Johnson SB, Dagum, Frechet and Erlang distribution functions. Very few of these models are classic models frequently applied for diameter distribution analysis in tropical forest (Bailey and Dell 1973, Rennolls *et al.*, 2007, Burkhart and Tome 2012).

Arboretum of the Department of Forestry and Wildlife, University of Uyo was established purely for research purpose. Lots of researches have been carried out in the arboretum(Etigale *et al.*, 2014, Ijeomah *et al.*, 2014) but unfortunately, no research were carried out to establish a model for diameter of teak trees .

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Teak (*Tectona grandis*) is a high value furniture wood being grown in plantations around the world. Teak is relatively easy to establish in plantations and, because of the demand for teak wood products, it has good economic prospects as a plantation species for fine woods. Teak is indigenous to India, Myanmar, Thailand and Laos. Its range is tropical, occurring between latitudes 25°N and 9°N (White, 1991). *Tectona grandis* L.F belongs to the family of *verbenaceae*. It is one of the most important and celebrated timber species of the Tropics (Katwal *et al.*, 2001). Its utilization benefits of workability, durability, attractiveness and strength has qualified it as one of the world best grade timber (Jackson 1994). Thus, there is the need to manage it.

This work therefore aims to model the diameter structure of teak in the arboretum and to select suitable distributions by means of fitting of probability density function. It is hoped that the results will serve as a useful input in management of the arboretum.

II. MATERIALS AND METHODS

a) Study area

The study was carried out in the arboretum of the Department of Forestry and Wildlife, University of Uyo. Uyo lies between latitudes 4°58' and 5°05' and longitude 7°54' and 8°00'E. The area is within the tropical rainforest zone of Nigeria. It has a mean annual rainfall of about 2, 581mm and an average of 165 rain days per annum. Mean annual temperature varies between 27 and 28°C, while the humidity in the area varies between 60% and 83%, with the lowest and highest value recorded in January and August, respectively (Ekanem, 2010)

The natural vegetation of the area is tropical rainforest characterized by emergent with multiple canopies. Some of the most commonly found trees in the area include *Gmelina arborea* *Cassia* species, *Lovoa weineana*, *Mammea Africana*, *Pterocarpus* species, *Mimusops djave*, and *Nauclea diderrichii*.

b) The data

Data were collected through direct enumeration and mensurement of individual trees (over bark) at breast height(1.3m above ground, dbh) of *tectona grandis* in its compartment. The measurements were

done by winding the diameter tape round each tree. Eight distribution functions were fitted to the diameter data obtained. The probability density functions (pdf) for the distribution are:

Generalized Pareto distribution

$$f(x) = \frac{1}{\sigma} \left(1 + k \left(\frac{x-\mu}{\sigma} \right) \right)^{-1-\frac{1}{k}} ; k \neq 0 \quad \text{Equation 1}$$

Weibull (3P) distribution

$$f(x) = \frac{\alpha}{\beta} \left(\frac{x-\gamma}{\beta} \right)^{\alpha-1} \exp \left[- \left(\frac{x-\gamma}{\beta} \right)^\alpha \right] \quad \text{Equation 2}$$

Log-Logistic (2P) distribution

$$f(x) = \frac{\alpha}{\beta} \left(\frac{x}{\beta} \right)^{\alpha-1} \left(1 + \left(\frac{x}{\beta} \right)^\alpha \right)^{-2} \quad \text{Equation 3}$$

Generalized Gamma (4P) distribution

$$f(x) = \frac{k(x-\gamma)^{k\alpha-1}}{\beta^{k\alpha} \Gamma(\alpha)} \exp \left[- \left(\frac{x-\gamma}{\beta} \right)^k \right] \quad \text{Equation 4}$$

Johnson SB distribution

$$f(x) = \frac{\delta}{\lambda \sqrt{2\pi} z(1-z)} \exp \left\{ - \frac{1}{2} \left(\gamma + \delta \ln \left(\frac{z}{1-z} \right) \right)^2 \right\}$$

where $z = \frac{x-\xi}{\lambda}$ Equation 5

Dagum (4P)

$$f(x) = \frac{\alpha k \left(\frac{x-\gamma}{\beta} \right)^{\alpha k - 1}}{\beta \left(1 + \left(\frac{x-\gamma}{\beta} \right)^\alpha \right)^{k+1}} \dots \dots \dots \text{Equation 6}$$

Frechet (3P)

$$f(x) = \frac{\alpha}{\beta} \left(\frac{\beta}{x-\gamma} \right)^{\alpha+1} \exp \left[- \left(\frac{\beta}{x-\gamma} \right)^\alpha \right] \dots \dots \dots \text{Equation 7}$$

Erlang (3P)

$$f(x) = f(x) = \frac{(x-\gamma)^{m-1}}{\beta^m \Gamma(m)} \exp \left[- \left(\frac{x-\gamma}{\beta} \right) \right] \dots \dots \dots \text{Equation 8}$$

where x = variable (diameter at breast height), α = shape parameter, β = scale parameter, γ = location parameter.

To fit the distribution to the diameter data, EasyFit 5.5 software was used. Easy Fit is probability distribution fitting software for Windows. It provides a complete set of features which allows the user to fit probability distributions to data, analyze the results and select the model which best describes the data.

III. RESULTS AND DISCUSSION

The summary of the descriptive statistics and goodness of fit of diameter distribution for University of Uyo forest arboretum are presented on Table 1 and 2. The results shows the diameter at breast height data

with mean 16.83, standard error 1.08, skewness 1.96 while that of excess kurtosis is 4.84 (Table 1). High positive skewness and peakedness means that considerable numbers of trees are concentrated in the lower diameter classes (Gadow, 1983). In addition, it indicates the presence of suppressed trees. Function fit assessment was based on Kolmogorov-Smirnov test value, the function providing the lowest values (0.0969) being considered the best function. Results of the Kolmogorov-Smirnov test for function fitting are provided in Table 2. Eight distribution functions were selected for ranking. The Kolmogorov-Smirnov tests indicate that these distributions can provide good fits for the diameter data.

Table 3 shows the parameter values of the eight functions of Teak trees in the arboretum while Figure 1 shows the graphs of observed and estimated probability function of dbh class for the arboretum. Greater percentage of the trees were in their lower dbh class (10-20cm) that is sufficient enough to replace trees in the upper dbh class in the future. Boubli *et al.*, 2004; Bobo *et al.*, 2006 also reported positive skewness distribution pattern in their studies. This implies that forest are still undergoing regeneration and recruitment, which are vital indicators of forest health and vigor (Jimoh *et al.*, 2011).

In addition to ranking, fitting quality may be attested by the frequency histograms (Figure 1). If the diameter distribution depicts a single peak with distortion of the density concentration to the left, this pattern must be kept despite silvicultural interventions (Rubin *et al.*, 2006, Podlaski and Zasada 2008, Zheng and Zhou 2010). Some species stood out by the higher number of individuals within the initial classes, which defines the distribution as 'inverted-J' type. This may be attributed to high density of the specie; also it could be as a result of the stand not had been thinned.

Generalized Pareto and Weibull function provided more satisfactory values for the Kolmogorov-Smirnov test. Weibull distribution have been analyzed and affirmed to be flexible by Bailey and Dell, 1973, Quang, 2004, Ekpa, 2014, Eder, 2010, and Shamaki *et al* (2019). This study shows that other than the Weibull function, other functions can be used to describe the diameter structure of stands.

Nevertheless, all functions being analyzed in this study provided satisfactory results for use in growth and yield modeling of Teak stands in the arboretum thus, they can be used as a pattern in order to planning and scheduling for stands to establish stable and resistant forests with maximum biological production.

IV. CONCLUSION

Effective forest management planning requires timely and reliable information on forest development. Reliable information is very crucial and fundamental to

sustainable management. Diameter distributions are important decision marking tools for stand management. In this study, different distribution models were used to characterize diameter of *tectona grandis* in university of Uyo arboretum, the stands showed diameter distribution with decreasing exponential curves. Greater percentage of the trees were in their lower diameter class, this may be attributed to high density of the species also as a result of the stand not had been thinned. Generalized pareto and Weibull function provided more satisfactory values for Kolmogorov-Smirnov test. The models can be used as a preliminary tool in scheduling silvicultural treatment in the arboretum. It will be ecologically and economically favorable to carry out selective thinning on large trees so that the undergrowth can develop to encourage stem diameter increment and so reach a useable size sooner.

