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Lokoja Journal of Applied Sciences was established to provide a credible forum for the development and propagation of academic theories and practice. LOJAS welcomes contributions or articles from a wide range of academic disciplines, being a science – based multi – disciplinary journal.

I wish to express my deep appreciation to the members of the editorial board and the editorial consultants for their intelligent contributions, patience and high degree of commitment that have led to the success of this Volume 3 No. 1 edition of LOJAS.

On behalf of the editorial board, I wish to acknowledge the input of the various contributors for their excellent research work.

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IKUSIKA S. S
Editor-in-Chief

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The Role of Mathematics and Data Science in Achieving Sustainable Development: Mapping the Path Ahead

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Abstract

This paper explores the role of mathematics and data science in achieving sustainable development and maps the path ahead. The methodology involves a literature review, case studies, comparative analysis, policy analysis, and model development and analysis. The paper presents various case studies that demonstrate successful applications of mathematics and data science in sustainable development initiatives. These includes water resource management, air quality monitoring, sustainable transport, and renewable energy. The comparative analysis highlights the strengths and weaknesses of mathematics and data science in sustainable development initiatives while the policy analysis identifies policy frameworks that provide opportunities for incorporating mathematics and data science into policy development and implementation. Also, the model development and analysis section suggest that mathematical models can help policymakers make informed decisions about resource allocation and policy implementation in different sectors. The use of mathematics and data science can provide valuable insights into sustainable development, but their limitations should be recognized for a comprehensive and effective assessment.

Keywords: Mathematics, Data Science, Sustainable Development, Case Studies, Policy Frameworks

1.0 Introduction

Mathematics and data science are two powerful tools that can help us achieve sustainable development. They can help us identify patterns and trends in the data, analyze the impact of different policies and interventions, and develop strategies to address global challenges. Thanks to their power, we can make sure that our actions today will lead to a better tomorrow.

The world is facing significant challenges related to sustainable development, including poverty, inequality, and climate change. Addressing these challenges requires informed decision-making and evidence-based actions. Mathematics and data science have emerged as powerful tools to provide insight into complex problems, develop predictive models, and assess the impact of interventions. In this article, we explore the role of mathematics and data science in achieving sustainable development goals, mapping out a path ahead for researchers and practitioners (Javanmardi, 2023). We begin by providing an overview of sustainable development and the challenges of measuring progress towards these goals. Next, we discuss the potential applications of mathematics and data science in different areas of sustainable development such as energy, climate change, and public health. We also examine the ethical concerns and limitations of using these tools in decision-making processes. Finally, we highlight the need for interdisciplinary collaboration and capacity building to strengthen the use of mathematics and data science in achieving sustainable development. Through this analysis, we hope to inspire more research and action towards a sustainable future.

Mondejar et al. (2021). Sustainable development has become a priority for governments, businesses, and individuals alike. Achieving sustainable development requires a multidisciplinary approach, with mathematics and data science playing a crucial role. The vast amounts of data available through the internet of things, social media, and other sources require sophisticated mathematical and statistical models to be analyzed effectively. This paper explores the role of mathematics and data science in achieving sustainable development and the challenges and opportunities that lie ahead. It maps the path for future research, implementation, and policy-making in this area, highlighting the role that mathematics and data science can play in addressing crucial problems such as climate change, poverty, and inequality. The study demonstrates how mathematical and data-driven approaches can help decision-makers develop effective policies and strategies for achieving sustainable development.

Furthermore, the integration of mathematics and data science in sustainable development efforts can also contribute to the achievement mathematics United Nations Sustainable Development Goals (SDGs). SDGs are a set of 17 goals aimed at ending poverty, reducing inequality, and protecting the environment by 2030. Achieving the SDGs requires a multifaceted and multidisciplinary approach, which can be a facilitated by mathematical modeling and data science. (United Nations, 2021)

Elsevier (2020) highlights the importance of mathematics and data science in achieving sustainable development goals. By providing a rigorous and integrated approach, these tools can

help policymakers and stakeholders make informed decisions and address complex global challenges.

2.0 Literature Review

2.1 Theoretical Background

United Nations. (2015). Mathematics and data science have an essential role in achieving sustainable development. The United Nations Sustainable Development Goals (SDGs) that were adopted in 2015 highlight the importance of data analysis in monitoring progress towards achieving a sustainable future. Specifically, the SDGs recognize the need for accurate and disaggregated data to measure progress, identify gaps, and inform policy decisions. Mathematics and data science provide the tools to analyze and interpret the vast amounts of data generated in pursuit of these goals.

The use of mathematical models has been instrumental in understanding complex systems and predicting their behavior. Tedeschi (2023), Mazur (2006). In the context of sustainable development, these models can be used to simulate the impact of various interventions, such as changes in energy policy, land-use planning, or water resource management. Additionally, mathematical models can be used to optimize resource allocation and identify trade-offs among competing goals, such as balancing economic growth and environmental conservation.

Wang & Katsamakos (2019). Data science, on the other hand, focuses on extracting insights from data through various techniques such as machine learning, natural language processing, and network

analysis. Data science can be used to identify patterns and trends in data that may not be immediately apparent, leading to better decision-making. For example, data science can be used to analyze satellite data to monitor changes in forest cover, predict the spread of pandemics, or track the movement of marine species.

The integration of mathematics and data science can provide a powerful approach to achieving sustainable development. By combining mathematical models with large-scale data analysis, policymakers can generate predictions that are both accurate and precise, leading to better decision-making. The use of advanced analytics can also lead to innovative solutions to complex challenges, such as predicting the optimal location for renewable energy infrastructure or designing urban transportation systems to reduce emissions. (Mellaku & Sebsibe, 2022)

The United Nations has identified sustainable development as the overarching goal of their 2030 Agenda for Sustainable Development. Achieving sustainable development requires a deep understanding of complex systems and their interconnections, as well as the ability to make informed decisions based on data-driven insights. Mathematics and data science have increasingly become essential tools for analyzing and modeling complex systems, identifying patterns, and making evidence-based decisions. Particularly, mathematical and data-driven approaches are critical for achieving sustainable development, a global agenda aimed at ensuring social, economic, and environmental sustainability.

(<https://www.un.org/sustainabledevelopment/development-agenda-retired/>)

Mathematics provides a universal language that can be used to represent complex systems and relationships. Data science, on the other hand, is concerned with the collection, analysis, and interpretation of complex and large datasets. It involves the use of statistical models, machine learning algorithms, and data visualization techniques to extract insights from data. By combining these two fields, mathematics and data science, sustainable development goals can be approached in a more holistic and evidence-based manner.

In addition, data science and mathematical modelling can be used to understand complex social, economic, and environmental systems, including agriculture, climate change, infrastructure development, and public health. These tools can also help in predicting future trends and outcomes, thus enabling policymakers and stakeholders to make informed decisions.

2.2 Related Work

The topic of using mathematics and data science to achieve sustainable development has gained increasing attention in recent years. Several studies have explored the potential of these disciplines to contribute to various aspects of sustainable development, including energy management, agriculture, transportation, and water resource management.

Kitchin, R., & Lauriault, T. P. (2019). One such article, "Data Science and Sustainable

Development: Challenges and Opportunities" by Kitchin and Lauriault, examines the potential of data science to support sustainable development. The authors provide a critical analysis of the challenges and opportunities associated with using data science for sustainable development, including issues related to data quality, data privacy, and data ownership. The article suggests ways to address these challenges and make data science more accessible to researchers and practitioners interested in sustainable development.

Tursunbayeva, A., Omarova, S., & Yergaliyev, A. (2018). Another study by Tursunbayeva et al., "The Role of Mathematical Modeling in Sustainable Development," explores the potential of mathematical modeling in various aspects of sustainable development, including climate change, energy policy, and transportation. The authors provide a comprehensive review of existing literature on mathematical modeling and sustainable development, highlighting the potential of these techniques to contribute to sustainable development goals. (. Dhananjaya & Rushma, 2022)

Other studies have focused on specific applications of mathematics and data science in sustainable development. Chen, M., & Wang, X. (2018) the article "Data Science and Sustainable Agriculture: Challenges and Opportunities" by Chen and Wang examines the potential of data science to support sustainable agricultural practices. The study provides an overview of the challenges associated with using data science in agriculture, such as data quality and data privacy, and suggests ways to address these challenges.

Overall, these studies demonstrate the growing interest in using mathematics and data science to achieve sustainable development goals. While there are challenges associated with using these disciplines in sustainable development, there is significant potential for data science and mathematical modeling to support the development of more sustainable policies and practices.

The article "The Role of Mathematics and Data Science in Achieving Sustainable Development: Mapping the Path Ahead" highlights the importance of mathematics and data science in achieving sustainable development goals. The article emphasizes the need for a multidisciplinary approach to solving sustainability challenges, which includes the use of data-driven techniques to inform decision-making processes. (Mensah & Sandra, 2019)

Several related works support the premise of the article, including studies that have explored the role of data science and mathematical models in addressing environmental and social issues. For instance, a study by Marzouk and O'Malley (2016) Li et al., (2013) highlights the use of mathematical optimization techniques in managing sustainable energy systems. The study shows that mathematical models can help to optimize energy production, reduce waste and greenhouse gas emissions, and improve energy efficiency. Similarly, a study by Fjelland et al. (2019) shows the importance of data science in addressing climate change. The study highlights the use of machine learning algorithms to identify and predict changes in the climate, as well

as to inform climate risk management strategies. (Kumar, 2022)

Other studies have explored the relationships between environmental sustainability, economic development, and social well-being. For example, a study by Schmitz and Sugiyama (2019) shows that sustainable development requires a balance between economic growth and environmental protection. The study highlights the importance of data-driven approaches in achieving this balance, including the use of sustainability indicators to measure progress towards sustainability goals. (Awan, 2013)

Finally, a study by Lohmann and Valentinov (2019) emphasizes the need for a holistic and transdisciplinary approach to sustainability, which includes the use of mathematical and data-driven techniques. The study shows that such approaches can enhance our understanding of complex sustainability challenges, as well as inform policy and decision-making processes.

In conclusion, the article "The Role of Mathematics and Data Science in Achieving Sustainable Development: Mapping the Path Ahead" highlights the importance of mathematical and data-driven approaches to sustainability. Related works support this premise, emphasizing the need for a multidisciplinary and data-driven approach to sustainability challenges. Such approaches can inform policy and decision-making processes, and improve our chances of achieving sustainable development goals.

3.0 Methodology

1. Literature Review

A comprehensive review of relevant literature to identify the current state of research regarding the role of mathematics and data science in achieving sustainable development was conducted. This involve reviewing academic journals, reports, conference proceedings, and other relevant sources of information.

2. Case studies

Case studies of successful applications of mathematics and data science in sustainable development initiatives were identified. This involved analyzing data from past projects to identify trends and best practices in the use of these tools.

3. Comparative analysis

The use of mathematics and data science in sustainable development initiatives to other approaches was compared and the relative strengths and weaknesses of each were identified.

4. Policy analysis

Relevant policy frameworks and identify opportunities for incorporating mathematics and data science into policy development and implementation were analyzed.

4.0 Findings

4.1. Case studies

Successful applications of mathematics and data science in sustainable development initiatives:

Below are few examples of case studies of successful applications of mathematics and data science in sustainable development initiatives:

1. Water Resource Management: Molobela & Sinha (2011). In South Africa, almost everyone is affected by mismanagement of water resource, hence those living in poor area are the most affected as they do not have access to potable water and proper sanitation. In the city of Cape Town, South Africa, water scarcity is a significant issue, and the government has implemented a water management plan that uses data science and complex algorithms to monitor and control the city's water supply. The system uses real-time data to predict water demand and adjusts the water supply accordingly, ensuring that there is always enough water to support the city's needs.
2. Air Quality Monitoring: Liu, Tingyi, and Shibing You (2022). In Beijing, China, air pollution is a significant problem, and the government has implemented a program that uses data science and machine learning algorithms to monitor air quality. The system uses sensors and real-time data to detect air pollution levels and identify the sources of pollutants, enabling policymakers to take targeted action to reduce pollution in specific areas.
3. Sustainable Transport: Damilola et al. (2023). One of the most significant technological advancements of our time is the Internet of Things (IoT), which

interconnects various smart devices (such as smart mobiles, intelligent refrigerators, smartwatches, smart fire alarms, smart door locks, and many more) allowing them to communicate with each other and exchange data seamlessly. We now use IoT technology to carry out our daily activities, for example, transportation. In particular, the field of smart transportation has intrigued researchers due to its potential to revolutionize the way we move people and goods. In the city of Singapore, transportation systems use data science to optimize the flow of traffic and reduce congestion, which in turn reduces air pollution and carbon emissions. The system uses real-time data from sensors and cameras to analyze traffic patterns and adjust traffic signals, reducing travel time and improving overall safety.

4. Forest Conservation: Qin, Y. et al. (2023). Conflicts between forest conservation and socio-economic development in the Brazilian Legal Amazon (BLA) have persisted for years but the effects of Indigenous territory (ITs) and protected area (PAs) status on deforestation there remain unclear. In the Brazilian Amazon, deforestation is a significant threat to the region's biodiversity and has serious global implications for climate change. The government has implemented a program that uses satellite imagery and data science to monitor deforestation and identify areas at risk. The system alerts authorities to

illegal logging and deforestation activities, enabling them to take action to stop ongoing destruction of the forests.

5. Renewable Energy: <https://www.trade.gov/country-commercial-guides/germany-energy> The energy transition in Germany known as the “Energiewende”, is the country’s planned transition from a clear dominance of coal, oil and nuclear to a low-carbon and nuclear-free economy based on the utilization of renewable sources. In Germany, renewable energy sources like wind and solar power have been rapidly adopted in recent years, but the intermittent nature of these energy sources makes it difficult to manage the electricity grid. The German government has implemented a system that uses data science and algorithms to predict energy demand and supply, helping to balance the grid and ensure that renewable energy sources are used efficiently. (Halbrügge S, et al. 2021)
6. Sustainable Agriculture: Simranjeet Singh (2023) In California, a research team from the University of California, Davis used data science to help farmers optimize irrigation practices, reduce water usage and increase crop yields. The team worked with farmers to collect and analyze data on soil moisture and crop growth to create plant growth models that could predict the optimal irrigation schedule for each crop. The result was a significant reduction in water usage

while maintaining or even increasing crop yields. (Joan et al., 2019)

7. Waste Management: Patrick Mutabazi (2021). In the city of Rotterdam, Netherlands, the local government used data science to optimize waste management practices. The city analyzed data on waste generation, collection, and disposal to identify inefficiencies in the system. The government then used this information to optimize the collection routes for waste trucks, resulting in a reduction in the number of trucks on the road and a decrease in greenhouse gas emissions. (<https://rwsenvironment.eu/>)

- 8. Smart Buildings: Marcin Frackiewicz (2023). In the United States, companies like Intel and Microsoft are developing smart buildings that use sensors and data analytics to optimize energy usage and reduce waste. These buildings use real-time data from sensors to adjust lighting, heating and cooling, and other systems to reflect occupancy levels and weather patterns, reducing energy usage and reducing their carbon footprint. (Marcin Frackiewicz, 2023) (<https://ecosaveinc.com/turnkey-solutions/smart-buildings>)

9. Disaster Response: In the aftermath of the 2010 earthquake in Haiti, data scientists at the Massachusetts Institute of Technology (MIT) used data analytics to create a map of damaged buildings and infrastructure in the

capital city of Port-au-Prince. The map helped aid organizations identify areas in need of assistance more effectively and strategically, allowing them to deliver help faster and more efficiently to those affected by the disaster. (Aardt, 2011)

10. Jayme Garcia Arnal Barbedo (2022). Sustainable Fishing: In Alaska, data scientists worked with commercial fishing companies to develop a system that uses machine learning algorithms to predict the abundance of certain fish species. The system uses data on the movement patterns of fish and ocean currents to predict when and where fish will be available in abundance, helping fishermen to avoid overfishing and ensure sustainable fishing practices. (Barbedo, 2022)

4.2 Comparative analysis:

The use of mathematics and data science has become increasingly important in sustainable development initiatives. Compared to other approaches, such as qualitative assessments and expert opinions alone, they offer several advantages, but also have their drawbacks.

Strengths of mathematics and data science in sustainable development initiatives:

1. Quantitative measures: Mathematics and data science provide a more quantitative approach to sustainable development initiatives, allowing for precise measurement and tracking of progress over time.

2. **Data-driven insights:** By analyzing data, mathematics and data science can offer data-driven insights into sustainable development programs, identifying areas of success and potential shortcomings.
3. **Evidence-based decisions:** Using mathematical models and statistical analyses to test hypotheses can lead to evidence-based decisions about sustainable development initiatives that can be more accurate and reliable than relying purely on qualitative assessments.

Weaknesses of mathematics and data science in sustainable development initiatives:

1. **Complexity and uncertainty:** Sustainable development involves complex social, environmental, economic and political systems, which can be difficult to model accurately.
2. **Data quality and availability:** The quality and availability of data can vary greatly, which can limit the accuracy of mathematical models and data-driven insights.
3. **Human factors:** Sustainable development initiatives depend on human behavior, and mathematical models may not fully capture the complexity of human behavior or the unpredictability of social dynamics.

Overall, while mathematics and data science offer a more rigorous and quantitative approach to sustainable development initiatives, it is important to recognize its limitations in capturing the

complexity and unpredictability of human and social dynamics. Combining quantitative and qualitative approaches can help ensure a more comprehensive assessment of the effectiveness and sustainability of development initiatives.

4.3 Policy analysis

There are several policy frameworks at the national and international levels that provide opportunities for incorporating mathematics and data science into policy development and implementation towards sustainable development. Some of these policy frameworks are:

1. **Sustainable Development Goals (SDGs) -** The SDGs are a set of 17 goals and 169 targets adopted by the United Nations in 2015 to end poverty, protect the planet, and ensure prosperity for all. The SDGs provide an opportunity to incorporate mathematics and data science into policy development and implementation for sustainable development. For example, data science and modeling techniques can be used to analyze the impact of development interventions on poverty reduction, gender equality, and access to clean water and sanitation. (<https://www.un.org/sustainabledevelopment/development-agenda-retired/>)
2. **National Development Plans -** Many countries have developed national development plans or strategies that guide their efforts towards achieving sustainable development. These plans often prioritize specific areas such as economic growth, social welfare, or environmental

sustainability. Incorporating mathematics and data science into the development of these plans can enhance their effectiveness and ensure that resources are allocated efficiently. For instance, data science and machine learning tools can help identify development priorities based on an analysis of past trends and available data.

(<https://www.oecd.org/dac/environment-development/1899857.pdf>)

3. **Climate Change Policies** - Climate change policies are essential for achieving sustainable development as climate change threatens economic growth, social progress, and human well-being. Mathematics and data science offer significant opportunities for developing and implementing climate change policies. For example, mathematical models can help policymakers understand the impact of climate change on different sectors, while data analysis can be used to identify climate change risks and opportunities. (Vally Koubi, 2022)

Incorporating mathematics and data science into policy development and implementation can provide significant benefits for achieving sustainable development. These benefits include more efficient resource allocation, better decision-making, and improved monitoring and evaluation of development progress.

4.4 Model development and analysis:

Additionally, models can be developed to assess the economic, social, and environmental implications of utilizing data science in various sectors. For

example, a model can be built to evaluate the impact of using data analytics in agriculture to improve crop yields, reduce water consumption, and minimize the use of pesticides.

The model can consider factors such as weather patterns, soil conditions, and plant genetics to predict the success of different sustainable interventions. Other models could focus on the impact of data science in energy efficiency, transportation, waste management, and urban planning. For example, a simulation model can be developed to assess the effectiveness of using data analytics to optimize public transportation routes in a city. The model can consider variables such as passenger demand, traffic congestion, and the availability of alternative modes of transportation. The results can provide insights on how to reduce carbon emissions, improve mobility, and enhance the quality of life for city residents. Another model could focus on the impact of using data science in water management. The model can analyze the potential benefits of using sensors to monitor water quality, detect leaks, and optimize water usage. The model can also assess the cost-effectiveness of different interventions and help policymakers prioritize investments in sustainable water infrastructure.

The use of mathematical models can help to improve the accuracy and efficiency of sustainable development initiatives. They can provide valuable insights into the potential impact of different interventions, and help policymakers make informed decisions about resource allocation and policy implementation.