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Table 1: dbh class for University of Uyo forest arboretum

Statistic	value
Minimum value	9.55
Maximum value	43.60
Range	34.05
Mean	16.83
Variance	56.41
Coefficient of Variation	0.45
Standard Error	1.08
Skewness	1.96
Kurtosis	4.84

Table 2: Kolmogorov-Smirnov test for the tested functions

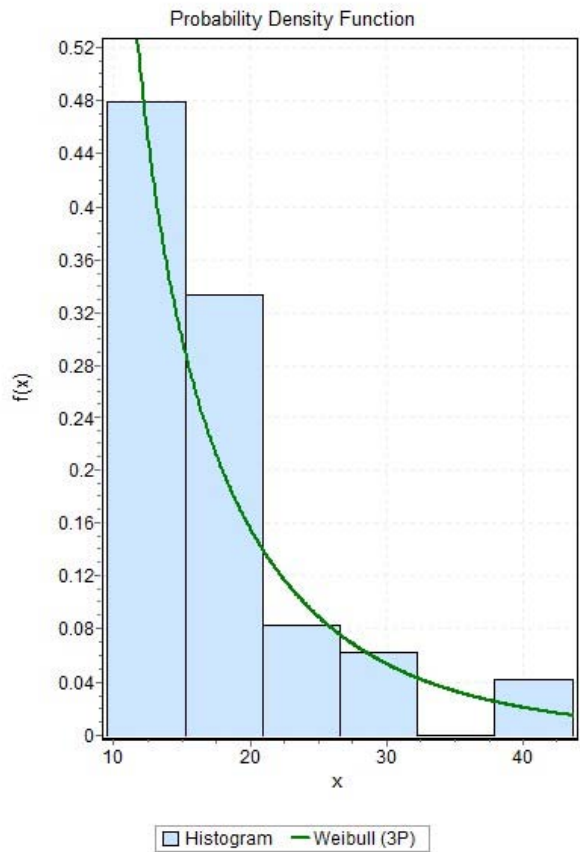
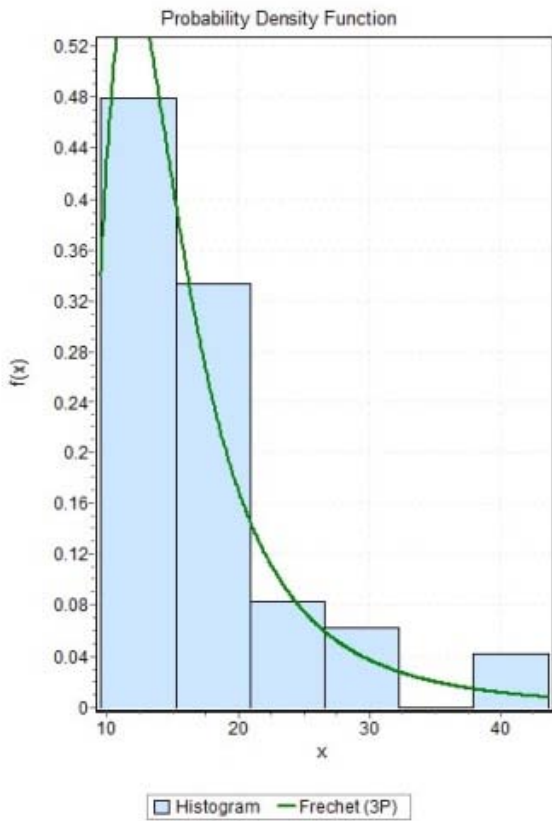
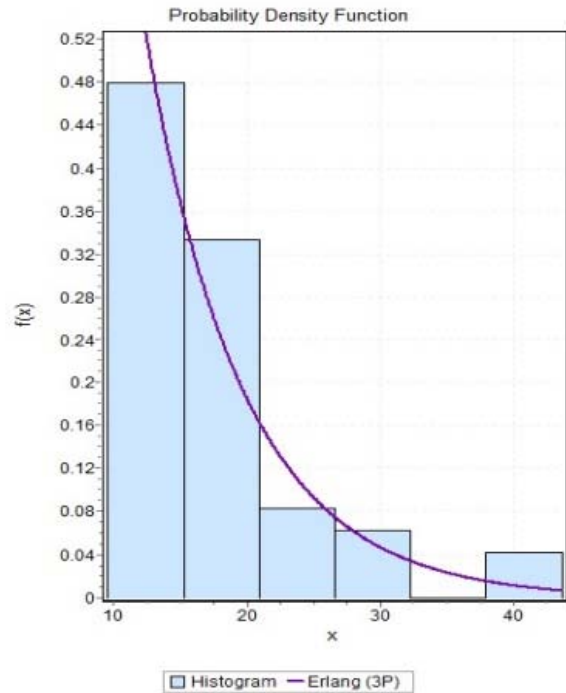
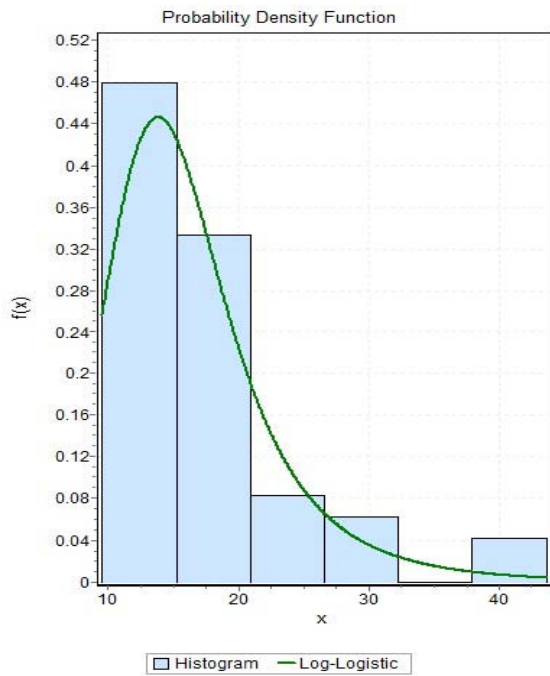
S/N	P.d.f	Kolmogorov - Smirnov	
		Statistic	Rank
1	Dagum (4P)	0.1207	6
2	Erlang (3P)	0.1237	8
3	Frechet (3P)	0.1215	7
4	Generalized Gamma (4P)	0.1185	4
5	Generalized Pareto	0.0969	1
6	Johnson SB	0.1185	5
7	Log-logistic (2P)	0.1053	3
8	Weibull (3P)	0.0988	2

Numbers in parentheses refer to the amount of parameters being used

Table 3: Distribution Parameter Estimate for Teak in the Arboretum

S/N	p.d.f	Parameter value
1	Dagum (4P)	$k=77.671, \alpha=2.6355, \beta=1.9456, \delta=2.8377$
2	Erlang (3P)	$m=1, \beta=7.2777, \delta=9.55$
3	Frechet (3P)	$\alpha=2.8123, \beta=10.83, \delta=2.1477$
4	Generalized Gamma (4P)	$k=0.77137, \alpha=0.93819, \beta=7.9583, \delta=9.55$
5	Generalized Pareto	$k=-0.0483, \sigma=8.1046, \mu=9.0974$
6	Johnson SB	$\delta=2.2316, \alpha=0.91737, \lambda=68.093, \xi=8.8876$
7	Log-logistic (2P)	$\alpha=4.5726, \beta=15.25$
8	Weibull (3P)	$\alpha=0.81387, \beta=7.6266, \delta=9.55$

Numbers in parentheses refer to the amount of parameters being used, α = shape parameter, β = scale parameter and γ = location parameter.



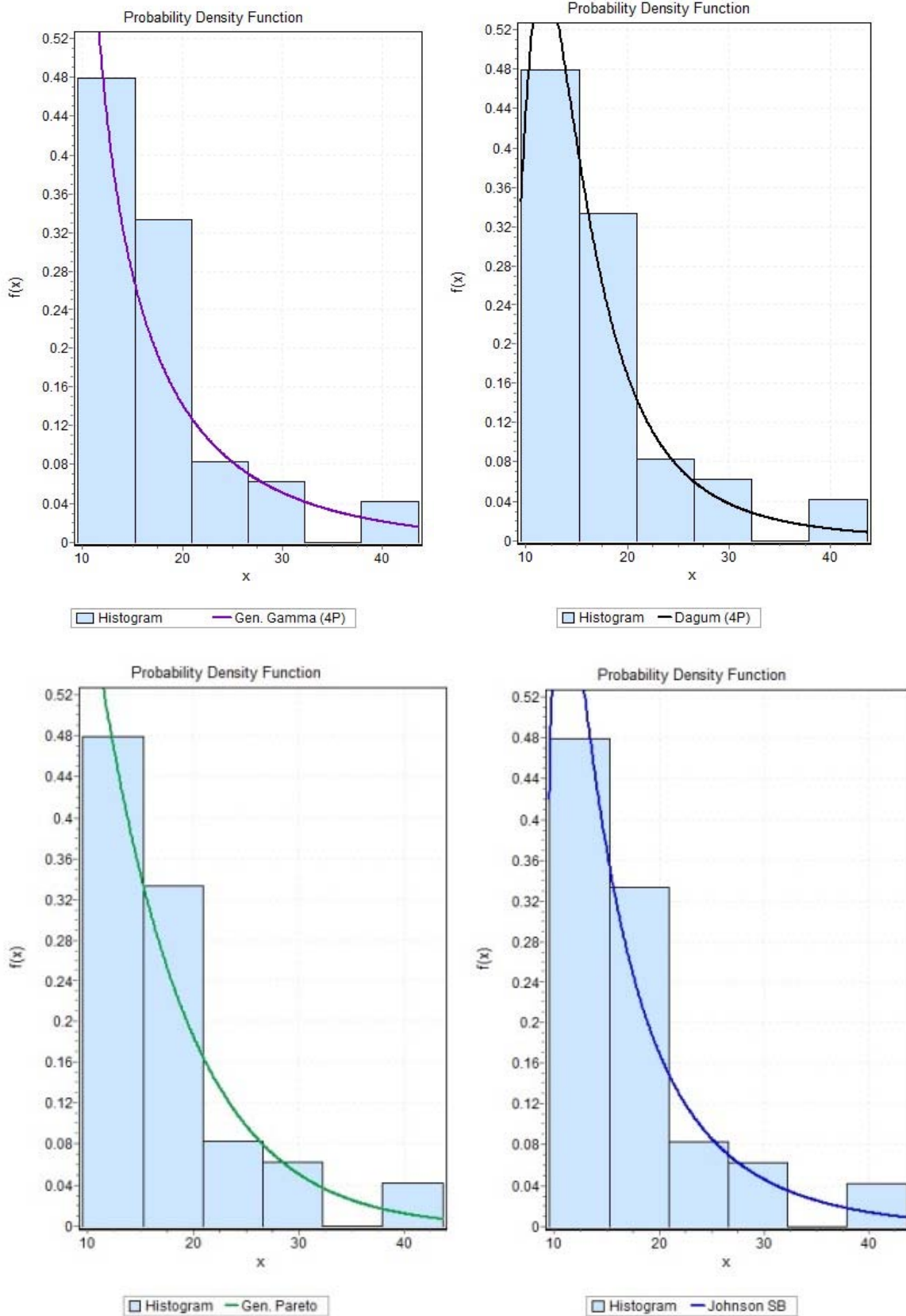


Figure 1: Graphs of observed and estimated probability function of dbh class for the arboretum



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Health Impact of Occupational Exposure to Noise – A Mixed Method Assessment

By Kennedy A. Osakwe

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Abstract- Introduction: Globally, activities in the oil and gas industry are accomplished with the aid of machinery with the potentials to generate high noise levels above 85 dB(A). A visit to a typical crude oil production facility in Sub-Saharan Africa(SSA) revealed noise-producing machinery such as generators, compressors, pumps, fluid, and gas flow, to mention but a few. This study assessed the health risks of exposure to noise in an offshore crude oil installation in Nigeria.

Keywords: noise, exposure, crude oil, machines, health impact.

GJSFR-H Classification: FOR Code: 040699



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Methods: A mixed-method approach was adopted to determine the associated health impacts. While the qualitative approach entailed the administration of questionnaires to exposed workers, the quantitative method involved the audiometric assessment of personnel exposed to noise sources at work the flow station and the statistical analysis of questionnaire administered using the Statistical Programme for Social Science (SPSS) version 18.0 SPSS.

Results: Although risk control measures were in place, health surveillance revealed a threshold shift but there was no exceedance of 30 dB (A). Relatedly, there are subjective evidence of Temporary Threshold Shifts (TSS) with symptoms.

Conclusion: Exposure to excessive noise levels remains a potential risk in the oil industry despite the robust risk control measures. Though there might not be presentation of hearing loss, there could be health complaints suggestive of Temporary Threshold Shift (TTS). This exposure could be a precursor to Occupational Noise-Induced Hearing Loss (ONIH), if exposure to excessive noise levels continues without mitigation.

Keywords: noise, exposure, crude oil, machines, health impact.

1. BACKGROUND

Exposure to occupational noise is the commonest causation of hearing loss in the United States of America [1]. The majority of industrial machines are operated by personnel and are usually exposed to associated noise for long periods[2]. Prolonged exposure to noise levels higher than 85dB (A), carries the potential risk of causing several health effects such as Noise-Induced Hearing Loss (NIHL). All over the world, exposures of more than 30 million workers to dangerous occupational noise levels at worksites prevails[2]. Noise is one of the most prevalent hazards in most settings with about nine million workers being

exposed to time-weighted average (TWA) sound levels of 85 dB (A) and above [3]. In the United States, about 30 million workers are exposed to harmful levels of occupational noise [4]. Globally, occupational noise is accountable for 16% of hearing loss in adults [5] which makes noise-induced hearing loss, potentially one of the occupational illnesses in the world. Noise-induced hearing loss (NIHL) is a sensorineural impairment that affects higher hearing frequencies (3,000 to 6,000 Hz) with an insidious onset after prolonged exposure to noise sources [6]. There are about 4 to 5 million (12-15%) employees in Germany that are exposed to noise levels of 85 dB or above [7]. Noise-induced hearing loss results from overstimulation and damage of the hair cells and their base structures in the inner ear by high noise levels [8]. About 9 million American workers experience exposures to a time-weighted average (TWA) sound level above 85 dBA[8]. Besides age-related hearing loss, noise-induced hearing loss is the second most common sensorineural hearing loss [9].

25% of the oil and gas industry workforce also experience exposures to noise levels above 90 dB on an 8-hour time-weighted average [10]. A routine audiometry test survey on 200 employees working in gas compression stations in India revealed a 6% prevalence rate of noise-induced hearing loss [11]. Prolonged exposure to high-level noise increases hearing threshold shift for higher frequencies and results in hearing loss related symptoms [12]. NIHL is an overlooked illness capable of affecting work safety and performance as well as cause economic losses[13]. In Nigeria, cases of workers' exposures to noise levels above 115 dBA have resulted in a significant increase in hearing threshold levels [14]. The implications of hearing loss are grave in the developing world, where treatment and rehabilitation services, personnel, and awareness are absent or limited [15]. Engineering upgrades in the capacity of the study facility were likely to increase noise levels with obvious concern to the workers. Hence, the need to objectively assess the health risks posed by the noise level in the flow station. [16].

The oil industry is a global market with highly sought-after energy products. The world is not ready to have this industry economically liquidated by financial compensations and under-productivity from occupational illnesses, including noise. Considering that noise is a compensable industrial illness, it is imperative that measures be put in place to prevent a negative

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financial impact on the industry [17,18]. The estimated cost of noise to developed countries ranges from 0.2 to 2% of the gross domestic product which may be higher in developing countries [19]. Anecdotal evidence reveals that NIHL will lead to losing highly trained and scarce skilled work force in developing countries to debility. Findings of the present study will contribute to the body of knowledge in managing workers' exposures and formulation of mitigating measures in developing countries. This study thus aimed at exploring noise frequency profile of a typical crude oil flow station, identifying the degree of health effects and present control and remedial measures.

II. METHODS

This was a descriptive, cross-sectional study conducted in a crude oil flow station: a water borne production platform anchored to the shore of the Atlantic Ocean in Nigeria. This facility consists of four decks of steel floating in shallow water with the topmost deck used as a Helideck. It houses several units containing several pieces of equipment including three crude-oil separators, generators, a compressor (that provides the pressure to propel crude oil in the pipeline), a metering skid (several meters that measure the volume of crude oil flowing through the facility), sets of valves, an export pipeline, flare stacks (gas flaring unit), an emergency shutdown unit, a surge vessel, a cathodic protector (that protects pipelines from corrosion), a chemical shed, risers (pipelines arising from the sea into the installation), a manifold unit (a network of pipelines), and pump & saver pit (a dumping pit for crude oil spills in the facility). This is anchored to an accommodation barge with 30-bed facility for the crew. The barge facility receives raw crude oil from the surrounding network of subsea well-heads through numerous flow lines and risers to the separators, which separates the crude into crude, gas, and water before pumping out products through an export pipeline to a distant gathering facility.

This facility lies between latitude 4° and 6° north of the equator and longitudes 5° and 9° east [20]. The region where the facility is located consists of 70,000 km² of mangrove swamp forest, marshy areas and several pockets of swamps [20]. It further consists of several hydrocarbon reservoirs, several oil and gas facilities belonging to several oil multinationals. The study population comprised workers for a single oil firm on the flow station. They included technical staff (electrical, mechanical, operation, instrument, station attendants, reservoir and drilling personnel) and support staff who worked a cycle of two weeks on and two weeks off. The inclusion criterion was personnel working in the noisy areas (pump house, generator building, compressor unit, separator area) of a crude oil flow station for a minimum of 4 hours daily fortnightly.

The sample size of the selected questionnaire respondents in this study consisted of 150 workers of the study population. Collection of both quantitative and qualitative data was done in this study. While the qualitative approach entailed the administration of questionnaires to workers in the oil industry, the quantitative method involved the audiometric assessment of personnel exposed to noise sources in this flow station with statistical analysis of questionnaires using the Statistical Programme for Social Science (SPSS) version 18.0 SPSS. Further qualitative data was collected during a walk-through survey in the facility, which entailed non-participant observation of activities, interaction with medics, operators, etc.