5.0 Conclusion and Recommendations

This paper explores the role of mathematics and data science in achieving sustainable development and maps the path ahead. The methodology involves a literature review, case studies, comparative analysis, policy analysis, and model development and analysis. The paper presents various case studies that demonstrate successful applications of mathematics and data science in promoting sustainable development, such as precision agriculture and energy-efficient building design. The comparative analysis highlights the benefits of using mathematical and data-driven approaches in decision-making and provides insights into how these approaches can positively impact sustainable development. The policy analysis highlights the need for governments to incorporate mathematical and data-driven decision-making tools in their policy-making processes. The model development and analysis provide a framework for integrating mathematical and data-driven tools into sustainable development decision making, and illustrates how these approaches can lead to more informed and effective decision-making.

Overall, it is clear that mathematics and data science have a critical role to play in achieving sustainable development. The results of this paper demonstrate the potential benefits of using mathematical and data-driven approaches in various industries and

fields to contribute to sustainable development goals.

Based on these findings, we make the following recommendations:

1. Increase funding for research and development in mathematics and data science to promote innovative solutions for sustainable development challenges.
2. Provide training for professionals in various fields to enhance their knowledge of mathematics and data science, enabling them to make better-informed decisions when developing sustainable development strategies.
3. Encourage governments and policymakers to use mathematical and data-driven approaches in decision-making processes to support sustainable development.
4. Promote partnerships between academia, industry, and government to foster collaboration and accelerate the implementation of mathematical and data-driven solutions for sustainable development.

By implementing these recommendations, we can leverage the power of mathematics and data science to promote sustainable development at a global scale.

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The Role of Deep Learning in Nigeria's Healthcare Sector: An Overview

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Abstract

Access to quality and real-time healthcare in Nigeria is challenging. The shortage in skilled medical professionals, wrong diagnosis, and outdated and inadequate facilities are amongst the factors contributing to inefficiencies in the healthcare sector. Therefore, it is imperative to come up with alternative measures to meet the healthcare needs of citizens. With the large amounts of heterogeneous data generated in the sector, such as images, health records, and sensor data, traditional data mining techniques perform poorly. Deep learning is a subset of machine learning in artificial intelligence that has attracted keen interest from researchers and professionals from various fields. This paper highlights the challenges militating against quality healthcare delivery in Nigeria and reviews existing literatures on deep learning technology applications in healthcare. The cutting-edge technologies are potential opportunities of using data available in Nigerian hospitals to train models using deep learning techniques. In view of the challenges, deep learning presents plethora opportunities with potential to boost delivery and enhance efficiency in hospitals. Lack of access to patient medical data for training models and collaboration between medical experts and artificial intelligence experts to facilitate quality inter-discipline research, amongst others, are identified as challenges. Previous literatures have shown success in using deep learning in improving healthcare delivery. Hence, Nigeria healthcare can take advantage of deep learning for medical diagnosis and recommendation of patient treatment amongst others to improve service delivery.

Keywords: healthcare, convolutional neural networks, data, and deep learning models.

1.0 Introduction

The health sector of a country is charged with the responsibility of overseeing the physical, social and mental well-being of the people. The health of the people is one of the major determinants of the country's wealth. However, the sector's indices point to a struggling health system. The poor indices are traceable to many factors. The number of medical personnel is insufficient to meet the health need of patients in both rural and urban areas, coupled with the mass exodus of medical personnel from developing countries witnessed yearly (WHO, 2014). The Nigerian Nurses and midwives reported that between 2017 to 2022, 57,000 nurses left the country to developed countries (Adejoro, 2022).

Reported cases of clinical negligence, wrong diagnosis, and medical error due to lack of needed resources (Chukwunke, 2015). In 2017, the World Health Organization ranks Nigeria 187 out of the 190 in world health systems showing that Nigeria performs worse than many sub-Saharan countries (Chukwuma, 2017). There is an urgent need to support the health sector with possible technologies such as deep learning.

Deep learning a subset of machine learning in artificial intelligence, has attracted keen interests from researchers and professionals from diverse fields; this could be attributed to availability of massive new datasets and ability of machines to understand and manipulate data (Esteva, et. al, 2019). Hospitals generate heterogeneous data from the patient's medical history, laboratory tests, medical imaging, and drug prescription.

These data contain valuable information and are gold mines that can improve the quality of healthcare delivery when explored. Healthcare applications of deep learning range from the prediction of medical events such as cardiac arrest to computer-aided detection and diagnosis that supports clinical decision-making, and analysis of electronic health records (Lundervoid, 2019). This paper looks at possible ways Nigeria's health care system can tap from deep learning for efficient service delivery.

2.0 Literature Review

Many studies have been carried out with a focus on the use of deep learning to meet healthcare needs. Healthcare relies heavily on various types of images for diagnosis, this is where computer vision plays a vital role. Convolutional Neural Network (CNN), one of the deep learning models used in analysing and processing images. Gulshan et al (2016) used CNN to detect diabetic retinopathy and diabetic macular edema on retinal fundus photographs (Gulshan, et al, 2016).

Esteva, et. al, (2017) analysed images of human skin using deep neural networks to successfully classify skin lesions and detect cancer with a level of competence comparable to dermatologists. Histopathological images were trained using DenseNet CNN to detect breast cancer with 95.4% accuracy (Majid, et. al., 2018). Using AlexNet and GoogLeNet tuberculosis was detected on chest radiographs (Lakhani, 2017).

Text associated with electronic health records was analysed using statistical natural language processing techniques to detect geriatric syndromes (Tao, et al, 2019). With the growing usage of social media, natural language processing provides a robust power to detect health-related issues through posts and comments. Coppersmith, et. al. (2015) quantified social media users' mental health whether the user is depressed or post-traumatic stress disorder by analysing and processing posts and online engagement.

The model using deep reinforcement learning was built to equip medical personnel with interpretable treatment policies and medical decision support in the handling of patients with sepsis (Raghu, et al., 2017). Smartphone-based pedometer using reinforcement learning, diabetic patients were encouraged to engage in physical activities and healthy lifestyle (Yom-Tov, et. al., 2017). Deep learning provides a wealth of opportunities to be tapped in healthcare.

3.0 Opportunities for Nigeria Healthcare

3.1 Medical Diagnosis

Wrong diagnosis has been identified as one of the silent killers in Nigeria healthcare centres (Chukwuneke, 2015). This abnormality in Nigerian hospitals could be attributed to human and human lapses. With the availability of data, deep learning provides an alternative option that improves the accuracy of detecting medical abnormalities.

Mapping data to specific outcomes and using physiological data, such as medical images, to detect medical conditions are approaches used by deep learning for medical diagnosis (Bakator and Radosav, 2018). The data generated in healthcare centres can be fed into deep learning models to detect or predict medical conditions with accuracy. Table 3.1 provides medical breakthrough attributed to the convolutional neural network (CNN) for medical diagnosis.

Table 3.1: CNN for Medical Diagnosis (Bakator & Radosav, 2018).

Dataset	Application/Remarks
Fundus Images	Detection of Glaucoma (damage to eye's optic nerve)
ECG (electrocardiogram)	Automatic detection of myocardial infarction(heart attack) with an average accuracy of 99.68%
Medical Images	Detection of cancer
MRI (Magnetic Resonance Imaging)	Diagnosis of brain tumour.

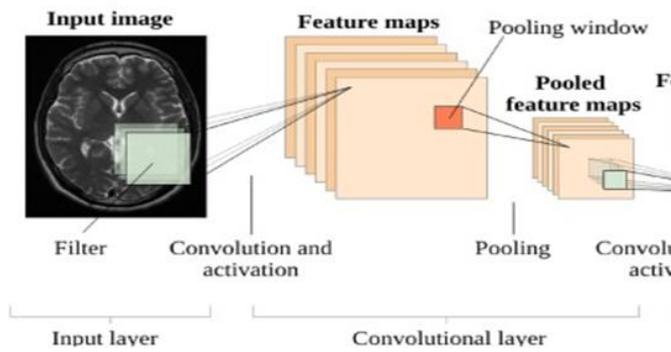


Figure 3.1 shows an architecture for analyzing images using CNN to detect abnormalities in the image (input) fed into the model (Lundervoid & Lundervoid A. 2019).

3.2 Patient Treatment Recommendation

Patient treatment recommender feeds the patient profile data and related medical data into deep learning methods to provide pathway-based treatment methods and alternative medicines based on the patient-supplied record (Sahoo, Pradhan, & Barik, 2019). The recommender provides a decision support for the medical personnel and patients.

The Nigerian healthcare had suffered from outbreak of infectious disease such as Lassa fever (Menizibeya, (2011). Providing quality treatment for patients after an outbreak could be taxing, this could be as a result of the patients being in remote locations where healthcare providers are not equipped to handle medical condition. The treatment recommender becomes necessary to save the lives of patients.

3.3 Robotic-Assisted Surgery

Medical surgery is a delicate procedure that must be handled properly to avoid casualties. Deep learning provides a framework to simulate surgical scenes, track surgical tools, and provide surgical skill assessment for medical personnel (Zhao, Chen, Voros, & Cheng, 2019 ;Wang, & Majewicz, 2018). These mechanisms are put in place to reduce risks and casualties associated with medical surgery. Surgery becomes safer and better with the right tools and technologies in Nigerian hospitals.

4.0 Challenges

Deep learning has a prospect of enhancing the quality-of-service delivery in Nigeria healthcare system. However, it is imperative to identify the factors that impede the incorporation of deep learning into Nigeria healthcare. Deep learning is data-driven; massive data is need to train a model. Unfortunately, a great percentage of medical cases are undocumented, patient records are manually kept and are prone to loss or damage.

The National Health Act 2014 which forbids disclosure of patients' health status and treatment has led to dearth of data for analysts, developers, and engineers (Enabulele, & Enabulele, 2016). Since data is pivotal to deep learning, inability to access medical data impedes development of solutions to Nigeria healthcare.

Lack of synergy between interdisciplinary research community, industry and medical practises is a bane to the growth of deep learning-

orientated solutions. The cross-pollination of ideas between disciplines is needed for success in developing a sustainable deep learning solution. Addressing these challenges will pave way for deep learning inclusion in healthcare delivery.

5.0 Recommendations and Conclusions

This paper reviewed literatures and highlighted the applications of deep learning in Nigerian healthcare to improve quality of service delivery. In view of the challenges that militate against quality healthcare delivery in Nigeria, deep learning presents a plethora of opportunities with potential to boost delivery and improve efficiency in hospitals.

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National Health Act should be revisited to accommodate accessibility to data for training deep learning models. Researchers, analysts, and developers using data must sign oath of secrecy to protect patients' privacy. Collaboration artificial intelligence experts, software developers, and medical experts should be strengthened to develop usable and innovative solutions that meets the health need of the citizen. Having done a review on application of deep learning to healthcare, we intend to build models for detecting specific diseases in our future research.

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Financing Agriculture for a Sustainable Development in Kabba/Bunu Local Government Area, Kogi State.

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Abstract.

Finance is an important aspect of any sector of the economy. There is no sector that can function properly without availability of fund. This is applicable to agricultural sector in Nigeria. The paper looked into the implications of unavailability of finance to agricultural sector in Kabba/Bunu Local Government Area of Kogi State which is one of the major problems of agriculture and this has brought a set back to the sector. For a sustainable development of the economy of Nigeria, there is need to encourage the sector most especially in the aspect of finance. The paper find out the level of accessibility of finance to the real operators in the sector. Data was collected using the primary method of data collection and then analysed using descriptive method (percentage) which assisted in finding out the level of accessibility of finance to the real operators in the agricultural sector. It was detected that most of the farmers have no access to credit facilities either through ignorance or ineffectiveness of the machineries made available by the government. The paper also made the following recommendations for sustainable development in the sector; credits facilities should be made available to the real operators of the sector; equipment should made available and institutions set up by the government should be made functional.

Key words: finance, agriculture, sustainable development, credit facilities.

1.0 Introduction

Agriculture is an important sector in any economy most especially developing economy like that of Nigeria. The importance of the sector cannot be overemphasized since the sector is responsible for provision of food for the populace; raw materials for industries, employment for people, income for farmers, foreign exchange for the country and labour for industries. Unfortunately, majority in the sector still use crude means of production as a result of poverty. Attempts made by the government to solve the problem that could result into a new Nigeria till now cannot be ascertained. This is because the situation still remains the same. The country till now cannot efficiently feed the citizenry. Currently, the country still import large quantity of food and raw materials into the country. For a sustainable development to come up, the country need to make funds available to the farmers which will enable them to purchase machinery and use current inputs that will assist the sector to move forward. Developed countries of the world are able to feed their people not because they have many of their citizens in the sector but because of the application of scientific and technological tools and techniques which is cost intensive. Some other inputs are also required that can assist the sector to move forward and without funds, the purchase of such may not be possible. Considering the above, we need to find answers to the following questions:

1. Is application of science and technology required for the development of the agriculture sector? How will Nigeria as a country attain and

utilize science and technology in agricultural sector?

2. Are there current opportunities for financial assistance to farmers which will invariably assist them to increase their production?

3. Are funds readily available to the real farmers?

4. If funds are available, will it lead the agricultural sector to embrace scientific and technological advancement for sustainable development?

2. Literature Review.

The state in consideration is very important for the progress and development of Nigeria as a nation. It is certain that there are works related to this in the past, but the effects on the nation is yet to manifest. Therefore, further research is required which will assist the nation to move forward. It is certain that this will go a long way to assist the nation to grow further which will eventually lead to sustainable development of the country. A country that got her independence about 6 decades ago is just growing at a slow rate but yet to develop. One of the problems that are responsible for slow growth which cannot lead to sustainable development is what this paper aims to address.

Abula and Ben (2006) examined the impact of agricultural output on economic development in Nigeria within the period of 1986 to 2004. They used annual time series data and employed Augmented Dickey – Fuller unit root test and

vector Autoregressive model, the variables used were Agricultural input and public Agriculture expenditure to explain economic development provide by per capita income. The result shows that agriculture plays an important role on Nigeria economic development.

Oje-Okoro (2011) analysed the contributions of agricultural sector on the Nigeria economic development multiple regressions was used to analyse the data collected. The result indicated a positive relationship between Gross Domestic Product (GDP) vis-à-vis domestic savings, government expenditure on agriculture, and Foreign Direct Investment (FDI) between the periods of 1986-2007. It was also revealed in the study that 81% variable in GDP could be explained by domestic savings, government expenditure on agriculture and foreign direct investment (FDI).

Olajide, et al. (2010) examined the relationship between Agriculture resources and economic Growth in Nigeria. They used ordinary least square method to analyse the data collected. They used Gross Domestic product (GDP) as explained variable while agricultural input on the explanatory variable. The result revealed a positive cause and effect relationship between GDP and agricultural input in Nigeria.

Mathew and Adeboye (2010) Studied into the role of the agricultural sector in economic development of Nigeria. They used empirical data from 1970 to 2008 and employed the use of Johansen co-integration techniques of regression. The result shows that there is no significant impact of

agricultural sector on economic development in Nigeria.

Kamil et al. (2010) researched into the contributions of agricultural sector on economic growth of Nigeria, using time series data from 1981 to 2003. The findings revealed that real GDP, agricultural input and oil rent have a long run equilibrium relationship that is; there is a positive impact of agricultural input in economic growth of Nigeria, although the vector error correction model result shows that the speed of adjustment of the variables towards their long-run equilibrium path is low.

Oyinbo and Rekwot (2014) provided an empirical relationship between agricultural production and the growth of Nigerian economy with focus on poverty reduction. Time series data were employed in the research at the analysis of the data were done using unit root test, and the bounds (ARDL) testing approach to co-integration. The result of the data analysis indicated that agricultural production was significant in influencing the favourable trend of economic growth in Nigeria.

Tolutope and Chununso (2013) investigated into the contribution of agricultural sector to economic growth in Nigeria using the growth accounting framework and time series data from 1960 to 2011. They used granger test, which showed that agriculture growth Granger cause GDP growth, however, no reverse relationship was found, the resilient nature of the sector is evident in its ability to recover more quality than other sectors from shocks resulting from disruptive events such as

civil war and economic recession. (Biwet et al 2018)

From the empirical review above, most scholars using various techniques and data agreed from their empirical findings that agriculture had a positive and significant impact on economic growth of Nigeria. Notwithstanding, most of the farmers in the rural sector of the economy have no access to fund to enable them practice mechanized agriculture. Most of the farmers still practise subsistence agriculture which cannot take the country to any progress.

CBN publications confirmed the following attempts made in the past and presently to assist the sector in moving forward.

Agricultural Credit Guarantee Scheme Fund (ACGSF)

The ACGSF was established by Decree No. 20 of 1977, and started operations in April, 1978. Its original share capital and paid-up capital were ₦100 million and ₦85.6 million, respectively. The Federal Government holds 60% and the Central Bank of Nigeria, 40% of the shares. The capital base of the Scheme was increased to ₦3 billion in March, 2001. The Fund guarantees credit facilities extended to farmers by banks up to 75% of the amount in default net of any security realized. The Fund is managed by the Central Bank of Nigeria, which handles the day-to-day operations of the Scheme. The Guidelines stipulate the eligible enterprises for which guarantees could be issued under the Scheme.

Between 1978 and 1989 when the government stipulated lending quotas for banks under the Scheme, there was consistent increase in the lending portfolios of banks to agriculture, but after the deregulation of the financial system, banks started shying away by reducing their loans to the sector due to the perceived risk. In order to reverse the declining trend several innovations and products were introduced under the Scheme such as:

Application forms under the Scheme are obtainable from various branches of participating banks throughout the country. (CBN publication)

Agricultural Credit Support Scheme (ACSS)

The ACSS is an initiative of the Federal Government and the Central Bank of Nigeria with the active support and participation of the Bankers Committee. The Scheme has a prescribed fund of N50.0billion. ACSS was introduced to enable farmers exploit the untapped potentials of Nigeria's agricultural sector, reduce inflation, lower the cost of agricultural production (i. e. food items), generate surplus for export, increase Nigeria's foreign earnings as well as diversify its revenue base. At national level, the scheme operates through a Central Implementation Committee (CIC) while at the Federal Capital Territory (FCT) and State levels, the Scheme operates through State Implementation Committees (SICs) instituted to ensure that the objectives of the scheme is realized without hindrance.

To access loans under ACSS, applicants (practicing farmers and agro-allied entrepreneurs with means) are encouraged to approach their banks for loan through the respective state chapters of farmers associations and State Implementation Committees. However, large scale farmers are allowed under the scheme to apply directly to the banks in accordance with the guidelines.

ACSS funds are disbursed to farmers and agro-allied entrepreneurs at a single-digit interest rate of 8 percent. At the commencement of the project support, banks will grant loans to qualified applicants at 14 per cent interest rate. Applicants who pay back their facilities on schedule are to enjoy a rebate of 6 per cent, thus reducing the effective rate of interest to be paid by farmers to 8 per cent.

The Implementation Guidelines will be determined administratively as soon as a decision is taken on the proposed fund. (CBN publication)

Commercial Agriculture Credit Scheme (CACCS)

As part of its developmental role, the Central Bank of Nigeria (CBN) in collaboration with the Federal Ministry of Agriculture and Water Resources (FMA&WR) established the Commercial Agriculture Credit Scheme (CACCS) in 2009 to provide finance for the country's agricultural value chain (production, processing, storage and marketing). Increased production arising from the intervention would moderate inflationary pressures and assist the Bank to achieve its goal of

price stability in the country. The primary objectives of the Scheme are to:

1. Fast-track the development of the agricultural sector of the Nigerian economy by providing credit facilities to large-scale commercial farmers at a single digit interest rate;
2. Enhance national food security by increasing food supply and effecting lower agricultural produce and products prices, thereby promoting low food inflation;
3. Reduce the cost of credit in agricultural production to enable farmers exploit the untapped potentials of the sector; and
4. Increase output, generate employment, diversify Nigeria's revenue base, raise the level of foreign exchange earnings and provide input for manufacturing and processing on a sustainable basis.

The Scheme which is a subcomponent of the Federal Government of Nigeria's Commercial Agriculture Development Programme (CADP) is financed through N200billion Bond raised by the Debt Management Office (DMO). Loans to eligible entities under the Scheme are disbursed at a maximum interest of 9 percent. The subsidy arising from this stipulated rate and the market rate on all loans granted, and the administrative expenses of the Scheme are borne by the Central Bank of Nigeria (CBN).

The Central Bank of Nigeria and the Federal Ministry of Agriculture and Waters Resources jointly ensure that the scheme is implemented

successfully. This is achieved through the Project Steering Committee (PSC) comprising the Honourable Minister of Agriculture and Water Resources (Chairman), the Governor of the Central Bank of Nigeria, Representatives of the Federal Ministry of Finance and Commercial Farmers, respectively and the Programme Coordinator of the Commercial Agriculture Development Programme. The day-to-day implementation of the Scheme is undertaken by a Technical Implementation Committee (TIC) made up of the Director of Development Finance Department, CBN as the Chairman, Head of Agricultural Credit Support Division, CBN and a Consulting Group as members, and the Programme Coordinator of the Commercial Agriculture Development Programme of the Federal Government as the Secretary.

CACS is operated in two tranches of 100 billion naira each. The 1st Phase of the tranche ran from May to December, 2009, while the 2nd tranche commenced in February, 2010. (CBN publication)

The National Accelerated Food Production Project (NAFPP) was established in 1973 aimed at accelerating the production of major staple crops. The programme which has three components of research, extension and agroservices used improved practices in place of traditional ones. It also provided facilities like credit, marketing, storage and processing facilities to farmers.

Provision of Credit Facility:

The recognition of the role of credit facility to agricultural development prompted government to establish the Nigerian Agricultural Development Bank with its headquarters in Kaduna. The bank gives loan directly to individual farmers, organizations and established institutions. Other credits are made available for agricultural development by commercial banks through Central Bank credit guidance and the Federal Agricultural Guarantee Scheme.

The sector is quite relevant and it must be taken seriously. Financing the sector will take the Nation from old Nigeria to new Nigeria. The positive action will enable the real farmers to embrace scientific and technological advancement that will lead to sustainable development of the country.

3. Methodology

This paper was analysed using the descriptive statistics (percentage). The data was collected through primary source (questionnaire). One hundred questionnaires were administered to farmers in various villages and hamlets of Kabba/Bunu LGA to determine availability of funds to the agricultural sector. The responses shown in the empirical results are the reflection of what is obtainable in the state

which is may be applicable to the country as a whole.

4. Empirical Result.

This section presents the data analysis of the data collected from the survey.

4.1 Analysis and Presentation of Data.

Table 1: Distribution of Population

Age(Years)	Respondent	Percentage %
15 – 30	15	15.5
31 – 40	22	22.7
41 – 50	20	20.6
Above 50	40	41.2
Total	97	100

Source: Field Survey, 2022.

Table 1 indicates that 41.2% of the farmers are 50 years and above, while 58.8 are below the age of 50.

Table 2: Gender of the Respondents.

Sex	Respondent	Percentage%
Male	75	76.5
Female	23	23.5
Total	98	100

Source: Field Survey, 2022.

Table 2 shows that majority of the farmers are male by gender. While the male is 76.5%, the female is 23.5%.

Table 3: Type of Farming practise.

Type	Respondent	Percentage%
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Subsistence Farming	90	91.8
Mechanized Agriculture	1	1.0
Cooperative Farming	-	-
Plantation Farming	7	7.1
Total	98	99.9

Source: Field Survey, 2022.

The table 3 shows that majority in the local areas practise subsistence farming which have 91.8%. This may be as result of poverty and no assistance from anywhere. If financial assistance is given to the farmers, they will be able to practise the rest systems of agriculture i.e. mechanized agriculture, Cooperative and Plantation agriculture.

Table 4: Have you ever receive encouragement from the government in form of loan?

	Respondent	Percentage%
Yes	01	1.04
No	95	98.96
Total	96	100

Source: Field Survey, 2022.

Table 4 shows that no encouragement from government in form of loan. Only 1.04% of the farmers received loan from government. This confirmed that despite government interventions through various financial institutions, the real farmers are either ignorant of the interventions.

Table 5: Have you ever receive loan from Bank?

	Respondent	Percentage%
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Yes	02	2.2
No	93	97.8
Total	95	100

Source: Field Survey, 2022.

Few of the farmers were able to get loan from financial institutions as shown in table 5. Only 2.2% were able to get loan from financial institution. 97.8% of the farmers could not get bank loan since bank loan is always at high interest rate with collateral security.

Table 6:..Any inputs from government?

	Respondent	Percentage%
Yes	02	2.1
No	95	97.9
Total	97	100

Source: Field Survey, 2022.

Only 2.1% of the respondents were able to receive inputs like fertilizers, seedlings etc. from government. While 97.9% have not receive.

Table 7: Availability of equipment and institutions to assist farmers.

	Respondent	Percentage%
Yes	9	10.1
No	80	89.9
Total	89	100

Source: Field Survey, 2022.

Only 10.1% of the respondents were able to access equipment and institutional services. While 89.9% were not able.

Table 8. If you are encouraged by government, will you improve or mechanised your farming?

	Respondent	Percentage%
Yes	95	98.96
No	01	1.04
Total	96	100

Source: Field Survey, 2022.

If the farmers are encouraged by the government and they are able to get loan, inputs and other assistance, 99% of the respondents will improve their farming activities and this will improve the productivity of the sector and that is encouragement for sustainable development.

4.2 Conclusion and Recommendations

The importance of the agricultural sector cannot be over emphasized in economic development of any nation. For a sustainable development of any nation, the sector must not be neglected and it must be encouraged by the government. Importance of finance in the sector is the bone of contention in this research which have been confirmed and the need for government to take step in ensuring sufficient funds in the sector to boost the increase in productivity is emphasized. If positive steps are taken, the sector will surely ensure sustainable development of the economy of Nigeria.

With the findings of this work and for agriculture sector to perform its function of providing food for the populace, raw materials for industries, income for farmers, employment opportunities, and others that any economy cannot do without, the researcher recommends the following;

1. Credit facilities should be made available to the real farmers which will definitely change their

status from subsistence farmers to mechanized farmers. This will go a long way to increase the productivity of the sector and lead to sustainable development. It will also affect the gross domestic product of the country and this will have a multiplier effect on the balance of payment of the country.

2. Equipment should be made available to the sector from federal, state and local government. The progress in the sector earlier on was positive when Nigeria gained her independence. This was as result of serious encouragement from government. Tractors, harvester etc. were made available by government through federal ministry of agriculture and state ministry of agriculture with their branches all over the country. These are no more available. Government should go back to

such projects and that will assist the country to move forward towards sustainable development.

3. Institutions and programmes established to grant loans to farmers should be revived and ensure the credit facilities get to the real farmers.

Such institutions include Agriculture Bank, Agricultural Credit Guarantee Scheme Fund (ACGSF), and Commercial Agriculture Credit Scheme (CACS).

4. A body should be set up by the government to monitor institutions and programmes of government for efficiency and proper management to achieve government purpose. Loans given should also be monitored for proper usage.

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THE EFFECTS OF SMARTPHONE FEATURES AND SETTINGS ON ENERGY CONSUMPTION DURING WHATSAPP CALLS: AN EMPIRICAL STUDY

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Abstract

The advent of the mobile phone and emerging technologies has improved the channel of communication. The challenges posed by geographic location and analogue telephony have been bridged with the introduction of social media platforms such as WhatsApp with call features. However, a significant portion of the battery is consumed during WhatsApp calls, which is a problem for users, as the application runs on devices that are limited in battery. Therefore, this study carried out an empirical study to determine possible ways to minimise power consumption during WhatsApp calls. PowerTutor was used to capture the energy consumed in Joules while phone features such as brightness, Wi-fi, Global System for Mobile communication (GSM), and low data usage settings were varied. The experiment was carried out on mobile phones running an android operating system. The outcome of the study showed that changing phone features and settings can affect battery drain during WhatsApp calls. This paper provides new insights into optimising energy usage during WhatsApp calls and the results showed users have a level of control on energy being consumed by their mobile phones. We suggest that the screen brightness should not exceed medium, Wi-fi with a strong network signal, and the low data usage in the WhatsApp setting be turned on. An improved energy consumption measuring tools for mobile apps will increase the quality of data captured for the method used during the empirical experiment and achieve better greener application.

Keywords: Battery, WhatsApp, Energy Consumption, Phone, Video, Voice, Call.

1.0 Introduction

WhatsApp started as a Mobile Instant Messaging (MIM) application with the capacity to share real-time text, videos, and audio files. This is an improvement to the traditional Short Message Service (SMS). The ability to have a group chat that simulates the one-on-one conference gave WhatsApp a more competitive edge over SMS. The application evolved to include features for audio and video calls.

Recently, 1.5 billion users in 180 countries were reported to use Whatsapp, and daily active users were set at 1 billion as of October 2018, thus ranking as the most used messenger application (Mansoor I., 2019). With the high usage of mobile phones, the decrease in the price of data by service providers, and the increased engagement on social media platforms; WhatsApp call has become one of the adopted platforms for real-time audio and video communication.

WhatsApp statistics indicated that users make 2 billion call minutes per day and 55 million video calls are made per day, with a total of more than 340 million video call minutes per day through the platform (Craig S., 2019). The application is available on iPhone, Android, and Windows Phones and can run on laptops. These phones can call and receive calls using Whatsapp. The application uses intensively the phone's hardware components, such as the camera, the screen, the audio, and the video components, to provide the voice and video calls. Taking into account the different components involved

during WhatsApp calls coupled with other applications running in the background, high battery or power consumption depletion becomes a challenge.

Although efforts are being made to increase the battery capacity of smartphones; tasks carried out on the phone call for a perimeter approach. Due to the frequent usage of WhatsApp to make calls and the tendency of draining the battery during operation. It has become necessary to identify the factors that influence power consumption and suggest possible solutions.

The objective of the paper is to carry out an experiment to identify factors that trigger power consumption and manipulate associated variables to minimise battery depletion during WhatsApp calls.

2.0 Related Work

Li et al. (2014) carried out an empirical study on the energy consumption of android applications. To generate data for the empirical study, applications were downloaded from the Google App Store. The outcome of the study showed that the network, the APIs of the system and the loops are factors that affect energy consumption in Android applications.

Jofri et al. (2017) analysed quality of experience (QoE) and energy consumption on mobile phones while video streaming. A hybrid energy-sensitive profiler and video streaming application were developed for the purpose of energy consumption analysis. The outcome of the analysis showed that resolution, frame rates, and other variations in video attributes are

factors that contribute to energy consumption in mobile phone streaming videos. However, the analysis did not establish the effect of the strength of the Wifi connection on power consumption while streaming videos online.

Ding et al. (2013) carried out a study to establish the impact of wireless signal strength on energy consumption in mobile phones while transferring data. A power model for 3G and Wi-fi technologies was developed which showed that the strength of the wireless signal affects the battery drain in mobile devices while transferring data, voice inclusive over a network.

High energy consumption was observed when voice over Internet Protocol (VoIP) is made over Wi-Fi. To address the energy consumption challenge, Agarwal et.al (2007) developed the Cell2Notify energy management architecture. Cell2Notify disables the Wi-Fi radio when VoIP is in an idle state and enables the radio when a VoIP call is initiated. The energy management mechanism adopted by the authors extends the battery lifetime of VoIP over Wi-Fi enabled smartphones.

Sharrab and Sarhan (2017) analysed the power consumed in live video streaming systems. The authors developed a model to maximise the power consumption, bitrate, and quality of live video streams. These were achieved by varying the camera's features such as resolution, frame rate, and quantisation.

However, despite previous studies, there is still much to examine about the power consumed by

the application and possible ways of minimising power consumption.

3.0 Methodology

To conduct the empirical study, WhatsApp was installed and running on Sony Xperia M4 Aqual Dual and Techno Droipad 10D P904 phones. The specifications for the phones used for the experiment are listed in table 3.1 and table 3.2. The two phones used both run the Android operating system. The choice of Android OS for the experiment was attributed to the operating system's popularity and Whatsapp users being predominantly accessing the messaging application via Android phones (Sawer, 2015).

PowerTutor 1.4 was installed on the Sony Xperia M4 Aqual Dual to measure the energy consumption of the WhatsApp messaging application. The android phones were charged to 100% and unplugged from the mains to rely solely on the phone's battery. Hardware-based energy measuring tools specifically designed for energy measurement may give a more accurate result. However, it may be difficult to measure energy consumed by specific app on the phone.

The Wi-fi sensor was disabled when the GSM network connection was in use during the experiment. Other sensors such as GPS, and Bluetooth were disabled. The experiment was carried out on the Sony Xperia M4 Aqual Dual phone while the Techno Droipad 10D P904 was used to observe the quality of video and audio output while manipulating settings (phone and WhatsApp) to minimize battery drain in the Sony Xperia phone. For the purpose of the

empirical study, WhatsApp calls were benchmarked to 60seconds.

Phone Features	Values
Name	Sony Xperia M4 Aqua Dual
Resolution	720 x 1280 pixels
Operating System	Android 6.0.1 (Marshmallow)
Screen Size	5.0 inches
Front-Facing Camera	5MP
Battery	Li-Ion 2400 mAh
RAM	2GB

Table 3.1: Phone 1 Specifications

Phone Features	Value
Name	Techno Droipad 10D P904
Resolution	1280 x 800 pixels
Operating System	Android 7.0 (Nougat)
Screen Size	10.1 inch
Front-Facing Camera	2MP
Battery	Li-Ion 7000mAh/4.35v
RAM	2GB

Table 3.2: Phone 2 Specifications

4.0 Results and Discussions

Brightness	Energy Consumed in Joules (Video Call)	Energy Consumed in Joules (Voice Call)
Low	3.5	1.4
Medium	4	1.5

High	6	2.8
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Table 4.1: Energy Consumed during WhatsApp Video and Voice calls with varying Screen Brightness

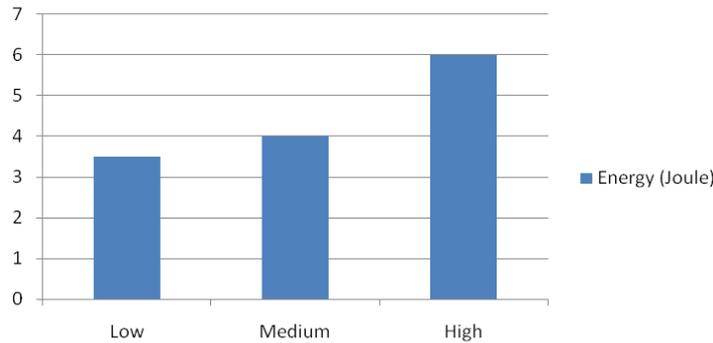


Figure 4.1: Energy Consumed during a video call with screen brightness variation.

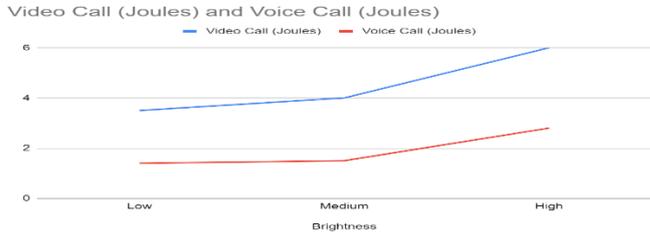


Figure 4.2: Energy Consumed during a voice call with screen brightness variation.

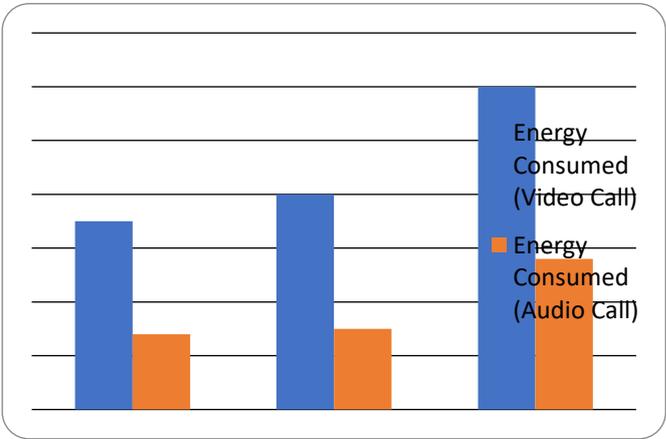


Figure 4.3: Energy consumption comparison between a video call and a voice call.

Attributes	Energy Consumed in Joules (Video call)	Energy Consumed in Joules (Voice call)
Wi-fi	2.3	1.8
GSM	3.6	2.8
Low data usage – ON	1.8	1.7
Low data usage- OFF	2.3	1.7

Table 4.2: Energy consumed during video and voice calls with network connections and data usage consideration.

Figure 4.5: Energy consumed during video call for different network connections and data usage.

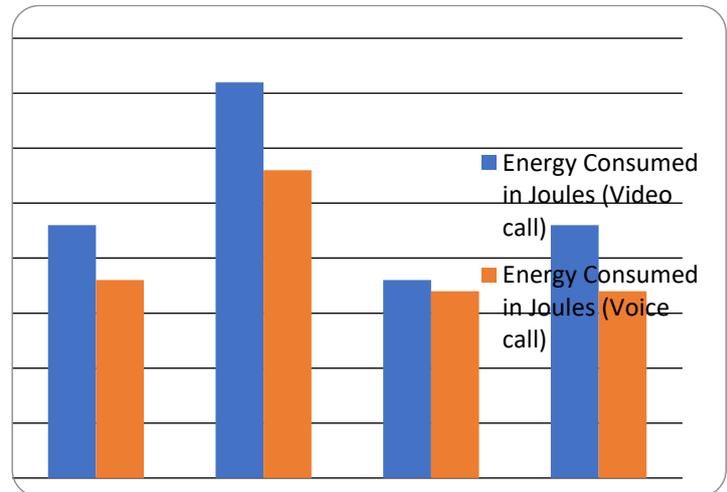


Figure 4.6: Comparison between video and voice calls with different network connections and data usage considerations.

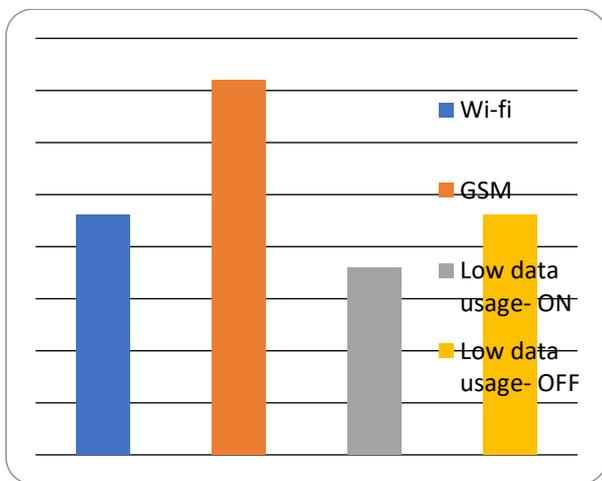
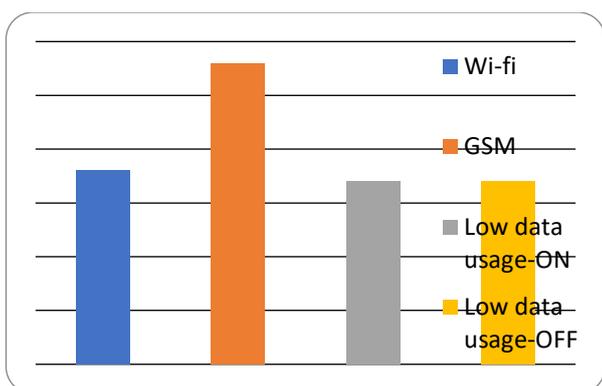


Figure 4.4: Energy consumed during video calls for different network connections and data usage.



From Figures 4.1 and 4.2 energy consumed increased with the level of screen brightness. High screen brightness consumed more energy, followed by medium while low screen brightness consumed the lowest energy. The difference between the energy consumed by low and medium screen brightness is small compared to the difference between medium and high. The implication is, that high screen brightness consumes more energy which translates to high battery drain while making video or voice calls. This corroborates the study by Carroll and Heiser (2010), which showed that phone brightness contributes considerably to the power dissipated in a smartphone.

The results in table 4.1 and figure 4.3 show that video calls on WhatsApp dissipate more energy than a voice call. The results are in line with a study carried out by Xiao et. al (2015) which

showed that real-time video calls are power-hungry and consume high power.