The noise survey was conducted throughout the flow station to identify noisy areas, noise sources and mean values were established. Noise measurements were taken for 30 seconds at each of 30 selected locations, approximately 5 meters apart on a grid, with the facility running at 95% of its capacity on the day of the noise survey. Purposive sampling technique was the adopted sampling technique. Frequency band analysis was undertaken at the location with the highest noise level (a Caterpillar generator). The area noise measurements and frequency band analysis were performed using a CEL-485 (serial number 109776), which was calibrated using a CEL-282 calibrator (serial number 3/10921327). CEL is the manufacturer of both the sound level meter and the calibrator based in California, United States of America.

The sound level meter consists of a readout display screen, microphone with wind-shield, electronic circuits and touch-screen keyboard. Secondary pre-calibration of the sound level meter was carried out using a calibrator. Primary calibration was carried out in the manufacturer's laboratory, while the secondary calibration was carried out on-site before measurement. The microphone in the meter detected the air pressure variations associated with sound and converted them into electrical signals. These signals were processed by the electronic circuitry of the instrument. The readout displayed the sound level in decibels on the readout screen before the data was stored. During noise measurements, the sound level meter was held at arm's length at the ear height of those exposed. Frequency band analysis was carried out to analyse the average noise level in the relevant frequency ranges. This allows selection of the appropriate hearing protection methods for the workers.

Interviewer administered questionnaires were designed and pre-tested using close-ended questions. The final questionnaire version was then designed to capture the nature of respondent tasks, health and safety, noise profile of workstation, health status, hobby activities, and noise levels at the workstation. The questionnaires were administered to 150 respondents with an accompanying participant information sheet.

A walk-through survey was also conducted in several units to observe activities carried out by personnel that could generate noise as well as other noise sources. The workers were observed for a period of 8 hours in each unit of the installation for noise-generating activities, sources of noise and other significant noise-generating activities in each workstation. Each group and task was identified with their observed job processes. Occasional questions were asked to gain an understanding of processes and explanations. This objective assessment was performed to corroborate the subjective evidence offered by the questionnaire. By normal company policy, a standard written consent form was attached to each of the questionnaires, which were signed by respondents after a detailed explanation of the purpose of the study by the interviewer. Respondents were informed of the voluntary nature of participation. No token or inducement was given to respondents who agreed to take part in the study. Permission for the conduct of the study within the

oil installation was sought and obtained from the superintendent of the oil installation.

III. RESULTS

The mean noise level in the core zone of the facility was established to be 86.8 dB (A). The core zone consists of the pump house, generator building, compressor unit and separator area.

a) Background Characteristics of Respondents

Age bracket 51-60 years had the highest frequency of 60(40.0%), and the majority of subjects (39.5%) were middle age ranging from 51 – 60 years. Participants with more than eight years of exposure had the highest percentage of 114(76.0%) while for occupation, operations personnel were most frequent with 60(40.0%). About 75% of the subjects had worked in the upstream oil industry for more than eight years. (Table 1).

Table 1: Baseline characteristics of study participants

Age (years)	n(%)
20-30	12(8.0)
31-40	48(32.0)
41-50	30(20.0)
51-60	60(40.0)
Total	150(100.0)
Duration of Exposure (years)	
2-4years	6(4.0)
5-8 years	30(20.0)
More than 8 years	114(76.0)
Total	150(100.0)
Occupation	
Support Personnel	18(12.0)
Electrical Personnel	18(12.0)
Instrumentation Personnel	18(12.0)
Operations Personnel	60(40.0)
Mechanical Personnel	36(24.0)
Total	150(100.0)

b) Degree of Noise Hazard (Mean of Threshold Frequency Shift)

The threshold shifts in all the frequencies (0.5 kHz, 1 kHz and 2kHz (Low-Frequency Sum); 1 kHz, 2 kHz& 3 kHz (Speech Sum); 3 kHz, 4 kHz& 6 kHz (High-Frequency Sum)) on both ears were less than 30dB (A) (Table 2).

c) Noise Threshold range for right and left ear among study participants

The mean of the threshold shift on both ears ranges from 12.67 dB (A) to 25.67 dB (A). Most subjects in operations and mechanical discipline reported difficulty in hearing (Table 3).

d) Frequency of Reported Health Effects of Exposure to Noise

All the subjects reported varying percentages of health effects except hearing loss. None of the subjects reported hearing loss. Annoyance and Headache both had the highest percentage occurrence 84(56.0%) while the least was sleep disturbance(4.0%) and irritability (4.0%)(Table 4).

Table 2: Degree of Noise Hazard (Mean of Threshold Frequency Shift)

Frequencies	Mean Ranges dB (A)	Remarks
Right Ear Frequencies: 0.5kHz, 1kHz & 2kHz (Low-Frequency Sum)	12.67 - 23.67	No mean exceedance above 30 dB (A)
Left Ear Frequencies: 0.5kHz, 1kHz & 2kHz (Low-Frequency Sum)	13.67 - 23.00	No mean exceedance above 30 dB (A)
Right Ear Frequencies: 1 kHz, 2 kHz & 3 kHz (Speech Sum)	16.00 - 25.00	No mean exceedance above 30 dB (A)
Left Ear Frequencies: 1 kHz, 2 kHz & 3 kHz (Speech Sum)	15.00 - 23.67	No mean exceedance above 30 dB (A)
Right Ear Frequencies: 3 kHz, 4 kHz & 6 kHz (High-Frequency Sum)	18.00 - 25.67	No mean exceedance above 30 dB (A)
Left Ear Frequencies: 3 kHz, 4 kHz & 6 kHz (High-Frequency Sum)	18.00 - 24.33	No mean exceedance above 30 dB (A)

Table 3: Noise Threshold range for right and left ear among study participants

Frequencies	Ranges dB (A)
Right Ear	
Right ear 0.5kHz	10.00 - 22.00
Right ear 1 kHz	10.00 - 24.00
Right ear 2 kHz	16.00 - 25.00
Right ear 3 kHz	16.00 - 26.00
Right ear 4 kHz	18.00 - 25.00
Right ear 6 kHz	18.00 - 26.00
Left Ear	
Left ear 0.5kHz	14.00 - 26.00
Left ear 1kHz	10.00 - 25.00
Left ear 2kHz	15.00 - 25.00
Left ear 3 kHz	15.00 - 25.00
Left ear 4 kHz	15.00 - 25.00
Left ear 6kHz	16.00 - 28.00

Table 4: Frequency of Reported Health Effects of Exposure to Noise

Variables (Symptoms)	Frequency			Percentage (%)	
	Yes	No	Total	Yes	No
Tinnitus	66	84	150	44.0	56.0
Annoyance	84	66	150	56.0	44.0
Headache	84	66	150	56.0	44.0
Hearing Loss	0	150	150	0	100.0
Difficulty in Hearing	48	102	150	32.0	68.0
Sleep Disturbance	6	144	150	4.0	96.0
Irritability	6	144	150	4.0	96.0
Tense Feeling	42	108	150	28.0	72.0

IV. DISCUSSION

Exposure to occupational noise sources potentially causes transient physiological outcomes which include increased heart rate, blood pressure, peripheral vasoconstriction and thus increased peripheral vascular resistance [17]. Several occupational studies have suggested that workers exposed to continuous noise for a prolonged period at

85 dB have a higher blood pressure compared to those not exposed to noise; however, this is a transient physiological occurrence [17]. All the subjects confirmed the existence of risk control programs [21] as evidenced by their training and information on the Hearing Conservation Programme, availability of hearing protection signage, plant maintenance schedule, annual noise assessment and personnel compliance with the use of recommended hearing defenders (Ear-Muffs and

Ear-plugs). However, personnel who have spent more than eight years working in the oil and gas industry commonly reported tinnitus, annoyance, headache and difficulty in hearing (hard of hearing). This raises concerns about the compliance of personnel with control measures where confirmed as being available. For most of the findings, the magnitude of the differences was small. Few significant relationships were found between small threshold shifts and markers of exposure and symptoms. This statistical relationship is consistent with literature on noise-induced hearing loss in which threshold shifts of less than 30 dB (A) are not usually associated with hearing loss. Though the threshold shift does not qualify for a classical definition of hearing loss (Permanent Threshold Shift-Permanent Threshold Shift) due to the non-exceedance of 30dB (A); it rightly situated a case of temporary threshold shift (TTS) [22]. Moreover, the presence of transient signs and symptoms such as tinnitus, headache, sleep disturbance, difficulty in hearing (temporary hard of hearing), and annoyance are suggestive of exposure to noise and occurrence of temporary threshold shift.

The presence of risk control measures as enshrined in the Hearing Conservation Programme is a testament to the high level of health risk management in Oil and Gas Companies; however, the effectiveness of these measures remains a subject to be investigated in further studies. Risk management measures should be able to manage health risks at ALARP (As Low As Reasonably Practicable). Managing risk exposure to noise in the oil industry be hooves both the employer and employee to synergize their responsibilities toward achieving this objective [11]. The risks should be assessed to include identification of noise hazards, estimate the probable exposure to noise sources, identify SMART (Specific, Measurable, Achievable, Realistic and Time-Bound) control measures, and document the processes involved. Besides identifying the risks, risk control measures should be deployed to protect employees ensuring that the legal limits are not exceeded. Delineation of hearing protection zone, use of hearing protection, provision of information and training to workers, maintenance of machines and annual health surveillance is a must-do. Though a lot of studies have been done on risk assessment, future work should focus on assessment and review of the mitigation value of risk control measures.