Results in figure 4.4 and figure 4.5 show that more energy was dissipated during video calls using GSM as the network connection. The low data usage setting in WhatsApp affects the energy consumption. The comparison in figure 4.6 shows that network connectivity plays a vital role in energy consumption.

5.0 Recommendations

For optimal energy usage during WhatsApp calls, we suggest the screen brightness should not exceed medium, Wi-fi with a strong network signal, and the low data usage in the WhatsApp setting be turned on.

Future research will focus on analyzing Quality of Experience (QoE) tailored to predict users' behaviour for effective energy management during WhatsApp calls. This will help strike a balance between energy saving and user preferences.

6.0 Conclusion

Video and voice calls using WhatsApp are battery-draining tasks. In this paper, we carried out an empirical study to explore possible factors that contribute to energy consumption while using WhatsApp for calls. The phone screen brightness, network connection, and data usage were varied and energy consumption was captured. Based on the data gathered during the empirical study, it was observed that altering the phone settings, turning on low data usage and network signal strength and Wi-fi can reduce battery drain when properly managed during WhatsApp calls.

Energy consumption based on 4G and 5G network were not extracted during the measurement. Furthermore, energy consumed by similar apps were not captured since the experiment focused on WhatsApp. Future works may consider measuring energy consumption using the new and evolving internet technologies and determine the impact of these network signals on energy consumption in WhatsApp and similar apps.

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**DEPARTMENT OF LIBRARY AND INFORMATION SCIENCE,
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Abstract

In accomplishing academic goal, access and retrieval of right information from the right sources using digital resources is very crucial. This paper explores on digital information resources for effective information access and retrieval in Federal Universities. The objective of this study is to identify digital resources that are available in the Universities. Through integral analysis of literature, the paper gave an in – depth evaluation of various concepts and types of digital resources that are available in Federal University Lokoja. In addition, the paper described librarianship in digital era, exploring the roles of digital librarians as negotiator, navigator, facilitator, educators and entrepreneur [marketing library services]. The paper further examines level of accessibility and retrieval of those resources by the users, which identified and reported a number of challenges which include: inadequate found epileptic power supply, lack of skills, frequent breakdown of network, etc. It was recommended that regular power supply, Re-skills of librarians, budget allocation for development of digital resources, improve on networking in other to overcome those challenges. It is believed that the framework will serve as a working tool for librarians and other stakeholders in ensuring effective uses of digital information resources.

Keywords: University library, Digital Librarian, Digital Information, Resource, Digitization,

1.0 INTRODUCTION

Dissemination of Knowledge through the provision of information resources has been observed to have grown tremendously in recent time. Hence the reason print resources lack the capacity to store information of this quantity. According to Nkoyo (2009), the invention of computers and other telecommunication technology resources in the 21st century gave so much access to information. However, the use of traditional library services till today still serves as a relevant tool for providing information resources to Students and researchers in Nigeria universities. Despite this, digital approach apart from being a current global trend cannot be compared in terms of function and access to easy usage. Advances in technology have resulted to the change from traditional system of searching information to an e-system of accessing and retrieving information. However, in this context, digital resources will be uses interchangeable with electronic resources (e-resource). The increased use of digital information resources has become common in today's universities compared to before, where printed information resources that have been used for research and teaching at universities around the world for centuries, digital resources are more convenient to access, easy to search, and downloadable. Okore et al. (2009). identified specific types of electronic information resources as consisting of electronic books (e-books), electronic journals (e-journal), e-proceeding, e-newspaper, e-reference etc.

Digital information resources in the expression of Okoro, (2008). in Oghenetega

(2014). are library materials produced in digital formats, such as, e-journals, e-books, reference work published online and CD-ROM, bibliographic databases, and other web based resources. The understanding of Okoro, (2008). in Oghenetega, (2014). shows digital information resources is not limited to only internet materials or resources but also encompass electronic library resources such as PC, CD-ROM, DVD etc However, digital information resources are still not universally available and accessible as their use can be sometimes very expensive. The purpose of this study is to identify the types of digital resources that available and examine the roles of digital librarian in digital era.

METHOD

This study employed the descriptive method of research, specifically the documentary analysis type in consulting the available records in the library. These records are the daily statistical records on the access and retrieval of digital resources, and user's statistical records generated from the databases. This method designed to gather factual and evidence-based information on the assessment of the digital resources. Documentary analysis is an investigation of a work in a visual presentation focus in a factual and informative manner. In addition, the researcher used the observation approach to identify the problems encountered by the users. of Libraries. Recorded their comments, complaints, problems encountered pertaining to digital resources access and retrieval. In the same vain, the researcher also observed twenty (5) faculty and staff members who utilized the electronic resources.

UNIVERSITY LIBRARY

The University libraries have long been recognized as the heart of the universities, to fulfil the mission of supporting the educational objectives of their parent bodies, which include teaching, learning, research and cultural development, the libraries had to develop and maintain standard books, journals, audio visual and electronic collection and services. University Library is referred to as the library established within a degree awarding institution generally for learning and research purposes (Bappah, 2011). However, the major objective is to assist the institution in which it is established to achieve excellence in teaching, research and extension work. Similar to this are the assertions of Reitz (2004) who reveals that a university library has the function of meeting the information, research, and curriculum needs of its students, faculty and staff in general. In the words of Aina (2004), the main purpose of a university library is to support the objectives of a university which are in the areas of learning, teaching, research and service. Ekere (2006) also shared this view by making an assertion that, the main purpose of the university library is to support the objectives of the university which is to promote teaching, learning and research. Thus, the university library is meant to serve the undergraduates, postgraduates, lecturers and other members of the university community. Bringing out further the idea behind the establishment of a university library, Kumar (2006) argued that a university library is a part of a university set up. Therefore, it exists to serve the objectives of its parent organization. In the claims of Chiemeké (2007) as cited in Joseph et al (2021),

the university library also helps as a medium of getting the latest scientific and technological information either in print or electronic form. By the turn of the 21st century, libraries in most Nigerian universities had become automated and the Internet had revolutionized information access thereby making the objectives of the library achievable. The university library takes advantage of these developments in providing so many services using digital information resources.

LIBRARY AND INFORMATION SCIENCE IN DIGITAL ERA

Libraries are design as non-profit organization, which developed their product called information. In other to create a positive image, the library must demonstrate their marketing approach in other to ensure effectiveness and efficiency in LIS.

According to Shuling, (2007), electronic information resources have gradually become a major resource in every university library. The emergence of electronic information resources, has tremendously transformed information handing and management in academic environments and University libraries in particular.

Thus, the librarian has the sole responsibility of performing professionalism in ensuring that information resources are electronically made available for users. In the same vein, Sreenivasulu, (2010), defines a digital librarian as a specially trained person who with a sense of professionalism manages and organizes the digital library.

The rapid development of technology in recent times have exposed new generation librarians, Currently, the role of librarians and

information professionals is to facilitate access to documents over the networks at the global level. The basic philosophy of librarianship is changed in delivering the electronic services to the user, and since time immemorial, libraries have used different mechanisms to do that, from Dr S.R. Ranganathan Librachine today's digital repositories. Librarians need to and are trying to build upon this foundation and leverage new technologies to build future services in libraries.

In the words, of Cox & Corral (2013). describe key evolving specialties in modern librarianship: digital librarians, system librarians, repository managers, digital curators, information managers and knowledge managers. Currently, a digital librarian is responsible to functionality for information storage, organize, data curation, metadata creation, knowledge mining, digital reference services, electronic information services, distribution of information, coordination with aggregators, discovering and accessibility of information on the web, Internet-based WWW, multimedia access and retrieval. Nowadays, the role of a librarian has completely changed in the digital environment. However, the fundamental roles of the digital librarian is as a result of changes experienced in technological innovations which led to the establishment of digital library against the traditional form that was long in practice.

According to Senthilkumar, (2010), the digital approach changed the work schedule of librarians to Negotiating, Navigating, Facilitating, Educating, (Library marketing services), Information filtering and many more. In similar view, Singh (2017) asserts that the role of librarians changed when their orientation of digital library

services with electronic devices upgraded. However, the changing roles and responsibilities of digital librarianship in Nigerian university libraries did not just start in one day rather it gradually changed through process as a result of rapid technological growth globally.

ACCESS AND RETREIVAL OF INFORMATION RESOURCES

Digital resources are valuable research tools in the 21st century knowledge management, thus, there is need for library to make those resources available for accessibility and in other to make retrieval effectively. Information Access is the ability to identify, retrieve, and use communicated knowledge or database effectively. Information retrieval on the other hand, is the recovery of information especially in a database stored in a computer or other electronic mediums. The goal of information access is to provide users with informative documents that satisfy them. This further explained that information access is a process by which users use information technology to seek, organize and understand information while information retrieval (IR) means to retrieve documents that users are likely to find relevant to their queries.

Agulu & Aguolu, (2002) defines accessibility as the means by which users can identify and use library resources that are available. Library resources can be inaccessible due to poor cataloging, poor arrangement or resources on shelves, poor labeling of books resources, and in a case of electronic resource, inaccessibility can be caused by electricity outages, low bandwidth and

lack of information literacy skills. Also, electronic resources can be inaccessible due to inadequate computers, need for password, and language of the document, lack of searching skills, and lack of computers literacy skills, difficulty searching and navigating within a library website, cost of printing and photocopy at the library, shortage of knowledgeable librarians, lack of customer orientation and electricity outages. Also Ugah (2008) and Adulsalami (2013) further identified natural and artificial barriers to free access to information. The libraries' poor reputation was attributed to a lack of accessibility to information.

Information Retrieval is a process, methods and procedures of searching, locating and retrieving recorded data and information from a file or data base. (Wikipedia, 2020). Information Retrieval can also be view as a science of searching for information in a document, searching for documents themselves, and also searching for the metadata that describe and data, or sound. The term has been correctly described as the process, methods and procedures used to selectively recall recorded information from a file or database (Reitz, 2004). Simply defined, Information Retrieval is the act of extracting information, recorded and unrecorded, from any receptacle or warehouse for onward dissemination or circle Information Retrieval activities are concerned with the organization, processing and access to information, irrespective of the form and formats. The following are the types of digital resources that are access and retrieve in some of our Universities Library include: e- journals, e- proceeding, e- book, e-newsletters, e- technical report, e- references materials, e- seminal, e- thesis, e- dissertation and e- project.

REVIEW OF RELATED EMPIRICAL STUDIES

In the work of Nwabueze and Urhiewhu, (2015) on the Availability and Use of Digital Information Resources by Undergraduates of Universities in Delta and Edo States, Nigeria shows an empirical view on the use and availability of digital resources... The observation checklist shows that none of the University libraries has e-Conference papers. Empirical studies show that at the Ambrose Ali University Library, ten types of digital information resources out of the thirteen types of digital information resources checked were available. The available digital information resources in the library are e-Journals; e-Technical report; e-Reference materials; e-Proceedings; e-Zines; e-Books; e-Newsletters; e-Grey document; e-Thesis; and e-Dissertation and all of them are six million, five hundred and fourteen thousand and seventy-eight (6, 5514078) in number. On the other hand, results from empirical study by Nwabueze and Urhiewhu, (2015). shows that at the Delta State University Library, four types of digital information resources are available. They are e- journals; e- proceedings; e- Books; and e-newsletters and the entire are fourteen million and two thousand four hundred and forty-five (14, 002445) in number.

Empirical result from the work of Ndakalu (2014) on Access and Utilization of Digital Information Services in Academic Libraries: the Case of University of Nairobi established the different digital information services available and accessible through library's homepage. The study findings shows that majority of the respondents used electronic journals (60%), 36% accessed online

public access catalogue, 33% preferred electronic books and 33% chose institutional repository. The study found out that majority of the respondents used electronic Journals as the preferred digital information resources.

PROBLEMS ENCOUNTER IN ACCESSING AND RETRIEVAL DIGITAL INFORMATION RESOURCES.

The above study reveal the following as the basic problems, which include: lack of funds; epileptic power supply; non-availability of online databases; inadequate number of computers to access digital information resources; inadequate bandwidth; Network problems; lack of skill to access digital information resources in local and foreign databases; Lack of formal training on internet use; Server slowness and frequent breakdown of digital resources are constraints to students effective use of digital information resources in accessing digital information resources were encountered by them as they tried to access the digital information resources.

BEST PRACTICES FOR ADDRESSING ACCESS AND RETRIEVAL ISSUES IN DIGITAL ERAs

1. Provision adequate/regular power supply.
2. Availability of online database in other to make retrieval easy.
3. Provision of adequate computers to access digital information resource.
4. I C T infrastructural development project.
5. Re- skills of librarian.

6. Formal training should be provided on internet usages.

7. Budget allocation for development of digital resources.

8. Libraries should improve on their networking in order to counter slowness and breakdown of network.

CONCLUSION

University library environment is changing drastically, with that university librarians are advice to keep pace with the trends otherwise they will be left behind. There is a need for library in provision of digital resources as well as keeping tracks of ICT resources in other to provide unlimited access to digital information resources. The success of University libraries in 21st centaury depend on provision, management and accessibility of digital information resources, which contend with the problem associated with administrative policies / practices, funding, staffing and digital information resources provision using ICT.

RECOMMENDATION

Based on the findings, of this study, the following recommendations are made:

1. Budget allocation for development of digital resources.
2. Re- skilling of librarians
3. Improve on network and networking systems of Nigeria universities.
4. Regular power supply.
5. ICT infrastructural development.

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SUSTAINABLE DEVELOPMENT IN NIGERIA: THE PIVOTAL ROLE OF LITERATURE**BY****BAJEH HAYATU,****OLANREWAJU FASASI AMINU****&****SUNDAY OGUCHE****KOGI STATE POLYTECHNIC, LOKOJA***Abstract:*

The rapid social and economic growth in Nigeria has an adverse effect on the environment and increased social inequality, necessitating a focus on sustainable development. Literature offers a promising platform for promoting sustainable development in Nigeria through the creation of awareness, promotion of social justice, and inspiring creativity or change. This paper aims to investigate the role of literature in promoting sustainable development in Nigeria and highlighting its significance in tackling the challenges that impede the achievement of sustainable development, including environmental degradation, poverty, and inequality among others. The methodology employed in this paper encompasses a multi-faceted approach to explore the role of literature in fostering sustainable development. The study also spotlights literary works that encourage sustainable development in Nigeria while emphasizing the potential of literature to inspire positive change. This study finds that literature holds the potential to inspire critical thinking, drive positive change and foster development.

Keywords: Sustainable, Development, Literature, SDG's, Nigeria

INTRODUCTION

Sustainable development is a global discourse that is resonant in developing countries in Africa, like Nigeria, where social and economic growth are pressing issues. In recent years, Nigeria has experienced rapid social and economic growth, but this growth has come at the cost of environmental degradation, pollution, public health hazard, and social inequality among others. As a result, there is an urgent need to balance economic development with environmental protection and social equity to achieve sustainable development in Nigeria. This necessitated the need to adopt a viable approach to achieving a development that is sustainable and in tandem with the global sustainable development goal demands.

Therefore, in line with historic steps taken by the world leaders at the 70th United Nations General Assembly in September 2015, Nigeria adhered and adopted the sustainable development 2030 global goals agenda. According to Nigeria's A Second Voluntary National Review (2020), The 2030 Agenda for Sustainable Development envisions a present and a future that is economically sustainable, socially inclusive, and environmentally resilient. This simply aligns with the universal charge to end poverty, protect the planet and ensure world peace and prosperity by the year 2030.

However, Literature has been established as a powerful tool for expression and it can promote sustainable development because it has the ability to reach and capacity to shape attitudes,

belief systems, behaviors, and people. This paper explores the role of literature in promoting sustainable development in Nigeria.

WHAT IS SUSTAINABLE DEVELOPMENT?

There are many definitions of Sustainable development abound. The Brundtland Commission's published report 'Our Common Future' defines it as Development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (United Nations General Assembly, 1987). The UN declaration of the 2005 World Summit refers to the contours of sustainable development as economic development, social development, and environmental protection. Also, Developmental educationist describes the term as 'the reduction of hunger and poverty in environmentally sound ways. It includes meeting the basic needs, expanding economic opportunities, protecting the environment, and promoting pluralism...' Nonetheless, Sustainable development is a concept that seeks to balance economic growth with environmental protection and social equity for present and future endeavors.

Sustainable development aims to meet the needs of the present generation without undermining the integrity of natural systems or compromising the ability of future generations to meet their own needs. The key components of sustainable development include environmental protection, social equity, and economic growth. Ejumudo

(2015) posits that central to sustainable development is efficient and effective natural resource management which encapsulates economic, social, and environmental components and requires societies to pursue growth paths that generate an optimal flow of income built on the twin principle of equity and justice. Before development can be considered sustainable, it must consider the pertinent issues, ranging from public health, energy consumption, waste management, social justice, environmental and climate change among others. It must also integrate socio-economic and environmental concerns into aspects of decision-making. Moreover, the key principle of sustainable development underlying all others is the integration of environmental, social, and economic concerns into all aspects of decision-making. All other principles in the SD framework have integrated decision-making at their core (Dernbach J. C., 2003; Stoddart, 2011). It is this concept of integration that differentiates sustainability from other forms of policy. Emas (2015) posits that the overall goal of sustainable development (SD) is the long-term stability of the economy and environment; this is only achievable through the integration and acknowledgment of economic, environmental, and social concerns throughout the decision-making process. The Sustainable Development Goals, adopted by the United Nations General Assembly in September 2015, span from 2016 through 2030 and formally represent the basic objectives of the United Nations. The 2030 Agenda for Sustainable Development outlines the vision, principles, and commitments toward

creating an equitable and more sustainable world for all. Its goals are 17 in number and 169 targets. A list of the goals are as follows: Zero Poverty, No hunger, good health and well-being, clean energy, clean water, gender equality, quality innovations, economic growth, quality education, responsible production and consumption, climate action, peace, and justice among others. These goals are subsumed under 5 critical areas also known as the '5 P's'. "These are People, Planet, Prosperity, Peace And Partnership"(Morton et'al., 2017). Meeting these goals can only be possible when certain measures are put in place but corruption in developing countries has indeed been an impediment to sustainable development. It stands as a major barrier to sustainable development in developing countries like Nigeria, creating significant challenges in the pursuit of its objectives.

THE CHALLENGES TO SUSTAINABLE DEVELOPMENT IN NIGERIA:

Nigeria faces several challenges in achieving sustainable development, including Poverty, inequality, environmental degradation, public health, climate change, etc. she is also among the list of the of countries struggling with environmentally degradation, including deforestation, desertification, and pollution as major environmental challenges. This is a result of the nefarious activities carried out by miners, oil and gas companies, vandals, etc in the different regions of the country. Environmental degradation according to Asaju & Arome (2015) is a process by which the resource base (air, water, soil/land) becomes depleted, thereby

reducing their originality and quality. This affects the general health of the biological environment. Air, water, and soil/land are the major resources that are vulnerable to depletion or being degraded through overuse and unfriendly human activities. The pollution caused by environmental degradation has reached its all-time high in places like the Niger Delta where available data shows that "the terrain has been overrun through deliberate over-exploitation carried out in total disregard for the basic principles of sustainable development management" Admin(2010). Gas flaring, water pollution caused by pipeline vandals, and air pollution have been a problem since oil exploration started in the region many decades ago one of the challenges of achieving sustainable development in the region.

Poverty also stands as one of the major causes and effects of environmental degradation (World Commission on Environmental and Development, 1987). The strong desire of impoverished rural residents to meet their basic needs compels them to exploit the limited natural resources in pursuit of financial stability and food security. However, these actions present significant obstacles to achieving sustainable development in Nigeria.

Poverty and inequality are also major challenges in Nigeria as a large amount of the population lives in poverty. Poverty has been classified into three groups: absolute, relative, and subjective poverty. Absolute poverty occurs where the citizens lack adequate resources particularly real income to obtain the basic needs required to

enjoy the barest minimum standard of living. Absolute poverty is more prevalent in Nigeria and relevant to this discourse because a major part of the citizens wallows in multidimensional poverty. According to statistica, In 2023, nearly 12 percent of the world's population in extreme poverty live in Nigeria, considering the poverty threshold set at 1.90 U.S. dollars a day (Sasu, 2023). A country with this high percentage of poverty rate despite its mass of resources cannot be regarded as sustainable or developed. Corruption also poses a significant threat to sustainable development because it enables the diversion of resources away from their intended purposes. This is one of the root causes of poverty in the land wherein the scare resources meant for all are embezzled by a few. Also, the Illegal activities on the environment such as illegal logging, wildlife trafficking, and illegal fishing driven by corruption not only deplete natural resources but also contribute to deforestation, biodiversity loss, and habitat destruction. Additionally, corruption can hinder the implementation and enforcement of environmental regulations, policies allowing polluters to operate without consequences and exacerbating environmental degradation.

ROLE OF LITERATURE IN PROMOTING SUSTAINABLE DEVELOPMENT IN NIGERIA:

The power of literature to advance sustainable development in Nigeria resides in its ability to raise awareness, advocate for social justice, and ignite creativity. Through literary works, authors have the capacity to educate and sensitize readers

about the significance of environmental protection, carbon emissions reduction, and preservation of natural resources. Literature has been playing a vital role in promoting social justice and equality by addressing topics related to gender, race, class, and culture that have positive impact on sustainable development. It also contributes to economic growth and development in Nigeria by inspiring innovation, entrepreneurship, and creativity. Additionally, literature provides insights into the role of culture, traditions, and indigenous knowledge in sustainable development. Specifically, Nigerian literature has played a pivotal role in promoting sustainable development. For example Nigerian literature has been used to address environmental challenges such as deforestation, desertification, climate change and eco criticism. Nigerian writers have also used literature to advocate for sustainable environmental practices and raise public awareness about environmental issues (Akinyemi & Adeyemi, 2018). Similarly, literature has been used to promote social sustainability in Nigeria. Writers have used literature to advocate for gender equality, human rights and inclusive economic growth, contributing to social cohesion and economic development. (Ogunyemi, 2016). Literature has also been used to promote cultural sustainability in Nigeria. Nigerian writers have used literature to preserve indigenous knowledge and practices that contribute to sustainable development. By promoting local knowledge systems and traditional practices, literature has helped to promote sustainable development while preserving cultural heritage (ogundele, 2016).

There are numerous examples of Literary Works Promoting Sustainable Development in Nigeria abound. These literary works promote sustainable development in Nigeria, including drama-plays, poetry and prose. For instance, Chinua Achebe's "Things Fall Apart" (1958), highlights the impact of colonialism on the environment, culture and development in Nigeria. "The Palmwine Drinkard" by Amos Tutuola, (1952), portrays the relationship between humans and nature and the importance of preserving the environment, it also spotlights culture, development and sustainability. "Half of a Yellow Sun" by Chimamanda Ngozi Adichie, (2006) addresses issues of gender, war, and social justice in the context of Nigeria's history. It also explores sustainable development overtly in the regions explored. Helon Habila's "oil on Water" (2010) is a notable Nigerian novel that takes a deep dive into the Niger-delta region, exploring the effects of oil exploration on both the environment and society. Its spotlight the environmental decline and other prevalent issues bedeviling the region. Nevertheless, Niyi Osundare's poetry, "The Eye of the Earth" (1986) spotlights the mitigating effects of deforestation, pollution, and waste on the world's climate. This collection of poems emphasizes the need to appreciate, and preserve nature and its inhabitants such as man, animals, plants, and water. Osundare captures this notion in his preface to the collection of poem

"waters are dying, forests are falling. A desert

Epidemic stalks a world where the rich and ruthless

Squander Earth's wealth on the investment of

Increasingly accomplished weapons on of death,

While millions of people perish daily avoidable hunger (1986: xvi).

These lines from Osundare's preface provided seems to describe a grim situation where various aspects of the environment and society are deteriorating. For example, "Waters are dying, forests are falling": This implies that bodies of water, such as rivers, lakes, and oceans, are becoming polluted, contaminated, or depleted. Similarly, forests, which are vital ecosystems, are being destroyed or cut down at an alarming rate.

"A desert": This line suggests that the overall condition of the environment is becoming barren, lifeless, and resembling a desert. It symbolizes the degradation of ecosystems, loss of biodiversity, and the absence of natural resources.

"Epidemic stalks a world": This indicates the presence of a widespread and severe disease outbreak that is affecting the entire world. The term "stalks" suggests that the epidemic is spreading menacingly, causing fear and uncertainty.

"The rich and ruthless squander earth's wealth": This highlights the actions of wealthy and unscrupulous individuals who misuse or waste the planet's resources. They exploit and deplete natural wealth without considering the long-term

consequences, exacerbating the problems faced by the environment and society.

"Investment of increasingly accomplished weapons of death": This refers to the allocation of resources and funds towards the development and improvement of highly lethal weapons. It suggests that significant investments are being made in military technology, focusing on destructive capabilities.

"Millions of people perish daily from avoidable hunger": This points out the tragic reality that millions of individuals lose their lives due to preventable starvation or malnutrition-related causes. It highlights the stark contrast between the excessive wealth possessed by some and the widespread poverty and food insecurity experienced by many.

In summary, these lines paint a bleak picture of a world facing environmental degradation, a rampant epidemic, disproportionate wealth distribution, and the tragic consequences of hunger and poverty. It emphasizes the urgent need for responsible resource management, humanitarian efforts, and a focus on addressing these global challenges. Like other Nigerian writers, Niyi Osundare's preoccupation in his poetry collection of poems *The Eye of the Earth* emphasizes on human responsibilities and actions to save nature as well as reconcile it with humanity. It is a clarion call on the appropriate authorities to take action to save the earth in order to achieve sustainable development through sustainable practices.

Literature, through various forms such as storytelling, drama enactment, and poetry, showcases the problems, solutions and ideas for sustainable development. It serves as a powerful tool to inspire individuals and authorities to take action, enforce laws and drive sustainability efforts. Additionally, literature gives a platform for marginalized communities in Nigeria like the Niger-Delta regions battling with oil spillage and ecosystem depletion by bringing their issues to the fore front and advocating for social justice.

In conclusion, literature has a crucial role to play in promoting sustainable development in Nigeria. By raising awareness, promoting social justice, equity, and inspiring creativity, literature contribute by disseminating knowledge and information about sustainable practices and equitable lifestyle. It also has a positive impact on the emotions, intellect and morality of the

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readers, making them mindful of the need for sustainable development.

RECOMMENDATION

Despite years of independence, multiple military and democratic transitions, Nigeria continues to struggles with achieving sustainable development. As a result, this study recommends the need for greater support and recognition of literature as a tool to facilitate sustainable development in Nigeria. This is because it has the ability to bolster and foster critical thinking, and societal dialogue for peace and sustainable development. Policymakers, educators, and the wider society must recognize the potential of literature and invest in its development and dissemination. This is germane because literary writers ploy to enhance green or sustainable growth correlates with GDP growth and it is perfect for sustainable development.

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The Future of Library Collections in the Digital Age: Challenges and Opportunities

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Abstract

As the world becomes increasingly digitized, libraries face unique challenges and opportunities in managing their collections. With the growth of digital media and the availability of online resources, libraries must adapt their collection development strategies to meet the changing needs of their patrons. This article explores the current state of library collections in the digital age, discusses the challenges facing libraries in managing their collections, and highlights the opportunities that digital technologies offer for enhancing library services.

Keywords: Library Collections, Digital, Digital Age, Future

Introduction:

Digital technology has transformed the way we access and use information, and libraries have not been immune to these changes. In recent years, digital technology has had a profound impact on libraries and library collections, from the way they are catalogued and searched to the materials they contain. This article will explore the impact of digital technology on libraries and library collections.

The digitization of information has had a profound impact on the way that libraries manage their collections. In the past, libraries primarily acquired physical books and other materials, but with the advent of digital media, the landscape of library collections has changed significantly. Libraries now must balance the demand for traditional materials with the need to provide access to digital resources.

The Purpose of the study:

This article will examine the challenges that libraries face in managing their collections in the digital age and the opportunities that digital technologies offer for enhancing library services. It will also explore some of the challenges and concerns associated with digital collections. will explore some of the emerging trends and technologies that are shaping the future of library collections.

The Research Questions:

- i. What are the key challenges faced by libraries in managing and curating digital collections, such as interoperability, community engagement, intellectual property rights, and sustainability?
- ii. How can libraries address the preservation of digital materials and ensure their long-term accessibility and usability?
- iii. What are the implications of the digital age on the role of libraries as cultural assets, and how can libraries maximize their research and educational potential in the digital era?

- iv. What are the changing expectations and demands of library users in the electronic age, and how can libraries meet these evolving needs?

The Future of Library Collections

The future of library collections is rapidly evolving due to advances in technology, changes in user behaviour, and shifting priorities within the library profession.

E-books:

E-books are becoming an increasingly important component of library collections. According to a recent survey, e-book usage in academic libraries has increased dramatically over the past decade (McMullen & White, 2018). E-books offer several benefits over print materials, including increased accessibility, flexibility, and cost-effectiveness. However, libraries must also address challenges associated with e-books, such as licensing agreements, digital preservation, and user experience.

Open Access:

Open access materials are also gaining prominence in library collections. Open access materials are freely available to users, and can include scholarly articles, books, and other materials. Open access materials can help libraries address issues of equity and access and can also provide opportunities for collaboration and innovation (Cox & Cox, 2018). However, libraries must also address challenges associated with open access, such as ensuring the quality and integrity of materials and managing the costs associated with supporting open access initiatives.

Data:

Data is another emerging area of library collections. Libraries are increasingly collecting, managing, and sharing data, and are playing a critical role in supporting research and scholarship in this area (Cervone & Faniel, 2017). However, libraries must also address challenges associated with data, such as ensuring privacy and security, managing the volume and

complexity of data, and developing new tools and services to support data management and analysis.

Virtual and Augmented Reality:

Virtual and augmented reality technologies are also emerging as potential components of library collections. These technologies can provide immersive and interactive experiences for users and can support a range of educational and research activities (Slobodian & Chan, 2018). However, libraries must also address challenges associated with these technologies, such as ensuring accessibility and addressing concerns around privacy and security.

The impact of digital technology on libraries and library collections

Access to Information:

One of the most significant impacts of digital technology on libraries is the increased access to information. Digital resources allow libraries to provide access to materials that were previously inaccessible due to their rarity, age, or location. Digitization projects, such as the Google Books Library Project, have made millions of books available online for free or at a low cost (Larsen & Williamson, 2017).

Cataloguing and Searching:

Digital technology has also transformed the way libraries catalogue and search their collections. With the help of digital tools and software, libraries can now digitize their catalogues and make them searchable online. This has made it easier for library users to find the materials they need and has also made it easier for libraries to manage their collections (Larsen & Williamson, 2017).

Collection Development:

Digital technology has also had a significant impact on library collection development. With the advent of e-books, libraries can now offer a wider range of titles to their users without the need for physical storage space. Libraries can also purchase e-books at a lower cost than print books, which has made it easier for libraries to

expand their collections (Larsen & Williamson, 2017).

Preservation:

Digital technology has also transformed the way libraries preserve their collections. Digital preservation methods, such as digitization and migration, can help libraries protect their collections from damage, deterioration, and obsolescence. Digital preservation also allows libraries to share their collections with other libraries and institutions around the world (Larsen & Williamson, 2017).

Challenges:

While digital technology has brought many benefits to libraries and library collections, it has also presented some challenges. For example, the proliferation of digital resources can make it difficult for libraries to manage their collections effectively. Digital resources also require specialized equipment and software, which can be costly for libraries with limited budgets (Larsen & Williamson, 2017).

Challenges and concerns associated with digital collections, such as copyright issues and preservation of digital materials.

Digital collections have many benefits, but they also come with a range of challenges and concerns. From copyright issues to preservation concerns, libraries must address these challenges to ensure that their digital collections are accessible and usable for years to come.

Copyright Issues:

One of the primary concerns associated with digital collections is copyright. Libraries must ensure that they have the right to digitize and share materials, and that they are not infringing on the copyright of others (Cronin, 2017). This can be particularly challenging for older materials where copyright ownership is difficult to determine, or for materials that were never copyrighted at all. Libraries must also ensure that they are not violating any licensing agreements when digitizing and sharing materials.

Preservation:

Preservation is another concern associated with digital collections. Digital materials can be lost or damaged due to technological obsolescence, hardware failure, or cyberattacks (Smith, 2016). Libraries must take steps to ensure that their digital collections are properly preserved and backed up to prevent loss or damage. This can be particularly challenging for libraries with limited budgets, as digital preservation can be costly.

Accessibility:

Accessibility is another challenge associated with digital collections. While digital collections can be more accessible than traditional print collections, they can also present accessibility challenges for individuals with disabilities. Libraries must ensure that their digital collections are accessible to all users, including those with visual, auditory, and motor impairments (Cronin, 2017). This can require significant effort and investment in accessibility features and tools.

Quality Control:

Quality control is another concern associated with digital collections. Libraries must ensure that the materials in their digital collections are of high quality, and that they have been digitized and preserved in a way that maintains their integrity and accuracy (Smith, 2016). This can require significant resources, including specialized equipment and staff with expertise in digitization and preservation.

The benefits of digital library collections, such as increased accessibility and preservation of materials

Digital library collections have become increasingly popular in recent years due to the numerous benefits they offer. From increased accessibility to improved preservation, digital library collections are changing the way we think about and use library resources. This article will explore the benefits of digital library collections.

Increased Accessibility:

One of the most significant benefits of digital library collections is the increased accessibility

they provide. Digital resources can be accessed from anywhere with an internet connection, making it easier for users to find and use the materials they need (Kizilcay & Ozcan, 2017). This is particularly beneficial for individuals who are unable to physically visit a library due to distance, mobility issues, or other factors.

Improved Preservation:

Digital library collections also offer improved preservation of materials. Digital preservation methods, such as digitization and migration, can help libraries protect their collections from damage, deterioration, and obsolescence (Larsen & Williamson, 2017). Digital preservation also allows libraries to share their collections with other libraries and institutions around the world, which can help to ensure that important materials are not lost or destroyed.

Expanded Collection:

Digital library collections also allow libraries to expand their collections beyond what is physically possible. Digital resources can be stored and accessed from a single location, which means that libraries can offer a wider range of materials without the need for additional physical storage space (Kizilcay & Ozcan, 2017). This is particularly beneficial for smaller libraries or libraries with limited budgets, as it allows them to offer a wider range of materials to their users.

Cost-Effective:

Digital library collections can also be more cost-effective than traditional print collections. E-books, for example, can be purchased at a lower cost than print books, which makes it easier for libraries to expand their collections (Larsen & Williamson, 2017). Digitization projects can also be more cost-effective than physical preservation methods, such as microfilming or binding.

Searchability:

Digital library collections are also more searchable than traditional print collections. Digital catalogues can be searched by keyword, author, title, or subject, which makes it easier for users to find the materials they need (Kizilcay &

Ozcan, 2017). This can also help to improve the efficiency of library staff, as they spend less time searching for materials and more time helping users.

The Role of Libraries in Preservation of Digital Materials for Long-Term Accessibility and Usability.

Develop a digital preservation policy: Libraries should establish a comprehensive policy that outlines their approach to digital preservation. The policy should provide guidance on the preservation of digital materials, ensure authenticity, reliability, and long-term accessibility, and lay the foundation for implementation. It should also address major institutional needs and define principles and rules for specific aspects of digital preservation.

Organize and manage digital content: Effective organization and management of digital content are crucial for preservation. Libraries should establish a systematic approach to organizing digital materials, such as creating main folders for each collection and implementing consistent naming conventions and metadata standards. Proper organization facilitates easy retrieval and ensures that files are not lost or misplaced over time.

Identify and document digital resources: Libraries need to identify where their digital resources are located. This includes understanding the storage mediums (e.g., digital cameras, personal laptops, cloud storage), taking inventory of the materials, and documenting their characteristics, formats, and associated metadata. This information helps in managing and preserving the resources effectively.

Implement metadata and documentation strategies: Metadata plays a crucial role in describing and providing context for digital materials. Libraries should follow established metadata standards, such as the PREMIS (PREservation Metadata: Implementation Strategies) standard, to ensure consistent and meaningful metadata. Good documentation practices help in understanding the technical and

intellectual aspects of digital objects, facilitating their long-term usability.

Stay updated on preservation technologies and practices: Rapid changes in technology can pose challenges to the long-term preservation of digital materials. Libraries should actively monitor and adapt to advancements in preservation technologies and best practices. This includes staying informed about new storage media, file formats, migration strategies, and emulation techniques. Regular training and professional development for staff members are essential to maintain expertise in digital preservation.

Ensure storage and backup strategies: Libraries must have reliable and secure storage infrastructure for digital materials. Implementing redundant backup systems, both on-site and off-site, helps mitigate the risk of data loss. It is essential to regularly test the integrity and accessibility of backups to ensure their effectiveness. Implementing data redundancy and disaster recovery plans can safeguard against potential threats to long-term accessibility.

The changing expectations and demands of library users in the electronic age, and how can libraries meet these evolving needs.

The changing expectations and demands of library users in the electronic age pose challenges and opportunities for libraries. To meet these evolving needs, libraries can consider the following strategies:

Reassessing the role of libraries: Libraries need to reassess their role in the electronic age and adapt to the changing information environment. This involves understanding the shifting expectations and demands of library users and aligning library services and resources accordingly. Libraries should actively engage with users to gather feedback and insights on their evolving needs.

Embracing digital formats: With the transition from print to digital formats, libraries should focus on building and expanding their electronic collections. Allocating resources towards

electronic materials, such as e-books, online journals, and databases, can better cater to the preferences and needs of users in the electronic age.

Adopting emerging technologies: Libraries can leverage emerging technologies to enhance user experiences and provide innovative services. This includes embracing library automation, implementing Internet of Things (IoT) solutions, and exploring new tools and platforms for information access, retrieval, and delivery.

Personalizing services: Libraries can strive to personalize their services and resources to meet individual user needs. This can involve implementing recommendation systems, offering customized information literacy programs, and providing tailored research support. By understanding user preferences and behaviours, libraries can create more meaningful and relevant experiences.

Enhancing accessibility and convenience: Libraries should prioritize accessibility and convenience in the digital age. This can include improving remote access to library resources, implementing mobile-friendly platforms and apps, and offering extended operating hours. Libraries can also explore partnerships with other institutions to provide seamless access to a wider range of resources.

Continuous user engagement and feedback: Libraries should maintain open channels of communication with users to understand their evolving needs and expectations. Conducting surveys, focus groups, and user studies can provide valuable insights for enhancing services, resources, and overall user experiences. Regularly soliciting feedback and incorporating user suggestions can help libraries adapt and meet evolving user needs effectively.

Conclusion:

Digital library collections offer numerous benefits, including increased accessibility, improved preservation, expanded collections, cost-effectiveness, and improved searchability. As digital technology continues to evolve, it is

likely that these benefits will continue to grow, and digital library collections will become an even more essential part of the library landscape. By actively embracing digital technologies, adapting services to user expectations, and staying responsive to evolving needs, libraries can effectively meet the changing expectations and demands of users in the electronic age.

Recommendations:

- i. **Embrace digital technologies:** Libraries should actively embrace digital technologies and integrate them into their collection management strategies. This includes adopting digital platforms for accessing and delivering library materials, implementing digital preservation techniques, and leveraging technologies such as artificial intelligence and machine learning to enhance collection organization and discoverability.
- ii. **Foster collaboration and partnerships:** Libraries should forge collaborations and partnerships with content providers, publishers, and other institutions to expand their digital collections and enhance access to diverse resources. Collaborative initiatives can help libraries overcome budget constraints and access a wider range of digital materials, thereby enriching their collections.
- iii. **Prioritize user needs and experiences:** Libraries must prioritize user needs and preferences in developing their digital collections. This involves conducting user surveys and assessments to understand their information requirements and preferences. Libraries should also ensure user-friendly interfaces, seamless access to resources, and personalized services to enhance user experiences.
- iv. **Address copyright and licensing challenges:** Libraries should navigate the complexities of copyright and licensing regulations associated with digital collections. They should actively advocate for fair use and open access

initiatives to expand the availability of digital resources while respecting intellectual property rights. Developing strategies for managing licensed content and negotiating favourable agreements with publishers are also crucial.

- v. Invest in staff training and professional development: Libraries need to invest in the continuous training and professional development of their staff to build digital competencies. This includes equipping librarians and information professionals with the necessary skills to manage digital collections, employ emerging technologies, and navigate evolving information landscapes.
- vi. Ensure long-term preservation and sustainability: Libraries must address the challenges of preserving digital materials for future generations. This involves implementing robust digital preservation strategies, including migration and emulation techniques, metadata management, and storage infrastructure. Libraries should also consider the long-term sustainability of their digital collections, ensuring ongoing access and usability.