The industrial noise mitigation strategy for already existing facilities should include compliant preventive and corrective maintenance (CM, and PM) schedule; substituting noisy equipment with low noise equipment during turn around maintenance; eliminate machinery with high noise levels above 105 dB (A) during maintenance campaign; use of personal protective equipment selected after attenuation [6, 11]; hazard communication using enlarged noise map, identification and display of ear protection zone (EPZ)

sign at the entrance of the facility, awareness training; conduction of annual audiometry for all exposed personnel and long term replacement plan with sound-proof generators [21]. Furthermore, there should be the inclusion of noise study outcomes during the design of new facilities, a policy of low noise equipment procurement in future maintenance programs and noise complaint units before the handover of newly constructed facilities.

V. LIMITATION

There is good internal validity between the results for the right and left ears. However, the occurrence of tinnitus is significantly associated with duration of exposure especially for personnel working at the facility for more than eight years. This could result from inherent bias in the sample occasioned by most of the workers being employed for more than eight years. Further data stratification might give a different result. This is not possible with the data available, but in the future, perhaps the questionnaire could be re-designed to include more categories at older ages. The study did not detect any presentation of hearing loss, though there could be health features suggestive of Temporary Threshold Shift (TTS).

VI. CONCLUSION

Exposure to excessive noise levels remains a potential risk in the oil industry despite the robust risk control measures. Though there might not be obvious presentation of hearing loss, there could be health features suggestive of Temporary Threshold Shift (TTS). This could be a precursor to Occupational noise-induced Hearing Loss should exposure to excessive noise levels continue without mitigation measures.

Conflict of Interest

The author declares that there is no conflict of interests regarding the publication of this paper.

Author's Contribution

Dr Kennedy A. Osakwe Adakporia designed the study protocol, conducted the field works (noise assessment, secured audiometry consent, audiometry), wrote the manuscript, managed the literature search and managed the statistical analyses of the study.

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Quantification of Noise and Air Quality Risks at a Crude Oil Flow Station

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Abstract- Background: Occupational and environmental hazards are continually encountered by oil and gas workers in operational facilities. This study thus aimed at quantifying the noise level and air quality parameters within a crude oil flow station in the Niger Delta Region of Nigeria. **Methods:** The study was conducted in one of the crude oil facilities at Escravosin Delta State of Nigeria. A descriptive, cross-sectional design was adopted in the study. Area noise measurements were undertaken at 40 locations within and outside the facility using a CEL-485 (serial number 109776). Air quality measurements were undertaken in fourteen (14) locations within the facility using CASELLA Micro dust pro (Dust Monitor) and Multi-Gas Meter.

Keywords: *air quality, occupational hazards, exposure, noise, noise assessment.*

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Quantification of Noise and Air Quality Risks at a Crude Oil Flow Station

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Abstract- Background: Occupational and environmental hazards are continually encountered by oil and gas workers in operational facilities. This study thus aimed at quantifying the noise level and air quality parameters within a crude oil flow station in the Niger Delta Region of Nigeria. **Methods:** The study was conducted in one of the crude oil facilities at Escravos in Delta State of Nigeria. A descriptive, cross-sectional design was adopted in the study. Area noise measurements were undertaken at 40 locations within and outside the facility using a CEL-485 (serial number 109776). Air quality measurements were undertaken in fourteen (14) locations within the facility using CASELLA Micro dust pro (Dust Monitor) and Multi-Gas Meter. Measured air quality parameters included Oxides of Sulphur (SO_x) (ppm), Oxides of Nitrogen (NO_x) (ppm), Carbon Monoxide (CO) (ppm), Carbon dioxide (CO₂) (ppm), Particulate matter (SPM) ($\mu\text{g}/\text{m}^3$) and Volatile Organic Compounds (VOC) (ppm). **Results:** While the noise level measured within the facility ranged from 76.8-111.7 dB(A), measured locations outside the facility ranged from 32.6-69.5 dB (A). Air quality parameters within the facility were found to exceed the limits established by the Directorate of Petroleum Resources in Nigeria. **Conclusion:** Operation of a functional crude oil flow station simultaneously contributes to noise and air pollution, which are potentially harmful to exposed workers within the facility. The results of this study generated new issues concerning health and safety practices in the oil and gas industry, which could lead to future research. Innovative ways to mitigate the harmful impact of exposure to noise and air pollutants should be deployed concurrently with the operation of a crude oil facility.

Keywords: air quality, occupational hazards, exposure, noise, noise assessment.

1. INTRODUCTION

The oil and gas industry has grown to become an economic contributor to Nigeria's economy, which is also a large employer of the labor force in Nigeria[1]. However, there have been concerns over the potential health and environmental impacts of crude oil production in Nigeria[2]. Though resources from the oil and gas industry sustain the Nigerian economy, activities in the oil industry pose potential risks especially to the frontline workers who might be exposed daily[3]. Occupational hazards refer to workplace factors, processes, circumstances, material substances; that have the potential to cause harm and

thus pose a threat to the health and safety of workers in all occupations [4]. It presents in the form of occupational health and safety hazards. Additionally, environmental hazards could mean any situation or state of events that poses a threat to the surrounding natural environment and adversely affects the health of an individual [5].

It is, however, important to distinguish exposures within the oil and gas facilities from exposures outside these facilities, which lies in the confines of the environment. Globally, a lot of attention has been devoted to the environmental impact of oil and gas activities, with little attention shown on the impact on frontline workers in the occupational domain. Occupational and Environmental hazards could broadly be classified as physical, ergonomic, chemical, biological, mechanical, and psychosocial hazards [6]. Ergonomic hazards in the oil and gas industry include manual handling, lifting, lowering, pulling, pushing, confined workspace access, narrow walkways, prolonged awkward posture and poor body mechanics [7]. Physical hazards in the oil and gas industry include ionizing and non-ionizing radiation, noise, whole-body vibration and vibrating hand-tools, inclement weather [7]. Chemical hazards include carcinogens like benzene, various acids, hydrogen sulfide, crude, mud component of drilling fluid, welding or cutting fumes as well as irritant, toxic, corrosive and sensitizing substances[8]. Biological hazards could be legionella, food-borne pathogens, to name but a few[7]. While these lists are in exhaustive, they constitute potentially harmful risks to frontline oil and gas workers. Exposure scenarios and categories of causative activities in the oil and gas industry that generates most of these hazards include seismic operations, exploration and drilling, production, preventive and corrective maintenance, processing of hydrocarbon, transportation of the unfinished and finished product, de-commissioning of installation etc[9]. During these activities, employees could further be exposed to varieties of hydrocarbon waste, process materials and substances in the work environment that portend significant occupational risk[9].

Relatedly, workers are exposed to unintentional gas leaks from oil and gas activities arising from equipment leaks, process venting, evaporation losses, disposal of waste gas streams (e.g., by venting or flaring), accidents and equipment failures, methane

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emissions from wastewater handling, methane from industrial wastewater and sludge streams, and nitrous oxide from human sewage. These hazards pose a variety of significant health and safety risks[10]. Crude oil and natural gas composition vary slightly, according to reservoirs; however, it possesses consistent toxicological properties. Chemicals such as polycyclic aromatic hydrocarbons (PAHs) and benzene are toxic components of crude oil and are a source of concern[8]. These chemicals along with others found in crude oil are volatile and capable of moving from the oil into the air. Once airborne, they can blow over the sea and creeks for kilometers, reaching communities far from the source of emission. Though they may be perceived as hydrocarbon odors; workers and people living in neighboring communities will be exposed to crude oil and natural gas aerosols in the air[8]. Differences in exposure will occur based on location, work and personal activities, age, diet, use of protective equipment, and other factors. Exposure to a combination of toxic chemicals, especially if they are capable of causing harm to organs in the body, increases the potential for adverse health effects[8, 10].

Gas flares releases a significant amount of greenhouse gases and causes the release of particulate matter, sulfur dioxide, nitrogen dioxide, and carcinogenic substances such as benzo(a)pyrene, dioxin, benzene and toluene, which can have severe health effects on unprotected frontline workers [1]. The paucity of information on the impact of hazards associated with oil and gas activities on frontline workers spurred the interest for this study. This study thus set out to examine and quantify the noise levels and amount of air pollution within crude oil flow stations in the Niger Delta region of Nigeria as representative hazards. The findings could be used as a guide to improve health and safety practices as well as drive further research within the stated research scope.