THE IMPACTS OF COVID-19 PANDEMIC ON ECONOMIC DEVELOPMENT IN NIGERIA**J.B. Ehimony,²C. ATOMODE ,³V.O Olokojo & ⁴E. E. Ezra.****Phone Number: +2348036537550,****Corresponding****author's email: tunde4yem@yahoo.com.****^{1,2 3}& ⁴Department of Statistics, School of Applied Sciences,****Kogi State Polytechnic, P.M.B. 1101, Lokoja.****Abstract**

This paper analysis the effect of COVID-19 pandemic on economic development in Nigeria with the emphasis on decline in socio-economic development. The result shows that there were decline in economic variables that enhance economic growth in Nigeria due to fall in price of petroleum products in international market, since the global world enforced lockdown due to outbreak of COVID-19 pandemic. We also observed that the demand for oil drop in large quantities in both Local and International market, while many industries in Nigeria downsized it staffs strength due to negative effect of COVID-19 pandemic. The Federal Government of Nigeria reacted quickly to the crunch by given a short term loan to small scale industries and some households were given little palliative to relief their suffering. We observed that these measures were unable to prevent the economic downturn in Nigeria. We recommend the legislative law to regulate the price volatility in all economics good. Also the government should establish a policy on food security by building foods warehouses for conservation of foods for human consumption. The Federal Government of Nigeria should finance in healthcare infrastructure to advance the capacity of the national health system that can withstand the outbreak of any epidemic diseases.

Keywords: COVID-19 Pandemic, Economic Recession, healthcare, palliative

1.0 Introduction

The coronavirus outbreak started in a city called Wuhan in China, it spread to Nigeria. The pandemic was more severe in Nigeria due to poor health system and lack of quick response by government on the incidence of the pandemic. The average Nigerian suffered as a result of feeble institutions that were unable to respond during the epidemic and a lack of appropriate social welfare programs that would have cared for impoverished and defenseless citizens affected by the crisis (Adenomon and Maijamaa, 2020). The distress in economic and financial sector steered the panic buying among the citizen, some business man hoard foreign currency and some households hoard some essential foods and commodity items, some industries downsize their staff's strength.

This article will investigate the impact of the COVID-19 pandemic on the Nigerian economy and its implications for living standards. According to Ozili and Arun (2020), the COVID-19 pandemic has had a negative impact on economic growth in all countries. They also believed that it would harm socioeconomic relations between countries due to restrictions on travel in the global travel industry, insufficient healthcare systems, food insecurity, price volatility, downsizing of staff in private sectors, and a setback in our educational program. Developing countries

were disproportionately harmed because they all rely on developed countries for economic transactions (Ozili and Arun, 2020). A current research was conducted on influence of COVID-19 on economic activities, the scholars review that COVID-19 pandemic is a threat to diplomatic relation with developed nations which affect economics, education and health. (Fernandes, et, al (2020); Atkeson, et, al (2020); McKibbin and Fernando, et, al (2020)). It was noted that Nigerian Scholars have not really examine the negative trend cause by COVID 19 pandemic on economic growth in African nations (Ozili 2020) . The effect of COVID-19 on economic crises has not been investigated in the recent literature. This study will investigate the extend of damages its cause by COVID-19 on economic development in African nations.

The economic recessions will be triggered as a result of decline in market activities and non-equilibrium in demand and supply of economic variables (Aregbeshola, 2018). Economic recession affect international trade leading to price shockwaves on import and export goods (Adeniran, 2018; Francois and Woertz, 2009). Economic recession occurred due to political instability and civil unrest through protests (Giugni and Grasso, 2016). Nigeria has been encountering economic crises since the year 2016 when the monetary policy on exchange

rate were forced to devalue against the dollar and adopted a managed-float foreign exchange system, which controlled the currency from the year 2016 to 2019. This measure gives a little relief to Nigeria economic system. During the COVID-19, the economic recession resurface it bite hard on citizens, there were price volatility, it was generally assumed that the unexpected and sustained increase in price of goods was as a result of negligent of the government to make plan for post COVID-19 pandemic and decline in the price of oil in international market are the most factors that contribute to economic recession in Nigeria. Ozili(2020) viewed that “poor health management scheme to control outbreak of COVID-19 pandemic could accelerate an economic crisis in Nigeria”. He observed that health sector, were not equip with advance technology to control and manage the pandemic, they only result on imposed and enforced of laws on social distancing policy and movement lockdown in Abuja, Lagos and Ogun states on the 30th March of 2020. These protocols affect economic activities leading to economic recession.

The analysis in this paper is to evaluate the effects of COVID-19 economic crises in Nigeria. This study will also contributes to existing literatures on factors that worsen the COVID-19 pandemic and the economic downturn in Nigeria.

2.0 Literature Review

Sanusi,(2010) reported that Nigeria had experienced two state of economic recession within a decade. The economic crisis of 2009 was as a result of the financial shockwave in global market which started from the year 2007–2008. The economic crisis in 2016 was as a result of the abrupt fall in oil price in international market. The causes of 2009 recession are bad risk management practices and poor corporate governance of Nigerian banks. The banking sector in Nigeria contribute more to Economic recession in the year 2009 while 2016 economic crisis was caused by unpredicted drop in oil price in international market, these changes affect the gross domestic product and Nigeria’s foreign reserve (Adeniran and Sidiq, 2018). It led to balance of payment deficits combined with an already high debt burden which plunged Nigeria into its second recession in a decade.

Reviewing the recent studies by some researchers in Nigerian on COVID-19 indicate effects of COVID-19 in economic development of Nigeria. Olapegba et al.(2020) evaluated the perceptions of COVID-19 in Nigeria. He discovered that average Nigerians have some delusions about COVID-19, for example, some believe that COVID-19 is a biological weapon released by Chinese government. “Nigeria had the highest number of COVID-19 cases in West

Africa and the third highest cases in Africa between March and April” (Ozili,2020). Ohia et al. (2020) predicted that COVID-19 will be more severe in Africa. African countries have brittle health systems since we are underdeveloped nation with insufficient health facilities. They claim that Nigeria’s current national health systems cannot meet the needs of the growing number of infected patients who require admission into intensive care units. Adenomon and Maijamaa (2020) perceived that COVID-19 has negative impact on the Nigerian stock exchange from the 2nd January 2020 to 16th April 2020. The outcomes indicate that the market loss in stock returns and high volatility in stock returns during the COVID-19 period in Nigeria.

Impact of COVID-19 on Nigeria economy

This paper will highlight the five major areas in which the COVID-19 pandemic has pose challenges on gross domestic products Nigeria economic.

Firstly, the COVID-19 pandemic has posed a serious challenges between bank and customers. The customers borrow money from bank for business transaction. The borrowers’

may not have the capacity to service their loans effectively due to lockdown protocol. This delay in payment of loan will affect banking system in operating effectively. The adverse effect of this delay in paying back the loan, will discouraged the bank to disincline to give more loans to borrowers. Since, more borrowers were struggling to pay back their loan .

Secondly, during COVID-19 pandemic the price of oil in international market can be describe as shockwaves reflecting the sharp decline in price index . Nigeria experienced a price spillover in international market leading to the drop in the price of crude oil. The price dropped from nearly US\$60 per barrel to as low as US\$30 per barrel in March 2020.The government had to borrow from external reserve to service the economic activities. During the pandemic, all the sources of income that will improve the revenue base of the country were shutdown: people were no longer travelling and this led to fall in the demand for aviation fuel and the revenue from automobile fuel decline affecting Nigeria’s net oil revenue and eventually affected Nigeria’s foreign reserve.

Thirdly, the pattern of supply chain of some essential economics goods and services dropped drastically due to global COVID -19, the global supply chain dropped which affects several importers leading to shut down of their factories and closed their borders particularly

China. Nigeria was severely affected because Nigeria is an import-dependent country, which was not self-independent. Nigeria experienced unavailability of key supplies such as pharmaceutical supplies, spare parts and finished goods from China.

Fourthly, the Nigeria budget was affected. The budget was initially planned with an oil benchmark of US\$57 per barrel. The reduction in oil price to US\$30 per barrel during the pandemic affected the budget which made it an obsolete and a new budget had to be formed which had to be re-priced with at low oil price.

Finally, the COVID-19 pandemics generally contribute negatively to Nigerian stock market. The market indices in the stock market lurched since all the investors pulled out their investments into so called safe havens such as US Treasury bonds. Also, the investors in stock market loses about NGN2.3 trillion (US\$5.9bn) barely in every three weeks after the first incidence case of coronavirus was confirmed and announced in Nigeria on 28 January 2020. The statistics indicates that the market capitalization of registered equities, which was valued at NGN13.657 trillion (US\$35.2bn) on Friday, 28 February 2020 depreciated by NGN2.349 trillion to NGN11.308 trillion (US\$29.1bn) on Monday 23 March 2020. Also the share index closed at 21,700.98 from 26,216.46 representing 4,515.48 points or

20.8% drop (4). The stock market crash is illustrated in Figure 1 while Table 4 shows the one-month movement in the all-share index.

The monetary and fiscal policy was the measured taken by the Central bank to revival the economic during COVID-19 pandemic. There was various supports given to the followings set citizens: households, businesses, regulated financial institutions and other stakeholders in-order to reduce the adverse economic effects of the COVID-19 pandemic. The followings were the support render by central bank during the pandemic: The Central bank grant loan moratorium on principal repayments within one year. The central bank offered reduction in interest rate as intervention for loan facilities from 9% to 5% beginning from 1 March 2020.

It also encourages the loan to deposit ratio (LDR) policy which allowed banks to extend more credit facilities to the economy. The fiscal authorities help Nigeria to review 2020 national budget of N10.59 trillion (US\$28bn). The Federal government of Nigeria pronounced that the budget was reduced by NGN1.5 trillion (\$4.90bn) as part of actions to respond to the impact of coronavirus on the economy and in response to the oil price crash. The new budget was benchmarked at US\$30 per barrel from US\$57 per barrel in the previous budget.

Factors that contributes to economic recession

Poor health infrastructure development

The failure of Nigerian government to revitalize our health sector affects the country to cope with the fast-spreading COVID-19 disease during the outbreak. The local drug manufacturers were not encouraged to manufacture drugs that could temporarily suppress coronavirus in infected patients. The Nigeria health sector only depend on APIs used to manufacture suppressant drugs could no longer be imported since China had shut down its factories and closed its borders to control the coronavirus pandemic that was ravaging China at the time. There were insufficient isolation centers in many states including in Abuja and Lagos. We observed that number of infected patients in Lagos grew worse to the extent that a stadium had to be converted to an isolation center.

COVID-19 and Underdeveloped Digital Economy

The statistics shows that before COVID-19 pandemic began, Nigeria already had a pathetic and underdeveloped digital economy. We observed during COVID-19 pandemic, there was barely any university or school that offered a full educational curriculum online from start to finish.

The developed nation used digital to recover from the economic crisis if Nigeria's digital economy was robust and well developed. The schools, universities and educators can put coursework online so that students quarantined at home do not have to miss out on key aspects of their education while school is closed or when students cannot get to school. E-commerce apps that enable online buying and selling can allow buyers and sellers to make purchases and sales while staying in their homes. Also, tele-health apps for health and wellness checks can allow individuals in all affected areas to take extra precautions to monitor their vital signs and learn how to reduce their risk of infection. Also in a developed nations, digital technology helped many businesses in developed countries survive from the effect of the COVID-19 outbreak, and it fashioned out an opportunity to enhance the country's digital economy. In the future, a well-developed digital economy in Nigeria, achieved through intense digital technology penetration, will play a greater role in reducing the effect of recessions in the country and will also help in supporting economic activities, social activities and the development of good healthcare systems.

Absence of Social Welfare Program

Before the COVID-19 outbreak, there were major social welfare problems in Nigeria which include child abandonment, armed

robbery, homelessness, mental health problems, divorce and problems of single parenting. These social welfare problems can only be addressed with serious social welfare policy and program. But, currently, social welfare activities in Nigeria are underdeveloped, poorly funded and are unavailable to majority of those who need them (Ahmed et al., 2017). The consequence of not having a national social welfare program became more evident during the coronavirus outbreak of 2020. During the outbreak, people had little to rely on, many poor citizens did not have welfare relief that could help them cope with the economic hardship at the time. There were no housing subsidies, no energy and utilities subsidies to individuals that were most affected by the coronavirus outbreak, no provision of social welfare services to vulnerable citizens in the population is the most proven way to protect them from economic hardship in bad times. In Nigeria, the lack of such welfare services for vulnerable people, households and poor individuals during the coronavirus outbreak caused severe pain and economic hardship to households and poor individuals. The implication of this is that social welfare has not been a policy priority by policymakers in Nigeria.

Methodology

In this study Descriptive and regression analysis will be used to evaluate the variables that contribute to economic recession during

COVID-19 and its implementation to gross domestic product.

Table 1. Data on global COVID-19 pandemic

Countries	Confirmed Cases (total)	Confirmed deaths (total)	Recovery cases (total)
Global	4,626,487	308,610	1,757,282
USA	1,484,285	88,507	326,242
Spain	274,367	27,459	188,967
Russia	262,843	2,418	58,226
Egypt	11,228	592	2,799
South Africa	13,524	247	6,083
Nigeria	5,450	171	1,320

Source(s): Worldometer [12]. Note that there may be unconfirmed cases which were never reported to the public health authorities.

The statistics shows that over 6,678,184 reported cases around the global see table 1 above the USA had the largest reported cases, followed by Spain and Russia on the reporting date. In Africa countries, South Africa had the largest reported cases, followed by Egypt and Nigeria on the reporting date. This is statistics as at 15th May 2020.

The spread of COVID-19 in Nigeria

Table2. The incidence of coronavirus in Nigeria and transmission Mode

Countries	Confirmed cases (total)	Confirmed d
Nigeria	5,162	16

Source: WHO situation report

Table 3: Confirmed COVID-19 Cases in Nigeria

Timeline	Confirmed cases	Affected states
17/03/2020	3	Lagos
21/03/2020	22	Lagos, Abuja and Ogun
30/03/2020	131	Lagos, Abuja, Bauchi, Enugu
15/04/2020	5,445	All states in Nigeria

Source(s): Nigeria Centre for Disease Control (NCDC)

From Table 2 above it indicate that the coronavirus infected people in Lagos before it spread to other parts of the country from March to May 2020. The above data were obtained from the World health Organization (WHO) on the same reporting data shows that Nigeria had over 5,000 cases, 167 mortality rate.

Table4. 2020 BUDGET ASSUMPTION AND ESTIMATES OF MACROECONOMIC VARIABLES

S/N	Macro aggregate	2020 budget	Cut/increase by Fed due to covid 19	Covid 19 period	Per cent %
1.	Oil production(MBPD)	2.18	1.7	2.0	-8.26
2.	Oil price(\$ per barrel)	57	30	\$12	-78.95
3.	Exchange rate	305	360	360	18.03

	(naira into \$)			
4.	Inflation rate (%)	10.81		12.26
5	GDP Growth rate(%)			

The 2020 budget propose for oil price per barrel is \$57 but due to covid-19 pandemic the price drop at \$12 per barrel with reduction of -78.95% the trade restriction in international oil market affected contribute this price volatility. The exchange rate move upward from #305 per dollar to #360 per dollar. We experience hyperinflation in both 2020 budget proposal and COvid-19 period with 12.26.

Table5. The components of Macro aggregate in Nigeria economy

	Macro aggregate	Cut/increase by Fed due to Covid 19	Covid 19 period	Perce nt %
1	Budget (₦ unlit ion)	10.59	10.27	-3
2	Revenue (₦ trillion)	8.42	5.08	-40
	Oil (₦ trillion)	2.63	0.25	-90
	Non-oil (₦ billion)	1.80	1.53	-15
3	Capital expenditure (₦ trillion)	2.78	2.63	-6

4	recurrent expend (₦ trillion)	4.49	4.46	-1
5	Debt service (₦ trillion)	2.45		2.55
6	Budget deficit	2.18	5.18	38

Source compiled by the authors from Premium Time Bloomberg and NBS

Nigeria experience budget deficit during Covid-19 from 2.18 to 5.18 trillion see table 5. The revenue from oil and non- oil sectors drop drastically due to Covid-19 pandemic at -90 and -15% respectively in all the oil sectors. The debt service increases with 0.1 unit. The causes of the drop is has a results of restriction in international oil market, closure of industries in the country, hyperinflation rate, decline foods supply to others countries and low in taxations

Table: 6 THE ACTUAL 2019 AND PROJECTED 2020 AGGREGATE REAL GDP/GROWTH RATIO

	Actual 2019 Real GDP		Projected 2020 Real GDP	
	Value # million	Gro wth rate	Value # million	Gro wth rate
Q1	16,384,06 3.26	2.08	16,769,4 69.04	2.35
Q2	16,892,75 6.91	2.12	16,957,1 39.69	0.35
Q3	18,459,49 1.59	2.28	16,760,7 48.54	-9.20
Q4	19,488,52 56064	2.55	18,260,0 36.88	6.30
Annua lize	71,224,89 1.64	2.77	68,741,3 84.50	3.49

Adapted from Olusanya and Ahamuefula 2020

From table 6 above the growth rate in 2019 and 2020 the projected growth rate of GDP varies, due to change in some GDP variables such as increase in exchange rate, hyperinflation, price volatility, decline in international oil market, restriction in import and export of goods and service, decline in revenue of non -oil sectors these occurred as a result of outbreak of COVID-19 pandemic. These affects the projected 2020 real GDP which reduces to 68,741, 384.50 at annual budget of 2020.

MULTIPLE REGRESSION MODEL

Multiple regression equation from quarterly projected aggregate real GDP from the years 1990 to 2020. **Model:** In this study regression model was used for data analysis.

The model below is presented as follows:

$$GDP = \beta_0 + \beta_1(IF) + \beta_2(ER) + \beta_3(FER) + \beta_4(FII) + \beta_5(SEN) + \beta_6(BOP) + \beta_7(FD)$$

$\beta_0 = \text{constant}$

$\beta_1, 2...3 = \text{coefficients of predictors}$

IR = Inflation rate, ER = Exchange rate,

FER = Foreign Exchange reserves, FII =

Foreign Institutional Investors

SEN= Sensex, BOP=Balance of Payments,

FD = Fiscal Deficit

The below model is an estimated parameters obtained from Multiple regression using Minitab software version 14. R –square is 0.96 describing the

coefficient of variation between GDP and IR = Inflation rate, ER = Exchange rate, FER = Foreign Exchange reserves, FII = Foreign Institutional Investors

SEN= Sensex, BOP=Balance of Payments,

FD = Fiscal Deficit

$$GDP = -58424.627 + 0.100(IR) + 0.239(ER) - 0.049(FII) - 0.067(FER) + 0.795(SEN) - 0.307(BOP) + 1.045(FD)$$

The results show that there is 96% variation accounted for between GDP and IR (inflation rate), ER (exchange rate), FER (foreign exchange reserves), FII (foreign institutional investors), SEN(Sensex), Balance of payment(BOP) and FD(foreign debt). These variations occurred as a result of the negative effects of the COV-19 pandemic on economic growth. The estimated parameters above indicate a 0.1 unit increase in inflation, which has negative effects on gross domestic product; there is also a 0.239 unit increase in the exchange rate, which has negative effects on GDP. There is a reduction of 0.049 units of foreign institutional investors due to threat of the COV-19 pandemic; this also affects the GDP. The foreign exchange reserve also dropped to 0,067 units, which has negative effects on GDP. There are additional increases of 0.795 units of Sensex on GDP despite the threat of the pandemic. The balance of trade dropped to 0.309 units, while the Fiscal deficit increased to 1,045 units.

CONCLUSION:

Inflation is highly correlated with GDP, but it is significantly influencing the GDP of the economy. The exchange rate is one of the important factors that influence the GDP of an economy. The depreciation in currency can cause importers to pay more for services, while

appreciation in currency can encourage exporters to export more, which can increase foreign currency reserves. Exchange rates and foreign currency reserves are highly correlated, which influences the economic recession since the currency of Nigeria has devalued. This will influence economic stability. The research provided empirical estimates of the relationship between the exchange rate and economic growth in Nigeria. The results suggested that there is a statistically significant direct relationship between the two variables. The Sensex is another important factor influencing GDP, as revealed by the current study. According to Lazear (2013), he believes that market indexes are better predictors of GDP growth. The market is a better and timelier forecaster of future GDP, perhaps because the market has a financial stake in getting it right. The study also revealed a negative relationship between GDP and Balance of Payments figures (current account balance plus Capital account balance).