II. METHODOLOGY

The study was carried out in a crude oil flow station, an installation located along the Escravos River in the Delta State of Nigeria. Though the facility is about 200 meters from the Escravos village, it is also surrounded by numerous fishing settlements and villages. Geographically, the installation lies between latitudes 4° and 6° north of the equator and longitudes 5° and 9° East of the Greenwich Meridian [11]. The installation is bounded on the North by the Escravos river, on the South by Escravos village, on the East by a mangrove swamp and numerous fishing settlements located about 80 meters away and on the West by the Nigeria Atlantic Ocean continental shelf. Accessibility to the site is by sea and air. The facility was chosen for the study because of the dense activities of oil exploration and production with the potentials for

hazard generation in and around the installation. The flow station receives crude oil from surrounding well-heads through numerous flow lines and rises to the separators; which separate the crude, gas and water before pumping out through an export pipeline to a distant gathering facility.

The materials used in this study includes Casella Micro dust pro (Dust Monitor), and Multi-Gas Meter for air quality analysis, CEL-485 (serial number 109776) Sound Level Meter and CEL-282 calibrator for noise survey.

To assess the risk of gas flare and fugitive emissions within the facility, air quality measurement was conducted. Air sampling with measurement of suspended particulate matter and air quality profiling was done using Casella Micro dust pro (Dust Monitor) and Multi-Gas Meter respectively, with readings taken from 14 sites in the facility environment. The Multi-Gas Meter was used to assess for Sulfur Oxides (SO_x), Nitrogen Oxides (NO_x), Carbon Monoxide (CO), Carbon dioxide (CO₂), and Volatile organic compounds. The dust monitor uses the principle of near forward light scattering to measure dust particle concentration. The air quality meter uses the principle of extractive sampling and ultraviolet fluorescence [12].

Area noise measurements were undertaken in 40 locations within and outside the facility using a CEL-485 (serial number 109776), which was calibrated using a CEL-282 calibrator (serial number 3/10921327). Noise measurements as 30 seconds LAeqs(averages) and frequency band analysis were undertaken at 20 locations approximately 5 meters apart on a grid within the facility running at 75-80% of its capacity on the day of noise survey; and 20 locations outside the facility (in the administrative and accommodation buildings). Purposive sampling technique was adopted in the selection of the 40-measurement locations within the facility. After putting on the hearing protection devices (Ear-muffs and Ear-plugs), the sound level meter (SLM), was switched on and turned to the high measurement mode. The measurement trigger was activated with the meter microphone pointed at the point of interest and noise level was measured and recorded. The sound level meter was calibrated at Casella measurement laboratories, the UK using a standard acoustic calibrator (94dB, 110 Hz sine wave). A-weighting for the general noise sound level was chosen. The instrument was held in the hand of the author and the microphone pointed at suspected noise sources. The MAX and MIN (maximum, minimum) modes were selected and the sound pressure level was displayed at their maximum and minimum readings. The average reading was then taken for each of the forty locations within and outside the facilities. Data was inputted with the Microsoft Excel spreadsheet (2007 version) and then imported into the Statistical Package for Scientific Solutions (SPSS) version 21.0 (statistical software package) for analyses. Tables and

graphs were used for data presentation and means were used for data expression.

III. RESULTS

In this study, assessment of the noise levels within and outside the Escravos flow station gave the following results. All twenty locations measured within

the facility had high noise levels ranging from 76.8 - 111.7 dB(A). Also, all twenty measured locations outside the facility revealed low noise levels ranging from 32.6-69.5 dB (A). These details are shown in Tables 1 and 2 below.

Table 1: Noise measurement within the facility

SN	Locations	LAeq dB (A)	Lmax dB (A)
1	Pump 1(Operational)	89.5	90.9
2	Pump 2(Operational)	90.0	94.1
3	Pump 3(Operational)	90.6	90.7
4	Pump 4 Station	85.1	87.1
5	Pump 5 Station	85.0	86.5
6	Turbine Unit	86.0	87.4
7	Caterpillar Generator	111.7	112.3
8	Air compressor	88.3	89.2
9	Surge Vessel 2	85.2	86.4
10	Saver pit	78.6	83.5
11	Low Pressure Separator 1	83.8	88.3
12	High Pressure Separator 1	84.1	87.0
13	Test Separator 1	80.2	81.8
14	Surge Vessel 1	82.8	84.9
15	Metering skid	82.6	84.2
16	Manifold area	82.2	83.0
17	Low Pressure Separator 2	83.4	84.0
18	High Pressure Separator 2	80.8	81.6
19	Test Separator 2	81.4	82.1
20	Mustering Area	76.8	80.8

Table 2: Noise measurements outside the facility

SN	Locations	LAeq dB (A)	Lmax dB(A)
1	Kitchen	69.5	70.9
2	Laundry	66.0	74.1
3	Accommodation Room	46.6	50.7
4	Recreation	45.1	55.1
5	Reception	45.0	56.5
6	Team leaders Office	41.0	53.4
7	Operations Office	42.7	44.3
8	Mechanical Office	41.3	49.2
9	Beach Masters Office	42.2	44.4
10	Clinic	38.6	43.5
11	Boat Men Office	39.8	44.3
12	Maintenance Office	34.1	37.0
13	Camp Boss Office	44.2	45.8
14	Electrical Office	42.8	44.9
15	Instrument Office	32.6	34.2
16	Workshop	42.2	43.0
17	Station Attendant Office	53.4	54.0
18	Tool Pushers office	45.8	51.6
19	Location Planner Office	51.4	52.1
20	Sewage treatment Room	46.8	50.8

Air quality analysis showed that respective parameters (Particulate Matter, Oxides of Sulphur, Oxides of Nitrogen, Carbon Monoxide, Carbon Dioxide, and Volatile Organic compound) exceeded the normal

limits provided by the Directorate of Petroleum Resources of Nigeria. This is shown in Table 3. Particulate matter (SPM) gave the highest observed levels. This is shown in Figure 1.

Table 4: Air quality analysis around the facility

Parameters	DPR Limit	Sample 1	Sample 2	Sample 3	Average values
Oxides of Sulfur (SOx) (ppm)	0.05	0.06	0.05	0.06	0.14
Oxides of Nitrogen (NOx) (ppm)	0.07	0.08	0.08	0.09	0.25
Carbon Monoxide (CO) (ppm)	8	8	9	10	9
Carbon dioxide (CO ₂) (ppm)	N/A	28.7	30.1	30.5	29.8
Particulate matter (SPM) (μg/m ³)	60 - 90	200.0	300.0	360.0	287
Volatile Organic Compounds (VOC) (ppm)	N/A	30	30	30	30

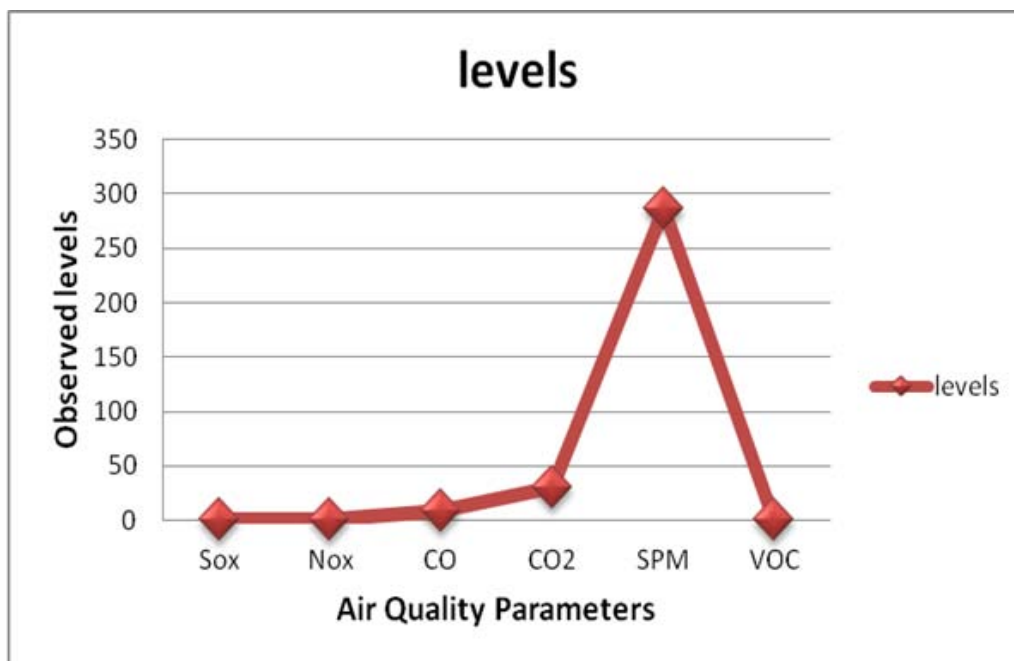


Figure 1: Graphical distribution of air quality parameters within the facility

IV. DISCUSSION

As seen in this study, the mean levels of noise and particulate matter concentrations exceeded permissible exposure limits. Thus noise and gaseous hydrocarbon emissions potentially constitute sources of occupational hazards to workers in this study, which agrees with similar findings of other authors [3]. In the oil and gas industry, temporal threshold shift could result from prolonged unprotected exposure to high noise levels[3]. This study showed that noise levels at the generator house and pump house exceeded normal permissible limits. This is in agreement with other studies that have shown that the sources of noise during the production phase in the oil industry include generator and turbine, compressor and pumps,

producing wells, flow dynamics, and occasionally flaring[3]. While the primary impact of noise is on the workers who work in the facility daily for two weeks before embarking on two weeks' time-off, these condary impacts from noise could be localized disturbance to wildlife, recreationists, and residents. The risk of exposure to noise sources within the facility can be reduced to As Low as Reasonably Practicable (ALARP) by using the Hierarchy of Controls, [3].