RECOMMENDATION

The Federal government of Nigeria should react quickly to the crunch by given a short term loan to small scale industries and households should be given little palliative to relief their suffering. We advise legislators to pass a bill that will regulate the price volatility in all economics

goods. The government should establish a policy on food security by building foods warehouses for conservation of foods for human consumption. The Federal Government of Nigeria should finance the healthcare infrastructure to advance the capacity of the national health system that can withstand the outbreak of any epidemic diseases.

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BIG DATA ANALYTICS AND PERSISTENCE OF CLIMATE CHANGE

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Abstract:

Climatological data is an intensive subject that has overwhelmingly affected by the era of big data. The big data analytics are used in diverse areas over the past decade. These have prompted the expectation of big data and its efficacy on measurement of persistence in climate change. The emerging of the topic, persistence in climate change has been at the vanguard of the big climate data analytics applications and comprehensive research have been carried out covering a variety of topics. This paper aims to present an over-view of big data in measurement of persistence in climate change over the recent years by investigating and summarizing the current status of big data applications in climate change related studies. It is also expected to serve as a one-stop reference for researchers with an overview of this trending subject at a look, which can be useful in controlling future research and developments in the exploitation of big climate data.

Keywords: big data; climatological; climate change; persistence

1.0 Introduction

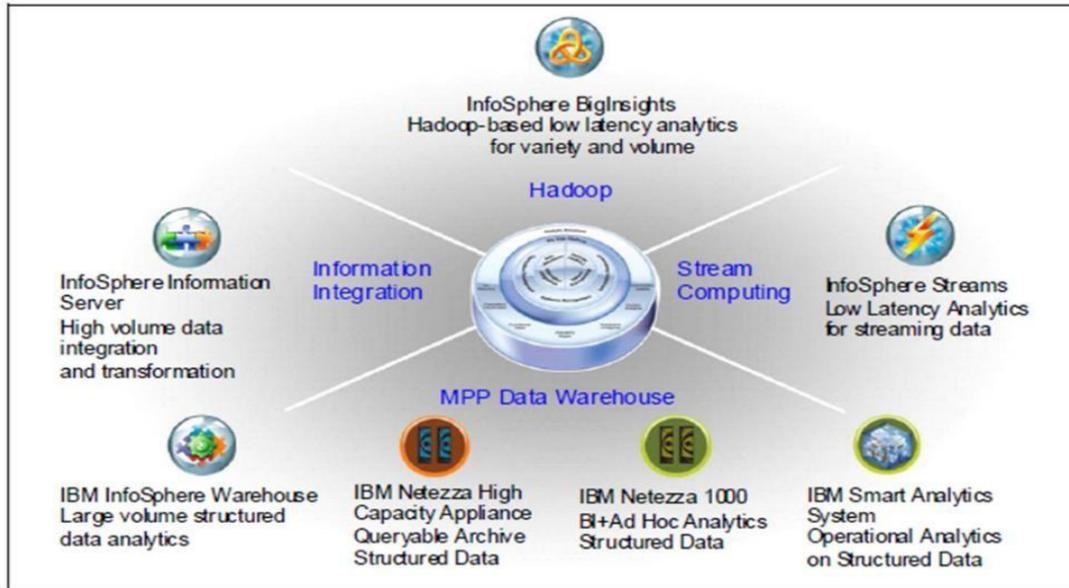
Big Data is data with a huge size. Big Data is a term used to describe a collection of data that is huge in volume and yet growing exponentially with time. In short such data is so large and complex that none of the traditional data management tools are able to store it or process it efficiently. "Extremely large data sets that may be analyzed computationally to reveal patterns, trends and association, especially relating to human behavior and interaction are known as Big Data."

Big Data analytics is the process of collecting, organizing and analyzing large sets of data in-order to discover patterns and other useful information. Big Data analytics can help organizations to have better understanding of information within big data and it also help to identify the data that is most important for decisions making.

This paper will contribute to the existing literatures by up- dating the general overview of big data applications in measurement of persistence in climate change with the most recently published research that reflects the cutting edge of this topic. This paper will serve as manual for researchers to gain the most up-to-date overview on big data analytics on climate change. It is expected to provide a comprehensive review for researchers to gain

better knowledge on the use of big data analytics to determine the trend of climate change in the global world. Climate Big Data is becoming one of the most talked about technology trends use in metrology. The real challenge with the climate big organization is to get maximum out of the data already available and predict what kind of data to collect in the future. Climate Big Data is too big a concept and there are many players – different architectures, different vendors and different technology use in its application.

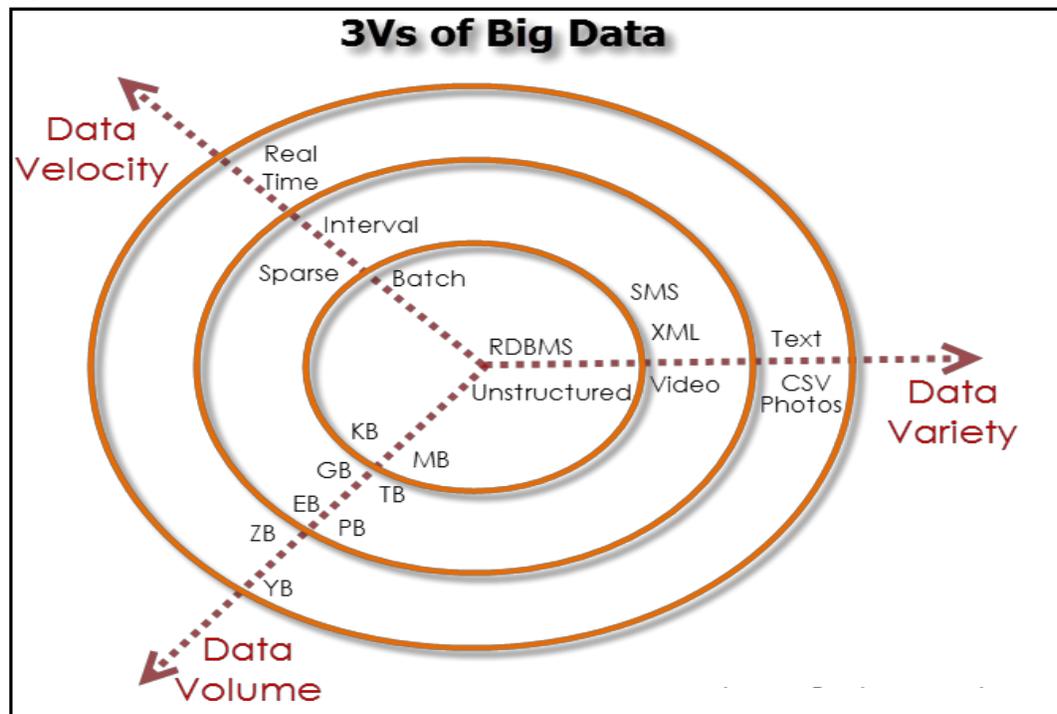
The three Vs of Big data are Velocity, Volume and Variety.



Climate Big data Characteristics

Figure 1 Climate

The three Vs of Big data are



Big Data Sphere

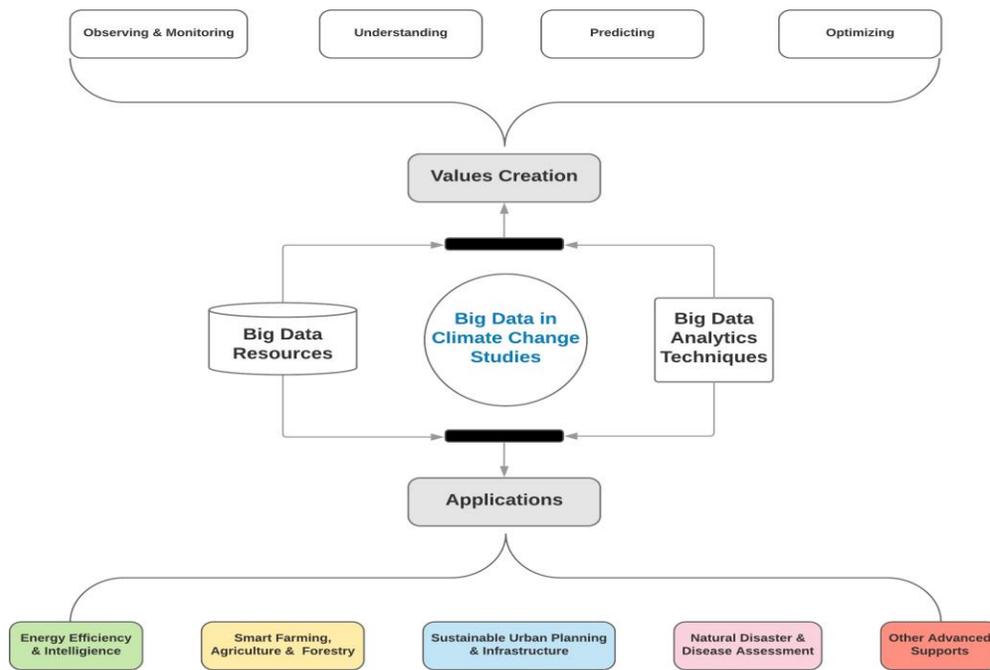
Velocity, Volume and Variety

Figure 2: Characteristics of Climate Big Data

2.0 Literature Review

Big data analytics have been evolving along with the developing of big data technologies in solving problem relating to climatology [1]. The accessibility, availability and exponentially of big data has help in applying big data analytics to compute the components that made up the earth orbits and its further helps to predicts the weather conditions.

change.[6,7]). The persistence in climate change is the amount of carbon dioxide release in large quantities, by rendering warming unchangeable, making it so difficult to predict the weather conditions. **Figure 1.** Framework of big data in measuring persistence in climate change.



The earth is complex dynamical systems which require big data analytics to improve the climate science. [3]. Climate change as an emerging study and also a data-intensive subject has been the research focus of big data scholars over the past several decades [4,5]. Exhaustive big data analytics applications have been carried out on big climate data, using technologies Internet system such as cloud computing, big data tools helps to investigate the persistence in climate

Researchers such as [2] describe persistence in climate change as change in the physical properties of atmospheric substance and these substances can be identified by using some statistical tools in measuring its contribution on weather conditions.

In measuring persistence in climate change, an existing research has applied big data

analytics aspects of agricultural variability and weather forecast to determine the level of persistence in climate change. Although overall this is not a new subject and there is a large amount of existing literature, there is no recent review to the best of our knowledge that particularly investigates the topic of big data in climate change, not to mention that the novel developments are progressing rapidly everyday along with the technological advancements.

In Figure 1, below it identified the applications of big data in climate change with two fundamental elements: the big climate data resources and the big data analytics techniques. It is summarized big data in climate change in four perspectives: observing and monitoring, understanding, predicting and optimizing, the major areas that are related to climatology where big data analytics are applicable emission of substances from GHG; smart farming and agriculture and forestry; sustainable urban planning and infrastructure; natural disaster and disease assessment; and other advanced supports.

Measuring Persistence in Climate Change using big data analytics

Observing and Monitoring

Big data analytics help to bring a thorough reveal of realities from the large volume of data

recorded. We notice that climate data contain significantly useful information and is also the fundamental asset of big data analyses. Monitoring the climate system is critical for better understanding the interactions within the system and its drives, respectively. Moreover, it is also beneficial for us to know the changes that may occur due to the global warming[3]. Thereafter, observing and monitoring can be considered as the fundamental value that big data exhibit the pattern of weather conditions when it is incorporated with climate change.

Understanding, Predicting and Optimizing

In the context of the nature of climate science, there need to understand the global scale changes of various observations and parameters use in measuring climate variability. These global scales are categorized in 3Hs (high dimension, high complexity and high uncertainty) it has made it easy for big data researchers to explore and analyse when mining climate data. Besides the building up the multidimensional system of collecting and monitoring climate change, big data has also stimulated the development of data-intensive analytics in climate change related.

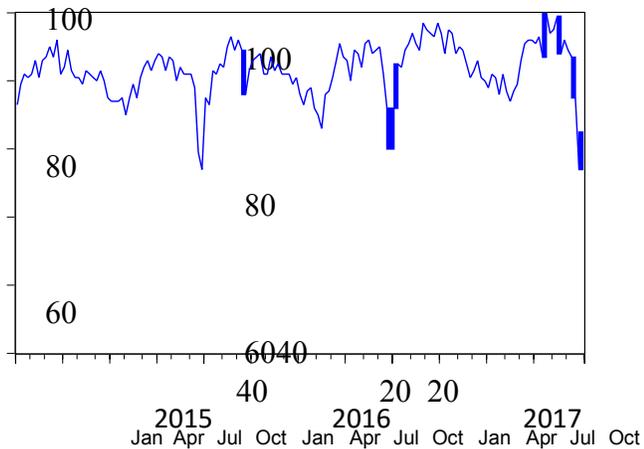
Understanding the big data according to [3]) we need to consider its 5Vs feature (volume, variety, velocity, veracity and value), revealing the hidden valuable information from big data requires adequate knowledge of the purposes of corresponding data as well as the technique for collecting the data.

Trends

Using the Google Trends. This procedure is based on the real-time index of interest for keywords that people search worldwide, and it has become a great tool for both academic research and practical implementations in marketing, journalism, entrepreneurship, etc. As can

be seen in Figure 2, the worldwide Google Trends of big data have shown the interest index over time, which is generally between 80 to 100 with 100 the peak popularity. It reflects the emerging and trending topic of big data and its relevant terms over the recent years. Although climate change has the average interest index around 40 over time, the rapidly ascending interest from 20 with a wide span over 60 within three years also confirms the increasing popularity and growing attention to climate.

Worldwide Google Trends of Big Data
Worldwide Google Trends of Climate Change



causality analysis petroleum industry banking [10], block chain and crypto currency, [9], etc.). This section further categorizes big data research in climate change mainly into five topics: energy efficiency and intelligence; smart farming, agriculture and forestry; sustainable urban planning and infrastructure; natural disaster and disease assessment; and other advanced supports. For each topic, a selective review of applications and research of recent years are presented in chronological order.

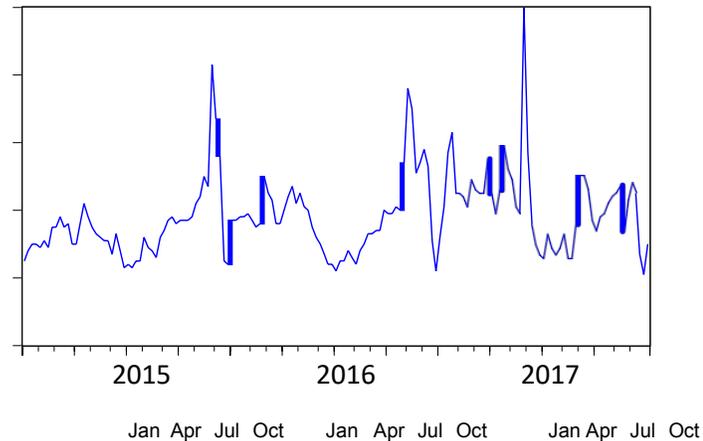


Figure 2. Google Trends index of big data and climate change from 2015-2017

Big Data Research on Climate Change

Besides a few systematical reviews of big data and its techniques, applications and challenges in a broad sense (see [11, 12]), there have been a number of subject-specific review papers that summarise big data applications in its selected subject (see, for example, crime analysis [8],

1.1. Emission from Greenhouse gases

One of the primary roles of big data analytics in climate change is managing and utilizing the resources to fight global warming. There have been exhaustive applications focusing on improving emission of gas substance.

[13] Provided a review of emission of

gas substance using big data analytics, in which the authors presented the industrial infrastructure and resources for managing GHG emission. The review of [14] summarised the data driven approaches for predicting amount of Gas emission in urban area, whilst the data driven technologies and applications are reviewed to determine the trend of Gas emission in the global world [16].

[15] focused on the prediction and classifications of gas emission on the future micro-scale change for a particular ; the review of [14] addressed the uncertainty analysis and big climate data in assessing building energy performance; from the perspective of data mining techniques and applications, a review of research on building operational performance improving is summarized in [17]. The available recent reviews have comprehensively covered the studies before 2017 and some of the research in 2017, here we focus on identifying the latest research on climate change [18] presented a practical and semi-automated artificial neural networks clustering method to measure the levels of persistence in climate change . To enhance the efficiency and operational performance cluster mining system was used to

measure the trend of emission of gas substance big data analytics.

Smart Farming, Agriculture and Forestry

Another subject that big climate data has significantly benefited from over the past decade is agriculture. Agriculture is one of the most vulnerable domains when the negative impacts of climate change emerge from the past several decades. Its production heavily depends on the natural resources and agriculture itself is also one of the main sources of Green House Gas (GHG) emissions. The developments of big climate data and its analytics have prompted the widespread use of smart information management system, precision agriculture, as well as intelligent automatic agriculture. These implementations all contribute to the climate-smart aims of optimizing production with minimum costs and GHG emissions. Big data applications in agro-environmental science are summarized in [19] with analyses of theoretical framework and instructions of three different case

studies so as to further address the limitations and challenges.

Some recent development focus on the forest ecosystem. Franklin et al. [20] adopted four kinds of big data for the prediction of global climate change impacts on the plant populations and communities. Although the availability of data contributes to the ecosystem and climate change studies, the limitations of spatial representation, plot data, heterogeneity issues, and lacking of data standards still need to be improved by future research.

Sustainable Urban Planning and Infrastructure

Apart from the ecosystem and forestry resource management, the increasing greenhouse gas emission has brought attention to the urban planning and infrastructure in a sustainable manner.

In [21-22], Hashem et al. have thoroughly verified the role of big data analytics in measuring persistence in climate change. The authors have proposed the model use of statistical tools to determine the cumulative distribution frequency

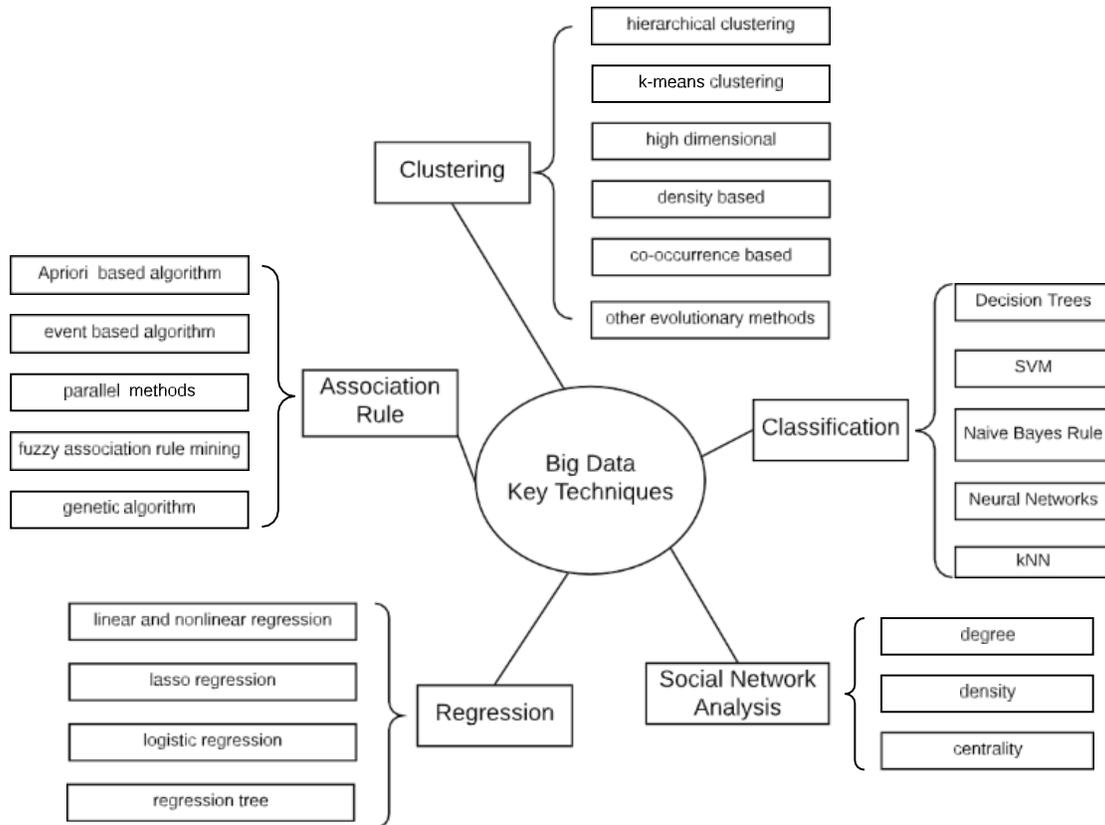
Natural Disaster and Disease Assessment

Over the past decade, there have been debates regarding the relationships between climate change and natural disasters and disease [23-24]. The climate change certainly increased the vulnerability and levels of risk with weather extremes and disease spread, and the natural disaster /disease assessment and management play an important role in climate science. The big data and climate change context as helps to acquire an up-to-date knowledge of big data analytics applications in natural disaster and/or disease management.