These controls include the elimination of noisy equipment, substitute noisy equipment with other equipment that makes less noise, isolates equipment with noise absorbent materials, applies engineering controls to equipment that cannot be eliminated or substituted to reduce noise, apply procedural controls to reduce duration or magnitude of exposure, and

provision of personal hearing protection. Furthermore, it is necessary that a comprehensive hearing conservation program (HCP) is put in place for all personnel exposed to noisy environments exceeding 85dBb (a). This program will include noise survey of suspected workstations, develop and deploy noise maps at facility entrances, identify exposed personnel, mandatory training on noise-induced hearing loss, mandatory annual audiometry, mandatory use of hearing protector, and compliance enforcement [13].

The presence of atmospheric pollutants poses an occupational health risk to the workers and environmental health risks to residents that reside near the generating facility. Common atmospheric pollutants encountered in different oil and gas sites include sulfur oxides (SO_x), oxides of nitrogen (NO_x), hydrogen sulfide (H_2S), carbon monoxide (CO), sulfur dioxide (SO_2), hydrogen cyanide (HCN), Ammonia (NH_3), particulate matter, heat radiation and noise [14]. Three months' average air quality analysis revealed Suspended Particulate Matter (SPM) concentration of $287 \mu\text{g}/\text{m}^3$, which is above the Federal Ministry of Environment (FMENV) limit of $250 \mu\text{g}/\text{m}^3$. Depending on the chemical composition and size of the SPM, prolonged exposure renders workers and inhabitants of host communities vulnerable to chronic respiratory disease; impairment of visibility, sensory irritation, worsens hay fever, and allergies; stunts the growth of vegetation; and leads to decreased visibility [14]. SPM is composed of small particles that are suspended in the air and settles to the ground slowly [15].

The most common sources of particulate matter from oil and gas operations are dust from the separation of crude oil and associated water, and engines used to power machinery at oil and gas facilities. Particulate matter release into the atmosphere can also occur during venting and flaring operations [16]. The analysis further revealed Volatile Organic Compounds (VOC) concentration of 30ppm, which is well above the FMENV limit of 20ppm. Volatile Organic Compounds (VOCs) are carbon-containing substances that readily evaporate into the atmosphere. Crude oil is a densely saturated carbon-containing substance, with Benzene and Toluene being the most common VOC in the oil and gas industry. They have the capacity to adversely affect lung function etc [14].

Also, Oxides of Sulphur (SO_x) concentrations were 0.14 ppm which lies above the FMENV limit of 0.01- 0.1ppm. Exposure to SO_2 at concentrations above 5.00 ppm could stimulate bronchio-constriction (as seen in asthma), aggravation of respiratory disease, impairment of pulmonary functions, irritation of eyes and pulmonary tract and reduced growth in plants. Sulfur dioxide reacts with other chemicals to form particulate pollution, which can damage the lungs and cause respiratory diseases; heart conditions, and premature death [16-18]. Oxides of Nitrogen (NO_x) concentrations

were 0.25 ppm, which is above the DPR limit of 0.07ppm and FMENV limit of 0.04-0.06ppm. The health impacts from NO_x include respiratory problems, heart conditions, and lung damage [16]. Carbon Monoxide (CO), concentration was 9ppm which is below the DPR limit of 8ppm. Prolonged and excessive exposure to an ambient accumulation of CO could bring about the formation of carboxy-hemoglobin and prevent oxygenation of blood, leading to suffocation and consequent death. It inhibits the blood's ability to carry oxygen and can cause dizziness, unconsciousness, and even death [14].

Several environmental challenges associated with petroleum exploration and production activities exist and are varied and multifaceted. Some of these problems include generation and disposal of aqueous effluent of oily waste, combustion of products of gas flaring at gathering stations and high environmental noise levels. One of the environmental problems associated with crude oil exploration and exploitation is linked to gas flaring [14]. The Department of Petroleum Resources (DPR) in 2002 produced a revised version of its Environmental Guidelines and Standards for the Petroleum Industries in Nigeria (EGASPIN). This guideline is in addition to other existing regulations on industrial standards promulgated by the Federal Environmental Protection Agency, 1991 (now Federal Ministry of Environment) to improve environmental management performance in Nigeria. This notwithstanding, several oil installations still violate the regulatory limits [14]. Environmental contaminants from gas flaring include a number of oxides of Nitrogen, Carbon and Sulphur, particulate matter etc [14,19]. The flares also contribute to acid rain, which causes the corrosion of aluminium roofs, soil acidification etc. Acidic soils have been described as having lost its and this could be harmful to crops. [20-21].

V. CONCLUSION

From the findings of this study, it can thus be concluded that the activities of the flow station contribute to noise and air pollution which could have potentially deleterious effects on workers' health and the environment. It is thus recommended that apart from applying the usual methods of reducing noise effects, innovative ways to reduce the noise generated be utilized to reduce noise pollution around oil and gas facilities. Adequate technologies to stop the flaring practices should be developed by utilizing the Associated Gas for electricity generation using gas turbines and re-injecting the Associated Gas into the oil field to enhance crude oil recovery. Gas is being increasingly seen as a viable source of energy to speed up development needs in Africa. In Nigeria, though gas is wasted through flaring activities, creating harmful air pollutants and biomass, it is still the mainstay of cooking

and other heating. Thus, attention should be paid to the reduction of gas flaring and channeling such gas for small-scale utilization such that it benefits the local communities.

Author Contributions: The author developed the study design and survey instrument, trained the research staff, and was involved in data analysis and manuscript preparation. He was also involved in data collection, data analysis and interpretation of the results.

Conflicts of Interest: The author declares no conflict of interest.

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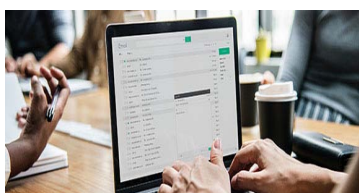
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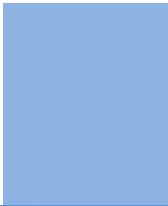
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Authors should carefully consider the preparation of papers to ensure that they communicate effectively. Papers are much more likely to be accepted if they are carefully designed and laid out, contain few or no errors, are summarizing, and follow instructions. They will also be published with much fewer delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and suggestions to improve brevity.



FORMAT STRUCTURE

It is necessary that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

All manuscripts submitted to Global Journals should include:

Title

The title page must carry an informative title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) where the work was carried out.

Author details

The full postal address of any related author(s) must be specified.

Abstract

The abstract is the foundation of the research paper. It should be clear and concise and must contain the objective of the paper and inferences drawn. It is advised to not include big mathematical equations or complicated jargon.

Many researchers searching for information online will use search engines such as Google, Yahoo or others. By optimizing your paper for search engines, you will amplify the chance of someone finding it. In turn, this will make it more likely to be viewed and cited in further works. Global Journals has compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Keywords

A major lynchpin of research work for the writing of research papers is the keyword search, which one will employ to find both library and internet resources. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining, and indexing.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy: planning of a list of possible keywords and phrases to try.

Choice of the main keywords is the first tool of writing a research paper. Research paper writing is an art. Keyword search should be as strategic as possible.

One should start brainstorming lists of potential keywords before even beginning searching. Think about the most important concepts related to research work. Ask, "What words would a source have to include to be truly valuable in a research paper?" Then consider synonyms for the important words.

It may take the discovery of only one important paper to steer in the right keyword direction because, in most databases, the keywords under which a research paper is abstracted are listed with the paper.

Numerical Methods

Numerical methods used should be transparent and, where appropriate, supported by references.

Abbreviations

Authors must list all the abbreviations used in the paper at the end of the paper or in a separate table before using them.

Formulas and equations

Authors are advised to submit any mathematical equation using either MathJax, KaTeX, or LaTeX, or in a very high-quality image.

Tables, Figures, and Figure Legends

Tables: Tables should be cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g., Table 4, a self-explanatory caption, and be on a separate sheet. Authors must submit tables in an editable format and not as images. References to these tables (if any) must be mentioned accurately.



Figures

Figures are supposed to be submitted as separate files. Always include a citation in the text for each figure using Arabic numbers, e.g., Fig. 4. Artwork must be submitted online in vector electronic form or by emailing it.

PREPARATION OF ELETRONIC FIGURES FOR PUBLICATION

Although low-quality images are sufficient for review purposes, print publication requires high-quality images to prevent the final product being blurred or fuzzy. Submit (possibly by e-mail) EPS (line art) or TIFF (halftone/ photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Avoid using pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings). Please give the data for figures in black and white or submit a Color Work Agreement form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution at final image size ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs): >350 dpi; figures containing both halftone and line images: >650 dpi.

Color charges: Authors are advised to pay the full cost for the reproduction of their color artwork. Hence, please note that if there is color artwork in your manuscript when it is accepted for publication, we would require you to complete and return a Color Work Agreement form before your paper can be published. Also, you can email your editor to remove the color fee after acceptance of the paper.

TIPS FOR WRITING A GOOD QUALITY SCIENCE FRONTIER RESEARCH PAPER

Techniques for writing a good quality Science Frontier Research paper:

1. Choosing the topic: In most cases, the topic is selected by the interests of the author, but it can also be suggested by the guides. You can have several topics, and then judge which you are most comfortable with. This may be done by asking several questions of yourself, like "Will I be able to carry out a search in this area? Will I find all necessary resources to accomplish the search? Will I be able to find all information in this field area?" If the answer to this type of question is "yes," then you ought to choose that topic. In most cases, you may have to conduct surveys and visit several places. Also, you might have to do a lot of work to find all the rises and falls of the various data on that subject. Sometimes, detailed information plays a vital role, instead of short information. Evaluators are human: The first thing to remember is that evaluators are also human beings. They are not only meant for rejecting a paper. They are here to evaluate your paper. So present your best aspect.

2. Think like evaluators: If you are in confusion or getting demotivated because your paper may not be accepted by the evaluators, then think, and try to evaluate your paper like an evaluator. Try to understand what an evaluator wants in your research paper, and you will automatically have your answer. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

3. Ask your guides: If you are having any difficulty with your research, then do not hesitate to share your difficulty with your guide (if you have one). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work, then ask your supervisor to help you with an alternative. He or she might also provide you with a list of essential readings.

4. Use of computer is recommended: As you are doing research in the field of science frontier then this point is quite obvious. Use right software: Always use good quality software packages. If you are not capable of judging good software, then you can lose the quality of your paper unknowingly. There are various programs available to help you which you can get through the internet.

5. Use the internet for help: An excellent start for your paper is using Google. It is a wondrous search engine, where you can have your doubts resolved. You may also read some answers for the frequent question of how to write your research paper or find a model research paper. You can download books from the internet. If you have all the required books, place importance on reading, selecting, and analyzing the specified information. Then sketch out your research paper. Use big pictures: You may use encyclopedias like Wikipedia to get pictures with the best resolution. At Global Journals, you should strictly follow here.



6. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right? It is a good habit which helps to not lose your continuity. You should always use bookmarks while searching on the internet also, which will make your search easier.

7. Revise what you wrote: When you write anything, always read it, summarize it, and then finalize it.

8. Make every effort: Make every effort to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in the introduction—what is the need for a particular research paper. Polish your work with good writing skills and always give an evaluator what he wants. Make backups: When you are going to do any important thing like making a research paper, you should always have backup copies of it either on your computer or on paper. This protects you from losing any portion of your important data.

9. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several unnecessary diagrams will degrade the quality of your paper by creating a hodgepodge. So always try to include diagrams which were made by you to improve the readability of your paper. Use of direct quotes: When you do research relevant to literature, history, or current affairs, then use of quotes becomes essential, but if the study is relevant to science, use of quotes is not preferable.

10. Use proper verb tense: Use proper verb tenses in your paper. Use past tense to present those events that have happened. Use present tense to indicate events that are going on. Use future tense to indicate events that will happen in the future. Use of wrong tenses will confuse the evaluator. Avoid sentences that are incomplete.

11. Pick a good study spot: Always try to pick a spot for your research which is quiet. Not every spot is good for studying.

12. Know what you know: Always try to know what you know by making objectives, otherwise you will be confused and unable to achieve your target.

13. Use good grammar: Always use good grammar and words that will have a positive impact on the evaluator; use of good vocabulary does not mean using tough words which the evaluator has to find in a dictionary. Do not fragment sentences. Eliminate one-word sentences. Do not ever use a big word when a smaller one would suffice.

Verbs have to be in agreement with their subjects. In a research paper, do not start sentences with conjunctions or finish them with prepositions. When writing formally, it is advisable to never split an infinitive because someone will (wrongly) complain. Avoid clichés like a disease. Always shun irritating alliteration. Use language which is simple and straightforward. Put together a neat summary.

14. Arrangement of information: Each section of the main body should start with an opening sentence, and there should be a changeover at the end of the section. Give only valid and powerful arguments for your topic. You may also maintain your arguments with records.

15. Never start at the last minute: Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

16. Multitasking in research is not good: Doing several things at the same time is a bad habit in the case of research activity. Research is an area where everything has a particular time slot. Divide your research work into parts, and do a particular part in a particular time slot.

17. Never copy others' work: Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

18. Go to seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

19. Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.



20. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

21. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

22. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

23. Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium through which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

INFORMAL GUIDELINES OF RESEARCH PAPER WRITING

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

Writing a research paper is not an easy job, no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record-keeping are the only means to make straightforward progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear: Adhere to recommended page limits.



Mistakes to avoid:

- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

Choose a revealing title. It should be short and include the name(s) and address(es) of all authors. It should not have acronyms or abbreviations or exceed two printed lines.

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite references at this point.

An abstract is a brief, distinct paragraph summary of finished work or work in development. In a minute or less, a reviewer can be taught the foundation behind the study, common approaches to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study with the subsequent elements in any summary. Try to limit the initial two items to no more than one line each.

Reason for writing the article—theory, overall issue, purpose.

- Fundamental goal.
- To-the-point depiction of the research.
- Consequences, including definite statistics—if the consequences are quantitative in nature, account for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- Single section and succinct.
- An outline of the job done is always written in past tense.
- Concentrate on shortening results—limit background information to a verdict or two.
- Exact spelling, clarity of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else.

Introduction:

The introduction should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.



The following approach can create a valuable beginning:

- Explain the value (significance) of the study.
- Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- Briefly explain the study's tentative purpose and how it meets the declared objectives.

Approach:

Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done. Sort out your thoughts; manufacture one key point for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory specifically—do not take a broad view.

As always, give awareness to spelling, simplicity, and correctness of sentences and phrases.

Procedures (methods and materials):

This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order, but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt to give the least amount of information that would permit another capable scientist to replicate your outcome, but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section.

When a technique is used that has been well-described in another section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show all particular resources and broad procedures so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step-by-step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

- Report the method and not the particulars of each process that engaged the same methodology.
- Describe the method entirely.
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
- Simplify—detail how procedures were completed, not how they were performed on a particular day.
- If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

What to keep away from:

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings—save it for the argument.
- Leave out information that is immaterial to a third party.



Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part as entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or manuscript.

What to stay away from:

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit your results, and put the whole thing in a reasonable order.

Put figures and tables, appropriately numbered, in order at the end of the report.

If you desire, you may place your figures and tables properly within the text of your results section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an argument should be.

Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully described.

Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact, you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved the prospect, and let it drop at that. Make a decision as to whether each premise is supported or discarded or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."



Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work.

- You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of research will not counter an overall question, so maintain the large picture in mind. Where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

THE ADMINISTRATION RULES

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Please read the following rules and regulations carefully before submitting your research paper to Global Journals Inc. to avoid rejection.

Segment draft and final research paper: You have to strictly follow the template of a research paper, failing which your paper may get rejected. You are expected to write each part of the paper wholly on your own. The peer reviewers need to identify your own perspective of the concepts in your own terms. Please do not extract straight from any other source, and do not rephrase someone else's analysis. Do not allow anyone else to proofread your manuscript.

Written material: You may discuss this with your guides and key sources. Do not copy anyone else's paper, even if this is only imitation, otherwise it will be rejected on the grounds of plagiarism, which is illegal. Various methods to avoid plagiarism are strictly applied by us to every paper, and, if found guilty, you may be blacklisted, which could affect your career adversely. To guard yourself and others from possible illegal use, please do not permit anyone to use or even read your paper and file.



CRITERION FOR GRADING A RESEARCH PAPER (COMPILATION)
BY GLOBAL JOURNALS

Please note that following table is only a Grading of "Paper Compilation" and not on "Performed/Stated Research" whose grading solely depends on Individual Assigned Peer Reviewer and Editorial Board Member. These can be available only on request and after decision of Paper. This report will be the property of Global Journals.

Topics	Grades		
	A-B	C-D	E-F
<i>Abstract</i>	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
<i>Introduction</i>	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
<i>Methods and Procedures</i>	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
<i>Result</i>	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
<i>Discussion</i>	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
<i>References</i>	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring



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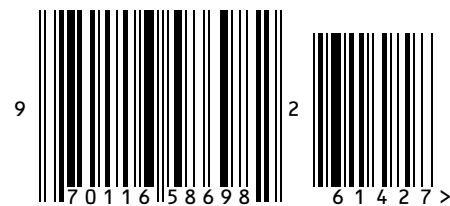
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