There are existing reviews on data mining applications in terms of combating natural disasters [20]—for instance, floods, storms, landslides, volcanic eruptions, tsunamis, earthquakes, etc., in which the authors summarized the relevant big data analytics applications in predicting, detecting and management strategy improvement for a variety of natural disasters, along with identifying existing challenges and future research directions. A review that specially targeted climate prediction applications in China can be found in [19].

It has been systematically reviewed in [25] of the big data analytics in global infectious disease surveillance, whilst its corresponding big data applications related

to climate science still stay in their early it includes a variety of approaches:



stage of development. Traore et al. [23] applied data mining techniques on satellite imagery data for identifying risk areas that are exposed to epidemic crisis. Similarly, Manogaran and Lopez [26,27] focused on dengue and proposed a big climate data based surveillance system for continuous monitoring and timely warning.

Key Techniques for Big Data in Climate Change

Clustering has the key objective of grouping similar or closely related data objects together through data exploration so that different objects are separated [28]. Its underlying fundamental concept is distance measure and

hierarchical clustering, k-means (partitioning clustering), high dimensional methods, density based clustering, co-occurrence based clustering and other evolutionary methods.

Classification, on the other hand, categorizes data objects into the predefined groups and it is one of the most fundamental big data analysis techniques with a collection of well-established methods [30]. One of the most well-known methods is decision tree, which applies a series of crafted questions so to achieve the classification tasks for attributes.

Figure 3. The structure of big

data key techniques.

Association Rule Mining was firstly proposed in [27] on the supermarket data set and aimed to investigate into co-occurrences among data objects. According to [29], it is a technique for identifying the simultaneous occurrence that happens more frequently than the average co-occurrence frequency existing in the data set.

Regression is also considered an important big data analysis technique due to its capabilities in dimension reduction, information extraction, estimation and prediction. The fundamental concept of regression is to investigate the relationship between two or more variables so to assist forecasting and decision-making. There are a variety of well-established regression techniques like linear and nonlinear regression, lasso regression, logistic regression and regression tree, etc.

4.0 Conclusions

Researchers have generally recognized the impact of big data analytics. We have summarized the milestones of Big Earth Data development and the big challenges that follow. In this paper, we present the most up-to-date overview of big data analytics in climate change on some selected research papers. It is observed that gas emission remains the factors

that contribute to persistence in climate change on smart farming/agriculture and natural disaster assessment. One of the research trends identified among the recent applications is cloud computing, which provides a better solution for big data storage, transmitting and computational requirements.

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EMERGING TECHNOLOGIES FOR LIBRARY SERVICES TOWARDS SUSTAINABLE ENVIRONMENTAL DEVELOPMENT: A REVIEW

By

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Abstract

Technologies for library services abound especially at this jet age and it has provided e-libraries services across the globe, with greater opportunities to enhance provision of library and information services to their users. This paper aims principally at exploring the various emerging technologies in the library, and how best they have improved the services of library environment. It employs review of relevant available literatures to seek and to identify various types of emerging technologies (ETs) and their uses in library environment. It also explores all types of libraries in Nigeria the opportunities for adoption and the challenges libraries are likely to face towards the utilization of emerging technologies (ETs). This paper found that Emerging technologies for libraries are available to satisfied the information needs of scholars in academic, public, school, special and research libraries especially in developed countries; it also promotes library services fast and provide better services that has an impact on librarians' and the libraries' creativity, serves as problem-solving skills, and self-image. The paper recommended that appropriate funding to library can address other challenges in the library and as libraries thrive on modern technologies, library staff are therefore, saddled with the responsibility of acquiring new skills and knowledge for onward adoption and use of the technologies to enable them provide round the clock library services to their diverse patrons.

Keywords: Emerging technology, Library services, Sustainability of Environmental Development.

1.0 Introduction

Emerging technologies comprise of technological tools that facilitate user services, Instruction, Library management and technical services in the library environment.

Technologies for library services abound especially at this jet age and it has provided e-libraries services across the globe, with great opportunities to enhance provision of library and information services to their users.

Many libraries particularly of the developed countries have been providing library and information services through the use of emerging technologies such as computer, Radio Frequency Identification Device (RFID) and communication technologies. Libraries in Nigeria should not be an exceptional in embracing and utilizing these technologies in order to serve their users in a more efficient and effective ways. However, there is a clear dimensional shift from traditional ways of providing library and information services to a digital dimension that is being engineered by information and communication technologies; this is because the emergence of new demands surrounding information and its delivery and deliberation naturally dictates the need for libraries to meet these emerging user interests and desires to create a newer, more participatory type of user interaction (Lubanga, S. & Mumba,

2014). As the scope of library and information services is changing significantly and is moving parallel with technological developments, it substantial changes are taking place in library and information centers as well as products and services offered therein therefore there is need for re-designing and transforming library and information centers and its services to meet the demands of contemporary societies. As it is now, we cannot afford to use the same old methods and strategies of offering services to library clientele and expect them to be effective. Transforming library and information centers is a necessity if library and information professionals must remain relevant and retain their place as information providers in the information conscious society or environment.

Problem Statement

Traditional services of libraries, provides limitless possibilities for expanding and interacting with the users globally, Libraries have long desired to make use of these technological resources to publicize their services and as a result, meeting the prospective demands of various user groups, some library professionals believe that there are minimal benefits to be gained from the use of developing technology for library services and applications. Some who are aware of its benefits are fearful of losing their employment, despite the fact that using information technology to library routine

will help them execute their work more effectively and efficiently. It is on this note that the application of information technology to academic library activities and services in Nigerian tertiary institutions will enable library professionals to identify, gather, organize, customize, and distribute information products and services to the user community in a variety of forms and kinds, in both physical and virtual locations in actual time. To this end, this paper aims principally at exploring the various emerging technologies in the library, and how best they have improved the services of library environment, employed reviews of literature method.

Concepts of Emerging Technologies

Emerging Technology, ET is a term that generally refers to as new technology, tools, machine and equipment. But it can also refer to the ongoing evolution of an existing technology; it can have slightly varied meanings depending on the context as used such as media, scientific, technical, superhighway, jet age, computerized, virtual, automation, paperless societies, digitalization, industrial, information technology, hi-tech and e- information. The word is most generally used to describe technologies that are being developed or will be available within the next five to ten years, and is normally reserved for technologies that are

having, or will have, substantial societal or economic implications (Mittal, 2017; Adebisi, 2011., Adebisi, 2016).

Emerging technologies ETs also described as technology that has great potential but has yet to prove its worth or gain in a widespread acceptance. The notions conveyed in emerging technology definitions on the other hand, can be summarized in four ways: (1) recent rapid expansion; (2) in the midst of transition and/or change; (3) untapped market or economic potential; (4) more science-based (Cervone, 2010).

Library Services

Emerging technologies comprise of technological tools that facilitate user services, Instruction, Library management and technical services in the library environment. These Libraries plays a prominent role in the academic and research institutions by providing access to information resources and services that stimulate learning, teaching and research activities. Hence, the success of any institution depends solely on its library; being the center of learning that provides diverse services and resources for the dissemination of information. Libraries support learning, teaching and research activities of their parent bodies; they cater for the needs of the library users, not only for but also in the conservation of knowledge

(Singh, 2018). As a result, the library, is the center of learning, provides a wide range of services and resources for information distribution. These services include readers' services, inter-library loan services, reservation services, selective dissemination of information, current awareness services, reprographic services, translation services and many more (Chukwuemeka & Onuoha, 2019). However, in his own opinion, Opoku (2011) defined Library service as the services that are more or less intangible in nature which normally takes place in an interactive environment between the users and the system of the service provider or Librarian. He further clarifies the traditional service as the conventional paper based on face-to-face services, whereas the technological service is the paperless and most advanced work carry out in library environment on the context of this paper. In his own observation Abubakar (2019) argued that library service is the activities adopted by any library to deliver information service in theory or practice that are valuable to the users' community.

Sustainability of Environmental Development

Dauda (2022) express environment as the contents present in our surrounding.

Environment of course simply mean things around us, life starting from where we live, eats, sleep and perform daily activities of our

job. It connotes our health status, patterns and our behaviours, it includes all we have at our disposal, it also involves the food, air, heat, water that we drink and use etc. all these must be improved on positively or to sustain the existing one and not to destroy them. Once this is done, we may have environmental development. Abubakar (2019) contend on library environment as it involves resources of the libraries, services and other activities prevailing in and around the library areas. Therefore, the need to manage and maintain the library environment because of its importance to users globally, library environment must be developed, improved in order to have full environmental development. Be that as it may, the prevailing development in our environment must be sustained. Also, the negative aspect of the library environment in question must be corrected to improve on the positive side of the environment for national development. What can we do to sustain the library environment? It could be through provision of adequate fund, over-use of materials must be minimized, Conserve resources and Preserve library resources therein.

Emerging Technologies for Library Services and Sustainability of Environmental Development

Emerging technologies, according to Funmilayo & Ayo (2020), offer librarians a unique chance to significantly improve user-centered services and to facilitate and promote collaboration between libraries and their users. Emerging technologies enable library professionals to identify, gather, organize, customize, and distribute information products and services to the user community in a variety of forms and kinds, both on demand and in advance, in both physical and virtual locations in real time. Though every library activity designed or built with active participation and feedback from its user community qualifies it as a library activity and technologies that can assist libraries in creating the collaborative and participatory environment that is required to deliver user-centre library services and to create new resources and build on existing ones using collective intelligence of users.

Today, we are witnessing a world of emerging technologies and it have affected all spheres of our lives, ranging from office work, bank transactions, industries' operations, educational systems, training, business, health care, security, transportation systems to house-keeping. Library being an integral part of our

community, it is equally affected by this technological revolution. The concept of a library as physical place where one can visit to get information is rapidly changing to a social cyberspace where users access, communicate and contribute to existing knowledge (Patel & Patel, 2018). However, the advent of emerging technology, Mittal (2017) argued that most of the library resources and services were transformed from analog to digital, for instance;

- i. printed library collection to Web based publishing like digital collection,
- ii. reference desks to Online/Virtual Reference Service,
- iii. closed access to anytime/ anywhere access of material through internet libraries,
- iv. Manual indexing and Bibliographies to Full Text Databases,
- v. manual Library Catalogue changed to OPAC (Online Public Access Catalogue) / Web OPAC,
- vi. Manual sharing of information to Networking of Libraries (Resource sharing networks),
- vii. Inter-Library Loan Service to Electronic Delivery of Information.

The new library technologies are available and many more are constantly emerging as the name

suggests. Technologies for libraries are ubiquitous; libraries in developed countries through ET_s meet the needs of their users. So also, Libraries in Nigeria as well, need to have the aspiration in adopting the emerging technologies, they need to assess and adopt emerging technologies in order to promote their services. Researchers have identified different types of emerging technologies being used for libraries and library services. Despite the challenges, there are so many emerging technologies that are adoptable by the Nigerian libraries due to their simplicity, affordability and importance (Bichi, (2021).

Adebisi (2016) stated that public libraries must have basic emerging technologies such as Wi-Fi, electronic resources; video conferencing, maker space and virtual reality facilities Amrohi, Garg & Chauhan (2015) have specifically spoken on the Web-Based emerging technologies and their applications in libraries and library services which attract little cost.

Kinds of Emerging Technology in the Library

As this study looks into emerging technologies and library services, as well as their worth in the library setting Funmilayo & Ayo (2020) discussed these technologies as follow:

1. Big Data

The vast effect of Information and Communication Technology (ICT) has resulted in a massive amount of data being generated by ordinary people, researchers, scientists, and other stakeholders all over the world (Karimi, 2014). Information professionals and data managers face significant difficulty in storing, analyzing, retrieving, and disseminating data. Large dataset storage and analysis can be a major benefit for library and information professionals since they have the necessary skills and knowledge to make the most of these vast data sets (Ajie, 2019).

2. Cloud Computing

Cloud computing is a technology that maintains data, software, and applications using the web (Internet) and central remote servers. Cloud computing according to Waljat (2018), allows users to access their personal and official files from any computer with internet access without having to install apps on their local workstation.

3. Internet of Things (IoT)

The current period is one of Information and Communication Technology, in which the internet has had a profound impact on many aspects of human life and activity. The Internet of Things (IoT) is the most cutting-edge developing technology for influencing library users by offering efficient and effective services in a more timely and easy

manner. It allows any natural and man-made objects to speak with one another and transmit data using IP addresses without the need for human intervention (Opoku, 2011).

4. Web 2.0/3.0

According to Rathna & Divyananda (2018), the introduction of the World Wide Web (WWW) and the internet as new media for information storage and distribution has created an unrivaled medium for delivering information at a faster and more cost-effective rate. The internet and web technology have revolutionized the way information is stored, retrieved, communicated, and disseminated in libraries. Library 2.0 is a cutting-edge web application that makes use of interactive, collaborative, and multimedia web-based technologies to offer web-based library services and resources. Web 2.0 is a two-way web technology in which users can read, write, and update any material on the internet. Library 2.0 is a cutting-edge web application that makes use of interactive, collaborative, and multimedia web-based technologies to offer web-based library services and resources. Web 2.0 is a two-way web technology in which users can read, write, and update any material on the internet. Blogs, social tagging, and social networking are just a few examples. Web 3.0, on the other hand, is built on a semantic web, in which information

and data are stored in such a way that computer systems can interpret them. It paves the way for the next generation of AI (Artificial Intelligence).

5. Institutional Repository

An institutional repository is a digital archive or collection of an institution's research and intellectual output (Karimi, 2014). It allows individuals throughout the world to access the institution's high-quality scholarship through the internet. In other words, an IR is a service that a research organization provides to its research and academic community for the management and appropriate dissemination of research output created by community members.

6. RFID Technology

RFID (Radio Frequency Identification Device) is a system that aids in the automatic tracking and identification of objects and is a useful tool for collection management. A transponder, often known as a tag, is a microchip that is attached to an antenna in an RFID system. A user can obtain detailed information or simple data like an identification number (Waljat, 2018).

7. Artificial Intelligence

Artificial Intelligence (AI) is becoming more and more prevalent in everyday life. Artificial Intelligence (AI) is the study of mental capacities using computational models in this age of science and technology.

8. Virtual Reality

A computer-generated simulation of a three-dimensional image or scene that can be interacted with in a supposedly real or physical way by a person wearing appropriate electronic equipment, such as a helmet with a screen inside or gloves with sensors, is known as virtual reality.

9. Augmented Reality

Augmented Reality (AR) is an interactive experience of a real-world environment in which computer-generated perceptual information augments in the items in the real world (Neogi & Partap, 2018).

10. Book Delivery Drone

Drones, according to Mittal (2017), are small flying machines that can be controlled remotely and are now being used in a variety of fields. Drones can be used in libraries to collect data or create content for the library. The drone can be used to distribute library materials to persons who are unable to visit the library, particularly

people with disabilities, older citizens, and those who live far away from the library.

11. Library Tracker

Is a device tool that aids in the automatic tracking and identification of objects and is a useful tool to locate books in the library; user can locate books or information with time and can easily obtain detailed information or simple data like an identification number (Waljat, 2018).

This device helps users to track the location of books on the shelf without wasting users time in the library or in any libraries such book might be shelved.

Impacts of Emerging Technologies for Libraries

The following are some of the advantages of High-End technology for libraries, according to Neogi & Partap (2019);

- It boosted libraries' capability to provide better and faster services.
- Current information is provided at the right time
- It has an impact on librarians' and the library's creativity, problem-solving skills, and self-image.
- Process innovations bring value to existing products and services.

- It strengthened library knowledge and opportunities for the future.
- Quick service is simple to deliver.
- It saves time.

Barriers in the Implementation of Emerging Technologies in Libraries

Despite the numerous benefits that these technologies provide for libraries, some obstacles impede the effective and efficient use of these facilities in Nigerian university libraries, Krubu & Asowaru (2011); Bichi (2021) asserted that inadequate management training and retraining of staff; inadequate funding, epileptic power supply, and a lack of search skills are the major factors militating against the efficient use of technological facilities in Nigerian university libraries. Inadequate finance, capacity building and unpredictable power supply were identified as roadblocks to technology adoption. Lubanga & Mumba (2021) explain the challenges of implementing emerging technologies in libraries, citing lack of established research and innovation centers, unpredictable technological changes in the twenty-first-century landscape, and university cultures that do not support research and innovation as key issues that stymie library R&D, creativity, and innovation.

Inadequate funding a lack of power supply, and poor maintenance, according to Bichi (2021),

are the biggest impediments to new technology adoption. Costs and quality of information are rising. Infrastructure issues, a lack of informatics/learning, and a lack of government help may be attributed to fiscal constraints, inadequate upkeep and culture updating, and a problem with record conversion. Nigeria and other developing countries are grappling with several issues as a result of the present digital revolution (Ajie, 2019).

Concerns around the deployment and utilization of new library practices and developing technologies are discussed by Cervone (2010). Appropriate funding for university libraries, good communication, and the adoption of an exceptional management style are just a few of the strategies for effective library management in the digital age (Bichi, 2018).

The implementation of new technology in libraries has been hampered by shortage of staff, limited finances, a lack of employee training, and institutional constraints (Golz, 2014). The employment of Web 2.0 technology in library services creates several significant challenges, including time consumption and concerns about privacy violations (Hussain & Jan 2018). Poor funding for the library, a lack of skilled library workers or a user education program on developing library technology, and frequent power outages were recognized as the key

barriers to the introduction of the latest technology in academic libraries (Oghenetega et al, 2014).

Hussain & Jan (2016) also mentioned a lack of skills and competence, as well as a lack of knowledge, ICT infrastructure, information resources, social computers, and poor institutional and physical structures, all of which harm the use of digital technology.

Oghenetega, Umeji, & Oboe (2014), have identified the challenges of adopting and using emerging technologies in Nigerian libraries thus:-

- **Funding:** Libraries, particularly academic libraries, continue to be underfunded. This has made it difficult for libraries to fully embrace emerging technologies, as some of these devices are costly to purchase, install, and maintain, denying information consumers of the opportunity afforded by technology.
- **Erratic power supply:** The proper operation of technical facilities is dependent on a consistent power supply. As a result, it is critical that any library that desires to use these technologies establish the necessary provisions for a continuous electric supply.

- **Lack of trained personnel:** There aren't enough trained technologists in libraries. As a result, the information technology service provided by libraries has little or no function.
- **Government policy:** The evolution of communication technology and its application for distant education is dependent on legislators' recognition of its value in supporting a knowledge-based society.

Conclusion

Emerging Technologies has come to stay in libraries as a revolution in information service provision. They are seen as a transformation of libraries from the conventional to computer-generated technologies and information centered. There are quite a number of these technologies that the library could adopt to make their services more effective than earlier. Additionally, Emerging technologies has come with opportunities in libraries can influence on to change the narrative of library service in Nigeria.

Recommendations

This paper therefore recommends that, since funding is the backbone of every development that comes into the library;

- i. The library is expected to work out more and better ways of sustainable funding to the library. This would go a long way to see to the utilization of these emerging technologies. And also funding to library can address other challenges faced in the library.
- ii. Training and retraining are recommended for librarians. Since these technologies are constantly evolving and revolving.
- iii. As libraries thrive on modern technologies, library staff are therefore, saddled with the responsibility of acquiring new skills and knowledge for onward adoption and use of the technologies to enable them provide round the clock library services to their diverse patrons.

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